

BY CHAS. T. SIMPSON.

In 1834, Dr. Jared P. Kirtland published the statement that the sexes of the North American Unios were distinct, and that the shell of the female was characterized by a swelling in the post-basal region, which was wanting in that of the male.<sup>1</sup> He seems to have thought at that time that all the American species were thus distinguished, but in a later publication he stated that he believed that about two-thirds of the American species have differentiated shells.<sup>2</sup>

This was corroborated by Dr. Isaac Lea,<sup>3</sup> who showed that this enlargement of the shell of the female was for the purpose of holding the charged oviducts, which, in such forms, were found in the posterior part of the outer branchiæ. Lea, at various times, described the soft parts of some 250 species of *Naïades*, mostly North American Unios, and in a considerable number of these he found that the embryos occupied the entire outer branchiæ, while in four species—*Unio multiplicatus* Lea, *U. rubiginosus* Lea, *U. subrotundus* Lea and *U. kleinianus* Lea—they filled all four leaves of the branchiæ.

In a statement made before the Boston Society of Natural History, Agassiz proposed to divide up the *Naïades* into genera founded on the differences of structure of the animal as well as the characters of the shell, and to include under one genus a number of species of Unios, some of which (including *U. ulatus* Say, the first one in the list) have the post-basal inflation of the female shell, and others in which it is lacking. Subsequently he used the name *Lampysites*, of Rafinesque, with *L. cardium* Raf. as a type, and he gives in his list under this genus a number of species, all of which have the differentiated shells, and carry the young in the posterior part of the outer branchiæ.<sup>4</sup>

In THE NAUTILUS, for December, 1895, Dr. V. Sterki published the results of his observations on American Unios, and gives some

<sup>1</sup> Observations on the Sexual Characters of the Animals belonging to Lamarck's family of *Naïades*. Am. J. Sci. and Arts, XXVI, 1834, p. 117-120.

<sup>2</sup> Remarks on the Sexes and Habits of some of the Acephtalous Bivalve Mollusca. Proc. Am. Assn. Adv. Sci., 1851, p. 85.

<sup>3</sup> Description of New Freshwater and Land Shells. Tr. Am. Phil. Soc.

<sup>4</sup> Proc. Bot. Soc. Nat. Hist., III, 1848-51, p. 356.

<sup>5</sup> Ueber die Gattungen unter den Nordamerikanischen Najaden. Arch. für Naturg., 1852, pp. 41-52.

very interesting statements regarding their anatomy. He places those species in which the young are carried in the posterior part of the outer branchiæ, and the female shell is inflated in the post-basal region, in a group designated as A, which he states, as a rule, have bright shells, and are gravid from late summer to winter. In group B all four branchiæ are charged throughout their length; the shells are generally dull colored, and do not show marked differences between male and female.

In my earlier attempts at classifying the *Naïades*, I based my arrangement almost wholly on shell characters. I did this because in the splendid collections of the National Museum we had either the types or authentic specimens of a very large proportion of the known, valid species, and because I was anxious to see whether a classification could be based on the shells alone that would be supported by the evidence of the anatomy. I have since then examined the soft parts of a large number of species, and carefully tabulated the results of the work of Lea and others, and I am exceedingly gratified in being able to say that in almost every case the characters of the animal and shell seem to essentially agree. In a few instances, the evidence of the former has thrown important light on relationships which could not be determined with certainty from shell characters alone, and *vice versa*. In some cases, where there at first seemed to be a contradiction, more careful study has shown essential agreement.

There are certainly two great groups of North American Unios. In the first the shell is generally, though not always, covered with a hard, smooth, bright epidermis, which is often rayed or marked with patterns of attractive color. It is rarely sculptured with anything beyond slight concentric ridges, and in only a few instances has it any ridge on the posterior slope, and, with possibly one or two exceptions, the outline is never arcuate, even in old age. The female shell is usually decidedly swollen in the posterior basal region to accommodate that part of the outer branchiæ which contains the embryos. The beak sculpture is generally delicate, consisting, for the most part, of close, fine, parallel ridges, which have a tendency to fall into an anterior and posterior loop, the latter sharp pointed below.

The embryos are contained in the posterior part of the outer branchiæ. The ovisacks are distinct, being separated by a suture, and the whole marsupium is rounded below, projecting generally,

especially when filled with young, below the inner gill. A slight fold commonly runs around it near the base, and parallel with it, which is often seen even when the whole is distended with young. The specialized marsupium of this group may be easily detected, even when it is empty, and when full it is a most beautiful object, the bases of the ovisacks being often rounded and colored. There are three or four, perhaps more, groups of this great division; one typified by such oblong, smooth forms as *Unio anodontoides*, *luteolus*, *caucosus* and *levisimus*; another in which the inflated part of the shell is of different texture from the rest, is often distinctly marked out, and sculptured with radiating ridges ending in teeth at the edge, including *Unio perplexus*, *sulcatus*, *brevidens* and the like; a third containing short forms with a distinct posterior ridge and remarkably painted epidermis, such as *Unio securis*, *donaciformis* and, perhaps, *capertus* and *dromus*.

This great group is certainly entitled to generic rank, and the division I have indicated may perhaps be made into subgenera. I believe that the name *Lampsis*, proposed by Rafinesque, and afterwards used by Agassiz, may be applied to this genus.

The second great group contains forms in which there does not appear to be any special differentiation in shells due to sexual characters, and which are true Unios. In fact I consider the question as to the distinction or separation of the sexes in the true Unios and Anodontas far from being settled, although it is one which has been fought over since the time of Leuwenhoek until the present. A number of excellent authorities have declared, after making many careful dissections, that the sexes of these forms were separate; others equally capable have concluded that they were united; that the earlier stage was that of a male and later on a female, while still others claim to have found the sexes united in some individuals and separated in others.

The shells of this great group are usually rather dull in color externally, they often have a decided posterior ridge, and generally become arcuate in outline in old age. The beak sculpture, as a rule, is rather coarse and irregular, in most cases consisting of a few nearly straight bars, which are thickened where they pass over the posterior slope. At the extreme anterior and posterior dorsal portions of the young shell there are often found fine, radiating ridges, which sometimes pass below into the heavy, horizontal undulations. The embryos are distributed throughout the whole length of the

gills, the branchiæ when distended with them being perfectly smooth outside, and looking like pads. There seem to be two great groups of these forms, one characterized by simple, oval or oblong shells destitute of any strong sculpture, and probably carrying the young, as a rule, only in the outer branchiæ, and this includes in the United States such forms as *Unio gibbosus* Bar., *U. tetralasmus* Say, *U. buckleyi* Lea, *U. crassidens* Lam. and *U. complanatus* Sol., and these are probably closely related to the European species. The other group has short, rather solid, often inflated shells, with a wide, heavy hinge plate, and it includes nearly all the pustulous, and all the plicate sculptured forms. Lea found the inner and outer gills filled with embryos in four of these species: *U. multiplicatus* Lea, *subrotundus* Lea, *kleinianus* Lea, and *rubiginosus* Lea, and it is probable that, under favorable conditions, all or most of these species carry young to some extent, in the inner as well as the outer gill, though so far as I have observed the inner gill is never so completely filled as the outer, and it is quite probable that with unfavorable conditions the former may not be used as a marsupium.

Besides these there are a few aberrant forms which may be, as Wetherby has suggested, "geological remnants," such as *Unio phaseolus* Hild., *U. irroratus* Lea, and *U. cornutus* Bar., having remarkable modifications of the branchial uterus or marsupium. These three species will probably have to stand as the types of as many genera.

But little is known concerning the anatomy of the foreign Unios. The soft parts of all the European species have been examined, I believe, and descriptions which go into the minutæ, so far as color and trifling peculiarities of form are concerned, have been published, but which give no idea of vital characters or structure. From all that I can learn the anatomy of the European forms is very much like that of the circumboreal *Unio margaritifera*, which is much like that of *Unio gibbosus*, *crassidens*, *tetralasmus* and the like. Of the Oriental and African forms I know almost nothing. I have examined the soft parts of gravid specimens of *Unio gabonensis* Kuster from Tropical West Africa, and found that in them the embryos filled the inner branchiæ alone.

It has been surmised that there was a close relationship between the Australasian Unios and those of South America. The shells of the species of the two faunas agree very closely in all characters; in being destitute of rays, and having a uniform olive-green epider-

mis and a slightly concentrically sculptured surface, simple outlines, rather dull, bluish-white nacre, compressed cardinals and imperfectly radial beak sculpture. Lea examined gravid specimens of *Unio peculiaris* Lea, and *firmus* Lea from South America, and found that only the inner gill was filled with embryos. Suter reported the same thing from an examination of *Unio menziesi* Gray from New Zealand. I recently received some fine alcoholic specimens of that species from him, and on examining them found, to my astonishment, that they agreed with Lea's descriptions of the soft parts of the South American forms as exactly as if they were the very animals that he had described. In all three species the outer gill is greatly produced below in the middle, the anal opening is destitute of papillæ, and there is no super anal opening at all, characters which are conspicuous in the South American species. I had previously placed these Australasian and South American Unios in a subgenus by themselves, for which I used the name *Diplodon*, applied by Spix to some Brazilian forms,<sup>6</sup> but I am satisfied that they are entitled to generic rank, and Spix's name may be used for the group. I do not believe that they belong to the same phylum with the *Unio gabonensis* which, from conchological characters, seems much more closely related to the forms of Southern India. This seems to add another link to the chain of evidence which goes to prove a relationship between the faunas of Australasia and South America, and it is a question whether this relation came about on account of migration, by way of an Antarctic land way from one continent to another, or whether the two faunas are remnants of an earlier and generally distributed northern fauna that was driven south and superseded by more modern forms. The Unios of South America and Australasia are simple forms, both anatomically and conchologically. Long ago Ihering predicted that the earliest Unios would be found to have radial beak sculpture; and two of the fossil species recently described by the writer<sup>7</sup> from what are supposed to be the Triassic freshwater beds of Texas have that which is strictly radial. In the Australasian and South American forms the beak sculpture is imperfectly radial, the central rays curve together and generally coalesce, and in some

<sup>6</sup> The Classification and Geographical Distribution of the Pearly Fresh-water Mussels. Proc. U. S. Nat. Museum, XVIII, 1896, p. 302.

<sup>7</sup> Description of Four New Triassic Unios from the Staked Plains of Texas. Proc. U. S. Nat. Museum, XVIII, 1896, pp. 381-385.

cases they are slightly broken. In some of the Indian and African forms this sculpture becomes irregularly rayed and zig-zagged; in the European forms it becomes somewhat concentric and often broken, while in *Lampisilis* we have the farthest departure from the simply radial, that is, the rays are all looped and joined in the center, where they are drawn up towards the beak. This genus has without doubt the most highly developed animal of any of the Unios, and is, in all probability, the most modern. I have seen no extinct forms which certainly belong to it, and it was probably developed in North American waters, to which it is still confined.

#### ISAAC LEA DEPARTMENT.

(Conducted in the interest of the Isaac Lea Conchological Chapter of the Agassiz Association by its General Secretary, Mrs. M. Burton Williams.)

#### COLLECTING IN MONTEREY BAY.

(Extract from the report of Mrs. E. H. King. From the Transactions of the Isaac Lea Chapter for 1896.)

In the month of September I spent two weeks at Monterey Bay, and collected shells on about three miles of shore line, rocky headlands and sandy beaches. Along the shore I found many patches of soil literally packed with fossil shells. In the black soil they are soft and crumple easily, but in the sand hills near the light house they are quite firm. *Haliotis rufescens* Swains, is the most abundant, but there are also great numbers of *H. cracherodii* Leach, and a variety of limpets; also *Chlorostoma funebre* A. Ad. I found in the sand hills a large perfect shell of *Purpura canaliculata* DuRoi, much larger than any of the live shells I have seen.

We go down on the rocks as the tide goes out, take our lunch with us, and work until the tide rises and compels us to return. The first shells we find are the Littorinas, so very plentiful that large spaces and crevices are full of them. Two species about *L. planicrura* and *L. scutulata*. There also the limpet appears, *Acmæa speciosa* is the highest, but is also found low down, and larger near low water. Next were *Acmæa patina* Esch., and *A. scabra* Nutt., then appears *A. persona* and *A. pelta* Esch. *Lottia gigantea* Gray, is very near low water mark, and a few large specimens of nearly all the others, the lower on the rocks they were the larger were their thin shells. Here also I found a few shells of *Gadinia reticulata* Sby.