

21) Eine deutliche Spur des Parenchyms, des für die adulten Tiere so charakteristischen Gewebes, ist nicht vorhanden.

22) Es fehlen Cilien, Excretionsorgane, ein After, sowie eine deutliche Anlage der Geschlechtsorgane.

23) Über die Weiterentwicklung des »Restmesenchyms« am anatomischen Vorderende (= physiologisches Hinterende) fehlt jede Beobachtung; daher kann man nur vermuten, daß aus ihm später die Gonaden und das »Parenchym« entstehen.

24) Ein Mund fehlt.

Wie aus dieser kurzen Darstellung ersichtlich ist, werden notwendigerweise die Ähnlichkeiten der Archiannelidenorganisation mit dem Bau der Nematomorphen als starke Konvergenzerscheinungen aufzufassen sein; denn die Trochophora, welche nach Hatschek die Stammform der Anneliden ist, weist nicht in der geringsten Hinsicht Homologien mit der *Gordius*-Larve auf. Ebenso unwahrscheinlich wird die, schon ohnedies von früheren Autoren angezweifelte Ähnlichkeit mit den Acanthocephalen. Auch mit den Nematoden sind die Nematomorphen nicht in Zusammenhang zu bringen. Ebenso wenig sind irgendwelche Organe der *Gordius*-Larven mit den Organen der Echinoderen homolog; denn das Vorderende der Echinoderen ist höchstwahrscheinlich tatsächlich auch ontogenetisch als ein Vorderende aufzufassen, während der »Vorderleib« der *Gordius*-Larve eigentlich einem Hinterende entspricht.

8. Again: Regeneration of the shell of Anodonta and other deformations of shells.

By A. B. van Deinse, Teacher of Biology, Gymnasium Erasmianum, Rotterdam, Holland.

(With 2 figures.)

eingeg. 2. März 1913.

With regard to my short communication in the Zoolog. Anz. of June 4th 1912 No. 19/20 Vol. 39, p. 575, I want to add some more about the same subject. I was able to examine about a hundred more new mussels, *Anodonta ventricosa*? and *A. cygnea*, about regeneration. Among this lot I found one specimen with a fine regenerate, viz. an *An. cygnea*. On the back edge, a little ventral, I found a $\triangle$ shaped hole, with a long dorsal cleft, narrowing more upwards. Both shells showed the hole, but the cleft-shaped continuation of it, going upwards, was only to be seen on one of the shells. The hole and the cleft were beautifully regenerated; the regenerated periostracum showed lines of growth. Here the crust of lime on the outside of the regenerated perio-

stracum, which I described on page 577 and 578 of my first communication, is wanting. This is caused by the peculiar place of the damage, viz. on the edge of the shell. Both the normal and the regenerated periostracum are almost on the same level here, and the regenerate does not protrude, nor is it bubbly on the inside of the shell, as was the case with the example described before (see fig. 2 page 576), where the new periostracum was lying quite in the depth in comparison with the normal periostracum of the shell. And this is the very reason why, in the first case, the crust of lime has been well saved and in this case, where it was quite on the surface of the shell, has been grazed off.

On the inside of the shell I could clearly follow the cleft on the mother-of-pearl; the regenerate of the cleft had formed a crest on it. On either side of this crest again were many very small pearls having grown to it, and which, therefore, have to be considered as being connected with the regenerate. Further, nowhere on the mother-of-pearl were any pearls to be found. So this agrees with what I wrote before in the middle of page 577. The $\%$ figure of regenerated mussels, occurring in nature, which I fixed at 1 in the first communication also appears to be right here. Besides I found in the same shell, near the top, on the mother-of-pearl, on the inside of one of the shells a formation which has nothing to do with regenerates, but which is remarkable enough to be mentioned. There we see over a length of 2 cm and a width of 0,4 cm a few little low crests running on the shell 2 longer and 3 short ones, partly connected with each other. They look like folds in the layer of mother-of-pearl and they owe their origin to the circumstance that the mantle showed folds when the mother-of-pearl was set off in this place. On the outside of the same shell nothing particular is to be discovered, and I am convinced that these folds have nothing to do with regeneration. It is true that these folds are only slightly developed, but it may occur that this development is very strong and then the shell which shows such a development on the inside, gets a very peculiar appearance. Among the hundred mussels mentioned above I saw a magnificent example of this (fig. 1). There we see a crest running over a length of 5 cm, which is 2 mm high in the middle, and on the front and back side ends in a point and imperceptibly runs into the mother-of-pearl. Above the crest are a number of very small pearls, grown to it. This crest is almost perpendicular on the surface of the shell and shows a slight curve in its course. On the outside of the shell nothing remarkable is to be found. For further examination I have sawed out of the middle of the shell a part with a piece of this crest. The periostracum of this square piece let go and on the inside this periostracum was still covered with a part of the prismatic layer.

The remaining part of the prismatic layer stuck fast to the mother-of-pearl of the crest. On this latter part, the crest, on the side of the prismatic layer, shows itself as a line. If we now look at ground pieces of this crest, taken perpendicularly on its linear direction, it first strikes us that the crest is quite massive and consists of layers of lime and thin lamellae of periostracum, alternately. This number of lamellae varies much according to our making a cross ground piece in different places of the crest. I counted 1—5 of them, without any regularity in their arrangement or appearance. Only one lamella is to be found constantly, namely one that runs exactly in the middle of the crest. This lamella originates from a layer of periostracum, which is lying between the prismatic layers of the shell. I clearly saw it bending almost perpendicularly at the basis of the crest and farther running on in a parallel

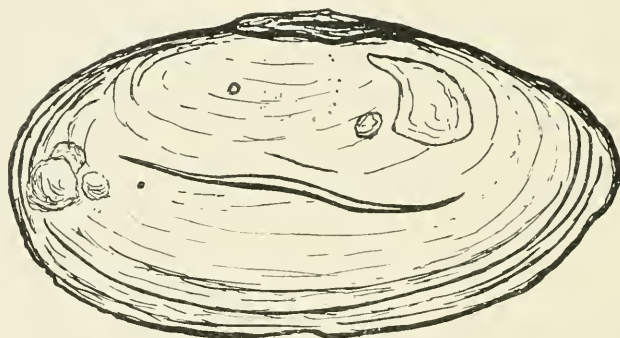


Fig. 1. *Anodonta cygnea*. $\frac{4}{5}$.

way with the usual layers of the shell. This lamella, the principal lamella, as it might be called, seems to me to have arisen first, and afterwards the other lamellae might have been formed by the scaling of the principal lamella, while lime was liberally formed everywhere between. So all this together has formed the crest rising almost perpendicularly on the shell of *Anodonta*. How and by what has this crest come about now? We know nothing about it with certainty. At the very time when I was occupied with these researches (May 1912), a study from Dr. A. Rubbel was published, on these and similar abnormalities, in the Zool. Anz. 14. 6. 1912, Volume 39, Nr. 21/22 page 632—643. Rubbel too saw these crests and thinks that they have been caused by "Fremdkörper". Once Rubbel even found a case of two crests above each other of which he gives a picture. I have never found this latter case. The first, inner crest of these two lying above each other, which Rubbel represents is the same as my case, and Rubbel too mentions a lamella of periostracum, running between the two crests. By a lucky

chance the mantle of the animal in the *Anodonta* of fig. 1 had been saved, and we see that in this mantle the impression of the crest appears clearly (see fig. 2. The $\leftarrow$ indicates the direction where the water streams in and on the edge of the mantle we see the papillae which are around the entrance.). The impression in the mantle exactly follows the bends of the crest, as is clearly to be seen if we compare fig. 1 with fig. 2. The impression of the mantle fitted on all sides very closely round the crest —.

I have once observed a case in which, on a natural regenerate, 2 crests and a few little pearls were found on the newly formed mother-of-pearl. According to Rubbel crests are already to be recognized on the outside of the shells, but in my opinion this is not nearly always the case. In the big crest described above, for instance.

Rubbel says that in *Anodonta cellensis* "Schalenconcretionen überaus häufig vorkommen". I found among 614 specimens of *Anodonta cygnea* and *Anodonta ventricosa*, only 5 specimens with crests.



Fig. 2. *A. cygnea*. Mantle. $\frac{4}{5}$.

And among as many specimens, I found 6 natural regenerates, so I could at the utmost mention 11 "concretionen" among 614 shells; I cannot call this a great number. Rubbel also finds very few pearls in *An. cell.* though he examined some hundreds of shells. In my opinion pearls are decidedly found much more generally in *A. cygnea* and *A. ventricosa*. Besides an *Anodonta* I have also once found a little crest on *Dreissensia polymorpha*. Besides in this shell the top, apex, was filled with a relatively very large concretion of very irregular form and while grinding it, I found that this concretion was partly hollow partly massive, and highly irregular. The massive part showed some nuclei of periostracum around which all was filled up with layers of lime. I found no trace of a parasite and on the outside the shell was quite sound. Finally I want to give a short description of a few other abnormal findings in *Anodonta* shells. An *A. cygnea* showed a layer of brown periostracum with a surface of $2\frac{1}{2}$ —3 cm² on the ordinary mother-of-pearl on the inside. Besides, above this spot, near the apex, again exactly such a piece of periostracum, $3\frac{1}{2}$ cm long and $\frac{1}{2}$ cm wide. These 2 secondary layers of periostracum are partly covered again with a thin

layer of lime with a great number of little pearls (?) on it, especially along the edges. This layer of lime is so thin in many places that the brown secondary periostracum shines through it. Of a parasite covered up, as Rubbel (Zool. Anz. Vol. 39 Nr. 21/22 S. 632—643) describes, viz. a larva of an insect (long 2 cm) covered with "Schalensubstanz", I found nothing here. The pearls (?) mentioned just now, beautiful, exactly round grains, very finely striped radiantly, and with equally fine concentric layers are lying both each separately and many melted together on the big brown piece of secondary periostracum. They rather remind one of "the white grains of lime", which form the beginning of the "polygonale Felderung", of the prismatic layer, however they are rounder, much bigger and much sharper striped radiantly and concentrically. They are much thicker too and I found no reasons to take them for these grains of lime of the "polygonale Felderung". Besides there are in the shell 3 big crests and a great number of little pearls grown to it. All these are developed especially on the obtuse side of the shell. On the outside of the shell, not a single abnormality whatever, is to be found. This is the finest example of succession of layers of periostracum and lime, which I ever found in an *Anodonta*. Here we have, going from the outside to the inside: periostracum (primary), prismatic layer, mother-of-pearl, another periostracum (secondary) and another layer of mother-of-pearl with a great number of little pearls(?) in it. And all this extends over a great part of the surface of the shell! So, here, the mantle has successively given life to very different layers indeed. I have not been able to find out what was the cause of this; I found nothing of a parasitic influence as I said already before. To this we can apply what Rassbach says (Zool. Anz. Bl. 38, Nr. 1, Bd. 39 3. Jan. 1912): . . . "daß das gesamte Außenepithel des Mantels imstande ist, je nach Bedarf das Produkt der Sekretion zu ändern" . . .

In the impression of the adductor muscle on the obtuse side of a shell of *Anodonta ventricosa* was found a concretion of pearls, with a surface of about $1\frac{1}{2}$ cm². The so-called "oil-stains", "Ölflecken", are sometimes found also in *Anodonta*, beautifully developed. I found as many as twelve, mostly near the apex. Another *Anodonta ventricosa* showed a burst on the outside. This burst has caused the origin of some crests and some pearls, bubbly on a large brown spot on the inside of the shell, exactly at the place of the burst. These were again near the apex. The last case is an *A. cygnea* with, in the middle, a little more near the top, 2 parallel dorsal crests, one of 1,5 cm and exactly under it one of $3\frac{1}{2}$ cm. The uppermost has in the middle of its course a thick pearl, of about 3 mm. Further some more very small pearls are to be seen, scattered about. On the outside of the shell no damage

whatever was to be found. It seems to me after what I mentioned above, that crests can arise through bursts in the shell as well as quite independently of these. In the last case Rubbel thinks of the penetrating of parasites and this really seems to me the most probable explanation, even though this parasite is not always to be found. That we find abnormalities, crests, oil-stains, pearls etc., so often, though not always, near the top, apex, and near the obtuse side of the shell can perhaps be put down to the fact that near the mouth of the animal is a spot where the edge of the mantle has not grown against the shell. So then there is for parasites and other strange bodies an opportunity to penetrate into the cavity between mantle and shell. Everywhere else the edge of the mantle is firmly grown together with the shell and there is no question of penetrating —.

After all I have said before, the question, whether we sometimes find regenerates and deformations also in the shells along our beach, seems quite obvious.

In *Mytilus edulis*, *Buccinum undatum*, *Macra stultorum*, *Solenensis*, *Fusus antiquus* and *Ostrea edulis* I found indeed regenerates. In *Tellina*, *Donax*, *Mya*, *Cardium*, *Pholas*, *Pecten* and *Natica* however I have never been able to find a trace of them. As far as I can judge the matter now, regenerates occur most in *Mytilus edulis*, besides rather often in *Buccinum undatum*. Much rarer in the other forms mentioned. All the shells mentioned are from the North Sea and found at: de Koog (Texel), den Helder, Huisduinen, Ymuiden, Noordwyk a./Z., Katwyk a./Z., Scheveningen, Kykduin, Hoek van Holland and Domburg. The information about *Ostrea edulis* I owe to Prof. Dr. G. C. J. Vosmaer, to whom I here wish to render thanks again for his interest. Prof. Vosmaer told me that, when *Ostrea* has been impaired by boring sponges, *Cliona celata*, the oyster reacts upon it by repairing the bored holes and closing the openings in this way. So *Ostrea* too is able to make regenerates. The greatest number of examples of regeneration I examined in *Mytilus*, viz. 8. The damage of one of these 8 cases had been caused by *Cliona* and is as far as regeneration is concerned the same as the cases of *Ostrea* just mentioned. In the shells of *Mytilus* are often found dents, on the outside, which then cover each other with the equivalent vaults on the inside. This phenomenon however has nothing to do with regeneration, though it may sometimes seem so. I do not know the cause of it. All the 8 regenerates were small, complete and only in 1 case accompanied by the formation of a few little pearls, exactly in the mussel which showed the greatest damage and the biggest regenerate. There was no preference as to the place of the damage. Here too I found, as in *Anodonta*, the regenerate larger than the hole to which it belonged. The secondary periostracum, on the re-

generate, was easily to be found and for the rest too the matter is the same as in *Anodonta*. I can deal with *Buccinum* and *Fusus* together. I had 4 *Buccinum* and 1 *Fusus*, which all showed the same burst, not only on the same spot, but they also had the same line of bursting. In these shells I always found the last greatest winding near the mouth over its whole width, broken in a rather zig-zag-line. How can it be explained that all the 5 shells had been damaged so heavily and exactly in the same way? I do not know what to answer to this, but I venture to suppose, that the strong pincers of *Cancer pagurus*, which, as is known, can quite easily crack these shells and feed on the inmates of them, are no strangers to this. But, as all the shells have been regenerated beautifully and very firmly, the crab must, through the merest chance, have left its prey in the lurch. In 1 *Buccinum* a hole had been pressed also in the second winding. The regenerate is so perfect that it is hardly to be seen on the inside. However it is so much the better to be seen on the outside. The zig-zag-lines of bursting are very sharply marked and contain long connected scales of the secondary periostracum, while the primary periostracum of the shells has been worn almost everywhere. After the bursting, the growth of the shells has further had its normal course. We sometimes find that the lines of growth of these shells, near the mouth are very strongly developed, and rise like crests. These crests of growth must be sharply distinguished from possible lines of bursting. The superficial resemblance is sometimes very great. I have one shell of *Macra stultorum* and one of *Solen ensis* with regenerates. Both regenerates are small and complete: in *Macra* on the edge of the shell and in *Solen* in the middle. The regenerate of *Macra* is by far the finest and exactly as in *Anodonta*, I have been able to find all the three layers in the regenerate. In all respects the case is the same as in *Anodonta*, to which I can therefore refer. I only want to draw the attention to the fact that I found in *Macra* again "the crust of lime on the periostracum of the regenerate", exactly as in *Anodonta*; see page 577 and 578 of my first communication on this subject. So it seems that in a typical regenerate, this "crust of lime" has to be there and that it is always on the new periostracum on the outside. So the fresh-water shells and the sea-shells regenerate in the same way, though I admit that more material for examination is still desirable. The regenerate of *Solen* is too unimportant for us to say much about. The newly-formed periostracum has been worn for a great part, while on the outside of the piece that has been saved, the "crust of lime" is again to be seen, but this crust too has been much damaged by the breakers, and is only slightly developed. —

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