

THE OSTRACOD SPECIES *ORTHONOTACYTHERE*
INVERSA (CORNUEL) AND ITS ALLIES IN THE
SPEETON CLAY OF YORKSHIRE

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ABSTRACT. The ostracod species *Orthonotacythere inversa* (Cornuel) is described and split into three subspecies which form an evolutionary sequence with *O. diglypta* Triebel. Other allied species are described from the Speeton Clay.

THE genus *Orthonotacythere* was proposed in 1933 by Alexander for one Cretaceous species. In 1934 he compared the shell characters and hinge structure of the genera *Monoceratina* and *Orthonotacythere* and expressed the opinion that the latter was a derivative of the former. In this later paper he described a further three species of the genus.

Though in his initial paper he mentions the likeness to *Cytheropteron*, in his 1934 paper Alexander dwells at length on the similarity between *Orthonotacythere* and *Monoceratina*.

He was also of the opinion that the hinge in *Orthonotacythere* had developed from that of *Monoceratina* by the development of crenulations along the median bar of the left valve, and the formation of terminal teeth in the right valve, and he thought that early forms of *Orthonotacythere* might be found in the Jurassic and Lower Cretaceous with a more primitive hinge than the type species, and a greater similarity to *Monoceratina*.

Though similarities to *Monoceratina* cannot be denied, it is found that the earlier members of this genus are in fact less akin to *Monoceratina* than are the later ones, and that the species of *Orthonotacythere* found in the Lower Cretaceous and Upper Jurassic have a shorter margin and a costate ornament. This costate ornament gradually changes to the characteristic tuberculate ornament of the type species as the genus is traced from the Upper Jurassic to the Upper Cretaceous.

Upper Jurassic species of *Orthonotacythere* still have a hinge with strong terminal teeth and crenulate elements. Instead of the dominant tuberculate ornament characteristic of *Orthonotacythere* s.s. these forms show a pattern of longitudinal ridges and reticulations. The posterior margin is angled at mid-height rather than at the dorsal margin as in the type species of *Orthonotacythere*. Some species, which tend to be confined to the Western European Lower Cretaceous, were grouped together by Neale (1960) into the subgenus *Acrocythere*, with *Orthonotacythere hauteriviana* Bartenstein 1956 as type species. On further examination of this species it was found that the median sulcus, typical of the genus *Orthonotacythere* s.s. is either absent or only weakly developed, and that the shape differs markedly from other species of this genus, being rather subrectangular and not ovate. On these further grounds it is thought advisable to raise the subgenus *Acrocythere* to full generic status, as suggested by Malz in 1961.

In the Hauterivian and Barremian beds at Speeton there are a number of forms of *Orthonotacythere* s.s. constituting a group differing in ornamentation from the type

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species. These species have an ornament composed of longitudinal and vertical ridges and reticulations on the lateral surface. The median sulcus, however, is smooth and very prominent, and the shape is more akin to *Orthonotacythere* s.s. than to *Acrocythere*. The group is centred around *O. inversa* (Cornuel) and *O. diglypta* Triebel. It has been found necessary to subdivide *O. inversa* into three subspecies which form a chronological and evolutionary sequence. *O. diglypta* from the Hauterivian and Lower Barremian shows a complex pattern of vertical and longitudinal ridges and a marked reticulation. The earlier subspecies of *O. inversa* show a relationship to *O. diglypta* but there is a tendency towards the loss of the vertical ridges, and reticulation and an increase of tuberculation as one ascends the sequence. In the later subspecies the ornament is more dominantly tuberculate than costate and tends towards that of the type species.

The genus *Orthonotacythere* can therefore be subdivided into two major groups. One group, which has a dominant costate and reticulate ornament, seems to be confined to Upper Jurassic and Lower Cretaceous strata, whilst the other group, which has a dominantly tuberculate ornament and differing shape, is confined to the Upper Cretaceous and Tertiary, having evolved from the earlier one during the Lower Cretaceous with *O. inversa* as an intermediate form.

This hypothesis, however, is not as simple as it first appears. Certain species of *Orthonotacythere* from the Valanginian, Berriasian, Middle Purbeckian, and Kimmeridgian either form part of the sequence or are related to the *O. diglypta* group. The costation and reticulation of these forms is increasingly complex as the sequence is traced into older strata. Other species, however, show a divergence from the sequence. *O. ramulosa* (Sharapova) from the Upper Hauterivian and Lower Barremian possesses a tuberculate ornament with strong reticulation but poorly developed costation. In this respect, and in its shape, it is very close to the type species. *O. anglica* Neale from the Lower Hauterivian has the intercostal areas smooth, and shows subdued tuberculation. The ribs are rather poorly differentiated when compared with the other species, and it also differs in the absence of a marked antero-dorsal tubercle. It is oval in shape and very globose. The pattern of ribbing is more complex than in *O. inversa* and is similar to that of *O. diglypta*. It is possible, therefore, that it shows the same kind of relationship to *O. diglypta* as *O. blanda* sp. nov. does to *O. inversa* s.s.

The subspecies of *O. inversa* and the other related species can, in view of their restricted range, be used for correlation, at least over short distances. A chart of the postulated evolutionary sequence is reproduced as text-fig. 1, whilst the variation in the ornament is shown on text-fig. 2.

SYSTEMATIC DESCRIPTIONS

Orthonotacythere inversa (Cornuel) 1848

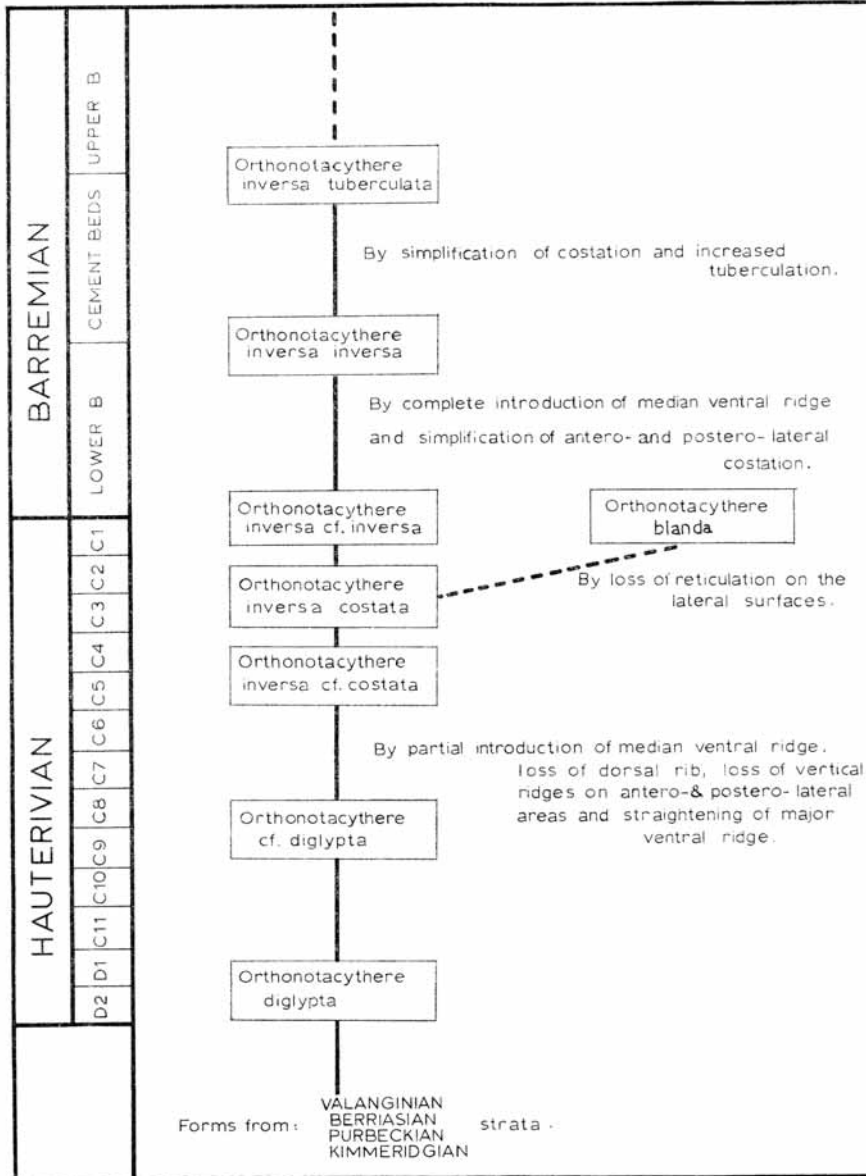
?*Cythere inversa* Cornuel 1848, p. 244, pl. 1, figs. 12-14.

Orthonotacythere inversa (Cornuel); Stchápinsky 1954, p. 496, pl. 22, fig. 1, text pl. 4, figs. 26 a-d.

Orthonotacythere inversa (Cornuel); Deroo 1956, p. 1516, pl. 3, figs. 46-48.

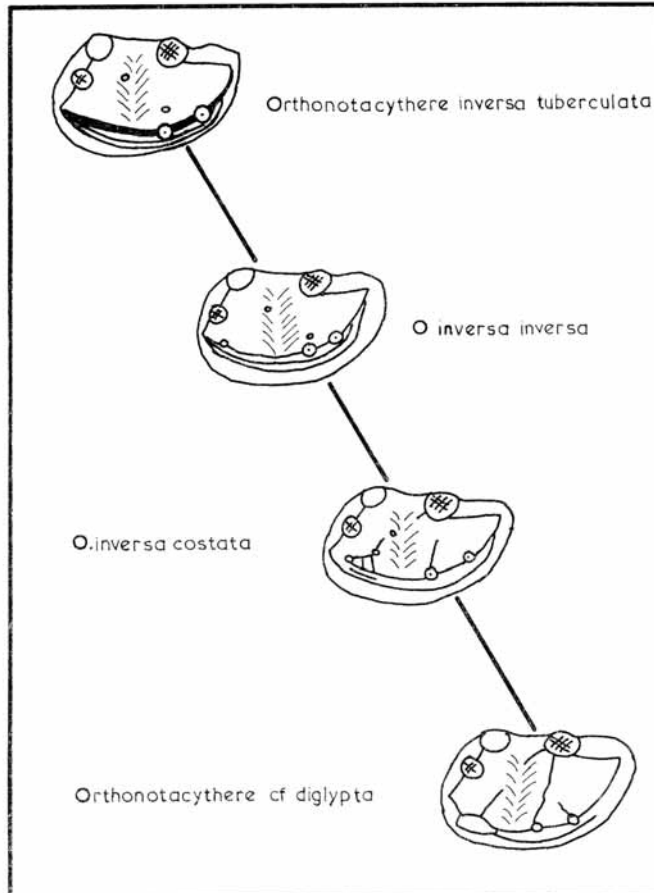
Orthonotacythere inversa (Cornuel); Neale 1960, p. 121, pl. 3, figs. 1a, b, 5a, b, pl. 4, fig. 11.

Description. This species is here split into three subspecies which differ only in the degree and distribution of the ornament. The internal features are identical and are therefore not repeated after the initial description.



TEXT-FIG. 1. Suggested evolutionary sequence for the genus *Orthonotacythere* at Speeton.

Carapace fairly large and oval in shape. Greatest height at the antero-dorsal angle, greatest width postero-ventrally. Dorsal margin long and straight: ventral margin convex and continued into the posterior margin to form a blunt caudal extension at the



TEXT-FIG. 2. Variation in ornament between subspecies of *Orthonotacythere inversa*.

postero-dorsal angle. A broad, smooth median sulcus divides the lateral surface. This sulcus is limited ventrally at about one-quarter height by a high keel-like longitudinal ridge. The median sulcus is deepest posteriorly and is separated from the inflated postero-lateral portion of the valve by a steep shelf. In some of the subspecies a small tubercle is situated antero-dorsally within the median sulcus.

A very large, smooth eye-tubercle occurs situated at the antero-dorsal angle. A further large tubercle lies ventrally of this at just over half-height. The two tubercles are joined by a short, prominent ridge. The arrangement of these tubercles forms one of the main features of this species and related forms. A further large tubercle lies antero-dorsally on the postero-lateral surface. This tubercle is very prominent and bears a network of reticulate ridges on its upper surface. Apart from the sulcus, the lateral surface is usually reticulate. Further vertical and longitudinal ridges occur together with other tubercles, but their distribution varies from subspecies to subspecies and their arrangement is therefore discussed for each of these individually.

The interior of the valve is deep and divided into two by a ridge which corresponds to the median sulcus. The marginal area is narrow and is crossed by few, short, simple radial pore canals. These number 8 to 10 anteriorly, and 3 to 5 posteriorly. Inner margin and line of concrescence coincide.

The hinge is long and narrow and in the right valve consists of two low terminal crenulate cusps separated by a locellate groove. Each cusp has four or five denticles which decrease in size towards the centre of the valve. In the left valve there are two elongated, strongly divided sockets which are separated by a long narrow crenulate, almost interdentate bar.

Orthonotacythere inversa costata subsp. nov.

Plate 61, figs. 9-10

Holotype. A male left valve from bed C. 2 at Speeton, no. HU-17-C-19-1.

Dimensions of type. Length 0.59 mm. Height 0.33 mm. Width 0.16 mm.

Other material. Nine specimens from beds C. 2 and C. 3 at Speeton, nos. HU-17-C-20-1-9.

Description. A subspecies of *Orthonotacythere inversa* showing the internal features and basic pattern of ornament characteristic of that species. It differs from the other subspecies in the degree and distribution of the surface ornament.

A high, keel-like longitudinal ridge runs parallel to the ventral margin at quarter-height. It limits the median sulcus ventrally and bears two prominent tubercles on the postero-lateral surface; one antero-ventrally and the other postero-ventrally. Each tubercle has a distinct pit upon its summit. From the anterior of these tubercles a very short indistinct ridge runs in the general direction of the antero-dorsal tubercle on the postero-lateral surface, but fades out very quickly. A fine horizontal ridge runs from the antero-dorsal postero-lateral tubercle to meet the continuation of the ventral ridge at the postero-dorsal angle. The anterior and posterior lateral surfaces are both strongly reticulate. Anteriorly the major ventral ridge runs on to the lower half of the antero-lateral surface, and forms part of a triangular complex of raised ridges bearing small tubercles at the anterior and dorsal corners.

A further keel-like ridge runs along the ventral surface parallel to the major ventral ridge. It is entirely distinct anteriorly, but posteriorly it joins the major ridge. Anteriorly it follows the anterior margin and at half-height joins a ridge running from the lower antero-dorsal tubercle, meeting in an obtuse angle. A further short longitudinal ridge runs between the two ventral ridges for the first quarter of their length. A fourth ventral ridge runs along the ventral undersurface below the aforementioned ridges for the

middle third of the valve's length. There are indications of an antero-dorsal tubercle within the median sulcus of certain specimens.

Occurrence. This subspecies is confined to beds C. 2 and C. 3 of Upper Hauterivian age at Speeton, but a closely related type is found in bed C. 4.

Remarks. This subspecies of *Orthonotacythere inversa* is the basal member of a series of forms showing derivation from *O. diglypta* and therefore bears the most resemblance to the latter. A slightly earlier form (Pl. 61, fig. 14) from bed C. 4, designated as *O. inversa* cf. *costata* (nos. HU-17-C-21-1 and HU-17-C-22-1-4), shows these similarities to an even greater extent.

O. inversa costata differs basically from *O. diglypta* in the lack of an oblique dorsal ridge running from above the antero-dorsal postero-lateral tubercle for part of the way across the median sulcus. There is also a lack of vertical ridges running from the position of the two ventral tubercles to join with the antero-dorsal, postero-lateral tubercle; in *O. inversa costata* these two ridges are replaced by the two pitted ventral tubercles. Further differences are the lack of a partial median longitudinal ventral ridge and the irregular nature of the path of the upper ventral ridge in *O. diglypta*.

O. inversa cf. *costata* is nearer to *O. diglypta* in that traces of the dorsal oblique ridge remain and the median ventral ridge is absent. There is a distinct tubercle antero-dorsally within the median sulcus. The two major ventral ridges, however, are still parallel and two prominent ventral tubercles occur.

Orthonotacythere inversa inversa (Cornuel)

Plate 61, figs. 1-8, 12, 13

Material. Thirty-two specimens from the Lower 'Cement Beds' at Speeton, nos. HU-17-C-23-1-5, 24-1-12, 25-1-15.

Measurements Males: length 0.59 mm. height 0.33 mm.
Females .. 0.50 mm. .. 0.33 mm.

Description. A subspecies of *Orthonotacythere inversa* showing the basic pattern of ornament and internal features common to the species, but having a characteristic arrangement of this ornament. In this subspecies the lateral surfaces are still strongly reticulate, but the costation is rather simplified. The deep smooth median sulcus bears a distinct antero-dorsal tubercle. The postero-lateral surface bears a large tubercle at its antero-dorsal margin, which is lower and more reticulate upon its upper surface than in the earlier subspecies. The sulcus is limited ventrally by a high major longitudinal ridge bearing two pitted tubercles upon its posterior half. Two other longitudinal ridges run below this ridge, the lower one being along the ventral surface. These ridges all join, both anteriorly and posteriorly, and parallel the margins to connect with ridges running from the antero-dorsal and postero-dorsal major tubercles respectively. Apart from the reticulation, the postero-lateral surface bears no other costation and there is only one small antero-ventral tubercle, just above the major ventral ridge. The antero-lateral surface bears a small tubercle set postero-ventrally in a region of raised reticulation.

Remarks. This subspecies differs from *O. inversa costata* in having the median ventral ridge completely formed, and in the complete lack of vertical cross ridges upon the postero-lateral surface. The ornament on the lower antero-lateral surface is simplified

and a strong tubercle occurs within the sulcus. This species is found between Cement Beds γ and η but related forms are found as low as the base of the Barremian. These related forms, designated *O. inversa* cf. *inversa*, differ in having a poorly defined tubercle within the sulcus, and have traces of vertical costation on the postero-lateral surface. The ornament on the ventral parts of the antero-lateral surface is also better defined. They can be regarded as forms intermediate between *O. inversa inversa* and *O. inversa costata*.

Orthonotacythere inversa tuberculata subsp. nov.

Plate 61, figs. 11, 15, 16

Syntypes. Three specimens HU-18-C-4-1-3 from above Cement Bed α .

Measurements. Males: length 0.56 mm.; height 0.30 mm.
Females: length 0.51 mm.; height 0.33 mm.

Other material. Sixteen specimens from Upper 'B' and the upper part of the Cement Beds, nos. HU-18-C-5-1-16.

Description. A subspecies of *O. inversa* in which the longitudinal costation and the tuberculation are the dominant feature of the ornament. The lateral surfaces are reticulate but the three ventral longitudinal ribs and the tubercles are all emphasized. A well-defined tubercle occurs antero-dorsally within the median sulcus. The ventral longitudinal ridges are very high and keel-like, and the upper one bears two large pitted tubercles on its posterior half. A small tubercle occurs in the centre of the antero-lateral surface and a further tubercle is found antero-ventrally on the postero-lateral surface. Apart from these tubercles and the reticulation, the lateral surfaces are devoid of further ornament.

EXPLANATION OF PLATE 61

All figures $\times 50$.

- Figs. 1-8, 12, 13. *Orthonotacythere inversa* s.s. (Cornuel). Middle Barremian. 1, Male carapace dorsal view, HU-17-C-23-5. 2, R.V. male lateral view, HU-17-C-23-3. 3, L.V. male lateral view, HU-17-C-23-1. 4, Male carapace ventral view, HU-17-C-23-5. 5, L.V. female lateral view, HU-17-C-23-2. 6, L.V. female internal view, HU-17-C-23-2. 7, R.V. female lateral view, HU-17-C-23-4. 8, R.V. female internal view, HU-17-C-23-4. 12, L.V. male dorsal view, HU-17-C-23-1. 13, R.V. male dorsal view, HU-17-C-23-3.
- Figs. 9-10. *Orthonotacythere inversa costata* subsp. nov. Bed C4, Upper Hauterivian. 9, L.V. male (holotype) lateral view, HU-17-C-19-1. 10, R.V. female lateral view, HU-17-C-20-1.
- Fig. 14. *Orthonotacythere inversa* cf. *costata* subsp. nov. Bed C4, Upper Hauterivian. L.V. male lateral view, HU-17-C-21-1.
- Figs. 11, 15-16. *Orthonotacythere inversa tuberculata* subsp. nov. Upper Barremian. 11, L.V. female lateral view, HU-18-C-4-1. 15, R.V. female lateral view, HU-18-C-4-3. 16, R.V. female lateral view, HU-18-C-4-2.
- Figs. 17, 18. *Orthonotacythere blanda* sp. nov. Lower Barremian. 17, R.V. female (paratype) lateral view, HU-18-C-2-1. 18, L.V. female (holotype) lateral view, HU-18-C-1-1.
- Figs. 19, 22. *Orthonotacythere* cf. *diglypta* Triebel. Bed C8, Lower Hauterivian. 19, L.V. lateral view, HU-18-C-6-2. 22, L.V. internal view, HU-18-C-6-2.
- Figs. 20, 21, 23-26. *Orthonotacythere ramulosa* (Sharapova). Upper Hauterivian-Middle Barremian. 20, Instar R.V. lateral view, HU-18-C-7-3. 21, L.V. lateral view, HU-18-C-7-2. 23, Carapace dorsal view (author's coll.). 24, R.V. internal view, HU-18-C-7-1. 25, R.V. lateral view, HU-18-C-7-1. 26, R.V. dorsal view, HU-18-C-7-1.

Remarks. This species which forms the youngest member of the group, being confined to Upper 'B' and the top of the Cement Beds, shows the final stage seen in the trend towards simplification of costation and increased tuberculation. In these respects it most resembles the forms of the genus seen in the Upper Cretaceous.

Orthonotacythere blanda sp. nov.

Plate 61, figs. 17, 18

Holotype. A female left valve from Bed LB5d, 3 feet above the base of 'Lower B', no. HU-18-C-1-1.

Measurements. Length 0.55 mm.; height 0.34 mm.; width 0.16 mm.

Other material. One paratype and five fragments nos. HU-18-C-2-1-6.

Description. This species differs from *O. inversa* s.s. in having the lateral surface completely devoid of reticulation, and the costation and tuberculation rather subdued. It also differs somewhat in shape, and is higher in relation to the length and more ovoid in general outline. The ornament follows the general basic pattern having the broad, deep median sulcus limited ventrally by a strong ridge. The pair of antero-dorsal tubercles occur, but in this case the lower one is not covered with reticulations. The postero-lateral antero-dorsal tubercle is prominent, but only shows traces of reticulation and the two ventral postero-lateral tubercles are simple and smooth. Apart from these tubercles the postero-lateral surface is devoid of ornament. The major ventral ridge is not as distinct, and posteriorly it becomes ill-defined and rather nodular. Anteriorly it terminates before the margin and has a small tubercle just beyond its extremity. Two other low ventral ridges occur, but they are rather indistinct. The median one is continued along the anterior margin to join the ridge running from the lower antero-dorsal tubercle. The antero-lateral surface bears a small tubercle ventrally, but there is no tubercle within the median sulcus.

Remarks. This easily distinguishable species appears to be confined to strata at the base of the Barremian (Lower 'B') and is very useful as a marker fossil.

Orthonotacythere cf. *diglypta* Triebel 1941

Plate 61, figs. 19, 22

Cytheropteron cf. *cuspidatum* Jones & Hinde; Weber 1934, pl. 8, fig. 8 (not fig. 9).

Orthonotacythere diglypta Triebel 1941, p. 391, pl. 4, figs. 33-37.

Measurements. Length 0.50 mm.; height 0.26 mm.; width 0.14 mm.

Material. Three specimens from bed C, 8 (Lower Hauterivian) at Spæton, nos. HU-18-C-6-1-3.

Description. Carapace ovate to subquadrangular in outline. Dorsal margin long and straight, ventral margin slightly convex. Greatest height at the antero-dorsal angle, greatest width postero-ventrally. A broad median sulcus divides the lateral surface. This sulcus is limited ventrally at about quarter-height by a high rather irregular longitudinal ridge. The sulcus is broad, smooth and deepest posteriorly. The antero-lateral and postero-lateral surfaces are coarsely reticulate and bear a series of ridges and tubercles.

A large smooth eye-tubercle occurs at the antero-dorsal angle. A further large tubercle lies ventrally of this at just over half-height. This tubercle bears a network of

reticulations upon its upper surface and is joined to the eye-tubercle by a short, strong ridge. A large tubercle lies antero-dorsally upon the postero-lateral surface.

A rather irregular ridge occurs ventrally below the sulcus. It bears two tubercles upon its posterior half, which are joined by fine vertical ridges to the antero-dorsal tubercle situated on the postero-lateral surface. Posteriorly the ventral ridge follows the margin to mid-height, where it meets an oblique ridge running from the last-mentioned tubercle. Anteriorly the ventral ridge follows a similar path to meet an oblique ridge running from the lower postero-dorsal tubercle. From a position one-quarter of the way along the ventral ridge, a further ridge runs obliquely across the antero-lateral surface in the postero-dorsal direction to meet a ridge running postero-ventrally from the lower antero-dorsal tubercle at about mid-height. A distinct ridge follows the dorsal margin starting posteriorly and curving to run slightly obliquely almost completely across the median sulcus. This ridge is joined in its central portion to the antero-dorsal tubercle situated just below it on the postero-lateral surface. A long straight ridge runs along the ventral surface joining the upper irregular ventral ridge anteriorly and posteriorly.

Remarks. This form shows all the basic features of the *O. inversa* group, especially in the number and arrangement of the tubercles and the ridges. It can be seen that it forms an early member of this series having a complex costation. By modification of its ornament along the trends seen in *O. inversa* s.l., the earlier subspecies of this later form are produced.

It differs principally from *O. inversa costata* in the irregular nature of the upper ventral ridge and the lack of a partial median ventral ridge. It also shows strong vertical costation on the lateral surfaces and has a dorsal ridge which almost crosses the sulcus. This form has been designated *O. cf. diglypta* as the dorsal ridge completely traverses the sulcus in *O. diglypta* s.s. It is therefore a later form of *O. diglypta* showing the first stages in the trend towards complete loss of the dorsal ridge.

Orthonotacythere ramulosa Sharapova 1939

Plate 61, figs. 20, 21, 23–26

Cytheropteron cf. *pedatum* var. *salebrosa* Jones & Hinde; Weber 1934, pl. 9, fig. 8.
non *Cytheropteron pedatum* (Marsson) var. *salebrosa* Jones & Hinde 1890, p. 39, pl. 3, fig. 8;
pl. 4, figs. 32–35.

Orthonotacythere ramulosa Sharapova 1939, p. 29, pl. 3, fig. 34.

Orthonotacythere ramulosa Sharapova; Liubimova 1955, p. 93, pl. 10, fig. 10

Orthonotacythere ramulosa Sharapova; Neale 1960, p. 212, pl. 3, figs. 8 *a-b*, 12 *a-b*; pl. 4, figs. 15–18.

Material. One pre-adult right valve from 3 feet above the base of 'Lower B' (Barremian) mounted as specimen no. HU-18-C-7-3, together with figured left and right valves from Bed C3 (Hauterivian) at Speeton, nos. HU-18-C-7-1–2.

| Measurement | Length | Height |
|--------------------------------|----------|----------|
| Adult left valve HU-18-C-7-2 | 0.65 mm. | 0.36 mm. |
| Instar right valve HU-18-C-7-3 | 0.52 mm. | 0.27 mm. |

Description. Carapace sub-rectangular in lateral view, with a long straight dorsal margin and a slightly convex ventral margin. The lateral surface is divided by a broad, smooth median sulcus. This sulcus contains a small spine in an antero-dorsal position at about

three-quarters height. In addition to the eye-tubercle, a further prominent tubercle occurs antero-dorsally at about three-quarters height. This tubercle, which is joined to the eye-tubercle by a low swelling, possesses a network of ridges upon its upper surface. A row of four very large, high, flat-topped tubercles occur at about quarter-height in a curved row paralleling the ventral margin. Two of these are situated on the ventral part of the antero-lateral surface, the other two being situated on the ventral part of the postero-lateral surface. Below these tubercles a high keel-like longitudinal ridge runs along the ventral surface. A further large tubercle is found at about three-quarters height immediately behind the sulcus on the postero-lateral surface, and a low irregular process is found at the postero-dorsal angle. Apart from the sulcus the lateral surfaces are finely reticulate.

The duplicature is narrow and crossed by a few simple radial pore canals. Inner margin and line of concrescence coincide. The hinge of the right valve consists of two terminal rows of denticles (about five in each) joined by a long, narrow interdentine groove.

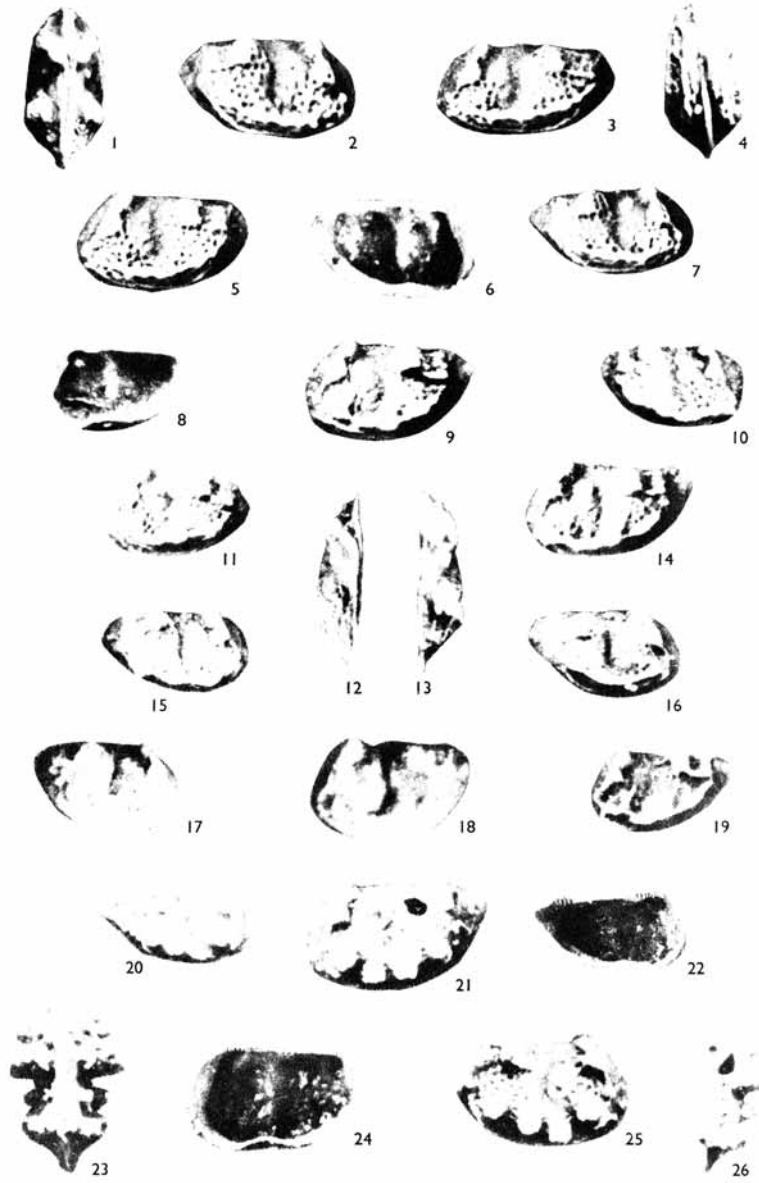
Remarks. This species by its basic pattern of ornament is related to the *O. inversa* group, but its exact position in the evolutionary sequence is uncertain. It is mainly found in the Upper Hauterivian beds.

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KAYE, *Orthonotacythere*