

CRETACEOUS AMMONITES FROM BATHURST ISLAND, NORTHERN AUSTRALIA

by C. W. WRIGHT

ABSTRACT. Sixteen species of ammonites are described from the Lower Albian, Cenomanian and Turonian. They include new species of *Sciponoceras*, *Scaphites*, *Chimbuites* and *Acanthoceras*. Others are well-known wide-ranging species. *Chimbuites* is now securely dated to the Cenomanian.

I AM grateful to Dr. M. F. Glaessner for arranging for me to study the extremely interesting collection of ammonites made by Dr. B. Daily in Bathurst Island in 1954, on the occasion of a National Geographic Society expedition to Melville Island (see text-fig. 1). Dr. Daily kindly prepared the locality map (text-fig. 1) and the stratigraphical columns (text-fig. 3).

Not only are there several new species, but many specimens are exceptionally well preserved. New details can, in some cases, be observed in species known for over a century. The collection extends our knowledge of the geographical range of certain widespread Cenomanian species. The occurrence of the regionally endemic *Chimbuites* with typical *Euomphaloceras* allows us to date the former genus with certainty for the first time.

The numbers given in the systematic descriptions are the register numbers in the collection of the Department of Geology, University of Adelaide.

SYSTEMATIC DESCRIPTIONS

Family HAMITIDAE Hyatt

Hamites (*Hamites*) (?) sp.

Material. Two decaying pyritic fragments, F.15880-1.

Description. The two small fragments belong to the early stages of an open, irregularly coiled *Hamites*-like form. The section is nearly twice as high as wide (4 mm. by 2.5 mm.). The ribs are rather distant (four in a distance just greater than the whorl height), rounded, prorsiradiate and nearly as strong on the dorsum as on the venter.

Occurrence. Both specimens were collected from a cliff, within 6 feet from the base of a measured section, at Numungumpi on the central south coast of Bathurst Island, in association with *Parengonoceras* (see below).

Hamites (*Stomohamites*) *simplex* d'Orbigny

Plate 81, fig. 1a-c

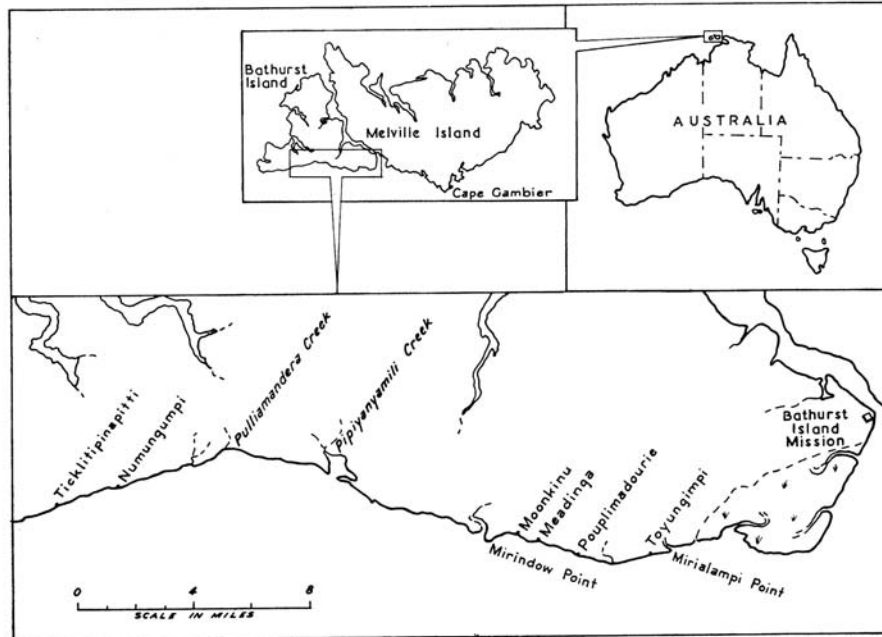
1842 *Hamites simplex* d'Orbigny, 550, pl. 134, figs. 12-14.

1956 *Hamites simplex* d'Orbigny; Sornay.

Material. Five specimens, F.15846-50.

Palaeontology, Vol. 6, Part 4, 1963, pp. 597-614, pl. 81-89.]

Description. Coiled probably in two more or less straight shafts after an initial open spiral. Whorl section oval to nearly circular. The more or less radial ribs are distant, high and narrow on the internal cast, but on the shell they are broader and lower and as wide as the interspaces. The aperture has the three prominent oblique ribs characteristic of *Stomohamites*. There are four and a half ribs in a distance corresponding to the (costal) whorl height.



TEXT-FIG. 1. Sketch-map showing localities mentioned in the text.

Remarks. Sornay (1956), refiguring d'Orbigny's types, explains that the whorl section is not always so oval as indicated by d'Orbigny. His photographs of the lectotype and paratypes show also that, except on the bend, the ribs are more radial than in d'Orbigny's figure. Taking these points into account, and the fact that the appearance of the ribs on the shell and on the internal cast differs, it is justifiable to refer the Bathurst Island specimens to d'Orbigny's widespread species. The one figured in Plate 81, fig. 1a-c is exceptionally well preserved and, for the first time, allows a description of the ribbing on the shell itself, since previously figured specimens have all been internal casts.

Occurrence. Four specimens come from the 3 feet immediately below the Tapara Bed at Meadinga, in company with the two new species of *Acanthoceras* described below. The fifth, F.15846, comes from an isolated beach pebble at Moonkinu. In Europe, *S. simplex* occurs sparsely throughout the Upper Cenomanian, but it is not clear at what point in

the Lower Cenomanian it evolved from the (rather similar) species of the genus that range up from the Upper Albian.

Family BACULITIDAE Meek
Sciponoceras glaessneri sp. nov.

Plate 81, figs. 2, 3

Types. The holotype is F.15852, paratypes F.15853–4 and about fifty other specimens.

Description. The shell tapers gradually; the whorl section is elliptical, at first considerably, but later only slightly higher than wide (e.g. 8 by 6, 10 by 8, 12 by 10.5 mm.). Constrictions are frequent, approximately one in a distance equal to the larger diameter. On the shell, the constrictions are feeble on the dorsum and inner third of the side, then deeper and wider, becoming bordered by a distinct, gently rounded, posterior collar; on both dorsum and venter they are transverse and almost straight, giving an illusion of squareness to the shell; on the sides they are flexuous and oblique, at an angle of 45° at mid-flank where the obliquity is greatest. On the internal cast, the constrictions are much wider and more distinct throughout. Between the constrictions there are frequent irregular slight, but distinct, folds, on and between which are striae, all following about the same course as the constrictions, and only a little weaker on the cast than on the shell. No apertural border has been seen. The suture has moderately frilled squarish bipartite elements.

Remarks. Cenomanian baculitids from the classic areas of Europe are known mainly from rather poorly preserved fragments of internal casts, usually more or less distorted; whereas the Bathurst Island material, though fragmentary, is mostly uncrushed and retains the shell beautifully preserved. The European material badly needs redescription. However, it is clear that the present specimens represent a new species, distinct from any described European forms. It differs primarily in its more frequent constrictions, nearly straight and transverse on dorsum and venter, its more distinct intermediate ribs, and its rather broadly elliptical whorl section. *S. roto* Cieśliński (1959, p. 39) has an almost circular whorl section at all stages, has one constriction in a length equal to about three diameters, and is almost smooth between constrictions. The Lower Cenomanian *S. baculoides* (Mantell), as interpreted by uncrushed specimens from the Isle of Wight [with the same close ventral ribbing near the aperture as Mantell's syntypes (1822, pl. 23, figs. 6, 7) and Sowerby's syntypes of *Baculites obliquatus* (a synonym) and the same type of apertural margin as in Sowerby's figure (1828, pl. 592, fig. 2)], has a more compressed whorl section, relatively straight oblique constrictions strongly projected on the venter, where they form a narrow chevron, and one constriction in a distance equal to just under two major diameters. The later *S. sp. nov.* with a different aperture, as figured by Crick (1896, p. 77, text-fig.), is otherwise rather like *S. baculoides*, but has somewhat more sinuous and deeper constrictions.

Considerable confusion exists about the nomenclature of the European Cenomanian baculitids. Mantell's and Sowerby's types were rather small fragments. D'Orbigny (1842, pl. 138, figs. 6–11) gave a restored, idealized and, in some respects, obviously incorrect figure, based on fragments that are probably mostly true *S. baculoides*. In 1875, however, Geinitz (p. 281) established a new species, *B. subbaculoides*, to include, besides

a variety of ventral European specimens, d'Orbigny's *B. baculoides*, which Geinitz held to be distinct from Mantell's species. He believed the latter to be identical with the Upper Turonian form described by Fritsch as *B. faujasi* var. *bohemicum* and now known as *Sciponoceras bohemicum*; evidently he confused the dorsal ribbing present near the aperture of *baculoides* with the regular ventral ribbing of *bohemicum*. In any case, the only specimen he figured as *subbaculoides* is probably the Lower Turonian *Sciponoceras gracile* Shumard.

Occurrence. *S. glaessneri* occurs with the two new species of *Acanthoceras* described below, and is thus later than, at any rate, some of the English specimens of *S. baculoides*, which occur in the lower *Schloenbachia varians* Zone with abundant *Mantelliceras*, and probably slightly earlier than English specimens of *S. sp. nov.* and *S. roto* which occur with typical species of *Acanthoceras*. The types listed are all from the beach platform outcrops at Meadinga on the south-east corner of Bathurst Island.

Sciponoceras sp.

Material. Several small fragments, the best, F.15883, in the matrix of a *Chimbuites* (no. F.15816).

Description. The section is very slightly higher than wide, the shell, and apparently the cast also, almost smooth, except for sparse feeble ventral folds on the shell, of which the stronger correspond to rather deep oblique constrictions on the cast. The distance between the constrictions is a little less than twice the major diameter.

Remarks. This form is distinct from *S. glaessneri*, but the specimens are not good enough to indicate its relations with contemporary European species.

Occurrence. In the loose beach boulders at Pouplimadourie, south-east coast of Bathurst Island.

Family TURRILITIDAE Hyatt
Hypoturrilites gravesianus (d'Orbigny)

Plate 81, fig. 5; text-fig. 2

1842 *Turrilites gravesianus* d'Orbigny, p. 596, pl. 144, figs. 3-5.

1857 *Turrilites gravesianus* d'Orbigny; Sharpe, p. 62, pl. 25, fig. 7; pl. 26, figs. 15, 16.

1953 *Hypoturrilites gravesianus* (d'Orbigny); Dubourdieu, p. 44.

Material. Five specimens, F.15809, 15834-7.

EXPLANATION OF PLATE 81

All figures are of natural size.

Fig. 1. *Hamites* (*Stomohamites*) *simplex* d'Orbigny; Cenomanian, Moonkinu. *a*, Side; *b*, venter; *c*, side view of cast taken from natural impression.

Fig. 2. *Sciponoceras glaessneri* sp. nov.; holotype, F.15852. Cenomanian, Meadinga. *a*, Side; *b*, venter.

Fig. 3. *Sciponoceras glaessneri* sp. nov.; paratype, F.15853. Internal cast. *a*, Side; *b*, venter.

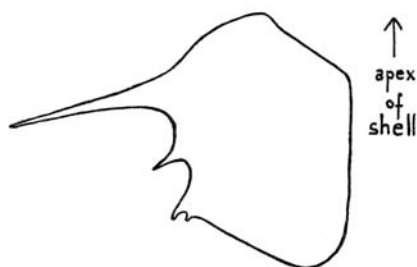
Fig. 4. *Turrilites costatus* Lamark; F.15838. Cenomanian, between Moonkinu and Meadinga.

Fig. 5. *Hypoturrilites gravesianus* (d'Orbigny); F.15835. Cenomanian, between Meadinga and Toyungimpi. *a*, Side; *b*, top, showing spines.

Fig. 6. *Scaphites dailyi* sp. nov.; holotype, F.15806. Cenomanian, Moonkinu. *a*, Side; *b*, venter of shaft; *c*, venter of hook.

Description. This well-known species is characterized by an apical angle of about 30°, a pentagonal whorl section, ten to twelve, or rarely a few more, very large spines in a row along the middle of the exposed side, and rows of smaller tubercles, each four to five times as numerous as the large spines, close together at the base of the side. Only two rows of these smaller tubercles are generally visible on an internal cast, but the lower and larger ones each support two small chisel-ended tubercles on the test.

The Australian material is interesting in that it includes external moulds of the spines, indicating their original shape and length (Pl. 81, fig. 5*a, b*). Text-fig. 2 shows diagrammatically the whorl section, and the size and direction of the spines. Several specimens, e.g. F.15809, have one or two more than the typical twelve to a whorl.



TEXT-FIG. 2. Diagrammatic and restored whorl section of *Hypoturrilites gravesianus* (d'Orbigny), Cenomanian, between Meadinga and Toyungimpi, showing the attitude and size of the spines.

Remarks. The species is readily distinguished from *H. tuberculatus* (Bosc) by its greater apical angle and its fewer and larger major spines, as well as by the notably asymmetric first lateral saddle of the suture (see Sharpe, 1857, pl. 26, figs. 14, 15).

Occurrence. *H. gravesianus* occurs both with the two new species within and immediately below the Tapara Bed between Meadinga and Toyungimpi, and also (F.15809) in one of the loose doggers found $\frac{3}{4}$ mile east of Pouplimadourie. Typically, in Europe, it is a Lower Cenomanian species, but occasional members of some Lower Cenomanian species of *Hypoturrilites* do occur in the Upper Cenomanian.

Turrilites costatus Lamarck

Plate 81, fig. 4

1801 *Turrilites costatus* Lamarck, p. 102.

1842 *Turrilites costatus* Lamarck; d'Orbigny, p. 598, pl. 145.

1857 *Turrilites costatus* Lamarck; Sharpe, p. 66, pl. 27, figs. 1-5, 15, 16.

Material. Eight specimens, F.15838-45.

Description. An acute angled species with a gently rounded outer face of the whorls, and with twenty-two to twenty-four well-rounded ribs, more or less oblique, particularly towards the aperture. The ribs are interrupted a little below the middle of the side and again near the base, so that there is an appearance of a rib, a large rounded tubercle, and a small weak tubercle. The Australian material is perfectly characteristic.

Occurrence. In and around the Tapara Bed between Moonkinu and Meadinga as well as on the beach platform just south of the Bathurst Island Mission. In Europe the species is most commonly found in the upper part of the Lower Cenomanian, below the horizon with abundant typical species of *Acanthoceras*.

Family SCAPHITIDAE Meek
Scaphites dailyi sp. nov.

Plate 81, fig. 6a-c

Material. The holotype, F.15806, and two paratypes, F.15807-8.

Description. An involute, inflated, globose species (but most *Scaphites* species are eventually found to include both inflated and compressed forms) with a short shaft and closely adpressed hook. An inward bulge at the beginning of the shaft covers the umbilicus of the spire. There are no tubercles. On the spire rather prominent primary ribs branch once or twice, giving rise to rather sharp well-spaced ribs that cross the flattened venter transversely. On the last part of the spire all the ribs weaken or disappear, and the last quarter whorl has only indistinct folds and fine striae. On the shaft and hook there are strong oblique primary ribs branching rather irregularly into two to four secondaries, with some intercalated ribs. Just before the constricted aperture the ribs again disappear.

Affinities and differences. In size and general appearance *S. dailyi* compares well with *S. striatus* Mantell (1822, p. 119, pl. 22, figs. 9 and 11 only = lectotype here designated, BM no. C.4799a), which is very close in turn to the Upper Albian *S. simplex* Jukes-Brown (cf. Spath, 1937, p. 505, text-fig. 177). However, the present form is readily distinguished from both these species by the bulge that covers the umbilicus, by the somewhat coarser ribbing, by the smooth area on the latter part of the spire, and by the more branched ribs on the shaft and hook. The widespread *S. obliquus* Sowerby has no umbilical bulge and has more regularly spaced primaries on the shaft which branch at a regular distance from the umbilical margin into three to six very fine secondaries.

The only previously described species with an umbilical bulge comparable with that of *S. dailyi* is *S. basseae* Collignon from the Cenomanian of Madagascar (Collignon, 1928) and Algeria (Sornay, 1955). *S. basseae*, however, has more or less regular even fine ribs, single or bifurcating, over the whole of the visible part of the spire, the shaft, and the hook. It is probable that *S. dailyi* is closely related to, and perhaps derived directly from, *S. basseae*.

Occurrence. *S. dailyi* occurs in the loose beach boulders with *Euomphaloceras* at Moonkinu. It is therefore of middle to upper Upper Cenomanian in age.

Family BINNEYITIDAE Reeside
Borissiakoceras (?) sp.

Plate 89, fig. 5

Material. A single crushed fragment, E.15851.

Description. So far as can be seen, this is a fragment of a small, high whorled, flat-sided, involute ammonite, with more or less flat venter and rounded shoulders. It has dense

feeble low falcate ribs. The shell is well preserved with a marked pink and green metallic lustre.

Remarks. This specimen was at first determined doubtfully as a *Falciferella*, for in general build, ribbing and the peculiar lustre of the shell it shows considerable resemblance to *Falciferella milbournei* Casey, the type species from the English Middle Albian. Examination of the figures of the Queensland Upper Albian *Falciferella* described by Brunnenschweiler (1959), however, suggested to me a connexion with certain Cenomanian species of *Borissiakoceras* from the United States. In fact, the Bathurst Island fragment compares well in all its preserved features with some specimens in my collection, given to me by the United States Geological Survey, from the base of the Cody Shale, Sheridan County, Wyoming (U.S.G.S. locality 21364), and identified as *B. reesidei* Morrow. This and other species of *Borissiakoceras* and its allies have recently been fully described by Cobban (1961).

Study of this poor fragment from Bathurst Island has thus had the interesting result of linking the peculiar family Binneyitidae, ranging from Cenomanian to Santonian, whose origin was unknown, with the recently discovered *Falciferella*, which is known to be derived from the Haploceratacean family Aconeceratidae (see Casey, 1961, pp. 118, 119, 137-8). Indeed *Falciferella* is very close to *Borissiakoceras*; the suture of *F. breddeni* Brunnenschweiler (1959, pl. 1, fig. 6), for example, resembles in a high degree that of *B. reesidei* Morrow (1935, pl. 50, fig. 5). Clearly *Falciferella* should be regarded as an early member of Binneyitidae, although *F. milbournei* Casey retains in simplified forms the Aconeceratine type of suture.

Occurrence. *Borissiakoceras* (?) *sp.* is found with *Acanthoceras tapara* immediately below the Tapara Bed at Meadinga.

Family HOPLITIDAE Douvillé
Chimbuites mirindowensis sp. nov.

Plate 82, figs. 1, 2

Material. The holotype, F.15811, and eight paratypes, F.15810, 15812-16.

Description. Moderately evolute, high whorled, widest at the umbilical shoulder, sides only slightly convex, converging to the broadly rounded and slightly flattened venter, umbilical wall steep with well-rounded shoulder. Ribs prorsiradiate, sinuous, well spaced, rather high and narrow at first, but becoming broader and flatter on later whorls, particularly on the venter where they form broad projected folds. The primary ribs arise as low blunt bullae on the umbilical shoulder. They may remain single or branch at the bulla or higher up the side. Slightly weaker ribs are intercalated irregularly. The density of ribbing varies considerably, paratype F.15810, for example, having nearly half as many ribs again as the holotype. Owing to the irregular branching, the spacing of the ribs on the venter is uneven. In some specimens the shell is astonishingly well preserved. The surface is very finely rugose and has close set radial rows of shallow pits. Frequent crimped marks are visible, perhaps scars from the edge of the mantle.

Remarks. *C. mirindowensis* resembles the type species *C. sinuosocostatus* Casey and Glaessner (in Glaessner, 1958) in many respects, for example in whorl section, sinuosity

of ribs and suture. It is distinguished chiefly by the ribbing. There is much less differentiation between primaries and secondaries in the present species. If a primary branches at the umbilical bulla the rear rib is the stronger; this may branch again three-quarters of the way up the side, but if not it is slightly more prominent on the venter than its neighbours.

Occurrence. All the specimens come from the loose boulders with *Euomphaloceras* on the beach between Mirindow and Mirialampi Points, F.15813 and F.15816 at Pouplimadourie, the remainder at Moonkinu, and are therefore of middle or upper Upper Cenomanian age. This suggests that *C. sinuosocostatus* Casey and Glaessner from New Guinea, which was originally recorded as an Aptian *Deshayesites* and was later described by analogy with related genera as probably Albian, is really Upper Cenomanian.

Family ENGONOCERATIDAE Hyatt

Parengonoceras attenuatum spinosum (Sommermeier)

Plate 89, fig. 3a, b

1910 *Knemiceras attenuatum-typicum* var. *spinosum* Sommermeier, p. 347, pl. 9, fig. 2.

? 1947 *Knemiceras attenuatum* (Hyatt), Krause var. *spinosum* Sommermeier; Knechtel, p. 93, pl. 16, figs. 3, 4.

1956 *Knemiceras attenuatum spinosum* Sommermeier; Benavides-Caceres, p. 449, pl. 46, figs. 11-12.

Material. Two pyritic specimens, F.15877 and 15878, and two small fragments, F.15879 and 15882; four other fragments have decomposed.

Description. Very involute. To a diameter of 20 to 25 mm. the venter is very narrow and the sides are flat and smooth, except for feeble umbilical swellings extending as faint traces of ribs leading to faint ventrolateral clavi. Thereafter the whorl thickness increases, the venter widens, the umbilical swellings become prominent spines (six to a whorl), the ribs and ventrolateral clavi become a little more distinct and feeble swellings appear two-thirds of the way up the flank.

The suture is characterized by numerous, more or less equal, elements; most of the saddles are squarish and bipartite, with bluntly rounded folioles; the lobes are rather more frilled than the saddles, have slender lobules and are generally tripartite.

Remarks. *P. attenuatum* is the smoothest and most compressed of a group of closely related species. *P. attenuatum spinosum* is distinguished from several similar feebly ornamented sub-species only by the precocious appearance and spinosity of the umbilical tubercles.

Occurrence. This subspecies and its associates are widespread in both hemispheres in the *Douvilleiceras mammillatum* Zone at the top of the Lower Albian. The Bathurst Island specimens, from within 20 feet of the base of a cliff section at Numungumpi on the south coast, indicate this horizon; but, as they occur at the base of a bed of glau-

EXPLANATION OF PLATE 82

All figures are of natural size. Both specimens from the Cenomanian of Moonkinu.

Fig. 1. *Chimbuites mirindowensis* sp. nov.; holotype, F.15811. a, Side; b, opposite side; c, venter.

Fig. 2. *Chimbuites mirindowensis* sp. nov.; paratype, F.15810.

conite sand which contains Turonian *Collignonicer* cf. *woollgari* 25 feet higher and as the Turonian rests conformably on the Cenomanian in bores nearby, they must be derived. Albian with pyritic fossils outcrops near Darwin, about 50 miles south of Bathurst Island.

Family ACANTHOCERATIDAE Hyatt
Acanthoceras tapara sp. nov.

Plate 83, Plate 84, figs. 1, 2; Plate 85, fig. 2; Plate 86, fig. 1

Material. The holotype, F.15830, and paratypes, F.15822-33.

Description. Moderately evolute, about one-third of the previous whorl being covered. The whorl section is slightly narrower to slightly wider than high (cf. Pl. 84, fig. 16 and Pl. 85, fig. 2*b*), rounded in intercostal, polygonal in costal section. There are twenty-six to twenty-nine ribs, irregularly long and short, the short branching from or intercalated between the primaries. The latter arise on the vertical umbilical wall, are raised into a long umbilical bulla, at which the width of the whorl is greatest, and bulge slightly at mid flank, after which they become broad and flat until the prominent lower ventrolateral spine; thereafter they are still more flattened until the clavate upper ventrolateral tubercle; on the venter the ribs are almost invisible and there is only a weak and low elongated siphonal tubercle. The secondary ribs resemble the primary except that they first appear on the lower part of the flank with no umbilical tubercle.

The holotype is a complete adult at a diameter of 290 mm. The other specimens are smaller, but are mostly incomplete.

Remarks. This abundant form is one of those transitional species between *Calycoceras* of the *newboldi* group and *Acanthoceras* which are difficult to place. To a diameter from 60 to 80 mm. the feeble ribs, flat sides and venter and the clavate upper ventrolateral tubercles resemble the features of many species of *Acanthoceras*, but at greater diameters the ribs become more prominent and, in some individuals at least, the whorl section becomes more rounded, recalling *Calycoceras*. The persistence of the ventrolateral tubercles, however, with the broad weak ribs between the lower and upper ventrolateral tubercles and the flat venter with weak ribs, suggest reference to *Acanthoceras* rather than to *Calycoceras*, despite the aspect of the lateral ribbing on the later whorls.

The number of ribs, the thinness and height of the lateral ribs at larger diameters and the very high rounded clavi of the upper ventrolateral row suffice to distinguish this species from other described *Acanthoceras*. Stoliczka's *Ammonites morpheus* (1865, pl. 38, fig. 1) is probably the most closely related of described forms, although the figured specimen has only two, instead of three, ventral tubercles; however, the asymmetry of the whorl section, tubercles and suture show that the specimen is malformed and that the venter should be trituberculate. *Ammonites morpheus* is rather more densely ribbed and reverts at a smaller diameter to the rounded whorl section and ribbing without ventral tubercles reminiscent of many *Calycoceras*.

Occurrence. *Acanthoceras tapara* is abundant in and around the Tapara Bed, which can be recognized in the coastal cliffs or on the beach platform over a great part of the distance between Moonkinu and Toyungumpi. Until the detailed phylogeny of Acanthoceratidae is a good deal clearer than it is now, it is impossible to place a new species accurately in the succession on only intrinsic evidence.

The name is derived from the native name for the pearly nautilus. Dr. Daily reports that when he was collecting these pearly ammonites from the Tapara Bed the natives recognized their affinities with the pearly nautilus and said 'Him Tjapara'. According to the local legend, when the moonman, also called Tjapara, dies, his head is washed up on the beach as the pearly nautilus.

Acanthoceras mirialampiense sp. nov.

Plate 84, fig. 3; Plate 85, fig. 1

Material. The holotype, F.15817, and paratypes, F.15818–21.

Description. The whorl section is markedly wider than high, the sides flat and parallel. There are twenty to twenty-two slightly flexuous, nearly rectiradiate ribs. To a diameter of about 35 mm. the ribs are low and feeble, and more or less regularly long and short; the long ribs have fairly prominent umbilical bullae; all have slightly clavate upper ventrolateral tubercles; the siphonal tubercles are long but weak. After about 35 mm. diameter the ribs are mainly primaries, but occasional short secondaries are intercalated; the primaries arise well down the umbilical wall, soon become high and bar-like, are raised into a prominent umbilical tubercle, have a low bulge at mid-flank, bear a slightly clavate lower ventrolateral tubercle, then broaden rapidly and become low until the high rounded upper ventrolateral clavus.

Affinities and differences. This species has fewer, less irregular and more distant ribs, and a squarer and more depressed whorl section than has *A. tapara*; the lower ventrolateral tubercles are as prominent though not so clavate as the upper ones. *A. mirialampiense* stands in much the same relationship to *A. tapara* as does *Calyoceras spinosum* (Kossmat) to *C. newboldi* (Kossmat). It has some resemblance to *A. deciduum* Hyatt, but that species has a much higher and less inflated whorl section. Etheridge's (1907, p. 18) rather poor specimens of *Acanthoceras* from Cape Gambier, Melville Island seem to belong to a species similar to, but not identical with, the present one.

Occurrence. The same as *A. tapara*.

Acanthoceras sp. cf. *quadratum* Crick

Plate 86, fig. 2; Plate 87, fig. 1

Cf. 1907 *Acanthus quadratum* Crick, p. 192, pl. 13, figs. 2, 2a.

Material. F.15805.

Description. The single, much worn, specimen is not well enough preserved for certain specific determination. It is very evolute, with a depressed whorl section and a broad flat

EXPLANATION OF PLATE 83

Acanthoceras tapara sp. nov.; Holotype, F.15830. Cenomanian, between Meadinga and Toyungimpi. Side $\times 0.75$. (See also Plate 86, fig. 1.)

EXPLANATION OF PLATE 84

All figures are of natural size. All specimens are from Cenomanian, between Meadinga and Toyungimpi.

Fig. 1. *Acanthoceras tapara* sp. nov.; paratype, F.15825. a, Side; b, venter.

Fig. 2. *Acanthoceras tapara* sp. nov.; paratype, F.15833. a, Side; b, venter.

Fig. 3. *Acanthoceras mirialampiense* sp. nov.; paratype, F.15818. Side.

venter. There are ten or more primary ribs with large bullate umbilical tubercles, and on the inner whorls there are as many intercalated ribs that appear on the umbilical wall, but are not raised into umbilical tubercles. On the inner whorls each rib has more or less equally spaced and equal sized lower and upper ventrolateral and siphonal tubercles. On the outer whorls the lower and upper ventrolateral tubercles amalgamate to form a single large blunt tubercle.

Remarks. So far as can be seen, this specimen closely resembles *A. quadratum* Crick from False Bay, Zululand, and similar specimens from England.

Occurrence. The specimen comes from a beach pebble at Moonkinu on the south-east coast. Comparable English specimens come from a horizon below that of *Euomphaloceras* such as also occur in the Bathurst Island pebbles, but the *A. cf. quadratum* may be derived from a slightly different horizon from the *Euomphaloceras*. Equally, the species may well persist.

Euomphaloceras cunningtoni (Sharpe)

Plate 88, fig. 2; Plate 89, fig. 1

- 1855 *Ammonites cunningtoni* Sharpe, p. 35, pl. 15, fig. 2.
 1864 *Ammonites meridionalis* Stoliczka, p. 76, pl. 41, fig. 1a-c.
 1897 *Acanthoceras cunningtoni* var. *cornuta* Kossmat, p. 11 (18), pl. 5 (16), fig. 1a-c.
 1907 *Acanthoceras meridionale* (Stoliczka); Pervinquière, p. 278, pl. 15, figs. 2-6.
 1937 *Cunningtoniceras cunningtoni* (Sharpe); Collignon, p. 40.
 1944 *Cunningtoniceras höltkeri* Erni, p. 470, pl. 11.
 1951 *Euomphaloceras euomphalum* (Sharpe); pars, Wright and Wright, p. 29.
 1953 *Acanthoceras ? eulesanum* Stephenson, p. 201, pl. 47, fig. 5, pl. 48, figs. 3, 4.

Material. F.15800, 15803.

Description. Very evolute, whorl section depressed, wider than high. Umbilical wall high and sloping. Sides vertical or converging slightly to the venter. Venter flat, or with flat siphonal area and sloping ventrolateral shoulders. Twelve to sixteen primary ribs rise on the umbilical slope, form large round to bullate tubercles at the umbilical shoulder, run radially up the side, and end in a prominent ventrolateral spine directed upwards or outwards. On the earlier whorls the venter is wide and more or less flat and is crossed by tuberculate ribs, among which may be rather deep constrictions. In most cases a broad flat rib runs from the large ventrolateral tubercle to a low clavate one, from which, in turn, run two rounded ribs, on each of which there is a rounded siphonal tubercle, in addition there are regularly intercalated ribs between the ventrolateral tubercles, and they bear three equally spaced rounded tubercles or a single siphonal one only. Occasionally, however, there are two rounded tubercles instead of the single clavate one, or other irregularities.

On the outer whorls the siphonal tubercles, the transverse ribs and alternate ventral tubercles tend to disappear; the ventrolateral tubercles and the next inner ones tend to amalgamate, with the result that the costal section may show a depression over the siphon.

The suture includes a broad squarish bifid first lateral saddle and a long narrow first lateral lobe extending as far back as the external lobe, more or less bifid and divided by a long narrow element of no great importance.

Remarks. Several species have been established for relatively large specimens of *Euomphaloceras* that differ, if at all, only in minor detail of ventral ribbing and tuberculation, or in the shape and size of the ventrolateral horns on the outer whorl. Comparison of the Bathurst Island specimens with the holotype of *E. cunningtoni* (Sharpe) and with the figures of *meridionale* Stoliczka, *cornutum* Kossmat and *eulesanum* Stephenson has helped to clarify the relationships of these forms. There is in fact very little material available of this group, not more, perhaps, than two or three dozen reasonably sized specimens. There is, therefore, the usual danger of allowing too little variability and of erecting too many species, each based on a handful of individuals.

In this genus anyhow, I would take little account of minor variations in the size and direction of the ventrolateral horns on the outer whorl or in the prominence of tubercles in relation to ribs on the venter in the middle growth stages. Moreover, the specimens figured in the literature show apparent differences due to varying types of matrix and to different techniques of illustration.

The holotype of *cunningtoni*, at the earliest stage visible, shows three siphonal tubercles to each ventrolateral; corresponding to two of these siphonal tubercles, there is on each side an elongated tubercle, exactly as in the holotype of Kossmat's var. *cornuta*. Stephenson's *eulesanum* has the same type of ventral ornament, but has slightly more ribs, and rather less prominent ventrolateral horns and umbilical tubercles on the outer whorls. In Stoliczka's *meridionale*, however, there are two separate rounded tubercles in the place of the single elongate one and the transverse ribs are more prominent and persistent; Pervinquière separated his specimens of this species from Stoliczka's type on the ground that the latter had narrow ridges connecting the tubercles of the successive transverse rows, but this is clearly not an important feature and is perhaps merely a matter of preservation. Pervinquière's *meridionale* var. *tuberculata* has larger and more regularly spaced tubercles, fewer in proportion to the ventrolateral ones. I would regard *meridionale* Stoliczka, including *africana* Pervinquière, and *tuberculata* Pervinquière as subspecies of *cunningtoni* Sharpe; neither *cornuta* Kossmat nor *eulesanum* Stephenson can, it seems to me, be separated from *cunningtoni* sensu stricto. *Cunningtoniceras holtkeri* Erni from New Guinea was stated to differ from *cunningtoni* in size and number of ribs, but Sharpe's figure is reduced and at comparable diameters the holotype of the two species are similar in rib density as in other characters.

There are two good specimens of this group from Bathurst Island. They are assignable to the subspecies *c. cunningtoni* (F. 15800) and *c. meridionale* (F. 15803), although the

EXPLANATION OF PLATE 85

All figures are of natural size. Both specimens are from Cenomanian between Meadinga and Toyungimpi.

Fig. 1. *Acanthoceras mirialampiense* sp. nov., holotype, F.15817. *a*, Side; *b*, venter.

Fig. 2. *Acanthoceras tapara* sp. nov.; paratype, F.15823. *a*, Side; *b*, aperture.

EXPLANATION OF PLATE 86

Fig. 1. *Acanthoceras tapara* sp. nov.; holotype, F.15830. Cenomanian between Meadinga and Toyungimpi. Apertural view, $\times 0.75$. (See also Plate 83.)

Fig. 3. *Acanthoceras* sp. cf. *quadratum* Crick; F. 15805. Cenomanian, Moonkinu. Venter, natural size.

Fig. 3. *Collignoniceras* sp. cf. *woollgari* (Mantell); F.15869. Turonian, Ticklitipinapitti. Side, natural size.

latter specimen shows ventral ornament of the *c. cunningtoni* type for a short space, just as the enlarged horns begin to appear.

In 1951 (p. 29) my brother and I considered Sharpe's *Ammonites cunningtoni* (with a diameter of about 150 mm.) to be merely the adult of his *A. euomphalus* (diameter 22 mm.). We based our opinion on several topotypes of *euomphalus*, larger than the holotype, which appeared to link that species with the still larger holotype of *cunningtoni*. Since then, we have studied a considerable number of *euomphalus* (over twenty in our own collection) and it has become clear that we were wrong to synonymize the two species.

Euomphaloceras euomphalus (Sharpe) is rather variable at all growth stages. Small examples (e.g. my coll. 20811, diameter 20 mm.) can be found which, in whorl section and ventral ornament, are probably indistinguishable from *E. cunningtoni* of similar size. At greater diameters, however, two distinct types of ventral ornament seem to be common in topotype material. Some specimens have strong transverse ventral ribs, frequent ventral constrictions, weak siphonal tubercles, and high pointed ventral tubercles on some of the ribs. The larger of Pervinquier's two specimens of *Acanthoceras giltairei* (1907, pl. xv, fig. 9a, b) is just such an example. Other topotypes have rather strong siphonal tubercles and paired ventral tubercles of equal strength on all the ventral ribs, there being three or four tuberculate ventral ribs to each ventrolateral tubercle: this multituberculate stage ends rather suddenly at a diameter of about 40 mm. and the ventral ornament then becomes like that of the other type with only two transverse rows of tubercles to each ventrolateral tubercle. At a greater, but still undetermined, diameter alternate rows of ventral tubercles disappear and, thereafter, the ornament comprises large distant umbilical tubercles and simple ventrolateral horns.

The suture in *E. euomphalus* is characterized in the earlier stages at least by a long, narrow first lateral saddle with converging, not parallel, sides and a very wide shallow first lateral lobe divided by a short stout element (cf. Pervinquier, 1907, fig. 108 on p. 286, sub *A. giltairei*). After a diameter of about 40 mm. the suture gradually approximates to that of *E. cunningtoni* (that is, the normal *Acanthoceras* type), but a fragment of *euomphalus* (my coll. 23353) at a diameter of about 100 mm. still shows a much shallower and wider first lateral lobe than that of *E. cunningtoni* although at this size with the amalgamation of the ventrolateral and ventral tubercles into large horns the first lateral saddle has the typical massive squarish shape of *E. cunningtoni* and *Acanthoceras*.

Occurrence. Both Bathurst Island specimens come from beach pebbles at Moonkinu, on the south-east coast. No exact dating within the Upper Cenomanian can be given for the rare specimens from England, France, North Africa and Texas, but all the evidence, stratigraphical and intrinsic, suggests that the species is later than the horizons with abundant typical *Acanthoceras* and earlier than the horizon with *E. euomphalus*.

Euomphaloceras lonsdalei (Adkins)

Plate 87, fig. 2; Plate 88, fig. 1; Plate 89, fig. 2

1928 *Acanthoceras lonsdalei* Adkins, p. 244, pl. 26, fig. 5, pl. 27, fig. 3.

1955 *Euomphaloceras lonsdalei* (Adkins); Stephenson, p. 62, pl. 6, figs. 6-20.

Material. F.15801-2, 15804.

Description. Rather evolute, whorl section squarish, only a little wider than high, sides parallel or slightly convergent. Venter gently arched, becoming flat with age. Up to sixteen primary ribs appear at the umbilical seam and strengthen on the shoulder, where most of them form large bullae, although some are feebler than the rest. On the flanks, the ribs are prominent and radial. They bear large outwardly directed, more or less conical, lower ventrolateral tubercles, clavate upper ventrolateral ones and rounded to subdued clavate siphonal tubercles. To a diameter of about 80 mm. there are, on the venter, one or two distinct intercalated ribs to each primary, weakening with age; most have rather feeble siphonal and some of them upper ventrolateral tubercles. At greater diameters the intercalated ribs become feebler and disappear, the siphonal tubercles on the primary ribs weaken and the lower and upper ventrolateral tubercles tend to amalgamate.

Remarks. *E. lonsdalei* is distinguished from *E. cunningtoni*, as defined above, by its less depressed whorl section, greater number of ribs and less pronounced multiplication of ribs and tubercles on the venter. *E. euomphalus* is even more extreme in these respects than *E. cunningtoni*. *E. alvaradoense* (Moreman) has higher whorls and feebler ribbing while its ventral tubercles disappear at a still earlier stage.

Occurrence. The Bathurst Island specimens come from the beach pebbles at Moonkinu on the south-east coast. In Texas, *E. lonsdalei* occurs in the basal Eagle Ford beds, a little later than the Tarrant, in which occurs *E. cunningtoni*.

Family COLLIGNONICERATIDAE Wright & Wright

Collignoniceras cf. *woollgari* (Mantell)

Plate 86, fig. 3; Plate 89, fig. 4

1822 *Ammonites woollgari* Mantell, p. 197, pl. 21, fig. 16.

1855 *Ammonites woollgari* Mantell; Sharpe, p. 27, pl. 11, figs. 1, 2.

1946 *Prionotropis woollgari* Meek (? non Mantell); Haas, p. 150, pls. 11–16, text-figs. 1–14, 23–78, 80–83.

1959 *Collignoniceras woollgari* (Mantell); Matsumoto, p. 105, text-figs. 55–57.

Material. F.15856–76.

Description. The specimens are all more or less crushed internal casts or impressions, of inner whorls only; the largest has a diameter of only about 30 mm. They therefore show insufficient features to allow one to decide to which of the various subspecies described by Haas (1946) they belong, or, indeed, to be quite certain that they do not belong to some other species of the genus.

EXPLANATION OF PLATE 87

All figures are of natural size. Both specimens are from the Cenomanian of Moonkinu.

Fig. 1. *Acanthoceras* sp. cf. *quadratum* Crick; F.15805. Side.

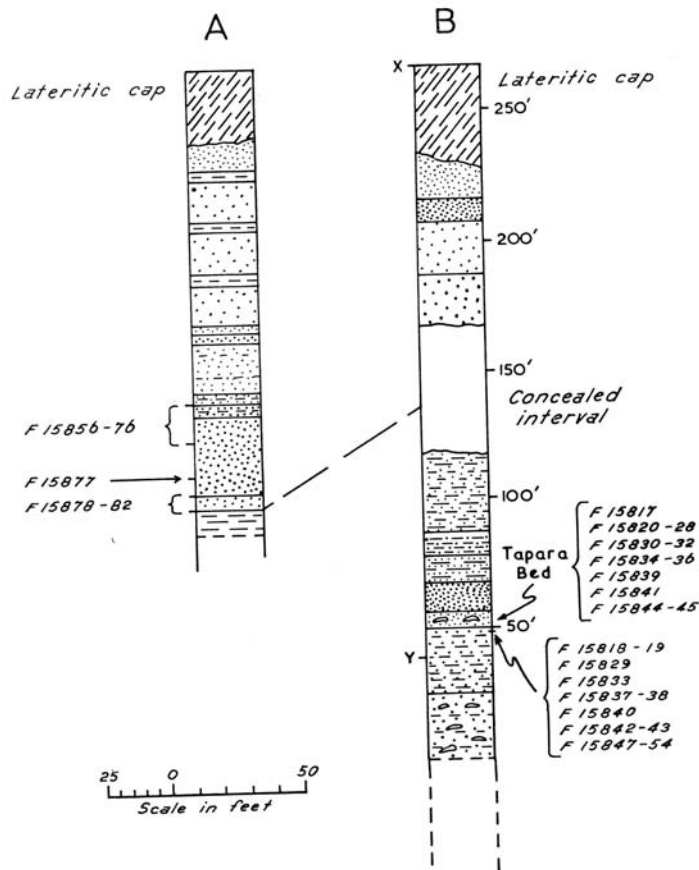
Fig. 2. *Euomphaloceras lonsdalei* (Adkins); F.15802. a, Side; b, venter.

EXPLANATION OF PLATE 88

All figures are of natural size. Both specimens are from the Cenomanian of Moonkinu.

Fig. 1. *Euomphaloceras lonsdalei* (Adkins); F.15801. Apertural view.

Fig. 2. *Euomphaloceras cunningtoni cunningtoni* (Sharpe); F.15800. a, Side; b, venter; c, aperture.



TEXT-FIG. 3. Stratigraphic columns, measured by Dr. B. Daily, 1954.

A. Stratigraphic column of the Cretaceous sequence between Ticklitipinapitti and Pipiyanyamili Creek, Bathurst Island, Australia. All units except the lowermost 10 feet of glauconitic clay are found in the measured cliff section at Pulliamandera Creek.

B. Stratigraphic column of the Cretaceous sequence exposed in coastal cliffs between Mirindow Point and the Bathurst Island Mission. That part of the section marked x-y was measured at Meadinga.

The stratigraphic position of all fossils found only *in situ* and mentioned in the text are located on columns A and B. The fossils described from beach boulders and dated as middle Cenomanian are believed to be derived by wave action from beds immediately below the oldest known out-cropping beds which are located on beach platforms in the Moonkinu and Pouplimadourie areas.

They are all moderately evolute with a more or less rectangular whorl section and a high crenulate keel. The narrow, rather high, ribs are mostly of the same strength, but in parts of some specimens they are alternately strong and weak. They have fairly prominent thin tubercles on the umbilical margin, small, but usually distinct, lower ventrolateral and rather stronger ventrolateral tubercles. At varying diameters the fine close ribbing of the earlier whorls become coarser and more distant.

Remarks. Haas (1946) has shown how wide is the variation of the ornament on the inner whorls of this species. Matsumoto (1959, p. 105), however, points out that some of Haas's varieties may belong rather to *C. hyatti* (Stanton).

Occurrence. Central south coast of Bathurst Island, F.15856-64 from cliffs at Pulliamandera, F.15865-76 from cliffs at Ticklitipinapitti. *C. woollgari* is widespread in the northern hemisphere and characterizes a horizon in the middle part of the Turonian, above that of *Mammites nodosoides*.

SUMMARY OF STRATIGRAPHICAL AND PALAEOGEOGRAPHICAL CONCLUSIONS

Albian. The only fully determined Albian ammonite in the collection, *Parengonoceras attenuatum spinosum* (F.15877-82, text-fig. 3), is one of a widespread group of forms characteristic of the top of the Lower Albian. These species of *Parengonoceras* are abundant in many Tethyan faunas, for example around the Mediterranean, in Iran, and in South America. Stray examples have even been found in England. The occurrence in Bathurst Island might be taken to indicate an open sea connexion north-westward, linking with the old world Tethys. Krause (1902) described from western Borneo some pseudoceratitic ammonites as *Knemiceras pinax*; his specimens, however, belong to an Upper Albian *Engonoceras* and were associated with a small Mortoniceratid.

Cenomanian. Two distinct Cenomanian faunas are represented on Bathurst Island. That which occurs *in situ* in and near the Tapara Bed includes the following:

- Stomohamites simplex* (d'Orb.)
- Sciponoceras glaessneri* sp. nov.
- Hypoturrites gravesianus* (d'Orb.)
- Turrilites costatus* Lamarck.
- Borissiakoceras* (?) sp.
- Acanthoceras tapara* sp. nov.
- Acanthoceras mirialampiense* sp. nov.

EXPLANATION OF PLATE 89

All figures are of natural size.

Fig. 1. *Euomphaloceras cunningtoni meridionale* (Stoliczka); F.15803. Cenomanian, Moonkinu. Apertural view.

Fig. 2. *Euomphaloceras lonsdalei* (Adkins); F.15801. Cenomanian, Moonkinu. Side.

Fig. 3. *Parengonoceras attenuatum spinosum* (Sommermeier); F.15877. Derived Lower Albian, Numungumpi. a, Side; b, aperture.

Fig. 4. *Collignoniceras* sp. cf. *woollgari* (Mantell); F.15866. Turonian, Ticklitipinapitti.

Fig. 5. *Borissiakoceras* (?) sp.; F.15881. Cenomanian, Meadinga.

Of the previously described species, none is of much value for accurate dating, although *Turrillites costatus* has a rather restricted range in the Lower Cenomanian, at any rate in England; it first appears, with *Scaphites equalis* Sowerby, above the horizon of abundant *Mantelliceras mantelli* (Sowerby), *ventnorense* Diener and allies and seems to be converted to a successional species, *T. acutus* Passy, by the period of abundant *Acanthoceras* of the typical square-whorled type. The two new species of *Acanthoceras* from Bathurst Island are morphologically intermediate between *Calycoceras* of the *newboldi* group and typical square-whorled *Acanthoceras*. *C. newboldi* and its allies, however, persist long after the first appearance of *Acanthoceras*, and too much stress cannot therefore be laid on the intrinsic evidence of these undescribed species for purposes of dating.

I would have been inclined to place the Tapara Bed fauna at about the middle of the Cenomanian, but the stratigraphical evidence, such as it is, indicates that this fauna is slightly younger than that of the beach boulders. On this slender evidence the Tapara Bed fauna would be well up in the Upper Cenomanian. Despite the fact that there are three new species, the fauna has links with that of part of the Utatur Beds of Southern India and includes widespread species of *Stomohamites* and *Turrilitidae*.

The fauna found in beach boulders includes:

Sciponoceras sp.
Hypoturrillites gravesianus (d'Orb.)
Scaphites dailyi sp. nov.
Chimbuities mirindowensis sp. nov.
Acanthoceras cf. *quadratum* Crick
Euomphaloceras cunningtoni (Sharpe)
Euomphaloceras lonsdalei (Adkins)

The two species of *Euomphaloceras* indicate a horizon about the middle of the Upper Cenomanian. They, the *Hypoturrillites* and the *Acanthoceras*, are widespread forms, suggesting open sea connexions, either north and east around the Pacific or north and west through the Tethys to Africa, Europe and beyond. *Euomphaloceras cunningtoni* is known from New Guinea and southern India, and comparable forms occur in Japan. *Scaphites dailyi* is related to a species that occurs in North Africa and Madagascar. *Chimbuities*, however, is otherwise known only from New Guinea and is apparently a regional endemic form.

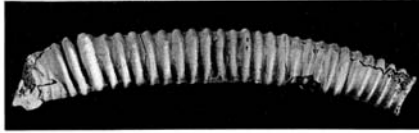
Turonian. The *Collignoniceras* are of a type abundant and widespread in Europe and North America and known also in western Asia, South America and Japan. Thus again an open sea connexion northwards or north-westwards is suggested at this date.

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C. W. WRIGHT
37 Phillimore Gardens,
London, W. 8



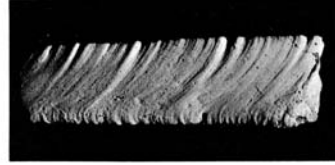
1a



1b



1c



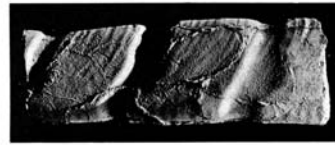
2a



4



6a



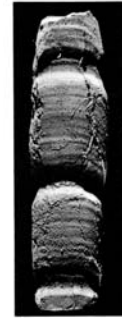
3a



6b



2b



3b



5a



6c



5b



1a



1b



2



1c

WRIGHT, Cretaceous ammonites



WRIGHT, Cretaceous ammonites



1a



1b



2a



2b



3

WRIGHT, Cretaceous ammonites



1a



2b

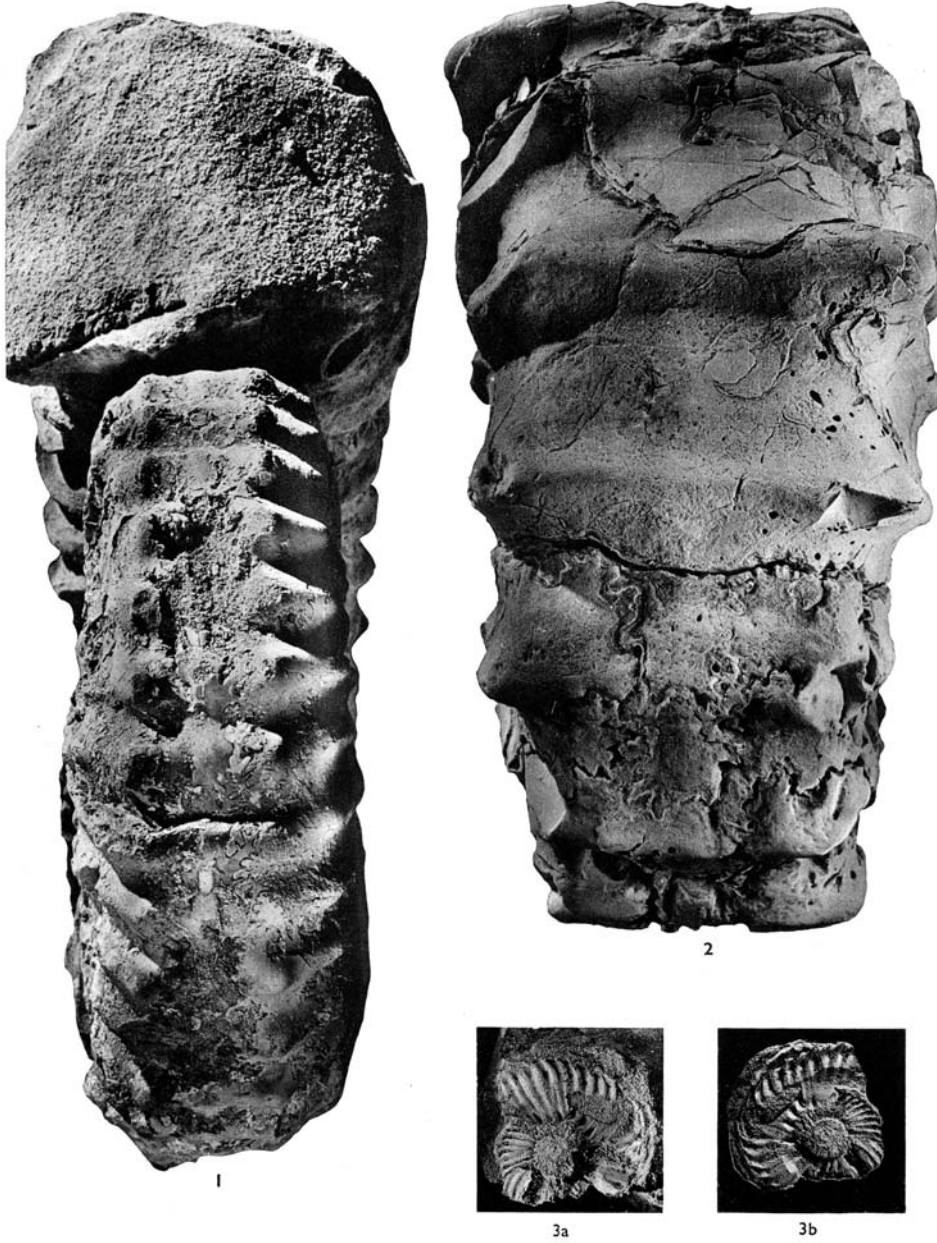


1b



2a

WRIGHT, Cretaceous ammonites



WRIGHT, Cretaceous ammonites

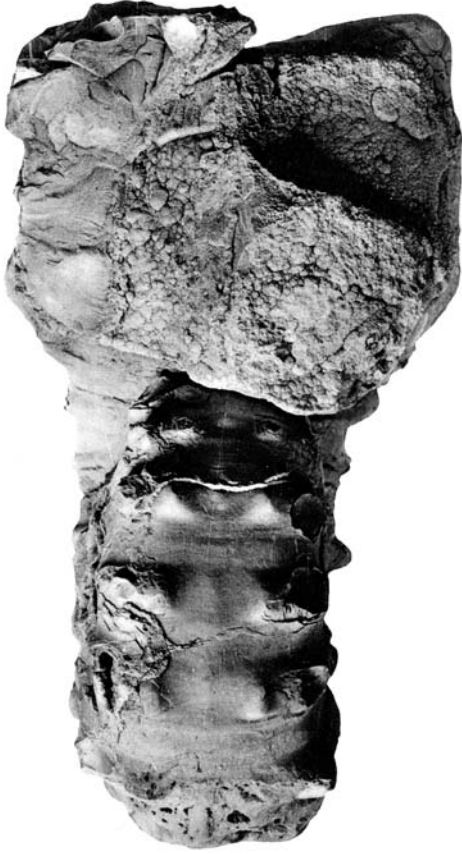


2b



2a

WRIGHT, Cretaceous ammonites



1



2b

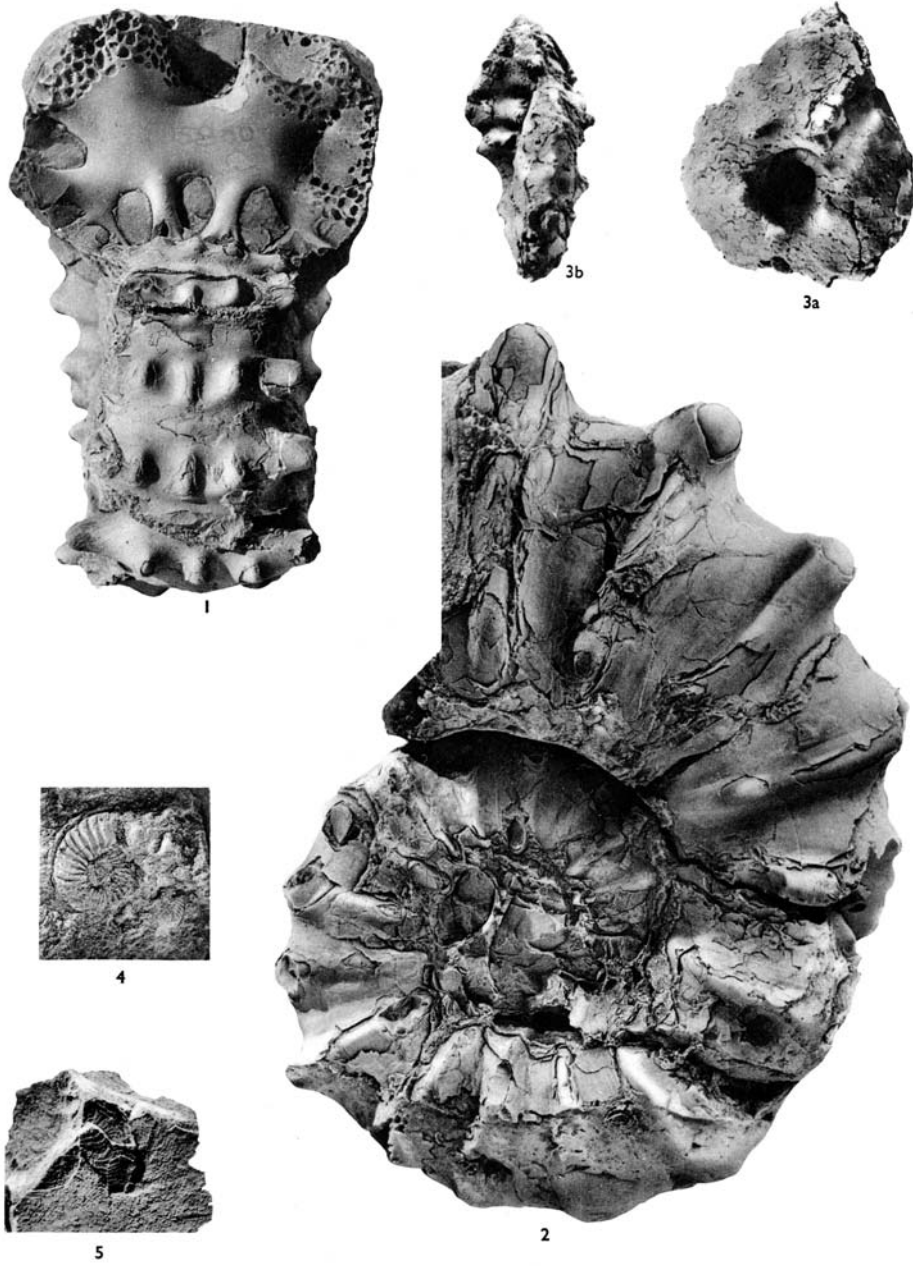


2c



2a

WRIGHT, Cretaceous ammonites



WRIGHT, Cretaceous ammonites
