

# Cretaceous faunas from Zululand and Natal, South Africa.

## The ammonite family Forbesiceratidae Wright, 1952

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Members of the cosmopolitan Cenomanian ammonite family Forbesiceratidae were already recorded from KwaZulu by G.C. Crick in 1907. Since that time, six additional specimens have been found. The species present are: *F. largilliertianum* (d'Orbigny, 1841), *F. beaumontianum* (d'Orbigny, 1841), *F. chevillei* (Pictet & Renevier, 1866) (of which *F. sculptum* Crick, 1907, and *F. nodosum* Crick, 1907, are synonyms); *F. cf. subobtectum* (Stoliczka, 1864), and *Forbesiceras* sp. An annotated list of described species of *Forbesiceras* is provided, as are figures of key species from Madagascar, including the type material of *Neopulchellia* Collignon, 1929, a subjective synonym of *Forbesiceras*.

**Key words:** ammonites, Forbesiceratidae, Cretaceous, KwaZulu-Natal, South Africa.

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### INTRODUCTION

The ammonite family Forbesiceratidae Wright, 1952, comprises but a single genus, *Forbesiceras* Kossmat, 1897. Its members are among the most distinctive normally coiled Late Cretaceous ammonites, characterized by their extremely involute coiling, highly compressed whorl section, narrow, tabulate venter, delicate, low relief ornament, and suture line, in which saddle E/A is subdivided by a large adventive lobe. The genus is restricted to the Cenomanian Stage, and species are widespread, if minor, elements of Cenomanian ammonite faunas. Many species are based on only a few specimens. In spite of this, several species have wide geographic, and narrow stratigraphic distributions, making them valuable stratigraphic indicators. Species of *Forbesiceras* were among the first ammonites to be described from KwaZulu-Natal. In 1907, G.C. Crick recognized three species from 'the deposit at the north end of False Bay', in material collected by W. Anderson, the one-man Geological Survey of Natal and Zululand. Crick mentioned four specimens, of which he described three, referred to three species: *Forbesiceras largilliertianum* (d'Orbigny, 1841), *Forbesiceras*

*sculptum* Crick, 1907, and *Forbesiceras nodosum* Crick, 1907. Subsequent work has confirmed the first identification; the latter two are junior subjective synonyms of *Forbesiceras chevillei* (Pictet & Renevier, 1866). The fourth specimen noted by Crick is specifically indeterminate. To this material we add six more specimens. One from the same locality as Anderson's material is referred to *F. chevillei*, two to *F. cf. subobtectum* (Stoliczka, 1864), and one to *Forbesiceras* sp. Two specimens from Ndumu in northern Zululand are referred to *Forbesiceras beaumontianum* (d'Orbigny, 1841), a species originally described from the Lower Cenomanian of Sarthe in northern France.

### REPOSITORIES OF SPECIMENS

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

BMNH: The Natural History Museum, London.

LPMP: Laboratoire de Paléontologie, Muséum National d'Histoire Naturelle, Paris.

OUM: Oxford University Museum of Natural History.

SAM: Natural History Collections Department, Iziko South African Museum, Cape Town.

UBGD: UFR Sciences de la Terre, Université de Bourgogne, Dijon (Collignon Collection).

### FIELD LOCALITIES

Details of field localities are given by Kennedy & Klinger (1975); further descriptions of these localities are deposited in the Geological Collections, Oxford University Museum of Natural History, The Natural History Museum, London, and the 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 parentheses 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.

Family **FORBESICERATIDAE** Wright, 1952

Genus *Forbesiceras* Kossmat, 1897

(*pro Discoceras* Kossmat, 1895, p.179, *non* Barrande, 1867, p. 177); *Cenomanites* Haug, 1898, p. 78; *Neopulchellia* Collignon, 1929, p. 5 (29)).

Type species

*Ammonites largilliertianus* d'Orbigny, 1841, p. 320, pl. 95; by the subsequent designation of Diener, 1925, p. 180.

Diagnosis

Very compressed, planulate, with tiny, shallow umbilicus, whorls high, very compressed, with narrow venter. Ornament variable, and may change dramatically through ontogeny. Ribs may be delicate, wiry, straight to feebly flexuous, and may increase by branching and intercalation; in other species they are broad and flat on the outer flank with steep, narrow adapertural, and broad, low adapical face; in still others the ribs are falcooid, straight on the inner to mid-flank, and concave on the outer flank, or may flex back and be strongly rursiradiate, straight, concave, or convex on the outer flank. The point of change in rib direction may be marked by a small rounded or radially elongated tubercle, or not. Ventrolateral clavi present or not, perched on sharp ventrolateral shoulders, that may be notched. Venter crossed by ribs equal in number to, or more numerous than the ventrolateral clavi, concave, flat or feebly fastigiate, with mid-ventral ridge or ventral ridges in some species. Ornament may be effaced or lost entirely at maturity. Suture deeply incised, with long, narrow lobes and saddles, tending to develop phylloid elements. Saddle E/A divided by a large adventive lobe.

Discussion

The lengthy diagnosis given above emphasizes the wide diversity of ornament shown by species of *Forbesiceras*, ornament that may change markedly between successive ontogenetic stages. The variable ornament is developed on

shells with a distinctive shape that differs only slightly between species. This, together with the distinctive suture, link what is perhaps the most ornamentally diverse group of species referred to a single genus of Late Cretaceous ammonites.

*Forbesiceras* was introduced by Kossmat (1897, p. 18 (125)) as a replacement name for *Discoceras* Kossmat 1895 (p. 179 (83)), preoccupied by *Discoceras* Barrande, 1867 (p. 177). *Cenomanites* Haug, 1898 (p. 78) is an objective synonym. *Neopulchellia* Collignon, 1929 (p. 5 (29)), type species *Pulchellia* (*Neopulchellia*) *gignouxii* Collignon, 1929 (p. 6 (30), pl. 3 (4), figs 18–20), by the subsequent designation of Wright (1996, p. 152) was introduced for two species, based on limonitic nuclei, from the Lower Cenomanian of Madagascar. The distinctive feature of the genus according to Collignon was the 'développement considérable que prend le lobule médiane de la première selle latérale'—exactly the same feature that is distinctive in the suture line of *Forbesiceras*. Casey (1965, p. 461) pointed out that *Neopulchellia* was a 'forbesiceratid' nucleus, and this view has been followed by subsequent authors. The type material of '*Neopulchellia*' *gignouxii* Collignon, 1929 (p. 6 (30), pl. 3 (4), figs 18–20) and '*N.*' *douvillei* Collignon, 1929 (p. 29, p. 5 (29), pl. 3 (4), fig. 17) together with specimens referred to these species by Collignon in 1964 (p. 20, pl. 321, figs 1410–1411) are illustrated here as Fig. 1A–K,O–S, together with a *Forbesiceras* nucleus (Fig. 1P,Q) identified as such by Collignon (1929, pl. 18(4), fig. 19) for comparison.

The following species are referred to the genus:

*Forbesiceras almerae* (Mallada, 1891), pl. 9, figs 1, 2; junior synonym of *F. chevillei*.

*Forbesiceras baylissi* Wright & Kennedy, 1984, p. 92, pl. 13, figs 4, 5.

*Forbesiceras beaumontianum* (d'Orbigny, 1841), p. 328, pl. 98, figs 1, 2; Wright & Kennedy, 1984, p. 91, pl. 12, figs 7, 8; pl. 13, fig. 1; text-figs 15a–c, 16a–f.

*Forbesiceras bicarinatum* Szász, 1976, p. 170, pl. 1; pl. 2; pl. 3, figs 1, 2; text-figs 1, 2; Wright & Kennedy, 1984, p. 96, pl. 14, figs 3–6; pl. 15, fig. 3; pl. 16, figs 1, 3, 4; text-figs 11f, 1–n.

*Forbesiceras brundrettei* (Young, 1958), p. 292, pl. 39, figs 1–3, 26–28, 33, 35–38; pl. 40, figs 6, 8, 11; Kennedy & Cobban, 1990, p. 91, pl. 1, figs 15, 16, 20, 23, 24; Kennedy & Cobban, 1993, p. 331, figs 3a–b, e–g, 1–1, n; 4a–g.

*Forbesiceras chevillei* (Pictet & Renevier, 1866), p. 102, pl. 4, fig. 2; Wright & Kennedy, 1984, p. 93, pl. 13, fig. 2; pl. 15, figs 1, 2; text-fig. 17.

*Forbesiceras clarki* Collignon, 1964, p. 64, pl. 336, fig. 1503.

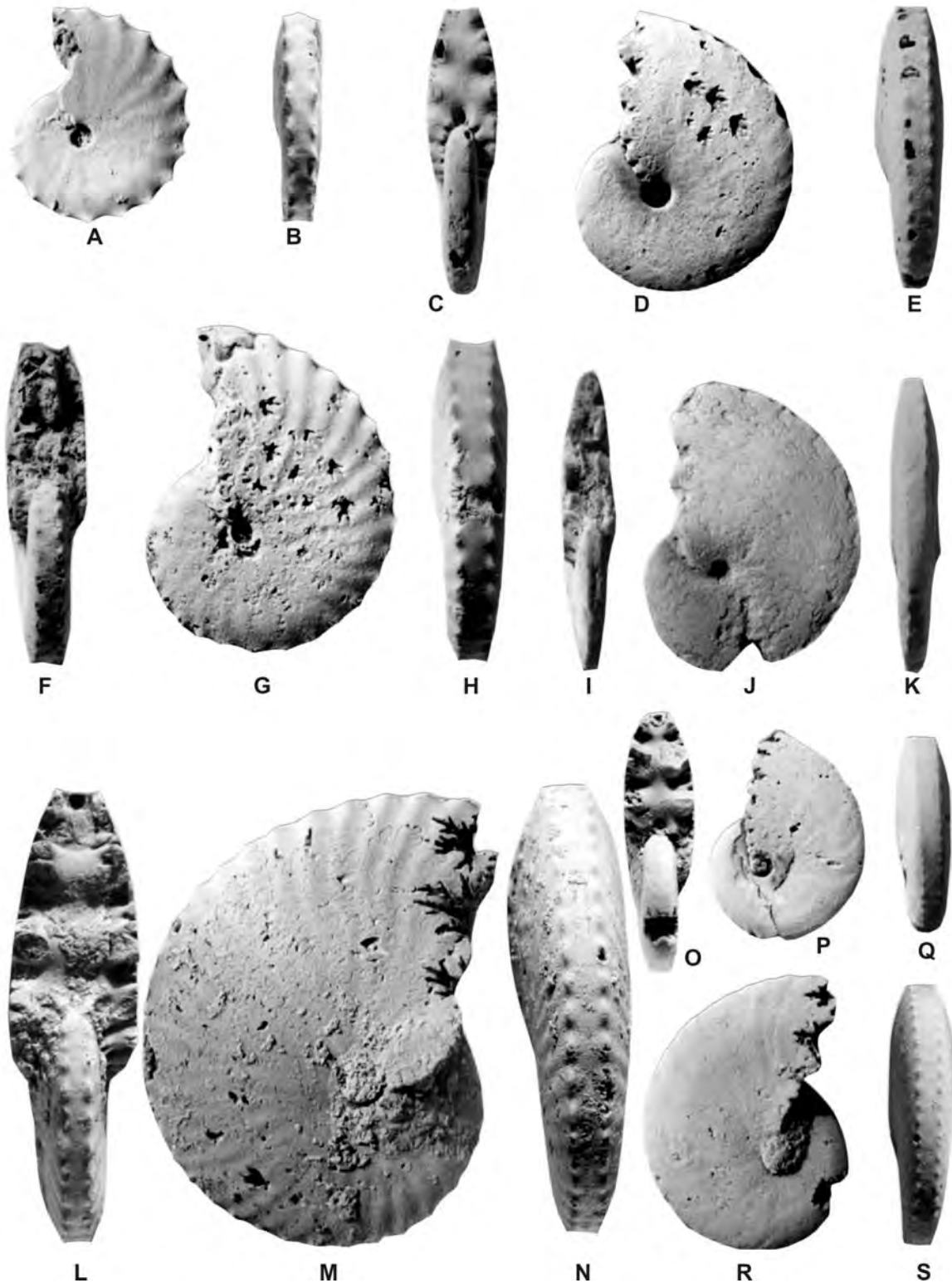
*Forbesiceras conlini* Stephenson, 1953, p. 205, pl. 56, fig. 1; pl. 57, figs 2–6.

*Forbesiceras* [*Pulchellia* (*Neopulchellia*)] *douvillei* Collignon, 1929, p. 5 (29), pl. 3 (4), fig. 17.

*Forbesiceras flicki* Pervinquière, 1907, p. 112, pl. 5, fig. 12.

*Forbesiceras furnishii* Collignon, 1964, p. 63, pl. 336, fig. 1504.

*Forbesiceras* [*Pulchellia* (*Neopulchellia*)] *gignouxii* Collignon, 1929, p. 6 (30), pl. 3(4), figs 18–20.



**Fig. 1.** A, B, F–K, P, Q. *Forbesiceras* [*Neopulchellia*] *gignouxii* (Collignon, 1929). A, B, the original of Collignon, 1964, pl. 321, fig. 1411, from the Lower Cenomanian of Beraketa sur Sakondry (Manera), Madagascar; UBGD collections. F–H, the original of Collignon, 1929, pl. 18 (4), fig. 18, from the Lower Cenomanian of the 'Champ de Tir de Diego,' Madagascar. I–K, the original of Collignon, 1929, pl. 18 (4), fig. 20; P, Q, the original of Collignon, 1929, pl. 18 (4), fig. 19, both from the Lower Cenomanian, 'Est d'Antsirane,' Madagascar, syntypes, all LPMP collections. C–E, O, R, S, *Forbesiceras* [*Neopulchellia*] *douvillei* (Collignon, 1929). C, E, the holotype, the original of Collignon, 1929, pl. 18 (4), fig. 17, from the Lower Cenomanian 'Est d'Antsirane,' Madagascar, LPMP collections. O, R, S, the original of Collignon, 1964, pl. 321, fig. 1410, from the Lower Cenomanian of Beraketa sur Sakondry (Manera), Madagascar; UBGD collections. L–N, *Forbesiceras* sp. juv., the original of *Forbesiceras largilliertianum* of Collignon, 1964, pl. 321, fig. 1409, from the Lower Cenomanian of Beraketa sur Sakondry (Manera), Madagascar; UBGD collections. All figures are x4.

- Forbesiceras largilliertianum* (d'Orbigny, 1841), p. 320, pl. 95; Wright & Kennedy, 1984, p. 89, pl. 11, figs 2–6; pl. 12, figs 1–3, 9; pl. 16, fig. 12; text-figs 12a–l, 13a–z'; 14a–h.
- Forbesiceras mikasaense* Matsumoto, 1986, p. 21, figs 1, 3-1a-c; 4, 1a-c; 5-1a-2b; 6-1a-5.
- Forbesiceras nodosum* Crick, 1907, p. 182, pl. 11, fig. 8; junior synonym of *F. chevillei*.
- Forbesiceras obtectum* (Sharpe, 1853), p. 20, pl. 7, fig. 4; Wright & Kennedy, p. 94, pl. 12, fig. 4; pl. 14, figs 1, 2; pl. 15, fig. 4; text-figs 16g–j; 18.
- Forbesiceras pseudobtectum* Collignon, 1964, p. 60, pl. 334, fig. 1500.
- Forbesiceras sculptum* Crick, 1907, p. 182, pl. 11, fig. 8; junior synonym of *F. chevillei*.
- Forbesiceras subobtectum* (Stoliczka, 1864), p. 96, pl. 49, fig. 2.
- Forbesiceras tenuipunctatum* Collignon, 1964, p. 63, pl. 336, fig. 1502.
- Forbesiceras varicostatum* Zaborski, 1990, p. 569, figs 1f, 2k–o.

#### Occurrence

The earliest well-documented *Forbesiceras*, *F. beaumontianum* and *F. largilliertianum* appear in the lower Lower Cenomanian (*carcitane* Subzone of the *mantelli* Zone of the European sequence). The latest is recorded from the upper Upper Cenomanian *geslinianum* Zone of the European sequence. The geographic range of the genus extends from southern England, France, Germany, Switzerland, Spain, Roumania, Turkmenistan, Iran, Algeria, Tunisia, Lebanon, Nigeria, Angola, KwaZulu-Natal in South Africa, Madagascar, south India, Japan, northern Mexico, to Texas and California in the United States.

#### *Forbesiceras largilliertianum* (d'Orbigny, 1841)

- Pl. 1, figs 2–5; Fig. 2A,F(pars),D,E
- 1841 *Ammonites Largilliertianus* d'Orbigny, p. 320, pl. 95 (pars).
- 1907 *Forbesiceras Largilliertianum* (d'Orbigny); Crick, p. 180, pl. 11, fig. 6.
- 1984 *Forbesiceras largilliertianum* (d'Orbigny, 1841); Wright & Kennedy, p. 89, pl. 11, figs 2–6; pl. 12, figs 1–3, 9; pl. 16, fig. 2; text-figs 12a–l; 13 a–z'; 14a–h.
- 1984 *Forbesiceras largilliertianum* (d'Orbigny, 1841); Kennedy & Juignet, p. 143, figs 22b–d; 25a–c; 26i,j; 27 c,d, g,h; 28a–f.
- 1985 *Forbesiceras largilliertianum* (d'Orbigny, 1841); Immel & Seyed-Emami, p. 97, pl. 3, fig. 5.
- 1986 *Forbesiceras largilliertianum* (d'Orbigny, 1841); Matsumoto, p. 17, fig 2-1a–d.
- 1991 *Forbesiceras largilliertianum* (d'Orbigny, 1841); Delamette & Kennedy, p. 446, fig. 8. 25.
- ?1992 *Forbesiceras largilliertianum* (d'Orbigny); Thomel, pl. 29, figs 1, 2.
- 1994 *Forbesiceras largilliertianum* (d'Orbigny, 1841); Kennedy, p. 222, pl. 2, figs 19, 20; pl. 6, figs 1–4.
- 2006 *Forbesiceras largilliertianum* (d'Orbigny, 1841); Kennedy *et al.* in Gauthier, p. 116, pl. 54, figs 1–3.

#### Types

The lectotype, by the subsequent designation of Wright & Kennedy (1984, p. 90), is LPMP-B46129, *ex* d'Orbigny Collection 6120-A-1, from the phosphatized Middle Cenomanian *Acanthoceras rhotomagense* Zone, *Turrilites costatus* Subzone fauna of the Rouen Fossil Bed of Rouen, Seine-Maritime, France. It is figured here as Fig. 2D,E. There are numerous paratypes, as listed by Wright & Kennedy (1984, p. 90), and Kennedy, Gauthier & Juignet (*in* Gauthier 2006, p. 117).

#### Material

BMNH C18170, the original of Crick (1907, p. 180, pl. 11, fig. 6), from the Lower or Middle Cenomanian Mzinene Formation of the Skoenberg, corresponding to locality 62 of Kennedy & Klinger (1975).

#### Description

The specimen is a wholly septate fragment 44.7 mm long, with a maximum preserved whorl height of 32.4 mm, and a breadth to height ratio of 0.4. The umbilicus is tiny, with a low, feebly convex umbilical wall. The inner to middle flanks are feebly convex, the outer flanks flattened and convergent, the ventrolateral shoulders narrowly rounded, the venter narrow, and very feebly convex to flat. Delicate ribs arise at the umbilical shoulder, and strengthen across the flanks, where they are narrow, crowded, and feebly concave on the outer flank. They have an asymmetric cross-section, with a steep adapertural face and a gently inclined adapical face. All ribs terminate in a narrow, obliquely placed ventral clavus. There is a low, blunt siphonal ridge.

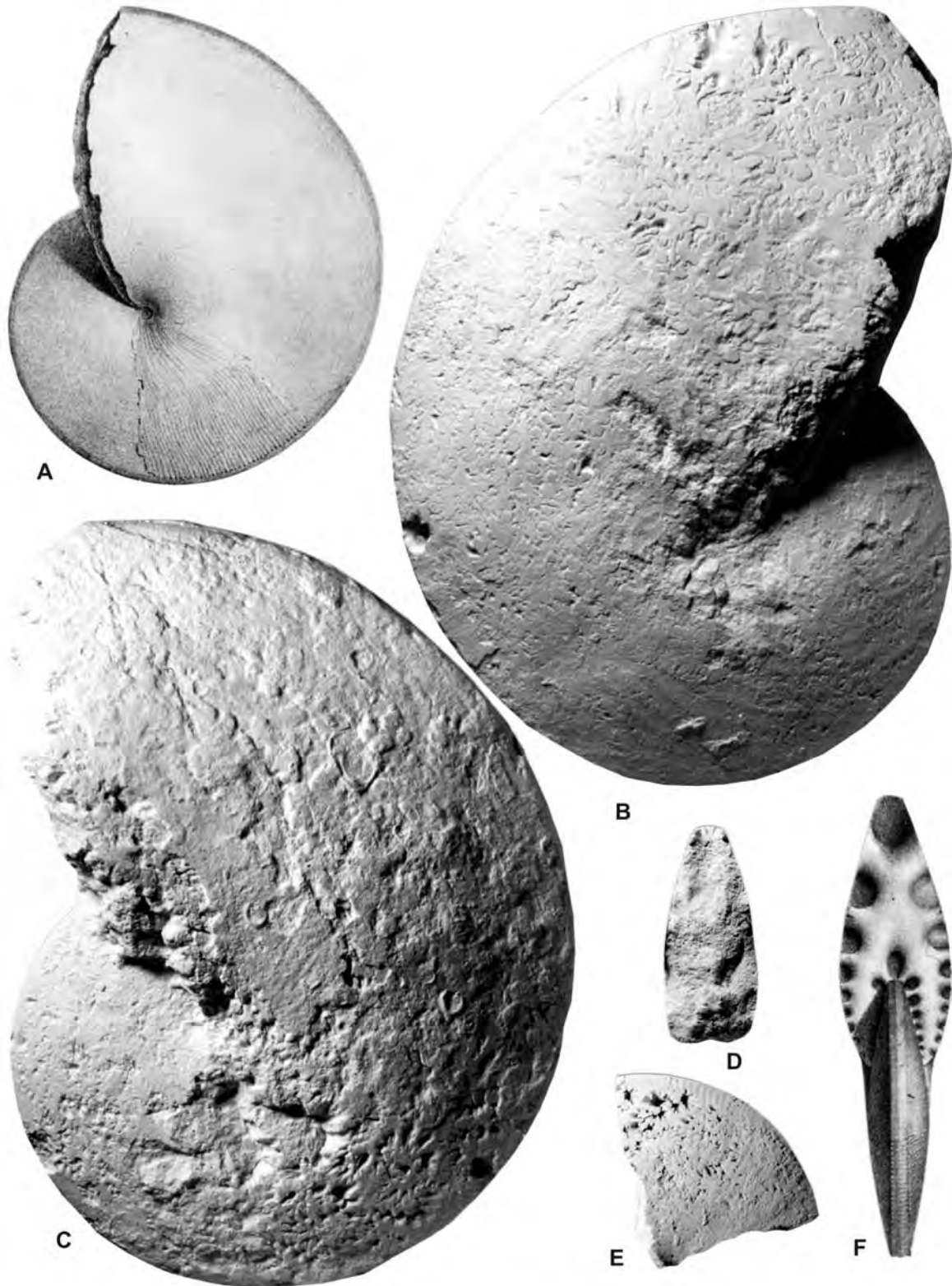
#### Discussion

*Forbesiceras largilliertianum* most closely resembles *F. beaumontianum* (d'Orbigny, 1841), described below, in that both have delicate wiry, radial ribs, without a distinctive geniculation or a lateral tubercle. They differ in that *largilliertianum* has a narrower venter than *beaumontianum*, which also has an evenly elliptical whorl section, and a tendency for the ribs to be relatively strong on the inner and outer flank, but weakened between.

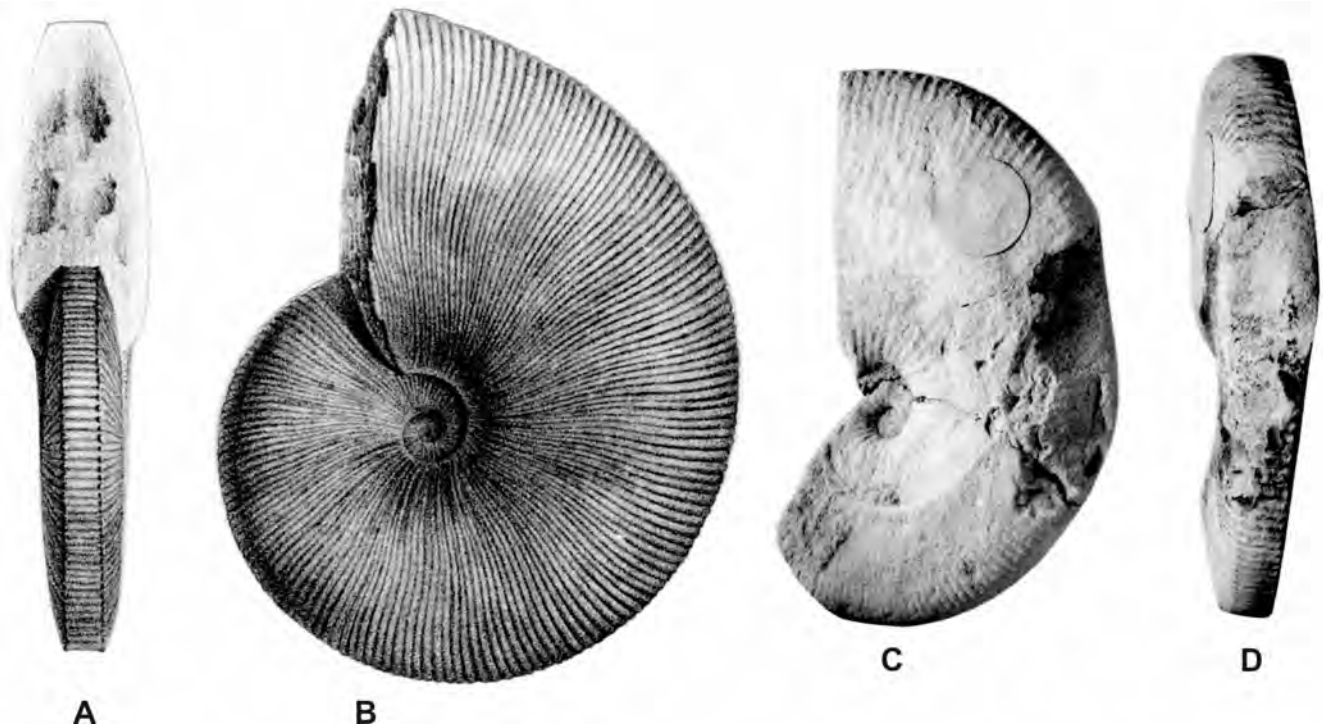
D'Orbigny's original illustrations of this species are a chimaera, based on both *F. largilliertianum* and *F. obtectum* (Sharpe, 1853) (p. 20, pl. 7, fig. 4), as noted by Kennedy, Gauthier & Juignet (*in* Gauthier 2006). The overall shape of the ammonite in d'Orbigny's pl. 95, figs 1, 2, reproduced here as Fig. 2A,F, is based on paralectotype LPMP-B16154 (*ex* de Vibraye Collection), an internal mould of *F. obtectum*. This can be demonstrated by the preservation of delicate recurved ribs on the outer flank of one side of the mould (Fig. 2B, lower half of figure). The ornament is also preserved on patches of phosphatized shell on the other side of the specimen (Fig. 2C), but here it is the delicate radial inner flank ornament that survives. D'Orbigny and his artist appear to have linked this to the radial ornament that extends across all of the flanks in *largilliertianum*, as in the lectotype (Fig. 2D,E), and added this to their reconstruction. The suture illustrated by d'Orbigny (1841, pl. 95, fig. 3) is also based on the de Vibraye specimen of *obtectum*.

#### Occurrence

The KwaZulu specimen cannot be precisely dated; associ-



**Fig. 2. A, F**, copy of d'Orbigny's original figures (1841, pl. 95, figs 1, 2), of *Ammonites largilliertianus*. These are a chimaera. The overall form of the shell is based on paralectotype LPMB-16154, a cast of which is shown as figs **B** and **C**. One flank of this specimen (**B**) preserves distinctive recurved outer flank ornament on the internal mould, on the adapical half of the outer whorl, showing the specimen to be a *Forbesiceras obtectum* (Sharpe, 1853). The other flank (**C**) retains traces of phosphatized shell on the inner flank, with delicate radial ornament preserved. D'Orbigny and his artist appear to have taken this as the basis for adding the ornament preserved on specimens such as the lectotype (**D**, **E**, LPMP-B4619, ex d'Orbigny Collection 6120-A-1) to the former specimen. **B**, **C**, **D**, **E**, are from the Middle Cenomanian *Acanthoceras rhotomagense* Zone, *Turrilites costatus* Subzone fauna of the Rouen Fossil Bed of Rouen, Seine-Maritime, France. **A** and **E** are reproduced at the same size as d'Orbigny's originals, which are said to be reduced by two-thirds. Figures **B** and **C** are x1; **D** and **E** are x2.



**Fig. 3. A–D, *Forbesiceras beaumontianum* (d'Orbigny, 1841). A, B, copy of d'Orbigny's original figures (1841, pl. 98, figs 1, 2). C, D, the lectotype, no. 5523 in the Collections of the École National supérieur des Mines, now housed in the Université de Lyon-Villeurbanne. It is from the Lower Cenomanian of the 'route de Lamennais à la Ferté-Bernard (Sarthe)', France. Preservation suggests it is derived from the lower Lower Cenomanian *Neostlingoceras carcitanense* Subzone of the *Mantelliceras mantelli* Zone. Both  $\times 1$ .**

ated faunas from the Skoenberg span the Lower and Middle Cenomanian. Where well-dated, *F. largilliertianum* ranges throughout the Lower and Middle Cenomanian. The geographic range extends from southern England, to France, Switzerland, northern Spain, Germany, Iran, central Asia, Algeria, Tunisia, KwaZulu in South Africa, Madagascar, south India, and Japan.

#### ***Forbesiceras beaumontianum* (d'Orbigny, 1841)**

Figs 3A–D, 4A–D, 5

1841 *Ammonites Beaumontianus* d'Orbigny, p. 328, pl. 98, figs 1, 2.

1984 *Forbesiceras beaumontianum* (d'Orbigny, 1841); Wright & Kennedy, p. 91, pl. 12, figs 7, 8; pl. 13, fig. 1; text-figs 15a–c; 16a–f (with full synonymy).

1984 *Forbesiceras beaumontianum* (d'Orbigny, 1841); Kennedy & Juignet, p. 147, figs 26d–h; 27i.

1986 *Forbesiceras beaumontianum* (d'Orbigny, 1841); Matsumoto, p. 19, fig 2-2a–d.

1991 *Forbesiceras beaumontianum* (d'Orbigny, 1841); Delamette & Kennedy, p. 446, fig. 8. 21. 8. 22.

1992 *Forbesiceras beaumontianum* (d'Orbigny); Thomel, pl. 25, fig. 5.

2005 *Forbesiceras beaumontianum* (d'Orbigny, 1841); Kennedy *et al.*, p. 385, text-fig. 10d,e.

2006 *Forbesiceras beaumontianum* (d'Orbigny, 1841); Kennedy & Juignet *in* Gauthier, p. 121, pl. 52, figs 1–3.

#### **Types**

The lectotype, by the subsequent designation of Wright & Kennedy (1984, p. 92), is no. 5523 (E 6910) in the collections

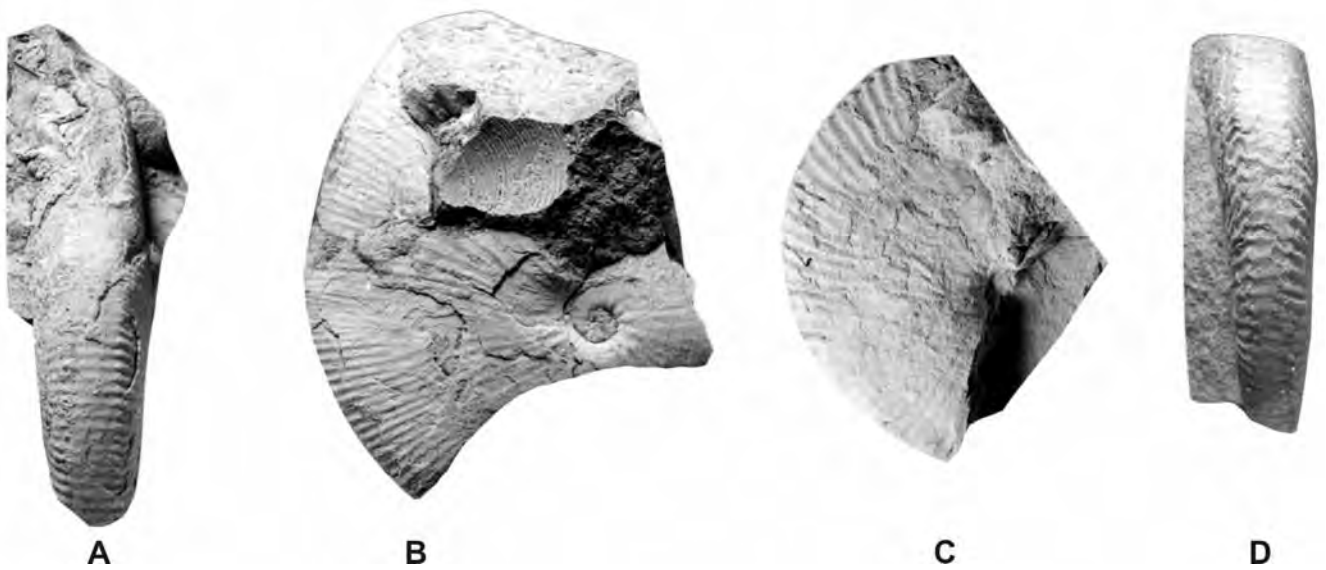
of the École National supérieur des Mines, now housed in the Université de Lyon-Villeurbanne. It is reillustrated in Fig. 3, together with d'Orbigny's original figures of the species. It is from the Lower Cenomanian of the route 'de Lamennais à la Ferté-Bernard (Sarthe)' in France; the preservation suggests the lower Lower Cenomanian *Neostlingoceras carcitanense* Subzone of the *Mantelliceras mantelli* Zone. A paralectotype, LPMP-B46137, illustrated by Kennedy & Juignet (*in* Gauthier 2006, pl. 52, fig. 3) is in the same preservation as the lectotype. A second paralectotype, LPMP, d'Orbigny Collection, no. 6124, is from Grasse, Var, France (Wright & Kennedy 1984, text-fig. 16e,f; Kennedy & Juignet *in* Gauthier 2006, pl. 52, fig. 2).

#### **Material**

OUM KX10391 and 10392, from locality 183 of Kennedy & Klinger (1975, p. 183), Ndumu, KwaZulu. The specimens are assigned to the Cenomanian II of Kennedy & Klinger (1975); one specimen (OUM KX10392) has a tuberculate *Mantelliceras* and a *Mariella* in its matrix.

#### **Description**

OUM KX10391 is a 120° whorl sector of phragmocone with a maximum preserved whorl height of 33 mm, retaining traces of powdery shell material. The coiling is very involute, the shallow conical umbilicus comprising less than 10% of the diameter, the umbilical wall low, flattened and outward-inclined, the umbilical shoulder very narrowly rounded. The whorl section is very compressed, with a whorl breadth to height ratio of 0.38, the flanks very feebly convex, and subparallel. The ventrolateral shoulders are very



**Fig. 4.** A–D, *Forbesiceras beaumontianum* (d'Orbigny, 1841). A, B, OUM KX10392; C, D, OUM KX10391, both from the Lower Cenomanian (Cenomanian II), at locality 183 of Kennedy & Klinger (1975), Ndumu, KwaZulu. Both  $\times 1$ .

narrowly rounded, the venter relatively broad for the genus, and very feebly convex. The flanks are ornamented by delicate narrow, crowded, feebly prorsiradiate ribs that

efface across the mid-flank region. They are at their strongest on the outer flank, and are projected slightly forwards. All ribs bear a tiny ventral clavus, the clavi linked across the



**Fig. 5.** *Forbesiceras beaumontianum* (d'Orbigny, 1841). The original of *Forbesiceras largilliertianum* (d'Orbigny) of Collignon, 1964, p. 60, pl. 334, fig. 1499, from the Lower Cenomanian of Collignon's 'Gisement 362. Antanimanga I (Mandabe)', Madagascar. UBGD, Collignon Collection.  $\times 1$ .



**Fig. 6.** The holotype of *Forbesiceras chevillei* (Pictet & Renevier, 1866), the original of Pictet & Renevier, 1866, p. 102, pl. 4, fig. 2, no. 3402 in the collections of the Musée géologique, Lausanne, from the 'couche moyenne' at Cheville, Valais, Switzerland. All  $\times 1$ .

venter by a delicate transverse rib that is narrower than the adjacent interspaces.

OUN KX10392 (Fig. 4A,B) is a fragmentary phragmocone in similar preservation, with a maximum preserved whorl height of 39.1 mm, and a whorl breadth to height ratio of 0.46. Ornament is finer than in the previous specimen, the delicate ribs well developed on the umbilical shoulder and innermost flank, very feebly flexuous across the flanks, effaced across the middle of the flanks, and strengthened on the outer flanks. This specimen shows a part of the external suture, with deeply incised E/A with subphyllid folioles, and divided into asymmetric halves by a large adventive lobe.

#### Discussion

As noted above, *Forbesiceras beaumontianum* most closely resembles *F. largilliertianum*, from which it is readily distinguished on the basis of whorl section and details of ornament. The *Forbesiceras largilliertianum* of Collignon (1964, p. 60, pl. 334, fig. 1499) is re-illustrated here as Fig. 5. The ornament and whorl section, notably the relatively broad venter, show it to be an example of the present species.

#### Occurrence

Where well dated in western Europe, *F. beaumontianum* characterizes the lower Lower Cenomanian *Neostlingoceras carcitanense* Subzone of the *Mantelliceras mantelli* Zone. The geographic distribution is southern England, France, KwaZulu in South Africa, Madagascar, and Tarrant County, Texas.

#### *Forbesiceras chevillei* (Pictet & Renevier, 1866)

Pl. 1, figs 1, 6–12; Pl. 2, figs 8, 12, 13; Fig. 6

1866 *Ammonites chevillei* Pictet & Renevier, p. 102, pl. 4, fig. 2.

1907 *Forbesiceras sculptum* Crick, p. 182, pl. 11, fig. 7.

1907 *Forbesiceras nodosum* Crick, p. 182, pl. 11, fig. 8.

1964 *Forbesiceras clarki* Collignon, p. 64, pl. 336, fig. 1505.

1984 *Forbesiceras chevillei* (Pictet & Renevier, 1866); Wright & Kennedy, p. 93, pl. 13, fig. 2; pl. 15, figs 1, 2; text-fig. 17 (with full synonymy).

1984 *Forbesiceras chevillei* (Pictet & Renevier, 1866); Kennedy & Juignet, p. 155, fig. 30a–d.

1985 *Forbesiceras sculptum* Crick, 1907; Immel & Seyed-Emami, p. 97, pl. 3, fig. 4.

? 1990 *Forbesiceras* cf. *chevillei* (Pictet & Renevier, 1866); Kennedy & Cobban, p. 91, pl. 1, figs 21, 22.

1991 *Forbesiceras chevillei* (Pictet & Renevier, 1866); Delamette & Kennedy, p. 446, fig. 9. 1–9. 3.

1995 *Forbesiceras sculptum* Crick; Colleté *et al.*, pl. 10, fig. 4.

1998 *Forbesiceras chevillei* (Pictet & Renevier, 1866); Kaplan *et al.*, p. 112, pl. 1, fig. 6; pl. 9, figs 9, 10; pl. 11, fig. 3.

1998 *Forbesiceras chevillei* (Pictet & Renevier, 1866); Lehmann, p. 19, pl. 2, fig. 6.

#### Types

The holotype of *Forbesiceras chevillei* is the original of Pictet & Renevier, (1866, p. 102, pl. 4, fig. 2), illustrated here as Fig. 6A–C, no. 3402 in the collections of the Musée géologique, Lausanne, from the 'couche moyenne' at Cheville, Valais, Switzerland.

The holotype of *Forbesiceras sculptum* Crick (1907, p. 182, pl. 11, fig 7), illustrated here as Pl. 1, figs 6–9, is BMNH C18171, from 'the deposit at the north end of False Bay,' in fact locality 62 of Kennedy & Klinger (1975), the Skoenberg.

The holotype of *Forbesiceras nodosum* Crick, (1907, p. 182, pl. 11, fig 8, illustrated here as Pl. 1, figs 1, 10–12, is BMNH C18172, from the same locality as the previous specimen.

#### Material

SAM-D.99E, from the Lower or Middle Cenomanian Mzinene Formation of the Skoenberg, corresponding to locality 62 of Kennedy & Klinger (1975).

#### Description

The holotype of *Forbesiceras sculptum* is a 90° sector of whorl with a maximum preserved whorl height of 27.9 mm (Pl. 1, figs 6–9). It retains silicified shell, and it is thus impossible to establish whether it is phragmocone or body chamber. Coiling is very involute, the umbilicus tiny, and near occluded. The whorl section is very compressed, with a whorl



breadth to height ratio of 0.38. The greatest breadth is below mid-flank. The inner flanks are feebly convex, the middle to outer flank region is flattened and convergent, the ventrolateral shoulders are flattened, converging to the narrow, feebly convex venter. Delicate, prorsiradiate ribs are convex across the umbilical shoulder, and narrow, straight and prorsiradiate on the inner half of the flanks. They give rise to much coarser, feebly concave falcoid ribs on the outer flank. These have an imbricate, scale-like appearance, with a steep adapical and gently inclined adapertural face. They terminate in strong clavi, perched on, and aligned parallel to, the ventrolateral shoulders. There is a low, broad mid-ventral ridge, crossed by broad, transverse undulations that give the appearance of siphonal clavi where they intersect the ridge.

The holotype of *Forbesiceras nodosum* (Pl. 1, figs 1, 10–12) is an almost wholly septate half whorl with a maximum preserved whorl height of over 60 mm, and an estimated original diameter of over 100 mm; none of the umbilical region is preserved. Recrystallized shell is preserved over much of the specimen. The whorl section is very compressed, with greatest breadth low on the flanks, the flanks feebly convex, subparallel, the ventrolateral shoulders narrowly rounded, the venter narrow, and feebly convex. The inner flanks appear to have been smooth. Widely-spaced mid-lateral bullae give rise to groups of up to three broad, scale-like ribs, the cross-section markedly asymmetric, with a steep adapical face. Additional ribs intercalate. All ribs broaden across the flanks, and terminate in tiny, ventral clavi. These are linked across the venter by pairs of delicate, feebly convex ribs, with one or two additional ribs intercalated between.

SAM-D.99E is a very corroded phragmocone 108 mm in diameter. It retains recrystallized shell on the adapical half whorl, where scale-like outer flank ribbing is preserved, as in the holotype of *F. nodosum* (compare Pl. 1, figs 1, 10–12 and Pl. 2, figs 8, 12, 13). The ribs terminate in long clavi, perched on and parallel to the ventrolateral shoulders. Clavi are linked over the venter by a broad swelling that bears two or three delicate transverse riblets. The rib-bearing swellings are separated by deep, narrow interspaces (Pl. 2, fig. 8).

#### Discussion

The holotype of *Forbesiceras chevillei* (Fig. 6) is a worn phosphatic fragment only. Coiling is very involute, with a tiny umbilicus. The whorl section is highly compressed, with feebly convex flanks and a narrow, flattened venter. The whorl breadth to height ratio is approximately 0.45. There are traces of fine prorsiradiate ribs on the inner flank, and small rounded tubercles at mid-flank. These give rise to groups of low, broad, flat ribs that strengthen on the outer flank and terminate in long, low, ventral clavi. These are linked over the venter by up to six fine transverse ribs, with additional riblets in the interspaces. Imperfect as the holotype is, it can be linked to the present material via the more numerous specimens from southern England described and discussed by Wright & Kennedy (1984, p. 93, pl. 13, fig. 2; pl. 15, figs 1, 2; text-fig. 17). *Forbesiceras chevillei* is one of a number of species with subdued inner flank and scale-like imbricate outer flank ribs. The holotype of *Forbesiceras clarki* Collignon, 1964 (p. 64, pl. 336,

fig. 1505) is re-illustrated here as Fig. 7A,B; it is from the Lower Cenomanian of Collignon's (1964) 'gisement 362, Antanimanga I'. It is an individual with the same style of ornament as the holotype of *Forbesiceras sculptum* (Pl. 1, figs 6–9), that is to say a *chevillei* at the growth stage prior to the development of the mid-lateral tubercles. The holotype of *Forbesiceras tenuipunctatum* Collignon, 1964 (p. 63, pl. 336, fig. 1502) is from the lower Middle Cenomanian of Collignon's 'gisement 363, Antanimanga II', and is refigured here as Fig. 7G,H. It has near-smooth inner flanks, traces of very feeble mid-lateral bullae, and much finer outer flank ribs than *F. chevillei*. The ventral ornament is lost through wear. The specimen referred to *F. nodosum* by Collignon (1964, p. 63, pl. 336, fig. 1503) is illustrated here as Fig. 7C,D. It is from the same horizon and locality as the holotype of *F. tenuipunctatum*. It has radially elongated mid-lateral bullae at an earlier ontogenetic stage than the present material. The holotype of *Forbesiceras furnishi* Collignon, 1964 (p. 63, pl. 336, fig. 1504) is again from Collignon's 'gisement 363, Antanimanga II'. It is illustrated here as Fig. 7E,F. It has lateral bullae and outer flank ribs that are intermediate between those of *tenuipunctatum* and *nodosum* of Collignon, and it is tempting to regard these three co-occurring forms as no more than intraspecific variants of a species closely allied to, if not conspecific, with *chevillei*. However, these specimens also closely resemble *Forbesiceras obtectum* (Sharpe, 1853) (p. 20, pl. 7, fig. 4; see revision in Wright & Kennedy, 1984, p. 94, pl. 12, fig. 4; pl. 14, figs 1, 2; pl. 15, fig. 4; text-figs 16g–j; 18) prior to the development of the later growth stage with strongly recurved outer flank ribs (see especially Wright & Kennedy, 1984, pl. 14, fig. 2b).

*Forbesiceras mikasaense* Matsumoto, 1986 (p. 21, figs 1, 3-1a–c; 4-1a–c; 5-1a2b; 6-1a-5) from the Lower Cenomanian of the Mikasa area of Hokkaido, was described as being indistinguishable from *Forbesiceras chevillei* up to the middle growth stage. Beyond this the Japanese species develops the distinctive swept-back outer flank ribs of *Forbesiceras obtectum/subobtectum* type (Matsumoto, 1986, figs 3, 4), whereas adult *chevillei*, as interpreted by Wright & Kennedy (1984, text-fig. 17; Kennedy & Juignet, 1984, text-fig. 30e,f) lacks such ribs, and becomes near-smooth.

#### Occurrence

Where well-dated in western Europe, *Forbesiceras chevillei* ranges from Lower to lower Middle Cenomanian. The geographic distribution is southern England, France, Germany, Switzerland, northern Spain, Turkmenistan, Nigeria, KwaZulu in South Africa, Madagascar, and, possibly, Texas.

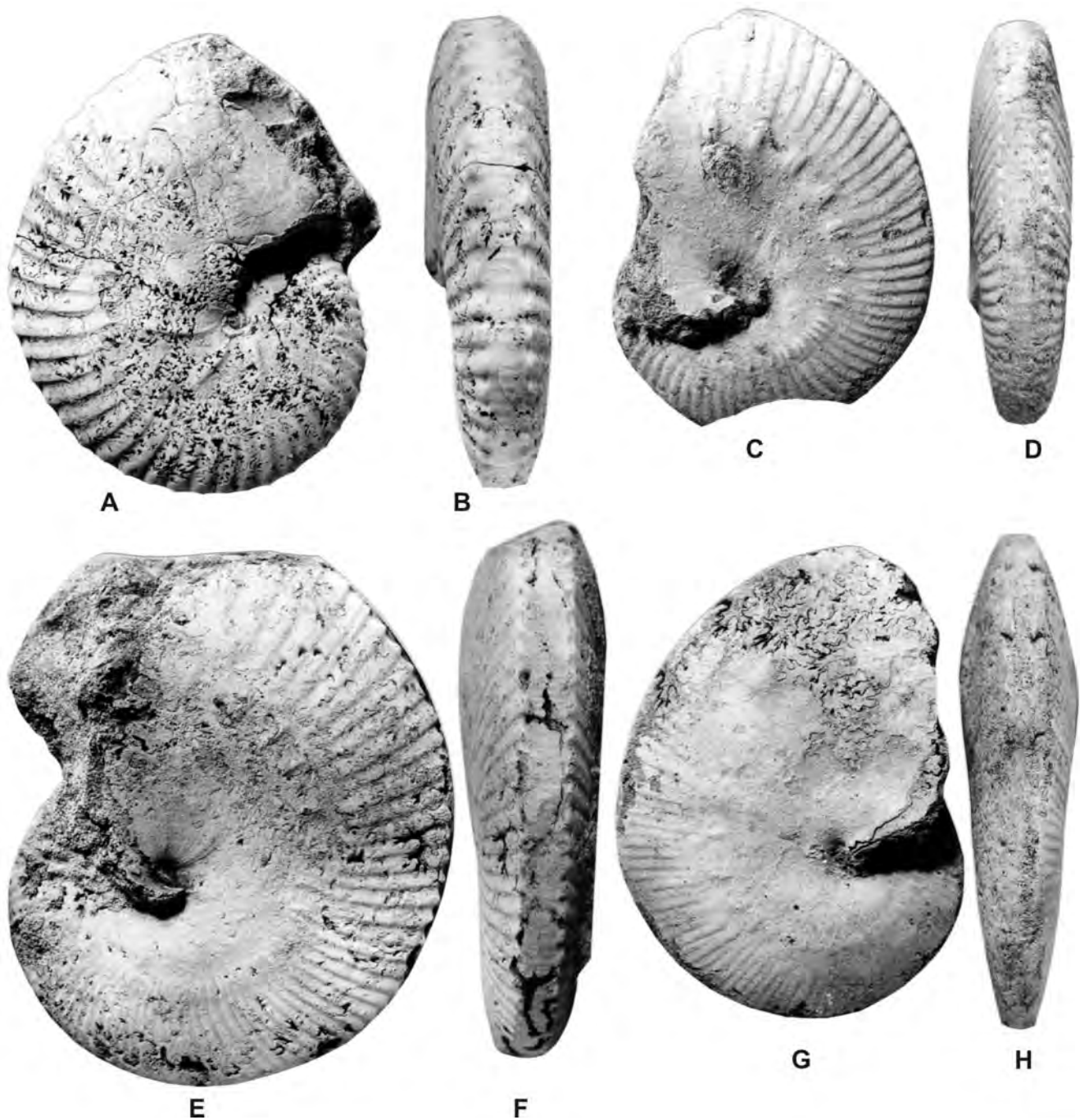
#### *Forbesiceras* cf. *subobtectum* (Stoliczka, 1864)

Pl. 2, figs 1–7

Compare:

1864 *Ammonites subobtectus* Stoliczka, p. 96, pl. 49, fig. 2.  
1964 *Forbesiceras subobtectum* Stol.; Collignon, p. 62, pl. 335, fig. 1501.

1984 *Forbesiceras* cf. *subobtectum* (Stoliczka, 1864); Wright & Kennedy, p. 95, pl. 12, fig. 5; text-fig. 11h,i (with additional synonymy).



**Fig. 7.** **A, B**, the holotype of *Forbesiceras clarki* Collignon, 1964, the original of Collignon, 1964 p. 64, pl. 336, fig. 1505, from the Lower Cenomanian of Collignon's 'Gisement 362. Antanimanga I (Mandabe)'. **C, D**, the original of *Forbesiceras nodosum* Crick of Collignon, 1964, p. 63, pl. 336, fig. 1503. **E, F**, the holotype of *Forbesiceras furnishi* Collignon, 1964, the original of Collignon, 1964, p. 63, pl. 336, fig. 1504. **G, H**, the holotype of *Forbesiceras tenuipunctatum* Collignon, 1964, the original of Collignon, 1964, p. 63, pl. 336, fig. 1502. The originals of C–H are from the lower Middle Cenomanian of Collignon's 'Gisement 363. Antanimanga II (Mandabe)', Madagascar. All specimens UBGD, Collignon Collection. All  $\times 1$ .

#### Material

SAM-D.995a,b, from the Lower or Middle Cenomanian Mzinene Formation of the Skoenberg, corresponding to locality 62 of Kennedy & Klinger (1975).

#### Description

SAM-D.995b (Pl. 2, figs 5–7) is an internal mould of a 180° sector of a phragmocone with an estimated diameter of

48 mm., and a maximum preserved whorl height of 28.2 mm. Coiling is very involute, with an occluded umbilicus. The whorl section is very compressed, with a whorl breadth to height ratio of 0.48. The flanks are very feebly convex, subparallel, with the greatest breadth around mid-flank. The ventrolateral shoulders are narrowly rounded. The siphuncle has weathered out, leaving a large mid-ventral groove. Eight narrow, straight, prorsiradiate primary ribs

arise at the umbilical margin and extend to mid-flank, some bifurcate. The ribs link to 10–11 rounded to feebly bullate mid-lateral tubercles. These give rise to one or two outer flank ribs, and additional outer flank ribs intercalate, to give a total of 17 ribs at the ventrolateral shoulder. The ribs are coarser than those on the inner flank, and vary in direction. Some continue the radial, prorsiradiate course of the inner flank ribs; others flex back, the latter becoming prevalent at the greatest diameter preserved. All ribs terminate in coarse ventral clavi, elongated parallel to the ventrolateral shoulders.

SAM-D.995a (Pl. 2, figs 1–4) is a worn and corroded phragmocone with an estimated original diameter of 53 mm. The whorl breadth to height ratio is 0.47. The outer flank ornament and ventral tuberculation correspond to the previous specimen. The venter is better preserved, and reveals the presence of a low transverse ribs linking the clavi across the venter, and a rounded, feebly undulose mid-ventral ridge.

#### Discussion

The presence of mid-lateral tubercles at a small diameter, outer flank ribs that are rounded in cross section rather than asymmetric and scale-like, and an absence of multiple ventral riblets linking clavi across the venter immediately distinguish these specimens from *F. chevillei*. They differ in no significant respects from *Forbesiceratid* cf. *subobtectum* of Wright & Kennedy (1984, p. 96, pl. 12, fig. 5) from the lower Middle Cenomanian of southern England. However, that specimen and the present individuals are much smaller than the type material of *subobtectum*, hence the qualified identification.

#### Occurrence

The present specimens cannot be dated more precisely than Lower or Middle Cenomanian. The comparable specimen from southern England is from the lower Middle Cenomanian. *Forbesiceratid subobtectum* is imprecisely dated in south India. The record from Madagascar is from the Lower Cenomanian.

#### *Forbesiceratid* sp.

Pl. 2, figs 9–11

#### Material

SAM-D2948, from the Lower or Middle Cenomanian Mzinene Formation of the Skoenberg, corresponding to locality 62 of Kennedy & Klinger (1975).

#### Dimensions

	D	Wb	Wh	Wb:Wh	U
SAMD2948	45.7 (100)	11.9 (26.0)	29.3 (64.1)	0.43	–(–)

#### Description

The specimen is a phragmocone of a juvenile, 45.7 mm in diameter. Coiling is very involute, the umbilicus occluded. The whorl section is very compressed, the inner to mid-flank region feebly convex, the outer flanks flattened and convergent. The greatest breadth is just outside the umbilical

shoulder. The ventrolateral shoulders are very narrowly rounded, the venter is very narrow, with a low, rounded mid-ventral ridge. Narrow, weak straight prorsiradiate ribs of variable strength arise at the umbilicus, and extend across the inner and middle flank, where they flex back, strengthen, increase by branching and intercalation, and are concave on the outer flank, all terminating in a narrow ventral clavus, elongated parallel to the line of the ventrolateral shoulders. The clavi are linked across the venter by low, broad, fold-like ribs that produce minor undulations where they cross the mid-ventral ridge. There are an estimated 22–24 ribs on the adapertural half whorl of the specimen.

#### Discussion

The delicate falcooid ribbing and very compressed whorl section distinguishes this specimen from all other Zululand *Forbesiceratid*.

#### Occurrence

As for material.

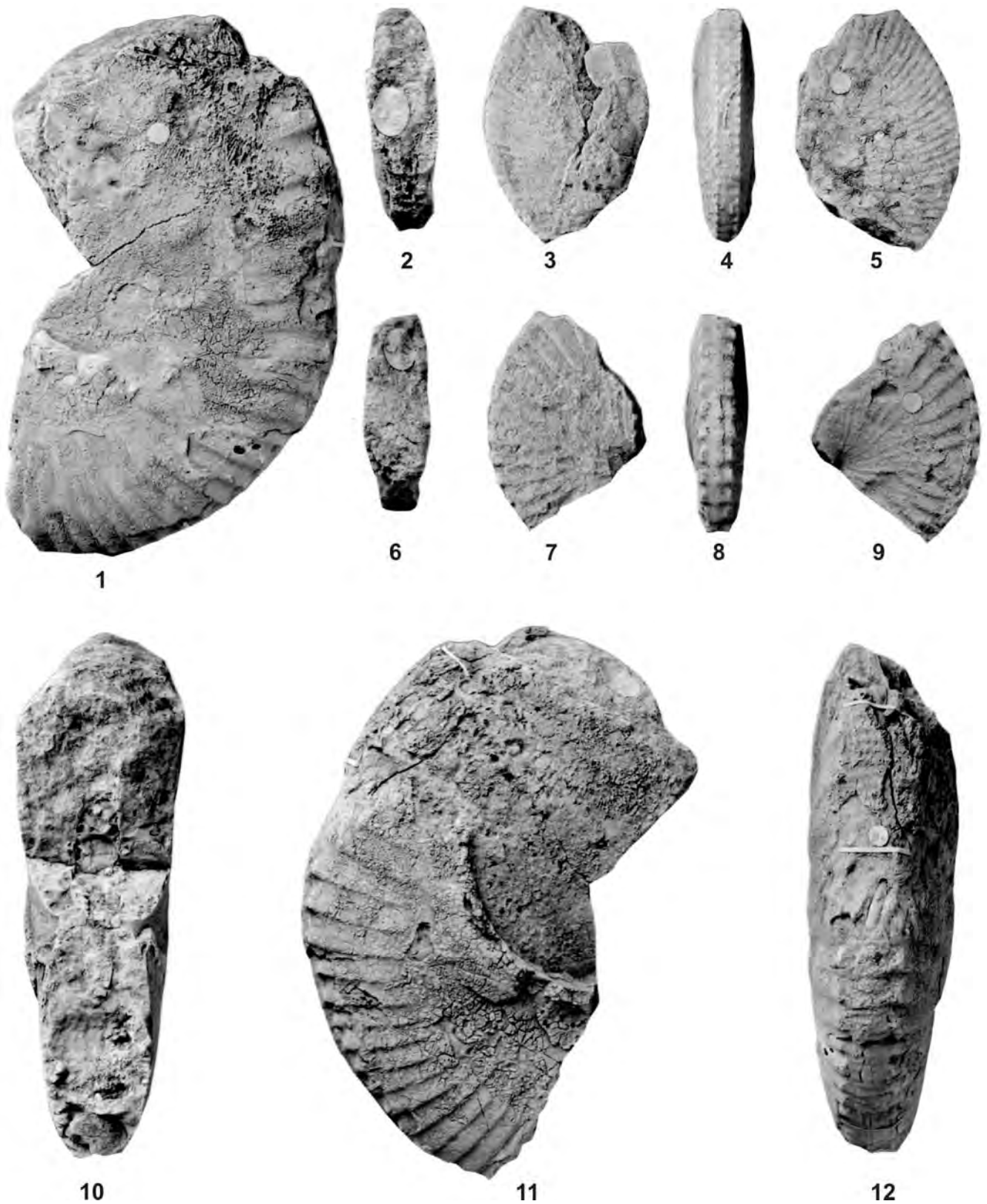
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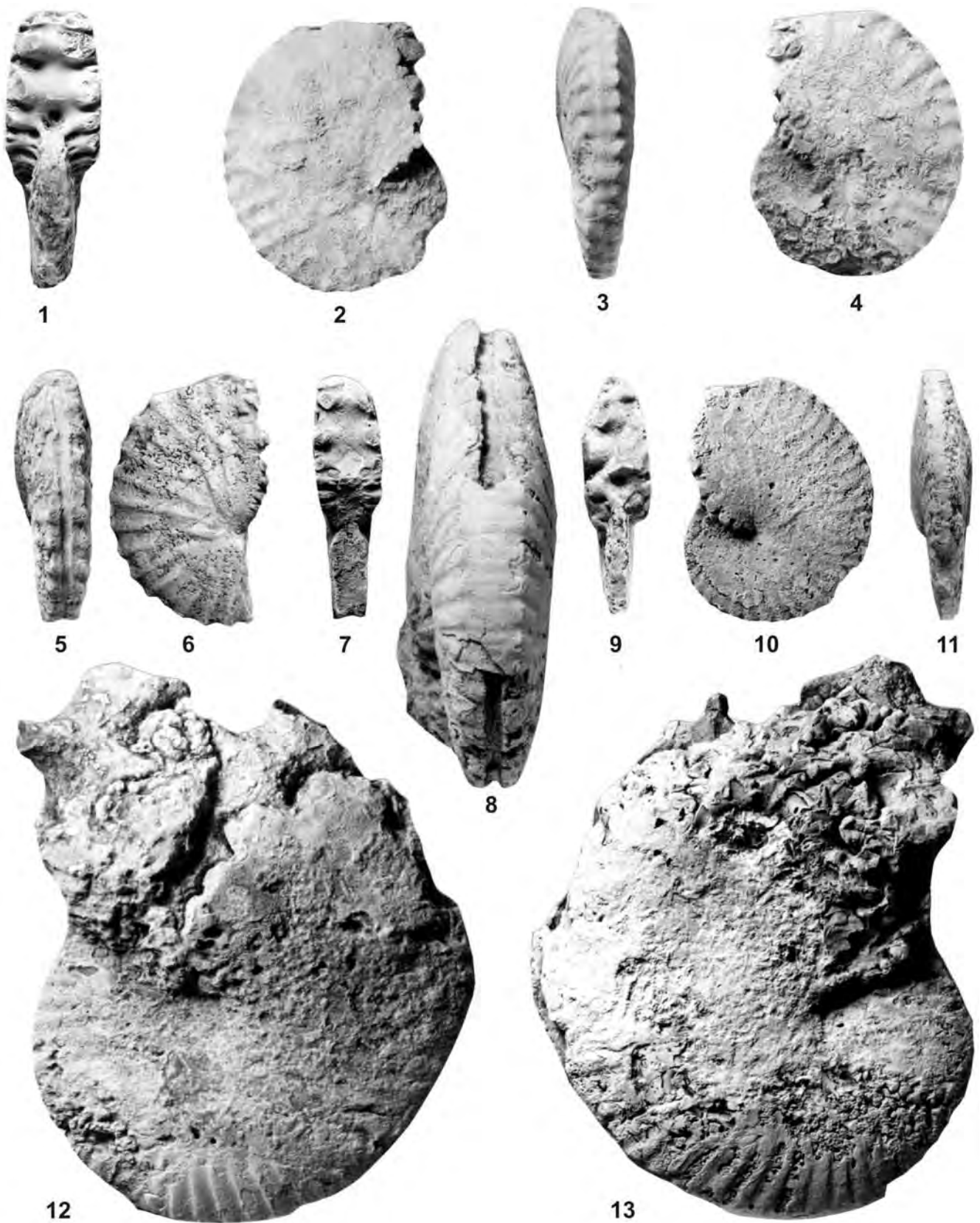
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**Plate 1. Figs 1, 6–12, *Forbesiceras chevillei* (Pictet & Renevier, 1866). 1, 10–12, BMNH C18172, the holotype of *Forbesiceras nodosum* Crick, 1907, p. 182, pl. 11, fig. 8; 6–9, BMNH C18171, the holotype of *Forbesiceras sculptum* Crick, 1907, p. 182, pl. 11, fig. 7. 2–5, *Forbesiceras largilliertianum* (d'Orbigny, 1841). BMNH C18170, the original of Crick, 1907, p. 180, pl. 11, fig. 6. All specimens are inferred to be from the Lower or Middle Cenomanian of the Skoenberg region, corresponding to locality 62 of Kennedy & Klinger (1975). All figures are  $\times 1$ . (Photographs courtesy of The Natural History Museum Photographic Unit, London.)**



**Plate 2. Figs 1–7, *Forbesiceras* cf. *subobtectum* (Stoliczka, 1864). 1–4 are SAM-D.995a; 5–7 are SAM-D.995b. 8, 12, 13, *Forbesiceras chevillei* (Pictet & Renevier, 1866). SAM-D.99E. 9–11, *Forbesiceras* sp. SAM-D.2948. All specimens are from the Lower or Middle Cenomanian of the Skoenberg region, corresponding to locality 62 of Kennedy & Klinger (1975). All figures  $\times 1$ .**