

# Cretaceous faunas from Zululand and Natal, South Africa. *Valdedorsella*, *Pseudohaploceras*, *Puzosia*, *Bhimaites*, *Pachydesmoceras*, *Parapuzosia* (*Austiniceras*) and *P.* (*Parapuzosia*) of the ammonite subfamily Puzosiinae Spath, 1922

William James Kennedy

Oxford University Museum of Natural History, Parks Road, Oxford OX1 3PW, and  
Department of Earth Sciences, South Parks Road, Oxford OX1 3AN, U.K.  
E-mail: jim.kennedy@oum.ox.ac.uk

&

Herbert Christian Klinger

Natural History Collections Department, Iziko South African Museum, P.O. Box 61, Cape Town, 8000, and  
6 du Toit Street, Porterville, 6810 South Africa  
E-mail: hklinger@iziko.org.za / hkling@telkomsa.net  
(with 27 figures)

Received 8 February 2014. Accepted 7 July 2014

Representatives of 20 species of the ammonite subfamily Puzosiinae Spath, 1922 are described from the Barremian and Aptian Makatini Formation, the Albian and Cenomanian Mzinene Formation, and the Coniacian part of the St Lucia Formation of northern KwaZulu-Natal, and the Santonian to Lower Campanian Mzamba Formation of northern Eastern Cape Province. The following are recognized: *Valdedorsella akuschaensis* (Anthula, 1899), *Pseudohaploceras matheroni* (d'Orbigny, 1841), *Puzosia mayoriana* (d'Orbigny, 1841), *Puzosia provincialis* (Parona & Bonarelli, 1897), *Puzosia furnitana* Pervinquière, 1907, *Puzosia compacta* Crick, 1907, *Puzosia natalensis* Crick, 1907, *Puzosia compressa* Kossmat, 1898, *Puzosia manasoensis* Collignon, 1961, *Puzosia eboroensis* Collignon, 1961, *Bhimaites bhima* (Stoliczka, 1865), *Bhimaites stoliczkai* (Kossmat, 1897), *Bhimaites pinguis* (Crick, 1907), *Bhimaites subtilis* (Crick, 1907), *Bhimaites gortanii* Venzo, 1936), *Parapuzosia* (*Parapuzosia*) *haughtoni* Spath, 1922, *Parapuzosia* (*Parapuzosia*)? *truteri* (Van Hoepen, 1968), *Parapuzosia* (*Austiniceras*) *subcompressa* (Crick, 1907), *Parapuzosia* (*Austiniceras*) *beantalyense* Collignon, 1961, and *Pachydesmoceras pachydiscoide* Matsumoto, 1954 (= ?*Matsumotoceras donlisteri* Van Hoepen, 1968).

**Key words:** Cretaceous, ammonite, Puzosiinae, KwaZulu-Natal, South Africa.

## CONTENTS

|                                   |   |   |    |  |    |
|-----------------------------------|---|---|----|--|----|
| Abstract                          | 1 | <i>Puzosia provincialis</i>                   | 5  | Subgenus <i>Parapuzosia</i>                          | 13 |
| Introduction                      | 1 | <i>Puzosia furnitana</i>                      | 6  | <i>Parapuzosia</i> ( <i>P.</i> ) <i>haughtoni</i>    | 13 |
| Conventions                       | 2 | <i>Puzosia</i> sp. group of <i>quenstedti</i> | 6  | <i>Parapuzosia</i> ( <i>P.</i> ) sp.                 | 14 |
| Repositories of specimens         | 2 | <i>Puzosia compacta</i>                       | 7  | <i>Parapuzosia</i> ( <i>P.</i> )? <i>truteri</i>     | 14 |
| Locality details                  | 2 | <i>Puzosia compressa</i>                      | 7  | Subgenus <i>Austiniceras</i>                         | 15 |
| Systematic palaeontology          | 2 | <i>Puzosia manasoensis</i>                    | 8  | <i>Parapuzosia</i> ( <i>A.</i> ) <i>subcompressa</i> | 15 |
| Family DESMOCERATIDAE             | 2 | <i>Puzosia eboroensis</i>                     | 8  | <i>Parapuzosia</i> ( <i>A.</i> ) <i>beantalyense</i> | 15 |
| Subfamily PUZOSIINAE              | 2 | Genus <i>Bhimaites</i>                        | 9  | Genus <i>Pachydesmoceras</i>                         | 16 |
| Genus <i>Valdedorsella</i>        | 2 | <i>Bhimaites bhima</i>                        | 9  | <i>Pachydesmoceras pachydiscoide</i>                 | 16 |
| <i>Valdedorsella akuschaensis</i> | 2 | <i>Bhimaites stoliczkai</i>                   | 10 | Acknowledgements                                     | 17 |
| Genus <i>Pseudohaploceras</i>     | 3 | <i>Bhimaites pinguis</i>                      | 10 | References   | 17 |
| <i>Pseudohaploceras matheroni</i> | 3 | <i>Bhimaites subtilis</i>                     | 12 | Figures 1–27   | 20 |
| Genus <i>Puzosia</i>              | 4 | <i>Bhimaites gortanii</i>                     | 13 |  |    |
| <i>Puzosia mayoriana</i>          | 4 | Genus <i>Parapuzosia</i>                      | 13 |  |    |

## INTRODUCTION

The subfamily Puzosiinae Spath, 1922 includes the largest and most bizarrely ornamented normally coiled ammonites.

*Parapuzosia* (*Parapuzosia*) *seppenradensis* (Landois, 1895), from the Lower Campanian of Westphalia, Germany, reaches a diameter of 1.74 metres (Kennedy & Kaplan,

1995). *Lytodiscoides* Spath, 1922, and the KwaZulu *Achilleoceras* Van Hoepen, 1951, the former with long, hollow ventrolateral horns, the latter with long umbilicolateral horns and a cockscomb ventral crest, are remarkable. Species that we would now refer to the genera *Puzosia* Bayle, 1878 and *Bhimaites* Matsumoto, 1954, were first described by Etheridge (1907) and Crick (1907) from the Albian and Cenomanian of the lower reaches of the Mzinene River, and the Munywana Creek in northern KwaZulu-Natal. Not all were figured, and their interpretation has remained problematic. Additional taxa from the same area were described by Venzo (1936). Spath (1921a, 1922) described a huge fragment of *Parapuzosia* Nowak, 1913 from the Santonian-Lower Campanian Mzamba Formation at Mzamba, in the Eastern Cape Province. Spath (1921b) recorded further material of representatives of the subfamily from northern KwaZulu-Natal, including a 670 mm diameter *Parapuzosia?* that is one of the largest ammonites recorded from South Africa, exceeded only by *Achilleoceras erasmusi* Van Hoepen (1951, p. 345, figs 1–3), at 840 mm in diameter (currently housed in the collections of the National Museum, Bloemfontein). There are additional records in Van Hoepen (1968), Kennedy, Wright & Klinger (1979), Cooper & Greyling (1996) and Kennedy & Klinger (2012).

Some very large specimens belonging to the subfamily are currently unavailable for study because of redevelopment of part of the South African Museum, and we have had to interpret them on the basis of existing accounts. Generic concepts of Albian to Campanian taxa used here correspond to those in Matsumoto (1988); those of *Pseudohaploceras* Hyatt, 1900 and *Valdedorsella* Breistroffer, 1947 to Wright (1996). Comprehensive synonymies of all of the Early Cretaceous taxa described below are to be found in Klein & Vašíček (2011). The following species are described below:

*Valdedorsella akuschaensis* (Anthula, 1899)  
*Pseudohaploceras matheroni* (d'Orbigny, 1841)  
*Puzosia mayoriana* (d'Orbigny, 1841)  
*Puzosia provincialis* (Parona & Bonarelli, 1897)  
*Puzosia furnitana* Pervinquière, 1907  
*Puzosia compacta* Crick, 1907  
*Puzosia natalensis* Crick, 1907  
*Puzosia compressa* Kossmat, 1898  
*Puzosia manasoensis* Collignon, 1961  
*Puzosia eboroensis* Collignon, 1961  
*Bhimaites bhima* (Stoliczka, 1865)  
*Bhimaites stoliczkai* (Kossmat, 1897)  
*Bhimaites pinguis* (Crick, 1907)  
*Bhimaites subtilis* (Crick, 1907)  
*Bhimaites gortanii* (Venzo, 1936)  
*Parapuzosia* (*Parapuzosia*) *haughtoni* Spath, 1922  
*Parapuzosia* (*Parapuzosia*) sp.  
*Parapuzosia* (*Parapuzosia*)? *truteri* (Van Hoepen, 1968)  
*Parapuzosia* (*Austiniceras*) *subcompressa* (Crick, 1907)  
*Parapuzosia* (*Austiniceras*) *beantalyense* Collignon, 1961  
*Pachydesmoceras pachydiscoide* Matsumoto, 1954

### 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 the 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.

### REPOSITORIES OF SPECIMENS

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

### LOCALITY DETAILS

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.

### SYSTEMATIC PALAEOLOGY

Suborder **AMMONITINA** Hyatt, 1889  
 Superfamily **DESMOCERATOIDEA** Zittel, 1895  
 Family **DESMOCERATIDAE** Zittel, 1895  
 Subfamily **PUZOSIINAE** Spath, 1922

Genus *Valdedorsella* Breistroffer, 1947  
 (= *Puezalpella* Dimitrova, 1967; *Weavericeras* Leanza & Wiedmann, 1980).

#### Type species

*Desmoceras akuschaense* Anthula, 1899, p. 104 (50), pl. 8 (7), fig. 3, by the original designation of Breistroffer, 1947, p. 76 (60).

#### *Valdedorsella akuschaensis* (Anthula, 1899)

##### Fig. 1A–C

- 1899 *Desmoceras akuschaense* Anthula, p. 104 (50), pl. 8 (7), fig. 3.  
 1961 *Desmoceras akuschaensis* Anth.; Eristavi, p. 76.  
 1962 *Valdedorsella akuschaensis* Anth. var. *madagascariensis* Collignon, 1962, p. 33, pl. 229, fig. 979.  
 1967 *Valdedorsella akuschaensis* (Anthula); Obata, p. 65, pl. 8, figs 1, 4; text-fig. 1.  
 2011 *Valdedorsella akuschaensis akuschaensis* (Anthula, 1899); Klein & Vašíček, p. 24.  
 2011 *Valdedorsella akuschaensis madagascariensis* Collignon, 1962; Klein & Vašíček, p. 24.

#### Types

The lectotype, by the subsequent designation of Obata (1967, p. 65), is the original of *Desmoceras akuschaense* Anthula, 1899, p. 104 (50), pl. 8 (7), fig. 3, from the Upper Aptian of Daghestan. There are two paralectotypes.

#### Material

OUM KX9521, from bed 18 of the Makatini Formation, Aptian III at locality 168 of Kennedy & Klinger (1975) on the Mfongosi Spruit, northern KwaZulu-Natal.

## Dimensions

|            | D             | Wb             | Wh             | Wb:Wh | U              |
|------------|---------------|----------------|----------------|-------|----------------|
| OUM KX9521 | 58.3<br>(100) | 32.6<br>(55.6) | 29.1<br>(50.0) | 1.12  | 12.7<br>(21.8) |

## Description

The specimen is a phragmocone 58.3 mm in diameter, retaining extensive areas of recrystallized shell. Coiling is involute, the deep umbilicus comprises 21.8% of the diameter, the umbilical wall high, with a flattened wall and narrowly rounded umbilical shoulder. The whorl section is depressed, with a whorl breadth to height ratio of 1.12, the greatest breadth just outside the umbilical shoulder, the flanks very feebly convex, subparallel, the ventrolateral shoulders broadly rounded, the venter broad, and very feebly convex. There are four strong collar ribs on the outer half whorl, straight, recti- to feebly rursiradiate on the inner flank, feebly concave on the outer flank and ventrolateral shoulder, and near-straight to barely convex across the venter. The collar ribs are succeeded by a shallow constriction. There are an estimated 12 delicate ribs between successive constrictions/collar ribs. They parallel the constrictions, are mere striae on the inner flank, strengthening on the outer flanks and ventrolateral shoulders, where they are feebly concave, strengthening and passing over the venter in a shallow convexity.

## Discussion

The present specimen differs in no significant respects from the lectotype. The variety *madagascariensis* of Collignon (1962 p. 33, pl. 229, fig. 979), differentiated on the basis of its narrower umbilicus and higher whorls, does not bear separation.

## Occurrence

Upper Aptian, Dagestan, Azerbaijan, Georgia, southern Ukraine, Bulgaria, southeastern France, Egypt, northern KwaZulu-Natal, Madagascar and Japan.

Genus *Pseudohaploceras* Hyatt, 1900  
(=*Caseyella* Cantú Chapa, 1976)

## Type species

*Ammonites liptoviensis* Zeuschner, 1856, p. 181, pl. 2, figs 1–3, by the original designation of Hyatt, 1900, p. 570.

*Pseudohaploceras matheroni* (d'Orbigny, 1841)

Fig. 2

1841 *Ammonites Matheronii* d'Orbigny, p. 148, pl. 48, figs 1, 2.

2006 *Pseudohaploceras matheroni* (d'Orbigny, 1841); Busnardo *in* Gauthier, p. 53, pl. 24, fig. 1.

2011 *Pseudohaploceras matheroni matheroni* (d'Orbigny, 1841); Klein & Vašíček, p. 40 (with full synonymy).

## Type

The holotype, by monotypy, is the original of d'Orbigny (1841, p. 148, pl. 48, figs 1, 2), from Cassis, Bouches-du-Rhône, France, in the Matheron Collection, housed in the

Muséum d'Histoire Naturelle, Marseille, refigured by Busnardo (*in* Gauthier 2006, pl. 24, fig. 1).

## Material

SAM-PCZ22497–22499 from bed 45 of the Lower Aptian (Aptian I) Makatini Formation at locality 170 of Kennedy & Klinger (1975), on the Mlambongwenya Spruit, in northern KwaZulu-Natal.

## Dimensions

|              | D             | Wb             | Wh             | Wb:Wh | U              |
|--------------|---------------|----------------|----------------|-------|----------------|
| SAM-PCZ22498 | 75.5<br>(100) | 35.5<br>(47.0) | 32.5<br>(47.0) | 0.92  | 21.5<br>(28.5) |

## Description

Coiling is moderately involute, with a deep umbilicus that comprises 28.5% of the diameter. The umbilical wall is flattened and slopes outwards. The umbilical shoulder is broadly rounded. The whorl section is slightly compressed, with a whorl breadth to height ratio of 0.92, flattened inner, and broadly rounded outer flanks and venter. The greatest breadth is outside the umbilical shoulder. There are five constrictions per half whorl on the internal mould. They are narrow at the umbilical seam and broaden markedly across the flanks and venter, prorsiradiate and feebly flexuous: convex on the inner to mid-flank, concave on the outer flank, and crossing the venter in a very broad, shallow convexity. They are preceded by a strong, narrow rib. There are 10–15 much weaker flexuous ribs between constrictions that are most obvious on the ventrolateral shoulders and venter, and weaker on the internal mould than where the shell is preserved. SAM-PCZ22498 retains replaced shell; there are no constrictions; their position on the mould is marked by a zone of strong growth striae but no actual ribs. The surface of the shell between these zones bears fine, distinctly flexuous and bifurcating ribs.

## Discussion

The present fragments differ in no significant respects from the holotype (Busnardo *in* Gauthier 2006, p. 53, pl. 24, fig. 1). *Pseudohaploceras liptoviense* (Zeuschner, 1856) (see synonymy in Klein & Vašíček, 2011, p. 39, and discussion in Gonzalez-Arreola, Pantoja-Alor, Olóriz, Villaseñor & Garcia-Barrera, 1996) is distinguished by the more numerous, flexuous constrictions. The present slight material does not provide a basis with which to assess the 'varieties/subspecies' *caucasicum* Luppov, 1949, p. 214, pl. 61, fig. 1), *lateumbilicatus* Avram, Duşa & Lupu, 1990 (p. 5, figs 1, 5; text-fig. 1, 15), *liptoviensesforme* Kilian, 1913 (pp. 301, 306) and *slatinensis* Dimitrova, 1967 (p. 142, pl. 76, fig. 1).

## Occurrence

The stratigraphic range of *Pseudohaploceras matheroni* is Upper Barremian to Lower Aptian. The geographic distribution extends from southeastern France to Spain, Upper Austria, Poland, Romania, Bulgaria, Georgia, central Tunisia, Egypt, southern Tanzania and northern KwaZulu-Natal.

Genus *Puzosia* Bayle, 1878

## Type species

*Ammonites planulatus* J. de C. Sowerby, 1827, p. 134, pl. 570, fig. 5, non von Schlotheim, 1820, p. 59; = *Ammonites mayorianus* d'Orbigny, 1841, p. 267, pl. 79, figs 1–3, by subsequent designation by H. Douvillé (1879, p. 91).

*Puzosia mayoriana* (d'Orbigny, 1841)

## Fig. 3

- 1827 *Ammonites planulatus* J. de C. Sowerby, p. 597, pl. 570, fig. 5 (non von Schlotheim, 1820, p. 59).
- 1841 *Ammonites Mayorianus* d'Orbigny, p. 267, pl. 79, figs 1–3.
- 1907 *Puzosia planulata* J. de C. Sowerby sp. nov. var. *natalensis* Crick, p. 213, pl. 14, fig. 4.
- 1907 *Puzosia concinna* Crick, p. 245.
- 1925 *Puzosia planulata* var. *natalensis* Crick; Diener, p. 123.
- 1936 *Puzosia mayoriana* (d'Orb.) var. *natalensis* Crick; Venzo, p. 68 (10), pl. 6 (1), fig. 9.
- 1955 *Puzosia concinna* Crick; Van Hoepen, p. 357.
- 1961 *Puzosia natalensis* Crick; Collignon, p. 88.
- 1984 *Puzosia (Puzosia) mayoriana* (d'Orbigny, 1841); Wright & Kennedy, p. 55, pl. 3 figs 1, 2, 4, 6, 9–12; pl. 4, figs 1, 2, 5–7; text-figs 1a, b, 2c, h, m, 3n–r, 4a–c (with synonymy).
- 2004 *Puzosia (Puzosia) mayoriana* (d'Orbigny, 1841); Kennedy & Jolkičev, p. 372, pl. 1, figs 4–6 (with additional synonymy).
- 2005 *Puzosia (P.) mayoriana* (Sowerby); Reboulet, Giraud & Proux, text-fig. 3a.
- 2006 *Puzosia mayoriana* (d'Orbigny, 1841); Kennedy & Juignet in Gauthier, p. 96, pl. 49, fig. 4.
- 2007 *Puzosia (Puzosia) mayoriana* (d'Orbigny, 1841); Kennedy & Latil, p. 460, pl. 1, figs 1–6; pl. 3, fig. 1.
- 2007 *Puzosia (Puzosia) mayoriana* (d'Orbigny, 1841); Szives, p. 96, pl. 13, fig. 9; pl. 14, fig. 7; pl. 19, fig. 8; pl. 28, figs 8, 10, 13.
- 2008 *Puzosia (Puzosia) mayoriana* (d'Orbigny, 1841); Kennedy, Amédro, Jagt & Robaszynski, p. 37, pl. 8, figs 15, 16.
- 2009 *Puzosia (Puzosia) mayoriana* (d'Orbigny, 1841); Kennedy & Bilotte, p. 47, pl. 3, figs 32, 33, 37–40.
- 2011 *Puzosia (Puzosia) natalensis* Crick, 1907; Klein & Vašíček, p. 83.

## Type

The lectotype, by the subsequent designation of Wright & Wright (1951, p. 35), is BMNH 9381, the original of J. de C. Sowerby (1827, pl. 570, fig. 5), from the Cenomanian Lower Chalk of Hamsey, near Lewes, Sussex.

## Material

BMNH C18306 (Fig. 3M–P, T–V), the holotype, by monotypy, of *Puzosia concinna* Crick, 1907, p. 245, from the 'middle tributary of the Manuan Creek', a locality indicating the specimen to be from the lower Upper Albian (Albian V) part of the Mzinene Formation. The syntypes of *Puzosia mayoriana* var. *natalensis* of Crick, 1907: his specimen a is BMNH C18238, his specimen b, the original of pl. 14, fig. 4, is BMNH C18239, which we here designate lectotype of *natalensis*. Both specimens are from from 'the deposit at the

north end of False Bay', that is to say the Cenomanian part of the Mzinene Formation of the Skoenberg. OUM KX 4705, 4707, and 4709, collected loose at locality 62 of Kennedy & Klinger (1975), the eastern 'horn' of the Skoenberg, and from the upper Lower or Middle Cenomanian part of the Mzinene Formation.

## Dimensions

|             | D             | Wb             | Wh             | Wb:Wh | U              |
|-------------|---------------|----------------|----------------|-------|----------------|
| OUM KX4707  | 24.0<br>(100) | 9.1<br>(37.9)  | 9.7<br>(40.4)  | 0.94  | 7.5<br>(31.3)  |
| BMNH C18239 | 26.5<br>(100) | 10.6<br>(40.0) | 11.0<br>(41.5) | 0.96  | 11.8<br>(34.6) |
| BMNH C18306 | 31.6<br>(100) | 10.6<br>(33.5) | 12.5<br>(39.6) | 0.85  | 9.8<br>(31.0)  |
| OUM KX4709  | 33.0<br>(100) | 11.4<br>(34.5) | 12.5<br>(37.9) | 0.91  | 11.3<br>(34.2) |
| BMNH C18238 | 34.1<br>(100) | 12.2<br>(35.8) | 14.5<br>(42.5) | 0.84  | 11.8<br>(34.6) |

## Description

BMNH C18306 (Fig. 3M–P, T–V), the holotype of *Puzosia concinna* is a well-preserved phragmocone with recrystallized shell preserved, and indications of the former presence of a further 240° whorl sector. Coiling is moderately evolute, with 59% of the previous whorl covered. The umbilicus is shallow, and comprises 31% of the diameter, with a low, feebly convex wall and broadly rounded umbilical shoulder. The whorl section is compressed ovoid, with a whorl breadth to height ratio of 0.84, the inner and middle flanks feebly convex, the outer flanks converging to broadly rounded ventrolateral shoulders and an arched venter. There are five well-developed narrow constrictions on the outer whorl. They are deeply incised into the umbilical shoulder, prorsiradiate on the inner flanks, flexing back and concave on the outer flanks and projected forwards to cross the venter in a narrow obtuse linguoid ventral peak. The inner flanks are near-smooth, but delicate, crowded ribs appear on the outer flanks, where they are concave, crossing the venter in a broad convexity. The penultimate constriction is preceded by a relatively coarse collar rib on the ventrolateral shoulders and venter. There are an estimated 25–30 ribs between successive constrictions. BMNH C18238 (Fig. 3A–D, I–L), the lectotype of *Puzosia mayoriana natalensis*, Crick's specimen a (1907, p. 214), is a phragmocone, retaining heavily corroded recrystallized shell, with indications of the former presence of a further 240° whorl sector. Coiling is moderately evolute, the umbilicus comprising 34.6% of the diameter, the umbilical wall low and feebly convex. The whorl section is compressed, with a whorl breadth to height ratio of 0.84, the greatest breadth below mid-flank, the inner and middle flanks feebly convex, the outer flanks converging to broadly rounded ventrolateral shoulders and an arched venter. Ornament is very corroded. At one point the ventral part of a constriction is preserved; it takes the form of an obtuse convex ventral peak with a narrowly rounded termination. Elsewhere there are traces of crowded, delicate concave ribs on the ventrolateral shoulders that sweep forwards and cross the venter in a convex ventral peak that does not match the course of the constrictions. BMNH C18239



(Fig. 3E–H), the original of Crick, 1907, pl. 14, fig. 4 is an even more corroded specimen, 27 mm in maximum preserved diameter, with a whorl breadth to height ratio of 0.96. Delicate, crowded convex ribs survive on parts of the venter, which they cross in a broad linguoid peak. Poorly preserved constrictions form a sharp ventral chevron.

OUM KX4707 and 4709 (Fig. 3Q–S, W, X) have the constrictions well preserved in the ventral area; they are in the form of an obtuse chevron, the sides concave, with a narrowly rounded apex, as in typical *mayoriana*.

#### Discussion

*Puzosia mayoriana* and its synonyms were comprehensively reviewed by Wright & Kennedy (1984, p. 55, pl. 3 figs 1, 2, 4, 6, 9–12; pl. 4, figs 1, 2, 5–7; text-figs 1a, b, 2c, h, m, 3n–r, 4a–c). The form of the ventral part of the constrictions and associated collar-rib immediately distinguish it from other *Puzosia* species from northern KwaZulu-Natal.

#### Occurrence

*Puzosia mayoriana* ranges from Upper Albian to Upper Cenomanian, and has a cosmopolitan distribution, with records from western Europe eastwards to Iran, North, East, West and South Africa, Madagascar, South India and Japan.

#### *Puzosia provincialis* (Parona & Bonarelli, 1897)

##### Fig. 4

- 1897 *Desmoceras provinciale* Parona & Bonarelli, p. 81 (29), pl. 11 (2), fig. 4.  
 1968 *Puzosia provincialis* (Par. & Bon., 1897); Wiedmann & Dieni, p. 118, pl. 10, figs 1, 8; pl. 11, figs 1, 2, ?4, ?5, ?7, ?12; text-figs. 74–5 ?.  
 1979 *Puzosia (Puzosia) mayoriana provincialis* (Parona & Bonarelli, 1897); Scholz, p. 66, pl. 11, fig. 10; pl. 12, figs 1, 2, 4, 5, 6, 9, 10; pl. 13, fig. 2; text-figs 19a, b, e, f.  
 1981 *Puzosia provincialis* (Parona & Bonarelli); Chiriac, p. 77, pl. 8, fig. 2; pl. 9, figs 2, 3; text-figs 28, 29.  
 1995 *Puzosia provincialis* (Parona & Bonarelli); Seyed-Emami & Immel, p. 386, fig. 27.  
 1996 *Puzosia provincialis* (Parona & Bonarelli); Seyed-Emami & Immel, p. 10, pl. 1, fig. 9.  
 1990 *Puzosia mayoriana provincialis* (Parona & Bonarelli); Marcinowski & Wiedmann, p. 57, pl. 6, fig. 3; text-fig. 25a, b.  
 2011 *Puzosia mayoriana provincialis* (Parona & Bonarelli, 1897); Klein & Vašíček, p. 85 (with additional synonymy).

#### Type

The holotype, by monotypy, is the original of *Desmoceras provinciale* Parona & Bonarelli, 1897, p. 81 (29), pl. 11 (2), fig. 4, refigured by Wiedmann & Dieni (1968, pl. 10, fig. 1), in the collections of the Geological Institute, Turin, and from the condensed Albian of Escragnolles, Alpes-Maritimes, France.

#### Material

SAM-A2002, from excavations for a bridge over the Hluhluwe River, south of Hluhluwe. SAM-A1129, from the Munywana Creek in the environs of locality 64 of Kennedy & Klinger (1975), both from the Upper Albian (Albian V) Mzinene Formation.

#### Dimensions

|           | D             | Wb             | Wh             | Wb:Wh | U              |
|-----------|---------------|----------------|----------------|-------|----------------|
| SAM-A2002 | 52.0<br>(100) | 20.3<br>(39.0) | 20.0<br>(38.5) | 1.01  | 17.7<br>(34.0) |
| SAM-A1129 | 59.0<br>(100) | 19.5<br>(33.0) | 24.5<br>(41.5) | 0.79  | 17.8<br>(30.7) |
|           | 71.0<br>(100) | 23.3<br>(32.8) | 28.5<br>(40.1) |       | 22.0<br>(30.9) |

#### Description

SAM-A2002 (Fig. 4A–C) is a well-preserved internal mould of a phragmocone, 52 mm in diameter. Coiling is evolute, with 38% of the previous whorl covered. The umbilicus is of moderate width, and comprises 34% of the diameter. The umbilical wall is flattened, the umbilical shoulder narrowly rounded. The whorl section is slightly depressed, with the greatest breadth just outside the umbilical shoulder. The flanks are flattened, convergent, the ventrolateral shoulders and venter broadly rounded. There are 7–8 strong, deep, relatively wide, falcooid constrictions per whorl. They are straight on the inner flank, convex at mid-flank, and concave on the outer flank, sweeping forwards and narrowing over the venter, which they cross in a broad convexity. There are up to an estimated nine fine concave ribs between successive constrictions on the ventrolateral shoulders and venter, which they cross in a broad convexity. SAM-A1129 (Fig. 4D–H) is less well preserved, and retains exfoliated shell. The coiling is more evolute than in the previous specimen, and the whorl section distinctly compressed. There are four constrictions per half whorl, with delicate ribs preserved only on the adapertural part of the outer whorl.

#### Discussion

The holotype of *Puzosia provincialis* is a tiny individual, only 22.5 mm in diameter, with whorl breadth equal to whorl height, the umbilicus comprising 31% of the diameter, and an estimated six to seven constrictions per whorl. These are falcooid, straight and prorsiradiate on the inner flank, convex at mid-flank, concave on the outer flank, projected strongly forwards on the ventrolateral shoulder, and crossing the venter in a broad convexity. Overall shell form and course of constrictions of the present specimens agree well with the holotype, but there are slightly more constrictions per whorl. Previous authors (for example Wiedmann & Dieni, 1968; Klein & Vašíček, 2011) regarded *Puzosia sharpei* Spath, 1923 (p. 46), as a synonym of *Puzosia provincialis*. The holotype is the original of Sharpe, 1855, pl. 12, fig. 4, refigured by Spath, 1923, pl. 1, fig. 11, and Cooper & Kennedy (1987, figs 1g, h, 5b); the species differs from *provincialis* most obviously in the form of the constrictions on the venter where they take the form of an acute V with concave sides, rather than the rounded obtuse linguoid form of the constrictions on the venter of *provincialis*. *Puzosia sharpei* is regarded as a synonym of *Puzosia mayoriana* (d'Orbigny, 1841), following Wright & Kennedy (1984) and Cooper & Kennedy (1987).

There is no agreement on the species limits of the diverse juvenile Albian *Puzosia* described from western Europe, as a comparison of treatments by Wiedmann & Dieni (1968),

Renz, (1968), Scholz (1979), Wright & Kennedy (1984), Marcinowski & Wiedmann (1990) and Klein & Vašíček (2011) indicate. The present material does not provide a basis for useful discussion, and only a limited synonymy is given above.

#### Occurrence

Upper Middle and Upper Albian, southeastern France, Sardinia, Germany, Poland, Romania, Iran, and northern KwaZulu-Natal.

#### *Puzosia furnitana* Pervinquierè, 1907

Fig. 1G–L

1907 *Puzosia Mayoriana* var. *Furnitana* Pervinquierè, 1907, p. 158, pl. 6, figs 27, 28.

1968 *Puzosia furnitana* Pervinquierè, 1907; Wiedmann & Dieni, p. 112, pl. 10, fig. 12; pl. 11, fig. 6; text-figs 70–71.

1990 *Puzosia furnitana* Pervinquierè, 1907; Marcinowski & Wiedmann, p. 54, pl. 6, fig. 2.

2011 *Puzosia furnitana* Pervinquierè, 1907; Klein & Vašíček, p. 73 (with full synonymy).

#### Type

Wiedmann & Dieni (1968, p. 112) referred to the original of Pervinquierè (1907) pl. 6, figs 27 and 28 (the same specimen, figured  $\times 1$  and  $\times 2$ ) as the 'holotypus'. However, Pervinquierè (1907, p. 158), based his 'varieté *furnitana*' on four or five specimens. Accordingly, we here designate the original of Pervinquierè, (1907, p. 158, pl. 6, figs 27, 28), from Guern er Rhezal, in central Tunisia, lectotype of *Puzosia furnitana*. It was described as being from the 'Vraconnien', that is to say the Upper Albian.

#### Material

OUM KX 5629, 5630, 5634, 5386 and 12335, from locality 65; OUM KX12478, from locality 66, all from the Upper Albian (Albian V) part of the Mzinene Formation.

#### Dimensions

|             | D             | Wb             | Wh             | Wb:Wh | U              |
|-------------|---------------|----------------|----------------|-------|----------------|
| OUM KX12335 | 24.0<br>(100) | 8.5<br>(35.4)  | 0.5<br>(43.8)  | 0.81  | 6.7<br>(27.9)  |
| OUM KX5386  | 48.8<br>(100) | 18.3<br>(37.5) | 20.2<br>(41.4) | 0.91  | 14.9<br>(30.5) |
| OUM KX5629  | 57.3<br>(100) | 21.3<br>(37.2) | 24.4<br>(42.6) | 0.86  | 18.2<br>(31.8) |

#### Description

The best-preserved specimen is OUM KX5629 (Fig. 1K, L), an internal mould with traces of limonitized shell. Coiling is moderately involute, with 60% approximately of the previous whorl covered. The umbilicus comprises 32% of the diameter, and is shallow, with a flattened, outward-inclined wall, and narrowly rounded umbilical shoulder. The whorl section is slightly compressed, with a whorl breadth to height ratio of 0.86, the flanks flattened and subparallel, the ventrolateral shoulders broadly rounded, the venter feebly convex. The internal mould bears five strong constrictions on the adapertural half whorl. They are deeply incised into the umbilical shoulder, relatively broad, straight and

prorsiradiate on the inner to middle flank, flexing forward on the outermost flank and ventrolateral shoulder and crossing the venter in a shallow convexity. Where shell is preserved, the inner flanks are seen to be smooth, the venter ornamented by dense riblets that parallel the course of the constrictions. OUM KX5630 (Fig. 1I, J), 56 mm in diameter, has a whorl breadth to height ratio of 0.9, and also has five constrictions per half whorl. Traces of shell reveal the presence of an adapical collar rib on the venter. OUM KX5386 (Fig. 1G, H) is a nucleus 35.3 mm in diameter and a 120° sector of outer whorl with a maximum preserved whorl height of 25.5 mm. The whorl breadth to height ratio is 0.86. It retains partially exfoliated limonitized shell material. The constrictions are strong on the internal mould, straight and prorsiradiate on the inner flank, flexing forwards and concave on the outer flank and ventrolateral shoulder, and crossing the venter in a broad convexity. They are markedly asymmetric in cross-section, with a steeper adapertural face.

#### Occurrence

Upper Albian, Tunisia, Sardinia, Poland, western Ukraine, Madagascar, and northern KwaZulu-Natal.

#### *Puzosia* sp. group of *quenstedti* Parona & Bonarelli, 1897

Fig. 5

#### Compare:

1897 *Puzosia Quenstedti* n.f. Parona & Bonarelli, p. 81 (29), pl. 11 (2), fig. 3).

2011 *Puzosia (Puzosia) quenstedti quenstedti* (Parona & Bonarelli, 1897); Klein & Vašíček, p. 86 (with full synonymy).

#### Material

SAM-Z26A–D, from the environs of localities 54–56 of Kennedy & Klinger (1975). OUM KX14437, from locality 66 of Kennedy & Klinger (1975). OUM KX5632–33, from locality 65 of Kennedy & Klinger (1975), all from the Upper Albian (Albian V) part of the Mzinene Formation.

#### Dimensions

|             | D             | Wb             | Wh             | Wb:Wh | U              |
|-------------|---------------|----------------|----------------|-------|----------------|
| OUM KX14437 | 53.6<br>(100) | 18.7<br>(34.8) | 25.9<br>(48.3) | 0.72  | 12.2<br>(22.8) |
| SAM-Z26-B   | 48.3<br>(100) | 15.0<br>(31.1) | 21.4<br>(44.3) | 0.70  | 11.8<br>(24.4) |
| SAM-Z26-A   | 50.5<br>(100) | 18.0<br>(356)  | 22.7<br>(45.0) | 0.79  | 1.5<br>(26.1)  |

#### Description

Specimens referred to the species range from 30–54 mm in diameter. The largest (OUM KX14437: Fig. 5D–E) retains part of the body chamber, but other specimens of comparable size are largely septate. It is unclear if all of the material is juvenile, or if this a genuinely diminutive species. Coiling is involute, the umbilicus small (22.8–26% of the diameter), shallow, with a low, flattened wall and narrowly rounded umbilical shoulder. The whorl section is compressed, with whorl breadth to height ratios of 0.70–0.79, the flanks feebly convex, subparallel, the greatest breadth below mid-flank. The ventrolateral shoulders and venter are broadly rounded. Internal moulds (Fig. 5F–H, K–M) are smooth, but

for five prominent constrictions per half whorl. These are deeply incised into the umbilical shoulder, straight and prorsiradiate on the inner and middle flank, and feebly concave on the outermost flank and ventrolateral shoulder, crossing the venter in a broad convexity. Where the shell surface is preserved (Fig. 5A–E, I, J, N), the inner flanks are ornamented by dense, crowded growth lines and lirae, straight and prorsiradiate on the inner to middle flank; these strengthen on the outer flanks, ventrolateral shoulders and venter. They are concave on the outer flank and ventrolateral shoulder, and cross the venter in a broad convexity. The constrictions are weakly expressed on the surface of the shell, and are flanked by narrow collar ribs, the adapical strengthened into a pronounced lip on ventrolateral shoulders and venter.

#### Discussion

These small specimens are distinguished from other Upper Albian *Puzosia* from northern KwaZulu-Natal by their compressed whorl section, involute coiling, well-developed constrictions that cross the venter in a broad convexity, and distinct fine, even ornament. Internal moulds have the same coiling and constrictions as the figured syntype of *Puzosia quenstedti* Parona & Bonarelli, 1897 (p. 81 (29), pl. 11 (2), fig. 3).

The taxonomy of *quenstedti* and its allies is unresolved, with very different approaches developed by previous authors (Wiedmann & Dieni, 1968; Scholz, 1979; Wright & Kennedy, 1984; Marcinowski & Wiedmann, 1990).

#### Occurrence

Upper Albian of northern KwaZulu-Natal.

#### *Puzosia compacta* Crick, 1907

Fig. 6A–K

1907 *Puzosia compacta* Crick, p. 246, pl. 15, fig. 7.

2011 *Puzosia (Puzosia)? compacta* Crick, 1907; Klein & Vašíček, p. 71.

#### Type

The holotype, by monotypy, is BMNH C18307, the original of Crick, 1907, p. 246, pl. 15, fig. 7, from the ‘middle tributary of the Manuan Creek’, a locality indicating the specimen to be from the lower Upper Albian part of the Mzinene Formation.

#### Material

SAM-Z1505, Z1505a, from the Upper Albian (Albian V) part of the Mzinene Formation on the north bank of the Mzinene in the environs of localities 54–56 of Kennedy & Klinger (1975).

#### Dimensions

|             | D             | Wb             | Wh             | Wb:Wh | U              |
|-------------|---------------|----------------|----------------|-------|----------------|
| BMNH C18307 | 21.8<br>(100) | 8.8<br>(40.4)  | 9.3<br>(42.7)  | 0.95  | 6.8<br>(31.2)  |
| SAM-Z1505   | 45.6<br>(100) | 17.3<br>(37.9) | 19.3<br>(42.3) | 0.90  | 13.4<br>(29.4) |
| SAM-Z1505a  | 57.0<br>(100) | 20.0<br>(35.1) | 22.9<br>(40.2) | 0.87  | 18.0<br>(31.6) |

#### Description

The holotype (Fig. 6A–F) retains extensive traces of recrystallized shell, and indications of the former presence of a further whorl. Coiling is moderately involute, the umbilicus shallow, with a convex, outward-inclined wall and broadly rounded umbilical shoulder. The whorl section is slightly compressed, with a whorl breadth to height ratio of 0.95, the greatest breadth well below mid-flank. The surface of the recrystallized shell is very corroded, and no ornament survives. There are four constrictions on the adapertural half of the outer whorl. They are deeply incised into the umbilical shoulder, straight and prorsiradiate across the flanks, sweeping forwards on the ventrolateral shoulders to form an obtuse ventral chevron with a narrowly rounded ventral peak.

SAM-Z1505a and Z1505 (Fig. 6G–I, J, K) may be larger specimens of *Puzosia compacta*. They have comparable proportions and very delicate riblets on the ventrolateral shoulders and venter, which they cross in a broad convexity. There are periodic convex collar-ribs that mark the site of the constrictions.

#### Discussion

This a problematic species. When compared with other *Puzosia* from northern KwaZulu-Natal, the distinguishing characters are the coiling, the only slightly compressed whorl section, and the form of the ventral part of the constrictions and associated collar ribs.

#### Occurrence

Lower Upper Albian, northern KwaZulu-Natal.

#### *Puzosia compressa* Kossmat, 1898

Fig. 1D–F

1865 *Ammonites Durga* Forbes; Stoliczka, p. 143, pl. 71, figs 6, 7.

1898 *Puzosia compressa* Kossmat, p. 184 (119), pl. 24 (18), fig. 4.

1906 *Desmoceras (Puzosia) compressum* Kossmat; Boule, Lemoine & Thévenin, p. 190 (18), pl. 17 (4), fig. 3; pl. 18 (5), figs 1, 2; text-figs 9, 10.

1961 *Puzosia compressa* Kossmat; Collignon, p. 28, pl. 2, fig. 1.

1964 *Puzosia praecompressa* Collignon, p. 55, pl. 332, fig. 1493.

1986 *Puzosia compressa* Kossmat; Chiplonkar, Ghare & Oka, p. 33, pl. 1, figs 7, 8.

1988 *Puzosia compressa* Kossmat, 1898; Matsumoto, p. 38.

2011 *Puzosia (Puzosia) compressa* Kossmat, 1898; Klein & Vašíček, p. 71 (with additional synonymy).

#### Type

The lectotype, designated by Matsumoto, 1988, p. 38, is the original of *Ammonites durga sensu* Stoliczka, 1865, p. 143, pl. 71, fig. 7, from the Utatur Group of Odium, South India.

#### Material

OUM KX12331, collected loose at locality 62 of Kennedy & Klinger (1975), the eastern ‘horn’ of the Skoenberg, and from the upper Lower or Middle Cenomanian part of the Mzinene Formation.

### Description

The specimen (Fig. 1D–F) is just under half a whorl of phragmocone retaining extensive areas of worn, recrystallized shell material. The estimated original diameter is 64 mm. Coiling is very evolute, the shallow umbilicus comprising an estimated 37% of the diameter. The umbilical wall is low, flat, the umbilical shoulder very narrowly rounded, the whorl section compressed, with a whorl breadth to height ratio of 0.65, the flanks flattened and subparallel, the ventrolateral shoulders broadly rounded, the venter very feebly convex. The surface of the figured side is worn. The inner flanks appear smooth. Ornament is preserved on the outermost flank, ventrolateral shoulders and venter. It consists of very fine, feebly concave, strongly prorsiradiate ribs that strengthen progressively across ventrolateral shoulders and venter, which they cross in a very obtuse chevron, with rounded apex. There is an ill-defined constriction at the adapical end of the fragment. It is straight and prorsiradiate on the inner flank, sweeping forwards and concave on the outer flank, and forming an obtuse chevron on the venter.

### Discussion

The lectotype is a much larger individual, still septate at a diameter of 130 mm, but with comparable proportions and ornament to the present, much smaller specimen. This differs in no significant respects from the comparably sized individual referred to this species from the Lower Cenomanian of Madagascar figured by Collignon (1964, p. 40, pl. 326, fig. 1461), and reillustrated here as Fig. 7A, B. *Puzosia praecompressa* Collignon, 1964 (p. 55, pl. 332, fig. 1493), also from the Lower Cenomanian, was differentiated from *compressa* on the basis of the broader whorl section, smaller umbilicus, and coarser ornament. The holotype is reillustrated here as Fig. 7C, D, and is clearly conspecific with the present species.

### Occurrence

Imprecisely dated within the Lower to Middle Cenomanian, with records from South India, Madagascar, and northern KwaZulu-Natal.

### *Puzosia manasoensis* Collignon, 1961

Fig. 9A, B

1961 *Puzosia manasoensis* Collignon, p. 34, pl. 5, fig. 2.

1965 *Puzosia manasoensis* Coll.; Collignon, p. 20, pl. 421, fig. 1747.

?1988 *Puzosia* cf. *manasoensis* Collignon; Matsumoto & Kera in Matsumoto, p. 43, text-fig. 7.

### Type

The holotype, by original designation, is the original of Collignon, 1961, p. 34, pl. 5, fig. 2, from the Lower Coniacian Zone à *Kossmaticeras theobaldi* et *Barroisiceras onilahyense* of his gisement 462, Manaso, west of Tongobory (Betioky), Madagascar, housed in the collections of the Laboratoire de Paléontologie of the Muséum National d'Histoire Naturelle, Paris.

### Material

SAM-Z1290, from the Lower Coniacian (Coniacian I) of

locality 62 of Kennedy & Klinger (1975), the Skoenberg, in northern KwaZulu-Natal.

### Dimensions

|           | D             | Wb             | Wh             | Wb:Wh | U              |
|-----------|---------------|----------------|----------------|-------|----------------|
| SAM-Z1290 | 78.0<br>(100) | 23.0<br>(29.4) | 29.0<br>(37.2) | 0.79  | 23.9<br>(30.6) |

### Description

SAM-Z1290 (Fig. 9A, B) is 78 mm in diameter. Coiling is fairly evolute, with 37% of the previous whorl covered. The shallow umbilicus is wide, and comprises 30% of the diameter. The umbilical wall is feebly convex, the umbilical shoulder narrowly rounded. The whorl section is compressed, with a whorl breadth to height ratio of 0.79, the greatest breadth well below mid-flank, the inner flanks feebly convex, the outer flanks converging to the narrow, arched venter. There are seven or eight major primary ribs per whorl. They arise at the umbilical seam, and strengthen across the umbilical wall and shoulder. They are narrow, rounded, and prorsiradiate, straight to feebly convex to mid-flank, beyond which they flex forwards, strengthen, and are markedly concave on the outer flank. They thicken and strengthen further on the venter, forming a distinctive convex linguoid peak. The primary ribs are preceded by a narrow smooth zone, sometimes slightly constricted. There are 14–17 much finer, narrow, rounded, flexuous intercalated ribs between successive primaries. They are strongly projected and concave on the outer flank. They extend, in attenuated form, to the inner flank and umbilical shoulder, where the surface of the replaced shell is well preserved.

### Discussion

*Puzosia manasoensis* differs from *Puzosia eboroensis* Collignon, 1961, the second *Puzosia* recorded from the Lower Coniacian of northern KwaZulu-Natal (see below), in the weaker, finer, more numerous ribs between successive constrictions, 14–17 in the present material *versus* 10–12 in *eboroensis*.

### Occurrence

Lower Coniacian of Madagascar, northern KwaZulu-Natal, and, possibly, Japan.

### *Puzosia eboroensis* Collignon, 1961

Fig. 8

1961 *Puzosia eboroensis* Collignon, p. 35, text-fig. 1.

### Type

The holotype, by monotypy, is the original of Collignon, 1961, p. 35, text-fig. 1, from the Lower Coniacian Zone à *Kossmaticeras theobaldi* et *Barroisiceras onilahyense* of his gisement 402, Eboro (Betioky), Madagascar, housed in the collections of the Laboratoire de Paléontologie of the Muséum National d'Histoire Naturelle, Paris.

### Material

SAM-Z1051, from the Lower Coniacian (Coniacian I) St Lucia Formation at locality 62 of Kennedy & Klinger



(1975). SAM-Z1157, is from the same horizon in the environs of locality 73 of Kennedy & Klinger (1975) 'Itweba'

#### Dimensions

|           | D             | Wb             | Wh             | Wb:Wh | U              |
|-----------|---------------|----------------|----------------|-------|----------------|
| SAM-Z1157 | 71.0<br>(100) | 21.4<br>(30.1) | 30.1<br>(42.4) | 0.71  | 18.0<br>(25.3) |
| SAM-Z1051 | 79.0<br>(100) | 23.0<br>(29.1) | 30.0<br>(38.0) | 0.77  | 27.5<br>(34.8) |

#### Description

SAM-Z1157 (Fig. 8D–F) is 71 mm in diameter, and retains extensive areas of partially exfoliated shell. The adapertural 70° sector of the outer whorl is body chamber. The shallow umbilicus comprises 25.3% of the diameter, the umbilical wall being low, subvertical, the umbilical shoulder narrowly rounded, the whorl section compressed, the greatest breadth some way below mid-flank, the whorl breadth to height ratio 0.71. The flanks are subparallel, feebly convex, converging to the high, arched venter. There are six to seven primary ribs per whorl, straight and prorsiradiate on the inner flank, flexing forwards and concave on the outer flank, and crossing the venter in an obtuse convex peak. They are preceded by an incipient constriction in some cases. There are 10–12 shorter, intercalated ribs between successive primaries, arising as feeble riblets on the inner flank.

SAM-Z1051 (Fig. 8A–C) is wholly septate, and retains partially recrystallized shell. Coiling is moderately evolute, with 45% of the previous whorl covered, the shallow umbilicus comprising 30.6% of the diameter. The whorl section is compressed, with a whorl breadth to height ratio of 0.79, the greatest breadth below mid-flank. There are at least six primary ribs per whorl, with 10–11 shorter intercalated ribs between.

Genus *Bhimaites* Matsumoto, 1954

#### Type species

*Ammonites bhima* Stoliczka, 1865, p. 137, pl. 69, figs 2, 3, ?*non* 1, by the original designation of Matsumoto (1954, p. 113).

#### *Bhimaites bhima* (Stoliczka, 1865)

Fig. 10A–E

- 1865 *Ammonites Bhima* Stoliczka, p. 137, pl. 69, figs 2, 3, ?*non* 1.  
 1898 *Puzosia Bhima* Stol.; Kossmat, p. 184 (119).  
 1925 *Puzosia bhima* Stoliczka; Diener, p. 123.  
 1936 *Puzosia bhima* Stoliczka; Venzo, p. 72 (14), pl. 12 (8), fig. 10.  
 1957 *Bhimaites bhima* (Stoliczka); Wright, p. 365, text-fig. 477, 1c, ?*non* 1a, 1b.  
 1961 *Bhimaites bhima* (Stoliczka); Casey, p. 142, text-fig. 45d, ?*non* 45b, c.  
 1961 *Bhimaites bhima* (Stoliczka); Collignon, p. 89.  
 1988 *Bhimaites bhima* (Stoliczka, 1865); Matsumoto, p. 20.  
 1996 *Bhimaites bhima* (Stoliczka); Wright, p. 74, text-fig. 56, 2c, ? *non* 2a, 2b.  
 2011 *Puzosia (Bhimaites) bhima* (Stoliczka, 1865); Klein & Vašíček, p. 94 (*pars*).

#### Type

The lectotype, designated by Matsumoto (1988, p. 20) is the original of Stoliczka, 1865, pl. 69, fig. 2, no. 272 in the collections of the Geological Survey of India, Kolkata, and from the Upper Albian of Moraviator, Tamil Nadu, South India. Paralectotype no. 271 in the same collection is the original of Stoliczka, 1865, pl. 69, fig. 1; this may belong to a different species (Matsumoto, 1988, p. 21).

#### Material

SAM-Z26E, from the environs of localities 54–56 of Kennedy & Klinger (1975).

SAM-Z1302, from the environs of locality 64 of Kennedy & Klinger (1975) – cliff on Munywana near mouth of Indabana. Both specimens are from the Upper Albian (Albian V) Mzinene Formation.

#### Dimensions

|           | D             | Wb             | Wh             | Wb:Wh | U              |
|-----------|---------------|----------------|----------------|-------|----------------|
| SAM-Z1302 | 65.0<br>(100) | 23.4<br>(36.0) | 31.8<br>(48.9) | 0.74  | 15.0<br>(23.1) |
| SAM-Z26E  | 69.9<br>(100) | – (–)          | 31.2<br>(44.6) | –     | 17.0<br>(24.3) |

#### Description

Both specimens are incomplete juvenile phragmocones, retaining extensive areas of variably exfoliated shell material. Coiling is involute, the small, shallow umbilicus comprising 23–24% of the diameter, the umbilical wall low, flattened, the umbilical shoulder narrowly rounded, the whorl section compressed, with a whorl breadth to height ratio of 0.74 in Z1302, the smaller specimen (Fig. 10D, E). The flanks are feebly convex, subparallel, the ventrolateral shoulders broadly rounded, the venter feebly convex. There are five narrow constrictions per half whorl. They are deeply incised into the umbilical wall, straight and prorsiradiate on the inner to middle flank, flexing forwards and feebly concave on the outermost flank and ventrolateral shoulder, and crossing the venter in a shallow convexity. Where shell material is preserved, the flanks are near-smooth, but for growth lines and striae. The ventrolateral shoulders and venter are ornamented by quite widely separated, delicate, feeble riblets that follow the course of the constrictions.

#### Discussion

The lectotype of *Bhimaites bhima* (Stoliczka, 1865, pl. 69, fig. 2) is much larger than the present specimens, with a maximum preserved diameter of 140 mm. It was briefly described by Matsumoto (1988, p. 21), who gave a whorl breadth to height ratio of 0.70 at a diameter of 115 mm diameter and 0.72 at a diameter of 142 mm, very much as in the present specimens. Stoliczka's figure suggests the specimen has lost most of the shell, although the sutures are not shown; it retains shell material on the inner flank, ornamented by growth lines and striae only. The course of the constrictions of the present specimens agrees with those of the lectotype. Spath (1921b, p. 274) and Klein & Vašíček (2011, p. 95) regarded *Puzosia pinguis* of Crick (1907, p. 218) as a synonym of *bhima*; we keep them separate on the basis of the different course of the constrictions, together with the

stronger ventral and ventrolateral ornament, and the strong adapical ventrolateral and ventral collar rib of *pinguis* (see below; Figs 12–20). The presence of a comparable collar rib equally serves to distinguish *Bhimaites subtilis* (Crick, 1907, p. 217, pl. 14, fig. 5; see below and Fig. 21).

We have not seen the specimen from the middle branch of the Manuan Creek described as *Puzosia* cf. *bhima* Stoliczka sp. by Spath (1921b, p. 274). From his description, it has a whorl breadth to height ratio of 0.85, much greater than in *bhima*, and a ventral collar rib associated with the constrictions, not seen in the present species, suggesting rather *Bhimaites pinguis*.

#### Occurrence

Upper Albian of South India and northern KwaZulu-Natal.

#### *Bhimaites stoliczkai* (Kossmat, 1898)

Fig. 11A–C

- 1865 *Ammonites Beaudanti* Stoliczka, p. 142, pl. 71, figs 1–4; pl. 72, figs 1, 2.  
 1868 *Ammonites Yama* Stoliczka, p. 35.  
 1898 *Puzosia Stoliczkai* Kossmat, p. 184 (119), pl. 24 (28), fig. 6.  
 1904 *Puzosia Stoliczkai* Kossmat; Douvillé, p. 239, pl. 31, fig. 1.  
 1907 *Puzosia Stoliczkai* F. Kossmat; Crick, p. 216.  
 1936 *Puzosia Stoliczkai* Kossmat; Venzo, p. 69 (11), pl. 11 (7), fig. 1.  
 1936 *Puzosia Stoliczkai* Kossmat var. *Spathi* Venzo, p. 69 (11), pl. 6 (2), fig. 1; pl. 11 (7), fig. 2.  
 1961 *Bhimaites stoliczkai* Kossm.; Collignon, p. 36, pl. 6, fig. 1.  
 1964 *Bhimaites stoliczkai* [sic] Kossmat; Collignon, p. 56, pl. 332, fig. 1496.  
 1968 *Bhimaites stoliczkai* (Kossmat); Wiedmann & Dieni, p. 123, pl. 17, fig. 13; text-fig. 78.  
 1972 *Bhimaites stoliczkai* (Kossmat); Renz, p. 716, pl. 7, figs 1, 2; pl. 8, fig. 2; text-fig. 7B: a, b, c.  
 ?1982 *Bhimaites stoliczkai* (Kossmat); Wiedmann & Boess, p. 496, fig. 9a, b.  
 1988 *Bhimaites stoliczkai* (Kossmat, 1898); Matsumoto, p. 20.  
 2011 *Puzosia (Bhimaites) stoliczkai* Kossmat, 1898; Kennedy in Gale *et al.*, p. 75, text-fig. 12s, t, u, 29a.  
 2011 *Puzosia (Bhimaites) stoliczkai* Kossmat; Klein & Vašíček, p. 95 (with additional synonymy).

#### Type

The lectotype, here designated, is the original of Stoliczka, 1865, pl. 71, fig. 3, from the Lower Cenomanian Utatur Group of Odium, Tamil Nadu, South India, housed in the collections of the Geological Survey of India, Kolkata.

#### Material

BMNH C18241, the original of Crick, 1907, p. 216, from ‘the deposit at the north end of False Bay’, that is to say the Cenomanian part of the Mzinene Formation of the Skoenberg, localities 61–62 of Klinger & Kennedy (1975).

#### Description

The specimen is a corroded 120° sector of phragmocone retaining recrystallized shell, and part of the preceding whorl. The maximum preserved whorl height is 41.4 mm. Coiling is involute, the umbilicus shallow, with a flattened,

outward-inclined umbilical wall and quite broadly rounded umbilical shoulder. The whorl section is very compressed, with a whorl breadth to height ratio of 0.64, the flanks very feebly convex, converging to the broadly rounded ventrolateral shoulders and feebly convex venter. The corroded surface of the specimen is smooth, but for four constrictions. They are concave on the umbilical wall and shoulder, sweep forwards and are straight on the inner flanks, are feebly concave on the outer flank, and cross the venter in a broad convexity.

#### Discussion

The specimen is referred to *Bhimaites stoliczkai* on the basis of the whorl section and course of constrictions. It differs from *Bhimaites pinguis*, described below, in its more compressed whorl section, different course to the constrictions, absence of a strong ventral collar rib preceding the constrictions, and absence of distinct ventrolateral and ventral ribs between constrictions at the same diameter (compare Fig. 11 and Fig. 14). *Bhimaites subtilis* (Crick, 1907) (Figs 6L–M, 21) described below, also has collar ribs and ventrolateral and ventral ribs.

#### Occurrence

Upper Albian and Lower Cenomanian where well-dated. The geographic distribution extends from South India to Madagascar, northern KwaZulu-Natal, Iran, Sardinia, Venezuela, and, possibly, northwestern Spain.

#### *Bhimaites pinguis* (Crick, 1907)

Figs 12–20

- 1907 *Puzosia pinguis* Crick, p. 218.  
 ?1921b *Puzosia* cf. *bhima* Stoliczka sp.; Spath, p. 274.  
 1921b *Puzosia pinguis* Crick; Spath, p. 274.  
 1925 *Puzosia pinguis* Crick; Diener, p. 123.  
 1936 *Puzosia australis* Venzo, p. 14 (72), pl. 11 (7), fig. 11; pl. 12 (8), fig. 8.  
 1954 *Puzosia pinguis* Crick, 1907; Matsumoto, p. 113.  
 1955 *Puzosia pinguis* Crick; Van Hoepen, p. 357.  
 1955 *Puzosia willemventeri* Van Hoepen, p. 357, text-figs 4, 5.  
 1961 *Desmoceras australis* Venzo; Collignon, p. 91.  
 1988 *Bhimaites australis* (Venzo, 1936); Matsumoto, p. 20.  
 2011 *Puzosia (Bhimaites) australis* Collignon, 1961; Klein & Vašíček, p. 94.

#### Types

The lectotype, here designated, is BMNH C18243, the original of Crick, 1907, p. 218; BMNH C18244 is a paralectotype, and the original of Crick, 1907, p. 219 (‘fragment of a larger whorl’), both from ‘the deposit at the north end of False Bay’ that is to say the Skoenberg, localities 61–62 of Kennedy & Klinger (1975), and either Upper Albian or Lower Cenomanian. The holotype of *Puzosia willemventeri* Van Hoepen, 1955, is SAM-PCZ16636 (ex Z20), the original of Van Hoepen (1955, p. 357, text-fig. 5), from the Upper Albian (Albian V) part of the Mzinene Formation on the north bank of the Mzinene River.

#### Material

We have numerous specimens, including the following: SAM-Z90, from the environs of localities 61–62 of Kennedy

& Klinger (1975). Z21281, from the environs of Beacon 624, locality 54 of Kennedy & Klinger (1975). SAM-A552, Z1281–82 from the environs of locality 64 of Kennedy & Klinger (1975) at the junction of the Munywana and Nda-bana creeks. SAM-H207/5/1 from bed 1, OUM KX11803 and 12688 from bed 6, and OUM KX11866 from bed 9–10 at locality 51 of Kennedy & Klinger (1975). OUM KX10961, from locality 52 of Kennedy & Klinger (1975). OUM KX11112, 12689, from locality 54 of Kennedy & Klinger (1975). OUM KX11146, 12682, 12683, 12687, from locality 56 of Kennedy & Klinger (1975). OUM KX12690, from locality 58 of Kennedy & Klinger (1975). OUM KX12693, from locality 64 of Kennedy & Klinger (1975). OUM KX5627, 12693–4, from locality 65 of Kennedy & Klinger (1975).

All specimens are from the Upper Albian (Albian V) Mzinene Formation.

SAM-A938 is from the Upper Albian or Lower Cenomanian part of the Mzinene Formation on the western part of the Skoenberg, close to locality 61 of Kennedy & Klinger (1975)

#### Dimensions

|              | D               | Wb              | Wh             | Wb:Wh | U              |
|--------------|-----------------|-----------------|----------------|-------|----------------|
| SAM-H207/5/1 | 58.0<br>(100)   | 17.9<br>(30.9)  | 23.7<br>(40.9) | 0.75  | 14.7<br>(25.3) |
| OUM KX5627   | 106.1<br>(100)  | 35.9<br>(33.8)  | 48.1<br>(45.3) | 0.74  | 27.5<br>(25.9) |
| OUM KX10961  | 111.3<br>(100)  | 36.8<br>(33.1)  | 50.3<br>(45.3) | 0.73  | 31.5<br>(28.4) |
| SAM-*Z1281   | 131<br>(100)    | 51 (38.9)       | 60.5<br>(46.2) | 0.84  | 29.5<br>(22.5) |
| OUM KX11416  | 137.2<br>(1000) | 51.2<br>(37.3)  | 61.7<br>(45.0) | 0.82  | 36.8<br>(26.9) |
| SAM-A938     | 149<br>(100)    | 52.6<br>(35.3)  | 66<br>(44.3)   | 0.80  | –              |
| SAM-Z90      | 171<br>(100)    | 68 (39.8)       | 82.5<br>(48.2) | 0.82  | 35.0<br>(20.4) |
| OUM KX11112  | 215<br>(100)    | 75.5<br>(35.10) | 92.8<br>(32.2) | 0.81  | 52.5<br>(19.1) |
| SAM-PCZ18636 | 288<br>(100)    | 99<br>(34)      | 142<br>(49)    | 0.7   | 56<br>(19)     |

\*Dimensions from Van Hoepen (1955, p. 357).

#### Description

SAM-H207/5/1 (Fig. 12A–D) is a very well-preserved phragmocone 58 mm in diameter, retaining its original aragonitic shell. Coiling is slightly involute, with 52% of the previous whorl covered. The umbilicus is shallow, and comprises 25.3% of the diameter, with a low, outward-inclined flat umbilical wall and very narrowly rounded umbilical shoulder. The whorl section is compressed, the whorl breadth to height ratio 0.75, the greatest breadth below

mid-flank, the flanks feebly convex, converging to broadly rounded ventrolateral shoulders and an arched venter. The surface ornament is perfectly preserved, and consists of crowded falcoid growth lines and striae, together with relatively widely separated lirae, straight and strongly prorsiradiate on the inner flank, flexed back and convex at mid-flank, and concave on the outer flank, sweeping forwards, and crossing the venter in a convex linguoid peak. Some of the lirae strengthen markedly on the ventrolateral shoulders and venter to form a much coarser linguoid collar rib to constrictions on the internal mould, but barely expressed on the surface of the shell. OUM KX11803 (Fig. 12E–G) and OUM KX11806, the former with a maximum preserved whorl height of 41 mm, have the original shell surface equally well preserved; the latter shows the lirae strengthening over the venter. SAM-A938 (Fig. 16), 149 mm in diameter, shows the progressive differentiation of flank and ventral ornament. The convex collar ribs are strongly developed across the venter, and the interspaces between successive collar-ribs bear well-developed minor ribs that strengthen progressively to the mid-point between successive collar ribs, before declining and near-effacing. This same pattern is seen in specimens such as OUM KX11416 and OUM KX10961 (Fig. 13).

The lectotype (Fig. 17) is a 120° sector of phragmocone 200 mm long, with a maximum preserved whorl height of 109 mm, and recrystallized shell preserved, and indications of the former presence of a further whorl. Coiling is involute, with 69% of the previous whorl covered. The umbilicus is of moderate depth, with a flattened, outward-inclined wall and quite narrowly rounded umbilical shoulder. The whorl breadth to height ratios 0.71, the greatest breadth below mid-flank, the inner and middle flanks feebly convex, the outer flanks converging to the broadly rounded ventrolateral shoulders and very feebly convex venter. Four major collar ribs are present on the fragment. They are straight and narrow on the inner flank, strengthen, flex forwards, and are markedly concave on the outer flank and ventrolateral shoulder. They cross the venter in a marked convexity, reaching their maximum strength at mid-venter. The flanks between collars are near-smooth. Numerous weak ribs appear on the outermost flank and ventrolateral shoulder, strengthen progressively, and cross the venter in a broad convexity; the number present between successive collar ribs cannot be established due to poor preservation.

The paralectotype, Crick's second specimen, BMNH C18242, is a very poorly preserved 60° sector of phragmocone with a maximum preserved whorl height of 140 mm, and traces of three collar ribs.

OUM KX12693 (Fig. 18) is a 120° sector of phragmocone whorl with replaced shell well preserved, with a maximum preserved whorl height of 95 mm and a whorl breadth to height ratio of 0.78. There are three widely separated collar ribs on the fragment. They arise on the umbilical shoulder, are straight and feebly prorsiradiate on the inner flank, flex forwards and are concave across the middle of the flanks, and near-straight and strongly prorsiradiate on the outer flank and ventrolateral shoulder. They strengthen over the venter, which they cross in a broad convexity. They are adapical to feeble constrictions. There are up to 12 delicate ribs between the successive primaries. They arise as mere



lirae on the umbilical wall, and strengthen progressively across the flanks, following the same course as the collar ribs. They are very weak on the inner flank, and reach their maximum strength over the ventrolateral shoulders and venter.

OUM KX11112 (Fig. 19) is a phragmocone 210 mm in diameter retaining extensive area of worn recrystallized shell. The umbilicus is of moderate depth, the umbilical wall flattened, the umbilical shoulder quite narrowly rounded. The whorl section is compressed, with a whorl breadth to height ratio of 0.75, the flanks feebly convex, converging to a rounded, arched venter. Where shell is absent, a single strong constriction is visible with a steep adapertural edge, concave and prorsiradiate on the ventrolateral shoulders and crossing the venter in a broad convexity. Where shell is well preserved, there are conspicuous collar ribs on ventrolateral shoulders and venter, adapical to constrictions that are feebly expressed on the shell surface. There are an estimated six constrictions and associated collar ribs per whorl. There are indications of very feeble ribs in places between successive collar ribs.

SAM-Z90 (Fig. 20) is 170 mm in diameter, part body chamber, and has lost most of the shell. The internal mould, covered in a thin film of recrystallized shell material, is near-smooth, but for strong constrictions, four on the adapertural half whorl. They arise at the umbilical seam, and are straight and prorsiradiate on the inner flank, flexed back and feebly convex at mid-flank and concave on the outer flank and ventrolateral shoulder. This specimen shows the striking difference between the ornament of shell surface and internal mould, with the ventral ribbing between successive collar ribs strong on the shell surface, and feeble to effaced on the mould.

Van Hoepen (1955, text-fig. 4) figured a specimen as *Puzosia willemventeri*, 500 mm in diameter with a very deep and broad constriction close to the margin at the greatest preserved diameter: it may be a near-complete adult. A similar constriction is seen on a large puzosiid referred to as *Ammonites planulatus* by Stoliczka (1865, pl. 68)

#### Discussion

*Bhimaites pinguis* differs from most of the other species referred to the subgenus in its development of ventrolateral ribs in middle and late growth, together with the presence of strong collar ribs. *Bhimaites aontzyensis* Collignon, 1961 (p. 37, pl. 6, fig. 2), from the Lower Cenomanian of Madagascar, and subsequently described from the Albian of Venezuela (Renz, 1972, p. 714, pl. 7, fig. 3; pl. 8, figs 1, 3, 4; pl. 9, fig. 1; text-figs 7A, 8) has fine flexuous ribs that extend from the umbilical shoulder where the surface of the shell is preserved, and develops coarse distant near-straight primary and intercalated ribs on the adapertural part of the phragmocone and the body chamber (Renz, 1972, pl. 8, fig. 4). The holotype of *Bhimaites australis* (Venzo, 1936) (p. 72 (14), pl. 11 (7), fig. 11; pl. 12 (8), fig. 8), from the Upper Albian part of the Mzinene Formation on the north bank of the Mzinene was illustrated by line drawings only. It is described as being 200 mm in diameter, with seven primary collar ribs on the 240° sector of whorl preserved. These are straight on the inner flank and concave on the outer flank and ventrolateral shoulder, and thicken into a ventral lip. It corresponds well

with the poorly preserved lectotype (Fig. 17), and OUM KX12693 (Fig. 18), and is regarded as a synonym.

#### Occurrence

Upper Albian (Albian V) and possibly Cenomanian, Mzinene Formation, northern KwaZulu-Natal.

#### *Bhimaites subtilis* (Crick, 1907)

Figs 6L, M; 21

1907 *Puzosia subtilis* Crick, 1907, p. 217, pl. 14, fig. 5.

1921b *Puzosia subtilis* Crick; Spath, p. 274.

1925 *Puzosia subtilis* Crick; Diener, p. 124.

1954 *Puzosia subtilis* [sic] Crick; Matsumoto, p. 113.

1955 *Puzosia subtilis* Crick; Van Hoepen, p. 357.

1961 *Bhimaites subtilis* Crick; Collignon, p. 89.

1988 *Bhimaites subtilis* (Crick, 1907); Matsumoto, p. 20.

2011 *Puzosia* (*Bhimaites*) *subtilis* (Crick, 1907). Klein & Vašíček, p. 96.

#### Type

The holotype, by original designation, is BMNH C18242, the original of Crick, 1907, p. 217, pl. 14, fig. 5, it is from 'the deposit at the north end of False Bay' of Crick, that is to say the Skoenberg, localities 61 and 62 of Kennedy & Klinger (1975), the eastern 'horn' of the Skoenberg, and of Cenomanian age.

#### Material

OUM KX12333, collected loose at locality 62 of Kennedy & Klinger (1975), and derived from the Lower or Middle Cenomanian part of the Mzinene Formation. OUM KX10348 and KX10350, from bed 3 of the Lower Cenomanian part of the Mzinene Formation at locality 181 of Kennedy & Klinger (1975) in the Ndumu area.

#### Description

The holotype (Fig. 21) consists of a 180° sector of phragmocone with a maximum preserved whorl height of 73 mm, with parts of two preceding whorls preserved. Coiling is involute, with 70% of the previous whorl covered. The umbilicus is small, of moderate depth, with a flattened, outward-inclined umbilical wall, the umbilical shoulder quite narrowly rounded. The whorl section is compressed, with a whorl breadth to height ratio of 0.63, the greatest breadth below mid-flank. The flanks are very feebly convex, converging to broadly rounded ventrolateral shoulders and venter. The surface of the replaced shell is corroded. The flanks appear to have been near-smooth, but for delicate growth lines and lirae. They are concave on the umbilical wall, flex forwards across the umbilical shoulder, and are markedly prorsiradiate on the flanks. They strengthen into delicate ribs that cross the venter in a very shallow convexity. There are three well-developed strong ribs on the ventrolateral shoulders and venter; they precede a weak indication of widely separate constrictions.

OUM KX10348 is a juvenile with an original estimated diameter of 70 mm, retaining partially exfoliated shell material. At a diameter of 57 mm the whorl breadth to height ratio is 0.74; the umbilicus comprises 23.5% of the diameter. There is a strong collar rib preceding the constrictions, and delicate ribbing is preserved on the ventrolateral



shoulders and venter. The partially exposed internal mould shows the constrictions to be straight and prorsiradiate on the flanks, projecting forwards and concave on the ventrolateral shoulder, and crossing the venter in a relatively narrow convexity.

OUM KX10350 (Fig. 6L, M) consists of a fragmentary nucleus and 120° outer whorl of phragmocone with fragments of the adapical end of the body chamber. The maximum preserved whorl height is 61.5 mm, the whorl breadth to height ratio is 0.71. A single constriction is preserved; it is straight and prorsiradiate on the flanks, concave on the ventrolateral shoulders, and convex on the venter.

OUM KX12333 is a 60° whorl fragment retaining recrystallized shell. The maximum preserved whorl height is 81 mm, the whorl breadth to height ratio is 0.68. The umbilical wall is flattened and outward-inclined, the umbilical shoulder quite narrowly rounded, the whorl section oval. There are two constrictions, weakly expressed where the shell is preserved, preceded by collar ribs that are strongly developed on the ventrolateral shoulders and venter. They are feebly prorsiradiate and feebly convex on the inner flank, feebly concave on the outer flank, and broadly convex over the venter. The surface of the shell between collar ribs smooth but for growth lines, striae and delicate ribs that are most conspicuous on the ventrolateral shoulders and venter, parallel to the constrictions and collar ribs. There are indications of the former presence of a further whorl in the form of part of the inner septum.

#### Discussion

*Bhimaites subtilis* differs from all of the other *Bhimaites* from northern KwaZulu-Natal in the combination of a compressed whorl section, numerous falcooid constrictions and associated strong collar-ribs, with very weak ornament between successive collar ribs, as discussed above under *Bhimaites bhima*.

#### Occurrence

Lower Cenomanian of northern KwaZulu-Natal.

#### *Bhimaites gortanii* (Venzo, 1936)

Fig. 10F, G; 11D–F

1936 *Puzosia gortanii* Venzo, p. 71(13) pl. 6 (2), fig. 2; pl. 11 (7), fig. 3.

1949 *Puzosia cf. gortani* Collignon, p. 16

1961 *Puzosia gortanii* Venzo; Collignon, p. 88.

2011 *Puzosia (Puzosia) gortanii* Venzo, 1936; Klein & Vašíček, p. 74.

#### Type

The holotype, by monotypy, is the original of Venzo (1936, p. 71 (13) pl. 6 (2), fig. 2; pl. 11 (7), fig. 3, from 'Ndabana-Umsinene', that is to say the Upper Albian (Albian V) Mzinene Formation in the environs of locality 64 of Kennedy & Klinger (1975). Venzo's original illustrations are reproduced here as Fig. 10F, G.

#### Material

SAM-Z380, from the Upper Albian (Albian V) Mzinene Formation in the environs of locality 57 of Kennedy & Klinger (1975). SAM-A456, presumably from the same locality.

#### Dimensions

|          | D              | Wb             | Wh             | Wb:Wh | U              |
|----------|----------------|----------------|----------------|-------|----------------|
| SAM-Z380 | 115.0<br>(100) | 36.4<br>(31.6) | 49.0<br>(42.6) | 0.74  | 32.5<br>(28.3) |
| SAM-A456 | 129.0<br>(100) | 42.0<br>(32.6) | 60.5<br>(46.9) | 0.69  | 33.2<br>(25.7) |

#### Description

SAM-A456 (Fig. 22) retains extensive areas of recrystallized and partially exfoliated shell material, and is part body chamber. Coiling is involute, with 70% of the previous whorl covered. The umbilicus comprises 17.5% of the diameter, and is shallow, with a deeply incised umbilical seam, a subvertical umbilical wall, and narrowly rounded umbilical shoulder. The expansion rate is quite low, the whorls compressed, the whorl breadth to height ratio 0.69, the greatest breadth below mid-flank. The whorl section is ovoid, with feebly convex, subparallel inner to mid-flanks, the outer flanks flattened and convergent, the ventrolateral shoulders broadly rounded, the venter feebly convex. Where shell is preserved, the ventrolateral shoulders are covered in dense, low, delicate, weak ribs, projected strongly forwards, and crossing the venter in a shallow convexity. Constrictions, 10–11 on the outer whorl, are barely detectable on the surface of the shell, but prominent on the internal mould. They are falcooid, straight and markedly prorsiradiate on the innermost flank, flexing back and feebly convex at mid-flank, deepening, sweeping forwards and concave on the outer flank and ventrolateral shoulder, and crossing the venter in a shallow convexity. They are strongly asymmetric in section, with a gently sloping adapical face and a steep adapertural face. The constrictions are preceded by a strong collar-rib on the venter. The internal mould is otherwise smooth, lacking the delicate ribbing present on the shell surface. SAM-Z380 (Fig. 11D–F) is a closely comparable individual, with a maximum preserved diameter of 123 mm, and an estimated 11 constrictions on the outer whorl.

#### Discussion

This species is distinguished from all other described *Bhimaites* by the more numerous, falcooid constrictions, and feeble ornament on the shell surface.

#### Occurrence

Upper Albian (Albian V) of northern KwaZulu-Natal.

#### Genus and subgenus *Parapuzosia* Nowak, 1913

#### Type species

*Sonneratia daubreei* de Grossouvre, 1894, p. 154, pl. 28, by the subsequent designation of Spath, 1922, p. 127.

#### *Parapuzosia (Parapuzosia) haughtoni* Spath, 1922

Fig. 23

1921b *Parapachydiscus* of the *colligatus-supremus* type; Spath, footnote || on p. 229 (*pars*).

1922 *Parapuzosia haughtoni* Spath, p. 128, pl. 8, fig. 1.

?1961 *Parapuzosia mozambica* Collignon, p. 48, pls 18, 19.

- 1963 *Parapuzosia magellanica* Leanza, p. 213, pl. 3, figs 1, 5; pl. 4, figs 1, 2.  
 1996 *Parapuzosia* cf. *haughtoni* Spath, 1922; Cooper & Greyling, p. 23, text-fig. 8d, 9a.

#### Type

The holotype, by monotypy, is BMNH C19439; a cast of the dorsum was figured by Spath (1922, pl. 8, fig. 1), it is from the Santonian to Lower Campanian Mzamba Formation at the mouth of the Mzamba Estuary in the Eastern Cape Province.

#### Description

The holotype is a large fragment from the adapical end of the body chamber, preserving traces of the final septum. The maximum preserved whorl height is 250 mm. A cast of the dorsum is shown in Fig. 23. The incomplete whorl height of the cast is 77 mm, the incomplete whorl breadth is 83 mm. There are four widely spaced, relatively coarse, feebly concave prorsiradiate ribs on the inner part of the preserved part of the flank. They bifurcate at what is estimated to be the mid- to outer flank region, while up to three ribs intercalate, to give a total of 21 ribs on the outer flank of the cast. They are strong, narrow, concave, sweep forwards over the ventrolateral shoulder, and cross the venter in a very obtuse chevron, the apex subacute.

#### Discussion

The holotype of *Parapuzosia magellanica* Leanza, 1963 (p.213, pl. 3, figs 1, 5; pl. 4, figs 1, 2) is of comparable size to the cast from the dorsum of the holotype of *P. (P.) haughtoni*, from which it differs in no significant respects. The location of the original is not known (Leanza stated it to be in Santiago, Chile, without naming the repository; his description, and figures, however, are based on a plaster cast in the collections of the U.S. National Museum). It was from the northern slopes of the Cerro Toro, in the Department of Ultima Esperanza in southern Chile. *Parapuzosia mozambica* Collignon, 1961 (p. 48, pls 18, 19), from the Lower Campanian of Madagascar, has comparable ornament at the same size, with identical rib pattern and strength; it may be a synonym, although the limited Mzamba material lacks the distinctive early growth stages that Collignon documented.

#### Occurrence

The holotype is imprecisely dated; a fragment compared to the species by Cooper & Greyling (1996) is firmly dated as Lower Campanian; both are from the Mzamba Formation at and 3 km NE of its type locality, the Mzamba Estuary in the Eastern Cape Province. The holotype of *Parapuzosia magellanica*, a synonym, is from the Department of Ultima Esperanza in southern Chile, and is dated as Early Campanian. The type material of *Parapuzosia mozambica*, a possible synonym, is from the Lower Campanian of Madagascar.

#### *Parapuzosia (Parapuzosia) sp.*

- 1921a 34. *Parapachydiscus* sp. ind.; Spath, table opposite p. 50.  
 1922 *Parapachydiscus* aff. *ootacodensis* Stoliczka sp.: Spath, p. 132, pl. 7, fig. 6.

#### Material

BMNH C19438, the original of Spath, 1922, p. 132, pl. 7,

fig. 6, from the Mzamba Formation at the mouth of the Mzamba Estuary, locality 1 of Kennedy & Klinger (1975) in the Eastern Cape Province.

#### Description

This worn specimen is wholly septate, and consists of a nucleus 120 mm in diameter and a fragment of outer whorl with a maximum preserved whorl height of an estimated 150 mm, with indications of the former presence of a further whorl. The umbilicus is deep, the umbilical wall feebly convex and outward-inclined, the umbilical shoulder relatively narrowly rounded. The whorl section (Spath, 1922, pl. 7, fig. 6) is compressed oval, with the greatest breadth well below mid-flank, the inner flanks subparallel, the outer flanks converging to broadly rounded ventrolateral shoulders and a feebly convex venter. On the penultimate whorl, there are 10 low, distant, coarse, feebly prorsiradiate ribs per half whorl on the inner to middle flank. These ribs are absent on the outer whorl fragment, the ventrolateral shoulders and venter of which are ornamented by coarse narrow ribs that cross the venter in a shallow convexity.

#### Discussion

This fragment differs from *Parapuzosia (P.) haughtoni* in the form of the ribbing of the outer whorl, with coarse primary ribs absent, the ribs crossing the venter in a shallow convexity, rather than a very obtuse chevron with a subacute apex. *Pachydiscus ootacodensis*, with which Spath compared it, has coarse distant primary ribs that extend to the umbilical shoulder at the same whorl height as the outer whorl of the present fragment.

#### Occurrence

Santonian or Lower Campanian, Mzamba Formation of northern Eastern Cape Province.

#### *Parapuzosia (Parapuzosia)? truteri* (Van Hoepen, 1968)

Figs 24, 25A

- 1921b *Parapuzosia* sp. nov. ind. Spath, p. 224, pl. 19, fig. 2; pl. 20, fig. 1; pl. 24, fig. 3.  
 1968 *Pachydesmoceras truteri* Van Hoepen, p. 158, pl. 2, text-fig. 1b.

#### Type

The holotype, by monotypy, is SAM-Z769, the original of Van Hoepen, 1968, p. 158, pl. 2, text-fig. 1b, from the Lower Coniacian St Lucia Formation of the Skoenberg.

#### Material

Van Hoepen referred two additional specimens to this species, SAM-Z803, and an individual in the National Museum, Bloemfontein, both from the same horizon and locality as the holotype. We also refer SAM-5513, the original of *Parapuzosia* sp. nov.? ind of Spath, 1921b, p. 224, pl. 19, fig. 2; pl. 22, fig. 1; pl. 24, fig. 3 to the species; it is from the St Lucia Formation of the 'Railway cutting, Umfolozi', and probably of Coniacian date.

#### Description

None of the specimens referred to this species are currently available for study. Van Hoepen's original description is as follows:

D: 608 mm (100), H: 228 mm (37.5), T: 187 mm (31), U 154 mm (25)

A very large ammonite with whorls growing regularly in height and thickness. Flanks are convex, passing over into a very narrow venter and into a slanting umbilical surface. Section oval. Older whorls are more evolute than the younger ones.

Ornamentation consists of numerous regular ribs standing close together and starting somewhere near the umbilical border or halfway up the flank. Amongst the ribs there is a slightly stronger one here and there; constrictions, some three in number, are seen on the last whorl. The slightly stronger ribs are a little thicker than the ordinary ones and the groove behind them is a little deeper and broader than the usual grooves. On the smooth inner whorl there are five of these constrictions. Sometimes there are from one to two shorter ribs between two long ones, and sometimes none. The ribs are concave on their anterior side and on the periphery. At the end of the whorl a portion of the surface has weathered and the number of ribs has to be guessed. At the extreme end of the whorl the surface is smooth. This beautiful *Pachydesmoceras* differs from other species by its regular, fine ribs.

From his photograph (Van Hoepen, 1968, p. 2), the holotype is seen to be wholly septate, with approximately 50 ribs on the adapical half of the outer whorl and primary ribs that extend to the umbilical shoulder obvious on the adapertural 90° sector of the outer whorl.

#### Discussion

SAM-5513, the original of *Parapuzosia* sp. nov.? ind of Spath, 1921b, p. 224, pl. 19, fig. 2; pl. 22, fig. 1; pl. 24, fig. 3, has the following dimensions according to Spath:

D: 670 (100); Wb: 225 (33.0); Wh: 325 (48.5) Wb:Wh: 0.69; U: 120 (18).

The whorl breadth to height ratio of the holotype of *truteri* is 0.82. Spath did not describe the specimen, and his pl. 19, fig. 2 and pl. 20, fig. 1 show it to be wholly septate, with no ornament visible. He also figured a plaster cast of the dorsum (pl. 24, fig. 3); Professor M.R. Cooper (Durban) has provided photographs of a part of this specimen (Figs 24, 25A) as well as the cast of the dorsum. These show the presence of crowded prorsiradiate ribs on the flank that sweep forwards and are concave on the ventrolateral shoulders, and cross the venter in a broad convexity. The partially exposed suture is deeply and intricately subdivided. It may well be a large specimen of *truteri*. A full understanding of this species must await an examination of the actual specimens.

#### Occurrence

Lower Coniacian of northern KwaZulu-Natal.

Subgenus *Austiniceras* Spath, 1922

#### Type species

*Ammonites austeni* Sharpe, 1855, p. 28, pl. 12, fig. 1, by the original designation of Spath, 1922, p. 127.

*Parapuzosia (Austiniceras) subcompressa* (Crick, 1907)  
Fig. 26

1907 *Puzosia subcompressa* Crick, p. 215.

1925 *Puzosia subcompressa* Crick; Diener, p. 124.

1955 *Puzosia subcompressa* Crick; Van Hoepen, p. 357.

1961 *Puzosia subcompressa* Crick; Collignon, p. 96.

1984 *Puzosia subcompressa* Crick, 1907; Wright & Kennedy, p. 60.

#### Type

The holotype, by monotypy, is BMNH C18240, the original of Crick (1907, p. 215), from the 'Deposit at the north end of False Bay', that is to say the Skoenberg, locality 62 of Kennedy & Klinger (1975).

#### Description

The holotype (Fig. 26) is a 120° sector of phragmocone with a maximum preserved whorl height of 93 mm, with parts of the two preceding whorls preserved, and retaining traces of silicified shell. Coiling is moderately involute, with 66% of the previous whorl covered. The umbilical wall is low, convex and subvertical. The umbilical shoulder is narrowly rounded. The whorl section is very compressed, with a whorl breadth to height ratio of 0.57, the greatest breadth below mid-flank. The inner flanks are feebly convex, sub-parallel, the outer flanks converging to broadly rounded ventrolateral shoulders and a feebly convex venter. Four well-preserved primary ribs are present on the adapertural 90° sector of the fragment. They are straight and prorsiradiate on the inner flank, feebly convex at mid-flank, and flexed forwards and feebly concave on the outer flank, projecting slightly forwards and crossing the venter in a broad convexity. The inner flanks between the primary ribs appear to have been smooth, or near-smooth. Intercalated ribs appear on the outer flank, and are concave and prorsiradiate, sweeping forwards and crossing the venter in a broad convexity, paralleling the primary ribs. There are an estimated 16–20 intercalated ribs between successive primaries.

#### Discussion

Wright & Kennedy (1984, p. 60) suggested the present species might be a synonym of *Parapuzosia (Austiniceras) austeni* (Sharpe, 1855) (p. 28, pl. 12, fig. 1, non 2 (= *Anapuzosia dibleyi* Spath, 1922) (see revision in Wright & Kennedy, 1984, p. 60, pl. 5, figs 3, 6; text-fig. 5). The poor preservation of the holotype of *compressa* makes comparison difficult, but *austeni* of comparable size (Wright & Kennedy, 1984, pl. 5, fig. 6) have fewer primary ribs, and the intercalated ribs extend down to the umbilical shoulder. We maintain it as a separate species at this time with no great confidence.

#### Occurrence

Lower or Middle Cenomanian of northern KwaZulu-Natal.

*Parapuzosia (Austiniceras) beantalyense* Collignon, 1961  
Fig. 9E, F

1961 *Parapuzosia (Austiniceras) beantalyense* Collignon, p. 44, pl. 13, fig. 1.

1965 *Austiniceras beantalyense* Coll.; Collignon, p. 20, pl. 421, fig. 1748.

#### Type

The holotype, by original designation, is specimen 3778, the original of Collignon, 1961, p. 44, pl. 13, fig. 1, housed in the collections of the Laboratoire de Paléontologie of the



Muséum national d'Histoire naturelle, Paris, and from the Lower Coniacian Zone à *Kossmaticeras theobaldianum* et *Barroisiceras onilahyense* of Collignon's gisement 748, south of Beantaly (Belo sur Tsiribihina), Madagascar.

#### Material

OUM KX10574, from Locality 13 of Kennedy & Klinger (1975), south of Mtubatuba, and from the Middle Coniacian (Coniacian II) part of the St Lucia Formation.

#### Description

The specimen is a 90° sector of phragmocone with a maximum preserved whorl height of 64.5 mm and part of the preceding whorl, with the original aragonitic shell preserved, and indications of the former presence of a further whorl. Coiling appears to have been moderately involute, the umbilicus shallow, with a low, flattened subvertical wall and narrowly rounded umbilical shoulder. The whorl section is compressed, with a whorl breadth to height ratio of 0.6, the flanks very feebly convex, converging to broadly rounded ventrolateral shoulders, and a very feebly convex venter. The inner and middle flanks are very feebly ornamented, with low, broad, straight, feebly prorsiradiate, barely discernible primary ribs, two of which are stronger and narrower collar ribs, flanking a narrow constriction. Ornament strengthens on the outermost flanks, where the ribs have increased by branching and intercalation, and are crowded, narrow, and prorsiradiate, sweeping forwards across the ventrolateral shoulders to cross the venter in a shallow, obtuse, convex peak.

#### Discussion

The fragment corresponds to the adapertural sector of the holotype, which is of the same size, whorl shape, degree of compression, and ornament. This is the only known Coniacian species of *Parapuzosia* (*Austiniceras*).

#### Occurrence

Middle Coniacian of northern KwaZulu-Natal and Madagascar.

#### Genus *Pachydesmoceras* Spath, 1922

(?= *Matsumotoceras* Van Hoepen, 1968)

#### Type species

*Ammonites denisonianus* Stoliczka, 1865, p. 133, pl.65, fig. 4; pl. 66, figs 1, 2; pl. 66a, by the original designation of Spath, 1922, p. 127.

#### *Pachydesmoceras pachydiscoide* Matsumoto, 1954

Figs 9B, C; 25B; 27

1954 *Pachydesmoceras pachydiscoides* (*sic*) Matsumoto, p. 101, pl. 9, fig. 2.

1958 *Pachydesmoceras rosewoodensis* Anderson, p. 222, pl. 31, fig. 1.

1959 *Pachydesmoceras pachydiscoide* Matsumoto; Matsumoto, p. 22, text-fig. 7.

1961 *Pachydesmoceras pachydiscoide* Matsumoto; Collignon, p. 42, pl. 12, fig. 1.

?1968 *Matsumotoceras donlisteri* Van Hoepen, p. 157, pl. 1; text-fig. 1a.

1988 *Pachydesmoceras pachydiscoide* Matsumoto; Matsumoto, Kawashita & Muramoto in Matsumoto, p. 127, text-figs 56–60.

#### Types

The holotype, by original designation, is specimen no. MM6660 in the collections of the University Museum, Tokyo University, the original of Matsumoto, 1954, p. 101, pl. 9, fig. 2, from an unknown horizon in the Miho Group of the Niabuchi Valley in South Sakhalin. There are three paratypes, listed by Matsumoto (1954, p. 101).

#### Material

OUM KX11066 and KX12691-2, from the Lower Coniacian part of the St Lucia Formation at locality 60 of Kennedy & Klinger (1975), the steep northern face of the Skoenberg.

#### Description.

OUM KX11066 (Figs 25B, 27) is a beautifully preserved specimen comprising a nucleus 120 mm in diameter and a 120° sector of the succeeding whorl, with a maximum preserved whorl height of 120 mm. It is wholly septate, and retains limonitized shell. There are indications of the former presence of a further whorl. Coiling is moderately involute, with just over 60% of the previous whorl covered, the umbilicus of moderate depth, with a flattened, slightly outward-inclined umbilical wall and a quite narrowly rounded umbilical shoulder; the umbilicus comprises approximately 28% of the diameter. The whorl section is compressed ovoid, with a whorl breadth to height ratio of 0.8, the inner flanks feebly convex and subparallel, the outer flanks converging to the arched and rounded ventrolateral shoulders and venter. The greatest breadth is below mid-flank. There are 35 ribs per half whorl at the ventrolateral shoulder of the nucleus. Primary ribs are sinuous, straight and prorsiradiate on the inner flank, concave on the middle to outer flank, projecting forwards on the ventrolateral shoulders, and crossing the venter in an obtuse rounded chevron. Additional ribs intercalate, and some of the long ribs bifurcate. Periodically ribs are strengthened, and are presumably associated with constrictions on the internal mould. On the outer whorl fragment there are periodic low, broad, presumably collar ribs, slightly sinuous and feebly prorsiradiate, feebly concave on the outer flank and ventrolateral shoulder, and crossing the venter in a broad convexity. Although distinct on the flanks, where there are numerous much weaker ribs, all ribs are of equal strength on the ventrolateral shoulders and venter.

OUM KX12692 is a further large septate fragment with a maximum preserved whorl height of 117 mm, a whorl breadth to height ratio of 0.75, and ornament comparable to that of the previous specimen.

OUM KX12691 (Fig. 9B, C) consists of a 180° sector of two whorls with a maximum preserved diameter of 57 mm and a further 120° sector of outer whorl with recrystallized shell preserved. The maximum preserved whorl height is 42 mm, the whorl breadth to height ratio 0.7. The umbilicus is shallow, with a flattened, outward-inclined wall and narrowly rounded umbilical shoulder. The flanks are feebly convex, subparallel, converging to broadly rounded ventrolateral shoulders and an arched venter. There are two primary ribs



on the outer whorl fragment. They arise on the umbilical shoulder, and are strong, straight, and prorsiradiate on the inner to middle flank, flexing forwards and concave on the outer flank, sweeping forwards, strengthening, and crossing the venter in a broad convexity. They are the adapertural collar ribs of strong, narrow constrictions on the internal mould. There are seven ribs between the successive primaries. They arise just outside the umbilical shoulder, strengthen progressively across the flanks, ventrolateral shoulders and venter, following a similar course to the primaries.

#### Discussion

This species was comprehensively reviewed by Matsumoto, Kawashita & Muramoto in Matsumoto (1988, p. 127), who discussed differences from other species referred to the genus.

The holotype of *Matsumotoceras donlisteri* Van Hoepen, 1968 (p. 157, pl. 1, text-fig. 1a) comes from a higher, Middle Coniacian horizon in the St Lucia Formation on the Msunduzi River, at a site corresponding to locality 145 of Kennedy & Klinger (1975). It is a large individual, just over 600 mm in diameter; the original figure is poor, and the specimen is not currently available for study. Van Hoepen diagnosed it as having the characters of the genus: 'This genus is close to *Puzosia*, especially when young, but its section is oval, and its umbilical wall is vertical, passing over sharply into the flank. Ornamentation is of two types. One series consists of very fine, closely spaced riblets on the periphery, which are slightly concave forwards and which start on the outer third of the whorl. The other series consists of broad, wave-like undulations which start on the umbilical border and pass in a radial direction across the flank, of which they cover about two thirds. These undulations are present on the whole of the last whorl. A portion of the last whorl is living chamber; apart from undulations, the surface of this is smooth. As large portions of the shell are decorticated, it may be that the fine riblets of the first series have disappeared; they are only present on the first third of the whorl. There are no constrictions'. This description and the figure are inadequate, and *Matsumotoceras donlisteri* is best treated as a *nomen dubium* until the type specimen is adequately described and figured (it is currently not available for study, and, according to one of us (H.C.K.), the specimen was fragmented after a fall from a shelf at the original locality of the Geological Survey in Visagie Street, Pretoria); it may well be a junior synonym of *Pachydesmoceras pachydiscoide*, and *Matsumotoceras* may thus be a junior synonym of *Pachydesmoceras*.

#### Occurrence

Middle and Upper Turonian of Japan. Upper Turonian of California. Lower Coniacian of Madagascar and northern KwaZulu-Natal.

#### ACKNOWLEDGEMENTS

Kennedy acknowledges the support of the staff of the Geological Collections, Oxford University Museum of Natural History, and the Department of Earth Sciences, Oxford, and the financial assistance of the Oppenheimer Fund (Oxford). The original of Figs 3A–P, were supplied by the photographic unit of the Natural History Museum, London. The

originals of Figs 24, 25A are from negatives taken by Prof. M.R. Cooper (Durban). Klinger acknowledges logistic support from the staff of the Natural History Collections Department, Iziko South African Museum, and financial support from the NRF, South Africa. We thank Prof. E. Yazykova and Dr Francis Amedro for their meticulous reviews of the manuscript.

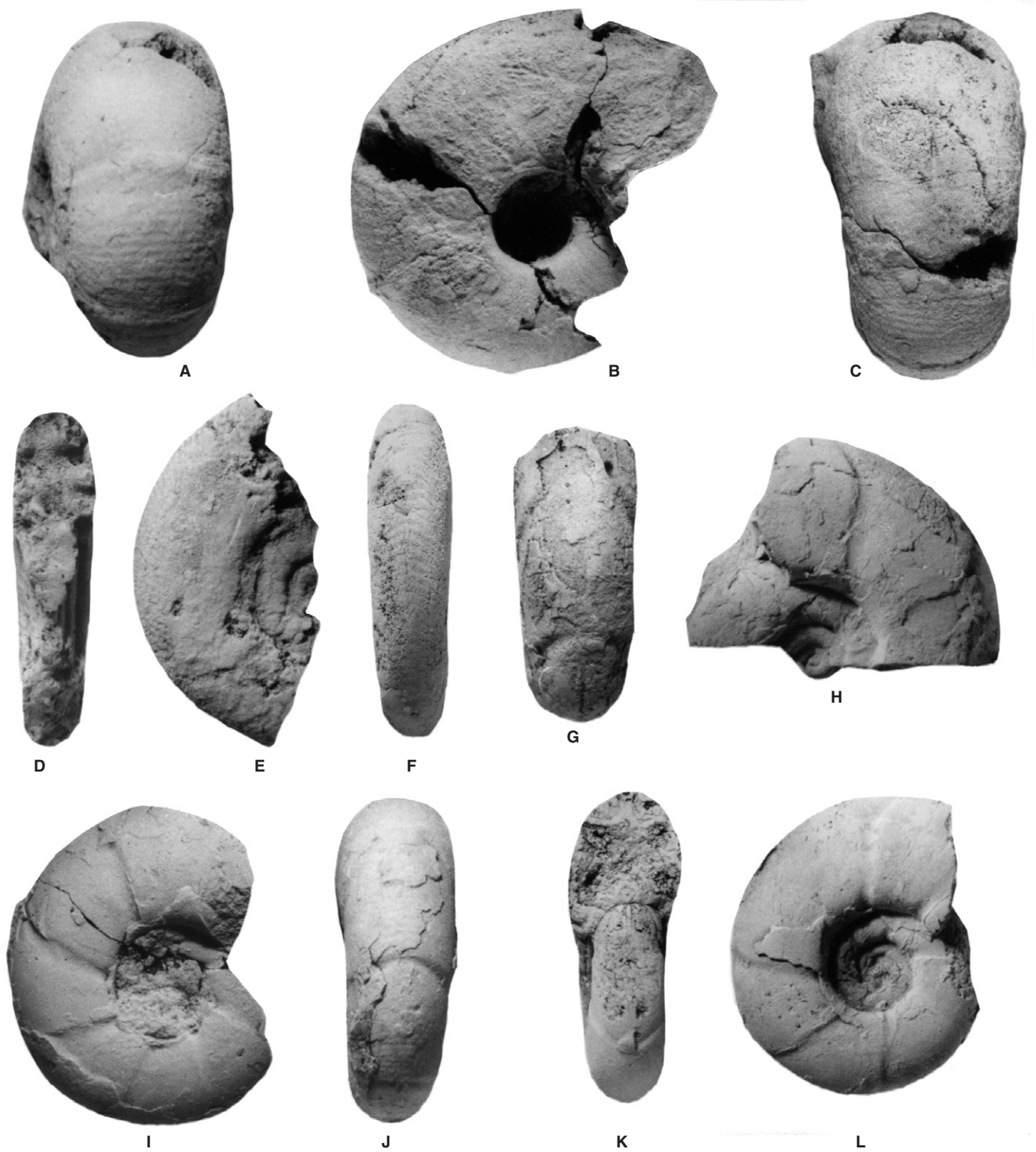
#### REFERENCES

- ANDERSON, F.M. 1958. Upper Cretaceous of the Pacific Coast. *Geological Society of America Memoir* **71**: xi + 378 pp.
- ANTHULA, A. D. 1889. Über die Kreidefossilien des Kaukasus. *Beiträge zur Paläontologie Österreich-Ungarns und des Orients* **12**: 55–160 (1–105).
- AVRAM, E., DUȘA, A. & LUPU, D. 1990. La faune d'ammonites des couches de Duimești (Monts Apuseni du Sud, Roumanie). *Dăria de Seăma ale Sedințiilor*. 3. *Paleontologie* **74**: 87–109.
- BAYLE, É. 1878. *Fossiles principaux des terrains. Explication de la Carte Géologique détaillée 4, (1), (Atlas)*, 158 pls. Paris: Service de la Carte Géologique.
- BOULE, M., LEMOINE, P. & THÉVENIN, A. 1906–1907. Paléontologie de Madagascar III Céphalopodes crétacés des environs de Diego-Suarez. *Annales de Paléontologie* **1**: 173–192 (1–20); **2**: 1–56 (21–76).
- BREISTROFFER, M. 1947. Sur les zones d'ammonites dans l'Albien de France et d'Angleterre. *Travaux du Laboratoire de Géologie de la Faculté des Sciences de l'Université de Grenoble* **26**: 17–104 (1–88 in separates).
- CANTU CHAPA, C.M. 1976. Estratigrafía de la Formación de la Peña (Aptiano sup.) en el área de Monterrey, N. L. *Revista del Instituto Mexicano del petróleo* **8**: 7–16.
- CASEY, R. 1961. A monograph of the Ammonoidea of the Lower Greensand. Part 3. *Palaeontographical Society Monographs*: 119–216.
- CHIPLONKAR, G.W., GHARE, M.A. & OKA, S.M. 1986. Desmoceratid ammonites from the Upper Cretaceous rock formations of south India. *Current Trends in Geology* **7**: 27–48.
- CHIRIAC, M. 1981. *Amoniti Cretacici din Dobrogea de Sud. Studiu biostratigraphic*. București: Editura Academiei Republicii Socialiste România. 143 pp.
- COLLIGNON, M. 1949. Recherches sur les faunes albiennes de Madagascar. V.: l'Albien supérieur d'Andranofotsy (Cercle de Manja) avec une notice stratigraphique par M. Hartz. *Annales Géologiques du Service des Mines de Madagascar* **19**: 1–40.
- COLLIGNON, M. 1961. Ammonites néocrétacées du Menabe (Madagascar). VII, Les Desmoceratidae. *Annales Géologiques du Service des Mines de Madagascar* **31**: 115 pp.
- COLLIGNON, M. 1962. *Atlas des fossiles caractéristiques de Madagascar (Ammonites), XI Aptien*. 64 pp. Tananarive: Service Géologique.
- COLLIGNON, M. 1964. *Atlas des fossiles caractéristiques de Madagascar (Ammonites), XI Cenomanien*. xi + 152 pp. Tananarive: Service Géologique.
- COLLIGNON, M. 1965. *Atlas des fossiles caractéristiques de Madagascar (Ammonites), XIII (Coniacien)*. vii + 88 pp. Tananarive: Service Géologique.
- COOPER, M.R. & GREYLING, E.H. 1996. Stratigraphy and palaeontology of a temporary exposure of the Mzamba Formation (Upper Cretaceous, Lower Campanian) in the Eastern Cape, South Africa. *Durban Museum Novitates* **21**: 11–24.
- COOPER, M.R. & KENNEDY, W.J. 1987. A revision of the Puzosiinae (Cretaceous Ammonites) of the Cambridge Greensand. *Neues Jahrbuch für Geologie und Paläontologie Abhandlungen* **174**: 105–121.
- CRICK, G.C. 1907. Cretaceous fossils of Natal. In: ANDERSON, W. *Third and Final Report of the Geological Survey of Natal and Zululand*. 161–250. London: West, Newman.
- DIENER, C. 1925. Ammonoidea neocretacea. *Fossilium Catalogus* (1: Animalia) **29**: 244 pp.

- DIMITROVA, N. 1967. [Fossils of Bulgaria. IV. Lower Cretaceous Cephalopoda (Nautiloidea and Ammonoidea).] 424 pp. Sofia: Bulgarian Academy of Sciences. [In Bulgarian with French summary.]
- DOUVILLÉ, H. 1879. (Note accompagnant le présentation de l'Atlas de t. iv de l'explication de la carte géologique de France de E. Bayle & R. Zeiller). *Bulletin de la Société Géologique de France* (3), **7**: 91–92.
- DOUVILLÉ, H. 1904. In: MORGAN, J. DE. *Mission Scientifique en Perse. Tome troisième. Études géologiques partie IV. Paléontologie, mollusques fossils.* 191–380. Paris: Leroux.
- ERISTAVI, M.S. 1961. [Ammonites from the Aptian and Albian of the southern Caucasus]. *Akademia Nauk GSSR, Trudy. Geologicheskaya Ikh. Ta., ser. Geol.* **12**(7): 41–77
- ETHERIDGE, R. 1907. Cretaceous fossils of Natal. II. The Umsinene River Deposit. *Report of the Geological Survey of Natal and Zululand* **3**: 67–90.
- GALE, A.S., BOWN, P., CARON, M., CRAMPTON, J., CROWHURST, S.J., KENNEDY, W.J., PETRIZZO, M.R. & WRAY, D. S. 2011. The uppermost Middle and Upper Albian succession at the Col de Palluel, Hautes-Alpes, France: an integrated study (ammonites, inoceramid bivalves, planktonic foraminifera, nannofossils, geochemistry, stable oxygen and carbon isotopes, cyclostratigraphy). *Cretaceous Research* **37**: 59–130.
- GAUTHIER, H. 2006. *Révision Critique de la Paléontologie Française d'Alcide d'Orbigny, 6, Céphalopodes Crétacés.* Leiden: Backhuys.
- GONZALES-ARREOLA, C., PANTOJA-ALOR, J., OLÓRIZ, F., VILLAŞEÑOR, A. B. & GARCIA-BARRETA, P. G. 1996. Lower Aptian Ammonitina *Pseudohaploceras lptoviense* (Zeuschner) in the Cumburindino Formation (southwestern Mexico). *Géobios* **29**: 35–43.
- GROSSOUVRE, A. de 1894. Recherches sur la craie supérieure, 2, Paléontologie. Les ammonites de la craie supérieure. *Mémoires du Service de la Carte Géologique détaillé de la France*, 1–264.
- HOEPEN, E.C.N. 1951. A remarkable desmoceratid from the South African Albian. *Paleontologische Navorsing van die Nasionale Museum, Bloemfontein* **1**: 345–349.
- HOEPEN, E.C.N. 1955. Turonian-Coniacian ammonites from Zululand. *South African Journal of Science* **51**: 361–377.
- HOEPEN, E.C.N. 1968. New and little known Zululand and Pondoland ammonites. *Annals of the Geological Survey of South Africa* **4**: 157–181(1965).
- HYATT, A. 1889. Genesis of the Arietidae. *Smithsonian Contributions to Knowledge* **673**: xi + 239 pp.
- HYATT, A. 1900. Cephalopoda. In: ZITTEL, K.A. VON 1896–1900, *Textbook of Palaeontology*, transl. Eastman, C.R. pp. 502–604. London and New York: Macmillan.
- KENNEDY, W.J., AMÉDRO, F., ROBASYNSKI, F. & JAGT, J.W.M. 2011. Ammonite faunas from condensed Cenomanian-Turonian sections ('Tourtiás') in southern Belgium and northern France. *Netherlands Journal of Geosciences* **90**: 209–238.
- KENNEDY, W.J. & BILOTTE, M. 2009. A revision of the cephalopod fauna of the 'niveau rouge' of the Selva de Bonansa, Huesca Province, northern Spain. *Byulleten Moskovskogo Obshchestva Ispytatelei Prirody, Ordol Geologicheskii* **84**: 39–70.
- KENNEDY, W.J. & JOLKIČEV, N. 2004. Middle Cenomanian ammonites from the type section of the Sanandino Formation of northern Bulgaria. *Acta Geologica Polonica* **54**: 369–380.
- KENNEDY, W.J. & KAPLAN, U. 1995. *Parapuzosia seppenradensis* (Landois) und die Ammoniten Fauna der Dülmener Schichten, Westfalen. *Geologie und Paläontologie in Westfalen* **33**: 127 pp.
- KENNEDY, W.J. & KLINGER, H.C. 1975. Cretaceous faunas from Zululand and Natal, South Africa. Introduction, Stratigraphy. *Bulletin of the British Museum (Natural History) Geology* **25**: 263–315.
- KENNEDY, W.J. & KLINGER, H.C. 2012. Cretaceous faunas from Zululand and Natal, South Africa. The desmoceratoid ammonite genera *Moretella* Collignon, 1963, *Beudanticeras* Hitzel, 1902, and *Aioloceras* Whitehouse, 1926. *African Natural History* **8**: 55–75
- KENNEDY, W.J., & LATIL, J-L. 2007. The Upper Albian ammonite succession in the Montlax section, Hautes-Alpes, France. *Acta Geologica Polonica* **57**: 453–478.
- KENNEDY, W.J., WRIGHT, C.W. & KLINGER, H.C. 1979. Cretaceous faunas from Zululand and Natal, South Africa. A new genus and species of tuberculate desmoceratacean from the Mzinene Formation (Albian). *Annals of the South African Museum* **78**: 29–38.
- KILIAN, W. 1913. In: FRECH, F. *Lethaea Geognostica. II. Mesozoicum 3 (Kreide).* pp. 289–398. Stuttgart: Schweizerbart.
- KLEIN, J. & VAŠIČEK, Z. 2011. Lower Cretaceous Ammonites V Desmoceratoidea. *Fossilium Catalogus* (1: Animalia) **148**: 311 pp.
- KORN, D., EBBIGHAUSEN, V., BOCKWINKEL, J. & KLUG, C. 2003. The A-mode ontogeny in prolecanitid ammonites. *Palaeontology* **46**: 1123–1132.
- KOSSMAT, F. 1895–1898. Untersuchungen über die Südindische Kreideformation. *Beiträge zur Paläontologie Österreich-Ungarns und des Orients*. **9** (1895): 97–203; **11** (1897): 1–46 (108–153); **11** (1898): 89–152 (154–217).
- KULLMANN, J. & WIEDMANN, J. 1970. Significance of sutures in phylogeny of Ammonoidea. *University of Kansas, Paleontological Contributions* **42**: 1–32.
- LANDOIS, H. 1895. Die Riesenammoniten von Seppenrade. *Pachydiscus Zittel Seppenradensis* H. Landois. *Jahresbericht des Westfälischen Provinzial-Vereins für Wissenschaft und Kunst* **23**: 99–108.
- LEANZA, A.F. 1963. *Patagoniceras* Gen. Nov. (Binneyitidae) y otros ammonites del Cretacico Superior de Chile Meridionale con notas acerca de su posición estratigráfica. *Boletín de la Academia Nacional de Ciencias* **43**: 203–225.
- LEANZA, A. & WIEDMANN, J. 1980. Ammoniten des Valangin und Hauterive (Unterkreide) von Neuquén und Mendoza, Argentinien. *Eclogae Geologicae Helveticae* **73**: 941–982.
- LUPPOV, V. 1949. [Atlas of index forms of the fossil faunas of the USSR] **10**: 328 pp. Moscow & Leningrad: Gostgeolizdat [in Russian]
- MARCINOWSKI, R. & WIEDMANN, J. 1990. The Albian ammonites of Poland. *Palaeontologica Polonica* **50**: 94 pp.
- MATSUMOTO, T. 1954. Family Puzosiidae from Hokkaido and Saghalien. *Memoirs of the Faculty of Science, Kyushu University, Series D, Geology* **5**: 69–118.
- MATSUMOTO, T. 1959. The Upper Cretaceous ammonites of California. Part II. *Memoirs of the Faculty of Science, Kyushu University, Series D, Geology. Special Volume* **1**: 172 pp.
- MATSUMOTO, T. 1988. A monograph of the Puzosiidae (Ammonoidea) from the Cretaceous of Hokkaido. *Palaeontological Society of Japan Special Papers* **30**: 1–179.
- NOWAK, J. 1913. Untersuchungen über die Cephalopoden der oberen Kreide in Polen. III Teil. *Bulletin international de l'Académie des Sciences de Cracovie. Classe des Sciences Mathématiques et Naturelles. Série B Sciences Naturelles* **1913**: 335–415.
- OBATA, I. 1967. Lower Cretaceous ammonites from the Miyako Group. Part 1. *Valdedorsella* from the Miyako Group. *Transactions and Proceedings of the Palaeontological Society of Japan* **66**: 63–72.
- ORBIGNY, A. d'. 1840–1842. *Paléontologie française: Terrains crétacés. 1. Céphalopodes.* 1–120 (1840); 121–430 (1841); 431–662 (1842). Paris: Masson.
- PARONA, C.F. & BONARELLI, G. 1897. Fossili Albiani d'Escrag-nolles, del Nizzardo e della Liguria occidentale. *Palaeontographica Italica* **2**: 53–107 (1–55).
- PERVINQUIÈRE, L. 1907. Études de Paléontologie Tunisienne. 1. Céphalopodes des terrains secondaires. *Carte Géologique de la Tunisie*, v + 438 pp.
- REBOULET, S., GIRAUD, F. & PROUX, O. 2005. Ammonoid abundance variations related to changes in trophic conditions across the Oceanic Anoxic Event 1d (latest Albian, SE France). *Palaios* **20**: 121–141.

- RENZ, O. 1972. Die Gattung *Puzosia* Bayle, *Bhimaites* Matsumoto und *Desmoceras* Zittel (Ammonoidea) im Oberen Albien Venezuelas. *Eclogae Geologicae Helvetiae* **65**: 701–724.
- RENZ, O. 1968. Die Ammonoidea im Stratotyp des Vraconnien bei Sainte-Croix (Kanton Waadt). *Schweizerische Paläontologische Abhandlungen* **87**: 1–99.
- SCHLOTHEIM, E.F. von. 1820. *Die Petrefaktenkunde auf ihrem jetzigen Standpunkte durch die Beschreibung seiner Sammlung...* lxii + 437 pp. Gotha: Becker.
- SCHOLZ, G. 1979. Die Ammoniten des Vracon (Oberalb, *dispar* Zone) des Bakony-Gebirges (Westungarn) und eine Revision der wichtigsten Vracon-Arten der Westmediterranen Faunenprovinz. *Palaeontographica* **A165**: 1–136.
- SEYED-EMAMI, K. & IMMEL, H. 1995. Ammoniten aus dem Alb (Kreide) von Shir-Kuh (N'Yazd, Zentraliran). *Paläontologische Zeitschrift* **69**: 377–399.
- SEYED-EMAMI, K. & IMMEL, H. 1995. Ammoniten aus dem Alb (höhere Unterkreide) des Zentralirans. *Palaeontographica* **A241**: 1–26.
- SHARPE, D. 1853–57. Description of the fossil remains of Mollusca found in the Chalk of England. I, Cephalopoda. *Palaeontographical Society Monographs*. 68, pp. 1–26 (1853); 27–36 (1855); 37–68 (1857).
- SOWERBY, J. 1812–1822. *The Mineral Conchology of Great Britain*. **1**, pls. 1–9 (1812), pls. 10–44 (1813), pls. 45–78 (1814), pls. 79–102 (1815); **2**, pls. 103–14 (1815), pls. 115–50 (1816), pls. 151–86 (1817), pls. 187–203 (1818); **3**, pls. 204–21 (1818), pls. 222–53 (1819), pls. 254–71 (1820), pls. 272–306 (1821); **4**, pls. 307–18 (1821), pls. 319–83 (1822). London: the Author.
- SOWERBY, J. DE C. 1823–1846. *The Mineral Conchology of Great Britain* (continued). **4**, pls 384–407 (1823); **5**, pls 408–443 (1823); pls 444–485 (1824); pls 486–503 (1825); **6**, pls 504–545 (1826); pls 546–580 (1827); pls 581–597 (1828); pls 598–609 (1829); **7**, pls 610–618 (1840); pls 619–623 (1841); pl. 624–628 (1843); pls 629–643 (1844); pls 644–648 (1846).
- SPATH, L.F. 1921a. On Upper Cretaceous Ammonoidea from Pondoland. *Annals of the Durban Museum* **3**: 39–56.
- SPATH, L.F. 1921b. On Cretaceous Cephalopoda from Zululand. *Annals of the South African Museum* **12**: 217–321.
- SPATH, L.F. 1922. On the Senonian ammonite fauna of Pondoland. *Transactions of the Royal Society of South Africa* **10**: 113–147.
- SPATH, L. F. 1923. A monograph of the Ammonoidea of the Gault. Part. 1 *Palaeontographical Society Monographs*: 1–72.
- STOLICZKA, F. 1863–1866. The fossil Cephalopoda of the Cretaceous rocks of southern India. Ammonitidae with revision of the Nautilidae etc. *Memoirs of the Geological Survey of India*. (1), *Palaeontologica Indica* **3**: (1), 41–56 (1863); (2–5), 57–106 (1864); (6–9), 107–154 (1865); (10–13), 155–216 (1866).
- STOLICZKA, F. 1868. Additional observations regarding the cephalopodous fauna of the South Indian Cretaceous deposits. *Records of the Geological Survey of India* **1**(2): 32–37.
- SZIVES, O. 2007. Albian Stage. In: Aptian-Campanian ammonites of Hungary. *Geologica Hungarica, Series Palaeontologica* **57**: 75–122.
- VENZO, S. 1936. Cefalopodi del Cretaceo medio-superiore dello Zululand. *Palaeontographia Italica* **36**: 59–133.
- WIEDMANN, J. & BOESS, J. 1984. Ammonitenfunde aus der Biskaya-Synkline (Nordspanien) Kreidegliederung und Alter des Kreide-Vulkanismus. *Eclogae Geologicae Helvetiae* **77**: 484–510.
- WIEDMANN, J. & DIENI, I. 1968. Die Kreide Sardinien und ihre Cephalopoden. *Palaeontographia Italica* **64**: 1–171.
- WRIGHT, C.W. 1957. [Cretaceous Ammonoidea]. In: MOORE, R.C. (ed). *Treatise on Invertebrate Paleontology. Part L, Mollusca 4, Cephalopoda Ammonoidea*. xxii + 1–490 pp., New York and Lawrence: Geological Society of America and University of Kansas Press.
- WRIGHT, C.W. 1996. *Treatise on Invertebrate Paleontology. Part L, Mollusca 4: Cretaceous Ammonoidea*. xx + 1–362 (with contributions by J.H. Calloman (*sic*) and M.K. Howarth). Lawrence, Kansas and Boulder, Colorado: Geological Society of America and University of Kansas.
- WRIGHT, C.W. & KENNEDY, W.J. 1984. The Ammonoidea of the Lower Chalk. Part 1. *Palaeontographical Society Monographs*: 1–126.
- WRIGHT, C.W. & WRIGHT, E.V. 1951. A survey of the fossil Cephalopoda of the Chalk of Great Britain. *Palaeontographical Society Monographs*: 1–40.
- ZEUSCHNER, L. 1856. Geognostische Beschreibung des Liaskalks in der Tatra und in den angrenzenden Gebirgen. *Sitzungsbericht der kaiserlichen Akademie der Wissenschaften in Wien* **19**: 135–182.
- ZITTEL, K.A. von 1895. *Grundzüge der Palaeontologie (Palaeozoologie)*. Munich & Leipzig: R. Oldenbourg.





**Fig. 1.** A–C, *Valdedorsella akuschaensis* (Anthula, 1899). OUM KX9521, from bed 18 of the Makatini Formation, Aptian III, at locality 168 of Kennedy & Klinger (1975). D–F, *Puzosia compressa* Kossmat, 1898. OUM KX12331, collected loose at locality 62 of Kennedy & Klinger (1975), the eastern ‘horn’ of the Skoenberg, and from the Lower or Middle Cenomanian Mzinene Formation. G–L, *Puzosia furnitana* Pervinquière, 1907: G, H, OUM KX5386; I, J, OUM KX5630; K, L, OUM KX5629, all from the Upper Albian (Albian V) Mzinene Formation at locality 65 of Kennedy & Klinger (1975). Figures are  $\times 1$ .

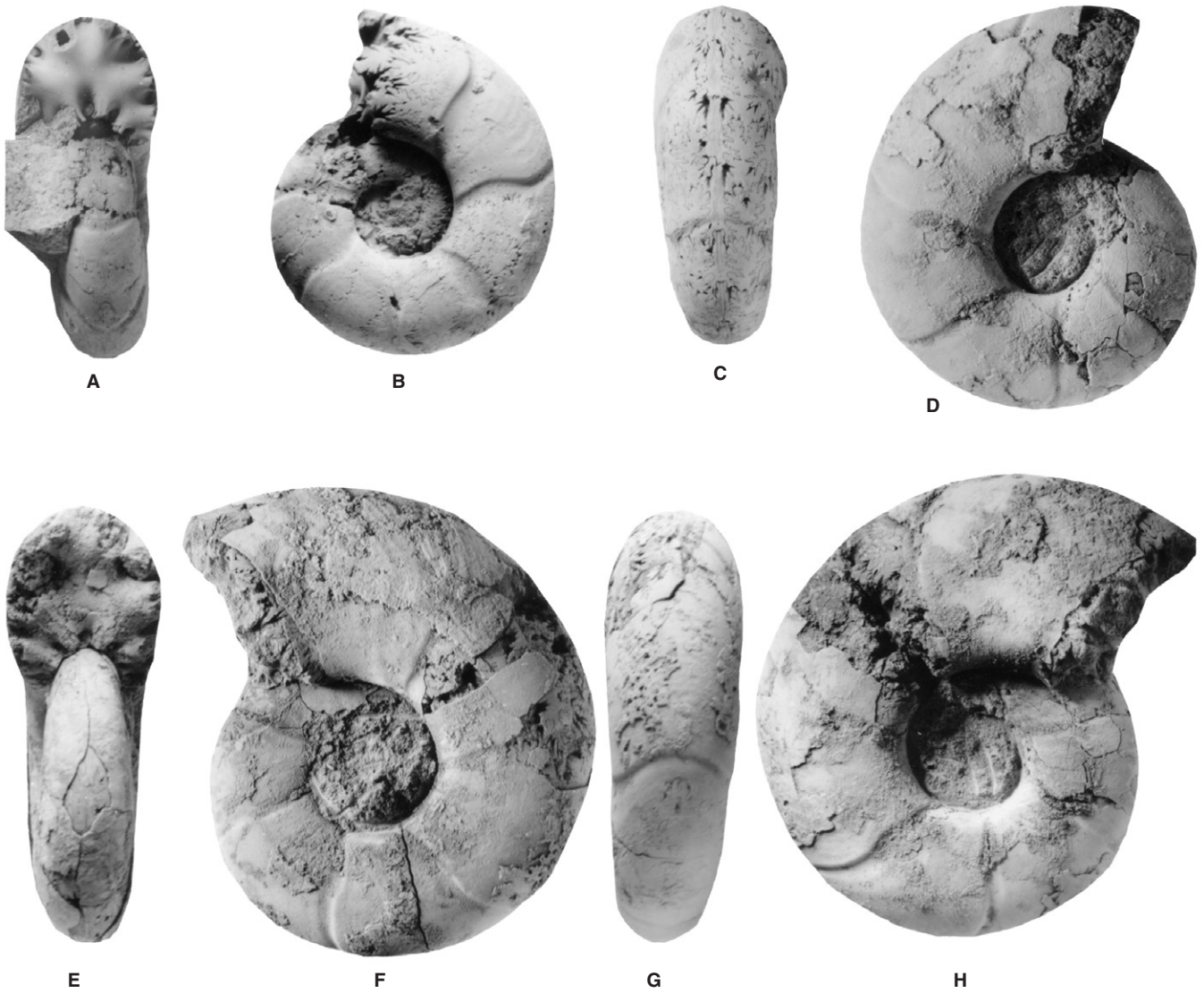




**Fig. 2.** *Pseudohaploceras matheroni* (d'Orbigny, 1841). **A**, SAM-PCZ22497; **B, C**, SAM-PCZ22498; **D–F**, SAM-PCZ22499, all from bed 45 of the Lower Aptian (Aptian I) Makatini Formation at locality 170 of Kennedy & Klinger (1975). Figures are  $\times 1$ .

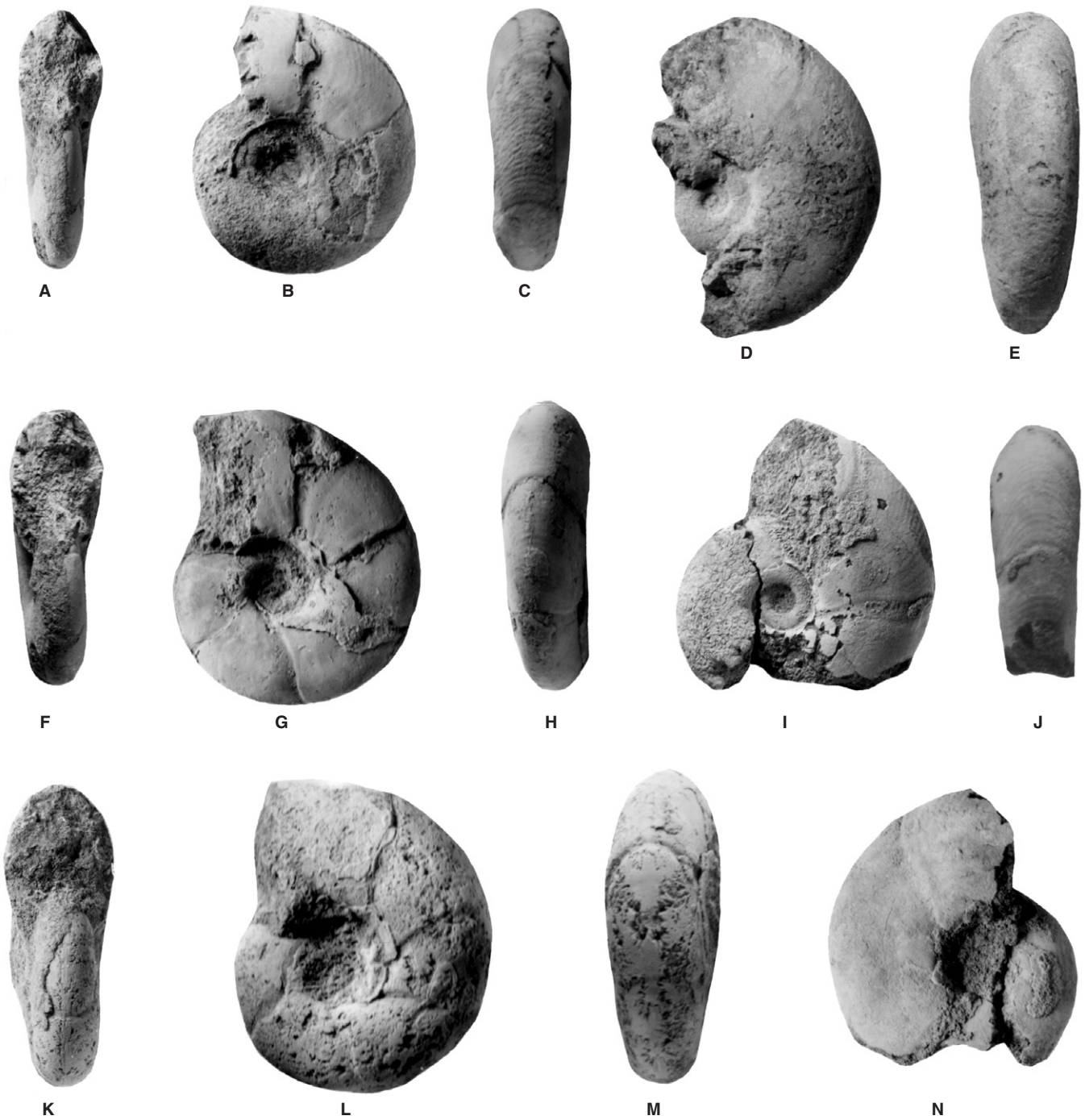


**Fig. 3.** *Puzosia mayoriana* (d'Orbigny, 1841). **A–D, I–L**, BMNH C18238, the lectotype of *Puzosia mayoriana* var. *natalensis* Crick, 1907, the original of Crick, 1907, pl. 14, fig. 4, from the 'deposit at the north end of False Bay', that is to say the Cenomanian part of the Mzinene Formation of the Skoenberg. **E–H**, BMNH C18239, the original of specimen b of Crick (1907), and a syntype of *Puzosia mayoriana natalensis* Crick, 1907, from the same horizon and locality as the original of Figs A–D, I–L. **M–P, T–V**, BMNH C18306, the holotype of *Puzosia concinna* Crick, 1907 (p. 245), from the Upper Albian Mzinene Formation of the 'middle Tributary of the Manuan Creek', that is to say close to locality 64 of Kennedy & Klinger (1975). **Q–S**, OUM KX4707; **W, X**, OUM KX4709, both from the Lower or Middle Cenomanian Mzinene Formation at locality 62 of Kennedy & Klinger (1975), the Skoenberg. Figures A–H, M–P are x1; Figs I–L, Q–X are x2.



**Fig. 4.** *Puzosia provincialis* (Parona & Bonarelli, 1897). **A–C**, SAM-A2002, from the subsurface at Hluhluwe. **D–H**, SAM-A1129, from the Munywana Creek in the environs of locality 64 of Kennedy & Klinger (1975). Both specimens are from the Upper Albian part of the Mzinene Formation (Albian V). Figures are  $\times 1$ .

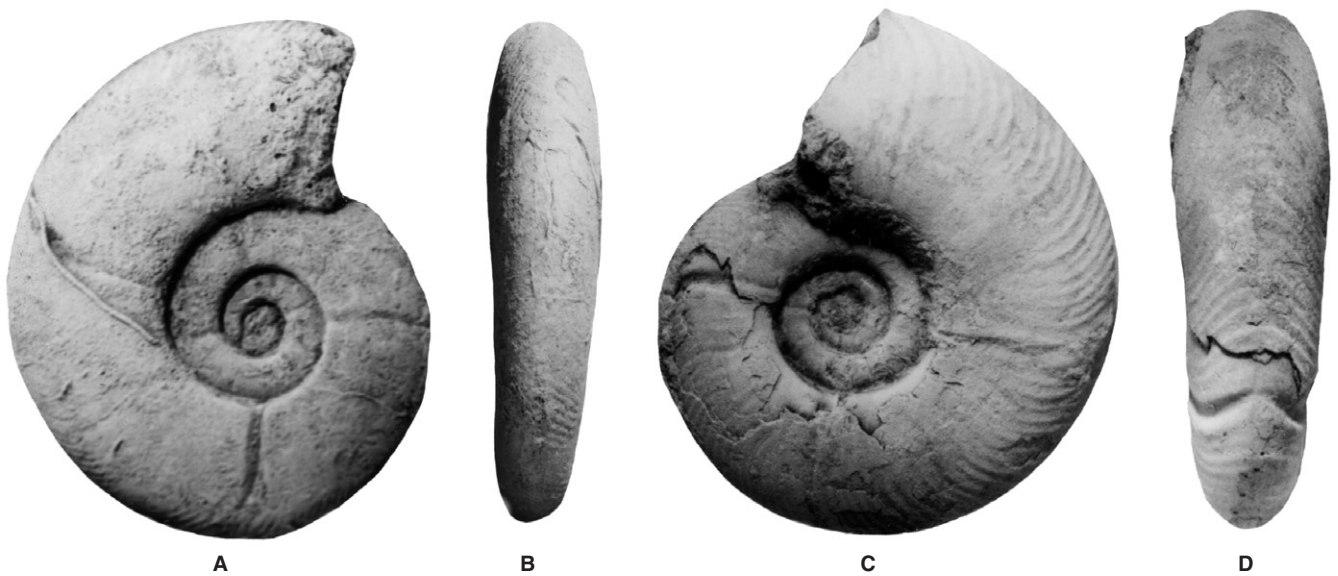




**Fig. 5.** *Puzosia* sp. group of *quenstedti* Parona & Bonarelli, 1897. **A–C**, SAM-Z26-D; **F–H**, SAM-Z26-B; **I, J, N**, SAM-Z26-C; **K–M**, SAM-Z26-A, all from the Upper Albian (Albian V) part of the Mzinene Formation in the environs of localities 54–56 of Kennedy & Klinger (1975). **D–E**, OUM KX14437, from the same horizon at locality 66 of Kennedy & Klinger (1975). All figures are  $\times 1$ .



**Fig. 6.** A–K, *Puzosia compacta* Crick, 1907. A–F, the holotype, BMNH C18307, the original of Crick, 1907, pl. 15, fig. 7, from the Upper Albian (Albian V) part of the Mzinene Formation of the 'middle tributary of the Munywan Creek', that is to say close to locality 64 of Kennedy & Klinger (1975). G–I, SAM-Z1505a; J, K, SAM-Z1505, both from the same horizon on the north bank of the Mzinene, in the environs of localities 54–56 of Kennedy & Klinger (1975). L, M, *Bhimaïtes subtilis* (Crick, 1907), KX10350, from bed 3 of the Lower Cenomanian Mzinene Formation at locality 181 of Kennedy & Klinger (1975). Figures A–C are  $\times 2$ ; Figures D–M are  $\times 1$ .



**Fig. 7. A, B, *Puzosia compressa*** Kossmat, 1898, the original of Collignon, 1964, p. 40, pl. 326, fig. 1461, from the Cenomanian of the Col de Vohimaranitra (Betioky), Madagascar. **C–D, *Puzosia praecompressa*** Collignon, 1964, the holotype, the original of Collignon, 1964, p. 55, pl. 332, fig. 1495, from the Cenomanian of Collignon's gisement 431, on the left bank of the Isovoky (Betioky), Madagascar. Both specimens are housed in the collections of the Université de Bourgogne. Figures are  $\times 1$ .

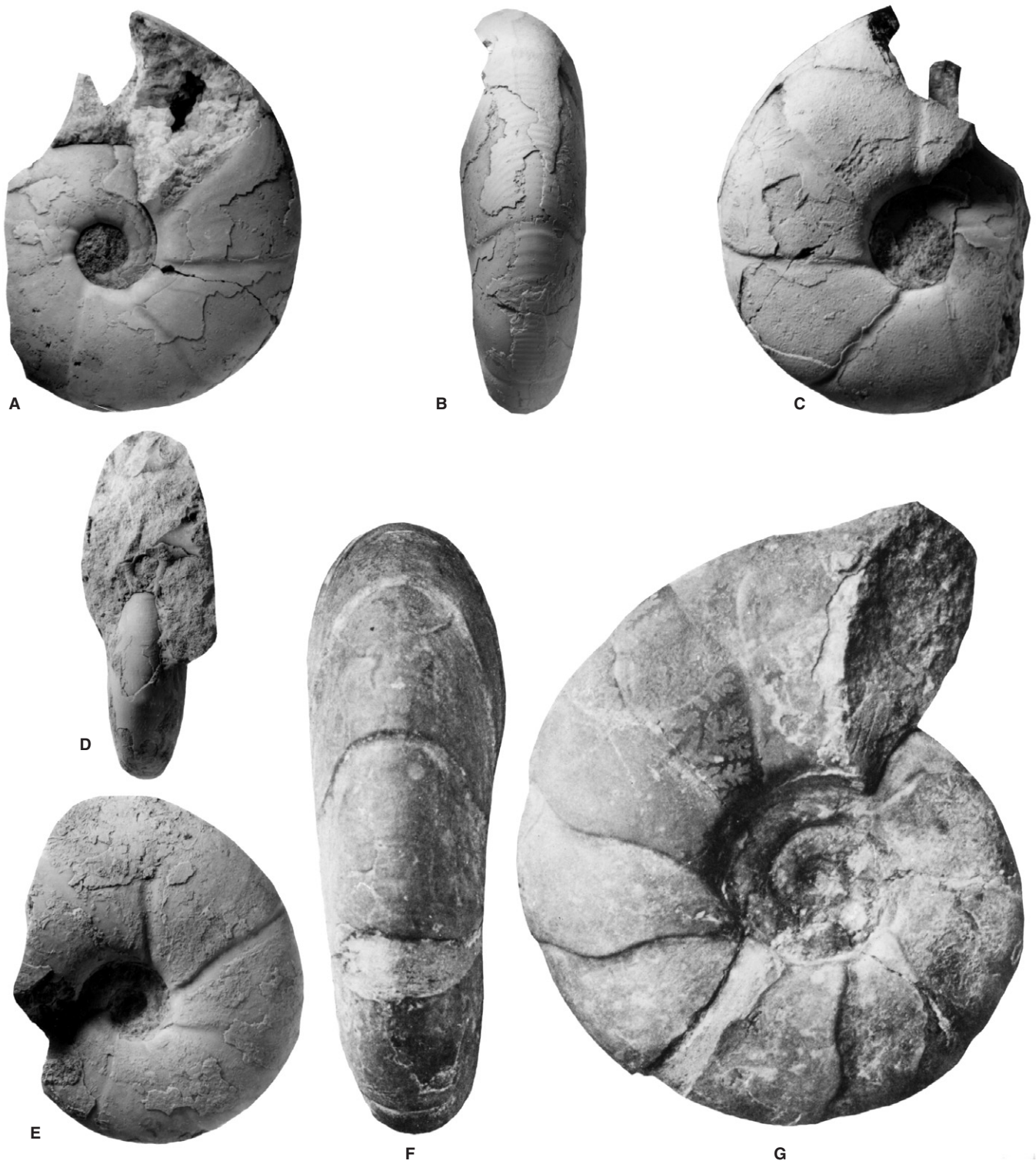




**Fig. 8.** *Puzosia eboroensis* Collignon, 1961. **A–C**, SAM-Z1051; **D–F**, SAM-Z1157, from the Lower Coniacian (Coniacian I) St Lucia Formation at locality 62 of Kennedy & Klinger (1975), the Skoenberg. Figures are  $\times 1$ .



**Fig. 9.** A, D, *Puzosia manasoensis* Collignon, 1961, SAM-Z1290, from the Coniacian Mzinene Formation on the Farm Insleep, in the environs of locality 64 of Kennedy & Klinger (1975). B, C, *Pachydesmoceras pachydiscoide* Matsumoto, 1954, OUM KX12691, from the Lower Coniacian (Coniacian I) at locality 60 of Kennedy & Klinger (1975). E–F, *Parapuzosia (Austiniceras) beantalyense* Collignon, 1961, OUM KX10574, from the Lower Coniacian (Coniacian I) part of the Mzinene Formation at locality 13 of Kennedy & Klinger (1975), south of Mtubatuba. Figures are  $\times 1$ .

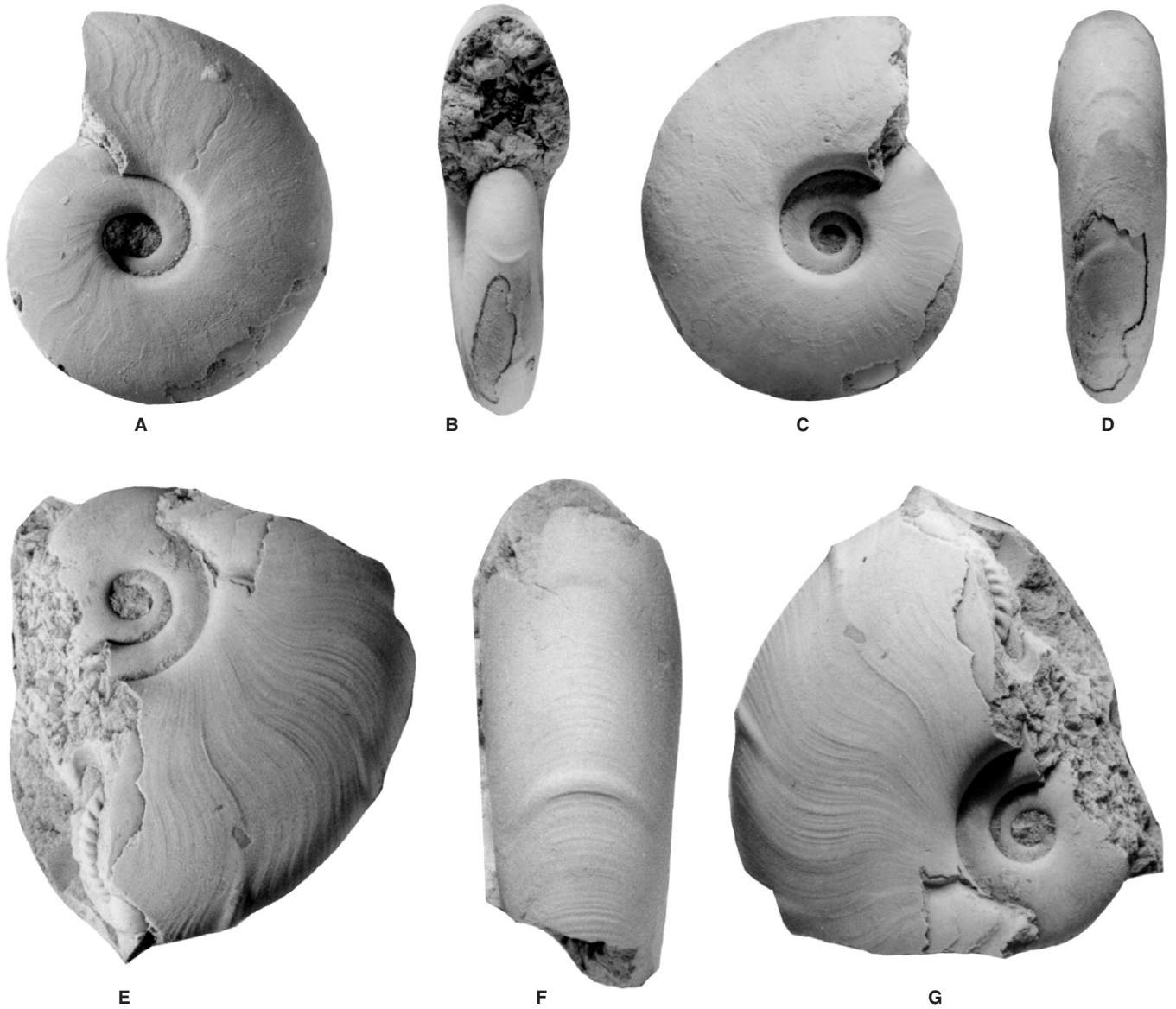


**Fig. 10.** A–E, *Bhimaites bhima* (Stoliczka, 1865). A–C, SAM-Z26E, from the Upper Albian (Albian V) in the environs of localities 54–56 of Kennedy & Klinger (1975). D, E, SAM-Z1302, from the same horizon at locality 64 of Kennedy & Klinger (1975) (cliff on the Muniwana near mouth of Ndabana). F, G, *Bhimaites gortanii* Venzo, 1936, the holotype, copy of Venzo, 1936, pl. 6 (2), fig. 2, from the Upper Albian (Albian V) part of the Mzinene Formation of 'Ndabana-Umsinene', that is to say the environs of locality 64 of Kennedy & Klinger (1975). Figures are  $\times 1$ .





**Fig. 11. A–C, *Bhimaites stoliczkai*** (Kossmat, 1898), BMNH C18241, the original of Crick, 1907, p. 216, from ‘the deposit at the north end of False Bay’, that is to say the Cenomanian part of the Mzinene Formation of the Skoenberg, localities 61–62 of Kennedy & Klinger (1975). **D–F, *Bhimaites gortanii*** (Venzo, 1936), SAM-Z380, from the Upper Albian (Albian V) part of the Mzinene Formation in the environs of locality 57 of Kennedy & Klinger (1975). Figures are  $\times 1$ .



**Fig. 12.** *Bhimaites pinguis* (Crick, 1907). **A–D**, SAM-H207/5/1, from bed 5, and **E–G**, OUM KX11803, from bed 6 of the Upper Albian (Albian V) part of the Mzinene Formation at locality 51 of Kennedy & Klinger (1975). Figures are  $\times 1$ .



**Fig. 13.** *Bhimaites pinguis* (Crick, 1907), OUM KX10961 from the Upper Albian (Albian V) part of the Mzinene Formation at locality 52 of Kennedy & Klinger (1975). Figures are  $\times 1$ .





**Fig. 14.** *Bhimaites pinguis* (Crick, 1907), SAM-Z1281, from the Upper Albian (Albian V) part of the Mzinene Formation in the environs of locality 64 of Kennedy & Klinger (1975). Figures are  $\times 1$ .



**Fig. 15.** *Bhimaites pinguis* (Crick, 1907). **A, B**, SAM-Z602, from the environs of localities 54–56 of Kennedy & Klinger (1975). **C–E**, OUM KX5627, from locality 65 of Kennedy & Klinger (1975). Both specimens are from the Upper Albian (Albian V) part of the Mzinene Formation. Figures are  $\times 1$ .



**Fig. 16.** *Bhimaites pinguis* (Crick, 1907), SAM-A938 from the Upper Albian (Albian V) part of the Mzinene Formation in the environs of locality 64 of Kennedy & Klinger (1975). Figures are  $\times 1$ .





**Fig. 17.** *Bhimaites pinguis* (Crick, 1907), the lectotype, BMNH C18243, the original of Crick, 1907, p. 218, from 'the deposit at the north end of False Bay', that is to say the Skenberg, localities 61–62 of Kennedy & Klinger (1975), and from the Upper Albian or Cenomanian Mzinene Formation. Figures are reduced  $\times 0.75$ , the specimen is 210 mm in diameter.



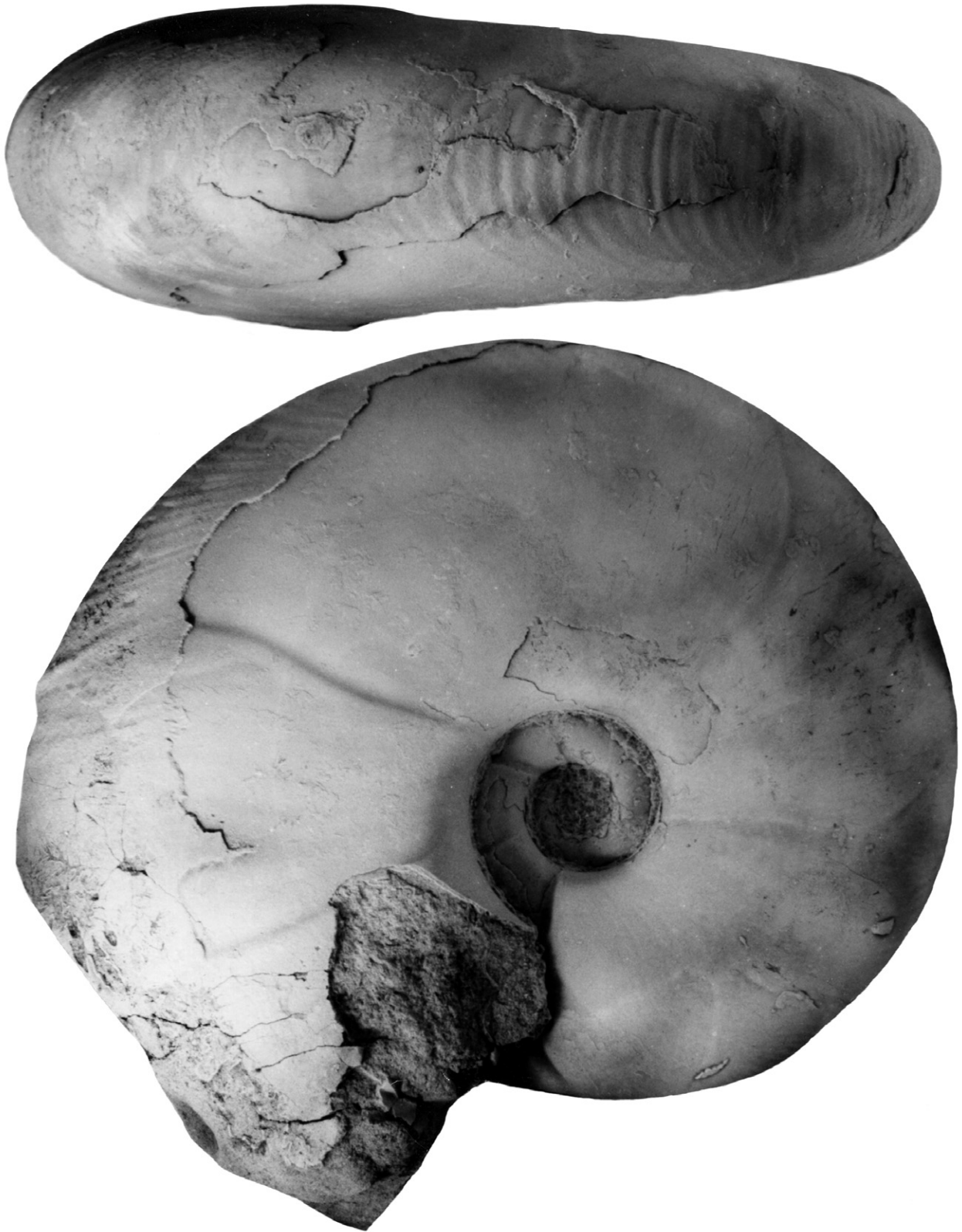
**Fig. 18.** *Bhimaites pinguis* (Crick, 1907), OUM KX12693, from the Upper Albian (Albian V) part of the Mzinene Formation at locality 64 of Kennedy & Klinger (1975). Figures are  $\times 1$ .



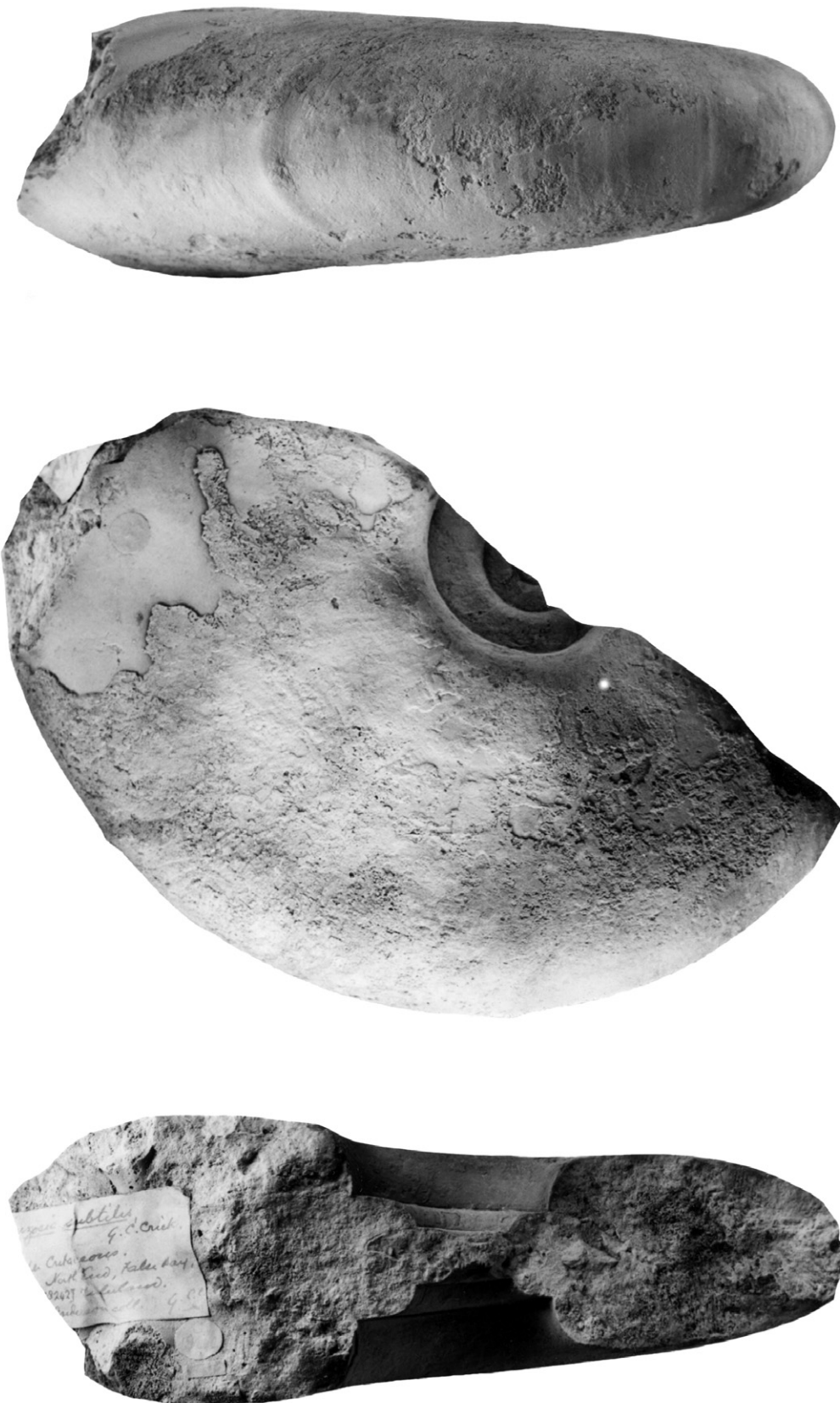


**Fig. 19.** *Bhimaites pinguis* (Crick, 1907), OUM KX11112 from the Upper Albian (Albian V) part of the Mzinene Formation at locality 54 of Kennedy & Klinger (1975). Figures are  $\times 0.95$ , the original is 210 mm in diameter.





**Fig. 20.** *Bhimaites pinguis* (Crick, 1907), SAM-Z90, from the Upper Albian (Albian V) part of the Mzinene Formation in the environs of localities 54–56 of Kennedy & Klinger (1975). Figures are  $\times 0.95$ .

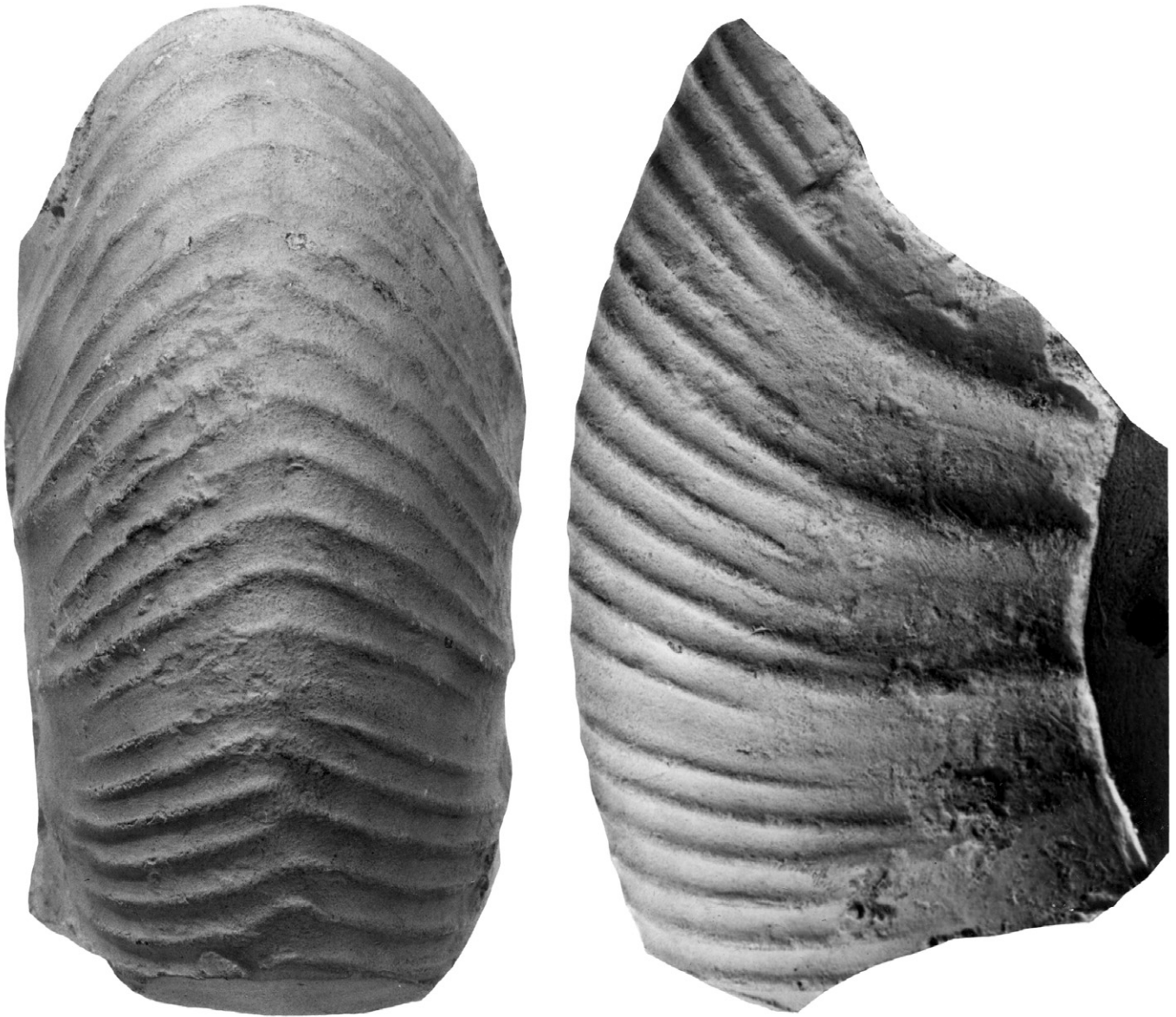


**Fig. 21.** *Bhimaites subtilis* (Crick, 1907). BMNH C18242, the holotype, the original of Crick, 1907, pl. 14, figs 4, 5, from the 'deposit at the north end of False Bay', that is to say the Lower to Middle Cenomanian part of the Mzinene Formation of the Skoenberg, localities 61–62 of Kennedy & Klinger (1975). Figures are  $\times 0.95$ .



**Fig. 22.** *Bhimaites gortanii* (Venzo, 1936), SAM-A456, from the Middle Albian (Albian V) in the environs of locality 64 of Kennedy & Klinger (1975). Figures are  $\times 0.95$ .



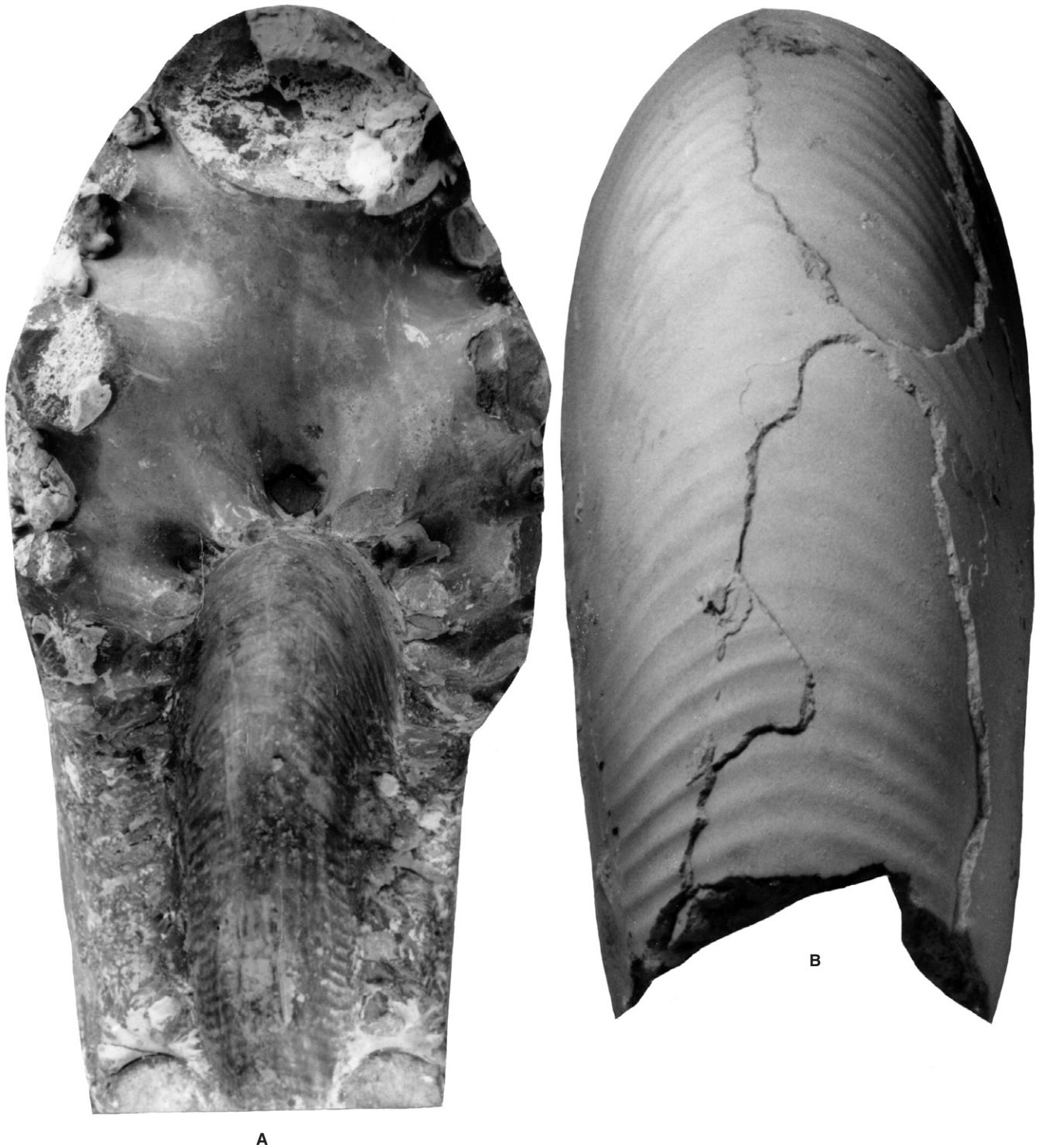


**Fig. 23.** *Parapuzosia* (*Parapuzosia*) *haughtoni* Spath, 1922, cast of the dorsum of the holotype, BMNH C19439, from the Santonian to Lower Campanian Mzamba Formation at the mouth of the Mzamba Estuary, locality 1 of Kennedy & Klinger (1975). Figures are  $\times 1$ .



**Fig. 24.** *Parapuzosia* (*Parapuzosia*)? *truteri* (Van Hoepen, 1968). SAM-5513, the original of Spath, 1921, pl. 19, fig. 2; pl. pl. 22, fig. 1; pl. 24, fig. 3, from the St Lucia Formation, 'railway cutting, Mfolozi', and probably of Coniacian date (photographs: M.R. Cooper). Figures are reduced,  $\times 0.6$  approximately.





**Fig. 25. A**, *Parapuzosia (Parapuzosia)? truteri* (Van Hoepen, 1968). SAM-5513, the original of Spath, 1921, pl. 19, fig. 2; pl. 22, fig. 1; pl. 24, fig. 3, from the St Lucia Formation, 'railway cutting, Mfolozi', and probably of Coniacian date (photograph: M.R. Cooper) (see also Fig. 24). **B**, *Pachydesmoceras pachdiscoide* Matsumoto, 1954. OUM KX11066, from the Lower Coniacian (Coniacian I) part of the St Lucia Formation at locality 60 of Kennedy & Klinger (1975). Figure A is reduced, x0.7 approximately. Figure B is x1.





**Fig. 26.** *Parapuzosia (Austiniceras) subcompressa* (Crick, 1907). The holotype, BMNH C18240, from 'the deposit at the north end of False Bay', that is to say the Lower or Middle Cenomanian part of the Mzinene Formation of the Skoenberg, localities 61–62 of Kennedy & Klinger (1975). Figures are  $\times 1$ .



**Fig. 27.** *Pachydesmoceras pachydiscoide* Matsumoto, 1954. OUM KX11066, from the Lower Coniacian (Coniacian I) part of the St Lucia Formation at locality 60 of Kennedy & Klinger (1975). (See also Fig. 25B.) Figure is  $\times 1$ .