Cretaceous faunas from Zululand and Natal, South Africa.

The ammonite subfamily Acanthoceratinae de Grossouvre, 1894

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Ammonites of the subfamily Acanthoceratinae occur in abundance at a single locality in KwaZulu, the eastern part of the Skenenbog, on the lower reaches of the Mzinene River, north-northeast of Hluhluwe. This is the classic locality from which William Anderson collected the material described by G.C. Crick in 1907 as being from the 'deposit at the north end of False Bay.' The fossils occur weathered out on the surface; there is no section. The ammonites described below are predominantly Middle Cenomanian, with indications of the presence of lower Upper Cenomanian on the basis of records elsewhere. The following species are described: Acanthoceras flexuosum Crick, 1907 (of which Acanthoceras crassissinatum Crick, 1907, Acanthoceras munitum Crick, 1907, Acanthoceras expansum Crick, 1907, Acanthoceras robustum Crick, 1907, Acanthoceras quadratum Crick, 1907, Acanthoceras hippocastanum Crick, non J. de C. Sowerby, and Acanthoceras laterum Crick, 1907, are synonyms), Acanthoceras cornigerum Crick, 1907, Protacanthoceras subwaterloti (Venzo, 1936), Cunningtoniceras? sp. a and sp. b, Calycoceras (Gentoniceras) gentoni (Brongniart, 1822) (of which Acanthoceras pseudostrictum Crick, 1907 is a synonym), Calycoceras (Newboldiceras) asiaticum asiaticum (Embo, 1894), Calycoceras (Newboldiceras) asiaticum spinosum (Kosmat, 1897), Calycoceras (Newboldiceras) cf. asiaticum hunteri (Kosmat, 1897), Calycoceras (Newboldiceras) planecestatum (Kosmat, 1897), Calycoceras (Newboldiceras) laticestatum (Crick, 1907), Calycoceras (Newboldiceras) breistrofferi (Collignon, 1937) and Pseudocalycoceras harpax (Stoliczka, 1864).

Key words: ammonites, Acanthoceratinae, Cenomanian, Mzinene Formation, KwaZulu-Natal, South Africa.

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INTRODUCTION

The ammonite subfamily Acanthoceratinae de Grossouvre, 1894, is a cosmopolitan group, members of which range from the upper Lower Cenomanian into the Lower Turonian. The composition of the group adopted here follows that of Wright (1996) apart from the exclusion of Hourquioceras Collignon, 1939, and Tunesites Pervinquiere, 1807, which should be referred to Euomphaloceratinae. Members of the group are
important stratigraphic indicators throughout their range. Representatives of Acanthoceras Neumayr, 1875, Protacanthoceras Spatham, 1823, Cunningtonoceras Collignon, 1937, Calycoceras (Gentoniceras) Thomel, 1972, Calycoceras (Newboldiceras) Thomel, 1972, and Pseudocalycoceras Thomel, 1972, are described below. These genera/subgenera are reviewed in detail by Wright & Kennedy (1981, 1987, 1990) and others, and we have nothing to add to previous accounts. Accordingly, the diagnoses given below are based on the work of these authors, to whom reference should be made.

The KwaZulu Acanthoceratinae recorded below come from a very restricted area in the Skoenberg region, north-northeast of Hluhluwe. The Skoenberg (Afrikaans for 'Shoe Mountain') is a crescentic hill that lies between the Mzinene and the Munywana rivers. The steep northern face rises to a height of over 30 m at the western end; to the east it falls away to the level of the flood plain. It is the abandoned river cliff of the Munywana, which is now located 700 m to the north. This richly fossiliferous locality was discovered by William Anderson in 1907 (p. 60), who described it as situated near the junction of the Manuan and Mzinene Rivers. The exposure shows a thicker series of beds than in any other locality from which I have collected. There are from 70 to 100 feet of strata exposed, chiefly calcareous sandy shales and sandstones, the whole being capped by a very hard calcareous sandstone full of broken shells. The beds are exposed almost continuously where the bank is precipitous. They are exceedingly prolific in fossils, chiefly Mollusca, Cephalopoda and Gastropoda. The Cephalopoda are exceedingly abundant, and range from half an inch to over a yard in diameter. The fossils weather out from the shales in perfect condition, but from long exposure on the surface to the atmosphere, rains, and tropical bush fires, they are largely composed of casts. Some good specimens however were obtained. These are described by Mr G.C. Crick, of the British Museum, in this Report, under the title of the "North End of False Bay Deposit".

The Skoenberg is the type locality of the Skoenberg Beds of Van Hoepen (1926, 1929). It was visited during the 1929 International Geological Congress (Du Toit & Van Hoepen 1929), and specimens collected by a number of those attending (see Heinz 1930; Besairie 1930; Venzo 1936; Dietrich 1938; Socin 1939; Montanaro & Lang 1937); they survive in a number of European collections (for example those of the British Museum, in this Report, under the title of the "North End of False Bay Deposit").

Kennedy & Klinger (1975) revised the stratigraphy of the Skoenberg area. They recognized an upper Upper Albian to Lower Cenomanian succession of Mzinene Formation silts with calcareous concretions at their locality 61, west of the western 'horn' of the Skoenberg, continued in their locality 62, the Skoenberg itself, and the source of the material described below. Fossils derived from the upper part of the Mzinene Formation littered the slopes of the Skoenberg, but exposures were inadequate to establish an actual succession. The Cenomanian succession is terminated by an unconformity, overlain by a thin Pterotrigonia conglomerate of Coniacian date that marks the base of the St Lucia Formation (Kennedy & Klinger 1975, p. 289, fig. 7). The actual boundary was exposed to the south of the Skoenberg, on the north bank of the Mzinene, at locality 60 of Kennedy & Klinger (1975). Here the Coniacian Pterotrigonia conglomerate capped up to 10 m of deeply weathered buff silts. Those immediately below the unconformity yielded acanthoceratids that we identified as Calycoceras aff. choffati (Kossmat, 1897), but now regarded as variants of Calycoceras (Newboldiceras) planeostatus (Kossmat, 1897). These in situ records provide only an imprecise upper Middle or Lower Upper Cenomanian horizon for the top of the Mzinene Formation here. The ammonites collected from the surface of the slopes of the Skoenberg occasionally occur as composite moulds in yellow-buff siltstones. The majority, however, commonly retaining recrystallized calcite, or silicified shell material, such that the sutures are rarely exposed. The overwhelming majority are phragmocones, their chambers infilled by sparry calcite and chalcedonic silica.

This weathered-out material is of more than one age, with Lower Cenomanian Mantleiceras, Sharpeiceras and Hypoturrilites, together with abundant Middle Cenomanian elements including the Acanthoceratinae described below, together with rare Turrilites schuchzerianus Bosc, 1801, rare Turrilites costatus Lamarck, 1801, and more common Turrilites acutus Passy, 1832. There is a specimen of the lower Upper Cenomanian Pseudocalycoceras harpax (Stolicza, 1864) from this locality in the collections of the South African Museum (SAM-PCZ22194; Fig. 63) that confirms the presence of lower Upper Cenomanian here.

REPOSITORIES OF SPECIMENS

The following abbreviations are used to indicate the repositories of specimens cited in the text:

BMNH: The Natural History Museum, London.
OUM: Oxford University Museum of Natural History.
SAM: Natural History Collections Department, Iziko South African Museum, Cape Town.

CONVENTIONS

Dimensions are given in millimetres: D = diameter; Wb = whorl breadth; Wh = whorl height; U = umbilicus; c = costal dimension; IC = intercostal dimension. Figures in brackets are dimensions as a percentage of diameter. The suture terminology is that of Korn et al. (2003): E = external lobe; A = adventive lobe (= lateral lobe, L, of Kullmann & Wiedmann 1970); U = umbilical lobe; I = internal lobe.

SYSTEMATIC PALAEONTOLOGY

Order AMMONOIDEA Zittel, 1884
Suborder AMMONITINA Hyatt, 1889
Superfamily ACANTHOCERATOIDAE de Grossouvre, 1894
Family ACANTHOCERATIDAE de Grossouvre, 1894
Subfamily ACANTHOCERATINAE de Grossouvre, 1894

Genus Acanthoceras Neumayr, 1875

Type species: Ammonites rhotomagensis Brongniart, 1822, pp. 83, 391, pl. 6, fig. 2, by the subsequent designation de Grossouvre, 1894, p. 27.
Diagnosis

Large, up to 300 mm diameter; the few known adult microconchs are about half the size of macroconchs. Early whorls with rounded to rectangular intercostal whorl section, with umbilical, inner and outer ventrolateral and siphonal tubercles, the latter two generally clavate, with or without distinct ribs; where present at this stage the ribs are irregularly long and short or branch from umbilical bullae. Later ribs may become uniformly long, or short ribs may persist; they are normally broad and rounded and they may strengthen or weaken; umbilical tubercles may enlarge, one or the other of the ventrolaterals may disappear and the other enlarge; the whorl section is slightly compressed to depressed, generally square, rectangular or trapezoidal in section.

The suture is rather simple with broad, more or less symmetrical, squarish trifid or bifid elements (Wright & Kennedy 1987, p. 153).

Occurrence

Middle Cenomanian, northern and southern Europe, North, West and southern Africa, Madagascar, south India, Japan, northern Australia, the U.S. Western Interior and western seaboard, Peru, J. Japan.

Acanthoceras flexuosum

Crick, 1907

Figs 1D–I, 2–25, 34A–C

1907 Acanthoceras flexuosum Crick, p. 184, pl. 12, fig. 1.
1907 Acanthoceras crassiamatum Crick, p. 185.
1907 Acanthoceras munitum Crick, p. 187.
1907 Acanthoceras expansum Crick, p. 188.
1907 Acanthoceras robustum Crick, p. 189.
1907 Acanthoceras quadratum Crick, p. 192, pl. 13, fig. 2.
1907 Acanthoceras hippocastanum J. de C. Sowerby sp.; Crick, p. 194, pl. 13, fig. 4.
1907 Acanthoceras latum Crick, p. 195, pl. 12, fig. 2.
1936 Acanthoceras flexuosum Crick; Venzo, p. 84 (26), pl. 7 (3), fig. 6.
1936 Acanthoceras hippocastanum Sow; Venzo, p. 85 (27), pl. 7 (3), fig. 2.
non 1971 Acanthoceras latum Crick; Kennedy, p. 89 (pars), pl. 57, fig. 1.
1975 Acanthoceras flexuosum Crick; Förster, p. 294, pl. 16, fig. 2; pl. 17, figs 2, 5.
1975 Acanthoceras rhombergense confusum (Guéranger); Förster, p. 248, figs 3, 4.
1978 Acanthoceras flexuosum Crick; Kennedy, pl. 2, fig. 1.
1978 Acanthoceras quadratum Crick; Kennedy, pl. 2, fig. 6.
1978 Acanthoceras latum Crick; Kennedy pl. 3, fig. 1.
1978 Acanthoceras sp. Kennedy, pl. 3, fig. 6.
1985 Acanthoceras robustum Crick, 1907; Zaborski, p. 33, fig. 37a, b.
1987 Acanthoceras crassiamatum Crick, 1907; Wright & Kennedy, p. 189, text-fig. 72a, b.
1987 Acanthoceras flexuosum Crick, 1907; Wright & Kennedy, p. 189, text-figs 72c, 73a.
1987 Acanthoceras robustum Crick, 1907; Wright & Kennedy, p. 189, text-fig. 73b, c.
1987 Acanthoceras latum Crick, 1907; Wright & Kennedy, p. 189, text-figs 66h, i, 72d, e.

Name of the species

As first revising authors we select the name flexuosum for the species.

Types

The holotype of Acanthoceras flexuosum Crick, 1907, p. 184, pl. 12, fig. 1, is BMNH C18174 (Fig. 1G–I).

The holotype of Acanthoceras crassiamatum Crick, 1907, p. 185, is BMNH C18175 (Fig. 1D–F).

The lectotype, here designated, of Acanthoceras munitum Crick, 1907, p. 187, is BMNH C18182 (Fig. 2D–F); paralectotypes are BMNH C18183-5.

The holotype of Acanthoceras expansum Crick, 1907, p. 188, is BMNH C18187 (Fig. 2G–I).

The lectotype, here designated, of Acanthoceras robustum Crick, 1907, p. 189, is BMNH C18189 (Fig. 2A–C); paralectotypes are BMNH C18188 (figs 2j, 3) and 18190.

The lectotype, here designated, of Acanthoceras quadratum Crick, 1907, p. 192, pl. 13, fig. 2, is BMNH C18194 (Fig. 4). Paralectotype BMNH C18195 is a Cunningtoni-cceras.

The holotype of Acanthoceras latum Crick, 1907, p. 195, pl. 12, fig. 2, is BMNH C18197 (Fig. 5).

Material

We have studied several hundred specimens, including SAM-PCZ 13474, 13489–99, 13501–13515, 13517–28, 13531, 13534; OUM KX 1749, 1750, 4371–4583. BMNH C90252–79. BMNH C18196 is the original of Acanthoceras hippocastanum Crick (1907, p. 194, pl. 13, fig. 4) non J. de C. Sowerby. BMNH C18176–81, C18191, C18192, C18199, C18231, C18232.

Dimensions

See Table overleaf.

Description

The majority of specimens are phragmocones, often partially silicified, with replaced shell present in many.

Coiling is evolute during middle and later growth, with less than 20% of the previous whorl covered, to just below the level of the inner ventrolateral tubercle. The umbilicus is of moderate width (19.6–27.7% of the diameter), and depth. The umbilical wall is flattened to feebly convex, the umbilical shoulder narrowly rounded. The whorl section is generally depressed in both costal and intercostal whorl section; costal whorl breadth to height ratios vary from 0.76 to 1.3. The greatest breadth is just outside the umbilical shoulder in intercostal section, and at the umbilical bulla in costal section. The intercostal section is rounded-trapezoidal, with a broad, flattened venter, broadly rounded umbilical and ventrolateral shoulders.

In our smallest specimens, at diameters of 5–7 mm, the ornament consists of seven conical inner ventrolateral tubercles per half whorl, with associated ribs on the outer flank, and feebly outer ventrolateral clavi. From around 8 mm diameter, the ornament of the middle growth stage appears, with from 8–10 umbilical bullae per whorl, perched on the umbilical shoulder. They give rise to single straight to feebly flexuous primary ribs that efface markedly at mid-flank. Short intercalated ribs alternate more-or-less regu-
larly with the primaries. They arise at mid-flank; some are linked to the umbilical bullae by tenuous striae. There are a total of 17–22 ribs per whorl at the umbilical shoulder. All ribs bear a conical inner ventrolateral tubercle, connected by a broad, low rib to clavate outer ventrolateral and siphonal tubercles. There is some variation in the strength and density of the ornament; depressed individuals are more coarsely ribbed and tuberculate than compressed ones. This style of ornament extends to a diameter of around 70 mm. As size increases beyond this, the intercalated ribs lengthen progressively until all extend to the umbilical shoulder, although not all develop umbilical bullae. As a result the third growth stage is characterized by primary ribs with bullae of very variable strength. This change in ribbing style is accompanied by a marked change in tuberculation. The umbilical bullae strengthen and migrate out to a mid-flank position, the inner ventrolateral tubercles develop into horns, and the siphonal clavi decline. The outer flanks become markedly concave in costal section at this growth stage. As size increases beyond 100 mm diameter, the outer ventrolateral clavi merge with the ventrolateral horn to produce a single protuberance that initially bears a trace of the clavi, thereafter lost. Ventrolateral ribbing and siphonal tuberculation also decline, so that in the largest phragmocones there are no more than low, broad undulations on the venter and a feeble siphonal ridge. At this stage the costal whorl section is characterized by concave flanks and a feebly convex venter.

We have two fragments of large adults. OUM KX1749 is a phragmocone fragment with a maximum preserved whorl height of 90 mm and an intercostal whorl breadth to height ratio of 1.2, the whorl section reniform, with the greatest breadth below mid-flank. Coarse umbilical bullae give rise to single coarse, broad, straight, prorsiradiate ribs that weaken at mid-flank before strengthening into coarse ventrolateral bullae, linked across the broad convex venter by a low, broad rib that weakens and effaces in the mid-ventral region. OUM KX1750 (Figs 23, 24) is a massive 120° sector of body chamber with a maximum preserved whorl height of 105 mm, with whorl section and coarse
ornament as in the previous specimen. When complete the estimated diameter must have exceeded 200 mm.

The holotype of Acanthoceras flexuosum Crick, 1907 (p. 184, pl. 12, fig. 1) is BMNH C18174 (Fig. 16–I), a wholly septate phragmocone that retains recrystallized shell. Coiling is moderately evolute; the umbilicus comprises 24% of the diameter, and is quite deep, with a broadly convex umbilical wall, the umbilical shoulder more narrowly rounded. The whorl section is slightly depressed, with the greatest breadth at the umbilical bullae in costal section, and just outside the umbilical shoulder in intercostal section. The inner and middle flanks are broadly rounded in intercostal section, the outer flanks flattened, converging to broadly rounded ventrolateral shoulders. The venter is broad and feebly convex. The costal section is rounded-polygonal. Eighteen to 19 primary ribs arise at the umbilical seam, and are weak, narrow, and concave across the umbilical wall. They strengthen across the umbilical shoulder and develop into pinched concave bullae of variable strength. These give rise to feebly flexuous, prorsiradiate primary ribs, either singly or in pairs, while there are occasional non-bullate primaries, to give a total of 24–25 ribs per whorl at the ventrolateral shoulder. All ribs develop a small, conical inner ventrolateral tubercle, linked by a low, broad prorsiradiate rib to a stronger outer ventrolateral clavus; a low, broad, transverse rib connects to a slightly weaker siphonal clavus. Where well preserved, the surface of the replaced shell bears strong growth lines and striae.

The holotype of Acanthoceras crassornatum Crick, 1907 (p. 185), is BMNH C18175 (Fig. 1D–F). It is a phragmocone 77.1 mm in diameter, and retains replaced shell, with indications of the former presence of a further half whorl. It is rather worn on one side. The specimen is no more than a third of the overall diameter, deep, with a feebly convex umbilical wall and a depressed whorl section. The style of ornament and ontogenetic changes correspond to those shown by Crick’s other specimens described above, of which it is a further variant. Coiling is very evolute, the umbilicus comprising 28.4% of the diameter, deep, with a feebly convex umbilical wall and broadly rounded umbilical shoulder. The whorl section is rounded-trapezoidal in intercostal section, with the greatest breadth just outside the umbilical shoulder. The greatest breadth is at the umbilical bullae in the polygonal costal section, and the whorl breadth to height ratio is 1.24. Fifteen to 16 primary ribs arise at the umbilical seam on the outer whorl, and develop into umbilical bullae of variable strength. On the penultimate whorl, and the adapertural part of the outer whorl, primary and secondary ribs alternate. On the adapertural part of the outer whorl, they are replaced by alternately strongly bullate and weakly to non-bullate primaries. Only the last few ribs have umbilical bullae of variable strength. The primary ribs are straight, feebly prorsiradiate, and broaden progressively across the flanks. All ribs bear conical inner ventrolateral tubercles that strengthen progressively around the outer whorl. At the beginning of the outer whorl, a low, broad, prorsiradiate rib links to a well-developed outer ventrolateral clavus, with a low, broad, transverse rib linking to a subequal siphonal clavus. As size increases, the rib linking the inner and outer ventrolateral tubercle broadens markedly, and changes from prorsiradiate to near transverse. The siphonal clavi are not preserved on the adapertural 120° sector of the outer whorl. Crick referred to Acanthoceras quadratum a second specimen, BMNH C18195, which appears to be a Cunningtonoceras.

BMNH C18196 (Fig. 11D–F) is the original of Acanthoceras hippocastanum Crick (1907, p. 194, pl. 13, fig. 4 non J. de C. Sowerby. It is a juvenile coarse-ribbed variant, with 9–10 umbilical bullae and 18 ribs at the ventrolateral shoulder of the outer whorl, which is 33.2 mm in diameter.

The holotype of Acanthoceras lautom Crick, 1907 (p. 195, pl. 12, fig. 2) is BMNH C18197 (Fig. 9). It is wholly septate, and slightly distorted into an ellipse, 114 mm in diameter, with replaced shell well preserved. Coiling is very evolute, the umbilicus comprising 29.5% of the diameter. The umbilical wall is feebly convex, the umbilical shoulder broadly
rounded. The intercostal whorl section is rounded-trapezoidal, with a whorl breadth to height ratio of 1.3, the greatest breadth below mid-flank. The costal section is depressed-polygonal, and concave between the tubercles. The greatest breadth is at the inner ventrolateral horns. On the penultimate whorl, ten primary ribs arise at the umbilical seam, and strengthen into strong, pointed umbilical bullae. These give rise to one or more stronger, broad, straight prosiradial ribs. On the outer whorl, 16 primary ribs arise at the umbilical seam. They strengthen progressively across the umbilical wall, and develop into coarse, progressively strengthening umbilical bullae. These give rise to low, broad, coarse, straight, recti- to feebly prosiradial ribs that link to progressively strengthening and ultimately massive inner ventrolateral horns. There are two non-bullate primary ribs at the apical end of the external whorl. A broad, transverse rib connects the inner ventrolateral horns to much weaker outer ventrolateral clavi. A low, broad, near-effaced transverse rib extends across the venter. There is a low continuous siphonal ridge that strengthens where it intercepts the ventral ribs. There are traces of siphonal clavi at the apical end of the outer whorl, but preservation is imperfect.

What appears to be a further fragment of this form is BMNH C18193 (Fig. 6), the specimen described by Crick (1907, p. 191–192) as Acanthoceras sp. It is a sector of penultimate whorl, and a 100° sector of outer whorl of a phragmocone with a maximum preserved whorl height of 80 mm. The intercostal whorl breadth to height ratio is 1; the costal ratio is 1.2. On the penultimate whorl, weakly and progressively strengthening inner ventrolateral horns arise at the umbilical seam. Both species also show a wide range of intraspecific variation. As noted by Wright & Kennedy (1987, p. 189) they can be separated in that in flexuosum, specimens around 100 mm diameter show predominantly long ribs on the last half whorl, with umbilical bullae of variable strength. This change to predominantly long ribs is accompanied by a marked change in tuberculation and whorl profile in costal section. It is initially polygonal, a trapezium with truncated corners, but as size increases the umbilical bullae strengthen and migrate outwards to an inner flank position. The inner ventrolateral tubercles develop into horns, and the siphonal clavi decline. The outer flanks become markedly concave in costal section. Beyond 100 mm diameter the inner and outer ventrolateral tubercles progressively merge into a single horn-like protuberance that initially retains traces of the outer ventrolateral clavis (Fig. 5 shows this well), but this is ultimately assimilated (Fig. 6). Ventral ribbing and tuberculation decline so that the largest specimens have only low, broad undulations on the venter, and a low siphonal ridge (Figs 20, 22).

**Occurrence**

Middle Cenomanian Mzine Formation of the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289), and southern Mozambique.

**Acanthoceras cornigerum** Crick, 1907

- **Fig. 1A–C**
- **1907** Acanthoceras conigerum Crick, p. 207, pl. 13, fig. 1.
- **1957** Acanthoceras conigerum Crick; Matsumoto, Saibo & Fukada, p. 18, text-fig. 5.
- **1969** Acanthoceras conigerum Crick; Matsumoto, Muramoto & Takahashi, p. 268, pl. 32, fig. 1; text-fig. 5.
- **1978** Acanthoceras conigerum Crick; Kennedy, pl. 2, fig. 5.

**Type**

The holotype, by monotypy, is BMNH C18230, the original of Crick, 1907, p. 207, pl. 13, fig. 1 (Fig. 1A–C).

**Dimensions**

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<td>69.4 (100)</td>
<td>30.8 (44.4)</td>
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<td>21.4 (30.8)</td>
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<td>23.9 (34.4)</td>
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**Description**

The specimen is wholly septate, and retains replaced shell. Colling is very evolute, the umbilicus is broad, and of moderate depth. The umbilical wall and should are broadly rounded. To a diameter of 47 mm, primary ribs arise at the umbilical seam, and are well developed and concave across the umbilical wall, strengthening into sharp bullae on the inner flank. These give rise to feebly flexuous prosiradial single ribs that alternate regularly with shorter intercalated ribs. All ribs develop an ill-defined inner ventrolateral tubercle,
linked by a prorsiradiate rib to an equally ill-defined outer ventrolateral tubercle. These tubercles are little more than angulations on the ribs. The ribs are strongly and broadly convex across the venter. There are ill-defined siphonal clavi on all ribs. On the remaining sector of outer whorl, the ribs are all primaries. They all bear a strong, subspinose umbilical bulla that migrates out away from the umbilical shoulder as size increases, ultimately occupying a mid-lateral position. A strong, high, feebly flexuous to straight prorsiradiate rib links to a large, outward- and upward-directed horn, with a strong rib linking the horns across the venter. There are in all 18–19 primary ribs on the outer whorl.

Discussion
Acanthoceras cornigerum is highly distinctive species, differing from all other described Acanthoceras species in the ill-defined inner and outer ventrolateral and siphonal tubercles of early growth, the rapid transition to exclusively primary ribs at a small diameter, together with the migration of the umbilical bulla out to mid-flank and the development of large, outward- and upward-directed horns, with a strong rib linking the horns across the venter. So distinctive is the species that it might be considered pathological but for the description of a larger individual from Hokkaido, Japan, that shows comparable distinctive ontogenetic changes (Matsumoto, Muramoto & Takahashi 1969 p. 268, pl. 32, fig. 1; text-fig. 5).

Occurrence
Middle Cenomanian Mzinene Formation of the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289).

Genus Protacanthoceras Spath, 1923

Type species
Ammonites bunburianus Sharpe, 1853, p. 25, pl. 9, fig. 3, by original designation by Spath 1923, p. 144.

Diagnosis
Dwarf offshoots of Acanthoceras reaching adult stage at diameters from 15 to 150 mm. Moderately involute, compressed and flat-sided to inflated with inner and outer ventrolateral and siphonal tubercles; intercalated or branched secondaries bear ventrolateral and siphonal tubercles. Tubercles weaken or disappear towards the end of the adult body chamber, and the ribs become broad and flat. Microconchs are 66–80% of the diameter of macroconchs and tend to have fewer and stronger ribs. In some species the ornamentation on the last whorl weakens. The suture is similar in plan to that of Acanthoceras, but simpler in detail (modified after Wright & Kennedy 1987).

Occurrence
Middle and lower Upper Cenomanian, southern England, France, Romania, Bulgaria, KwaZulu in South Africa, Madagascar, south India, and possibly Middle Cenomanian of Hokkaido, Japan.

Protacanthoceras subwaterloti (Venko, 1936)

Fig. 26
1936 Acanthoceras (Acompsoceras) subwaterloti Venzo, p. 87 (29), pl. 7 93), fig. 11.

Type
The holotype, by monotypy, is the original of Venzo, 1936, p. 87 (29), pl. 7 93), fig. 11, reproduced here as Fig. 26G, H, from the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975).

Material
Two specimens, SAM-PCZ22192 and 22193, from the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975).

Dimensions

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Description
SAM-PCZ22192 (Fig. 26D–F, M, N) is a phragmocone 25.8 mm in diameter, lacking the adapical 120° sector of the outer whorl, and with indications of the former presence of a further whorl. Coiling is moderately evolute, with 40% of the previous whorl covered. The umbilicus comprises 28–32% of the diameter, with a low, subvertical wall and narrowly rounded shoulder. The whorl section is compressed, with a whorl breadth to height ratio of 0.73, the greatest breadth well below mid-flank. The inner flanks are flattened and subparallel; the outer flanks converge to broadly rounded ventrolateral shoulders and a narrow, feebly convex venter. Primary ribs arise at the umbilical seam, and are low and broad, strengthening into a blunt bulla on the umbilical shoulder, producing a distinctive crenulate margin to the umbilicus. They give rise to low, broad, straight, prorsiradiate ribs that broaden and weaken at mid-flank before strengthening markedly on the outer flank, while additional ribs intercalate between successive primaries to give 20 ribs at the ventrolateral shoulder, corresponding to nine bullae at the umbilical shoulder of the 270° sector of outer whorl preserved. There are traces of a low, rounded, effaced inner lateral bulla at the adapical end of the outer whorl that is rapidly lost. All ribs bear strong, equal outer ventrolateral and weaker siphonal clavi, connected across the venter by a low, broad swelling.

SAM-PCZ22193 (Fig. 26A–C, I–L) has an estimated maximum preserved diameter of 25.5 mm (the venter at the adapertural end of the outer whorl is damaged). It closely resembles the previous specimen, with a total of 12–13 umbilical bullae on the outer whorl, and weak inner ventrolateral tubercles at the adapical end that are thereafter lost. The outer ventrolateral clavi are strong and persistent; the siphonal clavi are somewhat weaker.

Discussion
The very limited material attributed to Protacanthoceras subwaterloti most closely resembles the lower Upper Cenomanian Protacanthoceras bunburianum (Sharpe, 1853) (p. 25, pl. 9, fig. 3; see revision in Wright & Kennedy 1987 p. 215, pl. 55, figs 10–16; text-figs 83b, c; 84d–h). This differs in the persistence of inner ventrolateral clavi on
phragmocones of individuals of comparable ribbing strength, and the marked concavity and forward projection of the ribs on the ventrolateral shoulders.

The holotype of subwaterloti (Fig. 26C, D) is a fragment only, with a maximum preserved whorl height of 34 mm, while both of the present specimens retain indications of the presence of a further whorl, suggesting adults reached a substantially greater size than P. bunburianum.

Occurrence
Middle or lower Upper Cenomanian Mzinene Formation of the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289).

Genus **Cunningtoniceras** Collignon, 1937
(‘Synonym: Guerangericeras Thome, 1972, p. 119)

Type species
*Ammonites cunningtoni* Sharpe, 1855, p. 35, pl. 15, fig. 2; by the original designation of Collignon, 1937, p. 64(40).

Diagnosis
Large, evolute. Whorl section quadrate to depressed. Flanks typically ornamented by bullate primary ribs only, with inner and outer ventrolateral tubercles, the former commonly developing into horns that eventually assimilate the latter. For part of ontogeny, ventral ribs and siphonal tubercles more numerous than the outer ventrolateral, to which they are linked in pairs or groups of ribs, additional ribs with siphonal clavi intercalating between, the siphonal clavi commonly borne on a siphonal ridge. In later stages all ribs and tubercles except umbilical and fused ventrolateral may disappear and the ventrolateral tubercles extend sideways beyond the umbilical or obliquely upwards and may be excessively enlarged.

Discussion
Wright & Kennedy (1987, p. 193) derived *Cunningtoniceras* from *Acanthoceras* by the development of additional ventral ribs and siphonal tubercles. Subsequent work suggests that *Cunningtoniceras* preceded *Acanthoceras* in North Africa (Amedro in Robaszynski et al. 1994) and Western Europe (Gale 1995; Kaplan et al. 1998), and the relationships of early *Acanthoceratinae* require reassessment.

*Acanthoceras flexuosum* commonly show a siphonal ridge, and there are a number of KwaZulu specimens that develop more numerous ventral than flank ribs, and more numerous siphonal clavi. These are referred to here as *Cunningtoniceras* sp. a and b.

Occurrence
Middle and lower Upper Cenomanian, Europe, Turkmenistan, Middle East, North Africa, Nigeria, Angola, KwaZulu, Madagascar, southern India, Japan, New Guinea, Bathurst Island (northern Australia), U.S. Gulf Coast and Western Interior.

*Cunningtoniceras*? sp. a
Figs 27A–D, 28, 29
1907 *Acanthoceras quadratum* Crick, p. 193 (pars).

Material
OUM KX 1744, 4630–4634; SAM-PCZ13516, BMNH C18193.

Description
*OUM KX4632* (Fig. 27A–D) is a well-preserved 120° sector of phragmocone retaining recrystallized shell. The maximum preserved whorl height is 40.5 mm. Coiling is evolute, the umbilicus deep, with a feebly convex, outward-inclined wall. At the adapical end of the fragment the intercostal whorl section is very depressed oval, with a whorl breadth to height ratio of 1.58, the flanks very strongly convex, the ventrolateral shoulders and venter broadly and evenly rounded. Coarse primary ribs, of which five are preserved on the fragment, arise at the umbilical seam and sweep back across the umbilical wall, strengthening progressively. They strengthen into alternately weak and very strong umbilical bullae that mark the greatest whorl breadth in costal section, with a whorl breadth to height ratio of up to 1.45. A strong bulla on one flank corresponds to a weak bulla on the opposite flank at this stage. The bullae give rise to strong, very coarse recti- to feebly rursiradiate ribs that pass straight across the venter without diminution, and bear a subequal, bullate inner, and weakly rounded outer ventrolateral tubercle, and a weakly rounded to feebly clavate siphonal tubercle. This growth stage is succeeded by one in which the inner ventrolateral tubercles strengthen markedly into a prominent horn. At the largest preserved diameter the outer ventrolateral tubercle has all but effaced and merged with the inner ventrolateral horn, the venter feebly concave in costal section, with the rib and siphonal tubercle effaced.

A number of very worn fragments (OUM KX4630, 4631, 4633, 4634), with whorl heights of 19.8–38 mm, represent the remarkably depressed early growth stage of the species. The greatest breadth is at the umbilical bulla, and some ribs have a weak and strong bulla in corresponding positions on the opposing flanks. A feeble, low siphonal ridge links the siphonal clavi in some of these specimens. OUM KX4630 (Fig. 28C, D) shows the incipient development of pairs of ribs looping across the venter between outer ventrolateral clavi and a pair of siphonal tubercles corresponding to a single outer ventrolateral at the largest preserved diameter. By contrast, the impression of the venter of the penultimate whorl on the dorsum of the fragment shows equal numbers of outer ventrolateral and siphonal tubercles.

SAM-PCZ13516 (Fig. 29) continues the ontogeny, and is a 120° whorl sector with a maximum preserved whorl height of 57 mm. It bears five very distant coarse primary ribs with blunt umbilicolateral horns, linked to massive inner ventrolateral horns by a low broad rib that effaces on the outer flank. The outer ventrolateral tubercles are near-effaced, and the broad venter concave in costal section, the ventral ribbing effaced. OUM KX1744 (Fig. 28E) is a massive body chamber fragment with a maximum preserved whorl height of 64 mm. Coarse primary ribs arise on the umbilical wall, and strengthen into massive umbilicolateral horns, connected to massive ventrolateral horns by a low, broad rib. The ventrolateral horns are connected across the venter by low, broad ribs. These efface in the middle of the very broad venter. The costal ventral section is concave.
BMNH C18195, the second specimen referred to Acanthoceras quadratum by Crick (1907, p. 193), is a 180° sector of the penultimate whorl, and a 120° sector of the outer whorl that are wholly septate, with a maximum preserved whorl height of 55 mm. Parts of nine ribs survive on the penultimate whorl fragment, and parts of seven on the outer whorl.

Discussion
The smaller fragments referred to the species are highly distinctive. The presence of looped ventrolateral ribbing and multiplication of siphonal versus outer ventrolateral tubercles at one point on OUM KX4630 (Fig. 28C, D) suggest reference to Cunningtoniceras, but the limited extent of these diagnostic features on the material may be of no taxonomic significance, hence the qualified identification.

Occurrence
Middle Cenomanian (or lower Upper Cenomanian?) Mzinene Formation of the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289).

Cunningtoniceras? sp. b.
Figs 27E–F, 30
1907 Acanthoceras sp., Crick, p. 191.

Description
BMNH C18273 (Fig. 30) consists of a 120° sector of two phragmocone whorls, with a maximum preserved whorl height of 60.8 mm. Coiling appears to have been very evolute, the umbilicus deep, with a feebly convex, outward-inclined umbilical wall and broadly rounded shoulder. The whorl section is very depressed, rectangular, with rounded corners. The ribs are low and broad on the umbilical wall, and strengthen into strong, widely separated bullae, perched on the umbilical shoulder. The ribs are straight and prorsiradiate on the flanks, across which they strengthen progressively and develop into a pinched ventrolateral horn that does not rise above the level of the venter. The horns are linked over the venter by a very broad, transverse rib, which is feebly differentiated into a concave adapical and convex adoral rib. There are low, ill-defined siphonal tubercles.

What may be the inner whorls of this species are represented by OUM KX4574 (Fig. 27E, F), fragment of phragmocone with a maximum preserved whorl height of 46 mm. The whorl section appears to have been depressed trapezoidal in intercostal section. The costal section is depressed, and markedly concave between the umbilical and inner ventrolateral tubercles. Parts of eight ribs are preserved on the fragment. They arise at the umbilical seam, and strengthen across the umbilical wall, developing into well-developed pinched umbilical bullae. These give rise to strong, narrow, recti- to feebly rursiradiate primary ribs that are straight on the flanks and link to pinched inner ventrolateral horns. These are linked to effacing outer ventrolateral tubercles by a strong transverse rib, beyond which the venter is damaged.

Discussion
Feeble development of multiple ventral ribbing is a Cunningtoniceras-like feature, hence the questionable generic assignation. The quadrate costal whorl section, with broad, flattened venter, distinguishes the material from Cunningtoniceras? sp. a.

Occurrence
Middle Cenomanian (or lower Upper Cenomanian?) Mzinene Formation of the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289).

Genus Calycoceras Hyatt, 1900
(ICZN Generic Name No. 1352)

Type species
By designation under the Plenary Powers (ICZN Opinion No. 557) Ammonites navicularis Mantell, 1822, pp. 198, pl. 22, fig. 5 (ICZN Specific Name No. 1633).

Diagnosis
Small to large, rather evolute with oval, depressed round, subquadrate or polygonal whorl section. Strong, generally straight ribs cross uninterrupted a rounded or flat venter. There are up to seven rows of tubercles on the primary ribs: umbilical, inner and outer ventrolateral and siphonal. Secondary ribs lack the umbilical and sometimes the inner ventrolateral tubercles. Some or all tubercles may be lost early in ontogeny, or may persist, or be rejuvenated or not on the last part of the mature body chamber. Marked size dimorphism is probably general (from Wright & Kennedy 1987, p. 217).

Occurrence
Lower Middle to middle Upper Cenomanian, Europe, Asia, Africa, North America, Antarctica and possibly Brazil.

Subgenus Calycoceras (Gentoniceras) Thomel, 1972

Type species
Ammonites gentoni Bronniant, 1822, pp. 83, 392, pl. 6, fig. 6 from the lower Middle Cenomanian of Rouen, Seine-Maritime, France, by original designation by Thomel 1972, p. 65.

Diagnosis
Small to moderate-sized, inner whorls with umbilical, inner, and outer ventrolateral and siphonal tubercles in early growth, later whorls with umbilical bullae and, in some cases, weak outer ventrolateral tubercles on crowded or distant primary and secondary ribs (from Kennedy & Jüngst 1994, p. 30).

Occurrence
Middle and lower Upper Cenomanian in Western Europe, South Africa and south India.

Calycoceras (Gentoniceras) gentoni (Bronniant, 1822)
Fig. 31
1822 Ammonites gentoni Bronniant, p. 83, 392, pl. 6, fig. 6.
1907 Acanthoceras paucinodatum Crick, p. 203, pl. 13, fig. 3.
1990 Calycoceras (Gentoniceras) gentoni (Bronniant, 1822); Wright & Kennedy, p. 219, pl. 56, figs 1–3, 6–8; pl. 57, figs 2, 3, 8; pl. 58, fig. 7; pl. 66, figs 1, 2; text-figs 88a, c; 89a, b; 90a–c (with synonymy).
1990  Calycoceras (Gentoniceras) subgentoni (Spath, 1926a); Wright & Kennedy, p. 226, pl. 56, figs 4, 5; pl. 57, fig. 4; pl. 58, figs 5, 6; pl. 59, figs 1–4; text-figs 88k; 90a–f (with synonymy).

1990  Calycoceras paucinodatum (Crick, 1907); Wright & Kennedy, p. 228, text-fig. 91a, b.

1994  Calycoceras (Gentoniceras) gentoni (Brongniart, 1822); J. U. Keulemans, p. 30, figs 1a; 2d; 6d, e, j, k; 7a–l; 8a–e; 22a, b.

1998  Calycoceras (Gentoniceras) gentoni (Brongniart, 1822); Kaplan, Kennedy, Lehmann & Marcinowski, p. 156, pl. 26, figs 3–5.

Type
Lectotype, by the subsequent designation of R. Douvillé (1911), is the original of Brongniart (1822, pl. 6, fig. 6), from the lower Middle Cenomanian of Rouen, Seine-Maritime, France. It was refigured by Wright & Kennedy (1990, text-fig. 90a–c).

Material
BMNH C18214, the holotype of Acanthoceras paucinodatum Crick, 1907, p. 203, pl. 13, fig. 3.

Dimensions

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Description
BMNH C18214 (Fig. 31), the holotype of Acanthoceras paucinodatum, is 65.1 mm in diameter, and very worn and corroded on one side. The adapertural 90° sector of the outer whorl is body chamber. Traces of replaced shell survive on one flank. Coiling is evolute; the umbilical wall is flattened, the umbilical shoulder broadly rounded. The whorl section is depressed, the umbilicus comprises 29.2% of the diameter. The umbilical wall is flattened, the umbilical shoulder broadly rounded. The whorl section is depressed, rounded-polygonal at the adapical end of the outer whorl, becoming rounded-oval at the adacistal end. The specimen has been mechanically cleaned, and the ribbing ‘improved’ on the adapical parts of the outer whorl. The penultimate whorl bears alternately long and short ribs, the long ribs with small umbilical bullae, all ribs with inner and outer ventrolateral tubercles. The pattern persists onto the adapical 120° sector of the outer whorl, where the ribs are seen to be straight, prorsiradiate, and crowded. The primary ribs bear umbilical bullae, and both primary and intercalated ribs bear inner and outer ventrolateral tubercles. The preservation of the venter is defective and it cannot be determined with any certainty if a siphonal tubercle was present. On the adapertural 240° sector of the outer whorl, from a diameter of approximately 40 mm onwards, the inner, and then the outer ventrolateral tubercles efface, leaving an evenly and broadly rounded venter, crossed by well-developed transverse ribs. The ribs alternate regularly long and short to the greatest diameter preserved, the umbilical bullae weakening slightly.

Discussion
We follow Kennedy & J. U. Keulemans (1994, p. 36) in uniting slender-whorled, slowly expanding, paucicostate C. (G.) gentoni (Brongniart, 1822), and C. (G.) subgentoni (Spath, 1926), with more rapidly expanding densicostate whorls; Wright & Kennedy (1990, pp. 219–227) treated them as separate species, and regarded paucinodatum as a separate species. Comparisons with large new collections from southern England now persuade us that it is a synonym.

Occurrence
C. (G.) gentoni ranges from lower Middle to lower Upper Cenomanian. It is recorded from southern England, Haute-Normandie, Sarthe and Provence in France, Spain, and, possibly, Iran. The present specimen is from the Middle Cenomanian (or lower Upper Cenomanian?) Mziniene Formation of the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289).

Subgenus Calycoceras (Newboldiceras) Thomel, 1972

Type species
Acanthoceras newboldii Kossmat, 1897, p. 5 (112), by original designation by Thomel, 1972, p. 105; = Acanthoceras rhotomagensianum var. asiaticum) Jimbo, 1894, p. 177, pl. 20, fig. 1.

Diagnosis
Evolute, with polygonal to subcircular or subquadrate whorl section, rapidly expanding in breadth and height, strongly and often densely ribbed with strong and persistent umbilical and outer ventrolateral tubercles and less persistent inner ventrolateral and siphonal; occasionally there is a slight protuberance between the umbilical and inner ventrolateral tubercles. Typically the inner parts of the whorl sides are subparallel or weakly convergent and the outer third or quarter strongly convergent to a more or less flat venter. Known complete macroconchs are up to about 250 mm in diameter; fragments described below suggest macroconch phragmocones of up to 200 mm diameter. Adult microconchs range from 45 mm diameter but are more commonly 60–100 mm (modified after Wright & Kennedy 1990, p. 238).

Occurrence
Middle and lower Upper Cenomanian. Widespread in Europe, Africa, Madagascar, southern India, Japan, California, the U.S. Western Interior, and the James Ross Island Group, Antarctica.

Calycoceras (Newboldiceras) asiaticum asiaticum (Jimbo, 1894)

Figs 32, 33A–F, 34J–L, P, Q, 36–38, 44D, E, H, 57A–F

1865 Ammonites Rhotomagensis Defrance; Stoliczka, p. 66 (pars), including typicus (p. 68) (pars) and var. subcompressus (p. 68), pl. 34, figs 3, 4; pl. 35, fig. 1; pl. 36, fig. 1; pl. 37, figs 1, 2.

1894 Acanthoceras rhotomagensianum var. asiaticum jimbo, p. 177, pl. 20, fig. 1.

1897 Acanthoceras Newboldi n.sp. (Typische Form) Kossmat, p. 5 (112), pl. 1 (12), figs 2, 3; pl. 3 (14), fig. 2.

1907 Acanthoceras newboldii (typical form) F. Kossmat: Crick, p. 197.

1907 Acanthoceras newboldii var. spinosa F. Kossmat: Crick, p. 199 (pars), pl. 12, fig. 3.
1907 Acanthoceras nitidum Crick, p. 201 (pars).

1936 Acanthoceras newboldi var. spinosa Kossm.; Venzo, p. 82 (24), pl. 7, figs 3, 4.

1972 Newboldiceras (Newboldiceras) newboldi (Kossmat); Thomel, p. 106 (pars), pl. 40, figs 1–3; non pl. 34, figs 1–3; pl. 38, figs 1, 2; pl. 39, figs 1–3; pl. 41; ?pl. 42, figs 3, 4.

1990 Calycoceras (Newboldiceras) asiaticum asiaticum (Jimbo, 1894); Wright & Kennedy, p. 239, pl. 58, fig. 1; pl. 64, figs 1, 2; pl. 65, figs 1–3, 5, 7; pl. 72, fig. 3; text-figs 87a-c; 88f; 97; 98 (with full synonymy).

1994 Calycoceras (Newboldiceras) asiaticum asiaticum (Jimbo, 1894); Kennedy, p. 227, pl. 7, figs 7, 8; pl. 8, figs 1, 2.

1997 Calycoceras (Newboldiceras) asiaticum asiaticum (Jimbo); Wilmsen, pl. 16, fig. 1.

2004 Calycoceras (Newboldiceras) asiaticum asiaticum (Jimbo, 1894); Kennedy & Jolkicev, p. 275, pl. 3, fig. 1; pl. 4, figs 6, 7; pl. 5, figs 1–4.

2009 Calycoceras (Newboldiceras) asiaticum asiaticum (Jimbo, 1894); Wilmsen & Herbig, p. 64, pl. 1, figs a, b.

Type

The holotype by monotypy is the original of Jimbo, 1894, pl. 20, fig. 1, no. 1–105 in the collections of the Geological Institute, Tokyo University, from the Middle Cenomanian Sandstone of the Ikushumbets, Hokkaido, Japan. A cast is figured here as Fig. 38.

Description

Juvenile phragmocones vary from 17.7–71.4 mm in diameter. All retain recrystallized shell, and the sutures are not seen. Coiling is involute, with 40–44% of the previous whorl covered, the umbilicus of moderate depth, with a subventral wall and narrowly rounded umbilical shoulder. The costal whorl section is slightly depressed, with a whorl breadth to height ratio of 1.04–1.17, trapezoidal–polygonal, with the greatest breadth at the umbilical bullae. The intercostal whorl section is equidimensional, trapezoidal, with the greatest breadth low on the inner flank. Ornament is variable. The smallest specimens, between 17.7 and 26.2 mm (SAM-PCZ13460: Fig. 32F-I; 13472: Fig. 32A, B, J, K, L; 13473: Fig. 32P-R; 13477: Fig. 33A-F) have 12–14 primary ribs per whorl. They arise at the umbilical seam, strengthen across the umbilical wall and shoulder, and develop into well-developed umbilical bullae of variable strength. These give rise to single or two long prorsiradial ribs that strengthen across the flanks. Single ribs intercalate between successive primaries, and strengthen to match them at the ventrolateral shoulder, where all ribs bear a conical inner ventrolateral tubercle of variable strength. These are linked to feebly clavate outer ventrolateral tubercles by a strong prorsiradiate rib. A low broad transverse rib links the outer ventrolateral tubercles to feebly siphonal clavi.

Somewhat larger individuals are up to 42 mm in diameter (SAM-PCZ13428: Fig. 32P-R; 13433: Fig. 32M-O; 13468: 325–T), and have up to 40 ribs per whorl. Primary ribs have sharp umbilical bullae of variable strength, and generally sharp subspinose conical inner ventrolateral tubercles at small diameters; in some individuals these decline markedly as size increases. There are one or two long or short intercalated ribs between successive primaries, with inner ventrolateral tubercles that are generally weaker than those on the primary ribs. All ribs bear feebly clavate outer ventrolateral and siphonal tubercles, linked across the venter by a strong transverse rib.

The larger phragmocones vary from 59–72 mm in diameter (SAM-PCZ13431; 13437: Fig. 36D-F; 13441, 13476: Fig. 36A–C; 13485, 13486). SAM-PCZ13431 has 14 primary ribs on the outer whorl. The umbilical bullae are subspinose on the adapical half of the outer whorl, with one or two shorter ribs intercalated between, strong conical inner, and weaker feebly clavate outer ventrolateral and siphonal tubercles. On the adaperal half of the outer whorl, the umbilical bullae elongate, the ribs are feebly flexuous, the inner ventrolateral tubercles weaken and efface, outer ventrolateral clavi persist, siphonal clavi are lost, and the venter is convex in costal section, with a strong, feebly convex transverse rib. By contrast, SAM-PCZ13486 (Fig. 32 X, Y) shows the persistence of all rows of tubercles to a diameter 54 mm, the siphonal row weakening and offset as a result of damage to the shell and subsequent asymmetric regeneration thereafter. SAM-PCZ13437 (Fig. 36D-F) and 13476 (Fig. 36A–C) are relatively flexuously ribbed individuals with up to 40 ribs per whorl. Subspinose umbilical bullae of variable strength persist to the greatest preserved diameter, as do the outer ventrolateral clavi, the inner ventrolateral and siphonal tubercles efacing.

SAM-PCZ13455 (Fig. 37) is a fragment of a huge
phragmocone with a maximum preserved whorl height of 90 mm. Eight primary ribs with well-developed umbilical bullae of variable strength are preserved on the 120° whorl fragment. They alternate regularly with single intercalated ribs that arise below mid-flank, to give a total of 14 ribs on the fragment at the ventrolateral shoulder. All ribs retain subdoub inner and outer ventrolateral tubercles, linked across the venter by a broad transverse rib. This specimen closely resembles the holotype (Fig. 38).

Discussion

Calycoceras (Newboldiceras) asiaticum asiaticum and C. (N.) asiaticum spinosum (Kossmat, 1897) are closely allied, and linked by occasional passage forms. They differ in the much more robust tuberculation of the latter, well seen in the present material (compare Figs. 33A–E and G–R, Fig. 37 and Figs 40–43). The Acanthoceras newboldi var. spinosa Kossmat of Crick, 1907, p. 202: Fig. 23J–L is a juvenile of the present species. The Acanthoceras newboldi var. spinosa Kossmat of Crick, 1907, p. 199 is in part based on a specimen here referred to C. newboldi newboldi: BMNH C18212, specimen b of Kossmat, p. 199 (Fig. 23J–L) is a juvenile of the present species. The Acanthoceras newboldi var. spinosa Kossmat of Venzo, 1936, p. 82 (24), pl. 7, figs 3, 4, reproduced here as Fig. 44D, E, H) are interpreted as typical C. (N.) asiaticum asiaticum. More problematic is Acanthoceras gortanii Kossm., 1936 (p. 82 (24), pl. 7 (3), fig. 5, reproduced here as Fig. 44A–C). The holotype comes from the Skoenberg, and is a juvenile Calycoceras, here treated as specifically indeterminate.

Occurrence

Upper Middle Cenomanian, rarer in the lower Upper Cenomanian. Southern England, northern and southern France, Spain, Romania, Bulgaria, Tunisia, Madagascar, south India, and Japan, with possible records from Poland, Israel, and China. The present material is from the Middle Cenomanian (or lower Upper Cenomanian) (?). Mzine Formation of the Skoenberg, Kwazulu, locality 62 of Kennedy & Klinger (1975, p. 289).

Calycoceras (Newboldiceras) asiaticum asiaticum spinosum (Kossmat, 1897)


1897 Acanthoceras Newboldi var. spinosa Kossmat, p. 7 (114), pl. 2 (13), figs 2, 3; pl. 3 (14), fig. 1.

1907 Acanthoceras newboldi Newboldi var. spinosa F. Kossmat, Crick, p. 199 (pars), non pl. 12, fig. 3 (= C. (N.) asiaticum asiaticum).

1936 non Acanthoceras newboldi var. spinosa Kossmat.; Venzo, p. 82 (24), pl. 7, figs 3, 4.

1972 Newboldiceras (Newboldiceras) spinosum (Kossmat); Thomel, p. 110, pl. 42, figs 1, 2; pl. 46, figs 1–3.

1978 Calycoceras newboldi-choffati Crick (non Kossmat); Kennedy, pl. 4, fig. 4.

1990 Calycoceras (Newboldiceras) asiaticum spinosum (Kossmat, 1897); Wright & Kennedy, p. 249, pl. 64, fig. 3; pl. 65, figs 4, 6; pl. 66, figs 3, 4; pl. 68, fig. 1; pl. 70, fig. 3; text-figs 87a–c; 88d, i; 99; 100; 102; 107k (with full synonymy).

1994 Calycoceras (Newboldiceras) asiaticum spinosum (Kossmat, 1897); Kennedy, p. 226, pl. 9, figs 1–3, 7–9; pl. 10, figs 12, 13.

1997 Calycoceras (Newboldiceras) asiaticum spinosum (Kossmat); Wilsman, pl. 12, fig. 1; pl. 20, fig. 1.

Types

Lectotype, designated by Wright & Kennedy (1990) is the original of Kossmat’s 1897, pl. 2 (13), fig. 2, from the Uttar Group of Odium, South India. Paralleotypes are the originals of Kossmat’s pl. 2 (13), fig. 3, and pl. 3 (14), fig. 1. The paralleotype of Stoliczka, 1865, pl. 35, fig. 2 may not belong to this subspecies.

Material

SAM-PCZ13446, 13448, 13451, 13456, 13458, 13463, 13479, 13459, 13460, 13464, 13465, 13469, 13478, 13482; SAM D1005; OUM KX4592, 4601. BMNH C18205–18206, the originals of Crick, 1907, p. 200 (pars)

Dimensions

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<th>Wh</th>
<th>10.5 (45.10)</th>
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<td></td>
<td>PCZ13448</td>
<td>37.3 (100)</td>
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<td>1.2</td>
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<tr>
<td></td>
<td>PCZ13479</td>
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<td>1.4</td>
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<tr>
<td></td>
<td>PCZ13463</td>
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<td>28.6 (61.9)</td>
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<td>1.17</td>
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</table>

Description

The smallest individual is SAM-PCZ13458 (Fig. 33K–N), 24.8 mm in diameter. Coiling is moderately involute, the umbilicus of moderate depth with a convex, outward-inclined umbilical wall and more narrowly rounded umbilical shoulder that comprises 25.5% of the diameter. The primary ribs arise at the umbilical seam, and strengthen across the umbilical wall and shoulder, where they bear a progressively strengthening spinose umbilical bulla. The bullae give rise to broad, coarse, straight, prorsiradiate single ribs that link to very strong, coarse inner ventrolateral spines. A broad, coarse rib links to strong, subspinose outer ventrolateral clavi. Single shorter ribs intercalate between successive primaries, arising on the outermost flank or ventrolateral shoulder. They generally lack an inner ventrolateral tubercle, and have outer ventrolateral and siphonal clavi only slightly weaker than those on the primary ribs, and siphonal clavi equal in strength from those on the primary ribs. SAM-PCZ13478 (Fig. 33J, O, P) is a coarsely ribbed individual an estimated 33 mm in maximum diameter, with 12 primary ribs on the outer whorl, and strong inner and outer ventrolateral tubercles. SAM-PCZ13446 (Fig. 33G, H, Q, R) has two intercalated ribs separating successive primaries on the
adapertural third of the outer whorl at a diameter of 34.5 mm. SAM-PCZ13463 (Fig. 35D, E), 13464 (Fig. 35A–C), and 13479 (Fig. 33G, H, Q, R) are between 37.8 and 46.2 mm in diameter. The inner whorls are less markedly spinose than those of the previous individuals at the same diameter. The costal whorl sections are depressed polygonal, with the greatest breadth at the umbilical bullae. SAM-PCZ13464 (Fig. 35A–C) is a coarsely ornamented individual with 14 subspinose umbilical bullae on the outer whorl that give rise to single strong, straight, prorsiradiate primary ribs. One or two long or short ribs intercalate between successive bullate primaries; occasional long intercalatories extend to the umbilical shoulder without developing a bulla, to give a total of 27–28 ribs per whorl at the ventrolateral shoulder. All ribs bear strong subspinose inner ventrolateral tubercles and strong, feebly clavate outer ventrolateral tubercles, linked across the venter by a strong transverse rib that bears a slightly weaker siphonal clavus. SAM-PCZ13463 (Fig. 35D, E) has less robust ornament of this type, the inner ventrolateral tubercles of variable strength. SAM-D1005 (Fig. 35M–O) is 45 mm in diameter, with indications of the former presence of a further 180° whorl sector. The adapical half of the outer whorl has comparable flank ornament to that of the previous specimens, with indications of the former presence of a further 180° whorl sector. The ribs are strong and coarse, with a maximum preserved whorl height of 55.5 mm, the whorl breadth to height ratio is 1.55; the greatest breadth is at the umbilical tubercle in costal section. Coiling is evolute, the umbilical seam crenulated to accommodate the inner ventrolateral tubercles of the preceding whorl. There are nine coarse primary ribs on the outer whorl fragment. They arise at the umbilical seam, sweep back across the umbilical wall and shoulder, and develop into a strong umbilicolateral bulla. The ribs arise sinuosely or in pairs, and sweep back across the flanks. The inner and outer ventrolateral tubercles are concealed between the recrystallized dorsal shell wall of the succeeding whorl (now lost). The ribs are strong and coarse across the venter.

None of the specimens show the sutures.

Discussion

Calyucceras (N.) asiaticum spinosum differs from the nominate subspecies in its coarser tuberculation, the inner and outer ventrolateral rows persisting to maturity, as noted above under C. (N.) asiaticum asiaticum. See Wright & Kennedy (1990, p. 249) for a discussion of differences from other Newboldiceras species.

Occurrence

Upper Middle and lower Upper Cenomanian, southern England, France, Spain, Romania, Bulgaria, Tunisia, Madagascar, South India, Tibet(?), Japan and California. The present material is from the Middle Cenomanian (or lower Upper Cenomanian?) Mzinene Formation of the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289).

**Calyucceras (Newboldiceras) cf. asiaticum hunteri**

(Kossmat, 1897)

Fig. 45

Compare:

1987 Acanthoceras Hunteri Kossmat, p. 9 (116), pl. 3 (14), fig. 4.

1972 Newboldiceras (Newboldiceras) newboldi (Kossmat); Thomel, p. 106 (pars), pl. 34, figs 1–3; pl. 38, figs 1, 2; pl. 39, figs 1–3; pl. 41; non pl. 40, pl. 42, figs 3, 4.
1990 Calycoceras (Newboldiceras) cf. asiaticum hunteri (Kossmat, 1897); Wright & Kennedy, p. 251, text-figs 90g, h; 103; 104;110b.

Types
The lectotype, by the subsequent designation of Wright & Kennedy, 1990, p. 251, is the original of Kossmat (1897, p. 9 (116), pl. 3 (14), fig. 4), no. 1489 in the collections of the Geological Survey of India, from the Utatur Group of Odium, south India. A cast was figured by Wright & Kennedy (1990, text-fig. 103). The second specimen mentioned by Kossmat is a paralectotype.

Material
SAM PCZ13449; OUM KX4622.

Description
SAM-PCZ13449 (Fig. 45) is an internal mould of a 120° sector of phragmocone with a maximum preserved whorl height of 67.4 mm, corresponding to an original estimated diameter of 170 mm. It retains traces of limonitized test. Colling is moderately evolute, the umbilicus of moderate depth, with a flattened wall and broadly rounded umbilical shoulder. The whorl breadth to height ratio is 1.1, the greatest breadth below mid-flank, the inner to middle flanks broadly rounded, the outer flanks convergent, the ventrolateral shoulders broadly rounded, and the broad venter very feebly convex. Four coarse umbilical bullae perch on the umbilical shoulder and give rise to one or two coarse, straight, prorsiradiate primary ribs. One or two non-bullate long ribs or short ribs intercalate between the bullate primaries. The ribs flex slightly forwards and are very feebly concave on the ventrolateral shoulder, where feeble angulations mark the site of inner and outer ventrolateral tubercles, largely assimilated into the ribs at this diameter. The ribs are strong, coarse, and very feebly convex across the venter. Traces of the suluture line are visible, with a large asymmetri-cally bifid E/A.

OUM KX4622 is a very worn but comparable fragment of phragmocone with a maximum preserved whorl height of 75 mm, with a total of 12 ribs at the ventrolateral shoulder.

Discussion
Ribbing style and effacement of ventrolateral tuberculation separate this specimen from Calycoceras (Newboldiceras) asiaticum asiaticum and C. (N.) asiaticum spinosum. The fragment compares well with a cast of the holotype of hunteri before us.

Occurrence
The present material is from the Middle Cenomanian (or lower Upper Cenomanian?) Mzimene Formation of the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289).

Calycoceras (Newboldiceras) planecostatum (Kossmat, 1897)
1897 Acanthoceras Newboldi var. planecostata Kossmat; Crick, p. 201.
1907 Acanthoceras Newboldi var. planecostata F. Kossmat; Crick, p. 201.
1907 Acanthoceras choffati f. Kossmat; Crick, p. 205, pl. 12, fig. 5.
1978 Calycoceras newboldi-choffati Kossmat; Kennedy, pl. 4, figs 1–3 only.
1990 Calycoceras (Newboldiceras) planecostatum (Kossmat, 1897); Wright & Kennedy, p. 252, pl. 61, figs 2, 3; pl. 67, figs 1–4; text-figs 101c–e (with full synonymy).
1994 Calycoceras (Newboldiceras) planecostatum (Kossmat, 1897); Kennedy, p. 228, pl. 10, figs 2, 3.
1994 Calycoceras (Newboldiceras) planecostatum (Kossmat, 1897); Kennedy & Juignet, p. 50, text-figs 1c; 18a–c; 19a–c.
1996 Calycoceras (Newboldiceras) planecostatum (Kossmat, 1897); Kennedy; Blotte & Hansotte, p. 314, pl. 40, fig. 3.
1998 Calycoceras (Newboldiceras) planecostatum (Kossmat, 1897); Kaplan, Kennedy, Lehmann & Marcinowski, p. 158, pl. 26, figs 9–11.
2004 Calycoceras (Newboldiceras) planecostatum (Kossmat, 1897); Kennedy & J olkic ev, p. 376, pl. 3, figs 2–6, 8, 9.

Type
Lectotype, by the subsequent designation of Wright & Kennedy (1990, p. 252), is no. 14842 in the Collections of the Geological Survey of India, the original of Kossmat (1897, pl. 2(13), fig. 1), from the Utatur Group of Odium, south India. A cast is illustrated here as Fig. 54.

Material
SAM-PCZ13430, 13432, 13434–6, 13438–40, 13443, 13444, 13445–4, 13467, 13475, 13480–81, 13483, 13487, 13488, 13490, 13491, 13493, 13495, 13465 OUM KX4589, 4595, 4597, 4598, 4602, 4603, 4610, 4612, 4615. BMNH C18208–9, the originals of Acanthoceras newboldi-choffati Kossmat; Crick, p. 201. BMNH C18215–18228 the originals of Kossmat (1897); Kennedy & Jolkic ev, p. 376, pl. 3, figs 1–3 only.

Dimensions

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<th>Wh (mm)</th>
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<td>PCZ13488</td>
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<td>PCZ13442</td>
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<td>34. (41.8)</td>
<td>0.96</td>
<td>20.9 (25.7)</td>
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</table>
Description

Well-preserved phragmocones vary from 29.4–128 mm in diameter. Coiling is involute, with around 40% of the previous whorl covered, the umbilicus comprising 24–29% of the diameter, and of moderate depth, with a feebly convex vertical wall and narrowly rounded umbilical shoulder. The whorl section varies from slightly compressed to slightly depressed, with whorl breadth to height ratios that range from 0.82 (SAM-PCZ13430: Fig. 49D, F) to 1.2 (SAM-PCZ13487). The flanks are very feebly convex and parallel, the ventrolateral shoulders broadly rounded, the relatively broad venter very feebly convex. There are 37–44 ribs per whorl. Primary ribs arise at the umbilical seam, and sweep back, strengthen progressively, and are concave across the umbilical wall and shoulder, developing into a weak to moderately strong concave umbilical bulla. Successive primary ribs are separated by up to three intercalated ribs that arise at various levels from innermost to outer flank. The ribs are prorsiradiate and straight to feebly flexuous, strengthening progressively across the flanks. The smallest specimens (e.g. SAM-PCZ13454; Fig. 47A–C) have a feeble inner ventrolateral tubercle, lost beyond a diameter of 26 mm in this specimen, linked by a progressively broadening rib to a small outer ventrolateral clavus. The clavi are linked across the venter by a broad, flattened, feebly convex transverse rib between. On the outer whorl, an estimated 20 umbilical ribs are separated by up to three intercalated ribs that arise at or below umbilical level, giving rise to one or two ribs, with up to three long or short intercalated ribs separating the bullate ones. The ribs are narrow, crowded, prorsiradiate and very feebly flexuous, strengthening progressively across the flanks, feebly concave on the outermost flank and broadly convex across the ventrolateral clavi. A low, broad, feebly convex rib links the clavi across the broad, feebly convex venter. The ribs become broad, flat-topped, and ribbon-like on the adapertural half of the outer whorl.

Crick (1907, p. 205, pl. 12, fig. 5) referred a series of 13 specimens (BMNH C18215–18228) to Acanthoceras choffati Kossmat, 1897 (p. 12 (119), pl. 15 (4), fig. 1). A number of Crick's specimens are illustrated here (Figs 34D, G–I, 46 A–P, 56 A–K, 57 H). Wright & Kennedy (1990, p. 252) treated these specimens as variants of planecostatum, and regarded choffati of Kossmat as a separate species, which they referred to Proucaulycoceras (p. 221, explanation of fig. 87). A cast of the holotype of choffati is illustrated here as Fig. 55. The dimensions are as follows: D = 78.9 (100); Wb = 33.5 (42.5); Wh = 38.3 (48.5); Wb:Wh = 0.87; U = 16.1 (20.4). The cast reveals the original to be an internal mould, with traces of shell preserved, the sutures approximated and interfering, indicating the specimen to be an adult. The adapical 180° sector of the outer whorl is body chamber. On the phragmocone coiling is slightly involute, with 66% of the previous whorl covered, the umbilical wall undercut, feebly convex to flattened, the umbilical shoulder quite narrowly rounded. The whorl section is compressed, with feebly convex, subparallel inner and middle flanks, convergent outer flanks, broadly rounded ventrolateral shoulders and a feebly convex venter in intercostal section. The penultimate whorl shows small elongate prorsiradiate umbilical bullae that give rise to narrow, crowded primary ribs, either singly or in pairs, with up to three long or short ribs intercalated between. On the outer whorl, an estimated 20 umbilical bullae of variable strength perch on the umbilical shoulder. They give rise to one or two ribs, with up to three long or short intercalated ribs separating the bullate ones. The ribs are narrow, crowded, prorsiradiate and very feebly flexuous, strengthening progressively across the flanks, feebly concave on the outermost flank and broadly convex across the ventrolateral shoulders and venter. There are small outer ventrolateral clavi at the adapical end of the outer whorl, connected across the venter by a broad, flattened, ribbon-like rib, with a very feeble siphonal clavus. The siphonal clavi are rapidly lost, the outer ventrolateral clavi at the adapical end of the outer whorl. There is no evidence is lacking at this time.

The ornament of the phragmocone of the holotype of choffati differs in no significant respects from that of compressed variants of planecostatum in the present assemblage such as SAM-PCZ 13434 (Fig. 47D, E), 13452 (Fig. 48D, E), and 13480 (Fig. 50H–J). It may well be that choffati is no more than a microconch of planecostatum, but conclusive evidence is lacking at this time.

Occurrence

Upper Middle and lower Upper Cenomanian, south India, Morocco, Madagascar, KwaZulu, James Ross Island, Antarctica, Iran, Bulgaria, France, Germany and southern

| PCZ13443  | 92.9 (100) | 44.8 (48.4) | 40.0 (43.1) | 1.1 | 27.0 (29.0) |
| PCZ13465  | 128.0 (100) | 64.7 (50.5) | 61.0 (47.7) | 1.1 | 33.9 (26.5) |
England. The present material is from the Middle Cenomanian (or lower Upper Cenomanian?) Mzinene Formation of the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289).

### Calycoceras (Newboldiceras) laticostatum (Crick, 1907)

Figs 56L, M, 57G, J, K

1907 Acanthoceras laticostatum Crick, p. 201.

1978 Calycoceras group of naviculare (Mantell): Kennedy, pl. 4, fig. 8.

**Type**

The holotype is BMNH C18210, the original of Crick, 1907, p. 201.

**Material**

An unregistered specimen in the M.R. Cooper Collection, housed in the Department of Geology and Applied Geology of the University of KwaZulu-Natal (Fig. 57G, J, K) may also belong here.

**Description**

What may be an early growth stage of this species is represented by a 93 mm diameter phragmocone in the collections of the University of KwaZulu-Natal (Fig. 57G, J, K). The whorl section is depressed, the greatest breadth below mid-flank. The inner flanks are broadly rounded, the outer flanks convex and convergent. The broad venter is feebly convex. Primary ribs arise from well-developed umbilical bullae, and are separated by one or two intercalated ribs. The ribs are prorsiradiate, straight on the inner and middle flanks and feebly concave on the outermost flank. Low, coarse, and rounded, they broaden progressively across the flanks. All ribs bear feebly clavate outer ventrolateral tubercles, and there are feeble indications of inner ventrolateral tubercles on some ribs. The ribs are low, broad, and wider than the interspaces on the venter. There are no siphonal tubercles.

The holotype (Fig. 56L, M) is a 150 mm long phragmocone fragment retaining extensive areas of recrystallized shell. A detached fragment reveals the feebly convex venter of the penultimate whorl. It bears broad flattened ribs separated by narrower interspaces, with outer ventrolateral clavi, as in the specimen described above. The outer whorl fragment lacks most of one flank. The whorl section appears to have been depressed reniform in intercostal section, with the greatest breadth just outside the umbilical shoulder. The umbilical wall and shoulder are broadly rounded, the flanks converging to the feebly convex venter. There are three primary ribs on the fragment. They arise at the umbilical seam, sweep back are straight and across the umbilical wall, strengthening into coarse bullae on the umbilical shoulder. The primary ribs are coarse, broad, flattened and prorsiradiate on the flanks, across which they broaden progressively, and link to coarse inner ventrolateral clavi. A low broad prorsiradiate rib links these to somewhat weaker outer ventrolateral clavi that are in turn linked across the venter by a broad, ribbon-like transverse rib. Single intercalated ribs arise low on the flanks, and have a ventrolateral and venter development comparable to that of the primary ribs.

**Discussion**

Calycoceras (Newboldiceras) laticostatum is most closely allied to C. (N.) planeocostatum, from which the present material differs in the much more inflated whorl section, apparently late appearance and persistence of the inner ventrolateral tubercles, and the very coarse ribbing. Coarse ribbing characterizes Calycoceras (Proecalyoceras) picteti Wright & Kennedy, 1990 (p. 264, pl. 58, fig. 2; pl. 64, fig. 4; pl. 68, figs 1, 2; pl. 74, fig. 3; pl. 74, figs 2–6; text-figs 110d, g; 113, 114, 116a–d; 117; 119a–c), but here the ribs of the adult whorls are narrower, with wide interspaces, early loss of inner ventrolateral tubercles, and a flat venter (Wright & Kennedy 1990, text-fig. 113).

**Occurrence**

The present material is from the Middle Cenomanian (or lower Upper Cenomanian?) Mzinene Formation of the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289).

### Calycoceras (Newboldiceras) breistrofferi (Collignon, 1937)

Figs 58–60, 61C–E, 62

1937 Acanthoceras breistroffi Collignon, p. 38, pl. 6, fig. 4; pl. 9, fig. 2.

1964 Acanthoceras breistroffi Collignon; Collignon, p. 140, pl. 371, fig. 1616.

**Type**

The holotype, by monotypy, is the original of Acanthoceras breistroffi Collignon, 1937, pl. 6, fig. 4; pl. 9, fig. 2, from the Cenomanian of Ankomaka, Madagascar (Fig. 58).

**Material**

SAM-PCZ13445, 13450, 13453, 13457, 13461.

**Dimensions**

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<td>(48.2)</td>
<td>(40.7)</td>
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<td>(27.3)</td>
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**Description**

The holotype (Fig. 58) is an internal mould of a phragmocone 119 mm in diameter. Colling is very evolute, with 36% of the previous whorl covered; the relatively deep umbilicus comprises 31.9% of the diameter. The umbilical wall is flattened, the umbilical shoulder broadly rounded, the whorl section trapezoidal, the whorl breadth to height ratio 1.27, the greatest breadth close to the umbilical shoulder. The venter is broad, and very feebly convex. An estimated 18 primary ribs arise at the umbilical seam and strengthen across the umbilical wall, developing into sharp umbilical tubercles. Additional non-bullate primaries and short intercalated ribs give a total of an estimated 50 ribs per whorl at the ventrolateral shoulder. The ribs are strong, straight, sharp, and narrower than the interspaces. They broaden and strengthen across the flanks, project slightly forwards across the ventrolateral shoulders and cross the venter near
straight to feebly convex. There are indications of ventral- 
tubercles at the adapical end of the outer whorl, but these 
efface, and are replaced by a mere angulation in the rib 
profile.
SAM-PCZ13457 (Fig. 59) is a phragmocone 95 mm in 
diameter, with recrystallized shell preserved. Coiling is 
moderately evolute, the deep umbilicus comprising 26% of 
the diameter, with a feebly convex, outward-inclined wall 
and broadly rounded umbilical shoulder. The specimen has 
suffered postmortem crushing, and the original whorl section 
cannot be established. It appears to have been depressed, 
with feebly convex subparallel flanks, broadly rounded 
ventrolateral shoulders, and a broad, feebly convex venter. 
Parts of the penultimate whorl show primary ribs that arise 
at the umbilical seam, strengthen across the umbilical wall, 
and develop into strong spineous umbilical tubercles. There 
are 11 primary ribs on the adapical half of the outer whorl. 
They arise at the umbilical seam, and are strong and 
straight on the umbilical wall and shoulder, where they develop into 
prominent, sharp, subspinose umbilical tubercles, from 
which single narrow, strong, prosiradiale ribs arise and 
pass straight across the inner and middle flanks, flexing 
slightly forwards to become very feebly concave on the outer- 
most flank and ventrolateral shoulder. They are near 
straight to very feebly convex across the venter. Single ribs 
intercalate between successive primaries. They arise below 
mid-flank, and strengthen to match the primaries on the 
outer flanks, ventrolateral shoulders, and venter. The ven-
tral region of the adapical part of the outer whorl is 
damaged, but there are indications of small inner and outer 
ventrolateral and siphonal tubercles that are progressively 
lost, and are absent from the adapertural half of the outer 
whorl.
SAM-PCZ13453 (Fig. 60) is a half whorl of phragmocone 
with a maximum preserved diameter of 118 mm, and indica-
tions of the former presence of a further whorl. Coiling is 
moderately evolute on the outer whorl, the umbilicus deep, 
with broadly convex outward-inclined wall and broadly 
rounded umbilical shoulder. The whorl section is depressed, 
rounded-trapezoidal with feebly convex converging flanks, 
broadly rounded ventrolateral shoulders and a very broad, 
convex venter. Eight primary ribs arise at the umbilical 
seam, sweep back and strengthen across the umbilical wall, 
developing into a weak umbilical bulia, perched on the 
umbilical shoulder. The buliae give rise to single ribs at the 
adapical end of the fragment; the two adapertural buliae 
give rise to pairs of ribs. Long single ribs, arising below 
mid-flank, intercalate between the single primaries. The 
ribs strengthen progressively and are prosiradiale and very 
feebly flexuous across the flanks, flex forwards and broaden 
across the ventrolateral shoulders, and are low and feebly 
convex across the venter. There are no detectable tubercles 
on the ventrolateral shoulders and venter, or on the impres-
sion of the previous whorl preserved in the dorsal impressed 
zone of the outer whorl. By contrast, the dorsal impressed 
zone of the penultimate whorl records impressions of outer 
ventrolateral and siphonal tubercles at small diameters.
SAM-PCZ13461 (Fig. 61C–E) is a 120° sector of phragmo-
cone with a 180° sector of the penultimate whorl preserved to 
a maximum whorl height of 25.4 mm, with a whorl breadth 
to height ratio of 1.19. The coiling is moderately evolute, the 
umbilical wall high, with a feebly convex, outward-inclined 
wall. The flanks are feebly convex and subparallel, the 
ventrolateral shoulders broadly rounded, and the very broad 
venter feebly convex. There are eight primary ribs on the 
fragment. They arise at the umbilical seam, and strengthen 
across the umbilical wall and shoulder, where they develop into 
sharp bullae. These give rise to narrow straight primary 
ribs, separated by single shorter intercalated ribs, giving a 
total of 18 ribs on the outer flank of the penultimate whorl 
fragment. An examination of the fractured section gives no 
indication of ventrolateral or siphonal tubercles. The outer 
whorl of this fragment has a maximum preserved whorl 
height of 59.7 mm., with a whorl breadth to height ratio of 
1.17. Nine primary ribs arise at the umbilical seam and 
strengthen across the umbilical wall and shoulder, develop-
ing into a sharp umbilical bulla. The ribs become progres-
sively more widely spaced as size increases. The ribs are 
coarse, straight, and rectiradiate, and strengthen progres-
sively across the flanks, ventrolateral shoulders and venter. 
They cross the venter in a broad convexity at the adapical 
end of the fragment, and are near transverse at the 
adapertural end. Single intercalated ribs separate the 
primaries at the adapical end; all the ribs are primaries at the 
adapertural end. There are thus nine ribs at the umbilical 
shoulder and 12 at the ventrolateral shoulder of the frag-
ment.
SAM-PCZ13445 (Fig. 62A, B) is a 90° sector of phragmo-
cone with a maximum preserved whorl height of 55.8 mm, 
and a whorl breadth to height ratio of 1.20, bearing four 
widely separated primary ribs. It differs in no significant re-
pects from the preceding specimen.
SAM-PCZ13450 (Fig. 62C, D) is a large phragmocone frag-
ment with a maximum preserved whorl height of 64.2 mm., 
and whorl breadth to height ratio of 1.2, the whorl section 
depressed reniform. Four primary ribs are preserved on the 
fragment, and bear strong, sharp umbilical bullae. The ribs 
are straight and rectiradiate on the flanks, and strengthen 
progressively across flanks, ventrolateral shoulders and 
venter, where they are very widely separated, strong, and 
coarse.

The poorly exposed suture of SAM-PCZ13445 has a large, 
deeply incised bifid E/A, a narrow, bifid A, and a smaller U2.

Discussion
Calycoceras (N.) breistrofferi differs from other Newbidi-
ceras in the present collections in the early loss of all but the 
umbilical tuberculation, and the change from closely spaced 
to very widely separated ribbing at the largest preserved 
diameters. Large size and widely spaced ribbing at large 
diameters separate it from Calycoceras (Gentoniceras) species. 
The distinctive change in rib spacing is also seen in C. (N.) 
tunetanum (Pervinquière, 1907) (p. 268, pl. 13, fig. 4; Wright 
& Kennedy 1990, p. 251, pl. 69, fig. 2; text-figs 105, 106, 
107m, 110f; 1996, p. 401, pl. 124, fig. 1), but in that species 
the inner ventrolateral tubercles persists to maturity, and a 
size where they are lost in breistrofferi.
The Acanthoceras breistroffi of Collignon (1964, p. 140, 
pl. 371, fig. 1616) appears to have inner and outer 
ventrolateral tubercles to a diameter of over 90 mm. We are 
uncertain of its affinities.
Occurrence
Ankomaka, Madagascar, and the Middle Cenomanian (or lower Upper Cenomanian?) Mzinene Formation of the Skoonberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289).

Genus *Pseudocalycoceras* Thomel, 1969

Type species
*Ammonites harpax* Stoliczka, 1864, p. 72, pl. 39, fig. 1, 2, by the original designation of Thomel, 1969, p. 650.

Diagnosis
Whorl section slightly compressed to slightly depressed. Ribs flexuous to convex and rursiradiate, more or less regularly branching or alternately long and short, the primaries with umbilical bullae, characteristically twisted, and all ribs with inner ventrolateral nodate or clavate and outer ventrolateral and siphonal clavate tubercles. In some species one or two weak lateral tubercles may appear on primary ribs. Near the aperture the ribs narrow and approximate and the tubercles disappear (Wright & Kennedy 1981, p. 36).

Occurrence
Lower and middle Upper Cenomanian, England, France, Spain, Romania, Algeria, Tunisia, Israel, Lebanon, Angola, KwaZulu, Madagascar, south India, central and west Texas, New Mexico and the U.S. Western Interior.

*Pseudocalycoceras harpax* (Stoliczka, 1864)  
Fig. 63

1864 *Ammonites harpax* Stoliczka, p. 72 (pars), pl. 39, fig. 1 only.
1864 *Ammonites morpheus* Stoliczka, p. 80, pl. 38, fig. 1.
1897 *Acanthoceras harpax* (Stoliczka); Kossmat, p. 13 (120), pl. 4 (15).
non 1920 *Acanthoceras harpax* Taubenhaus, p. 16, figs 1, 2; pl. 5, fig. 6.
1931 *Acanthoceras harpax* (Stoliczka); Basse, p. 38, pl. 5, figs 17, 18.
1937 *Protacanthoceras harpax* Stol.; Collignon, p. 32, pl. 1, figs 1-4, pl. 8, figs 1, 2, including varieties ramaldaeni, ankomaekaseni, and tulearensis.
1962 *Calyoceras harpax* (Stol.); Avmenech & Shoresh, p. 332.
1964 *Protacanthoceras harpax* Stol.; Collignon, p. 145, pl. 373, fig. 1620.
1964 *Protacanthoceras harpax* Stol. var. ankomaekaseni Coll.; Collignon, p. 145, pl. 373, fig. 1621.
1964 *Protacanthoceras harpax* Stol. var. talinorensis Coll.; Collignon, p. 145, pl. 373, fig. 1622.
non 1966 *Eucalyoceras harpax* (Stol.) var. lattensis Thomel, p. 429, pl. 10, figs 1, 2 (= *Thomellites somayi* (Thomel, 1966)).
1966 *Eucalyoceras harpax* (Stol.) var. tulearensis (Coll.); Thomel, p. 429, pl. 9, figs 1-3 (= *Thomellites somayi* (Thomel, 1966)).
1972 *Pseudocalycoceras* (Pseudocalycoceras) *harpax* (Stoliczka); Thomel, p. 88.

non 1972 *Pseudocalycoceras* (Pseudocalycoceras) *harpax tulearensis* (Collignon); Thomel, p. 89 (= *Thomellites somayi* (Thomel, 1966)).
non 1972 *Pseudocalycoceras* (Pseudocalycoceras) *harpax lattense* (Thomel); Thomel, p. 89, pl. 32, figs 1, 2 (= *Thomellites somayi* (Thomel, 1966)).
non 1972 *Pseudocalycoceras* (Pseudocalycoceras) *harpax moustieriensis* Thomel, p. 90, pl. 31, figs 4, 5 (= *Thomellites somayi* (Thomel, 1966)).
non 1972 *Pseudocalycoceras* (Pseudocalycoceras) *morpheus* (Stol.); Thomel, p. 91, pl. 32, figs 3, 4.
1972 *Pseudocalycoceras* (Pseudocalycoceras) *harpax tulinorensis* (Collignon); Thomel, p. 90, pl. 29, fig. 3.
1975 *Pseudocalycoceras harpax* (Stoliczka); Matsumoto, in Matsumoto & Kawano, p. 8, text-fig. 1.
1975 *Pseudocalycoceras morpheus* (Stoliczka); Matsumoto in Matsumoto & Kawano, p. 10, text-fig. 2.
1981 *Pseudocalycoceras harpax* (Stoliczka); Wright & Kennedy, p. 36, text-fig. 14a, b.
1996 *Pseudocalycoceras harpax* (Stoliczka); Wright, p. 164, text-fig. 123, 5.

Name of the species
We regard *Ammonites morpheus* Stoliczka, 1864 (p. 80, pl. 38, fig. 1), as a pathological individual, and a variant of *harpax*, as first revising authors we select the name *harpax* for the species.

Type
The lectotype, by the subsequent designation of Matsumoto in Matsumoto & Kawano, 1975, p. 8, is no. 169 in the collections of the Geological Survey of India, a cast of which was figured by Wright & Kennedy, 1981, text-fig. 14a, b.

Material
SAM-PCZ22194 (SAM A640).

Description
The specimen (Fig. 63) is an internal mould of a 180° sector of body chamber with a maximum preserved diameter of 55.8 mm. Colling is moderately evolute, the shallow umbilicus comprising an estimated 30% of the diameter. The umbilical wall is flattened and subvertical, the umbilical shoulder narrowly rounded. The whorl section is compressed, with a costal whorl breadth to height ratio of 0.8, the greatest breadth at the umbilical bullae. The inner to middle flanks are flattened and subparallel, the outer flanks converging to the broadly rounded ventrolateral shoulders and feebly convex venter. There are eight primary ribs on the fragment. They arise at the umbilical seam, and are well developed on the umbilical wall and shoulder, where they develop into a prominent prorsiradiate umbilical bulla. These give rise to a single rib, with one or two longer short ribs intercalated between successive primaries to give a total of 18 ribs on the fragment. The ribs are prorsiradiate on the inner flank, flex back and are convex on the middle to outer flank, linking to rounded inner ventrolateral tubercles. A broadening rib sweeps forwards over the ventrolateral shoulder and passes straight across the venter and links to well-developed equal outer ventrolateral and siphonal clavate tubercles. This gives rise to a single rib, with one or two longer short ribs intercalated between successive primaries to give a total of 18 ribs on the fragment. The ribs are prorsiradiate on the inner flank, flex back and are convex on the middle to outer flank, linking to rounded inner ventrolateral tubercles. A broadening rib sweeps forwards over the ventrolateral shoulder and passes straight across the venter and links to well-developed equal outer ventrolateral and siphonal clavate tubercles.
Discussion

The fragment compares well with material from south India of comparable size that we have studied. The species most closely resembles *Pseudocalycoceras angolaense* (Spath, 1931) (p. 316) (see revisions in Kennedy, 1988, p. 42, pl. 4, figs 1, 2, 6–9; pl. 5, figs 1–12; pl. 8, figs 7, 8; pl. 22, figs 8, 9; text figs 10h, 11b, e, and Cobban, Hook & Kennedy, 1989, p. 29, figs 29, 73a–o, 74a–g). In their discussion of differences of *Pseudocalycoceras* dentonense (Moreman, 1942) (here regarded as a synonym of *angolaense*), Wright & Kennedy (1981, p. 38) noted the more narrowly arched ventral ribs. *Pseudocalycoceras* alaouitense (Basse, 1940) (p. 419, pl. 8, figs 1, 4, 5) and *paraalauitense* (Basse, 1940) (p. 449, pl. 7, fig 4; pl. 8, fig 2; pl. 9, fig 3) have as few as 12–16 strongly convex quasiradiate, predominantly primary ribs on what appear to be an adult microconch (Basse 1940, pl. 8, fig. 3) and macroconch (Basse 1940, pl. 8, fig. 6) body chamber.

Occurrence

Where well dated, the species is lower Upper Cenomanian. The geographic distribution is southeast France, Morocco, south India, KwaZulu, and Madagascar. The present specimen is from the Middle Cenomanian (or lower Upper Cenomanian)? Mznene Formation of the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289).

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REFERENCES


Fig. 1. A–C, Acanthoceras comigerum Crick, 1907. The holotype, BMNH C18230, the original of Crick, 1907, pl. 13, fig. 1. D–I, Acanthoceras flexuosum Crick, 1907; D–F, BMNH C18175, the holotype of Acanthoceras crassiornatum Crick, 1907, p. 185; G–I, BMNH C18174, the holotype of Acanthoceras flexuosum Crick, 1907, pl. 12, fig. 1. All specimens are from the ‘deposit at the north end of False Bay’ of Crick (1907, p. 164), that is to say the Middle Cenomanian Mzinene Formation of the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289). All figures are ×0.90.
Fig. 2. A–J, Acanthoceras flexuosum Crick, 1907. A–C, BMNH C18189, the lectotype of Acanthoceras robustum Crick, 1907, p. 189; D–F, BMNH C18182, the lectotype of Acanthoceras munitum Crick, 1907, p. 187; G–I, BMMH C18187, the holotype of Acanthoceras expansum Crick, 1907, p. 188; J, BMNH C18188, a paralectotype of Acanthoceras robustum Crick, 1907. All specimens are from the ‘deposit at the north end of False Bay’ of Crick (1907, p. 164), that is to say the Middle Cenomanian Mzinene Formation of the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289). All figures are ×0.90.
Fig. 3. BMNH C18188, a paralectotype of Acanthoceras robustum Crick, 1907, from the ‘deposit at the north end of False Bay’ of Crick (1907, p. 164), that is to say the Middle Cenomanian Mzinene Formation of the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289). Figures are ×1.
Fig. 4. Acanthoceras flexuosum Crick, 1907. BMNH C18194, the lectotype of Acanthoceras quadratum Crick, 1907, the original of Crick, 1907, pl. 13, fig. 2, from the ‘deposit at the north end of False Bay’ of Crick (1907, p. 164), that is to say the Middle Cenomanian Mzinene Formation of the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289). Figures are ×0.95.
Fig. 5. Acanthoceras flexuosum Crick, 1907, BMNH C18197, the holotype of Acanthoceras latum Crick, 1907, the original of Crick, 1907, pl. 12, fig. 2, from the ‘deposit at the north end of False Bay’ of Crick (1907, p. 164), that is to say the Middle Cenomanian Mzinene Formation of the Skoëenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289). Figures are ×0.95.
Fig. 6. *Acanthoceras flexuosum* Crick, 1907. BMNH C18193, the original of *Acanthoceras* sp. of Crick, 107, p. 191, from the ‘deposit at the north end of False Bay’ of Crick (1907, p. 164), that is to say the Middle Cenomanian Mzinene Formation of the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289). Figures are ×1.
Fig. 10. A–L. Acanthoceras flexuosum Crick, 1907. A–C, SAM-PCZ13526; D, E, SAM-PCZ13522; F, G, SAM-PCZ4435; H, I, SAM-PCZ13497; J–L, SAM-PCZ13521, from the Middle Cenomanian Mzinene Formation of the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289). Figures are ×0.90.
Fig. 11. A–U, Acanthoceras flexuosum Crick, 1907. A–C, BMNH C18199, the original of Acanthoceras latum Crick, 1907, p. 196 (‘The young of this species’); D–F, BMNH C18196, the original of Acanthoceras hippocastanum Crick, 1907, p. 194, pl. 13, fig. 4; G–I, BMNH C18176, the original of one of the specimens referred to by Crick (1907, p. 186) as possibly referable to Acanthoceras crassiornatum Crick, 1907; J–L, BMNH C18184, the original of specimen c of Acanthoceras munitum of Crick, 1907, p. 187; M–O, BMNH C18198, the original of specimen b of Acanthoceras latum of Crick, 1907, p. 196; P–R, BMNH C18185, the original of specimen d of Acanthoceras munitum of Crick, 1907, p. 187; S–U, SAM-PCZ13494, from the Middle Cenomanian Mzinene Formation of the Skoenberg, KwaZulu, locality 62 of Kennedy and Klinger (1975, p. 289). Figures are ×0.85.
Fig. 12. Acanthoceras flexuosum Crick, 1907. SAM-PCZ13530, from the Middle Cenomanian Mzinene Formation of the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289). Figures are ×0.95.

Fig. 13. Acanthoceras flexuosum Crick, 1907. SAM-PCZ13492, from the Middle Cenomanian Mzinene Formation of the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289). Figures are ×0.95.
Fig. 14. Acanthoceras flexuosum Crick, 1907. SAM-PCZ13528, from the Middle Cenomanian Mzinene Formation of the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289). Figures are ×1.
Fig. 15. *Acanthoceras flexuosum* Crick, 1907. SAM-PCZ13523, from the Middle Cenomanian Mzinene Formation of the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289). Figures are ×0.95.
Fig. 16. *Acanthoceras flesusum* Crick, 1907. SAM-PCZ13512, from the Middle Cenomanian Mzinene Formation of the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289). Figure is ×1.
Fig. 17. Acanthoceras flexuosum Crick, 1907. SAM-PCZ13512, from the Middle Cenomanian Mzinene Formation of the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289). Figures are ×1.
Fig. 18. Acanthoceras flexuosum Crick, 1907, SAM-PCZ13517, from the Middle Cenomanian Mzinene Formation of the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289). Figure is ×1.
Fig. 19. Acanthoceras flexuosum Crick, 1907. SAM-PCZ13517, from the Middle Cenomanian Mzinene Formation of the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289). Figures are ×1.
Fig. 20. *Acanthoceras flexuosum* Crick, 1907. SAM-PCZ13513, from the Middle Cenomanian Mzinene Formation of the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289). Figures are ×0.95.
Fig. 21. Acanthoceras flexuosum Crick, 1907. SAM-PCZ13518, from the Middle Cenomanian Mzinene Formation of the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289). Figure is ×1.
Fig. 22. Acanthoceras flexuosum Crick, 1907, SAM-PCZ13518, from the Middle Cenomanian Mzinene Formation of the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289). Figures are ×1.
Fig. 23. *Acanthoceras flexuosum* Crick, 1907. OUM KX1750, from the Middle Cenomanian Mzinene Formation of the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289). Figure is ×0.8.
Fig. 24. Acanthoceras flexuosum Crick, 1907. OUM KX1750, from the Middle Cenomanian Mzinene Formation of the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289). Figure is ×0.8.
**Fig. 25.** A–D. *Acanthoceras flexuosum* Crick, 1907. Copies of Venzo, 1936. A, B, ‘*Acanthoceras flexuosum*’, pl. 7 (3), fig. 6; C, D, ‘*Acanthoceras hippocastanum*’ pl. 7 (3), fig. 2; the original specimens were from the Middle Cenomanian Mzinene Formation of the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289). Figures are ×1.

**Fig. 26.** A–N. *Protacanthoceras waterloti* (Venzo, 1936). A–C, I–L, SAM-PCZ22193; D–F, M, N, SAM-PCZ22192; G, H, the holotype, copy of Venzo, 1936, pl. 7 (3), fig. 11; from the Middle (or lower Upper?) Cenomanian Mzinene Formation of the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289). Figs A–H are ×1; I–N are ×2.
Fig. 27. A–D. Cunningtoniceras? sp. a, OUM KX4312. E, F. Cunningtoniceras? sp. b, OUM KX4574, from the Middle (or lower Upper?) Cenomanian Mzinene Formation of the Skoengberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289). Figures are ×1.
Fig. 28. A–E. Cunningtoniceras? sp. a. A, B, OUM KX4631; C, D, OUM KX4630; E, OUM KX1744, from the Middle (or lower Upper?) Cenomanian Mzinene Formation of the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289). Figures are ×1.
Fig. 29. Cunningtoniceras? sp. a. SAM-PCZ13516, from the Middle (or lower Upper?) Cenomanian Mzinene Formation of the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289). Figures are ×1.
Fig. 30. Cunningtoniceras? sp. BMNH C18273, the original of Acanthoceras sp. of Crick, 1907, p. 241, and said to be from ‘the south branch of the Manuan Creek’; preservation suggests the specimen to be from the Middle (or lower Upper?) Cenomanian Mzinene Formation of the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289). Figures are ×0.95.

Fig. 31. Calycoceras (Gentoniceras) gentoni (Brongniart, 1822). BMNH C18214, the holotype of Acanthoceras paucinodatum Crick, 1907, pl. 13, fig. 3, from the ‘deposit at the north end of False Bay’ of Crick (1907, p. 164), that is to say the Middle (or lower Upper?) Cenomanian Mzinene Formation of the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289). All figures are ×1.
Fig. 32. A–Y. Calycoceras (Newboldiceras) asiaticum asiaticum (Jimbo, 1894). A, B, J–L, SAM-PCZ13472; C–E, SAM-PCZ13473; F–I, SAM-PCZ13460; M–O, SAM-PCZ13433; P–R, SAM-PCZ13428; S–U, SAM-PCZ13468; V, W, SAM-PCZ13468; X, Y, SAM-PCZ13486, from the Middle (or lower Upper?) Cenomanian Mzinene Formation of the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289). Figs A–C, H, I, M–Y are ×0.90; D–G, J–L are ×1.8.
Fig. 34. A–C, Acanthoceras flexuosum Crick, 1907, BMNH 18199, the original of Acanthoceras latum Crick, 1907 (‘young’, p. 196). D, G–I, Calycoceras (Newboldiceras) planeocostatum (Kossmat, 1897), BMNH C18225, original of specimen k of Acanthoceras choffati of Crick, 1907, p. 206. J–L, Calycoceras (Newboldiceras) asiaticum asiaticum (Kossmat, 1897), original of specimen b of Acanthoceras nitidum Crick, 1907, p. 201–2. E, M–O, Calycoceras (Newboldiceras) asiaticum spinosum (Kossmat, 1897), original of specimen c of Acanthoceras newboldi var. spinosum of Crick, 1907, p. 200. F, P, Q, Calycoceras (Newboldiceras) asiaticum asiaticum (Kossmat, 1897), original of specimen c of Acanthoceras newboldi, typical form, of Crick, 1907, p. 198, from the ‘deposit at the north end of False Bay’ of Crick (1907, p. 164), that is to say the Middle (or lower Upper?) Cenomanian Mzinene Formation of the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289). Figs A–C, G–Q are ×2; D–F are ×1.
Fig. 35. A–J, M–O, R, S. *Calycoceras* (Newboldiceras) *asiaticum spinosum* (Kossmat, 1897). A–C, SAM-PCZ13464; D, E, SAM-PCZ13463; F–H, SAM-PCZ13446; I, J, SAM-PCZ13448; M–O, SAM-PCZ13459; R, S, OUM KX4592. K, L, P, Q, *Calycoceras* (Newboldiceras) *planecostatum* (Kossmat, 1897). K, L, SAM-PCZ13432; P, Q, SAM-PCZ13482, from the Middle (or lower Upper?) Cenomanian Mzinene Formation of the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289). All figures are ×0.90.
Fig. 36. A–F. Calycoceras (Newboldiceras) asiaticum asiaticum (Jimbo, 1894). A–C, SAM-PCZ13476; D–F, SAM-PCZ13437, from the Middle (or lower Upper?) Cenomanian Mzinene Formation of the Skoeneberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289). All figures are ×1.
Fig. 37. Calycoceras (Newboldiceras) asiaticum asiaticum (Jimbo, 1894). SAM-PCZ13455, from the Middle (or lower Upper?) Cenomanian Mzinene Formation of the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289). Figures are ×0.95.
Fig. 38. Calycoceras (Newboldiceras) asiaticum asiaticum (Jimbo, 1894). Cast of the holotype, the original of Jimbo, 1894, pl. 20, fig. 1, no. 1–105 in the collections of the Geological Institute, Tokyo University, from the Middle Cenomanian Trigonia Sandstone of the Ikushumbets, Hokkaido, Japan. Figures are ×0.95.
Fig. 39. A–D, Calycoceras (Newboldiceras) asiaticum spinosum (Kossmat, 1897). A, B, SAM-PCZ13456; C, D, SAM-D1005, from the Middle Cenomanian (or lower Upper?) Mzinene Formation of the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289). Figures are ×0.90.
Fig. 40. Calycoceras (Newboldiceras) asiaticum spinosum (Kossmat, 1897), SAM-PCZ13451, from the Middle (or lower Upper?) Cenomanian Mzinene Formation of the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289). Figures are ×1.
Fig. 41. Calycoceras (Newboldiceras) asiaticum spinosum (Kossmat, 1897). SAM-PCZ13462, from the Middle (or lower Upper?) Cenomanian Mzinene Formation of the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289). Figures are ×0.95.
Fig. 42. Calycoceras (Newbolidiceras) asiaticum spinosum (Kossmat, 1897), SAM-PCZ13469, from the Middle (or lower Upper?) Cenomanian Mzinene Formation of the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289). Figures are ×0.95.
Fig. 43. *Calycoceras* (*Newboldiceras*) *asiaticum spinosum* (Kossmat, 1897). OUM KX4623, from the Middle (or lower Upper?) Cenomanian Mzinene Formation of the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289). Figures are ×0.80.

Fig. 44. A–H, copies of acanthoceratines from the Skoenberg figured by Venzo (1936). A–C, *Calycoceras* sp. juv., the holotype of *Acanthoceras gortani* Venzo, 1936, p. 82 (24), copy of pl. 7 (3), fig. 5. D, E, H, *Calycoceras* (*Newboldiceras*) *asiaticum asiaticum* (Jimbo, 1894), the *Acanthoceras newboldi var spinosa* of Venzo, 1936, p. 82 (24), pl. 7 (3), figs 3, 4. F, G, *Calycoceras* (*Newboldiceras*) *planeicostatum* (Kossmat, 1897), the *Acanthoceras choffati* of Venzo, 1936, p. 83 (25), pl. 7 (3), fig. 8. All figures are ×1.
Fig. 45. *Calycoceras* (*Newboldiceras*) *cf.* *asiaticum hunteri* (Kossmat, 1897), SAM-PCZ13448, from the Middle (or lower Upper?) Cenomanian Mzinene Formation of the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289). Figures are ×1.
Fig. 46. A–P. Calycoceras (Newboldiceras) planecostatum (Kossmat, 1897). Specimens described as Acanthoceras choffati Kossmat by Crick, 1907, p. 205, pl. 12, fig. 5, and assigned letters on p. 206. A–C, BMNH C18223, specimen i; D, E, F, BMNH C18228, specimen n; F–H, BMNH C18219, specimen o; J–L, BMNH C18218, specimen d; M, P, BMNH C18216, specimen b, the original of Crick, 1907, pl. 12, fig. 5; N, O, BMNH C18220, specimen f, all from the ‘deposit at the north end of False Bay’ of Crick (1907, p. 164), that is to say the Middle (or lower Upper?) Cenomanian Mzinene Formation of the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289). All figures are ×0.85.
Fig. 47. A–M. Calycoceras (Newboldiceras) planecostatum (Kossmat, 1897). A–C, SAM-PCZ13454; D, E, SAM-PCZ13434; F, G, SAM-PCZ13448; H–J, SAM-PCZ13435; K–M, SAM-PCZ13481, from the Middle (or lower Upper?) Cenomanian Mzinene Formation of the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289). Figs A, D–M are ×0.90; Figs B, C are ×1.8.
Fig. 48. A–H. Calycoceras (Newboldiceras) planecostatum (Kossmat, 1897). A–C, SAM-PCZ13440; D, E, SAM-PCZ13452; F–H, SAM-PCZ13439, from the Middle (or lower Upper?) Cenomanian Mzinene Formation of the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289). Figures are ×1.
Fig. 49. A–I. Calycoceras (Newboldiceras) planecostatum (Kossmat, 1897). A, B, SAM-PCZ13483; C–E, SAM-PCZ13430; F, G, SAM-PCZ13456; H, I, SAM-PCZ13442 from the Middle (or lower Upper?) Cenomanian Mzinene Formation of the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289). Figures are ×0.90.
Fig. 50. A, B, Calycoceras (Newboldiceras) asiaticum asiaticum (Kossmat, 1897), SAM-PCZ13431. C–J, Calycoceras (Newboldiceras) planecostatum (Kossmat, 1897). C, D, SAM-PCZ13467, E–G, SAM-PCZ13488; H–J, SAM-PCZ13480, from the Middle (or lower Upper?) Cenomanian Mzinene Formation of the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289). Figures are ×0.90.
Fig. 51. *Calycoceras* (Newboldiceras) *planecostatum* (Kossmat, 1897). SAM-PCZ13475, from the Middle (or lower Upper?) Cenomanian Mzinene Formation of the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289). Figures are ×1.

Fig. 52. *Calycoceras* (Newboldiceras) *planecostatum* (Kossmat, 1897). SAM-PCZ13443, from the Middle (or lower Upper?) Cenomanian Mzinene Formation of the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289). Figures are ×1.
Fig. 53. Calycoceras (Newboldiceras) planecostatum (Kossmat, 1897). SAM-PCZ13465, from the Middle (or lower Upper?) Cenomanian Mzinene Formation of the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289). Figures are ×1.
Fig. 54. Cast of the lectotype of *Calycoceras* (Newboldiceras) *planecostatum* (Kossmat, 1897), the original of Kossmat, 1897, pl. 2 (13), fig. 1, from the Utatur Group of Odium, south India. Geological Survey of India Collections no. 14842. Figures are ×1.

Fig. 55. Cast of the holotype of *Acanthoceras choffati* Kossmat, 1897, pl. 15 (4), fig. 1, from the Utatur Group of Odium, south India. Geological Survey of India Collections no. 14844. Figures are ×1.
Fig. 56. A–K, Calycoceras (Newboldiceras) planecostatum (Kossmat, 1897). Specimens described as Acanthoceras choffati Kossmat by Crick, 1907, p. 205, pl. 12, fig. 5, and assigned letters on p. 206; A, I, J, K, BMNH C18224, specimen j; B, C, E, BMNH C18227, specimen m; D, F, G, H, BMNH C18226, specimen l, M. Calycoceras (Newboldiceras) laticostatum (Crick, 1907), the holotype, BMNH C18210, all from the ‘deposit at the north end of False Bay’ of Crick (1907, p. 164), that is to say the Middle (or lower Upper?) Cenomanian Mzinene Formation of the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289). Figs A, D, E, L, M are ×0.95; Figs B, C, F–K are ×1.9.
Fig. 57. A–C, I. Calycoceras (Newboldiceras) asiaticum asiaticum (Jimbo, 1894). A–C, BMNH C18201, the original of Acanthoceras newboldi typical form, specimen b, of Crick, 1907, p. 198; I, BMNH C18204, original of Acanthoceras newboldi var. spinosa specimen a of Crick, 1907, p. 206, pl. 12, fig. 3. D–F, Calycoceras (Newboldiceras) asiaticum spinosum (Kossmat, 1897). BMNH C18205, original of Acanthoceras newboldi var. spinosa specimen b of Crick, 1907, p. 200. H. Calycoceras (Newboldiceras) planecostatum (Kossmat, 1897), the original of Acanthoceras choffati specimen g of Crick, 1907, p. 206. G, J, K. Calycoceras (Newboldiceras) laticostatum (Crick, 1897), an unregistered specimen in the M.R. Cooper Collection, housed in the Department of Geology and Applied Geology of the University of KwaZulu-Natal. All specimens are from the Middle (or lower Upper?) Cenomanian Mzinene Formation of the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289); the originals of A–I were originally described as being from the ‘deposit at the north end of False Bay’ of Crick (1907, p. 164). All figures are ×0.90.
Fig. 58. Calycoceras (Newboldiceras) breistrofferi (Collignon, 1937), the holotype, the original of Acanthoceras breistrofferi Collignon, 1937, p. 38, pl. 6, fig. 4; pl. 9, fig. 2, from the Cenomanian of Ankomaka, Madagascar, an unregistered specimen currently in the reserve collections of the Université de Bourgogne, Dijon. Figures are ×1.
Fig. 59. *Calycoceras (Newboldiceras) breistrofferi* (Collignon, 1937), SAM-PCZ13457, from the Middle (or lower Upper?) Cenomanian Mzinene Formation of the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289). Figures are ×0.95.

Fig. 60. *Calycoceras (Newboldiceras) breistrofferi* (Collignon, 1937), SAM-PCZ13453, from the Middle (or lower Upper?) Cenomanian Mzinene Formation of the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289). Figures are ×0.95.
Fig. 61. A, B. Calycoceras (Newboldiceras) asiaticum asiaticum (Kossmat, 1897), SAM-PCZ13438. C–E. Calycoceras (Newboldiceras) breistrofferi (Collignon, 1937), SAM-PCZ13461, all from the Middle (or lower Upper?) Cenomanian Mzinene Formation of the Skoeborg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289). Figures are ×0.95.
Fig. 62. A–D, Calycoceras (Newboldiceras) breistrofferi (Callignon, 1937). A, B, SAM-PCZ13445; C, D, SAM-PCZ13450, both from the Middle (or lower Upper?) Cenomanian Mzinene Formation of the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289). Figures are ×0.90.
Fig. 63. Pseudocalycoceras harpax (Stoliczka, 1864), SAM-PCZ22194 (SAM-A640), from the Middle (or lower Upper?) Cenomanian Mzinene Formation of the Skoenberg, KwaZulu, locality 62 of Kennedy & Klinger (1975, p. 289). Figures are ×1.