

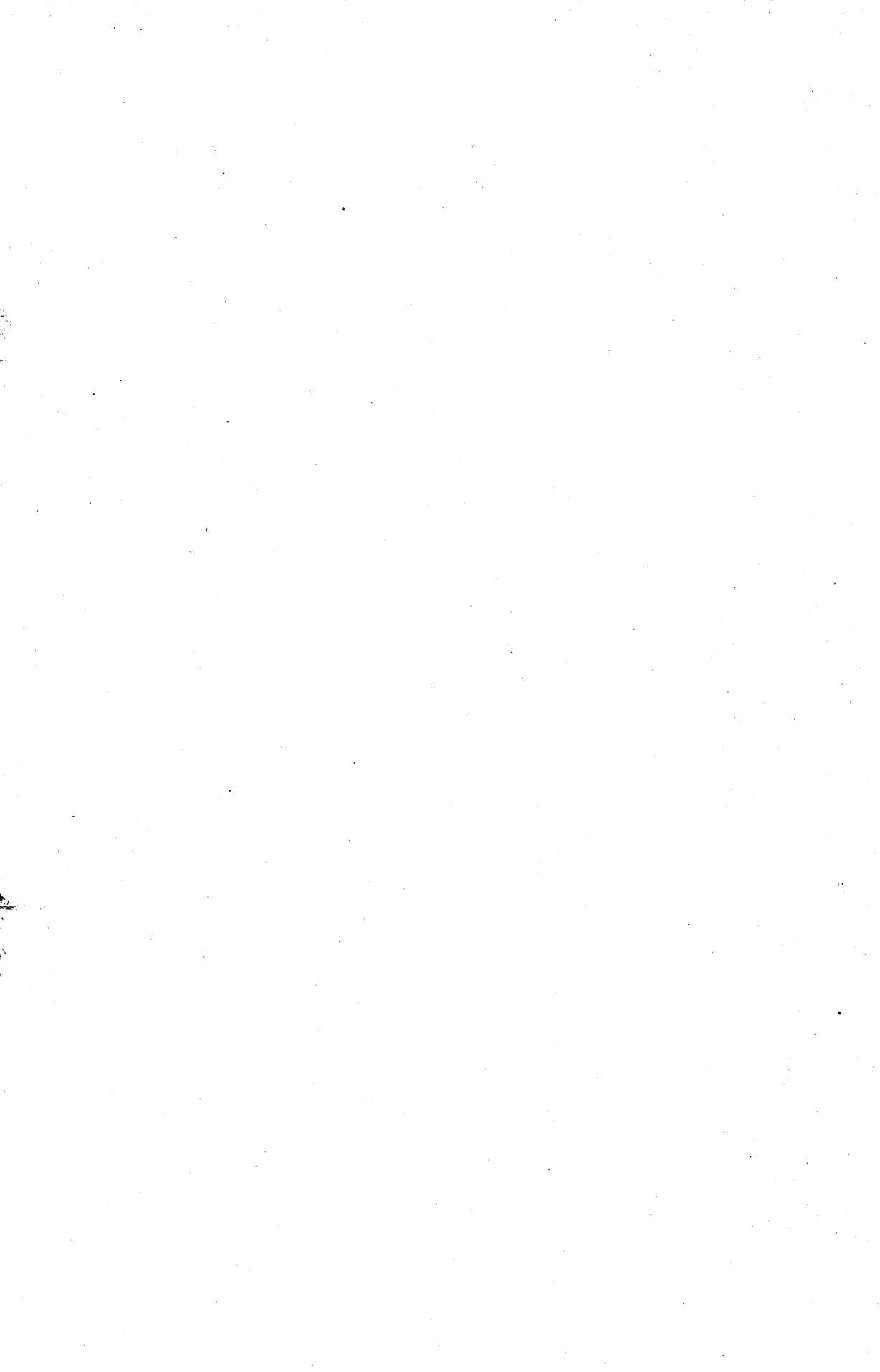
UNIVERSITY OF MICHIGAN  
MUSEUM OF ZOOLOGY  
MISCELLANEOUS PUBLICATIONS NO. 31

*GONIOBASIS* OF THE COOSA  
RIVER, ALABAMA

BY  
CALVIN GOODRICH

ANN ARBOR, MICHIGAN  
UNIVERSITY OF MICHIGAN PRESS  
June 27, 1936





## ADVERTISEMENT

The publications of the Museum of Zoology, University of Michigan, consist of two series—the Occasional Papers and the Miscellaneous Publications. Both series were founded by Dr. Bryant Walker, Mr. Bradshaw H. Swales, and Dr. W. W. Newcomb.

The Occasional Papers, publication of which was begun in 1913, serve as a medium for original studies based principally upon the collections in the Museum. The papers are issued separately to libraries and specialists, and, when a sufficient number of pages have been printed to make a volume, a title-page, table of contents, and index are supplied to libraries and individuals on the mailing list for the entire series.

The Miscellaneous Publications, which include papers on field and museum techniques, monographic studies, and other contributions not within the scope of the Occasional Papers, are published separately, and as it is not intended that they will be grouped into volumes, each number has a title-page, and, when necessary, a table of contents.

FREDERICK M. GAIGE  
Director of the Museum of Zoology

UNIVERSITY OF MICHIGAN  
MUSEUM OF ZOOLOGY  
MISCELLANEOUS PUBLICATIONS NO. 31

*GONIOBASIS* OF THE COOSA  
RIVER, ALABAMA

BY  
CALVIN GOODRICH

ANN ARBOR, MICHIGAN  
UNIVERSITY OF MICHIGAN PRESS  
June 27, 1936

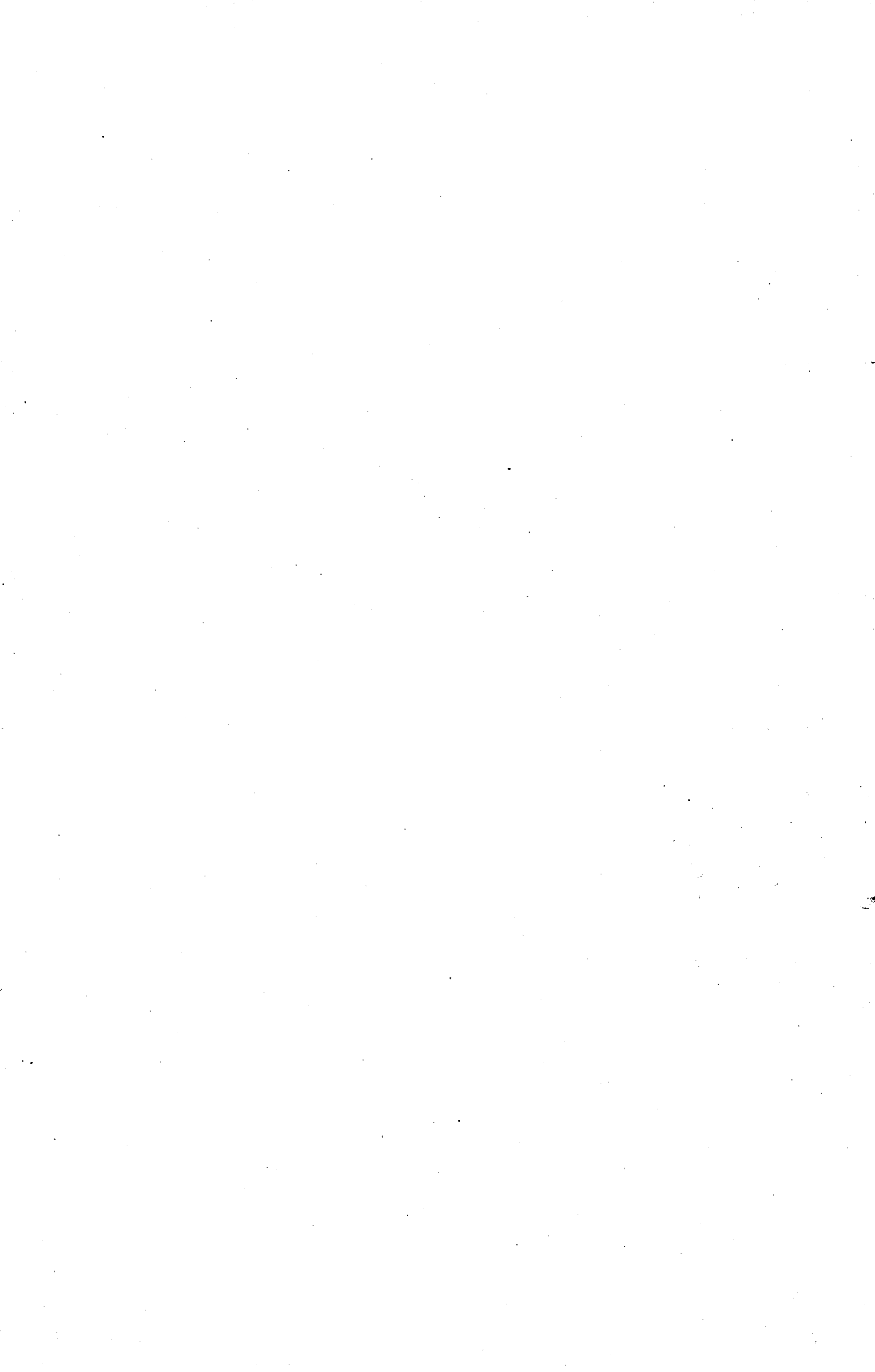


TABLE OF CONTENTS

	PAGE
THE OPERCULUM .....	15
THE RADULA .....	16
GROUP OF <i>GONIOBASIS HAYSIANA</i> (LEA) .....	17
<i>GONIOBASIS HAYSIANA</i> (LEA) .....	18
SYNONYMS OF <i>GONIOBASIS HAYSIANA</i> .....	19
<i>GONIOBASIS PUPOIDEA</i> (ANTHONY) .....	20
SYNONYMS OF <i>GONIOBASIS PUPOIDEA</i> .....	21
<i>GONIOBASIS CLAUSA</i> (LEA) .....	22
<i>GONIOBASIS ALABAMENSIS</i> (LEA) .....	22
SYNONYMS OF <i>GONIOBASIS ALABAMENSIS</i> .....	23
GROUP OF <i>GONIOBASIS VANUXEMIANA</i> (LEA) .....	25
<i>GONIOBASIS VANUXEMIANA</i> (LEA) .....	25
SYNONYMS OF <i>GONIOBASIS VANUXEMIANA</i> .....	27
<i>GONIOBASIS BULLULA</i> (LEA) .....	27
SYNONYMS OF <i>GONIOBASIS BULLULA</i> .....	28
<i>GONIOBASIS CAELATURA</i> (CONRAD) .....	29
SYNONYMS OF <i>GONIOBASIS CAELATURA</i> .....	30
<i>GONIOBASIS JONESI</i> , NEW NAME .....	31
GROUP OF <i>GONIOBASIS OLIVULA</i> (CONRAD) .....	32
<i>GONIOBASIS OLIVULA</i> (CONRAD) .....	33
SYNONYMS OF <i>GONIOBASIS OLIVULA</i> .....	34
<i>GONIOBASIS CYLINDRACEA</i> (CONRAD) .....	35
SYNONYMS OF <i>GONIOBASIS CYLINDRACEA</i> .....	37
<i>GONIOBASIS BELLULA</i> (LEA) .....	37
SYNONYMS OF <i>GONIOBASIS BELLULA</i> .....	38
<i>GONIOBASIS LACHRYMA</i> (ANTHONY, REEVE) .....	39
SYNONYMS OF <i>GONIOBASIS LACHRYMA</i> .....	40
<i>GONIOBASIS GIBBERA</i> H. H. SMITH, NEW SPECIES .....	41
<i>GONIOBASIS LAETA</i> (JAY) .....	42
SYNONYMS OF <i>GONIOBASIS LAETA</i> .....	44
<i>GONIOBASIS PILSBRYI</i> GOODRICH .....	45
GROUP OF <i>GONIOBASIS HARTMANIANA</i> (LEA) .....	46
<i>GONIOBASIS HARTMANIANA</i> (LEA) .....	46
SYNONYMS OF <i>GONIOBASIS HARTMANIANA</i> .....	47
<i>GONIOBASIS MACGLAMERIANA</i> , NEW SPECIES .....	48
<i>GONIOBASIS PYGMAEA</i> H. H. SMITH, NEW SPECIES .....	49
GROUP OF <i>GONIOBASIS CATENARIA</i> (SAY) .....	50
<i>GONIOBASIS CRENATELLA</i> (LEA) .....	50
<i>GONIOBASIS IMPRESSA</i> (LEA) .....	51
SYNONYM OF <i>GONIOBASIS IMPRESSA</i> .....	52
<i>GONIOBASIS CAPILLARIS</i> (LEA) .....	53
<i>GONIOBASIS FUSIFORMIS</i> (LEA) .....	54
<i>GONIOBASIS BREVIS</i> (LEA) .....	55
SYNONYM OF <i>GONIOBASIS BREVIS</i> .....	56
<i>GONIOBASIS PUPAEFORMIS</i> (LEA) .....	56
MISPLACED SPECIES .....	58
ACKNOWLEDGMENTS .....	59
REFERENCES .....	59





## GONIOBASIS OF THE COOSA RIVER, ALABAMA

This is the third paper devoted especially to the Pleuroceridae of the Alabama River system; the first, dealing with *Anculosa*, was issued in 1922, and the second, revising the genus *Gyrotoma*, received publication two years later. As before, the extensive collections of H. H. Smith in the Alabama Museum of Natural History have served as the foundation for the study. Mr. Smith for some time resided at Wetumpka near the mouth of the Coosa River. He later made a trip by small boat from Rome, Georgia, downstream. He wrote letters from localities in counties immediately above Wetumpka, but whether he adventured through the last series of rapids is not made clear from copies of his correspondence that are at hand. A return was made to the middle river rapids during the period that water was impounding behind the new dams, and he tells in that same correspondence of staying at Fort William Shoals until the last day they were available for collecting. It is known that he was on the river at Cedar Bluff, Cherokee County, Alabama, after this, and not long before his death he spent an autumn month with Dr. Bryant Walker on the Georgia head streams. Altogether, he touched the Coosa at more localities than has any other person interested in the Mollusca. He visited virtually all of its tributaries. He made careful notes as to locations and occasionally penned brief habitat observations. If now his notes are inadequate, it is because present day labors of the kind demand more detailed information and not because of lack of conscientiousness in the collector.

Dr. Isaac Lea, who gave names and descriptions to the bulk of Coosa River goniobases, received the largest amount of his material from Dr. E. R. Schowalter<sup>1</sup> who lived at Uniontown in Perry County, Alabama, and, besides collecting in streams nearer his home, visited such parts of the Coosa River as could be reached by railroad. If shells seen from Washington County, Alabama, are of his taking, he also journeyed down the Alabama River. He collected shells in quantity, as is attested by the great numbers of them that are in the Alabama Museum and which, in a degree, represent only salvage of a much larger collection. To judge by specimens of his supplying that are in northern museums, he let them go a little grudgingly. It seems likely that he had in mind to keep the mass of them together for studies of his own. As the war between the states ended his field journeys, so also it broke the thread of his interest in mollusks. Finally, the shells had to be rescued from the under side of a cellarless house, part of them by means of a shovel (Smith, 1909). The weakness of the Schowalter collec-

<sup>1</sup> This name was spelled Showalter in all the early literature on Alabama mollusks. In a note in the *Nautilus*, 27, 1914: 96, H. H. Smith corrects the spelling to Schowalter on information from Dr. Schowalter's son.

tion is that few of the lots are more specifically labelled than "Coosa River," "Cahawba River," or "Marengo County, Alabama."

Truman H. Aldrich was the immediate follower of Schowalter. Some of the Pleuroceridae that he took in the Alabama River at Selma appear now to be locally extinct by reason of field wash and dredging for navigation purposes. A collection that he made in the Coosa River where it borders Chilton County, Alabama, represents the first venture into an area that is still not very easy of access. In the 1880's, Dr. R. E. Call visited the Coosa headwaters and the river at Wetumpka. It is his material that is most extensively distributed in the museums. In value, collections made by H. H. Hinkley in the Coosa in 1903, at Wetumpka and two localities of the middle river, rank next to those of H. H. Smith. In addition to a painstaking habit, Hinkley had a liking for small mollusks, frequently ignored, and he brought to light the hitherto unknown genera *Amphigyra* and *Neoplanorbis*, apparently confined to the Coosa River.

Only the species of *Goniobasis* inhabiting either the Coosa River or the Alabama River are dealt with in this paper, the species restricted to tributary streams are ignored for the present. With one exception, these riverine species have certain gross characters in common. They are thick. In adult life, they have cylindrical phases even if they are not always cylindrical. Apertures are large in proportion to shell size. Plicate sculpture is likely to be vestigial, and striate sculpture, if present, generally takes the form of broad, flattened folds. Superficially, the shells resemble one another so closely that Tryon, who monographed the family, lumped the most of the Coosa and Alabama River goniobases under one sectional heading. In an earlier paper (Goodrich, 1935a), I have shown that *G. caelatura* (Conrad) of the river, a heavy, cylindrical, strongly striate shell, has allied creek forms that are relatively thin, conic, and limited in sculpture. This may be true also of other river species, but it is still to be demonstrated. The impression now is that most of the true riverine species stand apart today, their small-stream ancestral forms persisting as the streams themselves went through their evolution from small to large. In any case the affinities of goniobases of Coosa River aspect are not with species geographically distinct.

Twenty-four species have been recognized. Of these, three are new and two have been supplied with names to take the place of names preoccupied. This leaves a synonymy of seventy-one names—a number so large that explanation is called for if not a measure of fervent defense. At the price of repetition, a certain amount of history must be recited.

Most Pleuroceridae received description from Dr. Isaac Lea, one time president of the Academy of Natural Sciences of Philadelphia and vice-president of the American Philosophical Society. He was a member of

learned associations ranging from the Asiatic Society of Bengal to the Royal Northern Antiquarian Society of Copenhagen. He bore an honorary degree from Harvard University. He was, unquestionably, one of the dominating figures in the science of his time, and it is clear from his biographical account that men of more assured fame than his were proud to pay him respect. On top of this, he enjoyed easy access to publication the while that such a one as Audubon was compelled to solicit subscriptions to his works. It was natural then that geologists, clergymen, gentlemen planters, army officers, and travelers in general should send him, rather than others, the shells they came upon. So from 1827 to 1874, Dr. Lea issued papers on mollusks, some of them formidable in size and expensively illustrated. As a sort of lord of the ascendant, he was truculent in controversy and vigorously stood by the names he devised and the descriptions he put forth. It was, one must remember, a competitive era among naturalists. Now so far as the Pleuroceridae were concerned, the descriptions followed a formula so zealously that many of them are interchangeable—what will fit one species will do as well for others. Names were duplicated. Where an understanding of a species requires long series of specimens, Dr. Lea was frequently content with a single specimen, and that it was broken or malformed did not always serve as a brake on publication. Not once or twice, but several times, the types in the Lea collection of the United States National Museum are mixtures of species. Revision has been partly a task of disentangling and partly a business of reconstruction. Under the circumstances, the synonymy of seventy-one names was inevitable. It may be said to have been forecast by the temperament of an industrious, incautious and, I have no doubt, a likable personality. Of J. G. Anthony, who named some of the Coosa pleurocerids and more of those of the Cahaba River, the truth appears to be that he took Dr. Lea as a pattern and was handicapped by physical disadvantages. G. W. Tryon, Jr., undertook to bring order among the Pleuroceridae, attacking the subject with good will if not with boldness, but the shadow of his fellow-townsmen, Dr. Lea, was at his right hand.

Eighteen of the recognized species fall into five natural groups. Of the groups, three have members that inhabit both the Coosa and the Alabama rivers. One of the other two groups is confined strictly to the Coosa and the second to the Coosa and a few of its small branches. Five species are left standing separately. One of them more nearly approaches the genus *Gyrotoma* than any other species of *Goniobasis*. One has developed a specialized form of operculum that has been seen nowhere else except in *Anculosa*. One is racially in course of obsolescence, betraying in at least two regards the stigmata of decadence. The two other species are somewhat anomalous. They have characters that are more or less common to



most of the riverine goniobases, but neither of them has any particularly outstanding character of its own. They are recognizable as species on the sum of characters, their differentiation from associated species, and the fact that they colonize. Four of the five monophyletic species are restricted sharply to the Coosa River, and one is confined to the Coosa and the lower parts of two or three Coosa tributaries.

The table shows the distribution of the riverine species graphically.

Three faunal zones in the Coosa River and one in the Alabama River may be fairly defined by the occurrence within them of species either at their most flourishing stage in point of numbers or restricted to them. Similar zones occur in the Ohio, Cumberland, Tennessee, and Green of Kentucky rivers, but are there demarked most sharply by changes in genera or changes in the configuration of species rather than by a linear sequence within a single genus.

The first of these zones extends from Rome, Floyd County, Georgia, to the vicinity of Ten Island Shoals, St. Clair County, Alabama. Included are those parts of head streams which contain riverine goniobases. Two species belong here.

*G. caelatura*

*G. macglameriana*

The first of these is associated with creek species in at least the Conasauga River. Before Rome is reached in the Ostanaula and Etowah rivers, creek goniobases have dropped out, leaving *caelatura* alone. This and *macglameriana* are the only species of *Goniobasis* in the Coosa from Rome to the neighborhood of Cedar Bluff, Cherokee County, Alabama.

The second zone takes in the rapids from Ten Island Shoals to a point at or near The Bar, Chilton County, Alabama. It has nine representative species.

*G. alabamensis*

*G. pilsbryi*

*G. clausa*

*G. pygmaea*

*G. jonesi*

*G. impressa*

*G. lachryma*

*G. crenatella*

*G. gibbera*

Only three of these species have the "full run" of the zone. Four are upriver species within the zone; one begins at about the middle of the zone and ends, with four others, at The Bar.

The third zone extends from The Bar to Wetumpka, Elmore County. It has one exclusive species.

*G. haysiana*

A fourth zone may be defined as that part of the Alabama River which extends from a short distance above Selma, Dallas County, to Claiborne,

Monroe County. It is probably extensible at both ends into areas that have not yet been explored. It contains, besides *G. vanuxemiana* which is also in the Coosa River, two species: *G. pupoidea*, *G. olivula*.

Fourteen species are in these four lists. Nine are left which may be considered overlapping species, and a tenth is an inhabitant of the Tombigbee and Black Warrior rivers.

The chief peculiarity of the Coosa River is its prolonged juvenility. Most streams defined as rivers go through the stages of turbulent hurry, smoothly flowing middle life, and, at last, a deep and frequently stagnant period. Ruling out backwaters and a few lake-like expansions, the Coosa is fast flowing throughout virtually the whole of its length. It has the usual head streams rapids. There is a series of rapids midway in its course. On the falls line at Wetumpka, the river is interrupted by a number of bold reefs. Whatever old age the Coosa has is in the few miles between Wetumpka and the junction with the Alabama River. "All conditions, physical, chemical and biological, gradually change with distance along the main channel [of a river] and in a definite direction" (Welch, 1935). In the case of the Coosa River, the very early physical conditions have been very largely retained beyond the common rule. It is conceivable that the chemical conditions, although altered from those of head waters, have not altered so much as in a river of the more usual type. The result is a sort of biological fixity. *Goniobasis*, which is ordinarily a genus of small streams, has persisted far beyond the point where commonly it ceases to be a part of the molluscan fauna. It has gone through adaptations to resist the stronger stream flow, the greater pressures and the more lasting turbidity of flood, the prolongation of deep submergence. The Alabama River is a more quiescent stream than the Coosa, but not so much so as the lower Tennessee and Cumberland rivers that are untenable for *Goniobasis*.

Unpublished chemical data on the Cahaba River show that the pH of that stream increases slightly in a downstream direction and that the carbonate content remains nearly uniform from upstream to downstream. Both were found to be higher in the Jefferson County, Alabama, creeks than in the main Cahaba. As the Cahaba closely repeats the physical conditions of the Coosa, it seems highly likely that the chemical conditions of the latter river are much like those prevailing in the smaller river. There are slight differences in temperature with depth in a swiftly flowing river, and there can be small temperature differences as between the upper Coosa and the stream at Wetumpka. As a factor in the differentiation of the species, temperature may in all likelihood be ruled out. It is, indeed, not certain whether high temperature, a response to excessive light, or a breeding habit is the cause of midsummer migration of pleurocerids to the under sides of stones—a phenomenon observed in widely separated localities. So

far as light is concerned, goniobases of small streams have been seen both where there is a maximum of sunlight and where strong light could scarcely penetrate through bordering vegetation.

Pilsbry and Bequeart (1927) state that "the mechanical action of the current not only regulates the several species that inhabit a river system, but in some cases it may modify the morphological features of the shell." There is ground for believing that this mechanical action governs the distribution of such genera of the Coosa River as *Anculosa* and *Gyrotoma*, occupants of heavy current, but that it does so among the species of *Goniobasis* is not so clear. I am inclined to believe that it is the principal factor in modifying the proportions of pleurocerids in different parts of streams (see Goodrich, 1934), and this is implied in the observations on *Goniobasis livescens* of Lake Erie by Wiebe (1926)). Baily, Pearl, and Winsor (1933) remarked that erosion in pleurocerids of Gunpowder River of eastern Maryland "is chiefly accomplished by the action of silt carried along by the current, and that this action is somewhat retarded by the presence of sulphates in the water."

It appears probable that the cause of the nearly universal apical erosion among melanians is a combination of mechanical wear, chemical action, and attack by confervaceous algae. Such erosion varies irregularly in the Coosa-Alabama area. It is more conspicuous just within the mouth of Yellowleaf Creek, Shelby County, than in the adjacent Fort William Shoals of the Coosa River, more so in the Alabama River near Camden, Wilcox County, than at Selma above and Claiborne below this station. The mechanical action of the current, by shifting gravel and sand, is responsible for a great deal of destruction among the Pleuroceridae. Floods should be included under this head. In a letter, H. H. Smith spoke of revisiting Buck Creek at Helena, Shelby County, the summer after a freshet and finding the stream nearly barren of mollusks whereas, a year or two before, they had been abundant there. The same place in 1935, when Dr. Henry van der Schalie and I stopped there, had an enormous population of snails. Probably such instances of depopulization and repopulization have occurred repeatedly among rapids communities, and that they have played an important part in the dispersal of species, increasing one and altogether destroying another, may be drawn from such facts.

To a large extent, the goniobasic fauna of the Coosa River must be spoken of in the past tense. The habitat has been altered by dredgings for the improvement of navigation. The middle river rapids have been covered by impounded waters of the dams of the hydroelectrical companies. In addition, there has been a great increase in turbidity and silt accumulation by reason of the field wash. It is probable that the temporary turbidity of flood seasons has changed to permanent or nearly permanent turbidity.

Ellis (1931) describes the smothering effect of silt upon Unionidae of the upper Mississippi River. In the case of the Pleuroceridae of the Coosa River, this might not, it seems likely, be directly destructive since all except a comparatively few individuals live close to the surface and so long as their gills remain moist can exist where there is a mere film of water. Yet turbidity limits the plant growth which is dependent on considerable illumination, and silt tends to choke the deeper vegetation—and plant growth serves the goniobases not simply as food, but also often as anchorage. The economic aspect of the situation is that the Pleuroceridae have their place in that biota which maintains fish life.

Aside from the taxonomic revisions, the main purpose of this study, a few general conclusions are warranted, namely:

The colonies in which the least shell variation is shown are those at the very head of the Alabama River system and those at the end of the range of Pleuroceridae in the system. This is in keeping with findings in other drainage basins.

The alteration from a conic shape to a cylindrical shape occurs at an earlier stage in riverine species than where these species invade tributary streams. In other words, this kind of acceleration is at a faster rate in the river than in the creeks.

Plicate sculpture is more marked in creek forms than in river forms, persisting also for a greater number of whorls. A tendency is observable of a reduction or loss of striate sculpture in striate species than enter the creeks from the river.

Elliptical or elongate-ovate apertures are the mark of riverine forms rather than of creek forms, among which ovate apertures are the rule.

The penetration of riverine pleurocerids into the creeks is farthest in those small streams which have most nearly worn down to grade, such creeks in their lower parts approaching the stage of river estuaries.

No definite rule as to the occurrence of color bands in reference to position in stream could be noted among the goniobases of the Coosa and Alabama rivers. There does appear to be such a rule among shells of small tributaries, color banding increases in a downstream direction.

Hard and fast distinctions as between some of the species is impossible. There is, for example, an overlapping of *G. caelatura* and *vanuxemiana* in the upper river, vague differentiations occur between *G. clausa* and *alabamensis* at localities both above and below Ten Island Shoals, and there is a transition of *G. alabamensis* to *haysiana* in the Coosa River opposite Chilton County. Compared with the sharp specific differentiations that are obvious in certain families of Mollusca, several of these Pleuroceridae can only be called ecological races. They are "good" species to the degree that relatively constant lines can be drawn, and no more.



## THE OPERCULUM

Opercula of Coosa and Alabama rivers goniobases have (a) remained stable, (b) gone through modifications without apparent loss of function, (c) experienced modification with apparent deterioration of function. It will be convenient to discuss them by this grouping.

The single representative of the stable or unaltered type of operculum is that of *G. crenatella*. The species belongs to the most widely spread group of the genus. In all members of the group, the operculum is broadly ovate to broadly elliptical. The nucleus is set off from the margins, and the well-defined spiral lines are very loosely coiled, sometimes occupying an area fully half the whole diameter of the organ. There is firm ground for considering this the most primitive type of operculum occurring among recent melanians. In the text of this paper, I have followed Pilsbry and Bequeart (1927) in using the term paleomelanian as descriptive of the *crenatella* form of operculum. Still primitive and yet not so much so as to be called paleomelanian in a strict sense are opercula of *G. capillaris*, *pupaeformis*, and members of the *vanuxemiana* group. Here the organ has become more narrowly ovate, the nucleus is relatively nearer the left margin, and the spiral lines are less loosely coiled. There are some slight differences in shape among the species and rather more marked differences in size. In one instance, the latter appears to have an environmental bearing. These opercula may be accepted as steps toward the neomelanian type.

The operculum in the group of *G. olivula* is clavate, the greater diameter being as a rule below the center. The nucleus and the spiral lines are more or less sharply defined, and they are pushed toward the left or, in individual cases, upon the basal margin. Variation in size is correlated with size and age of the shells. Opercula of the group of *G. hartmaniana* have undergone a similar tightening of the volutions, but in shape the opercula are broadly ovate. In no instance was an operculum found to have the acute apex which is frequent in the *olivula* group. Size conforms to the large apertures. The operculum of *impressa* is large, broad, ovate to nearly rectangular—in old specimens almost shapeless. The spiral lines have become so tightly coiled as to be difficult to make out except in the young. Through wearing, the early nucleus and whorling may be lost. Such an operculum is typical in the genus *Gyrotoma* to which *impressa* is allied in certain characters of shell and radula. In *fusiformis*, the rib-like growth lines, representing early margins, have thickened and extended. They give the basal and the right margins a serrate appearance. The phenomenon begins early in the life of the snail, as can be seen in the spiral lines. The operculum of *G. pilsbryi* stands alone in *Gonobasis* although occurring in *Anculosa* and *Nitocris*. The nucleus has disappeared. There is no coiling. New growth is by extension of the left margin, equally at top and

base. The appearance of an operculum in a mature specimen of *pilsbryi* is that of a very small wood shaving. In all these, from *olivula* to *pilsbryi*, the operculum has retained its door-like protective function. It is neomelanian in the sense the term is employed by Pilsbry and Bequeart. Through acceleration, whorling has been completed at an early stage in the life history of the animals and, in *pilsbryi*, carried so far as to be eliminated.

The operculum in the group *G. haysiana* is uniformly small and ovate. The area of the spiral lines is usually indented. In *G. brevis*, the operculum is thin, elongate. The whorling has been crowded toward the left, often appearing as a vestigial feature on the basal margin. In both these instances, it would seem as if the operculum scarcely serves anything except a meager protective purpose. The species are progressing toward a non-operculate stage.

It should be explained that there is a good deal of individual variation in the opercula of the pleurocerids. Certain colonies, probably by reason of their position on rocks in heavy current, have eroded opercula, the wearing usually involving the lower part of the left margin. With age the operculum is often thickened, darkened, and misshapen. Instances have been seen of a sort of twinning, the operculum having two apices. In a letter, H. H. Smith reports finding instances in which the opercula had been lost and partially renewed. I have come upon no such example among Coosa River pleurocerids but believe that I have seen it in species of a tributary of the Tennessee River.

The operculum, as a whole, furnishes a simple historical record. Glimpses are supplied of evolutionary tendencies, unquestionably of local differences in animal behavior, and possibly of specialization as in *G. fusiformis* and *pilsbryi*.

#### THE RADULA

A. H. Cooke wrote in 1895 that "the radula . . . serves as a test for the distinction of genera and species." The test has lost its infallibility during the passing of forty years, for the radula, it has been learned, is not a constant. It is subject to change the same as the exo-skeleton of the gastropod, and the change may involve the individual mollusk, the colony to which it belongs, or all its race. On the strength of its operculum and sculptural equilibrium, *G. crenatella* may be accepted as the most primitive of any goniobases of the Coosa and Alabama rivers; nevertheless, its radula has nothing that distinguishes it sharply or even a little less than sharply from species of the river system that obviously have undergone comparatively recent evolution.

I have examined about seven hundred radulae of the Pleuroceridae. Cleanly cut characters have been found in *Anculosa* and *Eurycaelon* that distinguish these from other genera. *Pleurocera* and *Nitocris* have small, possibly degenerate, radulae, but so also have the members of the group

of *Goniobasis haysiana*. One may tell the radulae of *Io* by their large size. Yet otherwise, they are like the radulae of *Goniobasis* and *Lithasia*. About twenty radulae of *G. caelatura* from seven different localities show five different counts of denticles of the outer marginals. The same count in *G. pilsbryi* exceeds any in *caelatura*, but only one radula of *pilsbryi* has been seen. It may well be, going upon the experience with *caelatura*, that another specimen of *pilsbryi* from another locality would prove to have a different radula count.

After a study of all available radulae of Coosa and Alabama River goniobases, these bits of information may be put down for what they are worth. The formula of the median tooth is usually 3-1-3. It may be 4-1-4 or 5-1-5, and is sometimes asymmetrical in the same ribbon. The same colonies have the same medians as a rule. Laterals are the most fixed of all the teeth although they show different folds or cusps according to the different planes at which they are observed and whether they are in place or torn from the ribbon. The inner marginals have fewer denticles than the outer marginals, and are larger. In *G. impressa* and *laeta*, these marginals have a fist-like aspect. This is true of these teeth in species of *Gyrotoma*. In shell characters the two species of *Goniobasis* appear to have an ancestral relationship with *Gyrotoma*.

Where denticles of the outer marginals are large, they are few in number; where they are very small, they are numerous. *G. hartmaniana*, *impressa*, and *laeta*, large shells, have few denticles on the outer marginals, but *jonesi*, also a large shell, has relatively many, *olivula*, of smaller shell size, has the fewest denticles observed. Howe (1930) noted that the count of cusps in the radulae of *G. livescens* (Menke) of rivers of Wisconsin differed from the count in the same species taken in a small stream in Illinois; the differences, by his figures, showed mostly in the marginals. He ventured the hypothesis that such differences "may serve as a basis for distinguishing ecologically distinct variations of *Goniobasis livescens*." There is some faint promise that this may prove to be sound. Much very careful field observation would, of course, be required in order to establish it.

The radulae of carnivorous mollusks, such as the Oleacinidae, have become adapted or specialized to conform to particular feeding habits. Hinkley (1904) discovered *G. hartmaniana* to be rapacious, and this was verified by Smith; but as no special modification has been seen in the lingual ribbon of the species, it is possible that *hartmaniana* is carnivorous in the way that the Lymnaeidae are, not as an established habit, but only as opportunity offers.

#### GROUP OF *GONIOBASIS HAYSIANA* (LEA)

The four members of this group are alike in that they have the same epidermal texture, a slightly incurved outer lip, and a tendency to vary the shape of the aperture from elliptical to ovate. All are subplicate on

the neanic whorls, the plication beginning and ending at virtually the same points. They have, besides, the small Pleurocera-like operculum that, if not degenerate, seems to be in course of obsolescence. In spite of these close resemblances, there are differences among the mollusks that warrant the retention of four specific names.

The first species of the group appearing in the Coosa River is *G. clausa* (Lea). It is found in the section of the stream that borders Etowah, Calhoun, St. Clair, and Talladega counties, Alabama. Striate shells in this section greatly outnumber the smooth shells. As smooth shells become dominant, *clausa* disappears. A second species, *G. alabamensis* (Lea), inhabits shoals of Talladega and Shelby counties, and in lessening numbers goes down to Chilton County. Striation in *alabamensis* nowhere affects more than about thirty-five per cent of a representative collection. In most instances this sculpture is microscopic. An overlapping of *alabamensis* and *haysiana* (Lea), the third species, occurs in Chilton County. The prevailing sculpture of *haysiana* is of revolving striae. Smooth specimens are comparatively rare. A fourth species, *G. pupoidea* (Anthony), lives in the Alabama River. This shell, like *alabamensis*, is usually smooth on the mature whorls. Beginning with *clausa* above the middle river, we have a gradient of striate pleurocerids, smooth shells, striate shells, and then smooth shells again.

The operculum of the group reaches the greater part of its growth in quite young individuals. After that, accretions are small although proportionate to age. The spiral lines are well-defined, and confined to the lower third of the operculum. Commonly, the area of spiral lines is indented. The only radula of any of the four species that I have been enabled to examine is like that of *Pleurocera* in point of smallness. Otherwise, it differs from most radulae of *Gonobasis* only in the denticle count of the marginal teeth. The inner marginals have nine to ten cusps, the outer as many as eighteen. Except in *G. carinifera* whose outer marginals run to eighteen or twenty cusps, and *G. pilsbryi* with a count of twenty, no pleurocerid radula known to me is so multidentate.

*GONIOBASIS HAYSIANA* (LEA)

(Pl. I, Fig. 19)

*Melania haysiana* Lea. Proc. Amer. Phil. Soc., 2, 1842: 242.

To judge by several collections, this is the commonest pleurocerid on the Wetumpka shoals. The young shell is conic, subplicate, frequently bluntly angled at the periphery. With new growth, the shell becomes cylindrical, the plicae are subdued or obsolete, and the conspicuous ornamentation consists of revolving striae. Of three hundred and seventy-five Wetumpka specimens, 8.2 per cent lacked this sculpture. Color bands

occurred in 38.3 per cent. Usually, they were four in number. The extreme difference in diameter of fifteen shells that were measured was only two millimeters. Yet to the eye, the difference seems so great that the inclination is to consider the two forms to be specifically distinct. The average measurement of the fifteen specimens was 24.16 mm. altitude by 11.46 mm. diameter. Erosion has reduced these shells to three or four whorls. By matching them with younger individuals, it would appear that *haysiana* develops ten or eleven whorls in all. H. H. Smith took the species as far upstream as The Bar, Chilton County. There is here an apparent mixture of *haysiana* and *alabamensis*. A lot that in texture and general appearance is referable to *haysiana* comes from the Coosa River near the mouth of Yellowleaf Creek, Shelby County. These were probably selected by the collector from among the dominant *alabamensis* of the area. A habitat note made by H. H. Smith reads: "In moderately swift water, in shallows."

#### SYNONYMS OF *GONIOBASIS HAYSIANA*

*Melania oliva* Lea. Proc. Amer. Phil. Soc., 2, 1843: 242. A very nearly smooth form of *haysiana*.

*Melania ovalis* Lea (in part). Proc. Amer. Phil. Soc., 2, 1843: 242. The different lots of *ovalis* in the Lea collection of the United States National Museum are made up of *G. haysiana* and *G. laeta* Jay, 1839. The shell illustrated by Tryon appears to be an adolescent specimen of *laeta*.

*Melania arctata* Lea. Proc. Amer. Phil. Soc., 4, 1845: 166. Described as from Tuscaloosa, Alabama. It was, however, probably taken in the Coosa River at Wetumpka. The type lot consists of seven shells. The specimen selected by Lea for figuring is a narrow, distorted individual. Such shells were found among normal mollusks at Wetumpka by Schowalter, Call, and Smith, and can scarcely be considered as very rare.

*Melania harpa* Lea (in part). Proc. Amer. Phil. Soc., 4, 1845: 166. This has been a difficult mollusk to trace. All lots in the United States National Museum under this name were examined on two occasions without finding any that could be set down as types. The original specimens were from Dr. Budd, and the type locality was given as Tuscaloosa which was, it would seem, merely the place from which the shells were sent to Lea. One lot of the Smithsonian collection named *harpa* and labelled "ex auct., Tuscaloosa," consists of three shells of three species, *vanuxemiana*, *laeta*, and *haysiana*. A single shell from Schowalter, identified by Lea as *harpa*, is *vanuxemiana*. Some of Major Downie's takings in the Conasauga River were also determined as *harpa* by Lea. They are of *caelatura* Conrad. Lea speaks of the species as resembling *haysiana*, and this I would take his illustration to be although it has an appearance which partly grown *laeta* sometimes assumes.

*Melania coosaensis* Lea. Proc. Acad. Nat. Sci. Phila., 13, 1861: 118. A robust form of *haysiana* in which the aperture is more contracted than commonly. "Apparently confined to the shoals at Wetumpka and for 20 miles above"—(H. H. Smith).

*Melania lewisii* Lea. Proc. Acad. Nat. Sci. Phila., 13, 1861: 118. The description would serve for *laeta*, but the types, I feel certain are of *haysiana*. They are old, heavy, and much worn.

? *Melania gracilior* Lea. Proc. Acad. Nat. Sci. Phila., 13, 1861: 118. The name was preoccupied. *Ellipsoides* was substituted for it in Journ. Acad. Nat. Sci. Phila., 1862: 234. Types were not seen. The description fits *haysiana*. Lea distinguishes the shell from his *coosaensis* "in being without bands except obscure ones on the upper whorls, and in having but few raised striae." Tryon's figure is of a specimen having four well-marked color bands. Seven shells that were identified as *ellipsoides* by Lea are mixed *alabamensis*, *bullula*, and *bellula*.

? *Melania orbicula* Lea. Proc. Acad. Nat. Sci. Phila., 13, 1861: 118. Named from one juvenile specimen. It escaped observation when the examinations of types were made. The illustration and the description of shell and operculum fit *haysiana* more than any other species.

? *Melania nubila* Lea. Proc. Acad. Nat. Sci. Phila., 13, 1861: 118. The chief distinction credited to this shell is its "dark, nebulous character." The types were not seen. The specimen figured is an old, possibly gerontic individual. It came from the Coosa River at Wetumpka where *haysiana* is particularly abundant. I am inclined to think it is this species although the description would do for *laeta* almost equally as well.

*Melania glandaria* Lea. Proc. Acad. Nat. Sci. Phila., 13, 1861: 120. Five specimens in the type lot are all of *haysiana*.

*Lithasia cylindrica* Lea (in part). Proc. Acad. Nat. Sci. Phila., 18, 1866: 133. The description gives Schowalter as the collector, but the label for the types puts down Wheatley as the source of the specimens. One of the four types, the individual figured, has a basal sinus, undoubtedly pathological. The type lot is made up of *haysiana*, one specimen; *bellula*, one specimen; *brevis*, two specimens.

#### GONIOBASIS PUPOIDEA (ANTHONY)

(Pl. I, Fig. 15)

*Melania pupoidea* Anthony. Ann. Lyc. Nat. Hist. N. Y., 6, 1854: 104, Pl. 3, Fig. 3.

The shells that Anthony described came from the Cahaba River. The collector was Dr. Schowalter. Part of the material from which Schowalter made his selections for Anthony is in the Alabama Museum of Natural History. These specimens are pupaeform, high-spired, yellow-brown to rufous-

brown in color. The whorls are convex, a little shouldered, and the last whorl is somewhat flattened. The aperture is rather more ovate than that of *alabamensis* and yet may be called elliptical. About half the shells seen are microscopically striate, most of these revolving lines being on the bases.

Measurements in mm.	
Altitude	Diameter
23.25	9.75
21.25	9.50
16.75	10.00

Numbers of the species were taken by Clench and Van der Schalie in the Alabama River, six miles north of Tyler, Dallas County, Alabama. The young are pyramidal, angled, or carinate at the periphery, strongly plicate on the neanic whorls, striate on the base. Of ninety-nine that were examined, 34.3 per cent were striate, mostly microscopically. As a rule, this ornamentation was confined to the base. The percentage of banded shells was 65.6 per cent of the whole number. The spires of the Alabama River shells are shorter than the spires of the *pupoidea* taken by Schowalter in the Cahaba River. Mollusks of this location have experienced more than the usual amount of erosion, contrasting in this regard with specimens taken at Selma in the same county. So far as known, the lowermost occurrence of this species is at Selma. It does not appear in large collections from the Alabama River, Wilcox County, and Claiborne, Monroe County. The species has been taken in the Black Warrior River.

#### SYNONYMS OF *GONIOBASIS PUPOIDEA*

*Melania propinqua* Lea (in part). Proc. Acad. Nat. Sci. Phila., 13, 1861: 119. Types of this species came from the Coosa and Cahaba rivers. Those from the Cahaba are this species.

*Melania lita* Lea. Proc. Acad. Nat. Sci. Phila., 13, 1861: 121. Named from a single specimen. It is striate as are many individuals living in the same colonies with non-striate mollusks.

*Melania luteola* Lea. Proc. Acad. Nat. Sci. Phila., 13, 1861: 119. This form differs from the typical *pupoidea* only in being of larger size, having a wider aperture and a brighter yellowish brown color. The young do not develop plicae until the fourth or fifth whorl. This sculpture is seldom strong. The operculum is the same as that of the rest of the group.

*Melania corneola* Anthony. Proc. Acad. Nat. Sci. Phila., 12, 1860: 61. Three shells of the Schowalter collection in the Alabama Museum of Natural History appear to be of the lot from which shells were sent to Anthony.

The striae are low, nearly microscopic, covering the surface of only two of the specimens. This is the character which Anthony accented. The shells resemble young *lithasiae*, but probably belong to *pupoidea*.

*GONIOBASIS CLAUSA* (LEA)

(Pl. I, Figs. 21, 22)

*Melania clausa* Lea. Proc. Acad. Nat. Sci. Phila., 13, 1861: 120.

The ratio of smooth to striate specimens of this species occurring at Fort William Shoals is about two to one. It is virtually one to five among specimens taken farther upriver at Ten Island Shoals, Fomby Shoals, Leoto Shoals, and near Gilbert's Ferry, all in St. Clair County. The upstream shells are irregularly nodose, some being so nodulous as to be mistaken for *G. lachryma* (Anthony). Save in the matter of nodes, the resemblance of the shells of St. Clair County is with *haysiana*. The specimens from Fort William resemble *alabamensis*.

It may be that *clausa* is merely a large form of *alabamensis*, but the two are not together in the lots collected by Schowalter and Smith. This would appear to indicate that they were taken at different positions on the shoals, and there is evidence that different reefs of the same shoals in the Coosa River are sometimes occupied by different species. There are ten specimens in the Lea collection at the United States National Museum that were collected by Schowalter. One is a freakish, bullet-like individual. It was selected for illustration.

Measurements in mm.

Altitude	Diameter
27.25	13.00 Ft. William Shoals
27.00	12.00
26.50	12.75
23.50	12.00
24.00	12.25 Ten Island Shoals
23.50	12.75
23.00	12.75
22.50	12.50

*GONIOBASIS ALABAMENSIS* (LEA)

(Pl. I, Fig. 8)

This is the middle river member of the *G. haysiana* complex. It occurs in great numbers particularly on Fort William and Weduska shoals. Transitional individuals have been taken near the mouth of the Yellowleaf Creek of Chilton County. The shell is distinguished from *haysiana* by its uniformly smoother surface and its greater compactness. Nuclear whorls are



smooth. They are followed by small, strongly plicated, and carinated whorls. As the conic shape of the shell alters into cylindrical, the whorls are more tightly coiled, reaching their greatest diameter as a rule above the periphery of the body whorl. A fully grown mollusk attains about ten whorls. While many shells are striate, this ornamentation is usually much less conspicuous than in *haysiana* and is frequently merely microscopic. The ground color is yellow to dark brown. Occasionally a purple-black shell is seen that is seemingly the result of hyper-secretion of the mantle glands which control the deposit of color bands. These are commonly four in number. A single shell has been observed in which the bands are numerous capillary lines as in the case of *G. capillaris* (Lea). The aperture is usually elliptical, but a few of the river shells and most of the creek specimens have ovate apertures. The ovate shape of aperture is correlated with a bluntly rounded base. The columella is white, narrow, and seldom developed above the center. The outer lip is incurved from suture to below the periphery.

The average of twenty-one shells from Weduska Shoals, which may be taken as representative, is, altitude 20.97 mm., diameter 9.93 mm.

The proportion of striate to unstriate shells is:

	Number	Striate in %	Non-striate in %
Ft. William Shoals, Talladega Co. . .	120	33.6	63.3
Weduska Shoals, Shelby Co. . . . .	139	22.3	77.7
Mouth of Yellowleaf Cr., Chilton Co. . .	26	30.8	69.2
Yellowleaf Cr., Shelby Co. . . . .	204	25.0	75.0

One lot of 2173 Weduska Shoals shells in the collection of the Alabama Museum of Natural History was made up of 53.8 per cent unbanded specimens and 46.2 per cent banded. Of 120 shells from Ft. William Shoals, 90.8 per cent were banded. Of these, 81.6 per cent had the formula of four bands.

Schowalter sent *alabamensis* to Lea from Yellowleaf Creek, Shelby County. The locality was near the mouth of the stream. The shells are small, very plain, the characters rather poorly defined. In all seen by me, the apertures are ovate. H. H. Smith also took the species in Choccolocco and Cahatchee creeks, Talladega County.

#### SYNONYMS OF *GONIOBASIS ALABAMENSIS*

*Melania quadrivittata* Lea. Proc. Acad. Nat. Sci. Phila., 13, 1861: 119. Although described as smooth, the four types show a striate sculpture. The specimens are immature.

*Melania propinqua* Lea (in part). Proc. Acad. Nat. Sci. Phila., 13, 1861: 119. Types were from both the Coosa and the Cahaba rivers. The Coosa specimens are *alabamensis*.

*Melania fallax* Lea. Proc. Acad. Nat. Sci. Phila., 13, 1861: 120. The inflected columella of this form, to which Lea called attention, occurs occasionally in all lots of *alabamensis* collected by Schowalter and Smith. It appears to be only a slight individual variation. The types differ from typical shells also in being darker and a little more cylindrical. The differences cannot be considered of importance.

*Melania pudica* Lea. Proc. Acad. Nat. Sci. Phila., 13, 1861: 120. No types of this shell were found in the Lea collection although they were twice sought. The description is not very helpful. Lea says his species is related to *aequa*, which is *alabamensis*. The bulk of Schowalter's collections in Yellowleaf Creek, whence *pudica* comes, is in the Alabama Museum of Natural History. Among them are many specimens corresponding to the figure of *pudica*. I feel certain that the shell is only a smooth, reddish brown form of *alabamensis*, a little thinner than shells of the near-by Coosa River, more rarely banded, and otherwise indistinct of characters.

*Melania rara* Lea. Proc. Acad. Nat. Sci. Phila., 13, 1861: 121. The one specimen from which this mollusk was described is a freakish form of *alabamensis*.

*Melania shelbyensis* Lea (in part). Proc. Acad. Nat. Sci. Phila., 13, 1861: 121. The types are two in number. One is *alabamensis*.

*Melania solidula* Lea (in part). Proc. Acad. Nat. Sci. Phila., 13, 1861: 121. Another of the Yellowleaf Creek species. Lea says his types were two, and that the shells were from Schowalter. There are thirteen specimens in the Schowalter lot of the Lea collection. Four belong to *bellula* and nine to *alabamensis*. The shell figured for *solidula* is *alabamensis*.

*Melania aequa* Lea. Proc. Acad. Nat. Sci. Phila., 13, 1861: 122. Also a Yellowleaf Creek shell. The two types of *alabamensis*, one of them somewhat more striate than the other. Tryon places *aequa* near *fumea*.

*Melania fumea* Lea (in part). Proc. Acad. Nat. Sci. Phila., 13, 1861: 123. Again from Yellowleaf Creek. Of twelve specimens in the type lot, five belong to *alabamensis*.

*Melania crepera* Lea (in part). Proc. Acad. Nat. Sci. Phila., 13, 1861: 123. Seven of the eight specimens of the type lot are *alabamensis*.

*Goniobasis osculata* Lea. Proc. Acad. Nat. Sci. Phila., 14, 1862: 263. The first reason that Lea gave for separating this form from *alabamensis* was its smaller size. By Lea's own measurements, the difference amounts to three-fourths of a millimeter in altitude and one-fourth in diameter. Tryon considered *osculata* nearer to *fallax* than to *alabamensis*.

GROUP OF *GONIOBASIS VANUXEMIANA* (LEA)

The species of this group have the longest range of any of the goniobases of the Alabama system. They extend from head streams of the Coosa River in Georgia to the Alabama River at Claiborne, Monroe County, Alabama. Three of the river species are strongly striate, one is smooth. The shape of the adults is usually cylindrical. In some tributary streams there are allied species, subspecies, or formae (whatever their true position) wherein the juvenile conic shape is retained into maturity. There is a corresponding reduction of sculpture. These shells have been dealt with in an earlier paper (Goodrich, 1935a), and it may be remarked here only that in a general way the changes show a relationship with position in stream and stream size.

There are variations in the shape of the apertures of the river species which, so far as can be learned, are not correlated with variations in shell shape. Upstream and tributary forms of species that occur in the main river tend to reduce the strength of revolving sculpture and emphasize the more primitive axial sculpture. Studies of the color banding failed to show a variation among the four river species as regards locality in stream. Instances of reduction of the spines and marked enlargement of the body whorls, a phenomenon remarked in *Lithasia* elsewhere, were sporadic in the Coosa River colonies of *G. vanuxemiana* and common to those of the Alabama River. A possible instance of acceleration of sculpture was observed in *G. caelatura*, but not in the other three river species.

The operculum is virtually the same in all members of the group, being of moderate size, usually triangular in shape, and having well-marked spiral lines. Radulae show little variation except in the numbers of cusps of the marginal teeth. From what has been seen of these radulae, it would appear that the individuals of any given colony have about the same number of marginal denticles.

*GONIOBASIS VANUXEMIANA* (LEA)

(Pl. I, Figs. 10, 13)

*Melania vanuxemiana* Lea. Proc. Amer. Phil. Soc., 2, 1842: 242.

This species overlaps a small part of the range of *G. caelatura*, appearing in feeble colonies in the Coosa River bordering Etowah and St. Clair counties. It is conspicuous first at Fort William Shoals, Talladega County, is particularly common at Wetumpka, and inhabits the Alabama River as far downstream as Claiborne. A few creeks of the Coosa River are entered, but for only a short distance above the mouths.

The shell is large, thick, yellow to dark brown, banded or without bands. The apex is smooth to about the beginning of the fifth whorl, subplicate (but not always) on the fifth and sixth whorls. Striae begin after the plicae and continue as low, more or less crowded folds to the base of the body

whorl. The shape is first pyramidal, becoming cylindrical. The last whorl is flattened as a rule. The aperture of upstream shells is elliptical or elongate-ovate. At Wetumpka it is more distinctly ovate. The columella of a typical shell is narrow, white at the center and base, bluish at the top. It is well developed only in the old. The outer lip is usually straight in the young, incurved in adults, sometimes sinuous. The whole number of whorls appears to be eight. Bands may be four or five, rarely capillary. In the largest lot examined, 102 shells from Wetumpka, 52.9 per cent were of four bands; 1.9 per cent of five, 2.9 per cent capillary. The rest, or 42.2 per cent, were without bands. In the Alabama River, eighty-four per cent of ninety-four shells had four bands. The pigment of these bands was found to be deposited frequently only in the periostracum. The plicae of the few creek specimens seen were more pronounced than in the river lots.

Habitat notes by H. H. Smith (small stream three miles north of Wetumpka): "Rare in shallows, on stones and logs;" (Wetumpka) "Shallows west side of Coosa River, pools, generally still water or in gentle current, backwaters."

	Measurements in mm.	
	Altitude	Diameter
Ft. William Shoals .....	21.75	11.00
Weduska Shoals .....	22.75	11.50
Duncan's Riffle .....	25.25	13.00
Wetumpka .....	25.75	12.00
Wetumpka .....	24.00	11.00
Wetumpka .....	21.00	11.25
Alabama R.:		
near Tyler, Dallas Co. ....	21.00	11.25
Selma, Dallas Co. ....	19.00	11.00
near Camden, Wilcox Co. ....	20.25	12.50
Claiborne, Monroe Co. ....	19.00	11.00

A form that is commoner at Wetumpka than elsewhere is narrow, elongate, loose-coiled, and sometimes with a retrorse outer lip. Operculum, texture, and sculpture are those of typical *vanuxemiana*. A second form represents a continuation of the early conic shape into maturity. The apex is usually smooth, but strongly subpubescent specimens appear. The striae are usually more uniform than in the more normal shells. The periphery may be distinctly angled or bluntly rounded. This shell proved very puzzling for a long time until specimens were seen that connected it with the commoner form. Specimens have been taken, apparently, only on Weduska Shoals, at Duncan's Riffle, and Wetumpka. Examples appear in parts of the Lea collection of the United States National Museum among pleurocerids labelled *G. harpa*.

	Measurements in mm.	
	Altitude	Diameter
Weduska Shoals .....	23.75	12.00
Duncan's Riffle .....	26.00	12.00
Wetumpka .....	25.00	13.00
Wetumpka .....	24.75	12.00

SYNONYMS OF *GONIOBASIS VANUXEMIANA*

*Melania arctata* Lea (in part). Proc. Amer. Phil. Soc., 4, 1845: 166. Among shells credited to this species in the Lea collection, none of which I could positively identify as types, are examples of the elongate *vanuxemiana* that occurs at Wetumpka.

*Melania harpa* Lea (in part). Proc. Amer. Phil. Soc., 4, 1845: 166. See synonymy under *G. haysiana*.

*Melania rubicunda* Lea. Proc. Acad. Nat. Sci. Phila., 13, 1861: 118. The types are *vanuxemiana*. They are of the Wetumpka aspect, rough and coarse.

? *Melania purpurea* Lea. Proc. Acad. Nat. Sci. Phila., 13, 1861: 120. Lea's two specimens, by his account, were from Schowalter. The description and figure fit *G. Showalterii* (Lea) 1860, a species of the Cahaba River; yet a lot in the Lea collection named *purpurea* contains a specimen which is *vanuxemiana*. It is doubtful if this is the true *purpurea*, and the name is here, with qualification, set down as a synonym of *vanuxemiana*.

*Melania pergrata* Lea. Proc. Acad. Nat. Sci. Phila., 13, 1861: 122. The single specimen so named by Lea is *vanuxemiana*.

*Goniobasis negata* Lea. Proc. Acad. Nat. Sci. Phila., 14, 1862: 271. The types are two pleurocerids. One is *vanuxemiana*, the other the young of a species that was not recognized.

*GONIOBASIS BULLULA* (LEA)

(Pl. I, Fig. 11)

*Melania bullula* Lea. Proc. Acad. Nat. Sci. Phila., 13, 1861: 121.

The shell was described from Yellowleaf Creek, Shelby County, Alabama. H. H. Smith found it to be limited in this stream to the lowermost four miles. It occurred from two to four miles above the mouths of Canoe and Kelly's creeks, St. Clair County. The creek forms of *bullula* are more conic than river specimens. The range in the Coosa River is from near Slackland, Cherokee County, to The Bar, Chilton County, Alabama.

The inclination has been to assume that this species is simply a smooth form of the striate *G. vanuxemiana*. Specimens that have been examined are usually more rounded than in the case of *vanuxemiana*, are not so heavy,

and have a somewhat larger operculum; yet these seemingly distinctive characters might possibly be matched, with the exception of the sculpture, in *vanuxemiana*. H. H. Smith left no notes which would make it clear whether *bullula* was associated with *vanuxemiana* or occupied a different habitat. In the former instance there could be no hesitancy in making *bullula* a synonym of the earlier described species.

	Measurements in mm.	
	Altitude	Diameter
Coosa R., Ten Island Shoals, St. Clair Co. . .	21.75	10.75
Coosa R., Ft. William Shoals, Talladega Co. .	21.00	11.00
Coosa R., The Bar, Chilton Co. . . . .	21.75	10.50
Coosa R., The Bar, Chilton Co. . . . .	19.50	10.50
Yellowleaf Cr., Shelby Co. . . . .	21.00	10.50
Waxahatchee Cr., Chilton Co. . . . .	22.75	11.75

#### SYNONYMS OF *GONIOBASIS BULLULA*

*Melania elliptica* Lea. Proc. Acad. Nat. Sci. Phila., 13, 1861: 118. The body whorl and aperture of this shell are somewhat more elliptical than is usual in *bullula*. Otherwise, there are no differences.

*Melania propria* Lea. Proc. Acad. Nat. Sci. Phila., 13, 1861: 118. Except in size, this is scarcely different from *elliptica* which was described at the same time.

*Melania virgulata* Lea (in part). Proc. Acad. Nat. Sci. Phila., 13, 1861: 119. Three of the types are of young *G. hartmaniana*, one of *bullula*.

*Melania suavis* Lea. Proc. Acad. Nat. Sci. Phila., 13, 1861: 120. The two types are young of *bullula*. Tryon made *suavis* a synonym of *G. culta* (Lea) which in turn is a synonym of *G. laeta* (Jay).

*Melania shelbyensis* Lea (in part). Proc. Acad. Nat. Sci. Phila., 13, 1861: 121. The type locality is the Yellowleaf Creek of Shelby County, Alabama. Some of the melanians that enter the stream from the Coosa River are perplexingly modified, and there is some justification for the fact that of the nine types of *shelbyensis*, three different species are represented. One of the specimens is *bullula*.

*Goniobasis ellipsoides* Lea (in part). Journ. Acad. Nat. Sci. Phila., 5, 1862: 234. The shell was originally named *gracilior* which is preoccupied by *G. gracilior* (Anthony), 1854. The description is nearest to *haysiana* (Lea). In the Lea collection of the United States National Museum are three lots of seven shells under the label of *ellipsoides*. The writer is uncertain whether or not these are the types. In any case, *ellipsoides* is a synonym.

*GONIOBASIS CAELATURA* (CONRAD)

(Pl. I, Fig. 14)

Proc. Acad. Nat. Sci. Phila., 4, 1849: 154.

Conrad received his shells from J. Hamilton Couper who lived in eastern Georgia. The Savannah River was given as the type locality. Five other melanian species, described at the same time, were also so assigned. Yet all are northwestern Georgian, distinctly different from coastal plain shells. The range of *caelatura* is from the Conasauga River bordering Whitfield and Murray counties, Georgia, to the Coosa River, Talladega County, Alabama. Where the species enters tributaries it is soon replaced by more conic and less sculptured members of its group.

*G. caelatura* is pyramidal in the earliest stages, altering to the familiar cylindrical shape in the maturing whorls. Nuclear whorls are smooth. Subplicae appear at about the fifth whorl. Following this sculpture, are spiral lines or ridges which increase in number and strength and, in typical specimens, cover the entire surface of the adult shell. Spirals are almost invariably coarser in individuals from the Coosa River than in those of the tributaries. The aperture is large, a little produced; the columella white and varying in prominence; the outer lip usually straight.

A tendency in certain of the mollusks to reduce the folds to nodes, apparently through acceleration, led Lea to distinguish such shells specifically under the name of *granata*, and where this process was partial to apply the name *granatoides*. Of 287 adults from the Etowah River above Cartersville, Bartow County, Georgia, 62.3 per cent are of this nodulous sculpture. Only one per cent of 427 shells were sculptured in this way in a lot from the Etowah near Kingston, farther downstream. They ran to 11.8 per cent in seventy-six specimens from this river at Rome, Floyd County. The same irregularity of occurrence was noted in Conasauga and Oostanaula rivers representatives. The phenomenon was not seen in shells of the Coosa. H. H. Smith took short-spined shells in a few places in the Coosa River. It is not clear that in any place they constituted a distinct colony. The conviction is that these were abnormal mollusks living among normals. Obsolescent sculpture is observable in shells of two or three tributaries, but not in all creeks where *caelatura* occurs, variation in this matter in such localities being rather a substitution of typical shells with shells wherein loss of ornamentation is attended with alteration in shape. A study of banding failed to reveal any correlation of this feature with position in stream. Occasional very narrow forms occur, as in the Conasauga River, near Tilton, Georgia, and Little River, Cherokee County, Alabama. They do not apparently form colonies, but live with individuals more nearly typical.

	Measurements in mm.	
	Altitude	Diameter
Conasauga R., Treadwell, Murray Co., Ga. ....	17.50	10.75
Conasauga R., Tilton, Whitfield Co., Ga. ....	21.75	11.25
Oostanaula R., Rome, Floyd Co., Ga. ....	24.00	11.25
Chattooga R., Boiling Fd., Chattooga Co., Ga. ....	24.50	12.00
Chattooga R., near Cedar Bluff, Cherokee Co., Ala. .	24.50	12.75
Coosa R., Slackland, Cherokee Co., Ala. ....	24.25	13.00
Coosa R., Ten Island Shoals, St. Clair Co., Ala. ....	22.00	13.00
Choccolocco Cr., Talladega Co., Ala. ....	25.25	12.25

The operculum is of moderate size, about one-third higher than broad; thin in young specimens, reddish brown and without crinkling; nearly black in old individuals and more acute. The operculum is paucispiral, the spiral lines well-marked, but not so deeply defined as in extreme paleomelanian forms. Twenty-four radulae of *caelatura* have been examined. Centrals are well defined. They have usually three cusps on each side of a large middle cusp. As many as five side cusps have been observed in radulae where the number is usually three. The pedestal of the uniform laterals is long, in a slanting position, and is unbroken in outline. Considerable variation occurs in numbers of cusps of the marginals. This may have a geographical significance. Marginal cusp counts are here set down.

	Inner marginals	Outer marginals
Conasauga R., Treadwell, Ga. ....	5	10
Conasauga R., Tilton, Ga. ....	6	9-10
Etowah R., 5 mi. above Cartersville, Ga. ....	7	12-24
Etowah R., Cartersville, Ga. ....	7	16
Etowah R., near Kingston, Ga. ....	4-6	10-12
Coosa R., Cedar Bluff, Cherokee Co., Ala. ....	6	10

#### SYNONYMS OF *GONIOBASIS CAELATURA*

*Melania decorata* Anthony. Proc. Acad. Nat. Sci. Phila., 12, 1860: 55. Anthony used the young shells for his description although, by his own account, he collected both juveniles and adults. The four immature shells that were set aside as types are in the Museum of Comparative Zoology.

*Goniobasis binneyana* Lea. Proc. Acad. Nat. Sci. Phila., 14, 1862: 266. Lea speaks of his two types as smooth. They are, however, subplicate, the sculpture being that of *caelatura*. I take the shells to be partly grown examples of this species.

*Goniobasis flavescens* Lea. Proc. Acad. Nat. Sci. Phila., 14, 1862: 271. This is an upriver form of *caelatura*, possibly from the Conasauga River.



Lea gives "Oconee and Tennessee rivers, Tennessee" as localities. This is probably an error of the Rev. Mr. White, Lea's correspondent, who seems to have traveled over the area of eastern Tennessee and northern Georgia as a circuit rider.

*Goniobasis cadus* Lea. Proc. Acad. Nat. Sci. Phila., 14, 1862: 272. The type is a young specimen. It was received from Major Le Conte, who did most of his southern collecting in the vicinity of Rome, Georgia.

*Goniobasis tryoniana* Lea. Proc. Acad. Nat. Sci. Phila., 14, 1862: 272. The description and figure fit *caelatura* excellently. The Oostanaula River near Rome, Georgia, is given as one of the type localities. The "Oconee River and Tennessee River" localities supplied by White were erroneous.

*Goniobasis granata* Lea. Proc. Acad. Nat. Sci. Phila., 14, 1862: 272. Taken from the Etowah River near Canton, Georgia. Nearly typical *caelatura*. The shell illustrated by Lea was about three-fourths grown.

*Eurycaelon leai* Tryon. Amer. Journ. Conchology, 2, 1866: 5, Pl. 2, Fig. 3. From the Etowah River, Cartersville, Georgia. Tryon's shell has tubercles at the shoulder and "fine, close, revolving striae." Occasional specimens of *caelatura* occur in which the interrupted folds are confined to a part of the shell. The "striae" of Tryon appear to be the textural revolving lines, more or less plain on shells that have not experienced much wear by scouring silt.

*Goniobasis similis* Lea. Proc. Acad. Nat. Sci. Phila., 20, 1868: 151. A form sometimes occurring among more typical individuals of *caelatura*. It has small, closely-set revolving lines. It was taken in Conasauga River.

*Goniobasis connesaugaensis* Lea. Proc. Acad. Nat. Sci. Phila., 20, 1868: 152. In all likelihood, selected from among other specimens of *caelatura*. The two lots in the Lea collection in the United States National Museum consist of four specimens in which the sculpture is obsolescent. The tendency to reduce sculpture is noticeable among head-stream forms of ordinarily striate mollusks.

*Goniobasis granitoides* Lea. Proc. Acad. Nat. Sci. Phila., 20, 1868: 152. Also from Conasauga River. Lea speaks of it as larger than *granata*, more horn-colored and without bands.

#### GONIOBASIS JONESI, NEW NAME

(Pl. I, Fig. 27)

*Goniobasis wheatleyi* Lea. Proc. Acad. Nat. Sci. Phila., 20, 1868: 151.

The name is preoccupied by *Lithasia wheatleyi* Lea, Proc. Acad. Nat. Sci. Phila., 18, 1866: 133, a *Goniobasis*. The new name is in honor of Dr. Walter Jones, state geologist of Alabama, between whom and this shell there is a resemblance at least of hearty and robust vigor.

The mollusk is high-spined, stout, yellowish to purple-brown. The indicated number of whorls is ten. Post-embryonic whorls are smooth, carinate; plicae, if present, appear at about the fifth or sixth whorl. Striae begin at the sixth or seventh whorl and are fine as compared with those in *G. caelatura*. They are continued to the base although in some specimens there are smooth areas on the body whorl above the periphery. The body whorl is flattened as in most examples of *G. vanuxemiana*. The aperture is ovate, in no instance elliptical. Of 165 specimens examined, forty-six had color bands within the aperture. These usually number four. The columella is white, well developed in adults. The outer lip is straight or nearly so.

The operculum is broad as if to conform to a wide aperture. Nuclear whorls are distinct, occupying from one-fourth to nearly one-half the diameter of the operculum. They are near the basal margin.

The single radula that has been available for study appears small for so large a pleurocerid. There are thirty rows of teeth. Centrals vary from 3-1-3 to 4-1-4, seven of the thirty centrals being asymmetrical. In place, the laterals show four cusps each; detached and folded back these are seen to number seven. The inner marginals have eight cusps, the outer fourteen to sixteen.

The range of *jonesi* in the Coosa River is from Ten Island Shoals, St. Clair County, to The Bar, Chilton County, Alabama. Hinkley (1904) reports the species from Spring Creek, Farmer, Shelby County. I have seen no creek specimens. A note of H. H. Smith's speaks of the species as abundant "through the shoals region of the Coosa. It prefers quiet water, pools and eddies, and is often found along the shore in still stretches between the shoals. The animal is orange-tinted."

	Measurements in mm.	
	Altitude	Diameter
Ten Island Shoals, St. Clair Co., Ala. . . . .	27.25	13.25
Lonigan Shoals, St. Clair Co., Ala. . . . .	29.50	12.00
Lonigan Shoals, St. Clair Co., Ala. . . . .	25.25	11.75
Fort William Shoals, Talladega Co., Ala. . . . .	31.00	15.50
The Bar, Chilton Co., Ala. . . . .	28.00	14.00

#### GROUP OF *GONIOBASIS OLIVULA* (CONRAD)

The seven members of this group are alike in having a gyrotomoid texture of the periostracum, showing sometimes only in the uneroded young, a habit of tight coiling which barely reveals the carinae of early growth, undulatory plicae where plicae are present, and a tendency, more or less pronounced, toward the development of incipient sutural fissures. In two

species low bosses succeed the plicate sculpture. In two others these bosses have become definite nodulous sculpture. This sculpture in one species takes the phase of enlargement at the top of the nodes, in the other of enlargement at the base of the nodes. The differences may be assumed to be correlated with differences in the shell-secreting glands of the mantle. They are of interest, on one account, because the same phenomenon appears in *Lithasia*, another genus of the Pleuroceridae.

The range of the seven species is from the vicinity of Cedar Bluff on the Coosa River to Claiborne, Monroe County, all within the state of Alabama; in the lower parts of the Black Warrior and Tombigbee rivers; in the lowermost part of the Cahaba River, and in a few tributary creeks.

*GONIOBASIS OLIVULA* (CONRAD)

(Pl. I, Fig. 6)

*Melania olivula* Conrad. Amer. Jour. Sci., 25, 1834: 342, Pl. 1, Fig. 13.

This pleurocerid varies greatly in shape, being sometimes ventricose, occasionally nearly as elongate as examples of *Pleurocera*. It has, however, a few characters that are nearly constant. The epidermal texture consists of the fine, sometimes undulate growth lines that are noticeable particularly in the genus *Gyrotoma*. The neanic whorls are rounded as a rule, the body whorl tending to flatten. There is commonly an incipient sutural fissure. Of ninety-five specimens from the Alabama River near Camden, Wilcox County, Alabama, only two lacked this indentation.

*G. olivula* may easily be confused with the associated *G. pupoidea* (Anthony) and when young with juvenile examples of *G. vanuxemiana*, with which it also occurs, but with care the different species can be separated satisfactorily. The aperture varies in shape, being both elliptical and ovate in the same colony. The cylindrical aperture is correlated with a decidedly cylindrical, flat-whorled shell, the ovate aperture with one more nearly conic. Whorls are commonly shouldered. In mature specimens, the body whorl is frequently constricted just below the suture. The species appears to be limited to ten or eleven whorls. The line of the outer lip is in all cases more or less sinuous, and in some shells is retrorse. Young are slightly carinate or so tightly coiled that only the carina of the body whorl is to be seen. The shape is pyramidal, nearly flat on the striated base. Plicae begin at about the fourth whorl, are seldom conspicuous, and, as a rule, have disappeared before the seventh whorl has developed. The columella is narrow, is slow in development above the center, and has a nodular deposit of callus in old mollusks. Conrad figured a thick, elongate-ovate shell with wide, revolving folds. It was far from being typical of the species. Tryon (1873) substituted a figure of his own that is more recognizable as *olivula*. With less excuse, he altered Conrad's description.

The revolving striae are seldom observable to the unaided eye. When they occur, they are more often than not confined to the base. The variation of this feature in four localities of the Alabama River may be seen in the following table, the locations reading in a downstream direction.

	Number of shells	Striate above periphery in %	Striate on base only in %	No striae in %
6 mi. n. of Tyler, Dallas Co. ....	128	32.0	32.0	36.0
Selma, Dallas Co. ....	176	19.3	55.1	25.5
8 mi. w. of Camden, Wilcox Co. .	95	8.4	43.1	48.4
Claiborne, Monroe Co. ....	103	3.8	40.1	56.2

Color banding is of the common four-band formula. In instances, the pigment is laid only in the periostracum. The percentages of banded and unbanded shells were found to be virtually the same at the localities near Tyler and Selma, but banded shells, which were as high as 73.7 per cent of the whole at Selma, were fifty-nine per cent near Camden and only twenty per cent at Claiborne.

The range of *olivula*, so far as known, is from near Tyler, Dallas County, to Claiborne, Monroe County, all in the Alabama River. The species enters the lower parts of the Cahaba and Tombigbee rivers.

	Measurements in mm.	
	Altitude	Diameter
Alabama R.		
6 mi. n. of Tyler .....	19.00	10.25
Selma .....	22.50	14.00
8 mi. w. of Camden .....	21.00	12.00
Claiborne .....	20.00	11.50
Cahaba R.		
near Marion, Perry Co. ....	18.00	11.00
Tombigbee R.		
(Schowalter collection) .....	23.00	12.50

#### SYNONYMS OF *GONIOBASIS OLIVULA*

? *Melania bitaeniata* Conrad. New Fresh Water Shells of the United States, Phila., 1834: 52, Pl. 8, Fig. 6. Described as from the Black Warrior River. Conrad's figure is very poor, and the description is inadequate. Tryon's figure is "from an authenticated specimen in Coll. Anthony." A shell exactly conforming to this illustration was taken at Claiborne. Its only distinction is a distorted aperture which gives the specimen the appear-

ance of having an anterior sinus. Much of the *olivula* at Claiborne has the shape of *G. cylindracea*, which is one of the two commoner goniobases of Black Warrior River, and *bitaeniata* may be this species rather than *olivula*. In either case, it is pathological and should be ruled out of the nomenclature.

*Melania inflata* Haldeman. Monog. Limniades, cover of No. 3, 1841. So far as a short description gives a clue to this species, it appears to be a partly grown specimen of *olivula*.

*Melania proteus* Lea (in part). Proc. Amer. Phil. Soc., 4, 1845: 166. The types consist of three specimens of *G. pupoidea* (Anthony), 1854, and one of *olivula*. Without the types to guide one, nothing could be made of description and figures. It seems in the instance advisable to designate the specimen of *olivula* as the type of *proteus* and so preserve the identifiable *pupoidea*. Lea gives Tuscaloosa as the type locality of his shell. This was merely the place from which the shells were sent to him.

*Melania basalis* Lea. Proc. Amer. Phil. Soc., 4, 1845: 166. The specimen in the Lea collection which is seemingly the type of *basalis* belongs to *olivula*. Lea was never certain about this pleurocerid. Shells he gave this name to, besides *olivula*, are *G. bullula* (Lea) and *caelatura* (Conrad). Schowalter's specimens, so named, are *G. vanuxemiana*.

*Melania oppugnata* Lea. Proc. Amer. Phil. Soc., 5, 1852: 252. Cited as from the Alabama River. The two types are old and much worn specimens of *olivula* of the form taken near Camden, Wilcox County. Tryon (1873) considered them to be *G. cylindracea* (Conrad).

*Melania midas* Lea. Proc. Acad. Nat. Sci. Phila., 13, 1861: 119. The types are *olivula*. In establishing the genus *Eurycaelon*, Lea names *midas* as a representative species. This course was followed by Tryon. Before publication he appended a footnote expressing the opinion that *Eurycaelon* had no proper standing, and consisted simply of distorted goniobases and anculosae.

*Melania straminea* Lea. Proc. Acad. Nat. Sci. Phila., 13, 1861: 121. Lea gives the Coosa River as type locality. What appears to be the type lot is labelled as from the Alabama River. The shells are *olivula*.

*Goniobasis gibberosa* Lea. Proc. Acad. Nat. Sci. Phila., 14, 1862: 266. This is a large, shouldered form of *olivula* that occurs in the Alabama River at Selma.

#### GONIOBASIS CYLINDRACEA (CONRAD)

(Pl. I, Fig. 12)

*Melania cylindracea* Conrad. New Fresh Water Shells of the United States, Phila., 1834: 55, Pl. 8, Fig. 10.

This pleurocerid is close in shape to cylindrical shells of *G. olivula* that occur in the Alabama River at Claiborne, but it has undergone the entire

loss of the primitive plicate sculpture. Striate sculpture, when present, is reduced to lines on the base that are usually microscopic. The constriction of the body whorl is pronounced and frequent. The neanic whorls in almost all instances are overlapped by the maturing whorls. The elliptical shape of the aperture is persistent.

Several hundred specimens of very young shells were taken in Sucarnoochee Creek, Sumter County, Alabama, by Eldridge T. Norman in 1914. Plicate sculpture was seen in none. Embryo whorls are one and one-half to nearly two whorls. Post-embryonic whorls are carinate at the periphery and striate on the base. At about the seventh whorl, there begins a decided enlargement and overlapping. Juveniles are conic, the cylindrical shape being an adolescent and adult feature. This is true also to a large extent of the development of a sutural notch.

Straight outer lips are commonest in lots from the Tombigbee River at Columbus, Mississippi. They are occasionally retrorse. The characteristic gyrotomoid texture of the group is much subdued in *cylindracea*, the shells being of a bright, shining brown or yellow-brown rather than silky. It is possible that this is a mechanical effect since the species lives in gravel where currents carry scouring silt. This is supported by the fact that the young from Sucarnoochee Creek show the more or less undulate revolving textural lines. Color bands are more often absent than present. The aperture is ligulate at the top, flaring into an elongate-ovate shape at the base. The columella is white, narrow, and has a deposit of callus at the top in old individuals.

The operculum is somewhat wider in proportion to altitude than in other species of the group. There is none of the crinkling that is seen in opercula of the related *G. laeta* (Jay). Spiral lines are distinct and confined to the left margin near the base.

The species occurs in the Tombigbee River from Columbus, Mississippi, to near its mouth, and in the lower part of Black Warrior River. Hinkley (1904) reports the shell from the Coosa River at Wetumpka and Fort Wil-

	Measurements in mm.	
	Altitude	Diameter
Tombigbee R., Columbus, Miss. ....	23.00	11.50
Tombigbee R., Columbus, Miss. ....	19.25	10.00
Tombigbee R., Sumter Co., Ala. ....	18.25	10.00
Tombigbee R., Sumter Co., Ala. ....	17.00	9.50
Black Warrior R., Ala. ....	20.25	12.00
Black Warrior R., Ala. ....	19.25	11.00
Sucarnoochee Cr., Sumter Co., Ala. ....	20.00	9.50

liam Shoals. These latter specimens were probably *G. pupaeformis* Lea, which occurs in the locality and is not in Hinkley's list. I have not seen pleurocerids from Wetumpka that could be determined as *cylindracea*.

#### SYNONYMS OF *GONIOBASIS CYLINDRACEA*

? *Melania bitaeniata* Conrad. New Fresh Water Shells of the United States, Phila., 1834: 52, Pl. 8, Fig. 6. See remarks on this name under the synonyms of *G. olivula*.

*Melania auriculaeformis* Lea. Proc. Amer. Phil. Soc., 4, 1845: 166. The young of *cylindracea*.

? *Melania vesicula* Lea. Proc. Acad. Nat. Sci. Phila., 13, 1861: 118. Described from a single juvenile specimen. The type has the characteristics of young *cylindracea* except "a disposition on the upper part of the whorls to plication." It is possible that this is a young example of *Lithasia verrucosa* (Rafinesque) of the Tennessee River drainage. Lea says that the specimen "was found among others of a different species from Dr. Shwalter."

#### *GONIOBASIS BELLULA* (LEA)

(Pl. I, Fig. 2)

*Melania bellula* Lea. Proc. Acad. Nat. Sci. Phila., 13, 1861: 122.

This species is most common on the shoals of the Coosa River where the stream borders Talladega and Shelby counties, Alabama. There are noticeable differences among the shells of different shoals, too small to warrant separation even as races, but a good deal of uniformity within each colony. The local differentiation is carried somewhat farther in Yellowleaf Creek, Shelby County, where Lea's original lot was collected. Nearly all characters are here just a little reduced, the creek forms being thinner than the river forms, smoother, more nearly cylindrical; the size of the aperture in proportion to the size of the shell is larger. While the modifications are not striking, they are sufficient to prove confusing to the student. They were, indeed, particularly confusing to Lea as the synonymy of *bellula* will show. Only one small lot of river shells has been seen that closely follows the Yellowleaf Creek facies. It came from Fort William Shoals which are close to the mouth of the creek.

The young are pyramidal, carinate, or angled at the periphery, and they have one or two striations on the base. So far, the juveniles resemble those of *G. laeta* of the same group, but the plicae of *bellula* begin their development at an earlier stage than in *laeta* and become obsolete earlier. The ovate aperture of the young remains unchanged in maturity. The two central color bands are approximate. In older specimens, all four bands are equidistant. The columella of adults is white, narrow, and has a deposit

of callus at the top. In mid-growth many shells develop irregular knobs or bosses. Among quite normal shells taken on Weduska Shoals, Shelby County, are individuals in which these bosses are large and conspicuous as in *G. lachryma* (Anthony). Because of erosion of the spire, comparatively few shells show the plicate sculpture. For example, only twenty-seven plicate mollusks were found among 161 specimens taken on the Three-Island-Fort William-Peckerwood series of shoals. Of the 161 shells, 41.6 per cent were striate above the periphery, 42.8 per cent striate on the base only, and 15.5 per cent wanting striae. A Weduska Shoals lot numbered 135 specimens. Sixty per cent were striate above the periphery, 18.5 per cent striate only on the base, and the rest lacking in striae. The outer lip is straight or slightly indented at the top. About eighty-seven per cent of the Three-Island-Fort William-Peckerwood material and sixty-nine per cent of the Weduska Shoals lot had this indentation. The proportion of banded to unbanded specimens in the first named lot was about three to one, and nearly one to one in the Weduska shells.

The species appears in the river first at Fitz's Ferry, five miles above Gadsden, Etowah County, Alabama. It ranges in the Coosa to Wetumpka, Elmore County. Besides Yellowleaf Creek, H. H. Smith took *bellula* in Choccolocco Creek, near Eureka, Talladega County. The Wetumpka specimens, apparently rare, are small, striate over the whole surface, and with the indentation at the top of the outer lip.

The operculum is large, dark in old shells, clavate. It has not the crinkled cross lines of the related *G. laeta*. The nucleus is crowded into the left margin near the base.

	Measurements in mm.	
	Altitude	Diameter
Fitz's Ferry, Etowah Co., Ala. ....	19.50	10.00
Three-Island Shoals, Talladega Co., Ala. ....	18.50	11.75
Ft. William Shoals, Ala. ....	21.00	11.50
Weduska Shoals, Shelby Co., Ala. ....	20.50	11.00
The Bar, Chilton Co., Ala. ....	19.00	10.50
Wetumpka, Elmore Co., Ala. ....	18.50	10.00
Yellowleaf Cr., Shelby Co., Ala. ....	16.50	10.00
Choccolocco Cr., Talladega Co., Ala. ....	13.50	8.00

#### SYNONYMS OF *GONIOBASIS BELLULA*

*Melania solidula* Lea (in part). Proc. Acad. Nat. Sci. Phila., 13, 1861: 121. From Yellowleaf Creek. Four of the thirteen types in the Lea collection of the United States National Museum belong to *bellula*.



*Melania shelbyensis* Lea (in part). Proc. Acad. Nat. Sci. Phila., 13, 1861: 121. From Yellowleaf Creek. Among the species in the type lot is *bellula*.

*Melania punicea* Lea. Proc. Acad. Nat. Sci. Phila., 13, 1861: 123. Figure and description resemble the smooth forms of *G. haysiana* to a degree. Tryon (1873) says that it is "very closely allied to *pudica*, if not identical with that species." *Pudica* is a Yellowleaf Creek form of *G. alabamensis*. The types, however, are easily recognizable as an unbanded form of *bellula* that is not uncommon on Fort William and Weduska shoals.

*Melania crepera* (in part). Proc. Acad. Nat. Sci. Phila., 13, 1861: 123. From Yellowleaf Creek. A young specimen of *bellula* is in the type lot.

*Melania fumea* Lea (in part). Proc. Acad. Nat. Sci. Phila., 13, 1861: 123. Six shells of the type specimens belong to *bellula*.

*Melania propria* Lea. Proc. Acad. Nat. Sci. Phila., 13, 1861: 123. Non *M. propria* Lea, *ibid.*, p. 118. The name being preoccupied, Lea changed it to *Goniobasis lepida*, Journ. Acad. Nat. Sci. Phila., 5, 1863: 227, Pl. 34, Fig. 17. It was placed in the genus *Eurycaelon* by Tryon (1873). The type is a single specimen from Yellowleaf Creek. It is very like the form of *bellula* that Lea described as *M. punicea*.

*Lithasia vittata* Lea. Proc. Acad. Nat. Sci. Phila., 14, 1862: 273. Sent to Lea by Schowalter, the Coosa and Cahaba rivers being given as localities. The shells so named that are in the Lea collection and are from Schowalter are assigned simply to "Alabama" on the label. They consist of three specimens, two of which belong to *bellula*. The other shell is unrecognizable.

*Lithasia cylindrica* Lea (in part). Proc. Acad. Nat. Sci. Phila., 18, 1866: 133. The vial containing the types has four specimens representing three species. One of the shells is *bellula*.

#### GONIOBASIS LACHRYMA (ANTHONY, REEVE)

(Pl. I, Fig. 26)

*Melania lachryma* Anthony, Reeve. Monograph *Melania*, 1861: species 473.

It has been noted under *G. bellula* that the plicate sculpture of neanic whorls is succeeded by low bosses. In *lachryma*, these bosses are much enlarged, very conspicuous, and sometimes quite irregular in shape. The early plicae disappear at about the fourth whorl. The bosses that follow begin as shallow protuberances, increasing in size with growth. They extend from suture to periphery. Enlargement is made at the lower part of each boss. This is the manner of development of nodules and spines in the genus *Io*. Crowded, the nodulous sculpture appears to interfere with normal growth, throwing many individuals out of symmetry. Where a rest period comes at the height of a nodule the new growth is carried on smoothly from this point, not beginning anew on the plane of the shell.

Striae may occur above the periphery and on the base, on the base only, or be altogether absent. Shells with basal striae only are commonest. The gyrotomoid texture is present in all specimens that have been examined. This, together with the large, leaf-like operculum, helps to differentiate the species from accompanying *G. clausa* (Lea) when the latter has a nodulous sculpture. Of thirty-five specimens from Ten Island Shoals, twenty-one have four color bands, one has five, and one has three. The percentage of shells with sutural indentations is slightly higher than in *bellula*.

It is highly possible that *lachryma* is merely a mutation of *bellula* the same as the nodulous specimens of *bellula* occurring among normal shells on Weduska Shoals. Where *lachryma* is most common, Coosa River, Ten Island Shoals, St. Clair County, Alabama, two nodulous species of ancusae occur, the nodulous *Gyrotoma pyramidatum* Shuttleworth is abundant, and occasional nodulous individuals of *G. clausa* and *laeta* have been taken. In a letter, H. H. Smith has spoken of noting the same peculiarity of sculpture among shells of *Pleurocera prasinatum* (Conrad), ordinarily smooth. I do not feel justified, however, in throwing *lachryma* into the synonymy of *bellula* because of what seems to be an environmental influence involving several pleurocerids. In the few places where *lachryma* has been collected, it is stoutly bossed and unmixed with smooth forms that can be assigned to it. It may at least be considered a local race of consistent characters.

The species occurs in a stretch of the Coosa River about forty or fifty miles long, beginning at Gilbert's Ferry, Etowah County, and ending near Childersburg, Talladega County, Alabama.

	Measurements in mm.	
	Altitude	Diameter
Gilbert's Ferry, Etowah Co. ....	19.75	12.00
Ten Island Shoals, St. Clair Co. ....	25.75	14.00
Ten Island Shoals, St. Clair Co. ....	22.25	13.50
Lock 4, near Riverside, St. Clair Co. ....	20.00	10.50
Riverside, St. Clair Co. ....	15.75	10.00
Coosa R., Ala. (Schowalter coll.) ....	20.75	11.50

#### SYNONYMS OF *GONIOBASIS LACHRYMA*

*Melania gratiosa* Lea. Proc. Acad. Nat. Sci. Phila., 1861: 122. The description of *gratiosa* was ordered to be published on May 28, 1861. It is not clear from the available records whether this meant the day of ordering printing or the day of issue. It is probably the latter because Tryon, on the staff of the Academy, gives May, 1861, as the time from which to date *gratiosa*. In the same month, the section of Reeve's *Monograph of the*

*Genus Melania* was printed. Tryon, admitting the impossibility of establishing priority in the case, publishes both descriptions. I am left, therefore, to resolve the dilemma by designation. I consider *lachryma*, referring to tears, a more happily chosen name than *gratiosa*, here probably meaning "agreeable."

GONIOBASIS GIBBERA H. H. SMITH, NEW SPECIES

(Pl. I, Fig. 9)

SHELL.—Cylindrical, thick, shining yellow-brown; without color bands. Spire shortened and overlapped. About three and one-quarter whorls remaining of type. Early whorls conic, rounded, subplicate. Body whorl flattened, very much shouldered, nodulous; the bosses thickened at the shoulder and widely separated. Growth lines fine, crossed by discontinuous revolving lines that are worn away except on the newest shell growth. Revolving striae consist of flattened folds, conspicuous on the base and nearly microscopic above the periphery. Aperture elongate-ovate, a little produced. Columella white, of moderate breadth, thickened at the top. Outer lip slightly incurved at the suture, straight from above the periphery to the base.

OPERCULUM.—Elongate, the diameter slightly more than one-half the altitude. Rest periods not much more marked than the growth lines. The nucleus is on the left margin close to the base; spiral lines distinct, very closely coiled, neomelanian.

RADULA.—Centrals and laterals similar to those of most goniobases. The inner marginals have seven to eight large denticles, the outer marginals about sixteen very small and crowded cusps. Similar in all essentials to the radula of *bellula*.

MEASUREMENTS (in mm.).—Altitude 18.75, diameter 10.25; aperture-altitude 10.50, diameter 3.50.

TYPE LOCALITY.—Coosa River, Lonigan Shoals, two miles below Lock 2, St. Clair County, Alabama. Holotype in the Alabama Museum of Natural History, paratypes in the Museum of Zoology, University of Michigan.

The adult shells of this species are uniform as regards shape, color, absence of color bands, form of aperture, and character of operculum. Variations are in the prominence of the nodes which are sometimes so large as to seem to be deformities and in instances are almost obsolete, in the strength of the striae, and in the line of the outer lip which may be incurved at the suture or straight. The few juveniles that have been seen display many of the characteristics of adults except that the body whorl is globose rather than flattened and cylindrical. They indicate eight to nine whorls for the mature individuals. A scalariform specimen is very loosely coiled, broadly shouldered, and barely nodulous. The operculum has not been affected by the deformation of this shell.

The outstanding distinction of *gibbera* is that the thickening of the bosses occurs at the top and not at the base as in *G. lachryma*. Such a sculptural development is to be seen in *Lithasia geniculata* Haldeman and *salebrosa* (Conrad) of more northern streams.

Besides Lonigan Shoals, other localities where specimens have been taken are Leoto Shoals and Lock 2, both in the Coosa River bordering St. Clair County, Alabama. H. H. Smith was the collector. Curiously, the species has not been found on Ten Island Shoals which lies between Leoto Shoals and Lock 2.

	Measurements of paratypes in mm.	
	Altitude	Diameter
Leoto Shoals .....	18.00	9.25
Lonigan Shoals .....	19.50	10.25
Lonigan Shoals .....	19.00	10.00
Lonigan Shoals .....	17.00	9.25
Lonigan Shoals (juvenile) .....	11.50	7.00
Lock 2 .....	20.25	10.50

#### GONIOBASIS LAETA (JAY)

(Pl. I, Fig. 25)

*Melania laeta* Jay. Catalogue of Recent Shells, (3rd ed.), 1839: 122, Pl. 7, Fig. 11.

Next to *G. haldemaniana* (Lea), also of the Coosa River, this is the largest of all goniobases. It attains a height of 32 mm. and an extreme diameter of 17 mm.

The embryo shell is of one and one-half to two whorls. There is rapid widening until at the fourth whorl altitude and diameter are nearly equal. Low plicae appear on the fourth or fifth whorl. The periphery is carinate with usually a single striation below it. Revolving striae make their appearance above the periphery at about the sixth whorl. Usually, but not always, the plicae disappear early, the conspicuous sculpture of the adult shell being widely spaced striae of varying conspicuousness.

Two distinct forms of *laeta* inhabit the Coosa River. One occupies upstream localities from Cedar Bluff, Cherokee County, Alabama, to Riddle's Bend which is near the boundary line of Etowah and St. Clair counties. This shell is small if compared with the down-river form. The sculpture is finer and, in instances, almost obsolete. The lower river type is large, coarsely ornamented, and shows clearly affinity with the genus *Gyrotoma*. The shape of *laeta* is commonly conic, but in all lots examined, specimens were seen that adopted a cylindrical configuration. For example, eighteen out of twenty shells from Weduska Shoals were conic, one was

nearly cylindrical, and one was definitely so. Shape does not greatly vary in any one colony as a rule, but in localities opposite Chilton County the form of the shells varies greatly. A single scalariform shell, taken at Wetumpka, is so distorted that its operculum is virtually the only unmodified character. The aperture of *laeta* is large, ovate, usually produced. It has a deposit of callus at the top. The columella is white to reddish, narrow, and in mature specimens well developed. Color bands are usually four. To judge by specimens seen, there is an increase in unbanded shells in a down-river direction. Most commonly, the line of the outer lip is parallel with the axis of the shell, but particularly in the young, this line is reflexed from periphery to base. Incipient sutural fissures, amounting to a more or less conspicuous indentation, appear. It was found in two out of fifty-nine specimens of the upriver phase. Only one was seen in shells of the Ten Island area. About twenty per cent were so marked in Talladega and Shelby counties lots taken as a whole, twenty-six per cent in the Chilton County material, and thirty-six per cent in that of Wetumpka. The tendency toward obsolescence of the plicate sculpture is more marked in down-river than in upriver individuals. In lots from Ten Island Shoals, occasional shells have the bosses that seem to have a localized environmental bearing. Partly smooth shells are fairly common. They are most frequent at the beginning and the end of the range of the species.

*G. laeta* occurs in the Coosa River from Cedar Bluff, Cherokee County, Alabama, to Wetumpka, Elmore County. Only two creek localities are known. One is Big Canoe Creek, St. Clair County, the other is "Bean Creek, near Coosa River" of H. H. Smith's taking and not more definitely placed. Revolving striae are absent in specimens from the Big Canoe Creek.

The operculum is very large, leathery, and, in old specimens, black. Numbers of waving lines cross the lines of growth. The nucleus, which is clearly marked in young specimens, is reduced to tightly-coiled spirals in the adults. They occupy circumscribed space on the left margin near the

	Measurements in mm.	
	Altitude	Diameter
Cedar Bluff, Cherokee Co., .....	18.00	10.75
Fitz's Ferry, Etowah Co. ....	18.00	11.00
Riddle's Bend, Etowah Co. ....	27.50	15.50
Ten Island Shoals, St. Clair Co. ....	30.00	17.00
Ft. Williams Shoals, Talladega Co. ....	22.50	13.25
Weduska Shoals, Shelby Co. ....	32.00	15.00
The Bar, Chilton Co. ....	28.00	15.00
Duncan's Riffle, Chilton Co. ....	27.00	13.25
Wetumpka, Elmore Co. ....	25.00	15.50

base. The radula of a shell from Weduska Shoals had medians of 4-1-4 and laterals of six, and possibly seven, cusps. The inner marginals had six large denticles. No more than nine denticles, rather large, could be found among the outer marginals.

The largest shell of each locality was measured. Erosion involved from six to eight whorls of each specimen. The whole number of whorls of an adult would probably reach twelve.

#### SYNONYMS OF *GONIOBASIS LAETA*

*Melania robusta* Lea. Proc. Amer. Phil. Soc., 2, 1841: 88. Lea's single specimen was three-fourths grown. It is of the Wetumpka aspect. Since Jay supplied only a name and a recognizable figure, Tryon (1873) used Lea's description of *robusta* for that of *laeta*.

*Melania ovalis* Lea (in part). Proc. Amer. Phil. Soc., 2, 1843: 242. The original lot, which was from Foreman, was not seen during the examinations of Lea's types, but among lots in that collection which bear the name of *ovalis* are specimens of *laeta*. The shell illustrated by Tryon as *ovalis* belongs, instead, to *laeta*.

*Melania harpa* Lea (in part). Proc. Amer. Phil. Soc., 4, 1845: 166. Of four lots of the Lea collection and one of the Smithsonian collection, a gift from Lea, all named *M. harpa*, three contain specimens of *laeta*.

*Melania taeniolata* Anthony. Proc. Acad. Nat. Sci. Phila., 12, 1860: 59. The type is in the Museum of Comparative Zoology. It is a partly grown specimen of *laeta*.

*Melania calculoides* Lea. Proc. Acad. Nat. Sci. Phila., 13, 1861: 118. Probably from the Coosa River at Wetumpka. Lea says the shell is "nearest to *Melania (Goniobasis) robusta* . . .," which equals *laeta*.

? *Melania nubila* Lea. Proc. Acad. Nat. Sci. Phila., 13, 1861: 118. Possibly *laeta*. See under synonyms of *G. haysiana*.

*Melania culta* Lea (in part). Proc. Acad. Nat. Sci. Phila., 13, 1861: 122. The type specimen that is figured by Lea is pathological. Associated with it in the type lot are normal examples of *laeta* and one of *G. impressa* (Lea).

*Melania copiosa* Lea. Proc. Acad. Nat. Sci. Phila., 13, 1861: 112. Tryon made this a synonym of *G. ovalis* (see above). The type is *laeta*.

? *Melania blanda* Lea. Proc. Acad. Nat. Sci. Phila., 13, 1861: 122. Named from one specimen which appears to be a juvenile *laeta*. This name was preoccupied by *M. blanda* Lea, 1841, which is a synonym of *Goniobasis laqueata* (Say). The error was caught by Lea himself, who altered the name to *versa* (Journ. Acad. Nat. Sci. Phila., 6, 1866: 137). The correction was overlooked by Tryon who substituted *leai* for *blanda* (1873: 163). The shell was among the many taken by Schowalter in Yellowleaf Creek, Shelby

County, Alabama. If actually *laeta*, as suspected, this is another creek locality for the species.

• *GONIOBASIS PILSBRYI* GOODRICH

(Pl. I, Fig. 23)

*Melania showalterii* Lea. Proc. Acad. Nat. Sci. Phila., 13, 1861: 120; preoccupied by *Lithasia showalterii* Lea. Proc. Acad. Nat. Sci. Phila., 12, 1860: 188, a *Goniobasis*.

*Goniobasis pilsbryi* Goodrich, Nautilus, 41, 1927: 58.

The outstanding peculiarity of this *Goniobasis* is its ligulate operculum, known to no other species of the genus. Also so far as known, it is common to all individuals of the species. The ligulate operculum appears in *Nitrocris carinata* (Brug.), but not in all its colonies. It is present in *Anculosa griffithiana* Lea, a Coosa River shell, but with individuals having such opercula are others having the common spiral opercula. In a young specimen of *pilsbryi* which had attained seven whorls the operculum was 3.18 mm. in length. In an adult, the operculum was 23 mm. long. Growth proceeds by additions of lamellae of equal width at apex and base to the left margin, the oldest part of the operculum being about 2 mm. in width and the youngest as much as 10 mm. There is no indication of spiral nucleus.

The shell has characters allied with those of *bellula* and *laeta*. I am inclined to place it closest to *laeta* because the young shell decidedly resembles the juvenile of that species. The shell is conic and bluntly angled at the periphery. The aperture is ovate, rather large, and a little produced. Early whorls are carinate, subpubescent. With new growth, maturing whorls overlap the periphery of neanic whorls, giving the shell the effect spoken of as babylonical. The columella is white, narrow, and has a deposit of callus at the top. Lips of young shells are straight, but the outer lip becomes incurved as maturity approaches. The body whorl is shouldered and sometimes constricted. Striae are comparatively rare and when present are usually confined to the base. Color bands are four in number as a rule. The fine gyrotomoid texture of *pilsbryi*, the regularity of shape, and the usual restriction of erosion to the apex suggest that the species occupies protected spots out of the current very much as does *Pleurocera*.

Certain specimens taken by H. H. Smith and by him considered a new species were thought for a time to represent *pilsbryi* wherein the opercula have followed the familiar spiral development. Restudy has led to the conviction that these were merely individuals of *G. bellula* that lacked the incipient nodulous sculpture and otherwise resembled *pilsbryi*.

The mollusk is restricted to the Coosa River, the range being from about Hall's Island, Talladega County, to the mouth of the Yellowleaf Creek of Chilton County.

	Measurements in mm.	
	Altitude	Diameter
Three Island Shoals .....	19.75	11.25
Ft. William Shoals .....	23.00	12.00
Weduska Shoals .....	22.75	13.50
Mouth of Yellowleaf Cr. ....	24.00	13.00

#### GROUP OF *GONIOBASIS HARTMANIANA* (LEA)

In size, epidermal texture, and general appearance, the leading member of this group stands out prominently among all goniobases. It resembles in these points some of the Asiatic and African melanians. Its radula, however, fails to support the impression the shell gives of exceptional distinctiveness. It is of commonplace goniobasic character. The connection of *hartmaniana* with species of other groups is not clear. The links of the chain of development have been lost, and no river deposits are known that will furnish the information desired. In the case of the second member, *G. macglameriana*, relationship with other goniobases is more apparent. The species has retained the primitive plicate sculpture. The texture and appearance are the familiar ones of shells of the Coosa River. It is possibly an upstream phase of *hartmaniana* and represents an earlier stock, but if so the deviation of *hartmaniana* from the ancestral type has been too extreme to place the two mollusks under one name. The third member of the group, *G. pygmaea*, is a puzzling endemic. It is juvenile in point of size, old and possibly senile in other characters. Only repeated examination of the shells has forced the conclusion that they belong in this group rather than with one of less striking physical contrasts.

#### *GONIOBASIS HARTMANIANA* (LEA)

(Pl. I, Fig. 24)

*Melania hartmaniana* Lea. Proc. Acad. Nat. Sci. Phila., 13, 1861: 117.

This the largest *Goniobasis*. It inhabits the Coosa River from Leoto Shoals, St. Clair County, to Wetumpka, Elmore County, Alabama. Considering size and occurrence, it is a strange fact that the species did not come to notice during the twenty years previous to 1861, in which persons of the southern United States were sending mollusks to Isaac Lea. R. L. Call and H. H. Smith, to judge by their takings, found the species to be common at Wetumpka, and that is the place on the Coosa which was most frequently visited in the earlier days of collecting. It remained for Dr. Schowalter to discover *hartmaniana*.

Like other pleurocerids of the Coosa River phase, the species alters its shape from conic to cylindrical, but this is not done usually until the ultimate



whorl. The very young shell is sharply angled at the periphery. This is soon altered to the rounded form of maturing whorls, and, finally, to the flattened, frequently constricted last whorl. Overlapping begins at about the eighth whorl. Shells half-grown have a flask-like shape. Color is yellow to shining dark brown, the deeper hue coming with increased age. The very fine revolving lines which with growth lines make up the texture disappear early through wear. Certain undulations which appear occasionally on the neanic whorls are suggestive of plicate sculpture, but they are probably only adventitious depressions in the shell surface. No clearly cut striae are observable. The aperture is large, ovate, sometimes nearly round in very old specimens. There is a distinct channel at the base. The columella of an adult is white, rather broad, and has a deposit of callus at the junction with the outer lip. This lip may be straight, slightly sinuous, retrorse, or very slightly incurved at the suture. Color bands, not always present, number four.

On a label, H. H. Smith wrote: "Carnivorous, generally on other species of Pleuroceridae. In all that I have observed, the animal is dull orange in color."

The operculum is large, black, broadly triangular. The spiral lines are small, tightly-coiled, neomelanian. No special distinction could be observed in the radula except the exceptional length of cusps among the lateral teeth. The inner marginals had five to seven denticles, large and taloned. Denticles of the outer marginals did not exceed nine in number.

Tryon made *hartmaniana* a synonym of *G. ampla* (Anthony), a species of the Cahaba River. As pleurocerids go, the two have little in common except large size.

	Measurements in mm.	
	Altitude	Diameter
Leoto Shoals, St. Clair Co. ....	29.50	15.00
Ten Island Shoals, St. Clair Co. ....	25.00	13.75
Three Island Shoals, Talladega Co. ....	27.25	16.00
Ft. William Shoals, Talladega Co. ....	38.00	18.50
Weduska Shoals, Shelby Co. ....	38.75	18.00
Mouth of Yellowleaf Cr., Chilton Co. ....	38.00	18.50
Wetumpka, Elmore Co. ....	34.00	16.00

#### SYNONYMS OF *GONIOBASIS HARTMANIANA*

*Melania virgulata* Lea (in part). Proc. Acad. Nat. Sci. Phila., 13, 1861: 119. Of the four type specimens, three are *hartmaniana* and one is *bullula*.

*Melania mellea* Lea. Proc. Acad. Nat. Sci. Phila., 13, 1861: 120. Lea's shells are young specimens of *hartmaniana* from Wetumpka. The author speaks of their "honey-yellow" color and again, of the "unusual yellow, smooth epidermis." The light periostracum is one of the characteristics of juveniles of the species.

**GONIOBASIS MACGLAMERIANA, NEW SPECIES**

(Pl. I, Fig. 20)

**SHELL.**—Cylindrical, the diameter of body whorl one millimeter greater at the periphery than at the shoulder. Remaining whorls of type, two and one-half, the last one flattened. Sculpture strongly plicate on the upper part of whorls, microscopically striate on the base. Growth lines a little coarse, crossed by fine, waving lines, this texture showing clearly only on the newest shell growth. Aperture elongate-ovate, decidedly produced at the base, the shape conforming to the flattened body whorl. Four wide color bands. Columella broad, white, with a deposit of callus at top. Outer lip a little incurved at the suture, slightly sinuous. The general color of the shell is brown, darker spots appearing between the plicae of the body whorl.

**OPERCULUM.**—Thin, large, reddish brown, the diameter a little less than two-thirds the altitude. The nucleus is neomelanian, the spiral lines tightly coiled and confined to the left margin near the base. Area of attachment elliptical.

Soft parts have not been available for the examination of the radula.

**MEASUREMENTS** (in mm.).—Altitude 25; diameter 13; aperture-altitude 12.50, diameter 5.25.

**TYPE LOCALITY.**—Coosa River, near Center Landing, Cherokee County, Alabama. Holotype in the Alabama Museum of Natural History, paratypes in the Museum of Zoology, University of Michigan.

This mollusk was taken by H. H. Smith in sparing numbers in the Coosa River from Yancy's Landing just below Rome, Georgia, to Riddle's Bend, St. Clair County, Alabama. The greatest numbers were taken at Center Landing. Young from the Coosa at Kirk's Grove, Cherokee County, Alabama, are smooth above the periphery of the whorls for the first four whorls. Subplicae begin at the fifth whorl, increasing in prominence with new growth. Overlapping begins at the fifth or sixth whorl, the shell altering from conic to a bulbous shape. It is at this stage that striae, hitherto only on the base, develop above the periphery. These upper striae are not always present. Of twenty-two shells from the type locality, eight are striate on the upper halves of the body whorls. The line of the lip varies from straight to conspicuously sinuous. Older specimens show a tendency toward the

development of a sutural fissure. Banded specimens were taken only at Center Landing.

A label written by H. H. Smith reads: "It belongs to the group of *G. hartmaniana*; like that, it has an orange colored animal. Probably like *hartmaniana* it is carnivorous."

It is possible that the species is simply an upriver phase of *hartmaniana*, yet no connecting mollusks have been collected, and the characters as they stand warrant specific designation.

	Measurements in mm.	
	Altitude	Diameter
Yancy's Landing, Floyd Co., Ga. ....	20.25	12.75
Foster's Bend, Floyd Co., Ga. ....	22.25	12.00
Poole's Ferry, Floyd Co., Ga. ....	25.00	14.50
Cedar Bluff, Cherokee Co., Ala. ....	16.50	9.50
Ten Acre Island, Etowah Co., Ala. ....	24.50	12.00
Riddle's Bend, St. Clair Co., Ala. ....	22.00	11.50

All adult shells are much eroded. The species probably runs to ten or eleven whorls.

#### GONIOBASIS PYGMAEA H. H. SMITH, NEW SPECIES

(Pl. I, Fig. 17)

**SHELL.**—Conic, thick, very small for a Coosa River pleurocerid; yellow-brown and without color bands. Upper whorls tightly coiled, flattened, body whorl rounded. Sutures a little irregular. Aperture ovate, slightly produced. Columella white, developed to the junction with outer lip. Outer lip line parallel with the axis of the shell, not sinuous. Sculpture subpubescent on spire and upper half of body whorl; revolving striae over the whole surface of the last whorl.

**OPERCULUM.**—Thin, yellow-brown, the apex obtuse, the basal margin broadly rounded. The diameter of the operculum is slightly more than two-thirds the altitude. The nucleus has distinct spiral lines close to the left margin near the base.

**TYPE LOCALITY.**—Coosa River, Three Island Shoals, Talladega County, Alabama. Holotype in Alabama Museum of Natural History; paratypes in Museum of Zoology, University of Michigan.

**MEASUREMENTS OF TYPE** (in mm.).—Altitude 11; diameter 6.50; aperture-altitude 5.50, diameter 3.72 mm.

This species, small for the goniobases of the Coosa River, appears to be nearest in relationship to the large *G. haldemania*. In spite of its smallness, *pygmaea* has the characteristics of maturity—a development of

eight or nine whorls, a fully developed columella, and an operculum showing three to four rest periods. There is a good deal of uniformity among the specimens examined. No variation occurs in the line of the outer lip. Of thirty shells, seventeen have striae from near the suture to the base, eleven are striate on the base only, and two are wanting in this revolving sculpture. No banded specimens have been seen. The first two or three post-embryonic whorls are angulate at the periphery. A small amount of overlapping is noted on the mature whorls, yet not sufficient to alter the shape of the shell.

H. H. Smith's only note on his species says that it is found "on gravel shoals, gentle current; a few on rocks, swifter current." Numbers of *pygmaea*, probably taken in the type locality, are in the Schowalter collection under the name *G. corneola* (Anthony), which is identical with the young of *G. pupoidea* (Anthony).

The two largest specimens measure in mm.: altitude 12, 11, diameter 7, 6.50.

#### GROUP OF *GONIOBASIS CATENARIA* (SAY)

The members of this group have the widest geographical range of any group of goniobases, the range extending from southern Virginia to eastern Texas. Certain species are common in the coastal plain of Georgia and, particularly so, among springs, streams, and lakes of Florida. Others have penetrated to the border of Kentucky in eastern Tennessee, and one species inhabits the big springs at Tusculumbia and Huntsville in northern Alabama. Still another is to be taken in springs and spring branches discharging into the Cahaba River in the vicinity of Montevallo, Shelby County, Alabama. On the basis of the operculum, which is paleomelanian, this group is very ancient. That primitiveness probably explains the broad distribution. The one member of the Coosa River, *G. crenatella* (Lea), is possibly a vestigial *Goniobasis*, the last representative of a once more flourishing assemblage of closely related species. It stands out with peculiar distinctiveness against the background of coarse and heavy Coosa River pleurocerids.

#### *GONIOBASIS CRENATELLA* (LEA)

(Pl. I, Fig. 16)

*Melania crenatella* Lea. Proc. Acad. Nat. Sci. Phila., 12, 1860: 93.

This is a species of small size that is interesting on a number of counts. It is of a form usually taken only by pleurocerids inhabiting creeks, yet it apparently flourishes as well in the Coosa River as in some of the river tributaries. It varies little in size as between creek and river localities. It is one of three species of the family, the others being *G. troostiana* (Lea) and *Anculosa sulcata* H. H. Smith, whose striate sculpture is uniformly persistent. (See Goodrich, 1935b).

The shell is conic, carinate, plicate-striate. The plicae do not extend to the body whorl in the largest and oldest specimens seen. Striae are strong. They are carried from post-embryonic whorls to the bases of the mature whorls. The number of whorls appears to reach nine or ten. The aperture is small, ovate; the outer lip straight, but not exactly parallel with the axis of the shell. Held upright before one, the lip is seen to angle slightly to the right. The operculum is nearly as wide as high; the spiral lines well-defined and paleomelanian.

H. H. Smith has written on the back of a label:

Found through the shoals region of the Coosa, generally in rather quiet and shallow water, clinging to stones, oftenest on the lower side. I have collected it in one or two branches, for instance, Big Will's Creek, fifty miles up (above Ft. William Shoals).

The known Coosa River localities for *crenatella* are all in Alabama: Ten Island Shoals, St. Clair County; Three Island Shoals and Fort William Shoals, Talladega County; Weduska Shoals, Shelby County; Higgin's Ferry, Chilton County; Weoguska Shoals, Coosa County. Besides the Big Will's Creek mentioned by Smith, other tributary locations in which he collected the species in Alabama are: Kelly's Creek, St. Clair County; Choccolocco and Tallaseehatchee creeks, Talladega County.

	Measurements in mm.	
	Altitude	Diameter
Ten Island Shoals .....	11.00	5.00
Clarence Shoals .....	10.50	5.00
Ft. William Shoals .....	10.00	4.00
Weduska Shoals .....	8.00	4.00
Higgin's Ferry .....	8.50	4.25
Kelly's Cr. ....	8.00	3.50
Choccolocco Cr. ....	8.50	3.75

All of the species which follow apparently stand alone. They do not group with any of the foregoing species or with one another.

#### *GONIOBASIS IMPRESSA* (LEA)

(Pl. I, Fig. 18)

*Melania impressa* Lea. Proc. Amer. Phil. Soc., 2, 1841: 83.

This is one of the species of Coosa River goniobases that, in several regards, borders upon the genus *Gyrotoma*, which is endemic to the same stream. It is short-spined. An incipient fissure sometimes appears at the top of the outer lip. The operculum is large and neomelanian. The inner marginals of the radula suggest the clawed human hand as they do in

*Gyrotoma*. It may be that *Gyrotoma lewisii* (Lea), sculptured in the way that *impressa* is sculptured, may be only a form of this species in which the sutural notch is unusually deep. The rarity of the species is support for such a supposition.

The youngest specimen of *impressa* that has been seen is smooth for one and one-half whorls, loosely coiled. The next full whorl is stoutly carinate at the periphery and has a distinct raised line at the top, with faint revolving lines below. The fourth and fifth whorls have become striate, the carinae have altered to a bluntly rounded keel.

The crowded striae, which are the conspicuous ornamentation of the species, are not uniform, which is to say that there are smoothed areas on the shell of some individuals. The variation may occur in any colony and has no correlation with the parts of the river inhabited. Plicae are more distinct on lower river shells than on those of the middle river. They are broad, undulate, and, on the body whorl, irregular and lumpish. Color bands may be capillary lines or of the spaced, goniobasic pattern. The lip varies from straight to incurved at the suture. The keeling in the young is carried into a later age in areas above Fort William Shoals than in parts of the river below.

	Measurements in mm.	
	Altitude	Diameter
Ft. William Shoals, Talladega Co. ....	28.50	14.50
Ft. William Shoals, Talladega Co. ....	28.00	17.50
Duncan's Riffle, Chilton Co. ....	28.50	15.00
Butting Ram Shoals, Coosa Co. ....	28.50	15.50

The species is confined to the Coosa River, entering none of its tributary streams. The range is from Leoto Shoals, St. Clair County, Alabama, to shoals of Coosa County. No shell from Wetumpka has come to my notice, but as pleurocerids of Coosa County localities extend usually as far as Wetumpka, the absence of *impressa* from collections made in that place possibly mean only an oversight on the part of collectors.

#### SYNONYM OF *GONIOBASIS IMPRESSA*

*Melania crebristriata* Lea. Proc. Amer. Phil. Soc., 4, 1845: 166. Tryon made this mollusk synonymous with *impressa*, no doubt correctly. The type locality given by Lea, Tuscaloosa, Alabama, is erroneous. While Lea in his description of *crebristriata* gives the number of striae as from sixteen to twenty, he makes that number fifteen in comparing his species with *G. capillaris*.

*GONIOBASIS CAPILLARIS* (LEA)

(Pl. I, Fig. 3)

*Melania capillaris* Lea. Proc. Acad. Nat. Sci. Phila., 13, 1861: 122.

The chief distinguishing character of this species is the spiral ornamentation which involves the whole surface of the shell from post-embryo whorls to the base of the body whorl. On account of these striae, Tryon (1873) placed *capillaris* near *impressa* taxonomically; but unlike the latter species, *capillaris* has a babylonical spire, an operculum nearer to the paleo-melanian than to the neomelanian type, and a radula which carries no suggestion of relationship with the genus *Gyrotoma*.

Young are very tightly coiled, slightly keeled, sometimes carinate. Their sculpture is plicate-striate. The plicae are prominent in creek shells, obscure in river specimens. They early become obsolete. The striae appear on the second or third whorls in river forms, not until about the fifth whorl in those of the creeks. In some young specimens, this sculpture was seen to be delayed to the seventh whorl.

The aperture of the river *capillaris* is rather more elliptical than ovate, and is markedly produced. The columella is narrow, white, developed to the top of the aperture. The outer lip is straight or incurved near the suture. Color bands consist of capillary lines that are deposited in the upper slope of the revolving striae, showing as a rule only in the aperture, which means that while the shell material carries the pigmentation the periostracum does not. One specimen has been seen in which an excess of coloring material has permeated all the crystalline part of the shell. The river range of the species is from Cherokee County to Elmore County, Alabama.

Except that the shells are more often carinate than "stepped," *capillaris* of Chattooga River is very like that of the Coosa River, but in Big Cedar Creek, Floyd County, Georgia, there are conic rather than elliptical shells. The aperture is definitely ovate, not much produced. The plicae stand out plainly. Of twenty shells, fifteen have the usual capillary bands, two have areas of unbanded spaces, and three have bands following a common formula of five broad lines. This tendency to break into the conventional goniobasic banding habit is shown also in *capillaris* from Choccolocco Creek, Talladega County, Alabama. The plicae of these specimens are well marked, but the striae are subdued as though becoming obsolete.

The operculum is of moderate size, leaflike, thin, striate, reddish. The spiral lines involve nearly half the diameter of the lower third of the operculum.

The radula is without peculiarities setting it off from the radulae of most goniobases. The inner marginals have not the rounded, claw-like appear-

ance of those in *impressa* and species of *Gyrotoma*. The formula might be set down as:

$$\frac{12}{1} - \frac{6-8}{1} - \frac{4-5}{1} - \frac{3-1-3}{1} - \frac{4-5}{1} - \frac{6-8}{1} - \frac{12}{1}$$

	Measurements in mm.	
	Altitude	Diameter
Coosa R., Ft. William Shoals .....	21.75	12.00
Coosa R., Ft. William Shoals .....	19.75	11.00
Chattooga R., Cherokee Co., Ala. ....	20.25	12.00
Big Cedar Cr., Floyd Co., Ga. ....	18.00	11.00

### *GONIOBASIS FUSIFORMIS* (LEA)

(Pl. I, Fig. 7)

*Lithasia fusiformis* Lea. Proc. Acad. Nat. Sci. Phila., 13, 1861: 54.

Lea had six specimens which appear to have come from the Coosa River at Wetumpka. Here the shell has broad, revolving folds over the whole disk, a narrow aperture which is produced into a slight sinus at the base of the columella, and is dwarfed as compared with upstream examples. On the strength of the sinus, Lea considered the species to be close to the genus *Io*. Tryon (1873) remarked that "it is not improbable that this may eventually prove to be the young of some other species—*Showalterii*—or even *Downiei*." By the former, Tryon meant a *Goniobasis* of the Cahaba River, and by "*Downiei*," a smooth variant of *Lithasia armigera* (Say) of more northern waters. I am inclined to think that *fusiformis* is merely a characteristic Coosa pleurocerid that has developed a serrate operculum, peculiar and unique among goniobases, but known in two species of *Anculosa*.

The operculum is black, leathery, triangular to elliptical. The apex is obtuse, the base broadly rounded. Serrations are an extension of the riblike growth lines. In young specimens, this extends from the nucleus, around the basal margin, and along the right margin to the apex. The projections are subject to wear. Of thirty-nine opercula from Weduska Shoals, twenty-two show different degrees of wearing on the right margin. In *Anculosa foremani* Lea, serration involves the same marginal areas as in *fusiformis*. In *A. ligata* Anthony, only the basal margin is serrate.

The species is confined to the Coosa River from Weduska Shoals, Shelby County, to Wetumpka, Elmore County, Alabama. Young are rarely to be found. Adults are usually eroded to one or two whorls. One or two juveniles show subplicae. Only the specimens from Wetumpka are noticeably striate. Upstream, the shells are mostly smooth, showing only occasional evidences of striation at base and shoulder. Shape is conic or



nearly cylindrical, the spire much shortened. Mature specimens have a difference of only about a millimeter between diameter at periphery and diameter at shoulder of body whorl. The body whorl is much enlarged, flattened, sometimes ligulate. The aperture is elongate-ovate to elliptical, narrowed into a chink at the top. The sinus is not conspicuous in upstream shells. The columella is white, broad, sometimes projecting at the center and thickened at the junction with the outer lip. As a rule, the outer lip is slightly incurved at the suture and retrorse from periphery to base. Lea says his shells have four bands. Those taken by Smith had three broad, strongly-marked bands in most instances.

	Measurements in mm.	
	Altitude	Diameter
Weduska Shoals, Shelby Co. ....	17.50	10.25
The Bar, Chilton Co. ....	20.75	12.00
Cedar Island, Chilton Co. ....	18.50	11.50

*GONIOBASIS BREVIS* (LEA)

(Pl. I, Fig. 4)

*Melania brevis* Lea. Proc. Amer. Phil. Soc., 2, 1842: 242.

One form of this species is cylindrical in shape, is smooth to striate, and has an elliptical aperture. A contrasting form is conic, always stoutly striate, and has a short, ovate aperture. The two phases appear in lots collected in the Coosa River at Wetumpka and on Weduska Shoals. Of the first, H. H. Smith wrote: "it is common in shallows." No notes appear to have been made by him on the second shell. Whether the dimorphism is correlated with differences in habitat is unknown, but one is led to suspect so by reason of configuration and sculpture.

*G. brevis* is small, smooth to about the fourth whorl at which the axial subplicae begin. These are usually obsolete before the eighth whorl. Striae if present are on the bases at an early stage, and may cover the whole shell by the sixth or seventh whorl. On the mature shell of form one, this revolving sculpture consists of broad, flattened folds that show a tendency in most adults to disappear, and in some shells do disappear altogether. The texture is of fine growth lines crossed by minute revolving lines, usually straight. It is smoothed out by wear in the oldest individuals. Bands, where they appear, are usually four in number. One specimen with six bands has been seen and one with five. The ratio of banded to unbanded specimens is about one to nine in material from Fort William Shoals, three to two at Weduska Shoals, and three to seven at Wetumpka. The ratios are of uncertain value since the number of shells in any one of the lots examined has

not exceeded seventy. The outer lips of very young shells are straight. They become retrorse in older specimens and, in a few adults, the last extension of the lips shows an indentation at the suture.

The operculum is very thin, elongate, showing two principal periods of growth, possibly corresponding to rest seasons. The apex is acute, the basal margin usually flatly rounded, but sometimes nearly as acute as the apex. Spiral lines are obscure and crowded into the basal area near the left margin. This type of operculum has been seen in *Melanoides lateritia* (Lea) and *riquetii* (Grateloup) of the Philippines. It seems likely that the operculum is degenerate in all these instances.

	Measurements in mm.	
	Altitude	Diameter
Coosa R., Ft. William Shoals, Talladega Co.	13.00	8.75
Coosa R., Weduska Shoals, Shelby Co. . . . .	19.00	11.50
Coosa R., Weduska Shoals, Shelby Co. . . . .	20.00	11.50
Coosa R., Wetumpka, Elmore Co. (form 1) .	18.00	10.00
Coosa R., Wetumpka, Elmore Co. (form 2) .	16.00	9.00

*G. brevis* is confined to the middle and lower reaches of the Coosa River.

#### SYNONYMS OF *GONIOBASIS BREVIS*

? *Anculosa solida* Lea. Proc. Amer. Phil. Soc., 2, 1842: 243. Tryon made this a synonym of *brevis* with misgivings. Shells definitely recognizable as types were not seen by me during my examinations of the Lea collection; however, some of the specimens of the collection which were labelled *solida* were, in fact, *brevis*.

*Melania trivittata* Reeve. Monograph Melania, 1861: species 420. This represents a confusion of names and shells. For purposes of illustration, Reeve had a pleurocerid of the Cahaba River, but not the Coosa River *Goniobasis* under consideration. He did not recognize the genus *Goniobasis*, but clung to the older catch-all *Melania*. Since, plainly enough, the shell before him was not an *Anculosa*, but belonged to *Melania*, and inasmuch as *Melania solida* was preoccupied by an earlier species of Lea's it followed that renaming was in order. Hence *trivittata*.

*Lithasia cylindrica* Lea (in part). Proc. Acad. Nat. Sci. Phila., 18, 1866: 133. The types consist of one specimen of *G. haysiana*, two of *bellula*, and two of *brevis*.

#### *GONIOBASIS PUPAEFORMIS* (LEA)

(Pl. I, Fig. 1)

*Goniobasis pupaeformis* Lea. Proc. Acad. Nat. Sci. Phila., 16, 1864: 112. This shell has a superficial resemblance to *G. cylindracea* (Conrad).

The shape is alike in the two species, both have shortened spires and elongate, flattened body whorls, but *pupaeformis* has retained something of the plicate sculpture that *cylindracea* has lost. The upper part of the outer lip is incurved, not indented into an incipient fissure. The operculum is ovate rather than triangular or elliptical, and its spiral lines occupy a greater proportionate area than is the case in *cylindracea*. If on the strength of the operculum this latter species is "modern," then *pupaeformis* is much older.

Whorls are tightly coiled in the young. About the seventh whorl, overlapping begins; after this there is rapid enlargement. A few specimens of this cylindrical shell have been seen in which the diameter at the shoulder is from a quarter to a half millimeter greater than is the diameter at the periphery, meaning here the center of the body whorl. Some of the half-grown shells are bulbous. The aperture is elongate-ovate, a little produced. The columella is white, pearly. A callus deposit is at the top of the columella, varying in prominence with age. *Pupaeformis* has a gyrotomoid texture, most of the fine revolving lines being straight and regularly spaced rather than waving. Plicate sculpture, occasionally absent, is confined to one or two whorls of the spire. Striae are not common, and when present are on the base only. Changes occur in the shape of the outer lip, the ultimate line of it being sinuous, curved, or even retrorse. Bands are seldom well-defined. They are four in number. In about one-third of the specimens examined, the pigment is in the periostracum only.

The range of *pupaeformis* is from the vicinity of Riverside, St. Clair County, to Wetumpka, Elmore County, Alabama, no tributaries of the Coosa River being entered.

It is possible that *G. fabalis* Lea, 1862, has precedence of *pupaeformis*. The types of *fabalis* are four worn shells, much like *pupaeformis* and yet not definitely determinable. The specimens were collected by Dr. Spillman who is known to have visited the Coosa River. The locality for *fabalis* is given as the Tennessee River. It is unquestionably a Coosa form, but which one I have been unable to state with confidence.

	Measurements in mm.	
	Altitude	Diameter
Near Riverside, St. Clair Co. ....	17.00	9.50
Clarence Shoals, Talladega Co. ....	16.25	9.50
Three Island Shoals, Talladega Co. ....	19.00	9.00
Ft. William Shoals, Talladega Co. ....	16.25	10.25
Wetumpka, Elmore Co. ....	16.50	8.50
Coosa R. (Schowalter collection) ....	23.00	11.00

## MISPLACED SPECIES

These species have been credited to the Coosa River or the Alabama River erroneously:

*Melania taitiana* Lea. Proc. Amer. Phil. Soc., 2, 1841: 11. Alabama River at Claiborne is given as the type locality. The shell occurs in creeks near Claiborne.

*Melania laevigata* Lea. Proc. Amer. Phil. Soc., 2, 1841: 11. Alabama River at Claiborne is made the type locality. A creek shell, and probably identical with *taitiana*.

*Melania perstriata* Lea. Proc. Amer. Phil. Soc., 5, 1852: 252. Lea's two localities, "Coosa River, Alabama; Huntsville, Tennessee," are both incorrect. The shells came from Huntsville, Madison County, Alabama.

*Melania varians* Lea. Proc. Acad. Nat. Sci. Phila., 13, 1861: 120. From the Coosa River according to Lea's published account. The label of what is probably the type lot reads as from the Cahaba River, the correct locality.

*Goniobasis tenebrovittata* Lea. Proc. Acad. Nat. Sci. Phila., 14, 1862: 264. Received from Dr. Spillman as from the Coosa River. The shell is identical with *G. fascinans* (Lea) of tributaries of the river. Common in small streams in the vicinity of Fort William and Peckerwood shoals, Talladega County, Alabama, where Spillman appears to have collected.

*Goniobasis vauziana* Lea. Proc. Acad. Nat. Sci. Phila., 12, 1862: 265. Assigned to the Coosa River. The types equal *M. variata* Lea, 1861, of the Cahaba River drainage.

*Goniobasis infusata* Lea. Proc. Acad. Nat. Sci. Phila., 14, 1862: 270. Georgia and Coosa River, Alabama, are Lea's localities. There are two types. They are creek goniobases of the *caelatura* group.

*Goniobasis quadricincta* Lea. Proc. Acad. Nat. Sci. Phila., 16, 1864: 112. Lea gives four localities, one of them the Coosa River. The shells credited to the Coosa belong to *fascinans* (Lea), a species of Coosa River branches.

*Goniobasis venusta* Lea. Proc. Acad. Nat. Sci. Phila., 20, 1868: 152. Lea says he has only one specimen and that it came from the Coosa River. What is apparently the original lot of this species, collected by Dr. Schowalter, is in the Alabama Museum of Natural History. It is made up of two or three hundred specimens. The label of the Schowalter examples, doubtless correct, reads "Black Creek, Etowah County, Alabama."

*Goniobasis baculoides* Lea. Proc. Acad. Nat. Sci. Phila., 21, 1869: 125. Another creek mollusk that is assigned to the Coosa River. It belongs to *fascinans*.

One of the sections in which Tryon divided the genus *Goniobasis* is made up of "heavy, pupaeform or cylindrical species." The greater part of these species are Coosa River forms. In the classification, the Coosa mollusks

provide the pattern, and the impression is given that others, which may not be of that stream, are closely akin to them. To correct that error, the following species are discussed:

*Melania fusiformis* Lea. Proc. Amer. Phil. Soc., 2, 1841: 12. From "Tennessee." Supposed by Tryon to be near to *G. ambusta* (Anthony) which belongs to the Cahaba molluscan fauna. The types are the young of *Lithasia geniculata* Haldeman, 1840. One of the specimens shows the beginning of the characteristic sculpture of the species.

*Melania excavata* Anthony. Ann. Lyceum Nat. Hist. N. Y., 6, 1854: 99. The type is a deformed specimen, apparently of one of the Cahaba River species.

*Melania textilosa* Anthony. Ann. Lyceum Nat. Hist. N. Y., 6, 1854: 101, Pl. 2, Fig. 20. Anthony says the shell is from Georgia. It was placed by Tryon in the synonymy of *G. harpa* (Lea). The type is the same as *G. carinocostata* (Lea), 1845, an inhabitant of creeks.

*Melania abscida* Anthony. Proc. Acad. Nat. Sci. Phila., 12, 1860: 56. "Alabama." According to Tryon, it is "very closely allied to *G. crepera* Lea." The type in the Museum of Comparative Zoology, is a gerontic specimen of *Pleurocera alveare* (Conrad), probably from the Tennessee River system.

*Melania grisea* Anthony. Proc. Acad. Nat. Sci. Phila., 12, 1860: 61. "Tennessee River, North Alabama." This is *Lithasia salebrosa florentiana* (Lea), 1841.

#### ACKNOWLEDGMENTS

I am indebted to the Museum of Comparative Zoology and the United States National Museum for access to the types of Anthony and Lea. Through the kindness of Doctor H. A. Pilsbry, I was permitted to examine material that passed through T. A. Conrad's hands, shells that had once been part of the C. M. Wheatley collection and many that G. W. Tryon, Jr., worked with in the course of compiling his monograph of the Strepomatidae. Especially, I owe a debt to Doctor Walter Jones, State Geologist of Alabama, and Miss Winnie McGlamery of the Alabama Museum of Natural History. Doctor Jones entrusted the extensive collections of E. R. Schowalter and H. H. Smith to me with a generosity sometimes embarrassing. Miss McGlamery patiently gathered the mollusks together, packed and shipped them, and in many ways went to pains to supply information.

#### REFERENCES

BAILY, J. H., R. PEARL, and C. P. WINSOR

1932-33 Variation in *Goniobasis virginica* and *Anculosa carinata* under natural conditions. *Biologia Generalis*, 8: 607-630, Pls. 14-15; 9, 1 hälfte: 301-336, Pls. 7-9; 2 hälfte, 47-69.

- COOKE, A. H.  
1895 Molluscs. Cambridge Nat. Hist., 3: 1-459.
- ELLIS, M. M.  
1931 A survey of conditions affecting fisheries in the upper Mississippi River. U. S. Bureau Fish., Circ. 5: 1-18.
- GOODRICH, C.  
1934a Studies of the Gastropod family Pleuroceridae. I. Occ. Papers Mus. Zool., Univ. Mich., 286: 1-17, Pl. 1.  
1934b Studies of the Gastropod family Pleuroceridae. II. *Ibid.*, 295: 1-6, 1 fig.  
1934c Studies of the Gastropod family Pleuroceridae. III. *Ibid.*, 300: 1-11.  
1935a Studies of the Gastropod family Pleuroceridae. IV. *Ibid.*, 311: 1-11.  
1935b Studies of the Gastropod family Pleuroceridae. V. *Ibid.*, 318: 1-12.
- HINKLEY, A. A.  
1904 List of Alabama shells collected in October and November, 1903. Nautilus, 18: 37-45, 54-57.
- HOWE, S. W.  
1930 A study of the variations in the radula of a snail with particular reference to the size of the median teeth. *Ibid.*, 44: 53-63.
- LEWIS, J.  
1869 Catalogue of the shells of the Coosa River, Alabama. Am. Journ. Conchology, 5: 166-169.  
1877 Fauna of Alabama: I. Fresh water and land shells. Geol. Survey of Alabama, (reprint): 1-26.
- PILSBRY, H. A., and J. BEQUAERT  
1927 The aquatic mollusks of the Belgian Congo. Bull. Am. Mus. Nat. Hist., 53: 69-602, Pls. 10-77.
- SMITH, H. H.  
1909 The Schowalter collection. Nautilus, 22: 117-118.
- TRYON, G. W., JR.  
1865-66 Monograph of the family Strepomatidae. Am. Journ. Conchology, 1: 299-341; 2: 14-52, 115-133.  
1873 Land and fresh-water shells of North America, Pt. IV. Strepomatidae. Smithson. Misc. Coll., 253: i-iv, 1-435.
- WELCH, P. S.  
1935 Limnology. McGraw-Hill Co., New York: i-xiv, 1-471.
- WIEBE, A. H.  
1926 Variations in the freshwater snail, *Goniobasis Livescens*. Ohio Journ. Sci., 26: 49-68.



## PLATE I

All figures natural size except 16 and 17, which are twice natural size.

- FIG. 1. *Goniobasis pupaeformis* Lea, Coosa River, Ft. William Shoals, Talladega Co., Alabama.
- FIG. 2. *Goniobasis bellula* (Lea), Coosa River, Ft. William Shoals, Talladega Co., Alabama.
- FIG. 3. *Goniobasis capillaris* (Lea), Coosa River, Ft. William Shoals, Talladega Co., Alabama.
- FIG. 4. *Goniobasis brevis* (Lea), Coosa River, Ft. William Shoals, Talladega Co., Alabama.
- FIG. 5. Same species, lateral view. Coosa River, Wetumpka, Elmore Co., Alabama.
- FIG. 6. *Goniobasis olivula* (Conrad), Alabama River, west of Camden, Wilcox Co., Alabama.
- FIG. 7. *Goniobasis fusiformis* (Lea), Coosa River, Weduska Shoals, Shelby Co., Alabama. Operculum much enlarged to show serrate margins.
- FIG. 8. *Goniobasis alabamensis* (Lea), Coosa River, Ft. William Shoals, Talladega Co., Alabama.
- FIG. 9. *Goniobasis gibbera* H. H. Smith, new species. Type. Coosa River, Lonigan Shoals, St. Clair Co., Alabama.
- FIG. 10. *Goniobasis vanuxemiana* (Lea), showing the common and the occasional elongate forms. Coosa River, Wetumpka, Elmore Co., Alabama.
- FIG. 11. *Goniobasis bullula* (Lea), Yellowleaf Creek, Shelby Co., Alabama.
- FIG. 12. *Goniobasis cylindracea* (Conrad), Black Warrior River, Alabama.
- FIG. 13. *Goniobasis vanuxemiana* (Lea), keeled form. Coosa River, Alabama. Schowalter collection.
- FIG. 14. *Goniobasis caelatura* (Conrad), Oostanaula River, Rome, Floyd Co., Georgia.
- FIG. 15. *Goniobasis pupoidea* (Anthony), *luteola* of Lea, Alabama River, Selma, Dallas Co., Alabama.
- FIG. 16. *Goniobasis crenatella* (Lea), Coosa River, Clarence Shoals, Talladega Co., Alabama.
- FIG. 17. *Goniobasis pygmaea* H. H. Smith, new species. Type. Coosa River, Three Island Shoals, Talladega Co., Alabama.
- FIG. 18. *Goniobasis impressa* (Lea), Coosa River, Riverside, St. Clair Co., Alabama.
- FIG. 19. *Goniobasis haysiana* (Lea), Coosa River, Wetumpka, Elmore Co., Alabama.
- FIG. 20. *Goniobasis macglameriana* Goodrich, new species. Type. Coosa River, near Center Landing, Cherokee Co., Alabama.
- FIG. 21. *Goniobasis clausa* (Lea), Coosa River, Ten Island Shoals, St. Clair Co., Alabama.
- FIG. 22. Same species, lateral view. Coosa River, Ft. William Shoals, Talladega Co., Alabama.
- FIG. 23. *Goniobasis pilsbryi* Goodrich, Coosa River, near mouth of Yellowleaf Creek, Chilton Co., Alabama.
- FIG. 24. *Goniobasis hartmaniana* (Lea), Coosa River, Weduska Shoals, Shelby Co., Alabama.
- FIG. 25. *Goniobasis laeta* (Jay), Coosa River, Ten Island Shoals, St. Clair Co., Alabama.
- FIG. 26. *Goniobasis lachryma* (Anthony), Coosa River, Ten Island Shoals, St. Clair Co., Alabama.
- FIG. 27. *Goniobasis jonesi* Goodrich, new name. Coosa River, Ft. William Shoals, Talladega Co., Alabama.



