VOLUME 77 PART 6 FEBRUARY 1979 ISSN 0303-2515

QH
1
S67X
NH

SMITHSONIAN
APR 13 1979
LIBRARIES

# ANNALS

## OF THE SOUTH AFRICAN MUSEUM

CAPE TOWN

# INSTRUCTIONS TO AUTHORS

1. MATERIAL should be original and not published elsewhere, in whole or in part.

2. LAYOUT should be as follows:

(a) *Centred masthead to consist of*
Title: informative but concise, without abbreviations and not including the names of new genera or species
Author's(s') name(s)
Address(es) of author(s) (institution where work was carried out)
Number of illustrations (figures, enumerated maps and tables, in this order)
(b) *Abstract* of not more than 200 words, intelligible to the reader without reference to the text
(c) *Table of contents* giving hierarchy of headings and subheadings
(d) *Introduction*
(e) *Subject-matter* of the paper, divided into sections to correspond with those given in table of contents
(f) *Summary*, if paper is lengthy
(g) *Acknowledgements*
(h) *References*
(i) *Abbreviations*, where these are numerous

3. MANUSCRIPT, to be submitted in triplicate, should be typewritten and neat, double spaced with 2,5 cm margins all round. First lines of paragraphs should be indented. Tables and a list of legends for illustrations should be typed separately, their positions indicated in the text. All pages should be numbered consecutively.

Major headings of the paper are centred capitals; first subheadings are shouldered small capitals; second subheadings are shouldered italics; third subheadings are indented, shouldered italics. Further subdivisions should be avoided, as also enumeration (never roman numerals) of headings and abbreviations.

Footnotes should be avoided unless they are short and essential.

Only generic and specific names should be underlined to indicate italics; all other marking up should be left to editor and publisher.

4. ILLUSTRATIONS should be reducible to a size not exceeding 12 × 18 cm (19 cm including legend); the reduction or enlargement required should be indicated; originals larger than 35 × 47 cm should not be submitted; photographs should be rectangular in shape and final size. A metric scale should appear with all illustrations, otherwise magnification or reduction should be given in the legend; if the latter, then the final reduction or enlargement should be taken into consideration.

All illustrations, whether line drawings or photographs, should be termed figures (plates are not printed; half-tones will appear in their proper place in the text) and numbered in a single series. Items of composite figures should be designated by capital letters; lettering of figures is not set in type and should be in lower-case letters.

The number of the figure should be lightly marked in pencil on the back of each illustration.

5. REFERENCES cited in text and synonymies should all be included in the list at the end of the paper, using the Harvard System (*ibid.*, *idem*, *loc. cit.*, *op. cit.* are not acceptable):

(a) Author's name and year of publication given in text, e.g.:

'Smith (1969) describes . . .'
'Smith (1969: 36, fig. 16) describes . . .'
'As described (Smith 1969*a*, 1969*b*; Jones 1971)'
'As described (Haughton & Broom 1927) . . .'
'As described (Haughton *et al.* 1927) . . .'

*Note:* no comma separating name and year
pagination indicated by colon, not p.
names of joint authors connected by ampersand
*et al.* in text for more than two joint authors, but names of all authors given in list of references.

(b) Full references at the end of the paper, arranged alphabetically by names, chronologically within each name, with suffixes *a*, *b*, etc. to the year for more than one paper by the same author in that year, e.g. Smith (1969*a*, 1969*b*) and not Smith (1969, 1969*a*).

For books give title in italics, edition, volume number, place of publication, publisher.
For journal article give title of article, title of journal in italics (abbreviated according to the *World list o, scientific periodicals*. 4th ed. London: Butterworths, 1963), series in parentheses, volume number, part number (only if independently paged) in parentheses, pagination (first and last pages of article).

*Examples* (note capitalization and punctuation)

BULLOUGH, W. S. 1960. *Practical invertebrate anatomy*. 2nd ed. London: Macmillan.
FISCHER, P.-H. 1948. Données sur la résistance et de le vitalité des mollusques. *J. Conch., Paris* **88**: 100–140.
FISCHER, P.-H., DUVAL, M. & RAFFY, A. 1933. Études sur les échanges respiratoires des littorines. *Archs Zool. exp. gén.* **74**: 627–634.
KOHN, A. J. 1960*a*. Ecological notes on *Conus* (Mollusca: Gastropoda) in the Trincomalee region of Ceylon. *Ann. Mag. nat. Hist.* (13) **2**: 309–320.
KOHN, A. J. 1960*b*. Spawning behaviour, egg masses and larval development in *Conus* from the Indian Ocean. *Bull. Bingham oceanogr. Coll.* **17** (4): 1–51.
THIELE, J. 1910. Mollusca: B. Polyplacophora, Gastropoda marina, Bivalvia. *In:* SCHULTZE, L. *Zoologische und anthropologische Ergebnisse einer Forschungsreise im westlichen und zentralen Süd-Afrika* **4**: 269–270. Jena: Fischer. *Denkschr. med.-naturw. Ges. Jena* **16**: 269–270.

(*continued inside back cover*)

ANNALS OF THE SOUTH AFRICAN MUSEUM
ANNALE VAN DIE SUID-AFRIKAANSE MUSEUM

Volume 77 Band
February 1979 Februarie
Part 6 Deel

# CRETACEOUS FAUNAS FROM ZULULAND AND NATAL, SOUTH AFRICA THE AMMONITE SUPERFAMILY HAPLOCERATACEAE ZITTEL, 1884

By
WILLIAM JAMES KENNEDY
&
HERBERT CHRISTIAN KLINGER

Cape Town Kaapstad

The ANNALS OF THE SOUTH AFRICAN MUSEUM

are issued in parts at irregular intervals as material becomes available

Obtainable from the South African Museum, P.O. Box 61, Cape Town

Die ANNALE VAN DIE SUID-AFRIKAANSE MUSEUM

word uitgegee in dele op ongereelde tye na beskikbaarheid van stof

Verkrygbaar van die Suid-Afrikaanse Museum, Posbus 61, Kaapstad

OUT OF PRINT/UIT DRUK

1, 2(1–3, 5–8), 3(1–2, 4–5, 8, t.–p.i.), 5(1–3, 5, 7–9), 6(1, t.–p.i.), 7(1–4), 8, 9(1–2, 7), 10(1–3), 11(1–2, 5, 7, t.–p.i.), 15(4–5), 24(2), 27, 31(1–3), 32(5), 33

Copyright enquiries to the South African Museum

Kopieregnavrae na die Suid-Afrikaanse Museum

ISBN 0 908407 63 7

Printed in South Africa by
The Rustica Press, Pty., Ltd.,
Court Road, Wynberg, Cape

In Suid-Afrika gedruk deur
Die Rustica-pers, Edms., Bpk.,
Courtweg, Wynberg, Kaap

# CRETACEOUS FAUNAS FROM ZULULAND AND NATAL, SOUTH AFRICA
# THE AMMONITE SUPERFAMILY HAPLOCERATACEAE ZITTEL, 1884

By

WILLIAM JAMES KENNEDY

*Geological Collections, University Museum, Oxford*

&

HERBERT CHRISTIAN KLINGER

*South African Museum, Cape Town*

(With 20 figures)

[*MS. accepted 18 October 1978*]

ABSTRACT

Representatives of the superfamily Haploceratacеae Zittel, 1884, are locally common in rocks of Barremian age in northern Zululand, where *Sanmartinoceras* (*Sanmartinoceras*) *africanum* sp. nov. occurs at all stages of development from larval shells to discs which are still septate at a diameter of 120 mm, and represent the largest known specimens of the genus. *Sanmartinoceras* (*Theganeceras*) *nodosum* sp. nov., of Lower Aptian age, *Sanmartinoceras* (*Sinzovia*) *trautscholdi* (Sinzow), and an *Aconeceras* sp. of Upper Aptian age are other representatives of the Aconeceratidae, whilst the Binneyitidae are represented by specimens of *Borissiakoceras* of Middle Cenomanian age. In addition to systematic descriptions, the problems of recognizing dimorphism in these genera are discussed, and certain resultant taxonomic problems noted, and an annotated list of species referred to the two families is included.

## CONTENTS

| | PAGE |
|---|---|
| Introduction | 85 |
| Location of specimens | 86 |
| Field localities | 86 |
| Dimensions of specimens | 86 |
| Suture terminology | 86 |
| Systematic palaeontology | 87 |
| Annotated list of species referred to the Aconeceratidae and Binneyitidae | 117 |
| Acknowledgements | 119 |
| References | 120 |

## INTRODUCTION

The Haploceratacеae are the longest ranging of the Ammonitina, first appearing in the Middle Jurassic (Bajocian) and ranging to the Upper Cretaceous (Coniacian). As Casey has noted, two broad morphologies recur within the superfamily: firstly, smooth platycones, typified by the Haploceratidae and Binneyitidae, and secondly, variously ribbed or strigate oxycones with entire or



*Ann. S. Afr. Mus.* **77** (6), 1979: 85–121, 20 figs.

crenulate keels, typified by the Oppeliinae, Strigoceratidae and Aconeceratidae (Casey 1961*a*: 118). In the Cretaceous of Zululand both groups are represented, in the Upper Barremian and Aptian the Aconeceratidae are not uncommon at some levels, whilst the Binneyitidae occur as a great rarity in rocks of Middle Cenomanian age. Although only a few species are represented in the authors' collections, they are of some significance, for their specimens of Aconeceratidae allow, for the first time, the description of the detailed ontogeny of the widely occurring genus *Sanmartinoceras* Bonarelli, 1921, as well as clarifying some aspects of its stratigraphic distribution, whilst the present records of the binneyitid *Borissiakoceras* extend the known distribution of the group.

The following species are described below: *Aconeceras* sp., compared to *A. walshense* (Etheridge); *Sanmartinoceras* (*Sanmartinoceras*) *africanum* sp. nov.; *Sanmartinoceras* (*Theganeceras*) *nodosum* sp. nov.; *Sanmartinoceras* (*Sinzovia*) *trautscholdi* (Sinzow); and *Borissiakoceras* sp.

To this is added an annotated list of genera, subgenera and species referred to the two families.

## LOCATION OF SPECIMENS

The following abbreviations are used to indicate the repositories of the material studied:

| | |
|---|---|
| BMNH | British Museum (Natural History), London |
| GSM | Institute of Geological Sciences, London |
| MNHP | Muséum d'Histoire Naturelle, Paris |
| OUM | Oxford University Museum, Oxford |
| SAM | South African Museum, Cape Town |
| SAS | South African Geological Survey, Pretoria |

## FIELD LOCALITIES

Details of localities mentioned in the text are given by Kennedy & Klinger (1975); fuller descriptions of sections are deposited in the Palaeontology Department of the British Museum (Natural History), London; Geological Survey, Pretoria; and South African Museum, Cape Town.

## DIMENSIONS OF SPECIMENS

All dimensions given below are in millimetres:

D = diameter, Wb = whorl breadth, Wh = whorl height, U = umbilical diameter.

Figures in parentheses are dimensions as a percentage of the total diameter.

## SUTURE TERMINOLOGY

The suture terminology of Wedekind (1916), recently reviewed and discussed by Kullman & Wiedmann (1970) is followed here:

Is = Internal lobe with septal lobe, U = Umbilical lobe, L = Lateral lobe, E = External lobe.

## SYSTEMATIC PALAEONTOLOGY

Phylum **MOLLUSCA**
Class CEPHALOPODA Cuvier, 1797
Subclass AMMONOIDEA Zittel, 1884
Order AMMONITIDA Zittel, 1884
Suborder AMMONITINA Zittel, 1889
Superfamily HAPLOCERATACEAE Zittel, 1884
Family **Aconeceratidae** Spath, 1923

*Discussion*

The Aconeceratidae Spath, 1923, is a group of small to medium-sized, compressed, involute, commonly oxycone ammonites with flat or convex sides and a fastigiate to keeled venter. Ornament consists of weak to strong flexuous, commonly biconvex ribs and growth striae and a keel which may be minutely crenulate.

The following genera and subgenera have been placed in the family:
Genus *Protaconeceras* Casey, 1954, Hauterivian
Genus *Aconeceras* Hyatt, 1903, Barremian to Lower Albian
Genus *Sanmartinoceras* Bonarelli, 1921 (in Bonarelli & Nagera 1921), Barremian to Lower Albian
Subgenus *Sanmartinoceras* s.s., Barremian to Aptian
Subgenus *Sinzovia* Sazonova, 1958, Aptian
Subgenus *Theganeceras* Whitehouse, 1926, Lower Aptian
Genus *Doridiscus* Casey, 1961, Aptian
Genus *Nothodiscus* Casey *in* Collignon, 1962, Aptian
Genus *Gyaloceras* Whitehouse, 1927, Upper Aptian.

Aconeceratids have a wide geographic distribution extending from Greenland to Antarctica, although their occurrence is sporadic. In Europe at least, they occur in enormous numbers in some clay facies as in southern France, where the blue marls of the Fosse Vocontienne yield thousands of *Aconeceras* and Casey (1961*b*: 122) regarded them as an open sea group which invaded the neritic zone only in periods favourable for their growth. As will be seen below, however, their local abundance in carbonaceous nearshore sandstones of the South African Barremian is scarcely compatible with such a generalization.

The Haploceratacea as a whole are characterized by striking dimorphism (Makowski 1962, Callomon 1963, Kennedy & Cobban 1976 with references), but within the Aconeceratidae our knowledge is such that it remains most difficult to recognize dimorphic pairs. In *Aconeceras* itself, the many hundreds of specimens from the French Aptian examined are all pyritic phragmocones and it would appear that juveniles, at least, are most difficult to split into dimorphs, as Palframan (1969) found in some Jurassic haploceratids. The authors do know, however, of a few specimens referrable to the family in which

apertures are preserved: the original material of *S.* (*Sanmartinoceras*) *groenlandicum* Rosenkrantz, 1934 (in Bøgvad & Rosenkrantz), illustrated here as Figure 1A–C, is an obvious microconch with prominent lappets and a rostrum. Equally, *Gyaloceras smithi* Whitehouse, 1927, appears to be a female or macroconch. The specimen is reproduced here as Figure 2A. In most cases, however, the shell ornament of aconeceratids (as opposed to apertural form) gives little clue to dimorphism and a markedly biconvex growth line, indicating a long rostrum and blunt lappets, occurs, in the present material at least, in both small and large (if not mature specimens). The authors would, however, suggest that the presence of a strong spiral depression may indicate the possible presence of a long lappet (Figs 1A–B, 5C). The topic is returned to below under the discussion of *Sanmartinoceras.*

## Genus *Aconeceras* Hyatt, 1903

*Type species*

*Ammonites nisus* d'Orbigny, 1841.

*Discussion*

*Aconeceras* is represented by a single, poor specimen from the Aptian of Zululand; in consequence the reader is referred to Casey's (1961*b*: 123) extensive remarks on the genus.

*Occurrence*

The genus ranges from Barremian to Lower Albian and is widely distributed from western Europe and the U.S.S.R. to east Africa, Madagascar, Nepal, Antarctica and eastern Australia.

### *Aconeceras* sp.

*Material*

One specimen only, BMNH C80002, from the Makatini Formation, Aptian III, locality 166, Mfongosi Spruit, northern Zululand.

*Description*

The specimen is an external mould of an oxycone individual with an original maximum whorl height of over 20 mm. Coiling is very involute with a small, pit-like steep-sided umbilicus. The whorl section is high, compressed with the greatest breadth well below mid-flank. The flanks are distinctly flattened and the venter fastigiate.

The specimen is somewhat worn and there is no obvious trace of ornament preserved.

*Discussion*

Although poorly preserved, this specimen is clearly referrable to the genus *Aconeceras.* Amongst described species it is perhaps to be compared with the

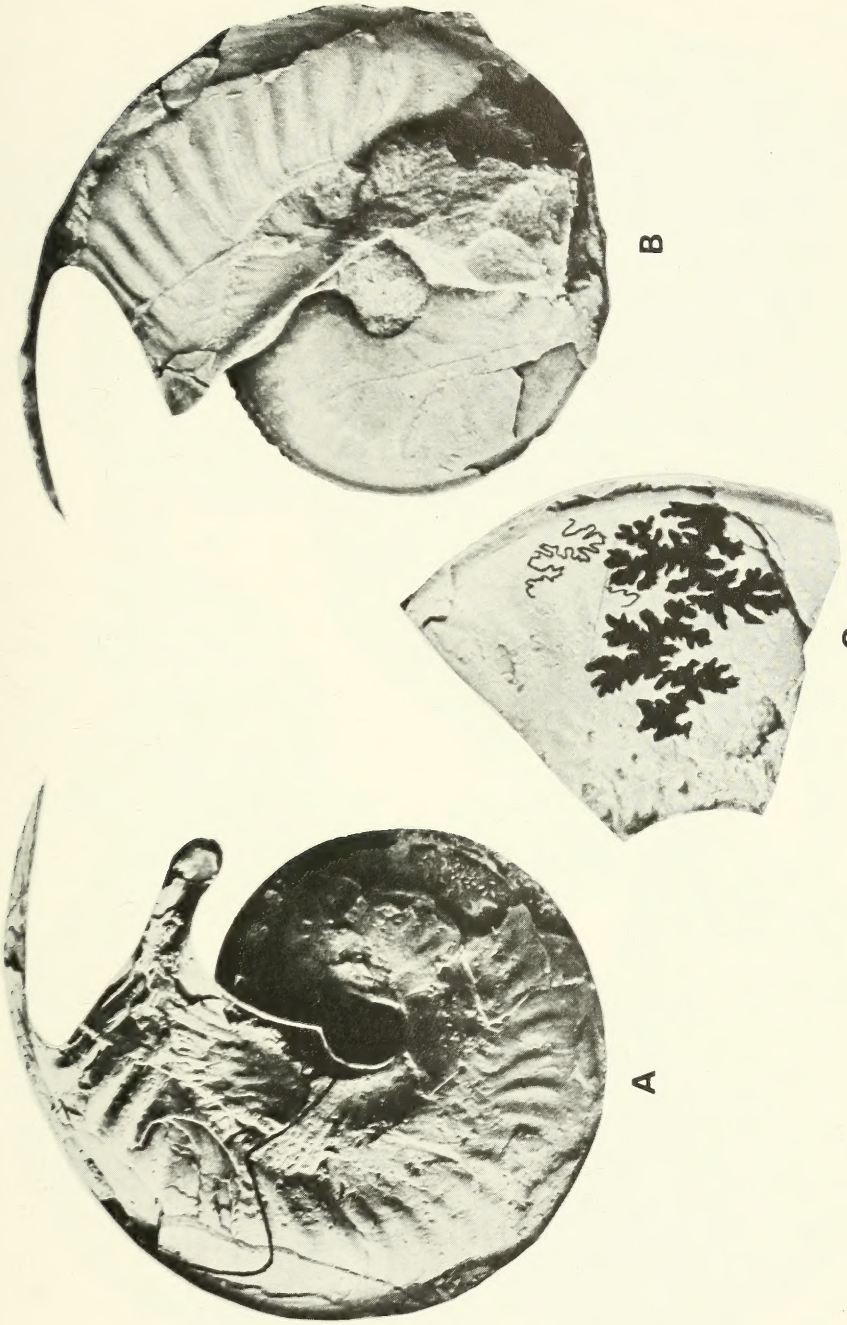


Fig. 1. *Sanmartinoceras* (*Sanmartinoceras*) *groenlandicum* Rosenkrantz, 1934. Copy of Bøgvad & Rosenkrantz (1934). ×2.

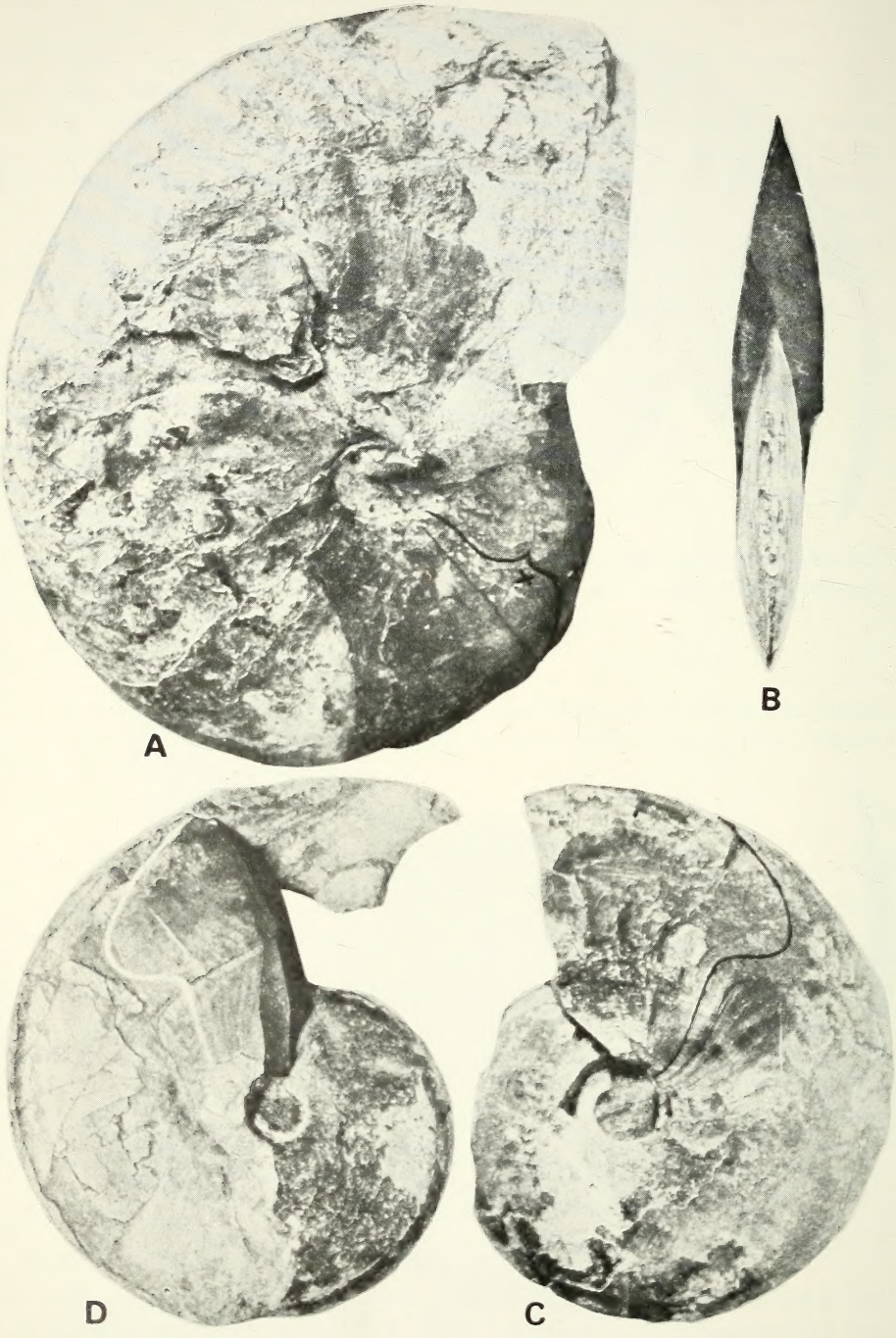


Fig. 2. A. *Gyaloceras smithi* Whitehouse, 1926. B–D. *Aconeceras walshense* (Etheridge), 1892. After Whitehouse (1926, 1927*a*). ×1.

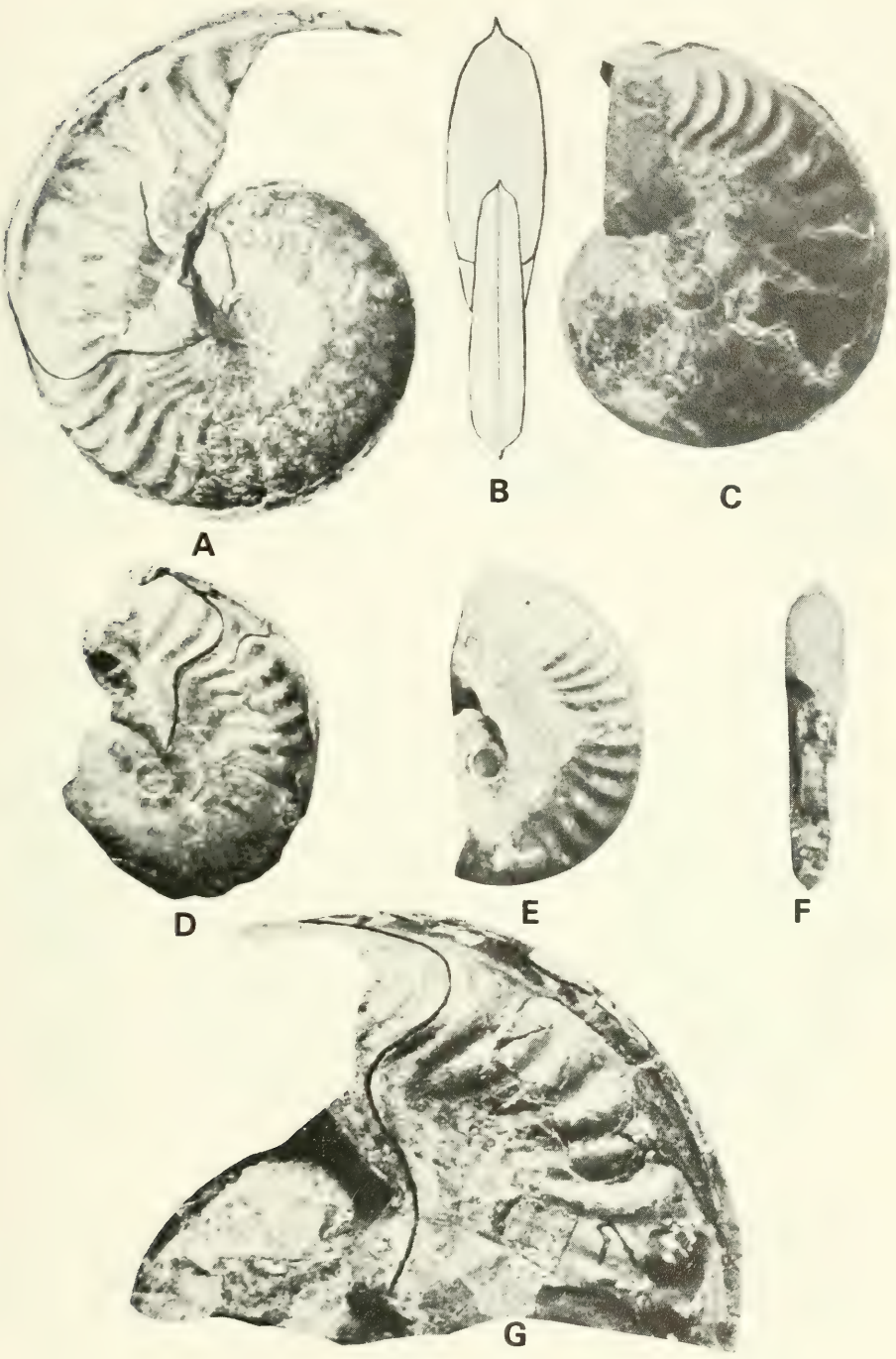


Fig. 3. A–C. *Sanmartinoceras* (*Sanmartinoceras*) *fontinale* (Hudleston), 1890.
D–G. *Sanmartinoceras* (*Sanmartinoceras*) *olenae* (Tenison-Woods), 1883. After Whitehouse (1927*a*). ×1.

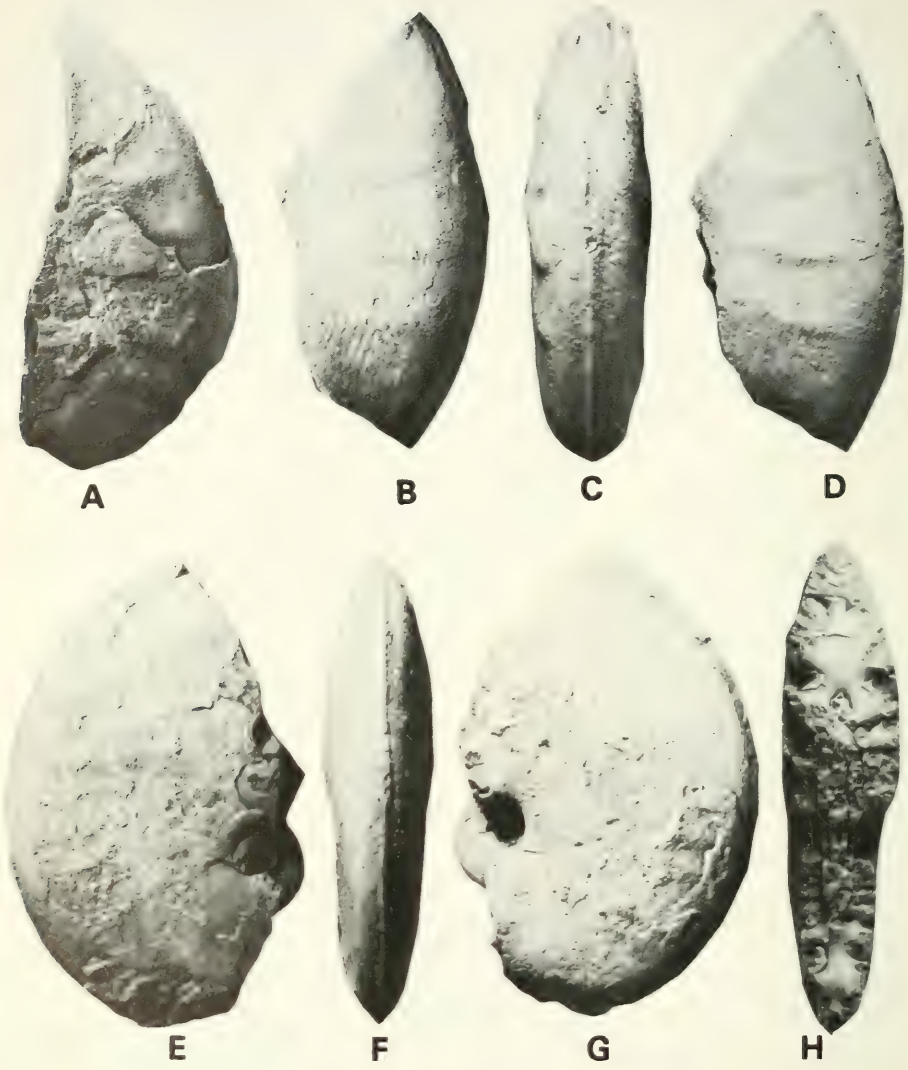


Fig. 4. *Sanmartinoceras* (*Sanmartinoceras*) *africanum* sp. nov., paratypes.
A. SAS H54/41/e. B–D. BMNH C79988. E–H. BMNH C79982. ×1.

Australian *Aconeceras walshense* (Etheridge) (see Whitehouse 1927*a*: 114, pl. 16 (figs 2–3); text-figs 1, 6–7) (Fig. 2B–D herein).

*Occurrence*

Upper Aptian of Zululand.

Genus *Sanmartinoceras* Bonarelli, 1921 (in Bonarelli & Nagera 1921)

*Type species*

*Sanmartinoceras patagonicum* Bonarelli, 1921 (in Bonarelli & Nagera 1921).

*Diagnosis*

Stout oxycones, initially smooth, with falciform striae and ribs, the latter weak on the inner flank, sometimes bunched, and strengthening into distinctive concave ribs on the outer flank. Keel finely denticulate.

*Discussion*

*Sanmartinoceras* was originally based upon crushed specimens from the Aptian of Lago San Martin, Argentina. Leanza (1970, text-fig. 14) (see Fig. 5A–B herein) has figured uncrushed topotypes, whilst Howarth (1958) and Thomson (1974) have figured other material from the sub-Antarctic Islands. Specimens are illustrated here as Figure 5C–D. Specimens of *S. patagonicum* with apertures preserved are unknown, but Rosenkrantz (in Bøgvad & Rosenkrantz 1934: 20, pl. 4 (fig. 3), pl. 5 (figs 1–5)) figured a species, *S. groenlandicum* Rosenkrantz, with a distinctive rostrum and lappets. These features, indicative of a microconch, have been incorporated into the generic diagnosis. Examination of these examples shows that the lateral lappets are associated with a distinct spiral groove (Fig. 1A–B). In the Antarctic specimens (Fig. 5C–D) similarly sized individuals show this groove developed to varying degrees at the same diameter, and the authors suspect it may prove a criterion for differentiation of immature males and females at similar diameters, in the type species at least. In the case of Australian *Sanmartinoceras* the problem is even more tantalizing. Whitehouse (1926; 1927*a*) described four aconeceratids from the Aptian of Walsh River. Two, *Sanmartinoceras fontinale* (Hudleston) (Fig. 3D–G, 7A–H) and *S. olenae* (Tenison-Woods) (Fig. 3A–C) have strong falcoid ribs and prominent rostra. The others are very feebly ornamented. *Aconeceras walshense* (Etheridge) (Fig. 2B–D) has falcoid growth striae, whilst *Gyaloceras smithi* Whitehouse (Fig. 2A) has an inflated whorl and fastigiate venter. The authors strongly suspect that these species are dimorphs but again cannot resolve the problem fully.

Within *Sanmartinoceras*, three subgenera have been recognized. In addition to *Sanmartinoceras sensu stricto*, *Theganeceras* Whitehouse, 1926, was treated as a subgenus by both Wright (1957) and Casey (1961*b*). Only three species, *S.* (*T.*) *falcatum* (von Koenen) (Fig. 6I–J) *S.* (*T.*) *scalatum* (von Koenen) (Fig. 6H) from the Lower Aptian of northern Germany, and *S.* (*T.*) *grande*

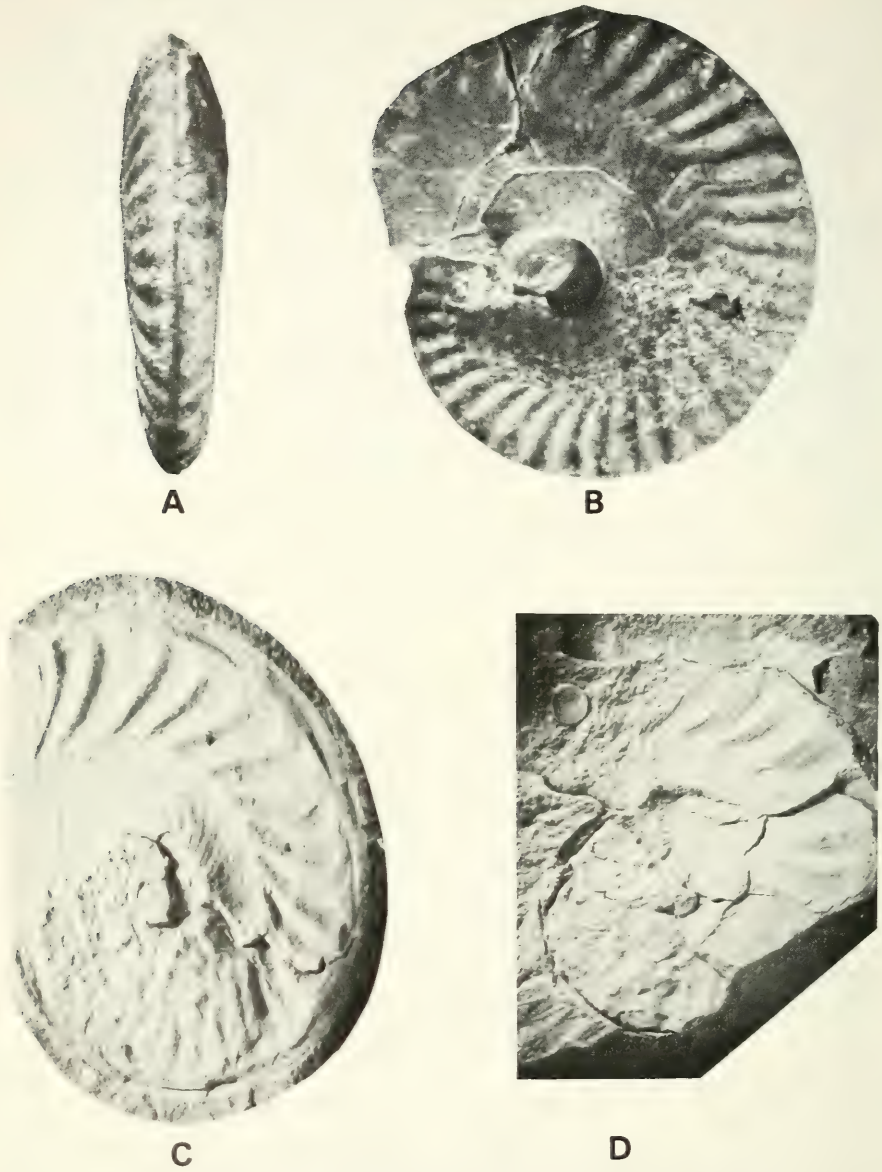


Fig. 5. *Sanmartinoceras* (*Sanmartinoceras*) *paragonicum* Bonarelli, 1921. A–B. Topotype, after Leanza (1970). C. BMNH C49055. D. BMNH C49057. C–D. from Alexander Land. ×1.

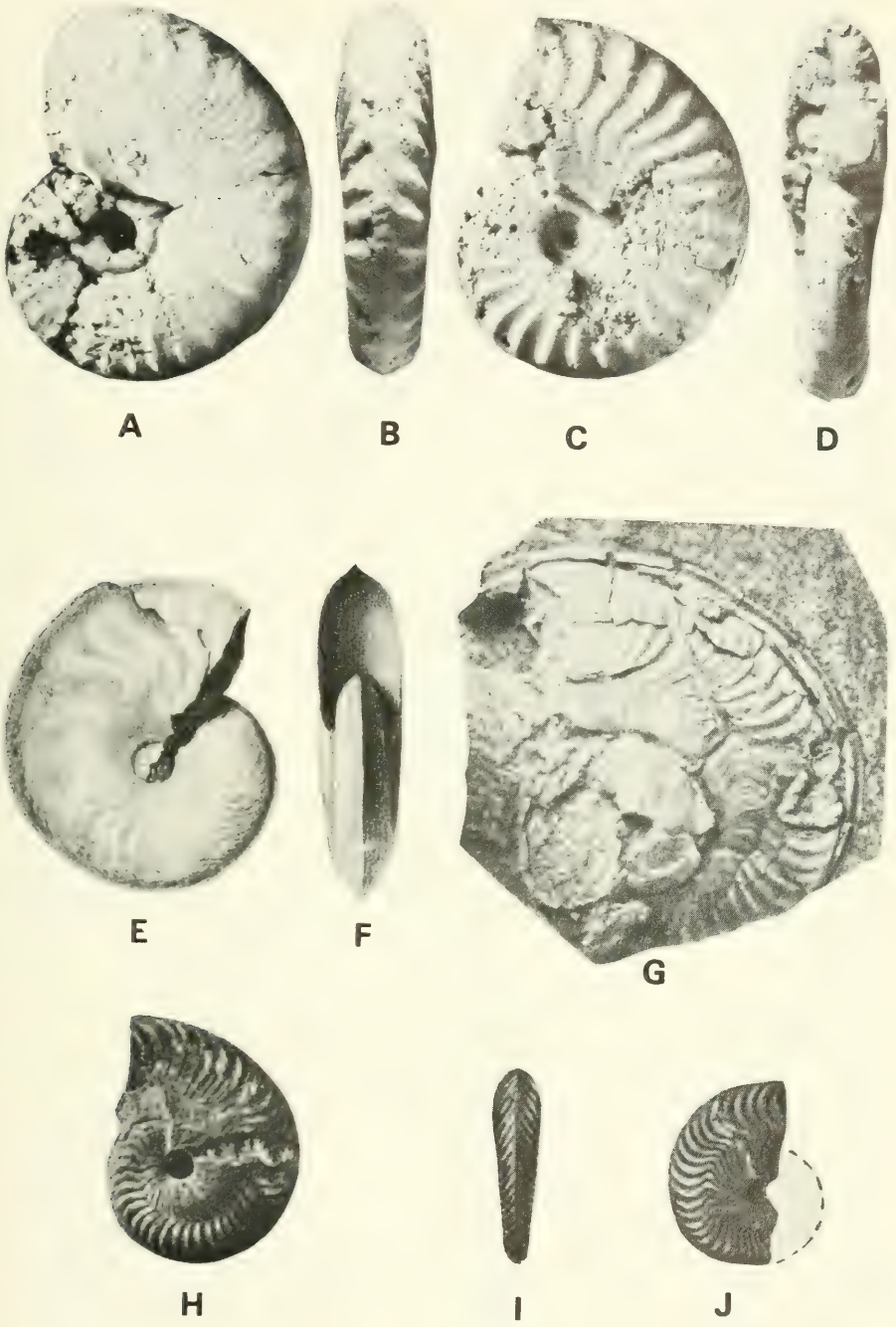


Fig. 6. A. *Sanmartinoceras* (*Sinzovia*) aff. *trautscholdi* (Sinzow), 1870. B–D. *Sanmartinoceras* (*Sinzovia*) *stolleyi* Casey, 1961. BMNH C14365 and 14362, from the Upper Aptian of Bekum, near Hildesheim, Germany. E–F. *Sanmartinoceras* (*Sinzovia*) *trautscholdi* (Sinzow), 1870. Copy of Trautschold (1865). G. *Sanmartinoceras* (*Theganeceras*) *grande* Thomson, 1974. After Thomson (1974). H. *Sanmartinoceras* (*Theganeceras*) *scalatum* von Koenen, 1902. I–J. *Sanmartinoceras* (*Theganeceras*) *falcatum* von Koenen, 1902. H–J after von Koenen (1902). All ×1.

Thomson (Fig. 6G) from the Aptian of Antarctica, have thus far been ascribed to the subgenus, which Casey (1961*b*: 132) diagnosed as lacking the smooth juvenile stage of *Sanmartinoceras* sensu stricto and having finer, more numerous dense ribs. As is described below, the single Zululand specimen referred to the subgenus suggests that dimorphism may also present taxonomic problems.

The subgenus *Sinzovia* Sazonova, 1958, differs from *Sanmartinoceras sensu stricto* (according to Casey 1961*b*: 133) in having a very low keel and absence or poor development of a spiral groove. It differs from *Theganeceras* in having a longer juvenile smooth stage and greater tendency to smoothness on the lower flank. The type species is illustrated here as Figure 6E–F, related German species as Figure 6A–D, and the only South African representative, *S.* (*S.*) *trautscholdi* (Sinzow), as Figure 7I–K.

*Occurrence*

*Sanmartinoceras* and its subgenera range from Upper Barremian to Aptian and are known from Greenland, western Europe, the U.S.S.R., Zululand, Madagascar, Nepal, Australia, Antarctica, Argentina and Papua.

Subgenus *Sanmartinoceras* sensu stricto

***Sanmartinoceras* (*Sanmartinoceras*) *africanum*** sp. nov.

Figs 4A–H; 8A–F; 9A–I; 10A–F; 11A–B; 12A–C; 13A–F; 14A–C; 15F–J; 16–17; 19D–E

*Sanmartinoceras* Kennedy & Klinger 197: 274.

*Types*

The holotype is SAS H54; paratypes are BMNH C79977–C80001, SAS H54/41a–d, SAS ZO(i), SAS LJE131a, SAS LJE112, SAS H54/17, SAS H54/33, all from the Makatini Formation, Barremian I–II, locality 170, Mlambongwenya Spruit, northern Zululand.

*Diagnosis*

A large (up to 120 mm diameter phragmocone) species of *Sanmartinoceras* in which the inner 'haft' of the ribs is narrow, straight and prorsiradiate and the outer 'blade' broad and markedly concave.

*Dimensions*

| | *D* | *Wb* | *Wh* | *Wb:Wh* | *U* |
|---|---|---|---|---|---|
| Holotype, SAS H54 | —(—) | 20,5(—) | 42–5(—) | 0,48 | —(—) |
| C79985 .. .. | 27,3(100) | 6,6(24) | 14,8(54) | 0,45 | 4,1(15) |
| C79978 .. .. | 120,0(100) | 28,8(24) | 69,8(58) | 0,41 | 7,3(7) |
| C79984 .. .. | 115,0(100) | 24,0(21) | 65,5(57) | 0.37 | 11,3(9,8) |

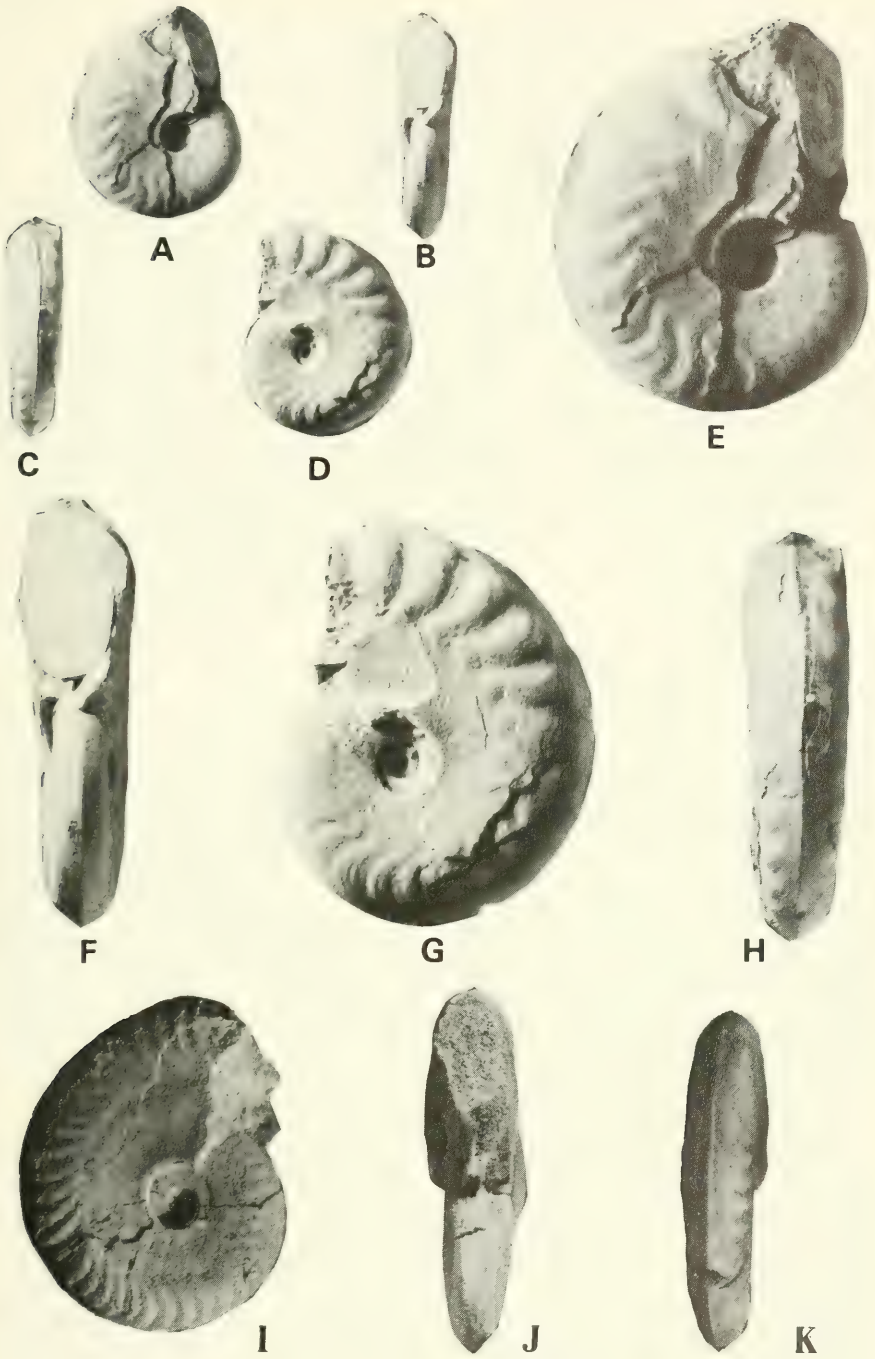


Fig. 7. *Sanmartinoceras* (*Sanmartinoceras*) *fontinale* (Hudleston), 1890. Holotype, BMNH C5306, Upper Aptian, Primrose Springs, north of Lake Eyre, south Australia. A–D ×1; E–H ×2. I–K. *Sanmartinoceras* (*Sinzovia*) *trautscholdi* (Sinzow, 1870). SAM–PCZ5919. ×1.

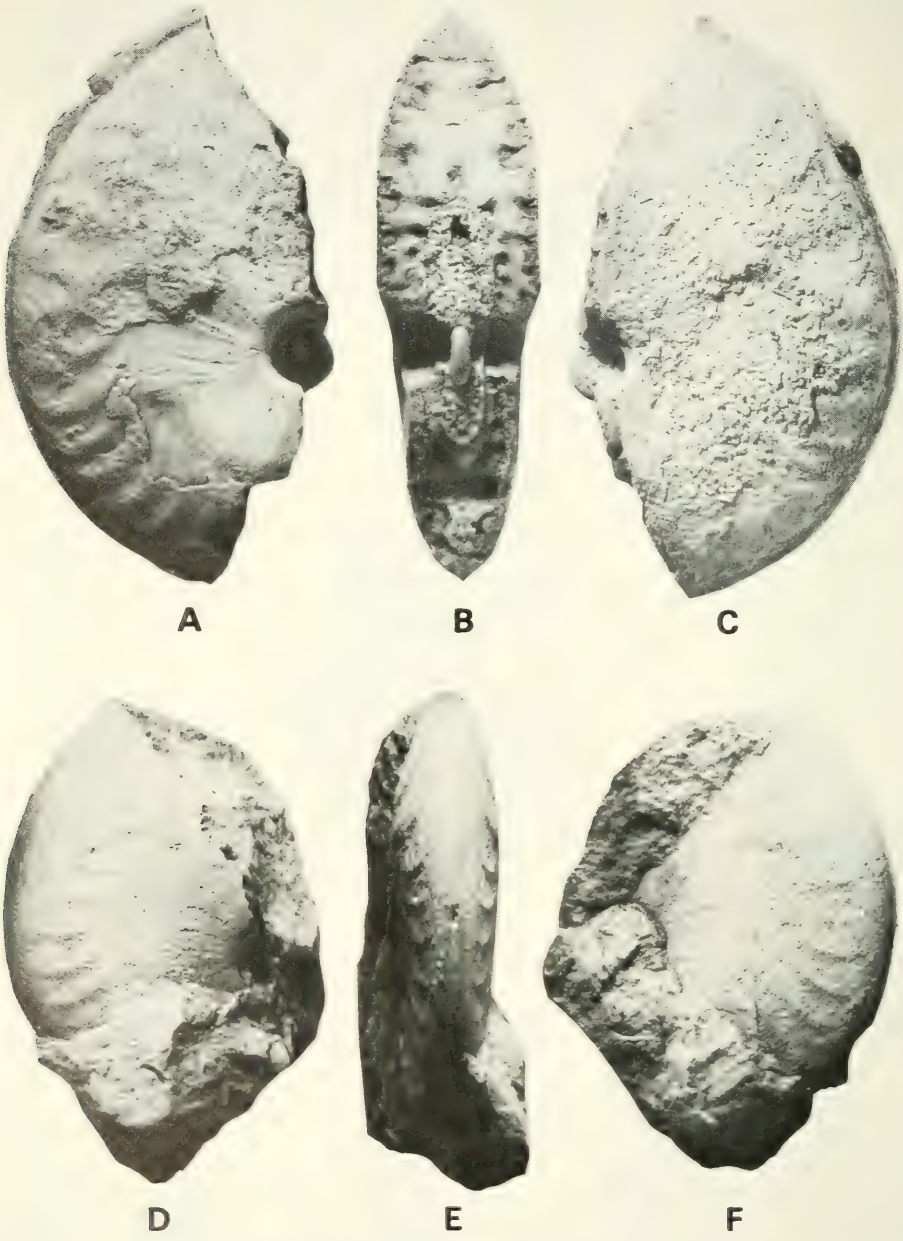


Fig. 8. *Sanmartinoceras* (*Sanmartinoceras*) *africanum* sp. nov.
A–C. Holotype SAS 54; D–F paratype BMNH C79989. ×1.

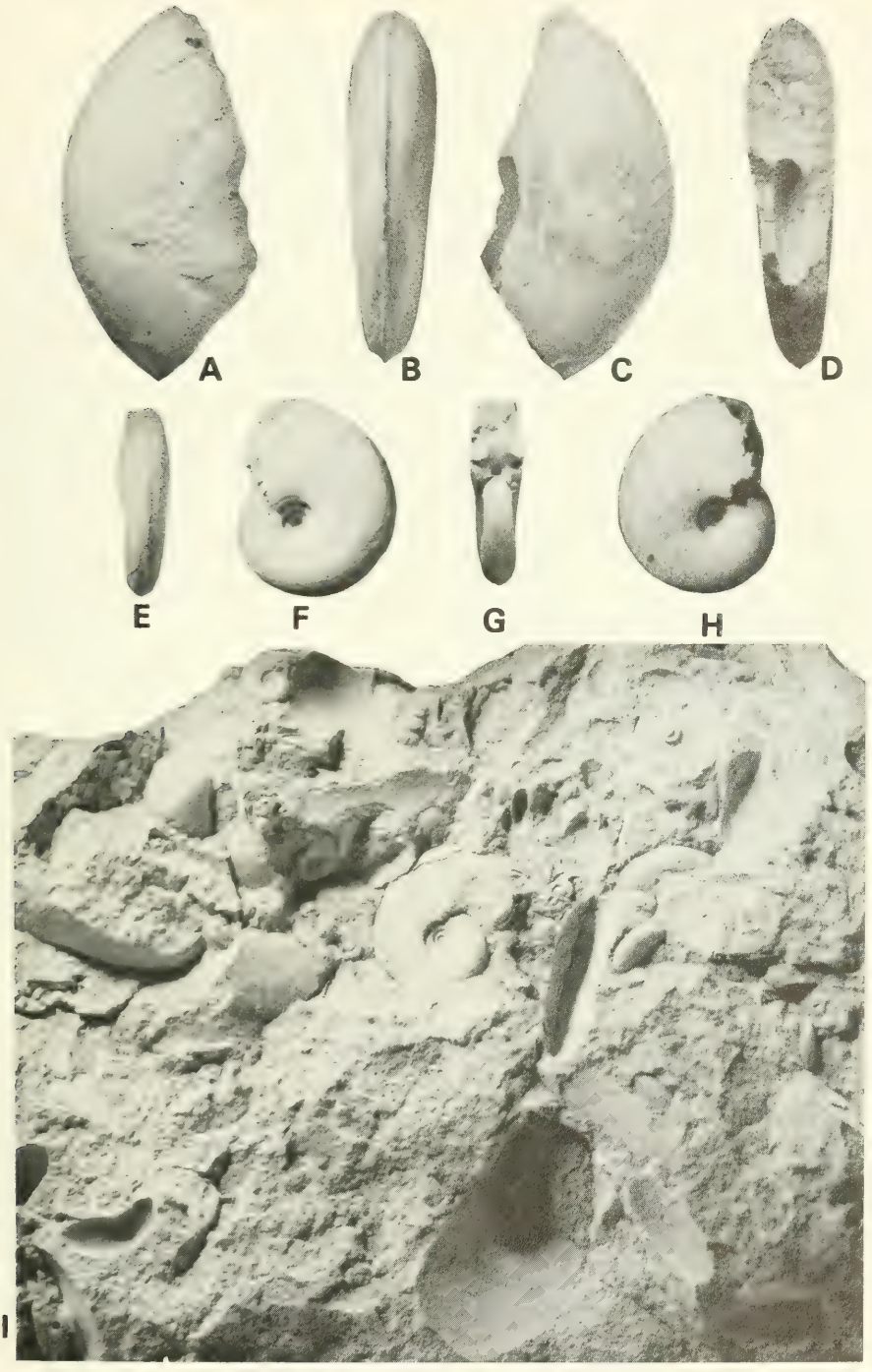


Fig. 9. *Sanmartinoceras* (*Sanmartinoceras*) *africanum* sp. nov., paratypes.
A–D. SAS H54/416. E–H. SAS H54/41a. I. BMNH C79996. All ×2.

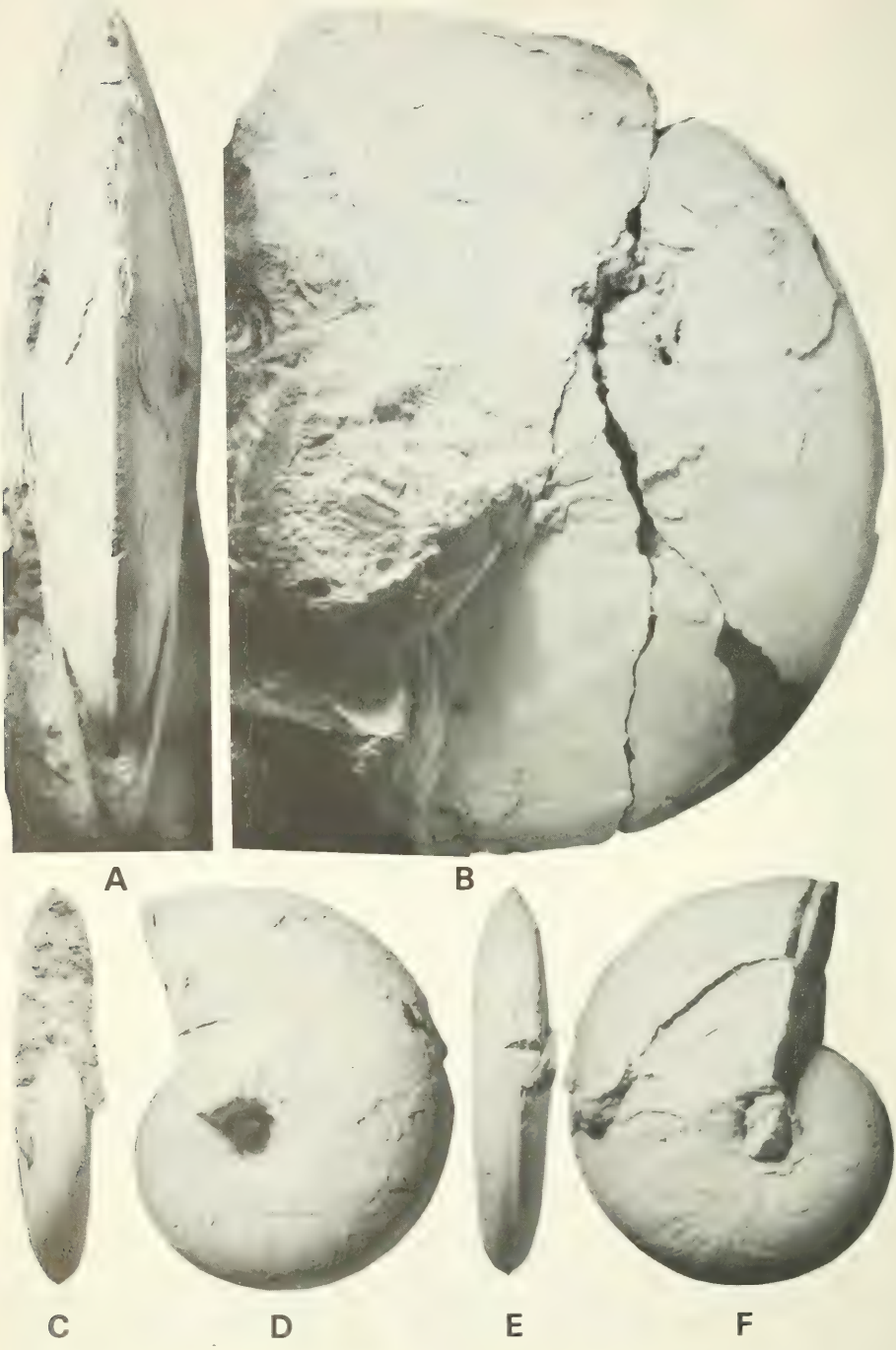


Fig. 10. *Sanmartinoceras* (*Sanmartinoceras*) *africanum* sp. nov., paratypes.
A–B. BMNH C79984. C–F. SAS H54/41c. A–B ×1; C–F ×2.

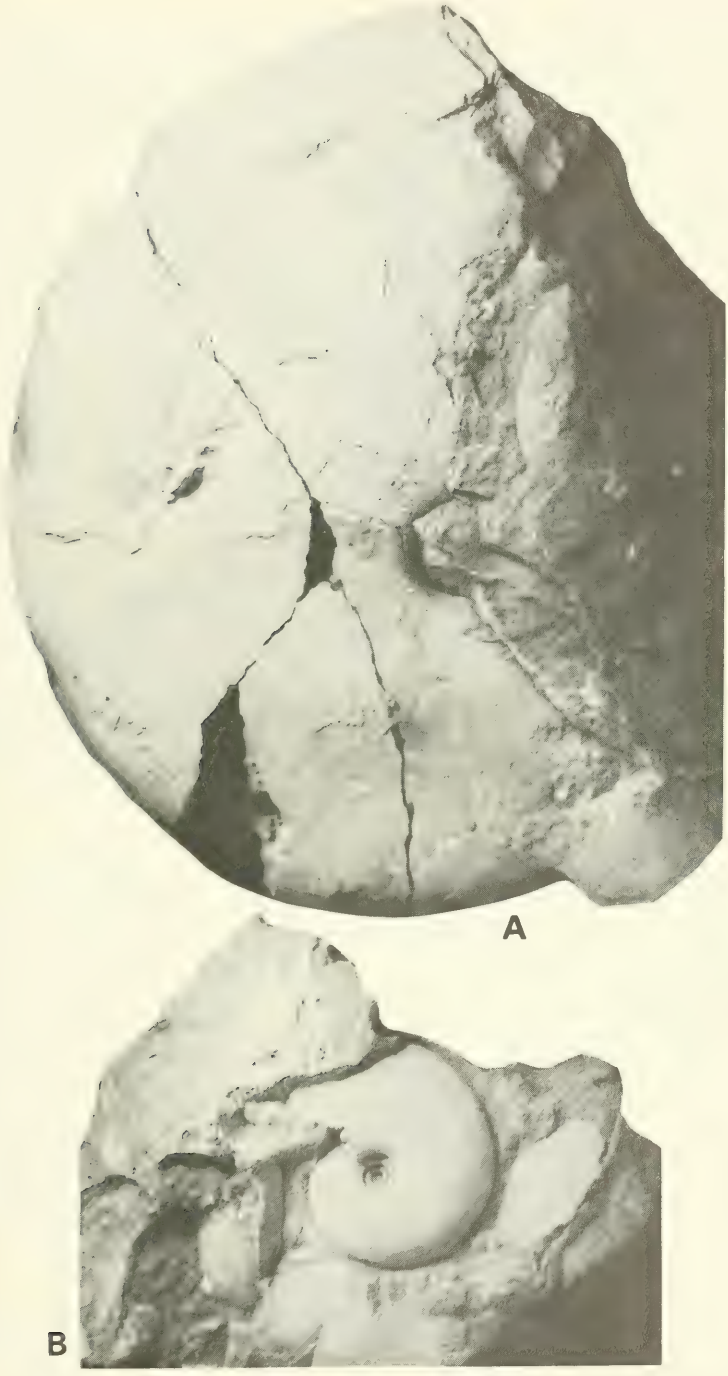


Fig. 11. *Sanmartinoceras* (*Sanmartinoceras*) *africanum* sp. nov., paratypes. A. BMNH C79984. B. SAS H54/41d. A ×1; B ×2.

*Description*

The barrel-shaped protoconch is succeeded briefly by rather stout whorls, beyond which, up to a diameter of 0,5–0,8 mm, the shell is moderately involute, slightly compressed, with flattened flanks and a rounded venter. All the available specimens are partially or wholly exfoliated, and any ornament, if present, must have been weak. A few specimens begin to show traces of a ventral ridge, but not a keel at this diameter, although these features may be an artefact of preservation.

From 0,8 mm onwards the shell is an oxycone, the coiling is very involute, with a tiny, crater-like umbilicus. The umbilical wall is flat and subvertical, with an abruptly rounded shoulder. The whorl section varies markedly; stout individuals have a whorl breadth to height ratio of 0,6; in slender individuals the figure is 0,4. Maximum whorl breadth is low on the flanks; the inner flanks are flattened, the outer flanks convergent; a distinct ventrolateral shoulder is developed, and there is a sharp keel which, when well preserved, can be seen to be minutely crenulated (Fig. 9E–H).

Ornament varies greatly. In some individuals (Figs 11B, 13C–D) there are only the finest growth striae. These arise at the umbilical seam, but are very weak. They pass forwards across the inner flank, strengthening as they do so, and sometimes splitting (Fig. 15G–J). They are at their maximum development at mid-flank, where they flex gently backwards, giving rise to a clear concavity which extends across the outer third of the flank (Fig. 13D). Striae decline on the ventrolateral shoulder and project strongly forwards to meet the keel at an acute angle. Individual striae correspond to individual crenulations on the keel. In robust specimens, e.g. BMNH C79983, striae are accompanied by distant, pronounced ribs, which are strongest at mid-flank; there is every intermediate between.

Middle growth stages are also characterized by a wide range of variation (Figs 4E–H, 8A–F). The holotype demonstrates the features of a strongly ornamented individual. It is wholly septate (Fig. 8B) retaining traces of shell. Coiling is very involute, with most of the inner whorls being covered. The tiny umbilicus is deep, with a high, flat, subvertical wall, abruptly rounded shoulder, and faint umbilical carina. The whorl section is compressed (breadth to height ratio is 0,48) with faintly concave inner flanks, a weakly inflated mid-flank region converging to distinct shoulders, clearly demarcated from a high, septate ventral keel. In none of the medium-sized specimens does the keel bear serrations. Ornament consists of fine, rectiradiate striae on the inner part of the flank, effaced at a spiral mid-flank depression. The outer flank bears low, blunt, concave ribs, declining at the ventrolateral shoulder, but projected forwards to meet the keel.

The largest available specimens are up to 120 mm in diameter, and are still wholly septate (Fig. 12A–C). In these, the whorls are quite robust, and ornament consists of striae on the inner flank with blunt, concave ribs on the outer flank. None of the present specimens has the aperture preserved. A few fragments show

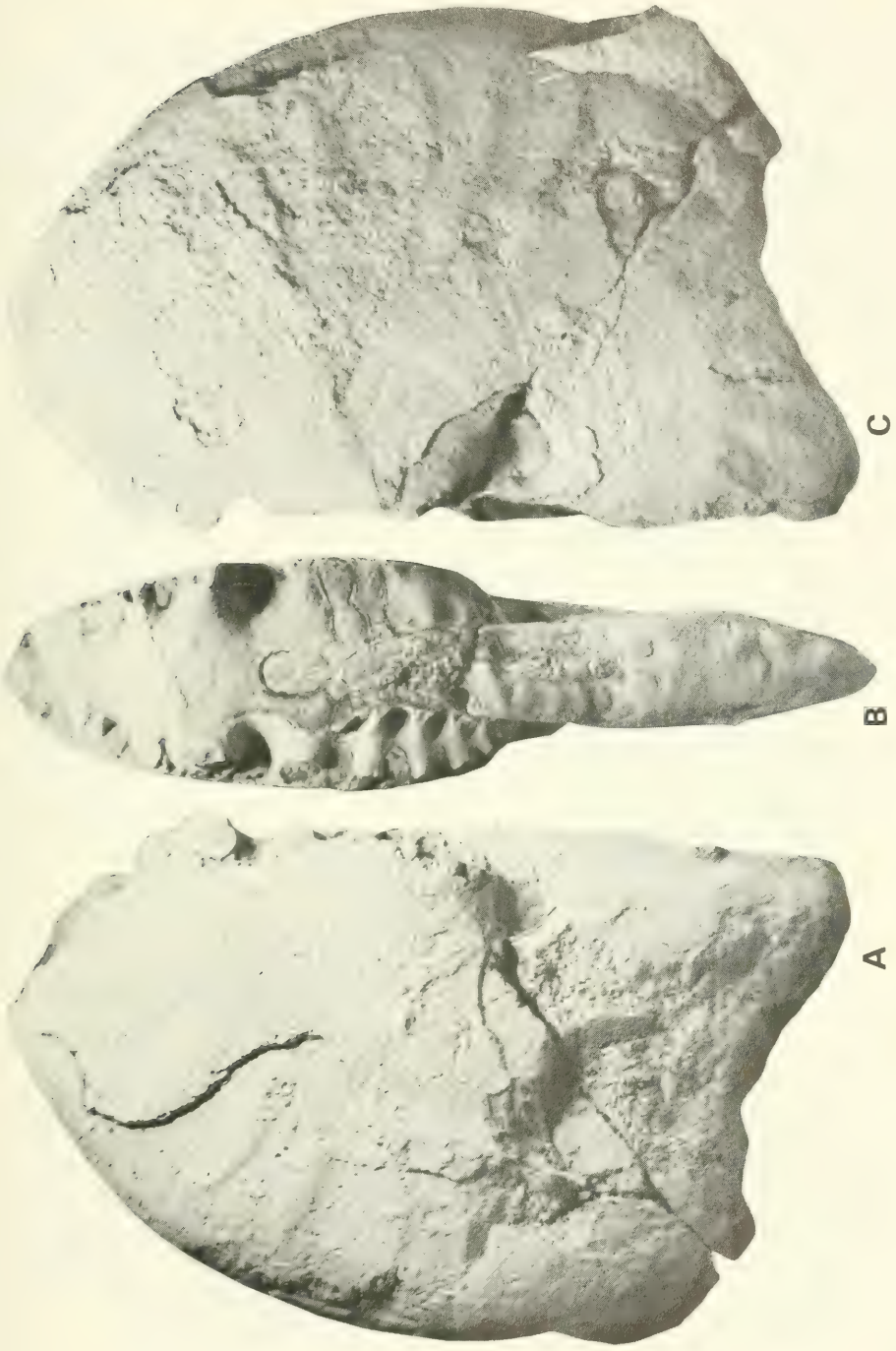


Fig. 12. *Sanmartinoceras* (*Sanmartinoceras*) *africanum* sp. nov., paratype BMNH C79978. ×1.

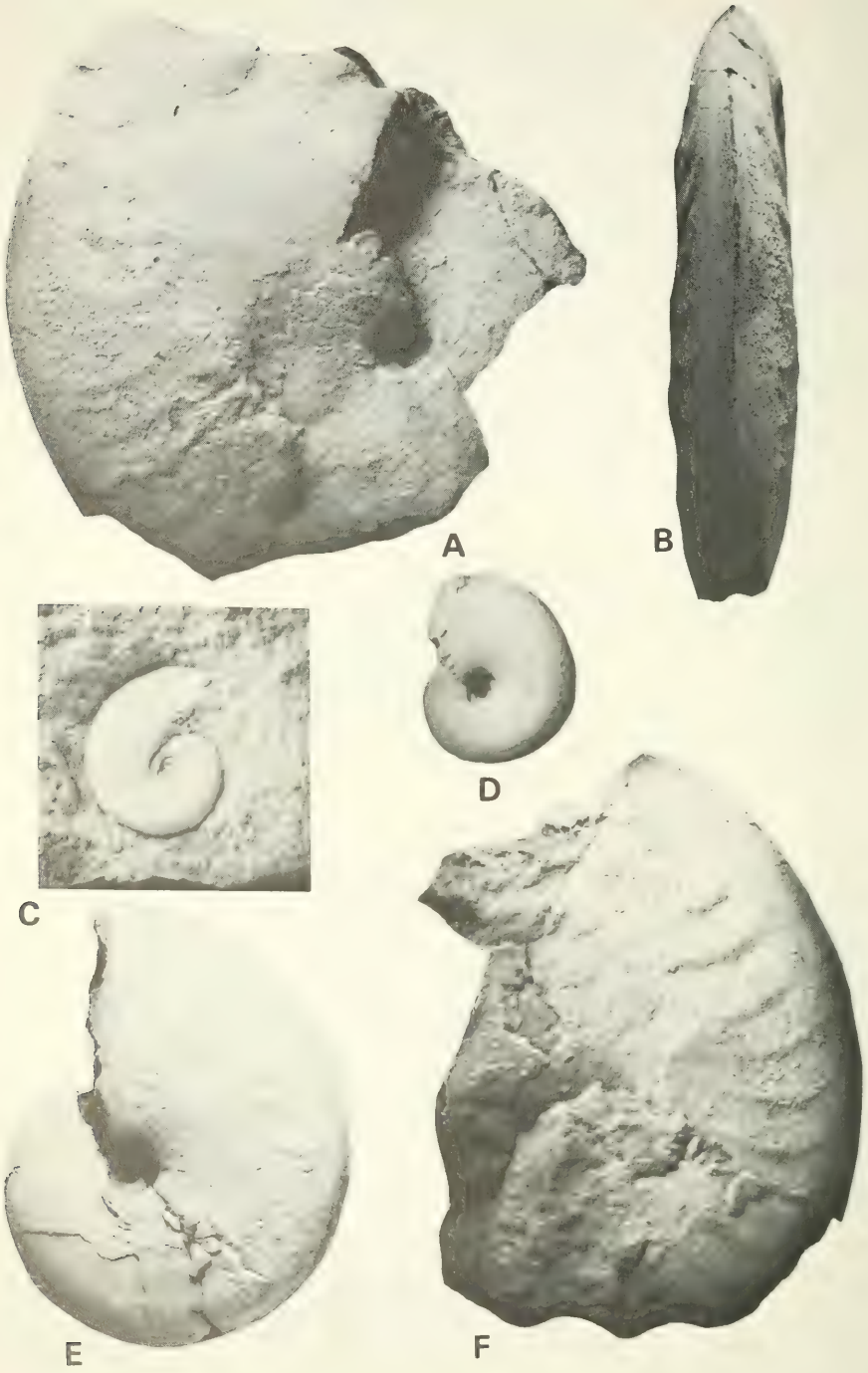


Fig. 13. *Sanmartinoceras* (*Sanmartinoceras*) *africanum* sp. nov., paratypes. A–B, F. SAS Zo(i). C. SAS LJE 131a. D. SAS H54/41a. E. BMNH C79979. A–D, E–F ×1; C–D ×2.

Fig. 14. A–C. *Sanmartinoceras* (*Sanmartinoceras*) *africanum* sp. nov., paratype SAS LJE 112. D–F. *Borissiakoceras* sp., M. R. Cooper Collection no. 16. A–C ×1; D–F ×2.

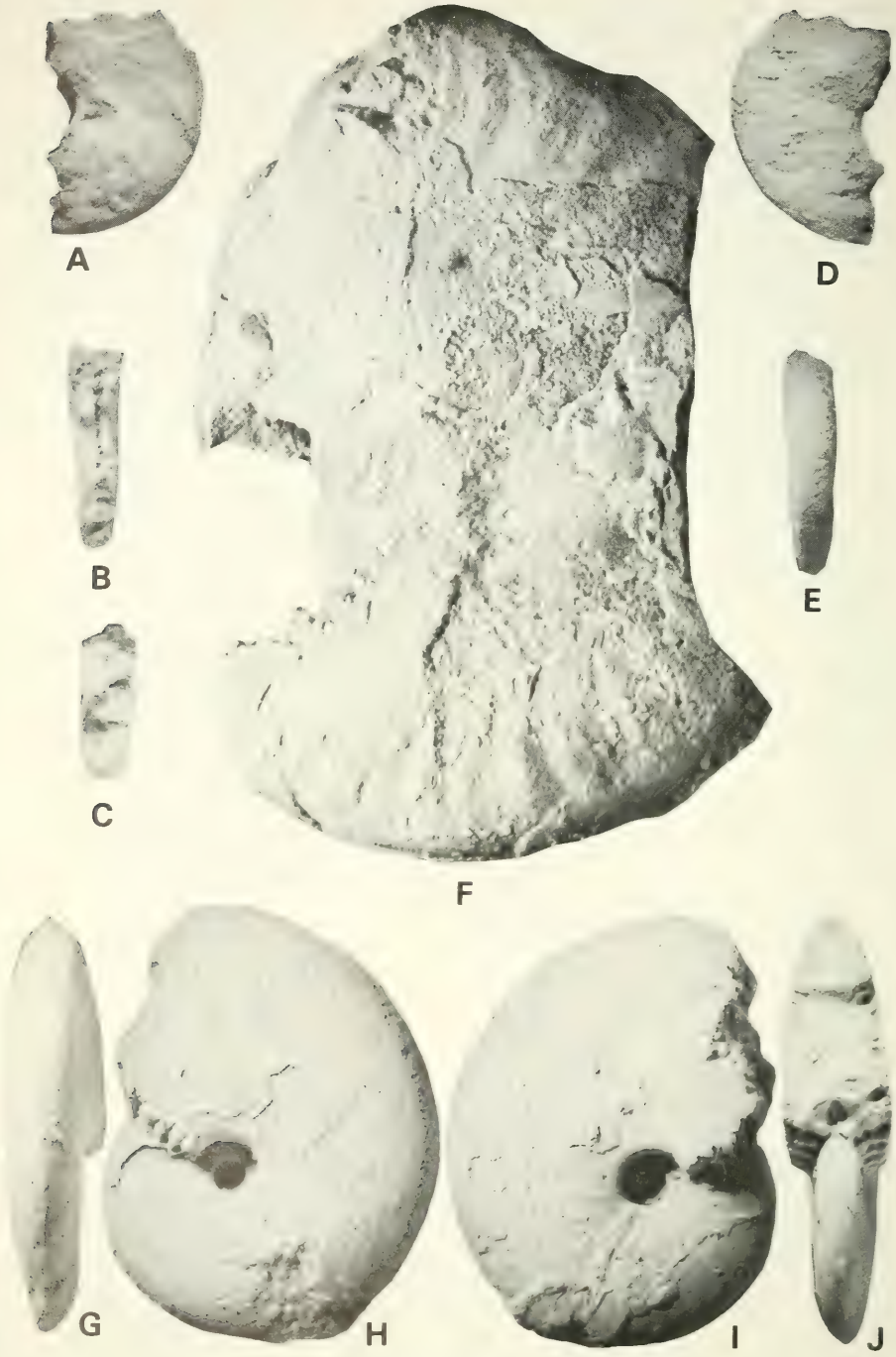


Fig. 15. A–E. *Borissiakoceras* sp., BMNH C80003. F–J. *Sanmartinoceras* (*Sanmartinoceras*) *africanum* sp. nov., paratypes. F is SAS LJE 112; G–J is BMNH C79985. A–E, G–J ×2; F ×1.

weak to strong strigations (Figs 4B–D, 13E). Where well preserved, this appears to be a feature of the dorsal shell layer, and not of the original external shell surface. That this occurs in some very large specimens suggests the species may have reached diameters close to 200 mm.

The available specimens show the details of suture development to advantage, as shown in Figure 16.

Mature sutures are deeply and intricately subdivided, as shown in Figure 17.

*Discussion*

The specimens show the ontogeny and range of intraspecific variation far better than in any previously described *Sanmartinoceras* whilst the specimens are the largest known for the genus. It is most unfortunate that none of the specimens retains apertures, but the rather distinct spiral flank depression present in the holotype suggests that it may be a microconch; the largest individuals (Figs 10A–B, 11A, 12A–D) are probably macroconchs.

Thomson (1974: 23) reviewed criteria used to differentiate species of *Sanmartinoceras* as follows:

(i) strength and form of ribbing,
(ii) the way in which ribs appear (i.e. abruptly or increasing gradually in strength),
(iii) the size of the individual at which ribs first appear.

In his discussion, however, he concluded that the form of the falcate ribbing alone was sufficient to separate species. Figure 18 compares the line of ribs and striae in the five described species; on this criterion alone it can be seen that the straight 'haft' and form of 'sickle' of the present species are quite different from the markedly biconcave rib of *S. olenae*, *S. fontinale* and *S. patagonicum*. A straight 'haft' characterizes *S. groenlandicum* (Fig. 18), but here the 'blade' is much more deeply concave with the inner half almost straight. As noted elsewhere, the authors do not regard the presence or absence of a lateral spiral groove as of specific significance, whilst the present specimens vary greatly in strength of ornament and growth stage at which it appears. The other feature which separates *S. africanum* from other species is its great size, but this may be no more than an artefact of preservation.

*Occurrence*

Upper Barremian of Zululand only.

Subgenus *Theganeceras* Whitehouse, 1927

***Theganoceras nodosum*** sp. nov.

Figs 19A–C, 20

*Holotype*

SAM-PCZ5708 from the Makatini Formation, Aptian I, locality 170, Mlambongwenya Spruit, northern Zululand.

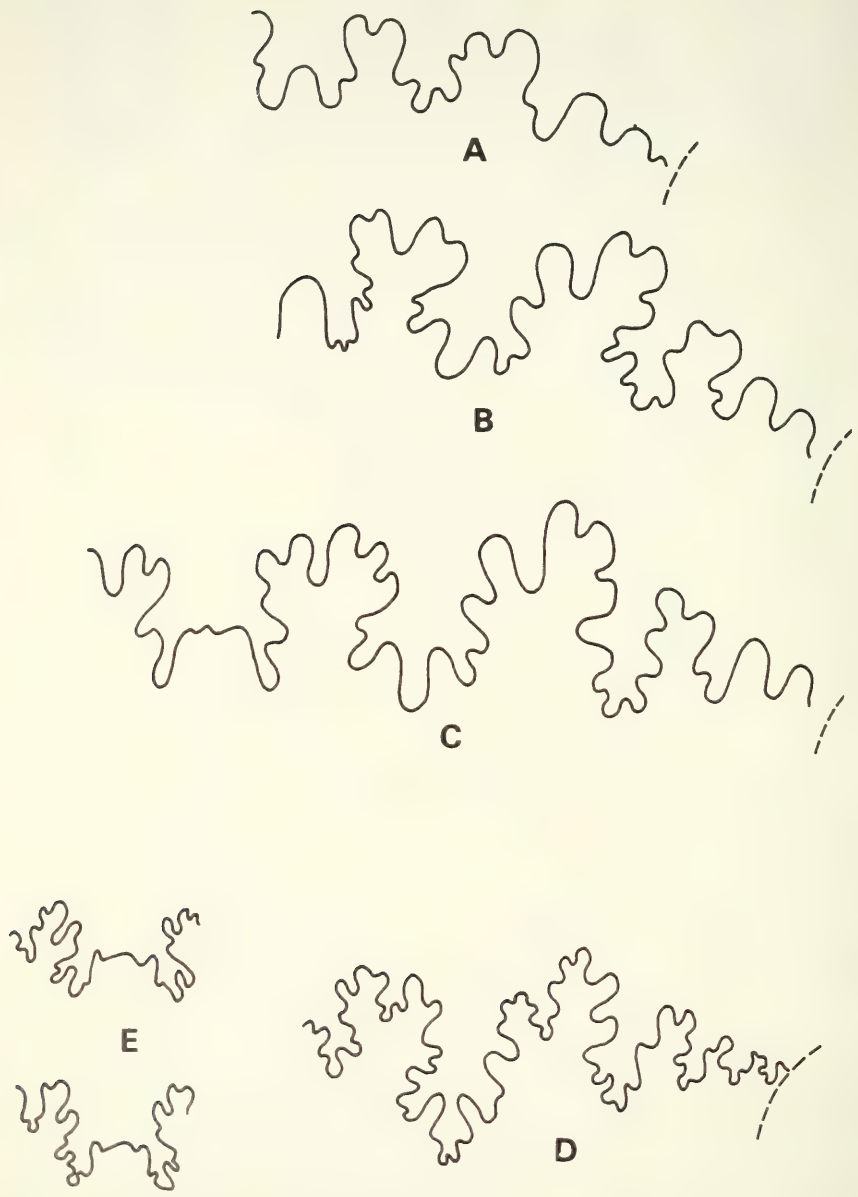


Fig. 16. Suture development in *Sanmartinoceras* (*Sanmartinoceras*) *africanum* sp. nov. A–C. BMNH C79979. D–E. SAS H54/41A. All ×12,5.

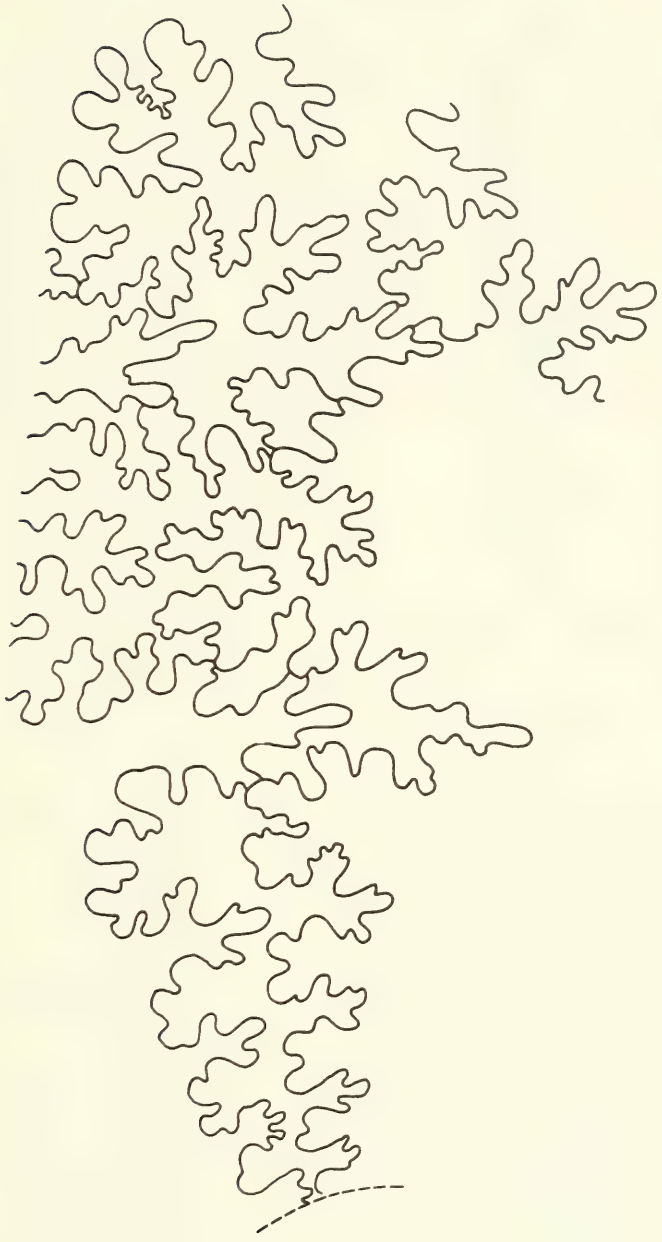

Fig. 17. Mature sutures of *Sanmartinoceras* (*Sanmartinoceras*) *africanum* sp. nov. SAS H54/41c. ×12,5.

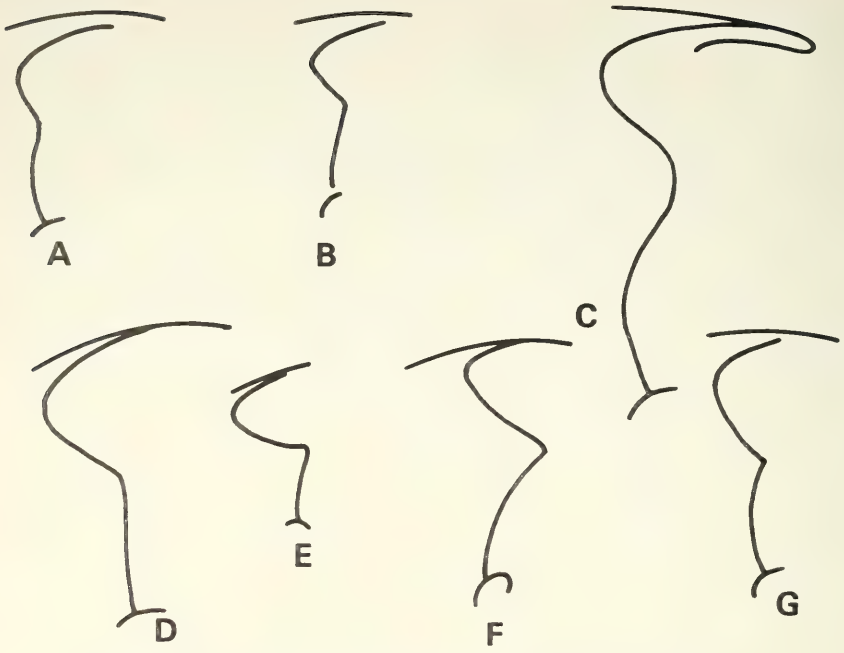


Fig. 18. Rib patterns in *Sanmartinoceras* (*Sanmartinoceras*) compared.
A. *S.* (*S.*) *olenae*. B–C. *S.* (*S.*) *fontinale*. D. *S.* (*S.*) *africanum*. E. *S.* (*S.*) *groenlandicum*. F–G. *S.* (*S.*) *patagonicum*.

*Diagnosis*

A large species of *Theganeceras* with broad, flat, falcoid ribs on the inner whorls which bear umbilical bullae and incipient ventral clavi. Outer whorls ornamented by bullae, flexuous growth lines, folds and constrictions.

*Description*

The unique holotype of this species comprises a crushed body chamber and a nucleus. Growth of calcite between shell and sedimentary infilling has produced an unduly thick 'shell' of partly diagenetic origin.

The inner whorl, at a diameter of approximately 38 mm, bears fourteen to sixteen closely spaced, low, broad, sickle-shaped ribs which are straight and prorsiradiate on the inner flank, flexing backwards at mid-flank and becoming markedly concave on the outer flank. The ribs are strong and well developed down to the umbilicus where a distinct bulla is present, whilst on the ventro-lateral shoulder they strengthen into an incipient clavus. The ribs themselves and interspaces between bear dense striae, sometimes strengthened into riblets, giving some ribs a bunched, fasciculate appearance. The venter is fastigiate, and bears strongly projected striae.

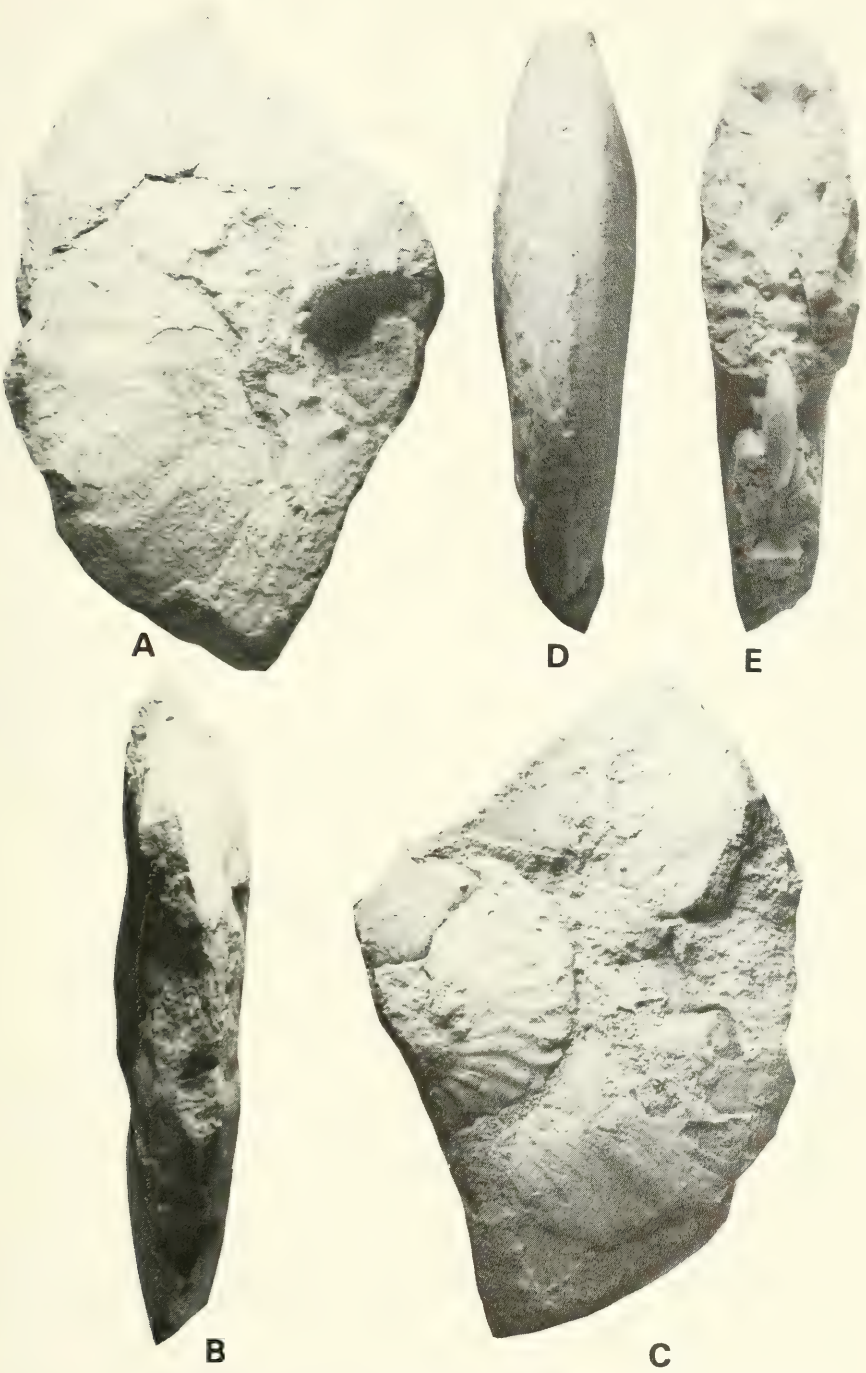


Fig. 19. A–C. *Sanmartinoceras* (*Theganeceras*) *nodosum* sp. nov., holotype, SAM–PCZ5708. ×1.
D–E. *S.* (*Sanmartinoceras*) *africanum* sp. nov., paratype, BMNH specimen. ×1.

The outer body whorl shows coiling to have been involute with a moderately large, deep, crater-like umbilicus with a flat, outwards-sloping wall. The whorl section is compressed, lanceolate, so that the overall shell form was an oxycone. The whorl breadth to height ratio is estimated as approximately 0,38, the greatest breadth being close to the angular umbilical shoulder. The preserved fragment bears seven small, sharp, comma-shaped bullae at the shoulder. These give rise to bundles of fine, dense, flexuous striae which, being crowded close to the umbilicus, appear as ribs, which fade out at a short distance from the bulla. The striae flex forwards to mid-flank, then backwards, to form the very shallow blade of a sickle. They are strongly projected across the ventro-lateral shoulder. Paralleling these striae are irregular, low folds and constrictions.

The imperfectly exposed suture is illustrated in Figure 20.

*Discussion*

The presence of well-developed ribs which extend to the umbilical shoulder indicates this specimen to be a *Theganeceras*. It differs from all previously described species in having broader, less markedly flexed ribs when young, as well as possessing umbilical bullae, which feature is unique for the subgenus. Only *S.* (*Theganeceras*) *grande* Thomson (1974, pl. 4 (fig. 9)) approaches this specimen in size; the unique holotype of that species is quite distinct, however, lacking bullae and having strongly flexed ribs and striae (Fig. 6G).

Equally, no *S.* (*Sinzovia*) bears bullae, and the closest species, *S.* (*S.*) *stolleyi* Casey (Fig. 6A–D), has ribs which efface on the inner flank. The presence of bullae also distinguishes our specimen from described *S.* (*Sanmartinoceras*) at comparable dimensions.

*Occurrence*

Lower Aptian I of northern Zululand only.

Subgenus *Sinzovia* Sazonova, 1958

*Sanmartinoceras* (*Sinzovia*) *trautscholdi* (Sinzow)

Figs 4I–K, 6E–F

*Ammonites bicurvatus* Trautschold (*non* Michelin), 1865: 22, pl. 3 (figs 17a–c).
*Oppellia Trautscholdi* Sinzow, 1870: 118, pl. A (figs 1, 1a–b only).
*Sinzovia trautscholdi* (Sinzow): Sazonova, 1958: 128, pl. 6 (fig. 2), pl. 8 (figs 1, 1a, 3–7), pl. 10 (figs 4–5) (with synonymy). Druschchitz & Kudryavtseva, 1960: pl. 42 (figs 7a–b). Collignon 1962: 31, pl. 229 (fig. 974).
*? Sanmartinoceras* (*Sinzovia*) sp. cf. *trautscholdi* (Sinzow): Casey 1961*b*: 136, pl. 26 (fig. 7).

*Holotype*

Trautschold's original of his plate 3 (fig. 17a–c), from the Lower Aptian of Simbirsk (now Polivna) in the Stalingrad area of Russia, on which Sinzow (1870: 118) based his species. The original figures are reproduced here as Figure 6E–F.

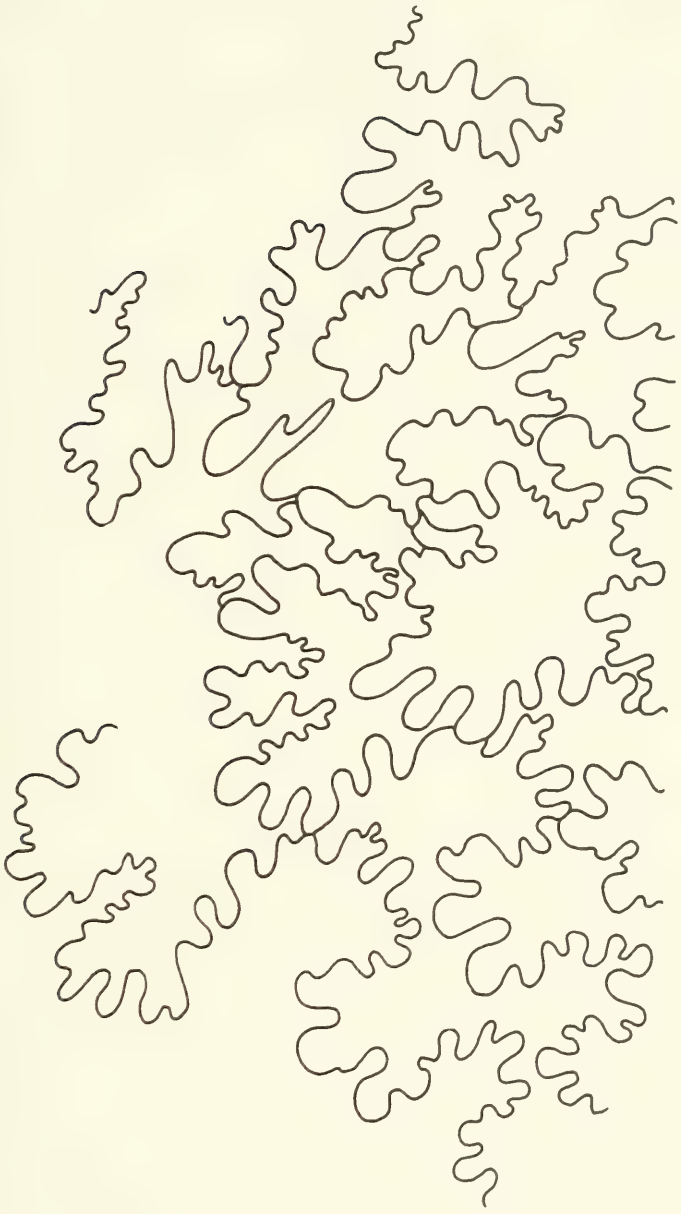

Fig. 20. *Sanmartinoceras* (*Theganeceras*) *nodosum* sp. nov., partial suture of the holotype, SAM-PCZ5708. ×12,5.

*Material*

SAM–PCZ5919 from the Makatini Formation, Aptian IV at locality 152, Mkuze Game Reserve, northern Zululand.

*Description*

The specimen is a beautifully preserved disc of which the last half of a whorl is body chamber. It retains extensive areas of replaced shell, in consequence of which the sutures are not fully decipherable. The dimensions are as follows:

| *D* | *Wb* | *Wh* | *Wb:Wh* | *U* |
|---|---|---|---|---|
| 43,0 | 10,0(23,3) | 22,0(51,2) | 0,45 | 9,0(20,9) |

Coiling is very involute, oxycone, with two-thirds of the previous whorl being covered. The umbilicus is small and shallow (20% of diameter), with a flat, subvertical wall. The umbilical shoulder is sharp and angular. The whorl section is very compressed, with a breadth to height ratio of 0,45. The inner flank is flattened to concave, with gently rounded, convergent outer flanks, converging to an acute, delicately keeled venter.

The inner, concave part of the flank is virtually smooth where shell is present, due to weathering. On the mould, however, there are delicate, concave, prorsiradiate, bunched striae which sweep forwards to a distinct spiral ridge at mid-flank and a parallel groove external to this. On the ridge and groove, the striae flex backwards in a marked convex projection. On the outer flank, they flex backwards to form a 'blade' corresponding to the bunches of 'handles' to what is an overall sickle-like ornament. The blades are strong, concave, blunt ribs, strong over most of the last whorl, although effacing on the venter, which is smooth on either side of a narrow, sharp ventral keel.

The sutures cannot be seen.

*Discussion*

On the basis of weakness of inner flank ornament, and strength and style of ribs on the outer flank, the authors would refer their single specimen to Sinzow's species. It is particularly close to the specimen from Ulyanovsk, Russia, illustrated by Casey (1961*b*, text-fig. 143 (1a–b)).

*Sinzovia stolleyi* Casey (1961*b*, text-fig. 143(g)) is more distantly and narrowly ribbed, as can be seen from Figure 6A–D herein.

*Sinzovia aptianum* (Sarasin) (1893: 155, pls 4–6 (fig. 12a–c); Casey 1961*b*: 134, pl. 26 (fig. 6a–b)) has blunter, fewer ribs on the outer flank.

*Sanmartinoceras?* (*Sinzovia?*) sp. nov. of Casey (1961*b*: 136, text-fig. 43(f)) is a Lower Albian species of uncertain affinity.

*Occurrence*

Lower Aptian of the U.S.S.R. and southern England; Upper Aptian of Madagascar and Zululand.

## Family **Binneyitidae** Reeside, 1927

The Binneyitidae are a family of micromorphs, characteristically platycone, with much reduced sutures. Two genera, *Borissiakoceras* Arkhangelsky, 1916, and *Binneyites* Reeside, 1927, were referred to the family by Wright (1957) who suggested derivation from the Acanthocerataceae, but subsequent work has revealed the presence of passage forms linking the family to the Aconeceratidae via *Falciferella* Casey, 1954. This Middle to Upper Albian genus has a vestigal keel when young and can be linked to the platycone but still feebly carinate Aptian aconeceratids *Doridiscus* Casey, 1961, and *Nothodiscus* Casey, 1962 (*in* Collignon 1962). The evolutionary origins of the family thus involved a change from oxycone to platycone with corresponding loss of keel, and sutural simplification.

### Genus *Borissiakoceras* Arkhangelsky, 1916

*Type species*

*Borissiakoceras mirabile* Arkhangelsky, 1916.

*Diagnosis*

Small, compressed, moderately involute to moderately evolute platycones. Flanks typically smooth, sometimes bearing narrow, falcoid ribs. A few species bear ventrolateral tubercles. Suture simple with narrow, bifid lobes and broader, bifid or trifid saddles.

*Discussion*

*Borissiakoceras* is a distinctive genus, differing obviously from the later (Coniacian) *Binneyites* Reeside, 1927, which has stronger lateral and ventrolateral ornament, sharp ventrolateral shoulders and more auxiliary elements in the suture. *Johnsonites* Cobban, 1961, has a simpler suture and a flat or concave venter.

*Borissiakoceras* is clearly descended from *Falciferella*, species of which extend to the Upper Albian. It is the only binneyitid in which dimorphism has been demonstrated (Kennedy & Cobban 1976: pl. 1 (figs 3–4)); males have stronger, more markedly biconcave growth striae and ribs, reflecting a similar aperture, with a short rostrum.

*Occurrence*

*Borissiakoceras* is best known from North America, ranging from Texas (Stephenson 1952, 1955) to Kansas and Colorado (Morrow 1935). Other United States occurrences are summarized by Cobban (1961). It also occurs in British Columbia (Warren & Stelck 1958) and Alaska (Cobban & Gryc 1961). In these regions it ranges from Middle Cenomanian to Lower Turonian. The type species comes from Turkestan and is probably of late Cenomanian age;

Bodylevsky & Shulinga (1958) record the genus from the Turonian–Coniacian of the northern U.S.S.R., and Kennedy & Juignet (1973) record it from the Middle Cenomanian of Normandy, whilst the present authors have seen a fragment from the Lower Cenomanian of Sarthe (Sorbonne collections). Wright (1963) records a doubtful species from the Middle Cenomanian of northern Australia, and the Engonoceratidae gen. et sp. nov. of Henderson (1973: 106, pl. 14 (fig. 8)) belongs here, as do the Middle Cenomanian specimens from Zululand described below.

*Borissiakoceras* sp.

Figs 14D–F, 15A–E

*Material*

Two specimens, BMNH C80003, and no. 16 in M. R. Cooper's collection, University of Natal, Durban, both from the Middle Cenomanian (Cenomanian III) Locality 62, the Skoenberg, Zululand.

*Description*

The specimens comprise a small phragmocone and a body chamber with a maximum whorl height of 7,4 mm. Coiling is involute with a small, shallow umbilicus comprising approximately 20 per cent of the diameter. The overall form is platycone, the whorl breadth to height ratio being approximately 0,5, with a low umbilical wall, flattened inner, and slightly convergent outer flanks, abruptly and narrowly rounded ventrolateral shoulder, and somewhat flattened venter. Both specimens are corroded, so that no trace of any original ornament remains. The suture is poorly exposed, but much simplified, with such elements as are visible resembling those of *B. mirabile*.

*Discussion*

Overall shell form and suture indicate these specimens to be *Borissiakoceras*, the first representatives of the genus, and indeed the Binneyitidae, to be described from Africa. Because of poor preservation it is not possible to identify them fully. They most closely resemble feebly ornamented species such as *B. mirabile* (see Kennedy & Juignet 1973) and *B. orbiculatum* (see Cobban, 1961: 750, pl. 88 (figs 15–41), text-figs 5a–f).

*Occurrence*

Middle Cenomanian of Zululand.

# ANNOTATED LIST OF SPECIES REFERRED TO THE ACONECERATIDAE AND BINNEYITIDAE

## Family **Aconeceratidae** Spath, 1923

### Genus *Protaconeceras* Casey, 1954

Type species: *Oppelia patagoniensis* Favre, 1908, by original designation.

*Protaconeceras patagoniense* (Favre), 1908: 634, pl. 34 (fig. 7), pl. 37 (figs 3–5), text-fig. 6. Lower Hauterivian of Patagonia.

*Protaconeceras* spp. nov. Casey, 1954: 270, pl. 7 (fig. 7), text-fig. 2. Upper Hauterivian, England.

### Genus *Aconeceras* Hyatt, 1903
(= *Adolphia* Stolley, 1907; *Adolphites* Hennig, 1932)

Type species: *Ammonites nisus* d'Orbigny, 1841, by monotypy.

*Aconeceras nisus* (d'Orbigny), 1841: 184, pl. 55 (figs 7–9). Casey 1961*b*: 128. Upper Aptian of western Europe, notably Gargasian clays of the Vocontian Trough. Also recorded from Madagascar and elsewhere, although many records are dubious.

*Aconeceras haugi* (Sarasin), 1893: 156, pls 4–6, text-fig. 11a–c. Lower Aptian of western Europe, Nepal (Bordet *et al.* 1971), and Madagascar (Collignon 1962) where it is said to be of Upper Aptian age.

*Aconeceras neonisoides* Casey, 1961*b*: 129, pl. 26 (figs 1, 9–10), text-fig. 41d–e. Lower Albian of southern England and north Africa (Sornay 1955; Dubourdieu 1956).

*Aconeceras australonisoides* Brunnschweiler, 1959: 11, pl. 1 (fig. 1a–b). Aptian of western Australia.

*Aconeceras whitehousei* Brunnschweiler, 1959: 12, pl. 1 (fig. 2a–b). Aptian of western Australia.

*Aconeceras walshense* (Etheridge), 1892: 493, pl. 42 (figs 10–11). Whitehouse 1926: 203, pl. 34 (fig. 1), pl. 37 (fig. 3); 1927*a*: 114, pl. 16 (figs 2–3), text-figs 1, 6–7. Aptian of Queensland.

*Aconeceras nisoides* (Sarasin), 1893: 155, pls 4–6 (fig. 10a–c), text-figs 3, 5. Lower Aptian of western Europe.

*Aconeceras luppovie* (Sazonova), 1958: 130, pl. 8 (fig. 2). Aptian of the U.S.S.R.

*Aconeceras saratoviensis* (Sazonova), 1958: 130 (= *Oppelia trautscholdi* Sinzow, 1898, pl. A (figs 4–5 only)). Lower Aptian of the U.S.S.R.

### Genus *Sanmartinoceras* Bonarelli, 1921

Type species: *Sanmartinoceras patagonicum* Bonarelli, 1921, by monotypy.

*Sanmartinoceras* (*Sanmartinoceras*) *patagonicum* Bonarelli, 1921, in Bonarelli & Nagera 1921: 27, pl. 5 (figs 3–6). See also Howarth 1958: 5, pl. 1 (figs 6–10); Leanza 1970: 215, fig. 14; Thomson 1974: 24, pl. 4b–f, text-fig. 7a. Aptian of Argentina and Antarctica. (See Fig. 6A–D herein.)

*Sanmartinoceras* (*Sanmartinoceras*) *groenlandium* Rosenkrantz, 1934, in Bøgvad & Rosenkrantz 1934: 20, pl. 4 (fig. 3), pl. 5 (figs 1–5). Aptian of east Greenland. (See Fig. 1A–C herein.)

*Sanmartinoceras* (*Sanmartinoceras*) *olenae* (Tenison-Woods), 1883: 150, pl. 7 (fig. 8), pl. 8 (fig. 1). Whitehouse 1926: 205, pl. 41 (fig. 3); 1927*a*: 117, pl. 17 (fig. 6), text-figs 3, 4, 9. Aptian of Australia. (See Fig. 3A–C herein.)

*Sanmartinoceras* (*Sanmartinoceras*) *fontinale* (Hudleston), 1890: 241, pl. 9 (fig. 1). Whitehouse, 1927*a*: 116, pl. 17 (figs 2–5). Aptian of Australia. (See Figs 3D–G, 7A–H herein.)

*Sanmartinoceras* (*Sanmartinoceras*) *africanum* Kennedy & Klinger, 1978 sp. nov. (See p. 96.) Upper Barremian of Zululand.

### Subgenus *Sinzovia* Sazonova, 1958

Type species: *Ammonites trautscholdi* Sinzow, 1870 (= *Ammonites bicurvatus* Trautschold, 1865 *non* Michelin, 1838) by original designation.

*Sanmartinoceras* (*Sinzovia*) *trautscholdi* (Sinzow), 1870: 118–119. See also *Ammonites bicurvatus* Trautschold, 1865: 22, pl. 3 (fig. 17a–c) (*non* Michelin); Casey, 1961*b*: text-fig. 135a–c. Lower Aptian of the U.S.S.R. and southern England; Upper? Aptian of Madagascar; Upper Aptian of Zululand.

*Samartinoceras* (*Sinzovia*) *aptianum* (Sarasin), 1893: 155, pls 4–6, fig. 12a–c. Casey 1961*b*: 134, pl. 26 (fig. 6a–b), text-fig. 43d–e. Aptian of France, southern England and elsewhere in Europe; Nepal (Bordet *et al.* 1971). (See Fig. 6E–F herein.)

*Sanmartinoceras* (*Sinzovia*) *stolleyi* Casey, 1961*b*: 133, 136; text-fig. 135g–h. Upper Aptian of Germany. (See Fig. 6A–D herein.)

*Sanmartinoceras?* (*Sinzovia?*) sp. nov. Casey, 1961*b*: 136, text-fig. 43f. Aptian of England.

v*non Sinzovia luppovie* Sazonova, 1958: 130, pl. 8 (fig. 2) = *S. luppovi* Casey, 1961*b*: 130. Lower Aptian of the U.S.S.R. An *Aconeceras* according to Casey (1961*b*: 133).

*?non Sinzovia saratoviensis* Sazonova, 1958 (= *Oppelia trautscholdi* Sinzow, 1898, pl. A (figs 4–5a only). Lower Aptian of the U.S.S.R. Also an *Aconeceras* according to Casey (1961*b*: 133).

Subgenus *Theganeceras* Whitehouse, 1926

Type species: *Oppelia scalata* von Koenen, 1902, by original designation.

*Sanmartinoceras* (*Theganeceras*) *grande* Thomson, 1974: 25, pl. 4g. Lower Aptian of Alexander Island. (See Fig. 6G herein.)

*Sanmartinoceras* (*Theganeceras*) *scalatum* (von Koenen), 1902: 54, pl. 45 (fig. 6). Lower Aptian of north Germany. (See Fig. 6H herein.)

*Sanmartinoceras* (*Theganeceras*) *falcatum* (von Koenen), 1902: 48, pl. 45 (figs 7–8). See also Casey 1961*b*: 132, pl. 26 (fig. 2). Lower Aptian of north Germany and England. (See fig. 6I–J.)

*Sanmartinoceras* (*Theganeceras*) (?) sp. Thomson, 1974: 26, pl. 4k. Lower Aptian of Alexander Island.

*Sanmartinoceras* (*Theganeceras*) *nodosum* Kennedy & Klinger sp. nov. (See p. 107.) Lower Aptian of Zululand.

Genus *Gyaloceras* Whitehouse, 1927

Type species: *Gyaloceras smithi* Whitehouse, 1927 by original designation.

*Gyaloceras smithi* Whitehouse, 1927*a*: 115, pl. 17 (fig. 1), text-fig. 8. Aptian of Australia. (See Fig. 2A.)

*Gyaloceras ibo* Reyment, 1955: 15, pl. 2 (figs 1–3), text-figs 3–4. Upper Albian of Nigeria. Casey (1961*b*: 139) has suggested that this species is 'a completely new development whose relationship to the Aconeceratidae is doubtful. Possibly it is congeneric with the *Aconeceras?* described by Haas (1942: 165) from the Upper Albian of Angola'.

? Genus *Eofalciferella* Brunnschweiler, 1959

Type species: *Eofalciferella condoni* Brunnschweiler, 1959, by original designation.

*Eofalciferella condoni* Brunnschweiler, 1959: 13, pl. 1 (figs. 3–4). Aptian of Australia. The only illustrations of this species are pencil sketches of the unique holotype, a crushed specimen from the Windalia Radiolarite. The species and genus are best treated as *nomen dubia*; Casey (1961*b*: 131) implies in his discussion of the genus that its affinities may be with *Sanmartinoceras*.

Family **Binneyitidae** Reeside, 1927

Genus *Falciferella* Casey, 1954

Type species: *Falciferella milbournei* Casey, 1954, by original designation.

*Falciferella milbourni* Casey, 1954: 274, pl. 7 (figs 1–5), text-fig. 3. Middle Albian of southern England.

*Falciferella malandiandrensis* Collignon, 1962: 32, pl. 229 (fig. 975). Upper Aptian of Madagascar. This species is keeled to a diameter of approximately 45 mm. It may be an *Aconeceras*, although Collignon (1962) indicates that it has a *Falciferella*-like suture.

Genus *Doridiscus* Casey, 1961

Type species: *Doridiscus rotulus* Casey, 1961, by original designation.

*Doridiscus rotulus* Casey, 1961*b*: 139, pl. 26 (fig. 8a–b), text-fig. 44c–e. Low Upper Aptian of southern England.

*Doridiscus* sp. nov. indet? Casey, 1961*b*: 140, text-fig. 44f. Upper Lower Aptian of southern England.

Genus *Nothodiscus* Casey *in* Collignon, 1962

Type species: *Nothodiscus planus* Casey, *in* Collignon, 1962, by original designation.
*Nothodiscus planus* Casey *in* Collignon, 1962: 32, pl. 229 (fig. 976). Upper Aptian of Madagascar.

Genus *Borissiakoceras* Arkhangelsky, 1916

Type species: *Borissiakoceras mirabile* Arkangelsky, 1916: 55, pl. 8 (figs 2–3), Lower Turonian of Turkestan. Kennedy & Juignet, 1973: 900, text-figs 1–2, Middle Cenomanian of France.
*Borissiakoceras compressum* Cobban, 1961: 747, pl. 87 (figs 19–33); pl. 89 (figs 1–9), text-fig. 4a–k. Middle Cenomanian of the United States Western Interior.
*Borissiakoceras reesidei* Morrow, 1935: 463, pl. 49 (fig. 7a–b), pl. 50 (fig. 5), text-fig. 8. Cobban, 1961: 749, pl. 88 (figs 1–14), text-fig. 3h–k. Middle Cenomanian of the United States Western Interior.
*Borissiakoceras orbiculatum* Stephenson, 1955: 64, pl. 6 (figs 1–4). Cobban, 1961: 750, pl. 88 (figs 15–41), text-fig. 5a–f. Middle/Upper Cenomanian of Texas and the United States Western Interior.
*Borissiakoceras* cf. *B. orbiculatum* Stephenson, 1955; Cobban 1961: 753, pl. 89 (figs 10–14), text-fig 5g, i. Uppermost Cenomanian of the Black Hills, United States Western Interior.
*Borissiakoceras inconstans* Cobban & Gryc, 1961: 187, pl. 38 (figs 30–37), text-fig. 2i–l. Latest? Cenomanian of Alaska.
*Borissiakoceras ashurkoffae* Cobban & Gryc, 1961: 188, pl. 38 (figs 38–43), text-fig. 2j–k, m. Lower Turonian of Alaska.
*Borissiakoceras* (?) sp. Wright, 1963: 602, pl. 89 (fig. 5). Middle Cenomanian of Bathurst Island, Australia.
*Borissiakoceras?* sp. Lower Cenomanian of Sarthe, France (Sorbonne collections).
*Borissiakoceras* sp. Kennedy & Klinger, 1978. (See p. 116.) Middle Cenomanian of Zululand.

Genus *Johnsonites* Cobban, 1961

Type species: *Johnsonites sulcatus* Cobban, 1961, by original designation.
*Johnsonites sulcatus* Cobban, 1961: 743, pl. 87 (figs 1–18), text-fig. 3a–g. Middle Cenomanian of Wyoming and Colorado in the United States Western Interior.
*? Johnsonites* sp., the original of Stephenson's (1952: 198, pl. 45 (figs 5–6)) *Euhoplites?* sp. from the Middle Cenomanian of Texas may also belong to this genus.

Genus *Binneyites* Reeside, 1927

Type species: *Binneyites parkensis* Reeside, 1927, by original designation.
*Binneyites parkensis* Reeside, 1927: 5, pl. 3 (figs 1–10). Cobban, 1961: 754, pl. 89 (figs 32–37), text-fig. 5s, t. Coniacian of Wyoming and Utah in the United States Western Interior.
*Binneyites carlilensis* Cobban, 1961: 755, pl. 89 (figs 15–22), text-fig. 5h, j–m. Mid-Turonian of South Dakota and Wyoming in the United States Western Interior.
*Binneyites aplatus* (Morrow), 1935: 465, pl. 49 (fig. 5), pl. 50 (fig. 6), text-fig. 7. Mid-Turonian of Kansas in the United States Western Interior.
*Binneyites rugosus* Cobban, 1961: 756, pl. 89 (figs 26–31), text-fig. 5n–p.
The Engonoceratidae gen. et sp. nov. of Henderson, 1973: 106, fig. 14 (no. 8), text-fig. 15, is either a *Borissiakoceras* or *Binneyites* of Turonian age.

## ACKNOWLEDGEMENTS

We thank Dr H. W. Ball, Dr M. K. Howarth and Mr D. Phillips of the British Museum (Natural History), Dr R. Casey and Mr C. J. Wood (Institute of Geological Sciences), Mr C. W. Wright and Dr M. R. Cooper (Oxford), for their advice and useful discussions. The assistance of the staff of the Geological Collections at Oxford University Museum, and South African Museum, Cape Town, is gratefully acknowledged as is the financial support of the Trustees of the Sir Henry Strakosh Bequest, the Royal Society, and Natural Environment Research Council.

## REFERENCES


ARKHANGELSKY, A. D. 1916. Les mollusques du Crétacé Supérieur du Turkestan. *Trudȳ geol. Kom.* n.s. **152**: 1–57.

BODYLEVSKY, V. I. & SHULINGA, N. I. 1958. Jurassic and Cretaceous faunas of the lower Yenisei River region, U.S.S.R. *Trudȳ nauchno-issled. Inst. Geol. Arkt.* **93**: 1–196 (In Russian.)

BØGVAD, R. & ROSENKRANTZ, A. 1934. Beiträge zur Kenntnis der unteren Kreide Ostgrönlands. *Meddr. Grønland* **93**: 15–28.

BONARELLI, G. & NAGERA, J. J. 1921. Observaciones geológicas en las immendiaciones del Lago San Martin (Territorio de Santa Cruz). *Boln Dir. gen. Minas Geol. Hidrol., B. Aires* ser. B. (Geológia) **27**: 1–39.

BORDET, P., COLCHEN, L., KRUMMENACHER, D., LE FORT, P., MOUTERDE, R., & REMY, M. 1971. Recherches Géologiques dans l'Himalaya du Népal, Région de la Thakkhola. Paris: Centre National de la Recherche Scientifique.

BRUNNSCHWEILER, R. O. 1959. New Aconeceratinae (Ammonoidea) from the Albian and Aptian of Australia. *Bull. Bur. Miner. Resour. Geol. Geophys. Aust.* **54**: 1–19.

CALLOMON, J. H. 1963. Sexual dimorphism in Jurassic ammonites. *Trans. Leicester lit. phil. Soc.* **57**: 21–56.

CASEY, R. 1954. *Falciferella*, a new genus of Gault ammonites, with a review of the family Aconeceratidae in the British Cretaceous. *Proc. Geol. Ass.* **65**: 262–277.

CASEY, R. 1961*a*. A monograph of the Ammonoidea of the Lower Greensand. *Palaeontogr. Soc.* (*Monogr.*) part **2**: 45–118.

CASEY, R. 1961*b*. A monograph of the Ammonoidea of the Lower Greensand. *Palaeontogr. Soc.* (*Monogr.*) part **3**: 119–216.

COBBAN, W. A. 1961. The ammonite family Binneyitidae Reeside in the Western Interior of the United States. *J. Paleont.* **35**: 176–190.

COBBAN, W. A. & GRYC, G. 1961. Ammonites from the Seabee Formation (Cretaceous) of northern Alaska. *J. Paleont.* **35**: 176–190.

COLLIGNON, M. 1962. *Atlas des fossiles carctéristiques de Madagascar* (*Ammonites*) *IX* (*Aptien*). Tananarive: Service Géologique.

DRUSHCHITZ, V. V. & KUDRYAVTSEVA, M. P. 1960. Atlas of Lower Cretaceous fauna of the northern Caucasus and Crimea. Moscow: Gostoptekhizdat. (In Russian.)

DUBOURDIEU, G. 1956. Étude géologique de la région de l'Ouenza (Confins Algéro-Tunisiens). *Publs Serv. Carte géol. Algér.* **10**: 1–659.

ETHERIDGE, R. 1892. *In:* JACK, R. L. & ETHERIDGE, R. *The geology and palaeontology of Queensland and New Guinea.* Brisbane & London.

FAVRE, F. 1908. Die Ammoniten der unteren Kreide Patagoniens. *Neues Jb. Min. Geol.* Beil. Bd. **35**: 601–647.

HAAS, O. 1942. The Vernay collection of Cretaceous (Albian) ammonites from Angola. *Bull. Amer. Mus. nat. Hist.* **81**: 1–224.

HENDERSON, R. A. 1973. Clarence and Raukumara Series (Albian-?Santonian) Ammonoidea from New Zealand. *Jl R. Soc. N.Z.* **3**: 71–123.

HENNIG, E. 1932. *Wesen und Wege der Paläontologie.* Berlin.

HOWARTH, M. K. 1958. Upper Jurassic and Cretaceous ammonite faunas of Alexander and Graham Land. *Scient. Rep. Falkld Isl. Depend. Surv.* **21**: 1–16.

HUDLESTON, W. H. 1890. Further notes on some Mollusca from South Australia. *Geol. Mag.* (3) **7**: 241–246.

HYATT, A. 1903. Pseudoceratites of the Cretaceous. STANTON, T. W. *ed. Monogr. U.S. geol. Surv.* **44**: 1–351.

KENNEDY, W. J. & COBBAN, W. A. 1976. Aspects of ammonite biology, biogeography & biostratigraphy. *Spec. Pap. Palaeont.* **8**: 1–133.

KENNEDY, W. J. & JUIGNET, P. 1973. First record of the ammonite family Binneyitidae Reeside, 1927 in western Europe. *J. Paleont.* **47**: 900–902.

KENNEDY, W. J. & KLINGER, H. C. 1975. Cretaceous faunas from Zululand and Natal, South Africa. Introduction, stratigraphy. *Bull. Br. Mus. nat. Hist.* (Geol.) **25**: 263–315.

KOENEN, A. VON. 1902. Die Ammonitiden des Norddeutschen Neocom. (Valanginien, Hauterivien, Barrêmien und Aptien). *Abh. preuss. geol. Landesanst.* n.s. **24**: 1–451.

KULLMAN, J. & WIEDMANN, J. 1970. Significance of sutures in phylogeny of Ammonoidea *Paleont. Contr. Univ. Kans.* **47**: 1–32.

LEANZA, A. F. 1970. Ammonites nuevos o pocos conocidos del Aptiano, Albiano y Cenomanino de los Andes australes con notas acera de su posicion estratigrafica. *Revta Soc. geol. argent.* **25**: 197–261.

MAKOWSKI, H. 1962. Problems of sexual dimorphism in ammonites. *Palaeont. pol.* **12**: 1–92.

MORROW, A. L. 1935. Cephalopods from the Upper Cretaceous of Kansas. *J. Paleont.* **9**: 463–473.

ORBIGNY, A. D'. 1840–1842. *Paléontologie française: Terrains crétacés.* 1. *Céphalopodes.* Paris: Masson.

PALFRAMAN, F. F. B. 1969. Taxonomy and sexual dimorphism in ammonites. Morphogenetic evidence in *Hecticoceras brightii* (Pratt). *In:* WESTERMANN, G. E. G. *ed. Sexual dimorphism in fossil Metazoa and taxonomic implications:* 126–154. Stuttgart: Schweizerbart'sche Verlagsbuchhandlung.

REESIDE, J. B. 1927. Cephalopods from the lower part of the Cody Shale of Oregon Basin, Wyoming. *Prof. pap. U.S. geol. Surv.* **150-A**: 1–19.

REYMENT, R. A. 1955. The Cretaceous Ammonoidea of southern Nigeria and the Southern Cameroons. *Bull. geol. Surv. Nigeria* **25**: 1–112.

SARASIN, C. 1893. Étude sur les *Oppelia* du groupe de *nisus* et les *Sonneratia* du groupe du *bivurvatus* et du *raresulcatus. Bull. Soc. géol. Fr.* (4) **21**: 149–164.

SAZONOVA, I. G. 1958. Lower Cretaceous deposits of the Russian Platform. *In:* FLEROVOI, O. V. Mesozoic and Tertiary deposits of the central regions of the Russian Platform. *Vses. Nauchno-Issled. Geol. Razved. Neft. Inst. Moscow*: 31–136. (In Russian.)

SINZOW, I. 1870. A geological sketch of the Saratow region. *Bull. Soc. Mem. St. Petersb.* (2) **5**: 103–161. (In Russian.)

SINZOW, I. 1898. *Bemerkungen über einige Ammoniten des Aptien.* Odessa.

SORNAY, J. 1955. Ammonites nouvelles du Crétacé de la région des Monts du Mèllegue (Constantine). *Bull. Serv. Carte géol. Alger* (1) Paléontologie **18**: 1–40.

SPATH, L. F. 1923. A Monograph of the ammonoidea of the Gault. Part 1. *Palaeontogr. Soc. Monogr.* **76**: 1–72.

STEPHENSON, L. W. 1952. Larger invertebrate fossils of the Woodbine Formation (Cenomanian) of Texas. *Prof. pap. U.S. geol Surv.* **242**: 1–226.

STEPHENSON, L. W. 1955. Basal Eagle Ford fauna (Cenomanian) in Johnson and Tarrant counties, Texas. *Prof. pap. U.S. geol. Surv.* **274–C**: 53–67.

STOLLEY, E. 1907. Ueber ein norddeutsches aequivalent der Clansayes Fauna Südfrankreichs und der Schweiz. *Centrlbl. Min. Geol. u Pal.* **1907**: 266–270.

TENISON-WOODS, J. E. 1883. On some Mesozoic fossils from the Palmer River, Queensland. *J. Proc. R. Soc. N.S.W.* **16**: 147–154.

THOMSON, M. R. A. 1974. Ammonite faunas of the Lower Cretaceous of south-eastern Alexander Island. *Scient. Rep. Falkld Isl. Depend. Surv.* **80**: 1–44.

TRAUTSCHOLD, H. 1865. Der Inoceramen-Thon von Simbirsk. *Bull. Soc. Imp. Nat. Moscou.* **34**: 432–457.

WARREN, P. S. & STELCK, C. R. 1958. Lower Cenomanian Ammonoidea and Pelecypoda from Peace River area, western Canada. *Bull. geol. Div. Res. Coun. Alberta* **2**: 36–51.

WEDEKIND, R. 1916. Über Lobus, Suturallobus und Inzision. *Zentbl. Miner. Geol. Paläont.* **1916**: 185–195.

WHITEHOUSE, F. W. 1926. The Cretaceous Ammonoidea of eastern Australia. *Mem. Qd Mus.* **8**: 195–242.

WHITEHOUSE, F. W. 1927*a*. Additions to the Cretaceous ammonite fauna of eastern Australia. Part 1. (Simberskitidae, Aconeceratidae and Parahoplitidae). *Mem. Qd Mus.* **9**: 109–120.

WHITEHOUSE, F. W. 1927*b*. Additions to the Cretaceous ammonite fauna of eastern Australia. Part 2. *Mem. Qd Mus.* **9**: 200–206.

WRIGHT, C. W. 1957. *Mesazoic Ammonoidea. In:* MOORE, R. C. ed. *Treatise on Invertebrate Palaeontology*, Part L, Mollusca 4: Kansas; New York: University of Kansas Press and Geological Society of America.

WRIGHT, C. W. 1963. Cretaceous ammonites from Bathurst Island, northern Australia. *Palaeontology* **6**: 597–614.

6. SYSTEMATIC papers must conform to the *International code of zoological nomenclature* (particularly Articles 22 and 51).

Names of new taxa, combinations, synonyms, etc., when used for the first time, must be followed by the appropriate Latin (not English) abbreviation, e.g. gen. nov., sp. nov., comb. nov., syn. nov., etc.

An author's name when cited must follow the name of the taxon without intervening punctuation and not be abbreviated; if the year is added, a comma must separate author's name and year. The author's name (and date, if cited) must be placed in parentheses if a species or subspecies is transferred from its original genus. The name of a subsequent user of a scientific name must be separated from the scientific name by a colon.

Synonymy arrangement should be according to chronology of names, i.e. all published scientific names by which the species previously has been designated are listed in chronological order, with all references to that name following in chronological order, e.g.:

Family **Nuculanidae**

*Nuculana* (*Lembulus*) *bicuspidata* (Gould, 1845)

Figs 14–15A

*Nucula* (*Leda*) *bicuspidata* Gould, 1845: 37.
*Leda plicifera* A. Adams, 1856: 50.
*Laeda bicuspidata* Hanley, 1859: 118, pl. 228 (fig. 73). Sowerby, 1871: pl. 2 (fig. 8a–b).
*Nucula largillierti* Philippi, 1861: 87.
*Leda bicuspidata:* Nicklès, 1950: 163, fig. 301; 1955: 110. Barnard, 1964: 234, figs 8–9.

*Note* punctuation in the above example:
comma separates author's name and year
semicolon separates more than one reference by the same author
full stop separates references by different authors
figures of plates are enclosed in parentheses to distinguish them from text-figures
dash, not comma, separates consecutive numbers

Synonymy arrangement according to chronology of bibliographic references, whereby the year is placed in front of each entry, and the synonym repeated in full for each entry, is not acceptable.

In describing new species, one specimen must be designated as the holotype; other specimens mentioned in the original description are to be designated paratypes; additional material not regarded as paratypes should be listed separately. The complete data (registration number, depository, description of specimen, locality, collector, date) of the holotype and paratypes must be recorded, e.g.:

*Holotype*
SAM–A13535 in the South African Museum, Cape Town. Adult female from mid-tide region, King's Beach Port Elizabeth (33°51'S 25°39'E), collected by A. Smith, 15 January 1973.

*Note* standard form of writing South African Museum registration numbers and date.

## 7. SPECIAL HOUSE RULES

*Capital initial letters*

(a) The Figures, Maps and Tables of the paper when referred to in the text
e.g. '. . . the Figure depicting *C. namacolus* . . .'; '. . . in *C. namacolus* (Fig. 10) . . .'

(b) The prefixes of prefixed surnames in all languages, when used in the text, if not preceded by initials or full names
e.g. Du Toit but A. L. du Toit; Von Huene but F. von Huene

(c) Scientific names, but not their vernacular derivatives
e.g. Therocephalia, but therocephalian

*Punctuation* should be loose, omitting all not strictly necessary

*Reference to the author* should be expressed in the third person

*Roman numerals* should be converted to arabic, except when forming part of the title of a book or article, such as
'Revision of the Crustacea. Part VIII. The Amphipoda.'

*Specific name* must not stand alone, but be preceded by the generic name or its abbreviation to initial capital letter, provided the same generic name is used consecutively.

*Name of new genus or species* is not to be included in the title: it should be included in the abstract, counter to Recommendation 23 of the Code, to meet the requirements of Biological Abstracts.

SMITHSONIAN INSTITUTION LIBRARIES
3 9088 01206 6668

WILLIAM JAMES KENNEDY
&
HERBERT CHRISTIAN KLINGER

# CRETACEOUS FAUNAS FROM ZULULAND AND NATAL, SOUTH AFRICA THE AMMONITE SUPERFAMILY HAPLOCERATACEAE ZITTEL, 1884