

MOLLUSCOLOGIA, 1973, 14: 291-301

PROC. FOURTH EUROP. MALAC. CONGR.

THE MINUTE SHELL STRUCTURE OF THE GLOCHIDIUM OF SOME SPECIES OF
THE GENERA *UNIO*, *POTOMIDA* AND *ANODONTA* (BIVALVIA, UNIONACEA)

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INTRODUCTION

Anyone who has read or even leafed through texts on Unionacea systematics will easily understand the reason for this research which I have undertaken. In fact, the systematics of this group of molluscs is in chaos, particularly at the level of species. This systematic disorder is caused principally by the fact that the Unionacea, like most bivalves, do not possess a structure which gives valid characteristics so that the different species may be classified with any certainty. The only structure useful for classification, the shell, is in fact very variable, as it is subject to environmental factors, and so does not lend itself to a sure identification. In the past, exactly as has happened in all the other groups of molluscs, the study of the shells only has led to the creation of an incredible number of species, with the result that, if the place where they were taken is not considered, it is practically impossible to distinguish one species from another. Thus my attention was drawn to young bivalves, and in particular to those larval forms known everywhere as "glochidia." It seemed logical that larval forms which are highly differentiated, as in the glochidium, possessing as they do a small rather complicated embryo shell, would provide on further study characteristics useful not only for testing the validity of the classification of the different species, but also for the clarification of the interrelations between the different genera.

The shell and the attachment structures of the glochidium of *Unio*.

My research began with a study of the glochidium of a population of *Unio* living on the outskirts of Pavia. According to Zilch (1967), the species should be *U. elongatulus glaucinus* Porro, but in the past it has at times been called *U. requieni* and at other times *U. pictorum* or *U. alhesinus*.

The shell of the glochidium is made of 2 triangular valves, the mirror image of each other, held together by a ligament (Fig. 1). Under the scanning electron microscope at low magnification it is already possible to make out that the outer surface of the 2 valves is not smooth, but covered with numerous evenly-distributed protuberances (Figs. 2 and 4). In many places the valve surface is furrowed as well with numerous small hollows (Figs. 3 and 4). Finally, on examining fragments of valves, it is possible to make out that the shell is made of 2 parts. One is external, like a thin skin, with the above described protuberances on the outside, and one is internal, of a crystalline aspect, full of numerous holes (Figs. 2 and 3). The hollows noticed on the surface of the valves originate in the furrowing of the external skin following the holes of the crystalline layer. In both valves, the attachment structure is situated on the anterior apex and is made up of a margin possessing numerous pointed spines (Figs. 8 and 9). Closing the valves the margins fold towards the inside, fastening the spines firmly into the tissues of the host fish (Figs. 10 and 11). The apex of each valve, all around the spiny margin, has small very dense spines for a short stretch (Fig. 11).

The shell and the attachment structures of the glochidium of *Potomida*.

The research was carried out on the larval forms of *Potomida littoralis littoralis* (Lamarck) from the river Ebro, Spain¹. In this species which, according to Zilch (1967) belongs to the subfamily Quadrulinae of the Unionidae, there has been found a particular kind of glochidium. Its shell in fact has an hemispherical shape and lacks a spiny margin like that seen in *Unio*. There are only small spines distributed all along the edge of the 2 valves (Fig. 12). On the other hand the sculpture of the external surface of the valves strongly resembles that seen in *Unio* (Fig. 6). The external protuberances, as seen in *Unio* (Fig. 5), completely cover the smallest spines of the attachment edge (Fig. 7).

The shell and the attachment structures of the glochidium of *Anodonta*.

My research on the glochidium of *Anodonta* was carried out on materials coming from 2 different distant populations of *Anodonta*, the one from Lake Maggiore and the other from Lake Trasimeno (Italy). Nowadays these 2 populations, distinguished in the past by many different names, should be considered as belonging to 1 single species, *Anodonta cygnea* (Linnaeus) according to Zilch (1967). The shell of the glochidium of *Anodonta*, even if of greater size (about 300 μ long), appears as in *Unio*, in a triangular shape with 2 valves of equal size, held together by a ligament (Fig. 13). In this case, too, the external surface of the valves is not smooth, both the glochidium of the 2 different populations having numerous hairy excrescences. These are very thick near the base of the shell (Fig. 15), but they become more and more rare towards the central part of the valve where they are found in parallel rows (Figs. 14 and 16). Near the anterior apex of the shell the protuberances described are even rarer and less obvious.

As seen in *Unio*, the shells of the glochidium of *Anodonta* are also found to consist of 2 parts, one external, a very thin layer, the other internal, much thicker and of crystalline aspect (Figs. 17 and 19). There are many holes in the latter (Figs. 18 and 19). The numerous hollows which are seen on the outer surface of the valves (Figs. 13, 14 and 16) originate in the wrinkling of the external layer over the holes in the crystalline layer. The attachment structure of the glochidium of *Anodonta* is made in the same way in the 2 populations I examined, but *Anodonta* has certain characteristics which differ from those described in *Unio*. On each valve they consist of an apical margin that is covered with long pointed spines (Figs. 20, 23, 24, 25 and 26). There are fewer spines than in *Unio*, both at the base of the spiny margin and on the spiny margin itself (Figs. 21 and 22).

CONCLUSIONS

Besides giving simple information concerning the morphology of the shell and the attachment structure of the valves of the glochidium I examined, I believe I have also shown their importance. The material I examined is too scant to give any practical result, but the field is open, and with the help of European malacologists and others from the rest of the world, I hope to be able to examine other materials and so begin a comparison of the data obtained and attempt making use of these in a revision of the classification of Unionidae.

¹My sincere thanks to Dr. Adolf Zilch from Frankfurt, who sent me the material.

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SUMMARY

The shell and the attachment structure of the glochidia of some species belonging to the genera *Unio*, *Potomida* and *Anodonta* have been examined with the scanning electron microscope. The author points out that the number and disposition of the attachment spines and the external sculpture of the surface of the shell seem to offer sufficient characteristics to be used in the systematical study of these bivalves.

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FIG. 1. The shell of the glochidium of *Unio elongatulus glaucinus*. The ligament (L) holding together the 2 valves (V). 720x.

FIG. 2. The shell of the glochidium of *Unio elongatulus glaucinus*. In this fragment it is possible to see the external part of the shell like a thin skin (E) and the internal one of crystalline aspect (I). 3,000x.

FIG. 3. The shell of the glochidium of *Unio elongatulus glaucinus*. Fragment showing 2 of the holes of the internal crystalline layer externally closed by the "thin skin" like layer. 10,000x.

FIG. 4. The shell of the glochidium of *Unio elongatulus glaucinus*. The outer surface of the "thin skin" layer is covered with numerous little protuberances. The hollows (H) on the surface originate in the furrowing of the "thin skin" following the holes of the crystalline layer. 10,000x.

FIG. 5. The shell of the glochidium of *Unio elongatulus glaucinus*. The "thin skin" layer is extended to completely cover the smallest spines of the attachment structure. 10,000x.

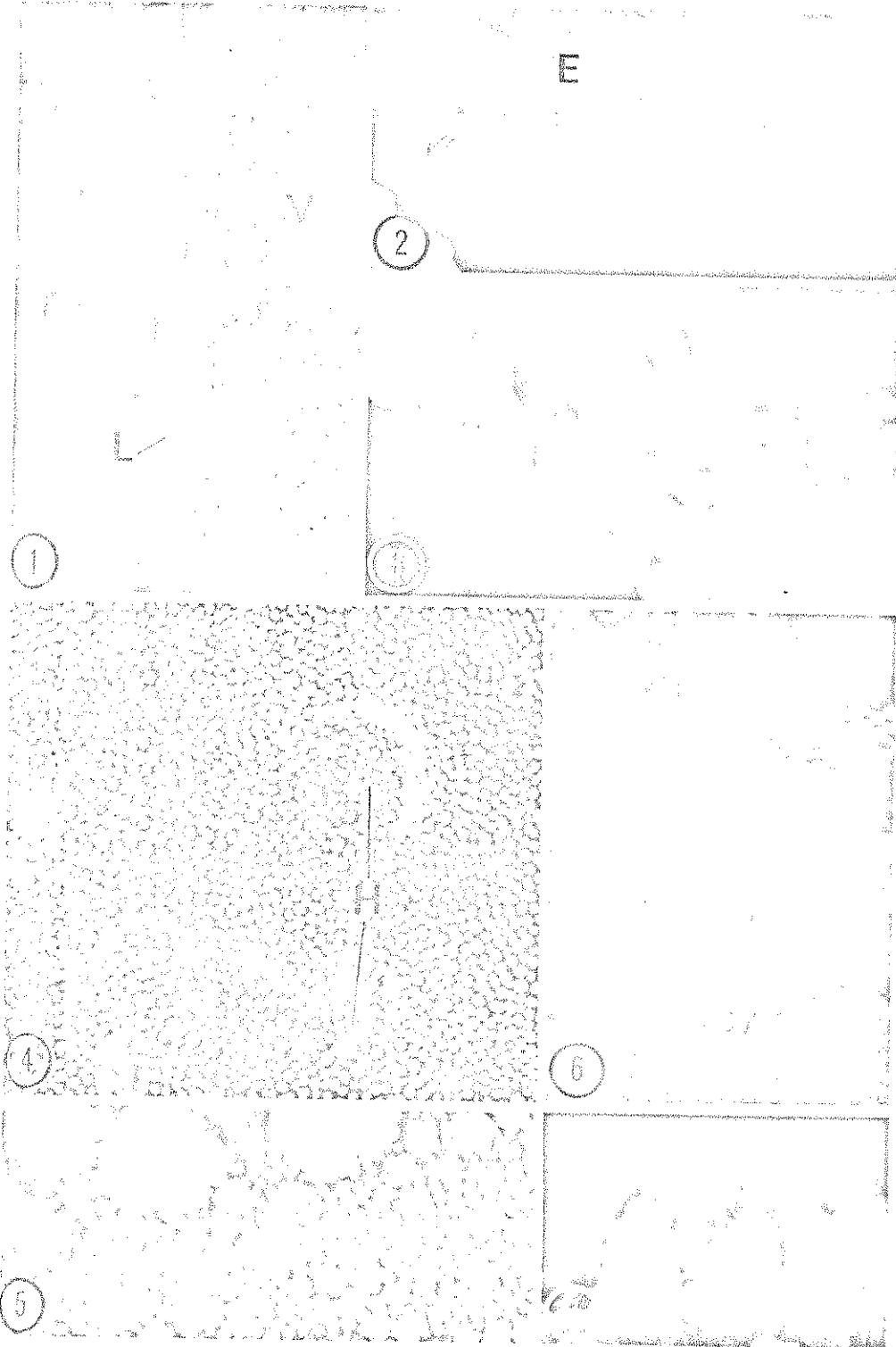
FIG. 6. The shell of the glochidium of *Potomida littoralis littoralis*. The outer surface of the shell is covered with numerous little protuberances. 16,000x.

FIG. 7. The shell of the glochidium of *Potomida littoralis littoralis*. The external little protuberances completely cover the spines of the attachment edge. 16,000x.

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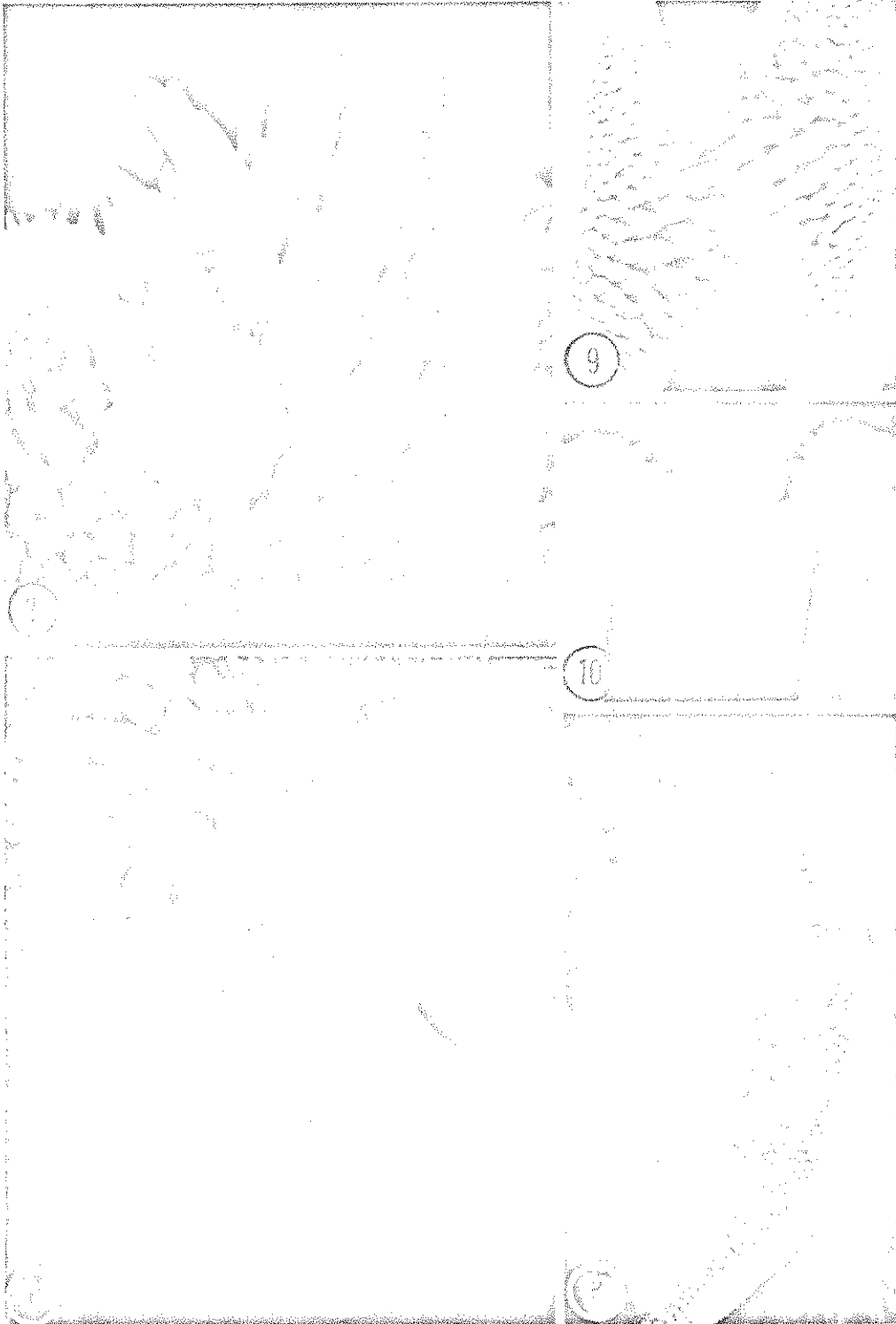
FIG. 8. The attachment structure of the glochidium of *Unio elongatulus glaucinus*. On the anterior apex of a valve there is the initial portion of the attachment structure possessing numerous pointed spines. 3,000x.

FIG. 9. The attachment structure of the glochidium of *Unio elongatulus glaucinus*. The initial portion of the attachment structure of the 2 valves of a glochidium. 1,350x.

FIG. 10. The attachment structure of the glochidium of *Unio elongatulus glaucinus*. Side view showing the spiny margin of the attachment structure folded towards the inside of the valve cavity. 1,000x.

FIG. 11. The attachment structure of the glochidium of *Unio elongatulus glaucinus*. The spiny margin with numerous rows of spines. 2,000x.

FIG. 12. The attachment edge of the glochidium of *Potomida littoralis littoralis*. The spiny structure is lacking; numerous small spines are distributed all along the edge of the valves. 1,000x.



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FIG. 13. The shell of the glochidium of *Anodonta cygnea* from Lake Trasimeno (Italy). 230x.

FIG. 14. The shell of the glochidium of *Anodonta cygnea* from Lake Trasimeno (Italy). The outer surface of the "thin skin" layer has, in the central part of the valves, numerous hairy excrescences in parallel rows. The hollows originate in the wrinkling of the external "thin skin" layer over the holes of the internal crystalline one. 10,000x.

FIG. 15. The shell of the glochidium of *Anodonta cygnea* from Lake Trasimeno (Italy). Near the base of the shell the hairy excrescences are very thick. 15,000x.

FIG. 16. The shell of the glochidium of *Anodonta cygnea* from Lake Maggiore (Italy). The hairy excrescences have the same shape and disposition as those seen on the outer surface of the "thin skin" layer of the glochidium of *A. cygnea* from Lake Trasimeno (Italy). 10,000x.

FIG. 17. The shell of the glochidium of *Anodonta cygnea*. In this fragment it is possible to see the 2 layers constituting the valves; the external one like a "thin skin" (E) and the internal one of crystalline aspect (I). 10,000x.

FIG. 18. The shell of the glochidium of *Anodonta cygnea*. Numerous holes are in the internal crystalline layer of the valves. 1,700x.

FIG. 19. The shell of the glochidium of *Anodonta cygnea*. The internal crystalline layer of the valves (I) of the glochidium is still present in the initial portion of the shell (S) of a young *Anodonta*. 3,000x.

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FIG. 20. The attachment structure of the glochidium of *Anodonta cygnea*. On the anterior apex of s₁ valve there is the initial portion of the attachment structure. The spines are fewer than in *Unio*. 2,600x.

FIG. 21. The attachment structure of the glochidium of *Anodonta cygnea*. The spiny margin is folded towards the inside of the valve cavity. 870x.

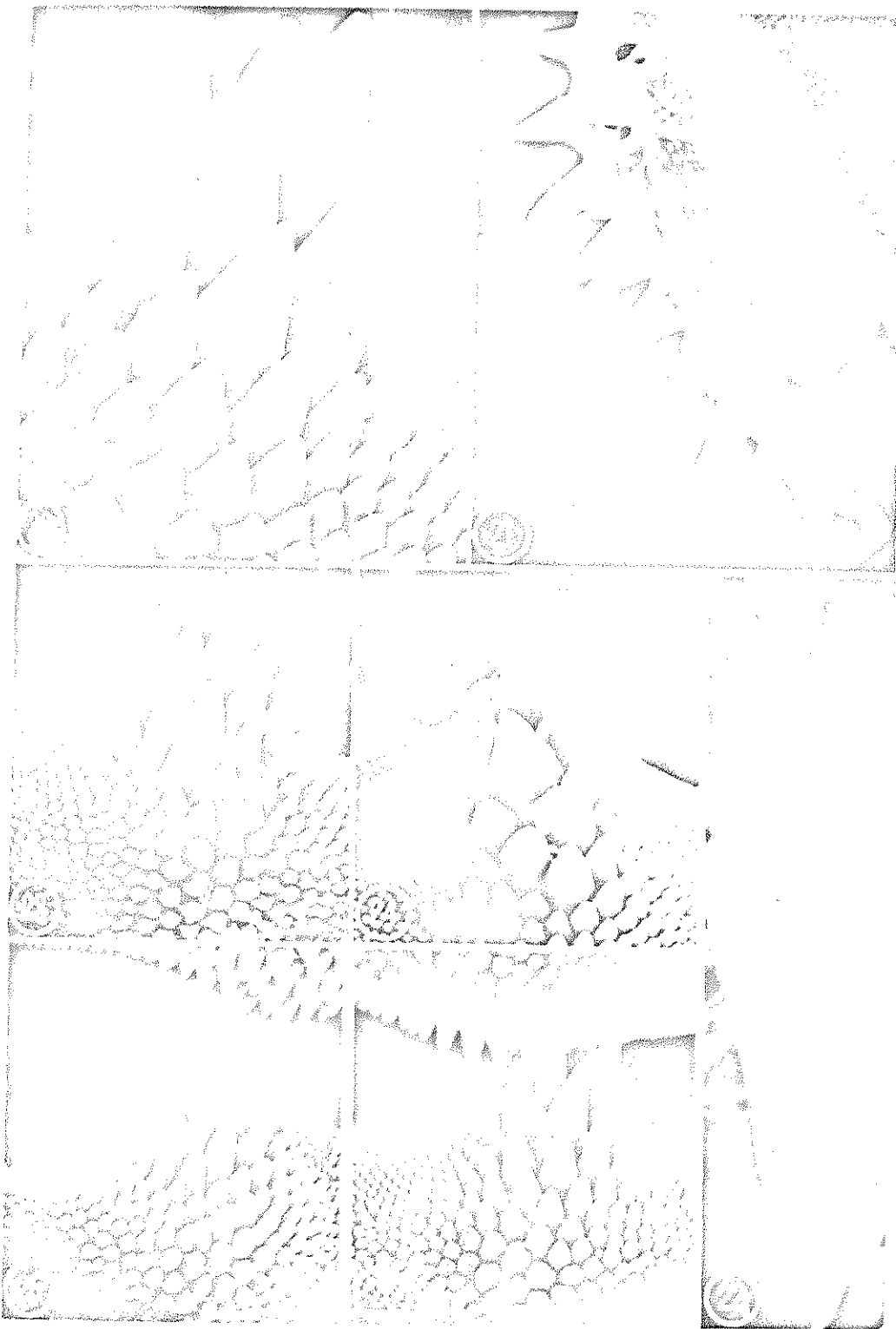
FIG. 22. The attachment structure of the glochidium of *Anodonta cygnea*. Few spines are on the spiny margin. 1,500x.

FIG. 23. The attachment structure of the glochidium of *Anodonta cygnea* from Lake Maggiore (Italy). The initial portion. 1,000x.

FIG. 24. The attachment structure of the glochidium of *Anodonta cygnea* from Lake Trasimene (Italy). The initial portion. 1,000x.

FIG. 25. The attachment structure of the glochidium of *Anodonta cygnea* from Lake Maggiore (Italy). The initial portion. 1,000x.

FIG. 26. The attachment structure of the glochidium of *Anodonta cygnea* from Lake Trasimene (Italy). The initial portion. 1,000x.



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