MICROSCOPIC SCULPTURE OF PEARLY FRESH-WATER MUSSEL SHELLS

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In a note under the description of *Diplodontites cookei*[1] special attention was called to its minute sculpture in the following words: "The sculpture of the exterior is remarkable and of great beauty. The radiating striae between the impressed radiating lines are of a fineness rarely if ever equaled in shells with the rude structure of the naiads." In the same paper the new species *Monocondylaea felipponei* was described, but nothing was said of its possessing minute radiating striae. In fact, the fine sculpture of this shell was not detected as it was not shown by the fairly strong hand lens used in making an examination. Later the use of a two-thirds inch objective on a compound microscope showed that this species has microscopic sculpture of the same general character as that of *Diplodontites cookei*. Even with a two-thirds inch objective careful focusing is needed to reveal the fine striae. The new species *Anodontites colombiensis* described in the same paper was then subjected to microscopic examination and was found to possess minute striae of the same nature as in the two species mentioned above.

The presence of microscopic striae in the three species mentioned above led to an examination of many other species of South American shells, and it was found that in those belonging to the family Mutelidae the striae were generally present, while in *Diplodon* and other genera of the Unionidae they were lacking. The investigation was then broadened to include an examination of many species representing practically all genera of naiads from all parts of the world. The results have been thought sufficiently interesting and important to warrant publishing them. The results are of value in themselves and the discovery of the minute striae will call attention to the fact that many details may lie close at hand and yet remain unnoticed for years. The genera *Anodontites* and *Monocondylaea* have been known for many years, but, so far as I have been able to determine,

[1] Proc. U. S. Nat. Mus., vol. 61, 1922.

no mention has ever been made of the microscopic features of the periostracum which are shown so clearly in many of the species. *Anodontites crispatus* Bruguiere, described in 1792, the type of the genus, has sculpture nearly as fine and beautiful as that of *Diplodontites cookei* and yet that fact has remained unrevealed for a period of 132 years. In the genus *Monocondylaea* the two species *M. paraguayana* Orbigny and *M. franciscana* Moricand were described in 1835 and 1837, respectively. Both species show the microscopic, radiating striae, the latter especially having them in unusual perfection. Apparently no mention of them has ever been made until the present time.

A somewhat parallel case, though relating to a different style of sculpture, is presented by the Chinese genus *Schistodesmus*, which possesses a concentric sculpture of microscopic striae wonderfully fine and beautiful. Baird and Adams (1867) in their description of the species *lampreyanus* failed to mention them, and they seem to have escaped any notice until 1900, when Simpson, in his description of the genus *Schistodesmus*, called attention to them thus: "Marvelously delicate, concentric, microscopic lirae." The genus *Cuneopsis*, also of China, has a similar sculpture, though on a cloth-like periostracum, and it seems that these two genera should stand next to each other instead of being separated by the genus *Gibbosula*, which Simpson has placed between them.

As has already been said, an examination has been made of the microscopic sculpture of shells of practically all the genera of naiads from all parts of the world. So far as those of the Unionidae are concerned, not much may be said at present. For our immediate purpose it is sufficient to say that in this family regularly arranged microscopic details are usually lacking, and none of them has a periostracum made up of fine radiating threads. With the naiads of the family Mutelidae the case is different. Here many species have an almost infinite number of radiating threads, and while the threads seem to be absent in a few species it is believed that with good material every species belonging to this family would reveal this type of periostracum and that it is a family characteristic.

This peculiar periostracum is so striking in many of the genera and species of the family that if it be shown that any species absolutely lacks it then the right of that species to a place in the Mutelidae becomes subject to some doubt.

The family Mutelidae as at present understood contains 14 genera, of which 6 are restricted to Africa, namely, *Spatha*, *Mutela*, *Chelidonopsis*, *Brazzea*, *Arthropteron*, and *Pleiodon*, while 6 are restricted to South America, namely, *Monocondylaea*, *Iheringella*, *Fossula*, *Leila*, *Mycetopoda*, and *Diplodontites*. *Anodontites*, the largest genus of Mutelidae, is restricted to America, some species

being found as far north as Mexico and others in Central America, while yet others are found in South America only, many of them as far south as Rio de la Plata, and one species as far as Patagonia.

Of the two genera *Brazzea* and *Arthropteron* no material was at hand for examination. Of the other 12 genera many species were given careful scrutiny. In the genus *Chelidonopsis*, of which only three specimens were available, there seems to be no sign of radiating threads. In the genus *Mycetopoda* threads were found on only a couple of specimens and then they were not of the usual type. The other 10 genera all showed the threads clearly in most of the species. The threads in the African genera *Spatha* and *Mutela* are much finer and more numerous than in the American genera, but the African genus *Pleiodon* has threads which are almost exactly like those of the South American genus *Monocondylaea*.

In general it may be said that the radiating striae resemble the threads in finely woven serge cloth when it is viewed with the naked eye, or perhaps it would be better to say that they resemble the fine ridges which occur on our finger tips. When viewed under the microscope the shells whose periostracum retains the threads look as if they had been marked with fingerprints.

In some cases the radiating threads are very clear and can be found on all parts of the shell. *Diplodontites cookei* and *Monocondylaea franciscana* are notable in this respect. In other cases the threads have disappeared from most of the shell, and sometimes there are but very small patches of threads left here and there. Frequently it is necessary to make a very careful search over the whole surface of a number of specimens in order to find a spot in which the striae have been preserved. In some of the groups of large *Anodontites* typified by *trapesialis* (containing *jewettianus*, *forbesianus*, *glaucus*, and others) no striae have thus far been observed. It is not possible to say at this time whether threads are lacking in these shells or have been worn away or lost in the shedding of a fugacious periostracum. In *Mycetopoda* the threads are not of the usual type. This genus will be discussed later in this paper in dealing with the species of shell which is called *Solenaia falcata* Higgins.

In the preceding paragraph reference has been made to a fugacious periostracum. Some explanation of this kind of periostracum is advisable, as its presence is not generally known. Very often there is a sort of bloom found in spots, or sometimes covering a large portion of the shell. Perhaps it has generally been mistaken for a deposit of some extraneous material. It seems to be a part of the periostracum. When present the bloom is likely to show the microscopic threads more clearly than do the parts of the shell from which the bloom has disappeared. It appears to be usually only temporary. On a specimen of *Anodontites tenebricosus* Lea

from Arroyo Miguelete, Montevideo, Uruguay (Cat. No. 270908, U.S.N.M.), the fugacious periostracum persists over a large portion of the shell, making this portion appear as if covered with very thin dead skin. On the portion where the fugacious periostracum has disappeared the surface has the appearance most usually seen in this species. In *Spatha wahlbergi* of South Africa the bloom persists in only a few spots and is so thin that it forms but the thinnest of films. In *Anodontites tenebricosus* Lea it is much thicker, more easily visible, and sometimes remains over a large area. In *Monocondylaea* it becomes somewhat like pale yellowish or whitish paper, and in many places where it has partly torn away from the shell it stands up on the surface in little concentric plates. This is what gives *Monocondylaea* the generally roughened appearance so often noted and sometimes mentioned in descriptions as being lamellate. In this genus there are numerous cracks arranged concentrically, with many cross cracks uniting them. In many of these cracks the fugacious periostracum persists throughout the life of the shell. This makes *Monocondylaea* one of the best genera for examination in a study of radiating threads, as they are almost always to be found on the paper-like fugacious periostracum remaining in the cracks. In some spots on the type of *Monocondylaea felipponei* Marshall little sheets of this kind of periostracum still lie flat and apparently loose except along one edge. In the genus *Diplodontites* there are but the faintest traces of a fugacious periostracum of any kind. Each genus seems to have its own peculiarities in this kind of periostracum.

In giving details of the radiating striæ of each genus frequent mention is made of the sinulus of the various species, and a few general remarks concerning this feature of the shell may well be made here. In most of the shells of the family Mutelidae the sinulus is distinctly triangular, but in a few cases where the shells have a very elongated form the sinulus, too, is elongated, and its triangular shape is not so apparent. In *Mycetopoda*, although the shell is elongated, the sinulus is distinctly triangular. The Mutelidae and the Aetheriidae are the only families in which the sinulus is typically triangular. The latter family contains the three genera, *Mulleria*, *Aetheria*, and *Bartlettia*. None of these has radiating striae so far as can be determined at this time. There seems to be no doubt as to some relationship between *Bartlettia* and *Mulleria* and the family Mutelidae. The form of the young of *Bartlettia* and *Mulleria*, the locality (South America) in which the two genera are found, the type of sinulus, and the texture of the shell seem to indicate a nearer relationship between these two genera and the Mutelidae than between *Aetheria* and the Mutelidae. The genus *Pseudodon* of eastern Asia sometimes has a triangular sinulus. It will be discussed in connection with the genus *Monocondylaea*.

Genus SPATHA

Plate 4, fig. 3

Microscopic radiating threads in this genus are finer than those of the South American genera. They are quite clear, though showing some tendency to become reticulate. The threads of *Spatha wahlbergi*, which are supposed to be represented on plate 4, figure 3, are the finest that have been observed in any shell. The striae are so fine that a satisfactory photograph could not be obtained. The figure shown here is magnified 50 diameters. Even with a magnification of 100 diameters a photograph did not show the striae. The specimen shows a bloom here and there, and on these spots the striae become very striking. It is estimated that there are in the neighborhood of 300 striae to the millimeter in this species. In this genus the species differ greatly in form, size, degree of polish, and in sculpture. It is interesting to note that the striae appear in *wahlbergi*, which is a very large, quite smooth shell; in *vignoniana*, which is rather small and extremely roughened with stout ribs; and in *chaziana*, which is a small, highly polished shell. In this genus, no matter what the form of the shell may be, whether long or short or rounded, the sinulus is always triangular, as it should be in Mutelid shells.

Genus MUTELA

In this genus the striae are fine like in the genus *Spatha*, but are not so clearly defined. They are more given to reticulating and do not have the appearance of threads laid alongside each other. They appear like a lot of fibers more or less felted rather than spun. It is quite difficult to find spots in which the threads show at all. All the species of *Mutela* have an elongated form—this length in proportion to height being especially marked in *Mutela rostrata*. The sinulus in this genus is not equilaterally triangular in any of the species, but the triangle is drawn out posteriorly into a long point, yet this does not necessarily mean that the sinulus falls outside of allowable variation of the Mutelid type, but simply that length of shell has affected form of sinulus. No satisfactory figure could be obtained in this genus.

Genus CHELIDONOPSIS

But three specimens of this genus, *Chelidonopsis hirundo*, were available for examination. It is a very peculiar shell, highly polished and very elongated, and has a sinulus which, like that of *Mutela*, does not exactly conform to the usual type in the Mutelidae. Further study with young specimens is necessary to determine the facts in this group.

Genera BRAZZEA and ARTHROPTERON

No material available for examination and data in general lacking.

Genus PLEIODON

Plate 4, fig. 2

In this genus but two species were available for study, *Pleiodon ovatus* Swainson from Senegal, and *P. speckii* from Lake Tanganyika. The latter is a very large old specimen and periostracal characters have disappeared. Of *P. ovatus* there are two rather young having a length of 50 and 60 millimeters, respectively. These two specimens have the radiating threads present over a large part of the surface and they are perfectly preserved and number about 105 to the millimeter. There are also seven adult specimens of this species in the collection, the largest having a length of 110 millimeters. In these specimens it is difficult to find a spot in which threads can be seen. The sinulus in this genus is aberrent from the Mutelid type, though in *P. speckii* it approaches it. The figure (pl. 4, fig. 2), is from a young *P. ovatus* from Senegal, Africa (Cat. No. 86774, U.S.N.M.). The broad light-colored band near the bottom of the figure represents the remains of fugacious periostracum attached along a growth line. Other remains are seen at the left of the figure.

Genus MONOCONDYLAEA

Plate 1, fig. 2; plate 2, fig. 1

In nearly every specimen of this genus the radiating threads persist on some part of the surface, regardless of the age of the specimen. Often they are to be found only on the paper-like remains of the fugacious periostracum which has been sheltered in the peculiar concentric and cross cracks nearly always found in these shells. In *Monocondylaea franciscana* Moricand the threads occur in fine condition, number about 85 to the millimeter, and are found over nearly the whole extent of the shell. On the single specimen of *M. felipponei* Marshall available for examination the threads number about 110 to the millimeter, cover nearly the whole shell, and are clearly defined and easy to find. *M. franciscana* is figured on plate 1, figure 2. The specimen came from Rio Francisco, Brazil (Cat. No. 86334, U.S.N.M.). *M. felipponei* is represented on plate 2, figure 1. It came from Barra del Arroyo Sacra, Paysandu, Uruguay (Cat. No. 340663, U.S.N.M.).

Some comparisons between the Unionid genus *Pseudodon* and the Mutelid genus *Monocondylaea* may not be amiss. The shells of *Pseudodon* present some peculiar and interesting features. The genus is restricted to Eastern Asia and some of the near-by islands.

The shells have an apparently near relationship to some of the South American naiads, especially to those of the genus *Monocondylaea*, because of the single cardinal tooth and the general character of the sinulus in some of the *Pseudodon* species. Because of these features, several species of *Pseudodon* were described as *Monocondylaea*, and many years passed before it became generally recognized that the apparent close relationship of the two genera comes from a superficial resemblance rather than from structural affinities. As time passed the shells were not only placed in different genera, but as they became more fully understood they were classified into different families, *Pseudodon* in the Unionidae and *Monocondylaea* in the Mutelidae. The collection of the United States National Museum contains many specimens representing eleven species of *Pseudodon*. All of these have been subjected to searching microscopical examination to determine the presence or absence of the radiating threads characteristic of *Monocondylaea* and other Mutelidae. No trace of such threads was found in any species. Their absence affords additional evidence of the lack of any very close relationship between *Pseudodon* and *Monocondylaea*.

As has been said above, the sinulus of *Pseudodon* often resembles that of the Mutelidae. In some species of *Pseudodon* the resemblance is quite sharp, but in others it is not clear or is lacking. Even in the cases in which it is most striking (as in *Pseudodon cambojensis* Petit, *P. polita* Mousson, and *P. cumingii* Lea) it lacks the sharply equilaterally triangular form of the sinulus of the Mutelidae, being more or less rounded at the lower point. Some of the other species of *Pseudodon*, such as *P. loomisi* Simpson and *P. crebristriatus* Anthony, have the sinulus as in the other Unionidae.

Genus IHERINGELLA

Of this genus, which shows an intimate relationship to *Monocondylaea*, but one specimen was available. It is *Iheringella isocardioides* Lea (Cat. No. 86326, U.S.N.M.), and comes from the Rio de la Plata, South America. While it is in rather poor condition, fortunately a few small spots are well enough preserved to show that the radiating threads occur in this genus. The striae do not show sufficiently well to photograph.

Genus FOSSICULA

Plate 2, fig. 2

But one of the two species was available; namely, *Fossicula fossiculifera* Lea, represented by four specimens, three of which came from the Parana River and one from Piricicaba, Sao Paulo, Brazil. This is a peculiar genus whose relationships point in two directions—to *Monocondylaea*, because of the cardinal tooth, and to

Anodontites, because of its form, colors, and wide prismatic border, which are exactly like those of *Anodontites patagonicus.* Were the portion of the hinge line bearing the tooth broken away one would be absolutely unable to separate *F. fossiculifera* from *A. patagonicus.* If *Fossicula* and *Leila* be valid genera it seems there should be some shifting in classification in order to bring the former near *A. patagonicus* and the latter near *A. trapesialis,* instead of arranging *Leila* between *Fossicula* and *Anodontites.* The radiating threads do not show well in any of the four specimens at hand, but enough remains to tell that the threads occur in this genus and that they are like those to be found in some specimens of *Anodontites patagonicus.* Plate 2, figure 2, represents a small spot in a specimen from Parana River (Cat. No. 86346, U.S.N.M.). It has about 105 threads to the millimeter.

Genus LEILA

The shells of this genus are uniformly large. In the whole family Mutelidae they are exceeded in size by only one species, *Anodontites trapesialis* Lamarck, with which perhaps they should be placed in a section of the genus *Anodontites,* or perhaps *trapesialis* should be taken from that genus and placed in the genus *Leila.* Surely the shells show a very near relationship to each other. The radiating threads in *Leila* are extremely fine and resemble those of the African genus *Spatha,* rather than those usual to the South American species of Mutelidae. They are of about the same nature as those of *Spatha wahlbergi.* In these large shells the striae are difficult to find because they are so very fine, and they seem to be easily lost as growth progresses. A specimen of *Leila blainvilleana* from the Amazon River (Cat. No. 25815, U.S.N.M.) shows the fine lines, but not clearly enough to be photographed.

Genus ANODONTITES

Plate 1, fig. 1; plate 2, fig. 3; plate 3, figs. 1 and 3

To this genus belong the larger portion of all the species referred to the family Mutelidae. There are recognized some 50 species of *Anodontites.* They have been divided into several sections and groups, but there is ground for believing that further study will result in dividing this genus into several genera. The shells now included in *Anodontites* show a wide range of characteristics, varying in form, size, colors, weight, sculpture, etc. For instance, compare *A. rotundus* Spix with *A. trapesialis* Lamarck; *A. patagonicus* Lamarck with *A. strebeli* Lea, and any of these with *A. tenebricosus* Lea; or compare *A. ensiformis* Spix and *A. falsus* Simpson with any of the other *Anodontites.* The genus has a great geographic range, extending from Mexico to Patagonia. In nearly all of the

species of this genus the radiating threads have been observed, though they have not yet been found in some. No doubt they will be found in all in the course of time. As might be expected in a genus containing so many species and ranging over so large a territory, there is some variation in the character of the microscopic striae, but it may be said that in all cases these striae conform to some one of the few variations found in the Mutelidae. Four specimens have been selected for illustration. Plate 2, figure 3, represents the striae on a typical *A. patagonicus* from Arroyo Miguelete, Montevideo, Uruguay (Cat. No. 335746, U.S.N.M.). Plate 3, figure 3, represents the striae on a specimen of the rotund form of the same species from the Uruguay River (Cat. No. 347885, U.S.N.M.). In this, the striae are unusually clear and cover a large part of the surface. Plate 3, figure 2, represents the threads on a specimen of *A. inaequivalvis* Lea from Lake Nicaragua, Central America (Cat. No. 59873, U.S.N.M.). Although the species is a very small one and comes from so far north, the striae, of which there are about 100 to the millimeter, are strictly according to type. The cracks and crevices of this shell, especially on the posterior dorsal area, are apt to retain remains of fugacious periostracum, which resembles little pieces of onion skin, and in which the striae show very plainly. In the two species composing the section *Virgula*, *Anodontites* (*Virgula*) *ensiformis* Spix and *A.* (*V.*) *falsus* Simpson, so far no radiating striae have been observed. As but five specimens were available for examination, it will be well to wait until additional material is studied before coming to any definite conclusions as to this group. Because of their great length they look unlike other *Anodontites*.

In the series which Simpson arranges as the "Group of *Anodontites crispatus*" twelve of the thirteen species have been examined and all of them show the radiating striæ. In all, the threads were easy to find, were well developed, and were distinctly of the Mutelid type. In this group all the species have the peculiarly puckered, radiating impressed lines, and drooping concentric folds which I have likened to festooned drapery and which Ortmann describes by the adjective "scalariform." Some of the species are rather rough, such as *A. crispatus;* others are highly polished, such as *A. strebeli* Lea and *A. holtonis* Lea. In this group, as in most other *Anodontites*, the striae are most easily found on some part of the posterior dorsal area, but it is not unusual to find them on the disk of the shell in spots covered with the puckered radiating impressed lines. Plate 1, figure 1, represents the radiating striae of a specimen of *Anodontites crispatus* Bruguiere from Venezuela (Cat. No. 24020, U.S.N.M.), in which there are about 90 striae to the millimeter.

This was the first species of *Anodontites* described and is the type of the genus. In many details the periostracum of this species re-

sembles that of *Diplodontites cookei* Marshall, and especially in the radiating striae and in the festooning of the coarser sculpture.

Genus MYCETOPODA

All the species of this genus are long and narrow, and have the general appearance of being out of place in the family Mutelidae, but notwithstanding their great length the sinulus is of the Mutelid type, though somewhat drawn out. Radiating striae of the usual type fail in this genus. In twenty-seven of the twenty-nine specimens examined no trace of radiating threads could be discovered. In two other specimens there were radiating marks resembling thumb prints. A specimen of *Mycetopoda pygmaea* Spix from Carthagena, United States of Colombia (Cat. No. 86795, U.S.N.M.), shows the striae best, but it is not sufficiently clear to be worth figuring.

The relationships of this genus have never been satisfactorily traced, and the peculiar nature of the striae in the periostracum adds another feature which should have further study.

Genus ————?

Plate 4, fig. 1

Under the head "genus unknown" attention is called to the shell known as *Solenaia falcata* Higgins. When Simpson, in 1900, published his Synopsis of the Naiades, or Pearly Fresh-water Mussels,[2] this shell was a puzzle to him. Higgins, in his description of the species,[3] gave its locality as "forest streams, near Chyavetas, Upper Amazons." As pointed out by Simpson, the shell is almost a miniature of *Solenaia emarginata* Lea, which inhabits Siam, and on this account he thought the habitat cited by Higgins was erroneous. He doubtfully substituted the locality Southeastern Asia and removed the species from the genus *Mycetopus* (=*Mycetopoda*) of the family Mutelidae in which Higgins placed it and shifted it to the genus *Solenaia* in the Unionidae. In 1914, when Simpson's Descriptive Catalogue of the Naiades or Pearly Fresh-water Mussels appeared, the species was still a puzzle to him and he again preferred to substitute the habitat "Southeastern Asia?" and remained firmly convinced that it could not have come from South America. Disregarding the close resemblance of *falcata* to *emarginata*, which may be only a resemblance without any backing of close relationship, the weight of the evidence at hand is in favor of a South American habitat for *falcata*. The main points of evidence in favor of this are, first, the type locality given in Higgins's description; second, a specimen in the Isaac Lea collection (Cat. No. 86788, U.S.N.M.), which Lea

[2] Proc. U. S. Nat. Mus., vol. 22, pp. 501–1044.
[3] Proc. Zool. Soc. London, p. 179, pl. 14, fig. 6, 1868.

received from Wheatly. It is figured on plate 4, figure 1. The locality given for this specimen is Amazon. Third, no specimen has ever been reported from Southeastern Asia. Fourth, the character of the periostracum. Were all other evidence lacking, this would be sufficient to establish the fact of a South American origin for the shell. The radiating microscopic threads are exactly like those found in *Diplodontitis cookei* Marshall, *Anodontites tenebricosus* Lea, *Monocondylæa franciscana* Moricand, and many other species of South American naiad. The striae number about 90 to the millimeter.

In what genus "*Solenaia*" *falcata* should be placed remains an open question. The data at hand is not sufficient to answer that question, and we must wait for further details as to anatomy, breeding habits, and beak sculpture. The U. S. National Museum contains six speciment representing four species of undoubted *Solenaia*. The periostracum of these is altogether different from that of *falcata* and shows no sign of radiating threads. To place it in the genus *Solenaia* would involve a faunistic mixing that would be unusual, namely, South America and Eastern Asia, and the difference between the periostracum of *falcata* and that of species whose right to a place in the genus *Solenaia* is undoubted would involve a mixing of not only generic characters but of features which are believed to be family characteristics.

Granting that "*Solenaia*" *falcata* is a South American shell and that it does not belong in the genus *Solenaia*, the next step is to define its position among the South American Naiades. It was described as a *Mycetopus* (=*Mycetopoda*). In a cursory consideration of it one would naturally place it in or very near the genus *Mycetopoda*, this allocation being made chiefly because of its elongated form. Possibly it does belong to that genus, but it is to be doubted. It may belong in the genus *Anodontites*, as it shows some relationship to arcuate specimens of the *tenebricosus* group. Its position here likewise is doubtful. In radiating threads its periostracum differs widely from that of *Mycetopoda*, in which genus what radiating threads have been observed being far from the kind usual in Mutelidae. Of *falcata* it may be said that its sinulus is not distinctly of the Mutelid type, not being clearly triangular nor subequilateral. This may be due to the great length of the shell in proportion to its height. The species may require a new genus to accommodate it.

Since the above was written our library has received a copy of a paper entitled "Nayades del Viaje al Pacifico," by F. Hass, published in Trabajos del Museo Nacional de Ciencias Naturales, Zoological series, Number 25 (Madrid, Spain, Aug. 1916). In this paper the supposed new species *Mycetopoda bolivari* Hass is described on page 36 and figured on plate 2, figure 2. It comes from Rio

Unuyacu, affluent of the Napo River, Ecuador. The Napo is a tributary to the Maranon, which in turn is tributary to the Amazon. The description, the figures, and the locality all show that this shell is the same species as the one described by Higgins as *Mycetopus falcatus* and called *Solenaia falcatus* Higgins by Simpson.

Genus DIPLODONTITES

Plate 1, fig. 3

It was in this genus that the microscopic radiating striae were first observed, and they were described and figured in the original description of the only species, *Diplodontites cookei* Marshall.[4] In this genus the striae are of unusual importance, as the allocation of the genus to its proper family depends upon shell characters and the striae afford additional evidence that it belongs in the Mutelidae. In this genus they are especially clear and cover nearly the whole surface of the shell, about 90 striae to the millimeter. Fugacious periostracum appears to be lacking, as at best there are only a few traces here and there of what may be this kind of material. The genus differs from all other Mutelidae in having three cardinal teeth. It agrees with them in having no lateral teeth, in the nature of the sinlus, and, like most of them, it comes from South America. The figure is from a paratype (Cat. No. 341473, U.S.N.M.), from a tributary of the Rio Colorado in the Province of Santander, Colombia.

SUMMARY

1. The radiating microscopic threads may be considered a family characteristic of the Mutelidae as they appear in all the genera, with the possible exception of the genus *Mycetopoda*.

2. This characteristic, being found in Mutelidae only, is confined to naiads inhabiting Africa, South America, Central America, and Mexico.

3. Data as to breeding, anatomy, and beak sculpture of the genus *Diplodontites* being lacking, its place in Mutelidae depends upon conchological features. The radiating striae add to the number of characters which indicate that it belongs in that family.

4. The nature of the periostracum of "*Solenaia*" *falcata* Higgins shows it to be South American, as stated by Higgins, and not from southeastern Asia, as supposed by Simpson. It also shows that *falcata* belongs in the family Mutelidae, although to what genus remains undecided.

5. The genus *Mycetopoda* does not strictly conform to the usual rule so far as microscopic threads and form of shell are concerned, though its sinulus is triangular, like that of other Mutelidae.

[4] Proc. U. S. Nat. Mus., vol. 61, 1922.

6. The sinulus and tooth of some of the shells of the genus *Pseudodon* of eastern Asia and near-by islands present a problem. It is believed that they do not indicate any close relationship of this genus to the Mutelidae.

7. The triangular sinulus, the absence of teeth, and the South American habitat of the genera *Mulleria* and *Bartlettia* of the family Aetheriidae seem to indicate some close relation of this family with the Mutelidae. The periostracum of *Mulleria* and *Bartlettia* shows no sign of radiating threads. Further study of this family with young specimens is desirable.

8. The number of striae on the shells in which a count has been made was:

	Per millimeter
Spatha wahlbergi Krauss	300
Pleiodon ovatus Swainson	105
Monocondylaea franciscana Moricand	85
Monocondylaea felipponei Marshall	110
Fossula fossiculifera Lea	105
Anondontites crispatus Bruguiere	80
Anondontites tenebricosus Lea	130
Anodontites patagonicus Lamarck	90
Anodontites inaequivalvis	100
"*Solenaia*" *falcata* Higgins	90
Diplodontites cookei Marshall	90

In conclusion it may be well to advise those who wish to make a microscopic examination of the radiating striae in the Mutelidae to begin, if possible, with *Diplodontites cookei* Marshall, then take *Monocondylaea franciscana* Moricand, and then *Anodontites crispatus* Bruguiere, passing from this to any of the other members of the family. The species mentioned will give the idea of what to look for.

EXPLANATION OF PLATES

PLATE 1

FIG. 1. *Anodontites crispatus* Bruguiere. At posterior portion of the disk × 30 diameters.

2. *Monocondylæa franciscana* Moricand. At the upper portion of the disk × 50 diameters.

3. *Diplodontites cookei* Marshall. At the center of the disk × 50 diameters.

PLATE 2

All figures × 50 diameters

FIG. 1. *Monocondylaea felipponei* Marshall. Anterior to the center of the disk.

2. *Fossula fossiculifera* Lea. Anterior to the center of the disk.

3. *Anodontites patagonicus* Lamarck. Posterior to the center of the disk.

PLATE 3

All figures × 50 diameters

FIG. 1. *Anodontites tenebricosus* Lea. At the upper portion of the disk.

2. *Anodontites inaequivalvis* Lea. On the dorsal ridge.

3. *Anodontites patagonicus* Lamarck. High up on the disk.

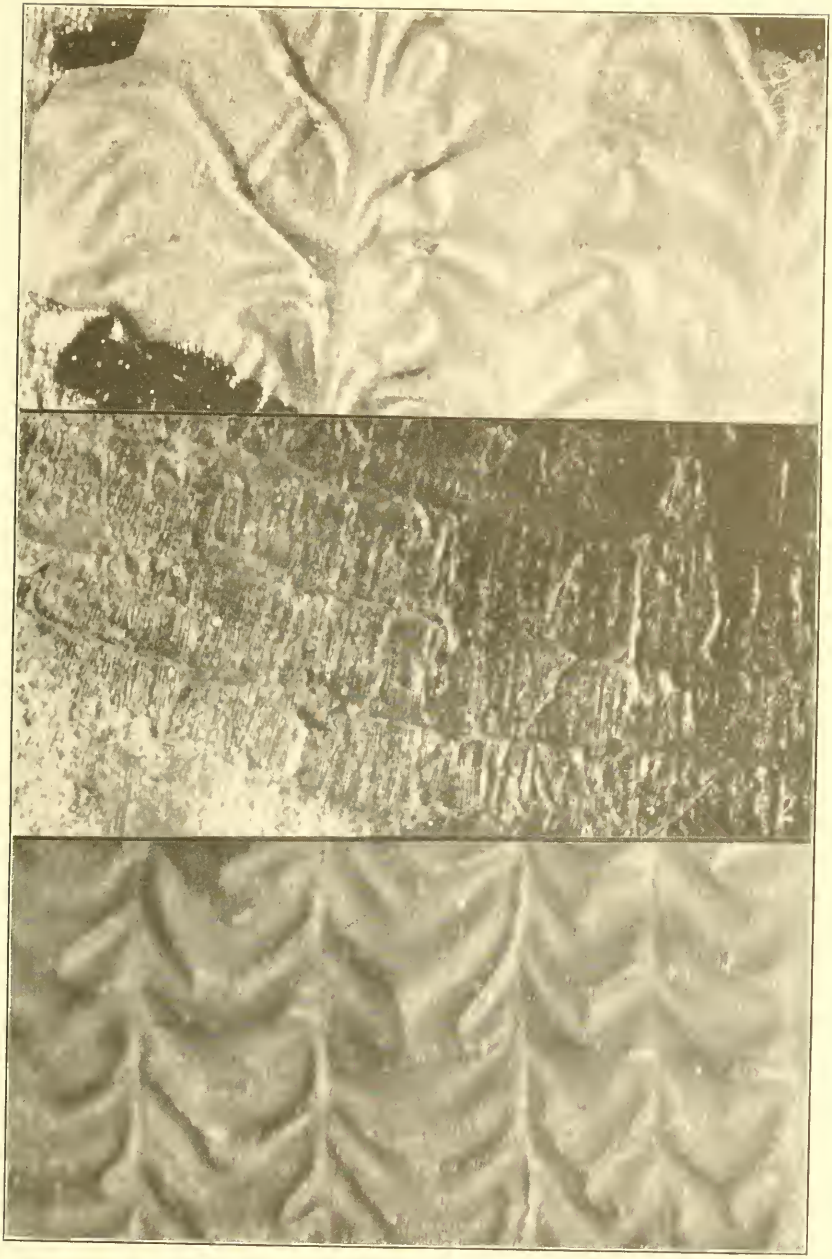
PLATE 4

All figures × 50 diameters

FIG. 1. "*Solenaia*" *falcata* Higgins. At the posterior dorsal angle.
It would have been better if this figure could have been arranged to have the striae running horizontally and the growth lines on a slant. Being near the posterior dorsal margin, the striae, which radiate from the beak, are, at this point, nearly parallel to the dorsal edge, and nearly horizontal.

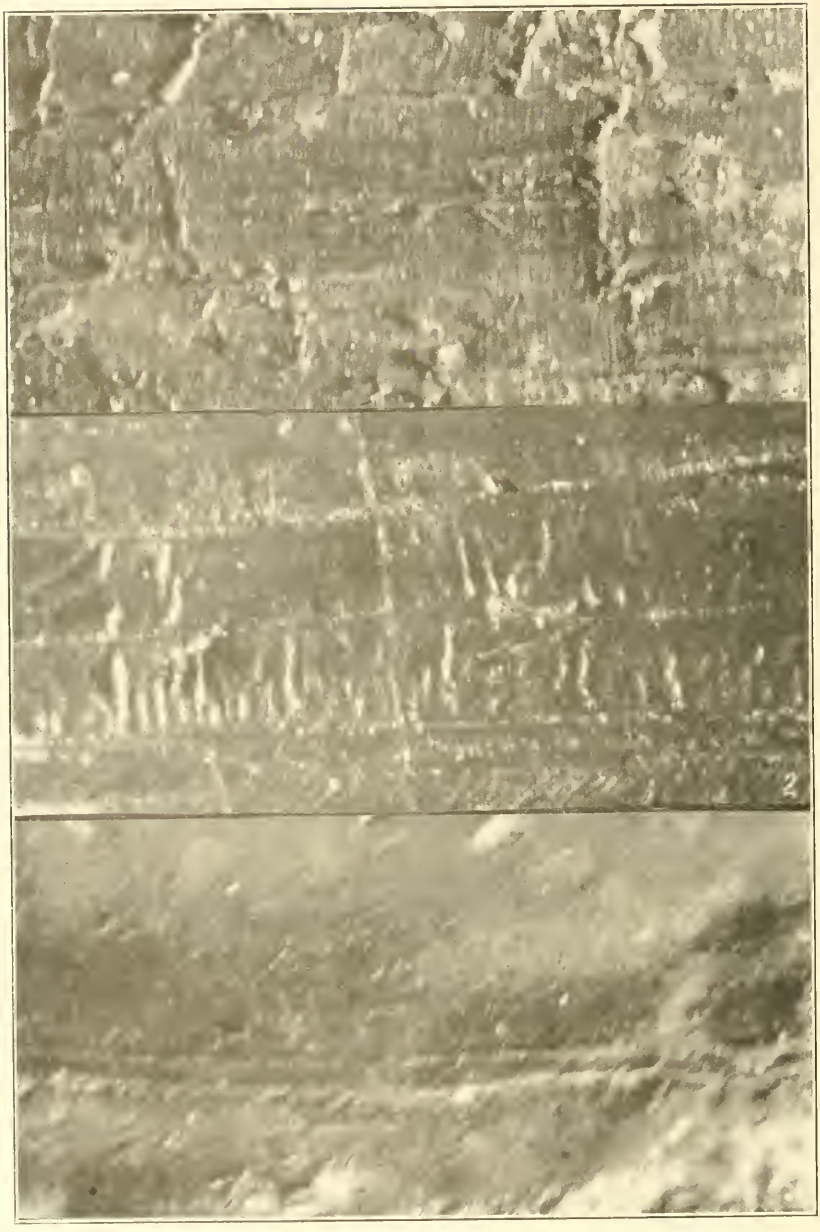
2. *Pleiodon ovatus* Swainson. Below the middle of the posterior dorsal ridge.

3. *Spatha wahlbergi* Krauss. Posterior to the center of the disk.



MICROSCOPIC SCULPTURE OF FRESH-WATER MUSSELS

FOR EXPLANATION OF PLATE SEE PAGE 13



MICROSCOPIC SCULPTURE OF FRESH-WATER MUSSELS

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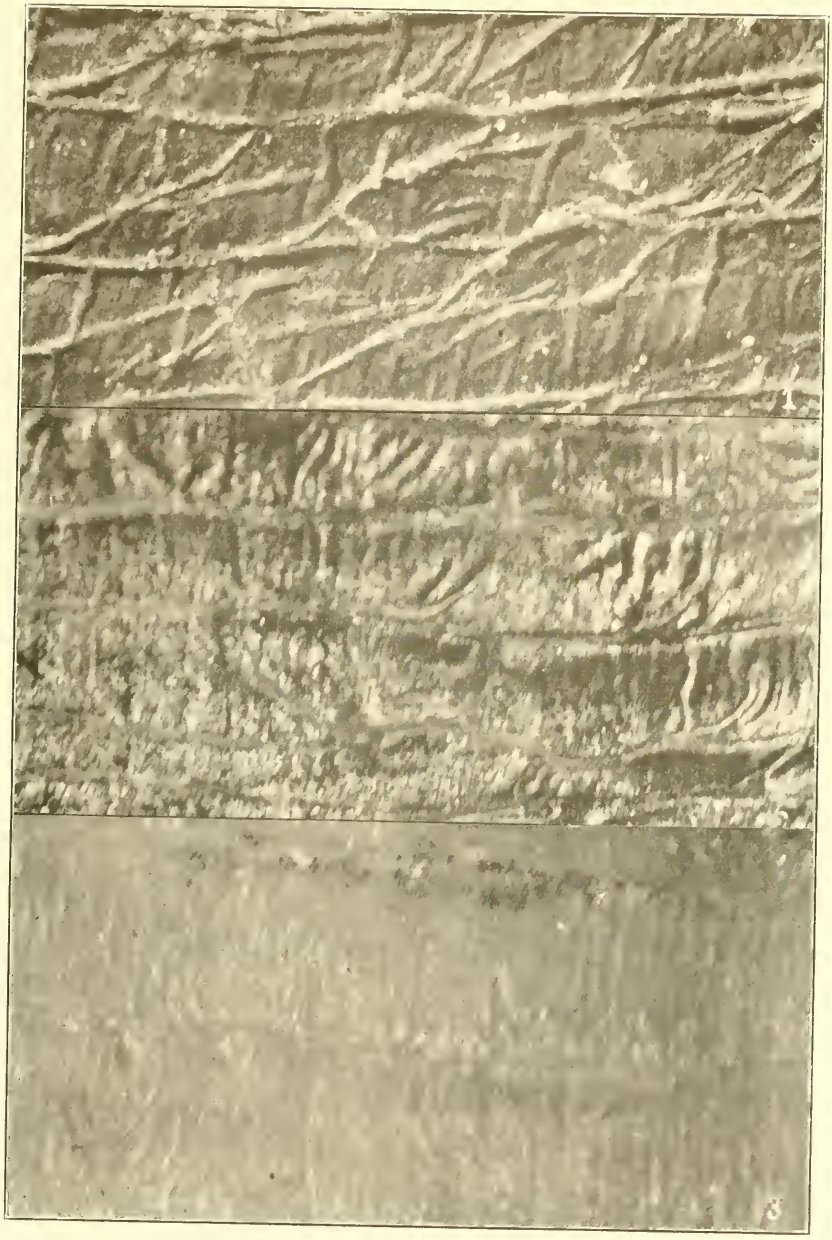

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