VARIATIONS in APERTURE CHARACTERISTICS of EIGHTEEN SPECIES of UNIONIDAE from LAKE ERIE

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Anatomical data pertaining to the soft parts of North American naiades (Unionidae) have been published almost since the discovery of the fauna. Rafinesque (1820) published figures of two species illustrating gills, palps, mantle lobes and foot, and the visceral mass arrangement. Barnes (1823), Kirtland (1834), Agassiz (1851), and Lea (1859) all stated the importance of soft anatomy in naiad classification. George B. Simpson (1884) was the first to do a detailed study of the anatomy of a North American naiad.

Near the beginning of the twentieth century, students such as Sterki (1895, 1898) and C. T. Simpson (1900) began to utilize soft parts in naiad systematics. Ortmann (1910, 1911, 1912) built upon and expanded this trend. These authorities chose to use both soft part features and shell characteristics in classification and phylogeny. As a result, most of the "higher" classification (i.e. genera, subfamily, family, super-family, etc.) is currently based on soft anatomy while species and subspecies are based on shell characters. On the species level the soft part descriptions often were qualitative terms such as "large," "normal," etc. (Baker 1898).

Modern workers recognize the exhibition of both genetic and environmental variation in a species' shell structure but, until recently, have done very little in this regard with the soft parts. Recent work by Kraemer (1970), Fuller and Bereza (1974), and Kokai (1974) has only begun to quantatively explore this variation. This study deals with the variation of the number, size, and arrangement of the papillae of the incurrent apertures of 18 species of naiades from one community in western Lake Erie. The intent of this study was to determine what soft part variation exists among, and within, the species of western Lake Erie.

The approximately 800 specimens used in this study were collected during the summer of 1970 from Fishery Bay of Lake Erie between South Bass and Gibraltar Islands, Ottawa Co., Ohio. This area was chosen because of the great abundance of naiades, the relatively large number of species, and its proximity to the Stone Laboratory of the Ohio State University. Specimens were preserved in a solution of 75% ethanol, 20% water, and 5% glycerin. This preservative somewhat alters the appearance of the soft parts because of some tissue contraction, dissolving of pigment, etc. The descriptions below, however, refer to specimens which were preserved exactly the same way and yielded consistent results in this type of solution. Observations of papillae were made using a binocular microscope at magnifications between 16x and 60x.

TABLE 1

Species Collected	*Number of Specimens*
1) *Anodonta grandis grandis* Say, 1829	5
2) *Quadrula quadrula* (Rafinesque, 1820)	6
3) *Quadrula pustulosa* (Lea, 1831)	28
4) *Amblema plicata plicata* (Say, 1817)	156
5) *Fusconaia flava* (Rafinesque, 1820)	92
6) *Cyclonaias tuberculata* (Rafinesque, 1820)	3
7) *Pleurobema coccineum* (Conrad, 1836)	40
8) *Elliptio dilatatus* (Rafinesque, 1820)	88
9) *Ptychobranchus fasciolaris* (Rafinesque, 1820)	6
10) *Obliquaria reflexa* (Rafinesque, 1820)	5
11) *Obovaria subrotunda* (Rafinesque, 1820)	7
12) *Truncilla truncata* (Rafinesque, 1820)	6
13) *Leptodea fragilis* (Rafinesque, 1820)	55
14) *Potamilus alatus* (Say, 1817)	108
15) *Ligumia recta* (Lamarck, 1819)	8
16) *Ligumia nasuta* (Say, 1817)	8
17) *Lampsilis radiata luteola* (Lamarck, 1819)	149
18) *Lampsilis ventricosa* (Barnes, 1823)	6

All species collected (Table 1) had papillae lining the margin of the incurrent aperture. Although many additional variations exist, the papillae of Lake Erie species were of four basic types. 1) TENTACULATE - elongated, solitary structures with a relatively uniform diameter from base to tip (Figure 1); 2) CONICAL - solitary papillae in which the diameter is obviously greater at the base) 3) BIFURCATED - papillae having two tips arise from the same base; 4) AGGREGATED - papillae in which more than two tips arise from a mutual base (Figure 2). Many species have combinations of, or slight deviations from, these four basic types. Several types of variation occurred among different specimens of the same species. First, the smaller, and presumably younger, specimens usually had fewer and smaller papillae than the larger specimens. Secondly, if a species had papillae which bifurcated or split, the bifurcations were more numerous in the larger specimens. These variations imply that, at least for some species from Lake Erie, the morphology and number of papillae change with age. The increase in appillae numer is more readily observed when a large sample size is available. Table 2 shows variation in papillae number with an increase in animal size for 156 specimens of *Amblema plicata*

TABLE 2

Animal Size	*Number of Specimens*	*Papillae Number*
40-49 mm	2	18 - 31
50-59 mm	6	30 - 52
60-69 mm	28	40 - 63
70-79 mm	45	39 - 84
80-89 mm	39	54 - 86
90-99 mm	30	66 - 97
100-109 mm	2	90 - 101
110-119 mm	4	110 - 132

Table 2. Number of papillae of the right side of the incurrent aperture of *Amblema plicata plicata* (Say, 1817) versus increase in animal size. In general, as the animal gets larger, the number of aperture papillae increases.

plicata (Say, 1817). It should be noted that these data, although typical, are not necessarily representative of papillae numbers for other Lake Erie species. Third, in some species the papillae, or clusters of papillae, were distinctly "ranked" in rows along the periphery of the aperture, but in other species the papillae were randomly distributed. A short description of the papillae of the incurrent apertures follows.

Anodonta grandis grandis Say, 1829.

Papillae in smaller specimens appear to be two-ranked with the inner papillae tentaculate and the outer papillae a short protuberance. In larger specimens the papillae of both ranks are more-or-less equal in length with less distinction of the rows. Bifurcations of the papillae occurred in only one specimen.

Quadrula quadrula (Rafinesque, 1820).

Most papillae are joined into distinct assemblages with as many as 23 papillae tips per cluster. The clusters are singly ranked along the aperture margin and vary in number in size. Solitary papillae may occur between, and lateral to, the larger clusters. The individual papillae are shorter than the aggregated clusters and sometimes bifurcate.

Quadrula pustulosa (Lea, 1831).

The papillae of *Q. pustulosa* are arranged in the most distinct assemblages of all the species from Lake Erie. The aggregated papillae are two-ranked, subequal in length, and have between 10 and 19 papillae tips per cluster. There are very few solitary papillae between the clusters or on the lateral edge of the aperture margin.

Amblema plicata plicata (Say, 1817.

The papillae of this species are the most variable in arrangement of all species observed. In a few specimens the papillae were solitary and bifurcating but in most specimens they were solitary conical or tentaculate. The smaller specimens generally had short, two-ranked protuberences and the larger specimens had elongated papillae distributed randomly along the periphery of the aperture. Aggregated papillae were not seen.

Fusconaia flava (Rafinesque, 1820).

Papillae are aggregated as in the genus

Quadrula. The papillae were small, of equal length, and numbered as many as 30 per cluster. The aggregations are two-ranked with the larger clusters medial. Shorter, solitary, non-bifurcating papillae are common throughout the entire lateral periphery of the aperture.

Cyclonaias tuberculata (Rafinesque, 1820).

Aggregate papillae arise from a mutual base but very short, bifurcating papillae occur between, and lateral to, the clusters. Aggregated papillae have five or six tips per group. The clusters may be two or three ranked and are smaller near the dorsal and ventral extremes of the aperture.

Pleurobema coccineum (Conrad, 1836).

Structure and arrangement basically the same as for *Fusconaia flava.* The number of papillae per cluster is much less however, with usually no more than six tips per assemblage.

Elliptio dilatatus (Rafinesque, 1820).

Papillae are solitary and may be two or three ranked around the perimeter of the aperture. Those of the lateral ranks are shorter. The larger specimens have longer papillae of more equal length arranged so that the ranking is obscured.

Ptychobranchus fasciolaris (Rafinesque, 1820).

Young specimens have papillae which are subequal, two-ranked, solitary protuberances. Older specimens have papillae slightly more elongated into a cone shape with the height of the cone being approximately three times as great as the base.

Obliquaria reflexa (Rafinesque, 1820).

Papillae are solitary, contiguous, and tentaculate. No ranking could be determined. The papillae are slightly smaller at the dorsal and ventral extremes of the aperture. There are no bifurcations.

Tuncilla truncata (Rafinesque, 1820).

Papillae are gathered into a contiguous mass. All are tentaculate with no bifurcations. They are equal in length throughout most of the margin of the aperture but a few shorter papillae are near the dorsal and ventral extremes.

Leptodea fragilis (Rafinesque, 1820).

L. fragilis has relatively large papillae which are few in number. Individual papillae are very conical and are very close together.

Potamilus alatus (Say, 1817).

Two types of papillae are about equally numerous. Half are conical solitary structures which are about four times as long as they are wide. Half are aggregates with two, three, or four papillae tips. The solitary papillae are more common at the dorsal and ventral extremes of the aperture.

Ligumia recta (Lamarck, 1819).

The papillae are subequal, single ranked, conical and contiguous. The length of each is about four or five times its width. Bifurcations occur in a few papillae of one specimen.

Ligumia nasuta (Say, 1817).

Papillae of equal length, without ranking, and tentaculate. Length of each about five times its width. Papillae are slightly more numerous than in *L. recta* and have no bifurcations.

Lampsilis radiata luteola (Lamarck, 1819).

Subequal, tentaculate papillae are three ranked in younger specimens but more randomly distributed in older. Bifurcations and splitting of the individual papillae is common. Length of each is about six times the width. Bases of some of the papillae are fused in some specimens.

Lampsilis ventricosa (Barnes, 1823).

Papillae are two or three ranked, some fused at the base, conical or Y-shaped bifurcations, and subequal in length. The base is very broad with small papillae tips. The tips are about one third as long as the entire structure of the papillae.

The species of naiades from Lake Erie demonstrated considerable variation in number, size, shape, and distribution of papillae along the margin of the incurrent aperture. The most obvious difference among the species was the aggregation of individuality of papillae. With the exception of *A. plicat* all members of the subfamily Ambleminae had aggregated papillae. *Potamilus alatus* was the only species outside the Ambleminae that had aggregated papillae. Further study of the soft parts of other species, Lake Erie species found in streams, and additional specimens of species represented by inadequate sample size, is needed before the value of

apertural structures in naiad classification can be determined with certainty.

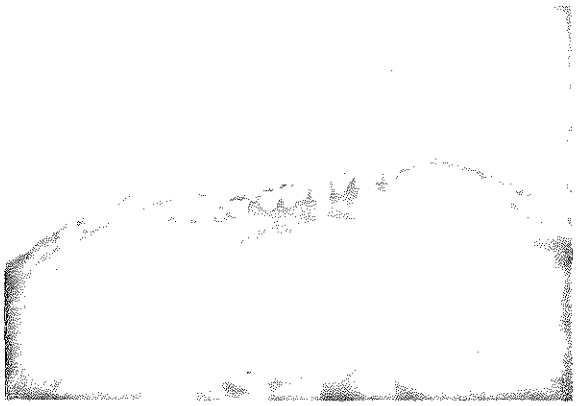

Figure 1. The papillae of *Elliptio dilatatus* (Rafinesque, 1820). These papillae are characteristic of the solitary, tentaculate type in which the diameter is uniform from base to tip. (x 30)

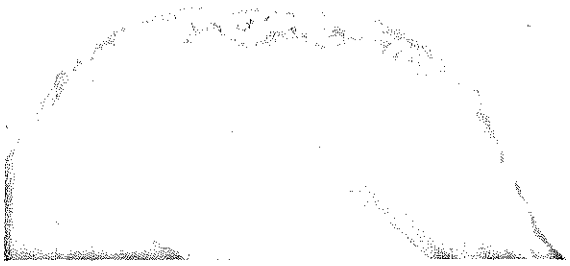

Figure 2. Aggregated papillae of *Quadrula quadrula* Rafinesque, 1820 (x 16). The characteristic of aggregated papillae is several tips arising from a mutual base.

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