

Recht interessant wäre es, zu erfahren, ob der Herzog von Bedford noch mehr Penrice-Wasserböcke in Woburn Abbey besitzt, oder ob der bisher nicht erkannte Vertreter dieser Art, über welche die Literatur noch so merkwürdig arm ist, auch dort ein Unikum war und vielleicht mit *onctuosus* zusammen aus seiner Heimat im Südwesten von Benguela dorthin gekommen war.

## 2. Regeneration of the shell of *Unio* and *Anodonta*.

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(With 2 figures.)

eingeg. 17. März 1912.

Rubbel's and Rassbach's communications about experiments of regeneration of *Anodonta* and *Margaritana*, executed at Marburg in 1910 and 1911 (Zool. Anz. Bd. 37, 1911, S. 169—172 and Bd. 39, 1912, S. 35—38) remind me of some observations I made three years ago. On the 17<sup>th</sup> of January 1909 I made an excursion in the environs of Utrecht and found three shells near Old-Amelisweerd Castle on the bank of the »Krommen Rijn« an almost stagnant river shut off by sluices. Two specimens of *Anodonta* and one of *Unio*. All three had the same peculiarity. The outside of the shells showed a big hole, about in the middle, and on the inside of the shell a large bubbly regenerate was clearly to be seen. The regenerate was perfect in the three cases and so the mussel had completely shut the hole. Remarkable was the great difference in surface between the hole on the outside and the regenerate on the inside of the shell (compare figs. 1 and 2). The surface of the regenerate is about 30 times as large as the surface of the hole. The regenerate is situated exactly between the impressions of the front and back adductor muscles and is squarish (see fig. 2). If one holds the shell against the light, the regenerate is outlined in black.

This black colour is caused by the sand that penetrated into the shell through the hole on the outside. This stands to reason as the mussel lives on the bottom of the water. Proportional to the big regenerate was the quantity of the sand that had penetrated into the shell, and which weighed more than 1,5 gram. Besides sand, about ten bigger stones, a *Planorbis*, and two shells of *Daphnia* and *Cypridina* had penetrated into the shell together with some parts of plants. The bubbly regenerate on the inside was covered with a layer of mother-of-pearl, running into the mother-of-pearl of the other part of the shell. Through the hole on the outside of the shell the regenerate at the outside is clearly to be seen after removal of the sand, and then the scaly periostracum is remarkable. I found all this in the three shells in the same

way. Such examples of natural regeneration under for the mussel normal circumstances do not often occur. Among the 414 shells, examined for this purpose, I found only 4, so about 1%. The example represented here, is probably *Anodonta ventricosa* Pfr.? I found the same with *Anodonta cygnea* and *Unio pictorum*.

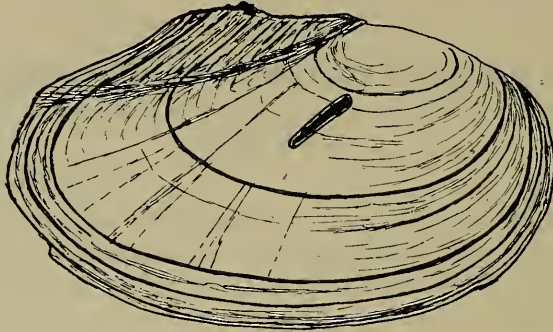


Fig. 1.

All three with holes and regenerates about in the middle of the shell. In an other specimen of *Anodonta ventricosa*? I have found a fine regenerate on the back edge of the shell. There the newly formed periostracum showed some distinct lines of growth. This regenerate too

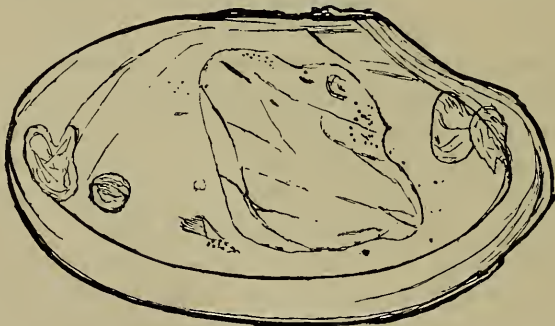


Fig. 2.

was perfect. As macroscopically the periostracum and the layer of mother-of-pearl of the regenerate in fig. 2 were clearly to be seen, so the prismatic layer could be shown microscopically. The latter showed itself as a layer of white grains of lime, lying on the inside of the periostracum. Many grains were lying separately, others were melted together, and, in this way, showed the »polygonale Felderung«, which Rubbel (see top of the first page) describes on page 171. The concentric layers and the radiancy of the lime grains I saw very clearly, just as Rubbel did.

Briefly, I came to exactly the same results as Rubbel, independent of him. The regenerates which I saw consisted of all three layers, periostracum, prismatic layer and layer of mother-of-pearl, and they were almost as firm as the shell itself. So I cannot agree with Brehms Tierleben, when on page 183 he speaks about »notdürftig ausgeflickt«. In my opinion the regenerate could not be more complete.

In the formation of the layer of mother-of-pearl on the regenerate, I saw some other things which neither Rubbel nor Rassbach describe. The layer of mother-of-pearl seems to be set off on the prismatic layer, on the »polygonale Felderung«, in figures which resemble very much what we call »frost-flowers«, in winter. Little pieces of the regenerate which were thin and transparent enough clearly showed the three successive layers. Where the figures of mother-of-pearl were to be seen, nothing or hardly anything, as was to be expected, could be seen of the »polygonale Felderung«, of the prismatic layer. The layer of mother-of-pearl of the regenerate further showed a great number of very small pearls that had grown to it; these were also found on the mother-of-pearl of the shell itself, near the regenerate. I have often noticed such a connection between regenerated damages of a shell and the occurrence of little pearls on the regenerate, or near it. Meanwhile both can occur independently of each other. The reverse however is more usual. With the experiments of regeneration which Rubbel and Rassbach executed, pieces were sawed out of the shell of the living animal, and the openings were generally stopped with cork or paper, covered with celloidin or layers of shellac. Of course the shells which I found in nature did without any protection and this is not without influence on the formation of the regenerate. Especially the periostracum that is being formed, is then exposed to detrimental influences. In the first place, a shell, the hole of which is stopped with paper etc., will probably regenerate much quicker than a shell left without any covering whatever. In my opinion the penetrating of sand etc. will rather arrest the process of regeneration and perhaps even damage the periostracum which at first is exceedingly thin. This is altogether out of the question with shells protected with paper etc. On the newly formed periostracum of my specimens I observed that its surface was folded and wrinkled over and over, while further the periostracum, on the outside, so on the side turned away from the prismatic layer, was covered, by pieces, with a white crust of lime. This crust of lime is therefore directly connected with the grains of sand etc. that penetrate into the shell through the hole. I found many grains of sand fixed in this crust and the greater part of the loose grains of sand was wholly or partly surrounded by lime. Some parts of the periostracum were quite covered with this layer of

lime; in other places the layer of lime was broken off or dissolved in smaller pieces of lime and big grains. In general I found the greatest quantity of lime against the parts of the periostracum that were folded most. The rest of the outer surface of the shell nowhere showed even the smallest traces of a crust of lime, so that we cannot help connecting the formation of it with the regenerate. Rubbel and Rassbach do not mention this crust of lime on the periostracum of the regenerate. This is perhaps owing to the fact that these examiners usually worked with shells into which no sand could penetrate, because of the paper coverings of the pieces of shell that were sawed out. The formation of the crust of lime might be caused by the stimulating influence effected by the grains of sand on the mantle, immediately after the shell of the mussel was damaged. This crust of lime must have arisen even before the formation of the periostracum of the regenerate. Then the complete regenerate ought to consist of 4 layers, the layer of crust of lime, the periostracum, the prismatic layer, and the layer of mother-of-pearl. How far this idea is correct, can only be proved by further examination of shells which are regenerated in a quite natural way. These are unfortunately only to be found in about 1% of the cases, as I said already above. So it is easier to do the experiments of Rubbel and Rassbach over again, but then without any covering of paper etc. of the parts of the shell that are sawed out. Then they might also succeed in showing the layer of crust of lime on the periostracum. At the same time we might follow the influence of the water-temperature, the light and the quantity of lime in the water on the process of regeneration. As to the latter Villepoix found that in lime-free water, the regenerates consisted of periostracum only. None of the regenerates that Rubbel found in 1911 were connected with the edge of the mantle, through which the periostracum is made, according to the general opinion. Exactly what I found with my specimens in 1909.

»Sie (the regenerates) sind vielmehr von dem unter den verletzten Schalenstellen gelegenen Mantelepithel secerniert. Es sind also die Außenepithelzellen des Mantels fähig, außer dem Perlmutter, auch Periostracum und Prismenschicht zu bilden.« Thus Rubbel concludes and in 1912 Rassbach comes to the same results. I quite agree with this and so I must contradict what is said on page 684 of the 2<sup>nd</sup> edition vol. I 1910 of Parker and Haswell's Text-Book: "The periostracum and the prismatic layer are secreted from the edge of the mantle only; the pearly layer from the whole of its outer surface." In other books too, in Lang a. o., we find the same assertion; this therefore must be wrong.

Leiden, 13. March 1912.

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