THE GEOLOGICAL MAGAZINE.

NEW SERIES. DECADE IV. VOL. III.

No. XII.—DECEMBER, 1896.

ORIGINAL ARTICLES.

I.—SOME NOTES ON THE APTYCHI FROM THE UPPER CHALK.

By H. P. BLACKMORE, M.D., F.G.S.

(PLATE XVI.)

IN 1853-6, when Mr. Sharpe published his monograph on the Cretaceous Cephalopoda of England, the various species were roughly placed according to the divisions of the Chalk formation as described by Conybeare and Philips. This, unfortunately, led to many mistakes: amongst others, Mr. Sharpe described *Belemnitella mucronata* as occurring "everywhere in the Upper Chalk of the South of England," whilst *Belemnitella quadrata* is only noticed as occurring in the Middle Chalk of Kent, Surrey, and Sussex; the fact being that *Belemnitella quadrata* is not found in the Middle Chalk, and *Belemnitella mucronata* is restricted to the highest zone of the Upper Chalk.

A careful study of the various Chalk beds by Barrois, Whitaker, Price, Evans, and others has resulted in establishing the fact that the Upper Chalk, which to the casual observer looks all alike, can be easily subdivided into various zones, each zone being characterized by the presence of certain typical fossils, amongst which the Belemnites play an important part. In the upper beds are found *Belemnitella mucronata*; these are immediately followed by others containing *B. quadrata*, and in the lower third of this zone is a small band which contains *B. lanceolata*; whilst still further down in the Marsupite zone is found the small *B. vera*.

UPPER CHALK ZONES IN THE NEIGHBOURHOOD OF SALISBURY.

1	100 feet	<i>Belemnitella mucronata</i> zone
2	150 feet	<i>Belemnitella quadrata</i> zone
		<i>Belemnitella lanceolata</i> band
3	200 feet	Marsupite zone with <i>Belemnitella vera</i>

G.M. Woodward del et lith.

West, Newman. imp.

Upper Chalk Belemnites.
to illustrate Dr H.P. Blackmore's paper

In the neighbourhood of Salisbury, the zone of *Belemnitella quadrata* is largely developed, as well as the smaller, more limited bed which contains *Belemnitella lanceolata*: a carefully-collected series of fossils from these two zones soon brought out the fact that *Aptychus leptophyllus* and *Belemnitella lanceolata* always occurred together, and that *Aptychus Portlockii* and *Belemnitella quadrata* were similarly associated. A further study of the specimens themselves revealed what this probably meant, viz., that these two Aptychi were the forward extension of the phragmocone, called by Huxley the pro-ostracum, of *Belemnitella lanceolata* and *Belemnitella quadrata* respectively. Let us now examine more closely and see whether the facts bear out this interpretation, and, for the sake of convenience, begin with *Aptychus leptophyllus*, as related to *Belemnitella lanceolata*.

If a specimen of the latter, sufficiently well preserved to show the form of the alveolar opening of the guard, be carefully examined, it will be noticed that the lateral curve of the anterior edge exactly fits the posterior end of *Aptychus leptophyllus*; and further, that these corresponding edges are similarly ended by roughened margins (Figs. 1 and 2); also, on the inner surface of the outer margin of the proximal end is a well-marked curved line (more apparent in some specimens than others), evidently caused by a fold of membrane which attached this part of the shell to the latero-dorsal end of the alveolus. The semi-crystalline structure and mineral condition of *Aptychus leptophyllus* are identical with the alveolar lining of *B. lanceolata*, both differing from the structure of the guard, corresponding in this respect with the analogous structure of the conotheca of *Belemnites paxillosus*, *B. inornatus*, and *B. ellipticus*, from the Lias and Oolite; furthermore, the singular and characteristic curves on the surface of the conotheca of the first of these species closely resemble the well-marked curved lines of growth seen on the inner concave surface of *Aptychus leptophyllus*. The outer surface of the proximal end of most of the aptychi shows distinct marks of lamination, indicating the secretion of successive layers of shell, deposited by the membrane as the animal increased in age.

This is an important point to notice, as it clearly proves that the shell grew from this end of the aptychus, and not from the straight lateral edge, as would have been the case if these aptychi represented the opercula of Ammonites. The well-marked curved lines of growth on the inner concave surface, as well as the direction of the few radiating longitudinal lines, also prove the same point.

The outer surface of the aptychi is smooth, convex, and thickened towards the outer edge, which in a side view presents a double curve; the distal end is terminated by a thickened, rounded, smooth ridge. The straight inner side is very thin, sharply curved inwards at its margin; some specimens from the Salisbury chalk-pits show the two halves united along this margin, one lapping over the other, the junction forming a straight groove which was probably a continuation of the ventral sulcus or the siphuncle.

The alveolar end of the guard of *B. lanceolata* is generally much paler in colour than the rest of the guard; but at about a quarter of

an inch from the free margin there is a well-marked stain of darker colour which follows the contour of the alveolar margin; this is so constantly present in well-preserved specimens that it is probably due to, or marks a point of attachment of, the membrane which united the pro-ostacum to the phragmocone. This darker marking can also be observed along the outer and upper curved margin of the aptychus.

The roughened termination of the thin alveolar margin, and corresponding irregularity of the proximal end of the aptychus, have been already noticed; from this it would appear there was no fixed shelly attachment of the pro-ostacum to the phragmocone; the union was one of membrane only, which would have allowed a considerable amount of movement to this portion of the shell of the Belemnite. This is also probably the reason why the aptychi in the Chalk are not found attached to the guard; the membranes would speedily decompose after death, and in decaying become separated from the heavier guard, which from its shape and weight would naturally sink to the bottom of the ocean, whilst the membranes containing the head, arms, and pro-ostacum would float away and be deposited probably far away from the guard.

One other point is worthy of note, viz. what one might term the suitability in point of size and shape. Fig. 4 represents the largest and Fig. 5 the smallest specimen found: both can be readily fitted to appropriate guards from the same bed of Chalk; whereas they would be utterly out of proportion as opercula of the huge *Ammonites leptophyllus*, which is also found in this locality, but in a much lower zone.

In the Marsupite zone of this neighbourhood Mr. Jebbett has, however, met with a fragment of a very different and much thicker, coarser aptychus, with numerous prominent points which project nearly an eighth of an inch from the external convex surface. My thanks are due to Mr. G. C. Crick for drawing my attention to several nearly perfect specimens from Charlton and Bromley, in Kent (Nos. 46,770, 48,741, 70,391), in the Natural History Museum, Cromwell Road, in every respect corresponding with a broken specimen from Salisbury. These aptychi are very different from those already described in this paper, and, from their size and the fact of their occurring in the Marsupite zone, they may be fairly assigned to *Ammonites leptophyllus*; certainly they could not belong to any Belemnite.

In the same zone of Chalk in which is found *B. lanceolata* and its pro-ostacum, have been discovered specimens of rhyncholites, which there is good reason for considering the beak of this Belemnite; no Ammonite or Nautilus being known in this zone at this locality. Two views of the upper mandible of a large Salisbury specimen are given in Pl. XVI, Figs. 6, 7.

Belemnitella quadrata differs in so many respects from *B. lanceolata* and *B. mucronata*, both in the shape and proportion of the alveolar cavity, as well as in the size and granular surface of the guard, that one is not surprised to find how widely the small aptychi which

Mr. Sharpe described in the Memoir of the Palæontological Society under the name of *Aptychus Portlockii*, differ from the pro-ostracum of *B. lanceolata*. There is, however, to be noticed the same appropriate correspondence in regard to size, between these small aptychi and the small contracted alveolar opening of *B. quadrata*; the largest specimen measuring in length 18 mm. and the smallest only 7 mm. The straight inner edge is very different from that of *Apt. leptophyllus*, being bent into an angular process which laps over the similar projection of the other shell—generally the left laps over the right—and when thus united they form on the inside a groove which corresponds with the internal groove previously described in the pro-ostracum of *B. lanceolata*. (See Figs. 10–12.)

There is no evidence how these small pro-ostraca were attached; but probably the attachment was loosely by membrane, not so near the guard as in *B. lanceolata*, and hence were even more easily detached and separated from the guard after the death of the Belemnite.

No trace of mandibles has been hitherto found associated with *B. quadrata*; the beak was possibly horny and not of the same composition, as the guard or pro-ostracum, hence it was not preserved, and has left no trace behind.

After having established the fact of the relationship of *B. lanceolata* and *B. quadrata* to the two aptychi found with them, attention was paid to the higher zone of the Chalk, and here it was discovered that *Aptychus rugosus* was associated with *B. mucronata*. As the guard and alveolar cavity of this species bear a close resemblance to the same parts of *B. lanceolata*, so *Aptychus rugosus* in many ways—in outline, general form, and relative size—resembles *Apt. leptophyllus*. There is the same thin, straight inner edge curved to lap over the margin of its fellow shell, and the curved lines on the inner concave surface are nearly identical. Externally, as the specific name indicates, the surface is marked with a series of roughened ridges, arranged in irregular parallel lines, which somewhat follow the outline of the upper and outer sides of the shell; these tuberculated ridges do not extend to the outside, which is terminated by a thin, flat, bevelled edge. The peculiar sculpturing of the external surface is probably due to the impression made by the roughened membrane which originally covered this extension of the phragmocone, and bears a close resemblance to the granular surface, so often seen on the guard of *B. quadrata*, and also very marked in the upper part of the guard of a large specimen of *B. mucronata*, from Westphalia, in the Natural History Museum, Cromwell Road, which is undoubtedly secreted by the membrane covering it.

Briefly, therefore, it appears that—

- (1) *Aptychus rugosus* is the pro-ostracum of *Belemnitella mucronata*.
- (2) *Aptychus leptophyllus* is the same part of *Belemnitella lanceolata*.
- (3) *Aptychus Portlockii* is the pro-ostracum of *Belemnitella quadrata*.
- (4) The large, coarsely punctate aptychus from the Marsupite zone is the true *Aptychus* of *Ammonites leptophyllus*.

It is consequently proposed that in future, as far as the first three are concerned, the term *aptychus* be omitted, the fossils being named after the several *Belemnites* of which they form a part.

EXPLANATION OF PLATE XVI.

1. Lateral view of guard of *Belemnitella lanceolata*, showing curve of alveolar margin, and the dark stain parallel to it.
2. External view of *Aptychus leptophyllus*, showing the smooth thickened ridge on upper and outer edge, and also laminated lower edge.
3. Internal view of same, showing the curved lines of growth, and curved line produced by membrane on the lower outer edge.
4. External view of largest specimen of *Apt. leptophyllus*.
5. Internal view of smallest specimen of *Apt. leptophyllus*.
6. Front view of *Rhyncholite*, the upper mandible of *Bel. lanceolata*.
7. Lateral view of the same.
8. External view of *Aptychus Portlockii*—the right perfect half, the left broken on inner edge.
9. External view of an example of *Apt. Portlockii*; the surface is nearly smooth, showing but few lines of growth.
10. External view of a specimen of *Apt. Portlockii*, slightly broken on inner and lower edges; lines of growth strongly marked.
- 11, 12. Two small examples of *Apt. Portlockii*, the two halves united on the inner margin at an angle which corresponds with that of the alveolar cavity of *Belemnitella quadrata*.
13. Internal view of right side of *Apt. Portlockii*, showing regular lines of growth.
14. Dorsal view of a part of guard of *Bel. quadrata*, showing the form of alveolar cavity and the curve of alveolar edges.
15. Lateral view of the same.
16. External view of a large specimen of *Aptychus rugosus* from the Upper Chalk, Norwich.

All the illustrations of *Bel. quadrata* and *Apt. Portlockii* are magnified two diameters, save Figs. 14 and 15, which, like the other figures, are of the natural size. The specimens are in the author's cabinet, Vale House, Salisbury.

II.—THE SO-CALLED MIDDLE SANDS AND GLACIAL GRAVELS OF EASTERN ENGLAND.

By Sir HENRY H. HOWORTH, K.C.I.E., M.P., F.R.S., F.G.S.

IN a previous paper I have discussed the post-Tertiary Clays of Eastern England.¹ In that paper I endeavoured to show that these clays, varying as they do in texture, composition, and contents, mark a varying geographical distribution and substratum rather than a succession of changes in time; that, so far as we can tell, they are for the most part on the same horizon, and interlock with each other, with occasional local overlaps; while they are united by one common element, namely, the presence of certain foreign boulders of the same general type in them all.

These clays are closely associated with largely developed beds of sand and gravel, which present similar problems for solution, and to some hitherto neglected features of which I should like to call attention. Before turning to these sands, etc., I would, however, add one or two additional facts and quotations in reference to the clays in support of my former conclusion. In Norfolk an attempt has been made to separate the so-called glacial clays

¹ GEOL. MAG., October, 1896, p. 449.