

movements a minute i.e. the same number as found in full-grown animals.

III. As yet no support has been found for the opinion that small but full-grown individuals of a certain species have more rapid intestinal motion than bigger individuals of the same species.

The following experiment shows that it is not the size or the age, but the kind of individual which affects the intestinal movements.

The intestine of a half-grown rat of 86 grammes (i.e. as heavy as the above-mentioned rabbit of 3 days) as well as the intestine of a guinea-pig 9 times this weight, (777 grammes) contracted exactly twice as rapidly as the intestine of the rabbit (rat and guinea-pig 35, rabbit 16—18 a minute).

A number of questions are connected with these facts. First the movements of the various parts of stomach and intestinal channel must be compared. Further birds and cold-blooded animals must be examined. These experiments we have partly carried out already. It is not sufficient to study the velocity of the intestinal movements, but it should also be investigated how much labour is performed by the intestine.

In short not only the anatomy, but also the *mechanical function* of the intestine and the various parts of the stomach and intestinal channel must still more be submitted to a *comparative* examination in the different species of animals.

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Paleontology. — “*The orientation of the shells of Beyrichia tuberculata* KLÖDEN sp.” By Dr. J. H. BONNEMA. (Communicated by Prof. MOLL.)

Among the smaller fossil Ostracoda the best-known is certainly *Beyrichia tuberculata* KLÖDEN sp., illustrations of which are found in nearly all the text-books on paleontology (1, p. 527) and stratigraphical geology (2, p. 130).

From the figures found in these books it appears that these valves present a lateral aspect which is more or less oval. One of the long edges is straight; the other is curved, which is also the case with the two short edges. On the side there are two nodes near one

short edge, and near the other there is a lobe, cut across by two furrows into three parts. In the space left between these lobes and the straight edge, there is an oval node, the long axis of which stands at right angles on the straight edge. This latter node is situated nearest to that short edge close to which the two nodes are found. Of these latter the one that is at the greatest distance from the straight edge, is sometimes considerably swollen. Such valves are assumed to have originated from female individuals and the swollen node to have served as ovarian pouch.

That this Ostracod is so universally known is undoubtedly due to its frequent occurrence in the upper silurian Beyrichian limestones of which a great many erratic boulders of Lower Germany consist. In our diluvium too such boulders are by no means rare.

But however well-known this species of Ostracoda may be, it soon appears on examining the literature on the silurian forms that the orientation of the shells is still doubtful, in other words which valves are to be considered as right ones and which as left.

Now the purpose of this paper is to solve this problem.

Before proceeding to this, however, I will first give a short account of the history of this problem.

The first person whom we may suppose to have been acquainted with this Ostracod, is LEOPOLD VON BUCH (3, p. 71). In 1828 he gave a representation of a piece of Beyrichian limestone and in this described *Chonetes striatella* DALM. sp., which he called *Leptaena lata*, and to which he gave the shells of *Tentaculites* as spines. To the Ostracoda found in this rock he gave the name of "*Leptaenenbrut*." It is quite possible that among these there were also valves of *Beyrichia tuberculata*, but this cannot be ascertained from the pictures. VON BUCH does not mention the orientation of the shells.

Neither do KLÖDEN (4, p. 112) and BURMEISTER (5, p. 72), who took the Ostracoda valves for cephalic and caudal shields of Trilobites. KLÖDEN was the first who in 1834 gave a clear representation of *Beyrichia tuberculata* as one of the forms which he classified among *Battus tuberculatus*.

Not until 1845 does BEYRICH (6, p. 47) assert that *Battus tuberculatus* is no trilobite on account of the asymmetry of the remains, but must be classified among the Ostracoda as it has a bivalved carapace. Later, in 1846, M'COY (7, p. 57) and independently of him, BOLL (8, p. 127) in 1847 instituted the genus *Beyrichia*. Only the former gives a sufficient account of the criteria of the new genus.

This author is the first in whose works we can find something about the question we are going to solve.

This, however, may first be divided into two parts. We shall first decide which edge is to be regarded as hinge line, or in other words along which edge the two valves moved with respect to each other, and next try to find out which edge is to be considered as anterior end, or in other words which of the two short edges was situated nearest the head of the animal. The first part of the question will be discussed first being easiest to solve.

M'COY had got so accustomed to the position which was to be given to the valves when they were still regarded as cephalic shields of trilobites that, in mentioning the criteria of the genus *Beyrichia*, he described the long curved edge as dorsal side and the straight edge as ventral. He did this also in a later publication (9, p. 135), though in the meantime SALTER (10, p. 351) in the description of a species of *Beyrichia* had taken the straight side as the dorsal edge. Later investigators always followed SALTER'S example and in my opinion this is quite in accordance with what we see elsewhere in nature in similar cases, so that I agree with him and consider this part of the question settled.

Now the second part of the problem remains to be solved and this will take us longer.

In mentioning the criteria for the genus *Beyrichia*, M'COY states that the least developed end is to be regarded as anterior also recognized by the location of the median furrow and the oval node in it nearest to that end. There are no data given for this assertion.

Nor does JONES (11, p. 85) mention any. Among the criteria of the genus *Beyrichia* he states that the posterior end of the valves is higher than the anterior end. From the description of *Beyrichia tuberculata*, however, it appears that he regards the end with the two nodes as the anterior end whereas this part is the highest. At a later date BOLL (12, p. 118) and KRAUSE (13, p. 30) did the same.

BARRANDE (14, p. 467) is the first who tries to prove that the position of the *Beyrichian* shells suggested by JONES, is probably the right one. He does this, however, by comparing the nodes at one end of the shells of some Bohemian Ostracoda with the lobes of the Tribolite-glabella. As these nodes occur on the tapering part of the shells, he takes this to be the cephalic part. As for myself, I would not follow this line of evidence; nor does it lead us any further towards the orientation of the *Beyrichian* shells, as the latter have nodes at both ends. BARRANDE himself admits this too.

Contrary to all former writers REUTER (15, p. 625) assumed that the end with the three bulb-like parts, was the anterior end. He did this because measuring showed him that this very end is the

lowest and that in recent Ostracoda the lowest end is generally anterior. Another reason for his line of conduct was the conjecture that the large node into which the lower of the two nodes has sometimes passed at one end, must be considered as the lodging place of the genital apparatus of the female individuals, whereas ZENKER had said that in recent Ostracoda this genital apparatus fills the widened and heightened posterior part of the shell.

This conception of REUTER was again refuted by JONES (16, p. 339) and KIESOW (17, p. 2) but like REUTER, they failed in furnishing convincing evidence.

Therefore KRAUSE (18, p. 12; 19, p. 4) proposed to retain the position most assumed till it should be proved wrong.

At a later date ULRICH (20, p. 630) was also of opinion that for the time being the best plan would be to follow the rule indicated by JONES and regard the least developed end as anterior.

In 1908 ULRICH and BASSLER (21, p. 280) in a paper on the *Beyrichiidae* devoted a chapter to this question and tried to solve it by the following way of reasoning.

With the species of the genus *Leparditia* the shells have on both valves near one end a so-called eye-tubercle, which as is universally accepted by paleontologists is to be connected with the visual organs. Therefore in *Leparditia* shells the end with the eye-tubercles is the anterior end. As the shells are lowest in front here and most developed behind, owing to a strong retral swing of the posterior edge, they assume that this is also the case with the *Beyrichiidae*. They apply these rules also to *Beyrichia tuberculata* and find then that the position suggested by REUTER, is the right one.

Soon after the publication of ULRICH and BASSLER's paper I found an opportunity of indicating that the rules given by these writers, as far as the Ostracoda of the Kuckers formation are concerned, were altogether at variance with the results I had found.

MOBERG and GRÖNWALL (23, p. 55), who the year after gave a terminology for the *Beyrichian* valves, accepted the position such as it had been suggested by JONES, but added :

“Dock bör framhållas, att denna terminologi på paleontologiens nuvarande ståndpunkt är endast hypotetisk, äfven om mycket talar till gunst för densamma.”

And this is the present state of the question.

As I have said already, I think I have enough data now to solve the problem and from this it will appear that the position suggested by JONES, is the right one. In doing so I must make use of what

I found some years ago in *Primitia Tolli* BONNEMA (22, p. 16) from the Kuckers formation and besides of what I noticed in valves of *Beyrichia tuberculata* KLÖDEN sp.

In *Primitia Tolli* (fig. 1) I found in the first place that the shells

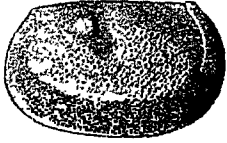


Fig. 1.

Left valve of *Primitia Tolli*
BONNEMA. $\times 15$.

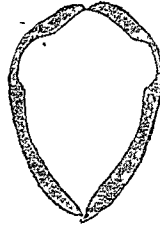


Fig. 2.

Transverse section of the entire
carapace of *Primitia Tolli* BONNEMA,
through the part of the lateral eyes,
anterior view. $\times 13$.

are very thin on the spots where the valves have a more or less distinct node (fig. 2). As according to ZENKER (24, p. 8) this is also the case with Ostracoda living in the sea, on the spots where the two composite eyes are located, the short edge of the two valves which is nearest to the node, appears to be the anterior edge. As the straight edge is to be regarded as hinge line, accordingly as dorsal edge, the orientation of the shell of this Ostracod is settled.

Besides I found that the two valves have a furrow behind the node. In this furrow there is a round spot in the lower part indicating the place where on the interior of the valve the adductor is fastened.

Further it appeared that the free edges of the right valve are sharp and that on those of the left valve there is a deep furrow. When the valves are closed the sharp edges of the right valve lie in the deep furrow of the left one.

In order now to determine which of the two short edges of the valves of *Beyrichia tuberculata* is to be regarded as anterior, I investigated in the first place whether there was any sign of a muscle impression. I succeeded in discovering this in valves originating from an erratic boulder of Beyrichian limestone found at Vollenhove. Now the muscle impression is located in the furrow between the oval node and the three bulb-like parts, as a light oval spot, the edge of which passes upward into a curved line, which runs to the superior part of the oval node (fig. 3).

From the location of the muscle impression I think I am justified in concluding that the oval node may be identified with the node

of *Primitia Tolli*; the part of the valve of *Primitia Tolli* which is situated in front of the node, and the part of the valve with the three bulb-like parts with that part of the valve of *Primitia Tolli*

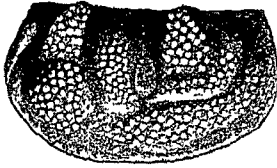


Fig. 3.

Left valve of *Beyrichia tuberculata* KLÖDEN sp. $\times 10$.

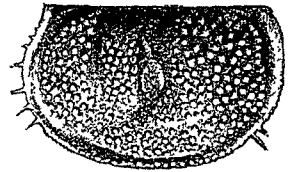


Fig. 4.

Left valve of *Beyrichia protuberans* BOLL. $\times 10$.

which is located behind the lateral groove. My opinion that this comparison was correct, was corroborated on comparing the valves of the Ostracoda mentioned above with one of *Beyrichia protuberans* BOLL, originating from an erratic boulder of Beyrichian limestone found at Groningen, which lies between the two others in structure (fig. 4).

From this then we may conclude that the edge near which the two nodes are located, is to be regarded as anterior.

Next I began to investigate if the structure of the free edges of the two kinds of valves was in accordance with the conclusion drawn from the location of the muscle impression.

For this purpose sections were made of the two kinds of valves at right angles to the dorsal edge, somewhere about the muscle impression. I then found that the structure of the free edges entirely corroborated my conclusion. The valve which I had interpreted as

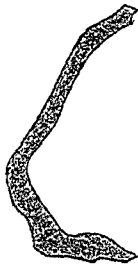


Fig. 5.

Transverse section of the right valve of *Beyrichia tuberculata* KLÖDEN sp., through the part of the muscle impression. anterior view. $\times 19$.



Fig. 6.

Transverse section of the left valve of *Beyrichia tuberculata* KLÖDEN sp., through the part of the muscle impression, anterior view. $\times 20$.

the right one (fig. 5) appeared to have sharp free edges and the

left one (fig. 6) appeared to possess a deep furrow as is the case with *Primitia Tolli*.

This, I think, shows sufficiently that JONES' orientation of the valves of *Beyrichia tuberculata* is the correct one.

As further result of my investigation I may tell that the dorsal edge of the right valve of *Beyrichia tuberculata* has a less deep furrow, in which the sharp dorsal edge of the left valve lies.

A more or less identical structure of the edges was also found in *Beyrichia Jonesii* BOLL var. *clavata* KOLMODIN (17, p. 15), of which

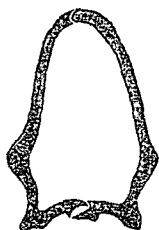


Fig. 7.

Transverse section of the entire carapace of *Beyrichia Jonesii* BOLL var. *clavata* KOLMODIN through the part where the muscle impression is undoubtedly located, anterior view. $\times 20$.

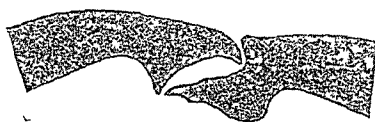


Fig. 8.

Part of the last figure magnified four times.

I possess entire carapaces originating from the clay of Mulde in Gotland (fig. 7 and 8). Here, however, the dorsal edge of the left valve is rounded off.

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