

A VISÉAN CEPHALOPOD FAUNA FROM NEW SOUTH WALES

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ABSTRACT. A fauna consisting of numerous specimens of the ammonoid *Beyrichoceras trevallynense* sp. nov., together with the nautiloids *Mooreoceras regulare* sp. nov., *Vestinautilus* sp., and *Knightoceras?* sp., is described from the Bingleburra Formation of the Gresford District, north-west of Newcastle, New South Wales. It is suggested that the fauna may be correlated with the middle to upper part of the *Beyrichoceras* zone of Europe.

THIS small, but important, cephalopod fauna was found by two of us (D. A. B. and K. S. W. C.) while visiting a locality recently examined and described by Roberts (1961). It occurs in the upper part of the Bingleburra Formation near Trevallyn at G.R. 570864 Dungog One-Mile Military Sheet, south of Gresford, N.S.W. (text-fig. 1). The formation consists mainly of mudstones, but includes relatively thin conglomerates, sandstones, and oolitic limestones. A black silty bioclastic limestone has yielded all of the present specimens. It is intercalated in a siltstone and sandstone body, which contains a rich brachiopod, polyzoan and molluscan fauna that is being described elsewhere by Roberts. As has been indicated previously by Roberts (1961, p. 83), the faunal and stratigraphical evidence suggests that the Trevallyn fauna is slightly older than those from Hilldale and Babbinboon, N.S.W. On the basis of the brachiopods and polyzoans, these have been correlated with the upper Osagean of North America. Recent trans-Atlantic correlation tables (e.g. Collinson, Rexroad, and Scott 1962) equate the Osagean with the German goniatite zones Cu II β - δ , that is, with the upper *Pericyclus* and lower *Beyrichoceras* zones. The newly discovered specimens are referred to *Mooreoceras regulare* sp. nov., *Vestinautilus* sp., *Knightoceras?* sp., and *Beyrichoceras trevallynense* sp. nov. *Prolecanites* sp. has previously been recorded at the locality (Roberts 1961, p. 82).

Cephalopods are rare in the Carboniferous rocks of New South Wales. Ammonoids have been described from only three other areas, namely, *Protocanites*, *Muensteroceras*, *Imitoceras*, and *Pericyclus* from the Werrie Basin (Delépine 1941; Campbell and Engel 1963), *Beyrichoceras* from the Gloucester Syncline (Cvancara 1958), and *Cravenoceras* from the Kempsey area (Campbell 1962). Nautiloids are somewhat more abundant and widespread, but though they have appeared quite frequently in faunal lists, they have been described and figured on one occasion only, namely, by de Koninck (1877) who recognized three European species, *Orthoceras martinianum?* de Koninck, *Cameroceas phillipsi* de Koninck, and *Nautilus subsulcatus* Phillips, each on the basis of a single specimen. The localities cited are exceedingly vague, and the specimens have since been destroyed by fire. Attempts to recover conodonts from this and related limestones have proved unsuccessful.

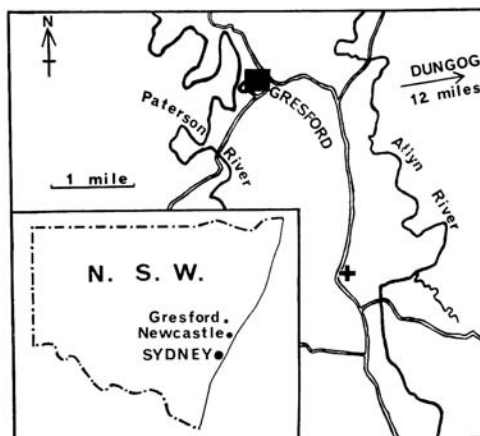
The authors are indebted to Mr. W. S. Bisat, F.R.S., for much helpful advice on the relationships of the goniatites.

SYSTEMATIC DESCRIPTIONS

Order NAUTILOIDEA

Genus MOOREOCERAS Miller, Dunbar, and Condra 1933

Type species (by original designation). *M. normale* Miller, Dunbar, and Condra (1933), from the Kansas City Formation, Missouri Series, Kansas City, Missouri.



TEXT-FIG. 1. Map of Trevallyn cephalopod locality, marked by +.

Remarks. Flower (1939) reported the presence of cameral deposits concentrated on the ventral side of the conch, and siphonal deposits of the *Pseudorthoceras* type in species which he assigned to the genus. However, Miller and Youngquist (1949) have re-examined the genoholotype and other specimens referred to the type species, and concluded that neither cameral nor siphonal deposits are present. We accept their interpretation herein.

Mooreoceras regulare sp. nov.

Plate 102, figs. 1-4; text-figs. 2-3

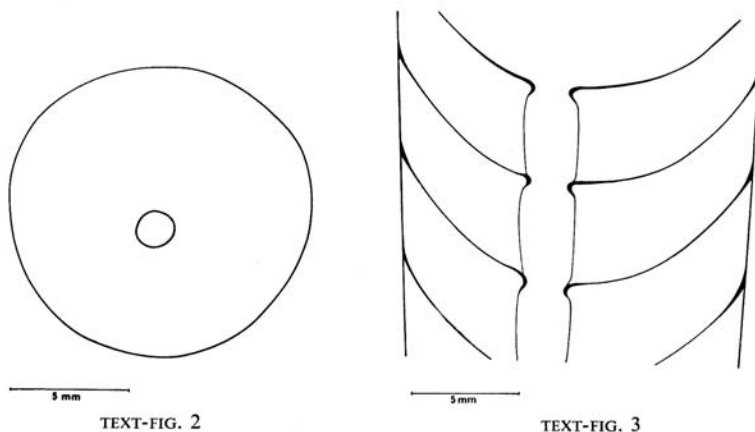
Holotype. A.N.U. 14027, from the Bingleburra Formation at Trevallyn; paratypes ANU 14028-9 from the same locality.

Diagnosis. Conch gradually expanding; siphuncle slightly excentric; connecting rings only weakly fusiform; no external ornament.

Description. Conch gradually expanding, almost circular in section, and reaching a length of at least 230 mm.; greatest observed diameter 31 mm.; surface completely smooth apart from very faint traces of growth-lines; septa simple, deeply concave (see Pl. 102, fig. 3) and spaced 3.5 mm. apart at a conch diameter of 9 mm., 4 mm. at 12 mm., and 5 mm. at 18 mm.; mural part of septa extending as much as two-thirds the length of the camerae; septal sutures almost circular, and transverse; siphuncle excentric by an amount slightly less than its own diameter, at conch diameters between 14 and 17 mm.;

septal necks cyrtocoanitic, with the area of adnation and the brim very narrow; connecting rings very fine, cylindrical over most of their length and slightly constricted at the septa; neither cameral nor siphonal deposits present; shell substance moderately thick.

Remarks. The material available consists of one almost complete phragmocone, several fragments of phragmocones, and part of a large living chamber. Part of the most complete specimen has been sectioned together with small fragments of another individual. All specimens are preserved with the shell substance intact.



TEXT-FIG. 2. Transverse section of *Mooreoceras regulare* sp. nov. showing the position of the siphuncle. ANU 14027.

TEXT-FIG. 3. Longitudinal section of *Mooreoceras regulare* sp. nov. ANU 14027.

The development of substances that uniformly line the inner surfaces of the camerae, including the connecting rings, clearly indicate the absence of cameral deposits; and the presence of a lining with a similar texture on one side only of the siphuncle proves the absence of siphonal deposits. In these respects the specimens do not accord with Flower's (1939) interpretation of the genus *Mooreoceras*. However, Miller and Youngquist (1949) have re-examined the genoholotype and other specimens referred to the type species, and concluded that neither cameral nor siphonal deposits are present. This excludes our specimens from *Adnatoceras* Flower and *Dolorthoceras* Miller. An unusual

EXPLANATION OF PLATE 102

Figs. 1-4. *Mooreoceras regulare* sp. nov. 1, 2, Latex cast of the exterior of partly exfoliated specimen, ANU 14027, $\times 1.5$. 3, 4, Section showing the internal structure, ANU 14027, $\times 2$ and $\times 3$. Figs. 5-11. *Vestinautilus* sp. 5, Lateral view, ANU 14024, $\times 1$. 6, Same specimen with the living chamber and first few camerae removed to show the ornament on the early whorls, $\times 2$. 7, 8, 10, 11, Ventral views of same showing profiles and fine ornament, $\times 2$, $\times 1$, $\times 2$, and $\times 2$. Note the shape of the septal suture in fig. 8. The profile on the upper part of fig. 8 does not show sufficiently deep channeling due to the flat face cut on one side of the specimen. 9, Polished surface showing penultimate septum and preceding four septa.

feature of our specimens is the almost cylindrical shape of the connecting rings. In most species of *Mooreoceras* they tend to be more fusiform.

The internal structures of the European species that resemble *M. regulare* externally are not sufficiently well known to warrant discussion of possible relationships. *M. indianense* (Hall) from the Rockford Limestone (Kinderhookian) of Indiana is similar in many respects but is more gently tapered. The specimens from the Marshall Sandstone which have been placed in *M. cf. indianense* by Miller and Garner also differ in having ovoid connecting rings.

Genus KNIGHTOCERAS Miller and Owen 1934

? 1953 *Subvestinautilus* Turner, p. 320.

? *Vestinautilus* (*Nikenutilus*) Shimansky, p. 129.

Type species (by original designation). *K. missouriense* Miller and Owen (1934) from the Cherokee Formation, Des Moines Series, Henry County, Missouri.

Remarks. This genus is inadequately understood because its type species is known only from a single specimen in which the form of the early whorls is not shown. Several species ranging in age from Lower Carboniferous (Gordon 1957; Ramsbottom and Moore 1961) to Lower Permian (Miller and Youngquist 1949) have been assigned to the genus. In those species in which the shape and ornament of the inner whorls can be determined, the venter and umbilical walls are slightly convex, and both carry faint spiral ornament (Gordon 1957; Ramsbottom and Moore 1961). Further investigation of the type species is clearly necessary before definite conclusions can be reached, but on the evidence presented above *Subvestinautilus* Turner is meanwhile placed in synonymy. *Vestinautilus* (*Nikenutilus*) Shimansky (type species *V. beleuthensis* Shimansky (1957) from the Viséan of Kazakhstan) is another closely related form, said to be distinctive in its gently lobate peripheral keel. It is noted that Miller and Youngquist (1949) record similar structures on the Permian *Knightoceras kempae*.

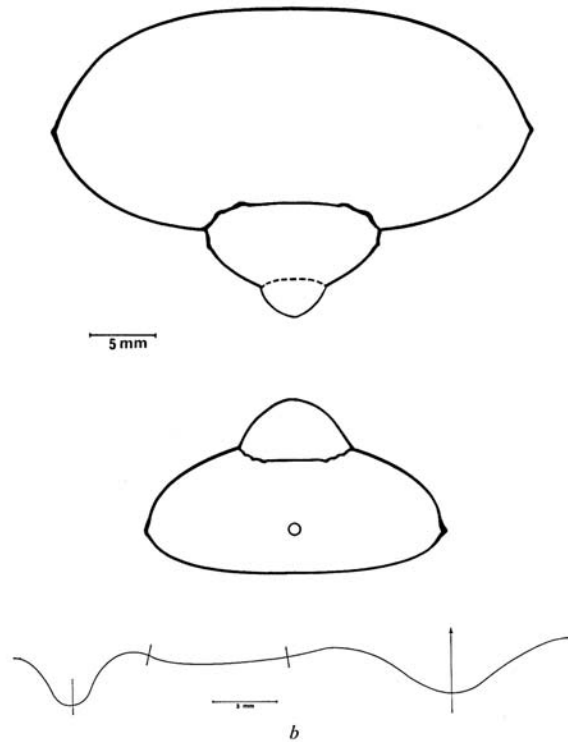
Knightoceras ? sp.

Plate 103, figs. 1-4; text-fig. 4a-b

Description. Conch rapidly expanding; umbilicus wide and perforate; umbilical wall of first whorl strongly convex but its venter not observed; early part of second whorl with strong peripheral keels almost at the ventral edge, and a broad venter gently convex overall but with a slightly concave median zone; peripheral keels becoming progressively more dorsal in position and less angular at later growth stages; venter becoming strongly and evenly convex; umbilical walls strongly convex throughout; a single spiral thread present on dorsal side of keel on first one and a half whorls, but thereafter absent; venter with three spiral ribs on either side of a broad smooth zone, rapidly fading on the first half of the second whorl; keels formed partly by shell flexure and partly by shell thickening; dorsal impressed zone slight, whorls overlapping preceding whorls to the level of the keels; transverse ornament of growth-lines only; hyponomic sinus 3.5 mm. deep at a whorl width of 11 mm.

Septa deeply concave in lateral section, slightly concave in longitudinal section; septal sutures on penultimate whorl with a deep ventral lobe, almost straight on the umbilical

whorls, and with a deep well-rounded dorsal lobe; last six septa occupy 30 mm. measured around the venter; siphuncle situated slightly ventrad of the centre of the septa; septal necks and connecting rings unknown.



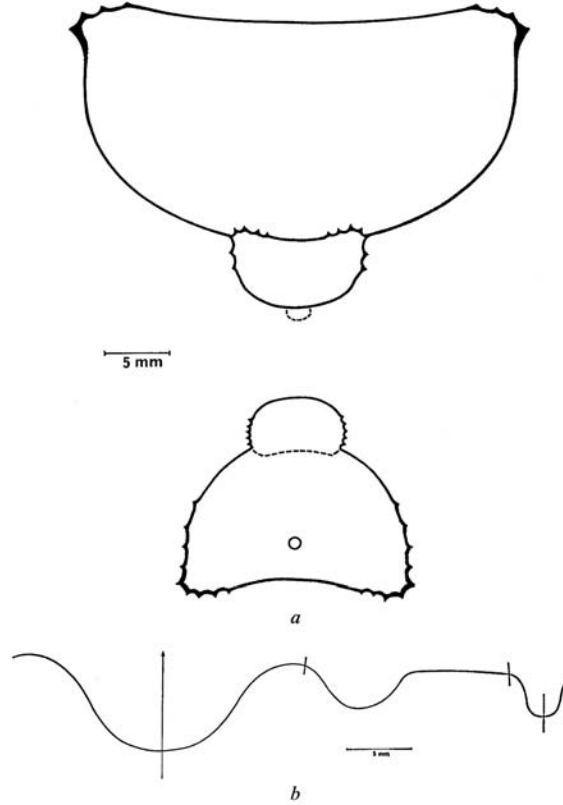
TEXT-FIG. 4. (a) Cross-section of *Knightoceras*? sp. ANU 14023. (Reconstructed.) (b) Suture-line of same specimen taken at total conch diameter of 32 mm., showing the positions of the umbilical seam and the peripheral keel. Both $\times 2$.

Remarks. The generic position of this specimen is in doubt. It resembles *Knightoceras* in the overall shape of the conch, the profile of the last whorl, the absence of strong spiral ornament, and the general shape of the suture-line. On the other hand it resembles *Vestinautilus* in that it has a slightly depressed venter on the early whorls, though it lacks the strong spiral ornament of that genus. The balance of evidence favours an assignment to *Knightoceras*.

Of the described species our specimen (ANU 14023) is probably closest to *K. loughphontaensis* Ramsbottom and Moore from the Viséan of Ireland, but that species has a more ventrally placed peripheral keel and more spiral lirae on the venter of the early whorls. *K. pattoni* Gordon has a much higher whorl profile, a less marked peripheral keel, and a more convex venter on the early whorls.

Genus VESTINAUTILUS de Ryckholt, 1852

Type species (by subsequent designation of Hyatt, 1884). *Nautilus konincki* d'Orbigny, from the Tournaisian of Tournai, Belgium.



TEXT-FIG. 5. (a) Cross-section of *Vestinautilus* sp. ANU 14024. (Reconstructed.) (b) Suture-line of same specimen taken at a total conch diameter of 35 mm., showing the positions of the umbilical seam and the peripheral keel. Both $\times 2$.

Vestinautilus sp.

Plate 102, figs. 5-11; text-fig. 5a, b

Description. Conch rapidly expanding; umbilicus wide and perforate; early parts of first whorl almost circular but with a slightly flattened venter; at three-quarters of the length of the first whorl the basic whorl shape is established, viz. maximum width across the peripheral keels, venter concave, flanks strongly convex, dorsal zone slightly impressed; height/width ratios of the whorls vary as in Table 1; peripheral keel sharp on early whorls but tending to become gradually more rounded adorally; spiral ornament of two

grades; coarser threads four in number in a zone on the flanks up towards the peripheral keel, extending back almost to the adapical tip and fading out after about $1\frac{1}{2}$ whorls; on the lateral parts of the venter three or four similar coarse threads, one stronger than those on either side of it and extending further apicad; very fine threads (12–15 per mm.) over the entire venter at all growth stages; very prominent transversals present on the second half of the first whorl, but indistinct elsewhere; hyponomic sinus almost linguiform, and 6 mm. deep at a whorl width of 12 mm.

Suture pattern on first half whorl not observed; thereafter shape relatively constant (text-fig. 5*b*); septa deeply concave and dorsally meeting the conch wall at a very low angle; siphuncle situated about one-third of the whorl height from the venter, septal necks very short, orthochoanitic; connecting rings slightly fusiform.

TABLE 1

Total diameter (D)	Height of whorl (H)	Thickness of whorl (T)
14 mm.	4.5 mm.	—
23	8.5	13 mm.
31	11.5	18
37	14	23
47	18	33 est.

Remarks. The specimen ANU 14024 is almost complete, but ANU 14025 is only a fragment of the penultimate whorl. The preservation is sufficiently good to enable the shape and ornament of the inner whorls to be determined by stripping off the outer ones, which were subsequently replaced.

These specimens are assigned to *Vestinautilus* on the presence of: (a) the concave venter on the early whorls; (b) the strong sharp peripheral keel on the early whorls, tending to become more rounded on the living chamber; (c) the gradual reduction of the spiral and transverse ornament during ontogeny; (d) the wide, open, perforate umbilicus; (e) the convex profiles of the umbilical walls throughout; (f) a deep ventral sinus in the suture and a shallower lateral sinus on the flanks.

The type species, *V. konincki* (d'Orbigny), has a strongly convex venter on the last whorl according to de Koninck (1878, p. 138), but some of his figured specimens are concave at least at the beginning of the living chamber (pl. 30, fig. 1). It is concluded that the species is very variable in this character, and that the occurrence of a flattened to slightly concave venter on the living chamber of our specimen is of little taxonomic importance.

There are no overseas species with which close comparison can be made.

Material. ANU 14024–5.

Order AMMONOIDEA
Sub-order GONIATITINA
Family GONIATITIDAE
Genus BEYRICHOCERAS Foord 1903

Type species (by subsequent designation of Bisat, 1924, p. 84). *Goniatites obtusus* Phillips 1836, p. 234, pl. 19, figs. 10, 11, ? 13 (non fig. 12 = *Glyphioceras phillipsi* Foord and Crick 1897, p. 172 (*vide* Foord 1903, p. 163)). Middle Viséan, Yorkshire, England.

Much has been written about the similarities and differences between *Muensteroceras* Hyatt 1884, *Beyrichoceras* Foord 1903, *Beyrichoceratoides* Bisat 1924, and the group of genera founded by Bisat (1952)—*Bollandites*, *Bollandoceras*, and *Cowdaleoceras*. We are inclined to agree with Miller and Garner (1955, p. 137) that the last three genera are probably not recognizable as such, especially when we observe the variation that may occur in the ontogenetic development of even a single species, such as the one under discussion here. In our view, they probably lie within the range of variation between typical *Muensteroceras* and typical *Beyrichoceras*. This is also the view of Gordon (1957, p. 40) who does, however, retain *Bollandites* as a separate genus.

On the basis of the type species of both *Muensteroceras* (*Goniatites*) *oweni* Hall var. *parallelus* Hall, from the Kinderhookian Stage of Indiana, U.S.A., and *Beyrichoceras* (see above), we consider the main distinguishing character of the latter to reside in the adult ventral lobe which is moderately wide, rather than narrow, and the flanks of which diverge orad while the prongs diverge apicad. On these grounds, the present species is regarded as a *Beyrichoceras*.

It is of interest to note that Miller and Furnish (1957, p. 157) place *Bollandoceras* Bisat 1952 and other related genera in the synonymy of *Muensteroceras* Hyatt. There is no evidence, however, that *B. submicronotum* Bisat (the type species) has a narrow ventral lobe with parallel sides as in Hyatt's genus.

Beyrichoceras trevallynense sp. nov.

Plate 103, figs. 5–10; text-figs. 6a–h, 7

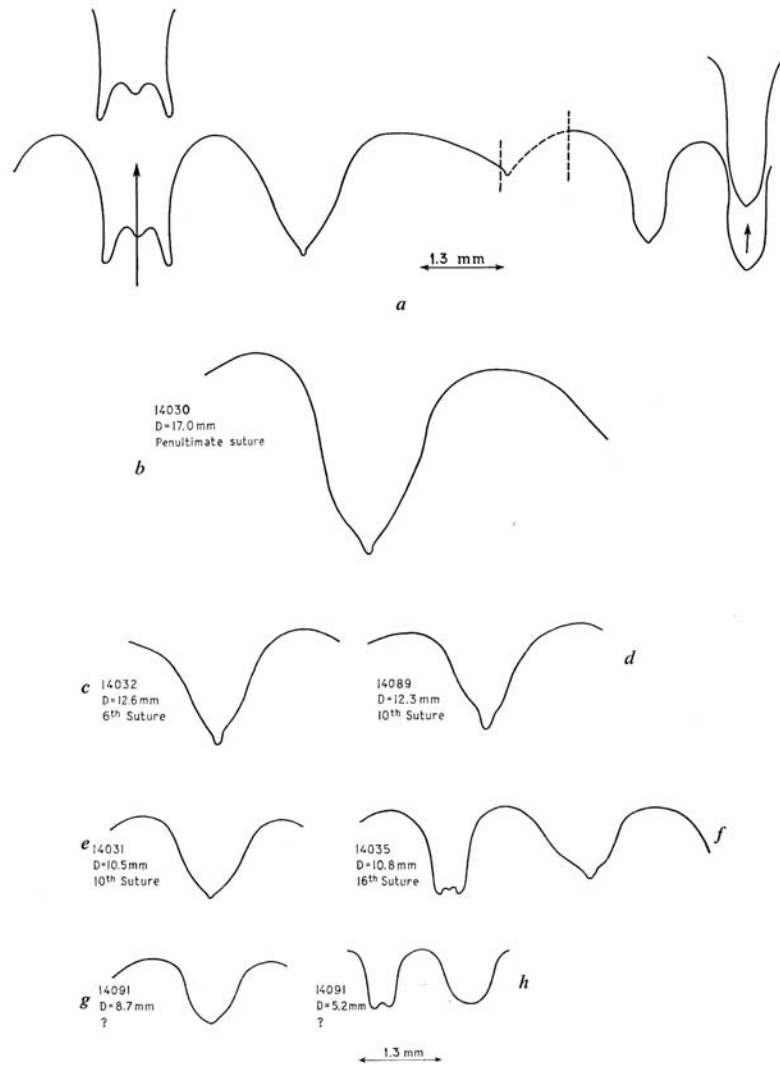
Holotype. ANU 14032, Bingleburra Formation, Trevallyn, south of Gresford, New South Wales. (Pl. 103, figs. 7, 8; text-fig. 6c.)

Diagnosis. Small *Beyrichoceras* with five to six shallow constrictions; transverse growth-lines not forwardly inflected; lingua absent. Suture-line in adult with secondary ventral saddle about one-third height of ventral lobe; first lateral saddle rather broad; lateral lobe teat-shaped.

Description. Conch ellipsoconic, thin-shelled, broadly discoidal to subdiscoidal, involute. Umbilicus small. Whorls six to seven, almost completely overlapping, becoming relatively higher in maturity; walls of mature whorls thickened internally by deposits in the region of the umbilical shoulder. Aperture not seen, but body chamber extending at least 270° from the saddle-line of the last septum. Ornamentation slight, of fine transverse growth-lines curving apicad very slightly at the venter, concentric striae absent; constrictions well marked, radial, straight, five to six per whorl, slightly and broadly sinuate on the venter. Chambers eighteen to twenty per whorl. Sutures *Beyrichoceras*-like (see diagrams below).

Remarks. The description is based on a large number of almost complete specimens and many fragments. In no case, however, could the shape of the outer margin of the aperture be discerned although from the nature of the slightly backwardly curved fine striae crossing the venter, it may be assumed that this margin was probably fairly plain.

With the large quantity of available material, it has been possible to obtain a considerable amount of information on the morphology of the conch. The largest specimen present in the collection approaches 20 mm. in diameter (14040) and is probably almost



TEXT-FIG. 6. *Beyrichoceras trevallynense*, sp. nov. *a*, Penultimate suture-line at $D = 12.7$ mm.; derived from ANU 14032. Dotted line represents assumed, but obscured section between umbilical shoulder and umbilical seam. *b-h*, Comparative portions of suture-lines taken at different levels. Sutures, where indicated, are numbered from the adult end.

complete, since the body chamber on the specimen extends for almost 270° of rotation before reaching the crest of the saddles of the last chamber.

As seen in text-fig. 6a, the suture-line in the adult (14032) comprises a ventral lobe with a secondary saddle slightly less than one-third of its height. The adult ventral lobe is also almost parallel-sided with a slight constriction opposite the summit of the secondary ventral saddle, the prongs of the lobe often being directed slightly outwards.

TABLE 2

Measurements of selected specimens (in mm.):

ANU no.	D	T	UD*	H (max.)	h (max.)
14030	17.3	10.1	1.8	9.7	—
14031	13.6	7.6	1.5	6.5	3.3
14032	15.5	7.9	1.6	—	—
14033 (x-s)	17.4	9.1	1.5	8.5	4.6
14034	17.3	9.4	—	—	—
14036 (x-s)	17.0 approx.	9.1	1.5	9.0	5.2
14040 (x-s)	19.4	9.3	—	10.4	5.0
14041	16.7	10.1	1.9	—	—
14090	10.6	6.7	—	—	—

*UD = Umbilical Width

Measurements of two cross-sections (see text-fig. 7 for notation)

ANU no. 14033			D (max.) = 17.4 mm.			ANU no. 14036			D (max.) = 17.0 mm. approx.		
H ₁	8.5	h ₁	4.6	T ₁	9.1	H ₁	9.0	h ₁	5.2	T ₁	9.1
H ₂	6.4	h ₂	3.4	T ₂	7.2	H ₂	6.0	h ₂	3.0	T ₂	7.2
H ₃	4.3	h ₃	2.2	T ₃	5.9	H ₃	4.3	h ₃	2.0	T ₃	5.9
H ₄	2.8	h ₄	1.4	T ₄	4.7	H ₄	2.6	h ₄	1.4	T ₄	4.4
H ₅	1.8	h ₅	1.1	T ₅	3.9	H ₅	1.8	h ₅	1.0	T ₅	3.8
H ₆	1.4	h ₆	0.8	T ₆	2.8	H ₆	1.2	h ₆	0.8	T ₆	2.6
H ₇	1.0	h ₇	0.6	T ₇	2.3	H ₇	0.9	h ₇	0.5	T ₇	2.4
H ₈	0.8	h ₈	0.5	T ₈	1.9	H ₈	0.7	h ₈	0.4	T ₈	1.7
H ₉	0.6	h ₉	0.4	T ₉	1.5	H ₉	0.6	h ₉	0.3	T ₉	1.3
H ₁₀	0.5	h ₁₀	0.4	T ₁₀	1.1	H ₁₀	0.5	h ₁₀	0.3	T ₁₀	1.0
H ₁₁	0.4	h ₁₁	0.3	T ₁₁	0.9	H ₁₁	0.4	h ₁₁	0.3—	T ₁₁	0.8
H ₁₂	0.3+	h ₁₂	0.2	T ₁₂	0.7					T ₁₂	0.7
H ₁₃	0.3—	h ₁₃	0.1+	T ₁₃	0.6					T ₁₃	0.6

In earlier stages of ontogeny, however, there are quite marked contrasts. Apart from the smaller size, the sides of ventral lobe become convergent apicad and the secondary ventral saddle decreases considerably in height (text-fig. 6f, h). The very prominent lateral lobe in mature and adolescent stages is distinctly angular with a teat-shaped prong usually directed slightly towards the venter. In early stages, however, it is quite rounded or reverse saddle-shaped (text-fig. 6g, h). The umbilical lobe is shallow, widely open V-shaped, and its prong lies just inside the umbilical shoulder. The umbilical saddle has its crest on the umbilical seam. The dorso-lateral and dorsal lobes are deep, narrow, parallel-sided, with the sides converging sharply to the prong in each case. No information is available on any changes that may occur in the ontogeny of these lobes.

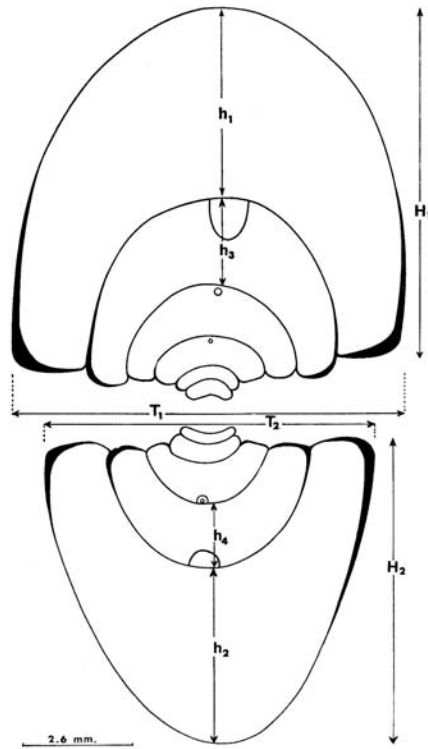
In seeking for comparisons among the goniatites from the *Beyrichoceras* Zone in the north of England (Bisat, 1934), the present species appears to fall into his *B. micro-*

notum group and is evidently fairly close to *B. submicronotum* Bisat (1934, p. 291, pl. 23, figs. 5, 6; text-fig. 19), later chosen as the type species of *Bollandoceras* Bisat, 1952.

Beyrichoceras trevallynense differs externally from *B. submicronotum* in having no apparent forward inflexion of the transverse growth-lines from the flank, forming a lingua, at any stage. Comparison of the suture-line indicates that the secondary ventral saddle in the adult of the present species is considerably higher than in *B. submicronotum*, and the first lateral saddle is much broader. Bisat also indicates that some of his specimens were considerably larger (30 mm.) than the Trevallyn forms.

From *B. micronotum* Phillips, differences in the present species lie in the greater number of shallower constrictions, the smaller size, and the suture-line in which, according to Bisat (1934, p. 288, text-fig. 18), the ventral saddle is markedly higher. However, in so far as the last feature is concerned, Gordon (1957, p. 41, text-fig. 15) has identified as *B. micronotum* specimens from the III α zone in Alaska and remarks that '... the ventral lobe of the Alaskan specimen is a little more deeply notched by the median saddle than shown by Bisat for the lectoholotype'.

Kullmann (1961) has also identified a species of *Beyrichoceras* (which he regards as a subgenus of *Goniatites* de Haan) from the Lower Carboniferous of the Cantabrian Mountains of northern Spain, and compares it with *B. micronotum* Phillips. In these specimens the flanks of the ventral lobe are convergent, though showing a slight tendency to converge less towards the prongs.



TEXT-FIG. 7. *Beyrichoceras trevallynense*, sp. nov. Section through specimen ANU 14033. Notation used refers to tables. Specimen is slightly distorted.

Apart from the larger dimensions of the Moroccan forms described by Delépine (1941, p. 62, pl. 3, figs. 25–32) as *B. micronotum*, there is insufficient information

EXPLANATION OF PLATE 103

- Figs. 1–4. *Knightsoceras*? sp. 1, 2. Lateral and ventral views of ANU 14023, $\times 1$. 3. View of the septum shown on the right side of fig. 1. Note the dorsal flexure and the position of the siphuncle, $\times 1.25$. 4. Same specimen with most of the living chamber removed, $\times 1$.
- Figs. 5–10. *Beyrichoceras trevallynense* sp. nov. 5. A partly exfoliated specimen showing the fine growth-lines, and the absence of a lingua, ANU 14034, $\times 3$. 6. A phragmocone, ANU 14035, $\times 3$. 7, 8. Lateral and ventral views of an almost complete partly exfoliated specimen, holotype, ANU 14032, $\times 3$. 9. ANU 14031, $\times 3$. 10. Polished median section, ANU 14033, $\times 3$.

on the nature of the suture-line to distinguish these specimens from the present species.

Cvancara (1958, p. 882) with considerable doubt placed a single distorted specimen from the Lower Carboniferous of the Barrington-Gloucester area of New South Wales in the genus *Beyrichoceras*. In our opinion, the suture-line of this specimen, with the margins of the ventral lobe diverging strongly orad and the ventral saddle almost half the height of the lobe, suggests that it is not a typical *Beyrichoceras*, on the basis accepted above. Cvancara's specimen is certainly very different from those of the present species.

Other material. Figured paratypes (ANU 14030, text-fig. 6*b*; ANU 14031, Pl. 103, fig. 9; text-fig. 6*e*; ANU 14033, Pl. 103, fig. 10; ANU 14034, Pl. 103, fig. 5; ANU 14035, Pl. 103, fig. 6; text-fig. 6*f*; ANU 14036, text-fig. 7; ANU 14089, text-fig. 6*d*; ANU 14091, text-fig. 6*g, h*). Two specimens have been presented to the British Museum (N.H.), where they are numbered C72220 and C72221.

THE AGE OF THE FAUNA

The determination of the age of the fauna depends almost entirely on *Beyrichoceras trevallynense* sp. nov. and *Prolecanites* sp., since the nautiloid genera are all long ranging and the species are not closely comparable with any known species. As indicated above *B. trevallynense* belongs to the *B. micronotum* group which in Britain characterizes the subzones 3 and 4 (Bisat 1934, p. 292; 1952, p. 159) of the *Beyrichoceras* zone. It is closest to *B. submicronotum* which occurs earlier than the main development of *B. micronotum*, and which is found in probable equivalents of subzone 3 (*B. castletonense* and *B. cf. excavatum*). The genus *Prolecanites* first appears in subzone 2 (*Goniatites hudsoni* and *G. antiquatus*) and persists beyond the end of the Viséan. There is an association of *B. submicronotum* with *Prolecanites discoides* at Cow Low Nick, Derbyshire, in beds which apparently underlie those with the typical subzone 4 assemblage.

In Belgium (Delépine, 1940) and in North Africa (Delépine, 1941) members of the *B. micronotum* group have been found in association with species, and in stratigraphical positions, comparable with those of Britain.

At present there is confusion in the literature about the correlation of the British B zone with the German zonal sequence. For example, Pareyn (1962) correlated the B zone with the top of II γ and the lower half of III α making no mention of the intermediate II δ zone. Gordon (1957) linked the entire British B zone with the lowermost two-thirds of the German III α zone. However, in our opinion the best evidence available suggests that Bisat's subzones 3 and 4 of the *Beyrichoceras* zone are correlates of the uppermost II δ and lower III α zones of Germany.

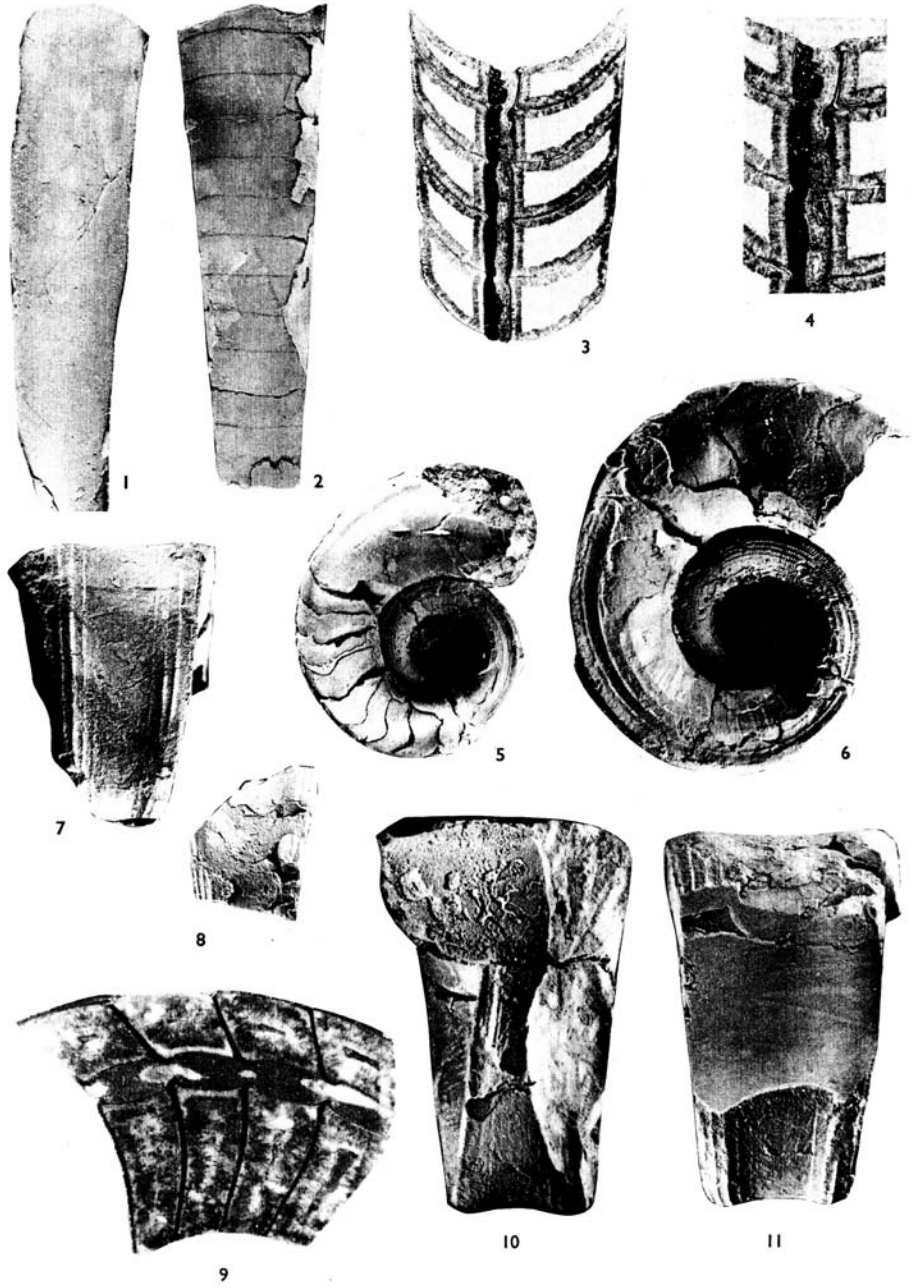
We conclude therefore that the cephalopods indicate that the Trevallyn fauna is to be correlated with the middle to upper part of the B zone of Britain and the uppermost II δ or lower III α of Germany.

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