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M. R. A. THOMSON, B.Sc., Ph.D.

*British Antarctic Survey*

*and*

*Department of Geology, University of Birmingham*


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## ABSTRACT

A SYSTEMATIC study of more than 160 specimens belonging to 12 ammonite families is given. At least 38 species are recognized but poor preservation of most specimens makes them only generically determinable. One new heteromorph genus, *Antarcticoceras*, is proposed. Ten species are identified with or compared with known forms and seven are recognized as new, although their preservation is such that only four of these have been formally named: *Bochianites gracilis*, *Antarcticoceras antarcticum*, *Sanmartinoceras* (*Theganeceras*) *grande* and *Silesites antarcticus*. Other small heteromorphs and one oppeliid probably belong to new genera. The faunas are notable for their content of heteromorph forms; oppeliids, desmoceratids and silesitids are locally abundant. At least four distinct faunas ranging from Berriasian to Lower Albian age are recognized. The close proximity of the highest and lowest stratigraphical levels in the area (on either side of Pluto Glacier) suggest the presence of a large-scale fault in the locality of the glacier. In the appendix the known occurrences of the aconeceratid genus *Sanmartinoceras s.s.* are reviewed and it is concluded that the genus is not necessarily restricted to beds of Upper Aptian age or younger but it may also occur in the Lower Aptian.

## CONTENTS

# I. INTRODUCTION

THE Ammonoidea described here all came from exposures near the coast of the south-eastern part of Alexander Island between lat. 71°04′ and 71°35′S. (Fig. 1) and Stephenson Nunatak. At 17 localities in this area (Fig. 2) detailed measurements by B. J. Taylor, L. E. Willey and the author have enabled the compilation of a series of stratigraphical sections, most of which have been correlated by faunal and lithological means so that the relative stratigraphical positions of such localities are already known. The sections cover a total stratigraphical thickness of more than 2,000 m. Ammonites collected from ten of the above localities (Z, A, B, C, R, H, S, N, T and W) and three others (V, X and Y) enable broad age limits to be set on various parts of the sedimentary sequence.

The species described belong to the families Phylloceratidae, Lytoceratidae, Tetragonitidae, Macroscaphitidae, Bochianitidae, Crioceratitidae, Ancyloceratidae, Ptychoceratidae, Oppeliidae, Berriasellidae, Desmoceratidae and Silesitidae. The variety of heteromorph forms is striking and examples are readily found at most localities but, since many of these are fragmentary, they remain in the collections unidentified. Phylloceratids, lytoceratids, tetragonitids and berriasellids are represented by sporadic occurrences only; oppeliids, desmoceratids and silesitids are locally abundant.

Any study of the Ammonoidea from south-eastern Alexander Island is hampered by the generally poor preservation of most of the specimens and indeed this may be said of most of the fossil groups from this area. All of the ammonites occur as internal and/or external moulds, usually of crushed individuals, and remains of the test when present are only fragmentary. Only in a few cases have the sutures been preserved and, where possible, every effort has been made to reproduce these for illustration. The following methods have been employed:

i. Tracing from photographs.
ii. Composite drawings from a series of sketches made using a low-power microscope fitted with a camera lucida.
iii. Cellulose peels.

Methods (i) and (ii) were used for flat or gently curved whorls and method (iii) for strongly curved ones.

The poor state of preservation of many of the specimens is reflected in the number of individuals described here which are only ascribed a generic identification (often tentative) or which are simply related to known species by means of the designations "cf." and "aff.". In faunas such as these, new species, if not new genera, are inevitably present but the literature is already overburdened with species based on extremely poor material and new species in the present faunas have only been named where the preservation of the material would allow ready identification of similar examples if found elsewhere.

Some of the best-preserved specimens occur as external moulds and, for both study and photographic purposes, it was expedient to cast these in latex which had been coloured by the addition of a few drops of Indian ink. Acceptable photographs were easily made from these casts after they had been thinly coated with ammonium chloride. Natural internal moulds were usually photographed in their normal state but, where natural coloration obscured detail, coating the specimen with grey poster paint (Casey, 1960, p. xxxiv) prior to photographing was found useful.

In the descriptions of the various species the following abbreviations have been used to denote the measurements which were made:

*D* The diameter of the whole specimen at which the three following measurements were taken. Where possible this was always the greatest diameter of the specimen.
*h* The height of the outer whorl from umbilical seam to venter.
*u* The diameter of the umbilicus.
*w* Maximum width of the outer whorl. (It was rarely possible to measure this.)
$D_{max.}$ An approximation to, or estimate of, the greatest diameter when a specimen was incompletely preserved. In this case *D* was the greatest diameter at which it was also possible to measure *h*, *u* and possibly *w*.

The nomenclature for parts of the suture is the same as that used by Casey (1960, p. xxxiii) in his monograph on the Ammonoidea of the Lower Greensand.

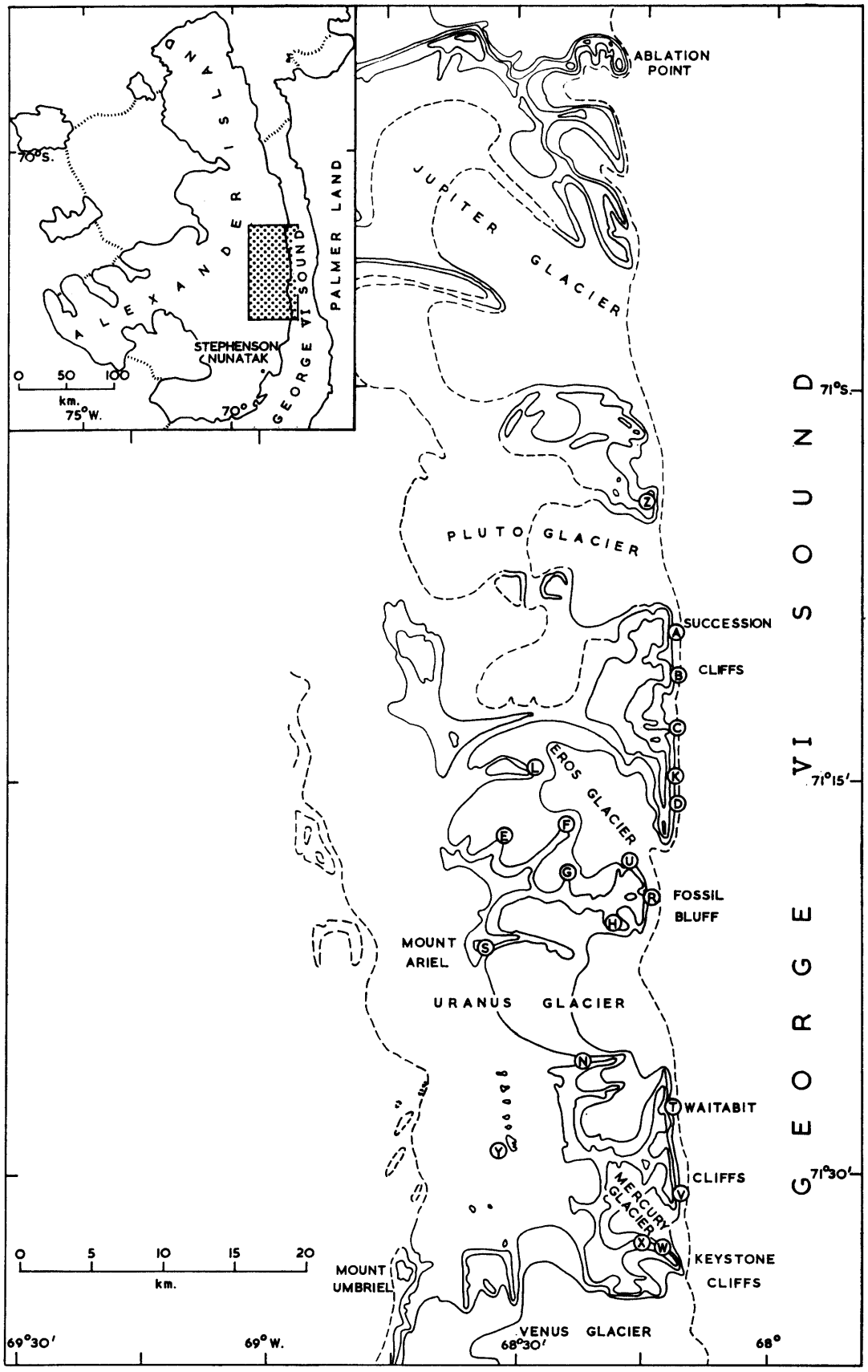


FIGURE 1

Sketch map of part of Alexander Island showing the positions of localities referred to in the text. The form lines are approximate.

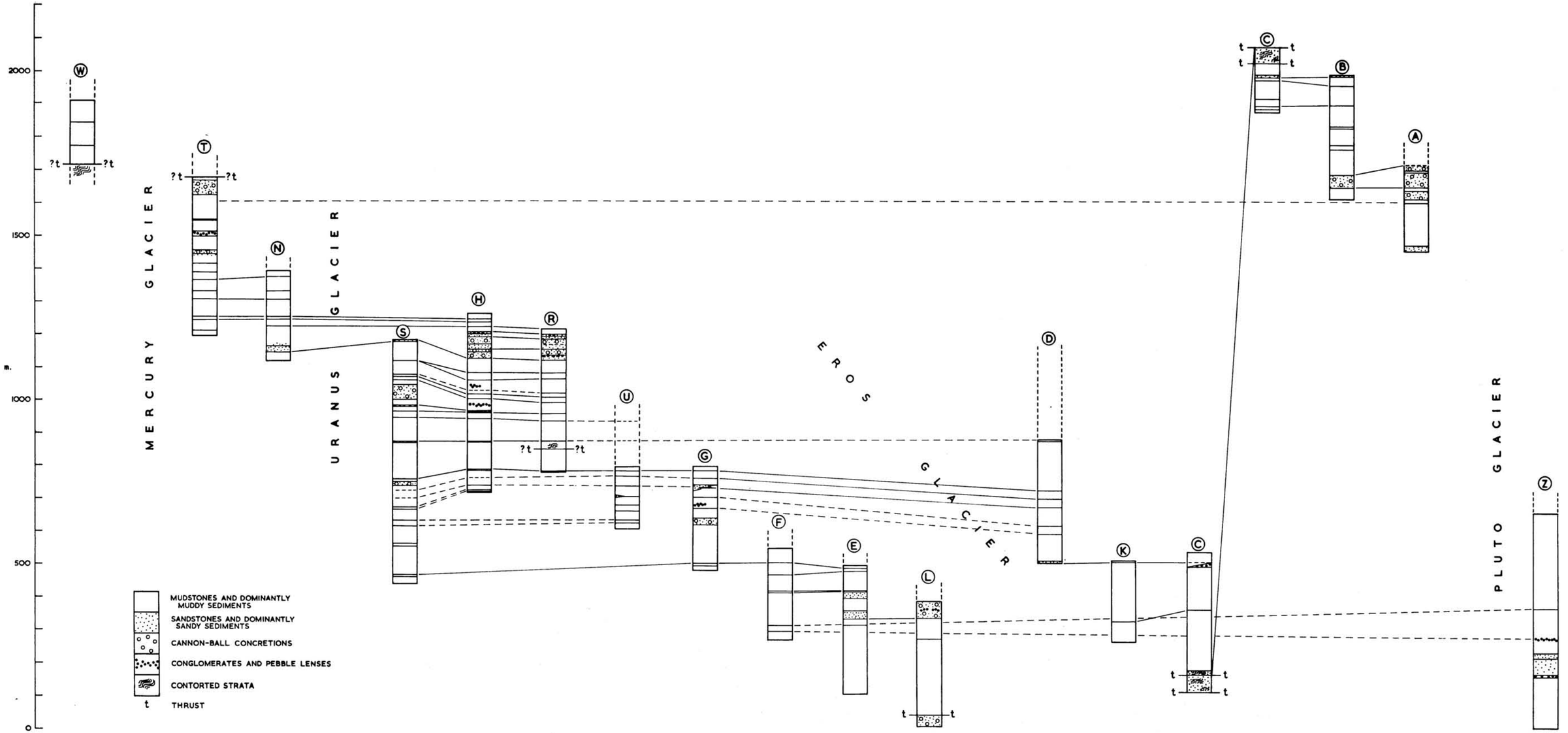


FIGURE 2

Correlation diagram for the measured stratigraphical sections in south-eastern Alexander Island. This represents a final analysis of the data outlined by Taylor (1971) and attempts to show each measured section in its relative stratigraphical position. The tentative correlation of locality Z with locality F is based on the evidence of belemnite faunas. Locality W cannot yet be satisfactorily correlated with other sequences in Alexander Island but it is shown in its probable relative stratigraphical position.

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# II. SYSTEMATIC DESCRIPTIONS

## Family Phylloceratidae Zittel 1884

### Genus *Phylloceras* Suess 1865
### *Phylloceras* sp.

Plate Ia

*Phylloceras* sp.; Thomson, 1971*b*, p. 158.

*Material*

One example (KG.401.151) from locality Z, one side being preserved as an internal mould, the other still bearing the test.

*Description*

The specimen (Plate Ia) is small, entirely septate and has a diameter of about 25 mm. It has been partly flattened but nevertheless probably had a relatively high and narrow whorl cross-section with its maximum width near the mid-line; in its present state the maximum width is about 6 mm. The umbilicus is relatively shallow and dish-like. The external surface of the test appears smooth but when viewed at a magnification of $\times 20$ or more it is seen to be covered with numerous very fine radial lirae.

*Remarks*

This specimen is too crushed for satisfactory comparison with known species; in such feebly ornamented species the exact shell form is particularly important for classification purposes.

### Genus *Phyllopachyceras* Spath 1925
### *Phyllopachyceras aureliae* (Feruglio 1936)

Plate Ie

*Phylloceras aureliae* Feruglio, 1936, p. 41, pl. IV, figs. 1 and 3–5 (? *non* fig. 2).
*Phylloceras aureliae* Feruglio; Leanza, 1967*b*, p. 148, 150.
*non Holcoptychites neuquensis* (Douvillé); Leanza, 1967*b*, p. 150.
*Phyllopachyceras aureliae* (Feruglio); Thomson, 1971*b*, p. 160, fig. 3g.

*Material*

One internal mould of a laterally flattened specimen (KG.106.4) from the basal mudstones of the section measured at locality W.

*Description*

The maximum diameter of the specimen is 96 mm. but, allowing for crushing, the true diameter would have been somewhat smaller. The shell form (Plate Ie) is strongly involute, the outer whorl enveloping all the others and leaving only a very small umbilical funnel. Ornament consists of strong rounded ribs which originate a short distance away from the umbilicus, curve forward and then pass radially across the flank and over the venter. A few ribs bifurcate in the ventral third or quarter of the flank; more often there are intercalated ribs. On some areas of the mould numerous fine radial threads can be seen. Parts of the last suture are preserved (Plate Ie) and these exhibit the typical phylloid elements of the saddles as found in the Phylloceratidae. However, it is not preserved well enough to demonstrate the tetraphyllic form of the saddles which would be expected in *Phyllopachyceras*.

*Remarks*

This specimen compares closely with the Patagonian specimens of *Phylloceras aureliae* first described and illustrated by Feruglio (1936, pl. IV, figs. 1 and 3–5). The only important difference between those

specimens and the present one is that the former lack the fine radial threads which Feruglio noted were also present on the closely related species *Ammonites infundibulum* d'Orbigny (type species of *Phyllopachyceras* Spath). However, d'Orbigny (1840–42, p. 131–32) did not mention the presence of radial threads and Uhlig (1883, p. 180) noted that, in specimens of this species from Wernsdorf, radial threads were scarcely perceptible on the internal mould and then only on the better-preserved specimens. The lack of threads on the Patagonian specimens of *Phyllopachyceras aureliae* is probably due to non-preservation rather than original non-existence.

Feruglio's (1936, pl. IV, fig. 2) example is tentatively excluded from the synonymy of *P. aureliae* because it possesses three deep constrictions which do not appear to have been previously described in coarsely ribbed phylloceratids of the *P. infundibulum* type. For a similar reason the specimens which Feruglio (1936, p. 49) identified as *Holcoptychites neuquensis* (Douvillé) and which Leanza (1967*b*, p. 150) included under *P. aureliae* are also excluded. If it should be proved on the evidence of more and better material that constrictions are truly characteristic of *P. aureliae* in Patagonia, the identity of the present specimen will have to be reconsidered.

Although d'Orbigny's (1840–42, pl. 39, figs. 4 and 5) illustrations of *P. infundibulum* are probably idealized, his description bears out the regularity of the ornament of alternating major ribs and short intercalated ribs. This contrasts strongly with the ribbing in *P. aureliae* where the intercalated ribs are not only a variety of lengths but the major ribs bifurcate at varying positions on the flank. A specimen from the Barremian of Wernsdorf, referred to *P. infundibulum* by Uhlig (1883, pl. IV, fig. 1), is larger than that described by d'Orbigny and has ribs on the last part of the outer whorl which bifurcate about two-thirds of the way across the flank from the umbilicus. This suggests a close relationship between the two species discussed here.

### *Phyllopachyceras* cf. *baborense* (Coquand 1880)

Plate Ib and c; Fig. 3a

For early synonymy see Collignon, 1937, p. 112.
cf. *Phylloceras baborense* Coquand; Collignon, 1937, p. 112, pl. XVI, figs. 4–6.
cf. *Phyllopachyceras baborense* Coquand; Collignon, 1962*b*, pl. CCXVI, fig. 945.
*Phyllopachyceras* cf. *baborense* (Coquand); Thomson, 1971*b*, p. 159.

#### *Material*

One small internal mould (KG.1.672) from locality R which clearly shows the form of the sutures and also still has some of the test adhering to it.

#### *Description*

The coiling of the specimen is extremely involute so that the strongly inflated outer whorl, which is a little higher than wide, envelops all the others. The umbilicus is deep and funnel-shaped, its centre probably being punctate. Small fragments of the test adhering to the venter on the anterior part of the mould are ornamented with fine radial threads, of which ten were counted in the space of 4 mm.; fragments of test

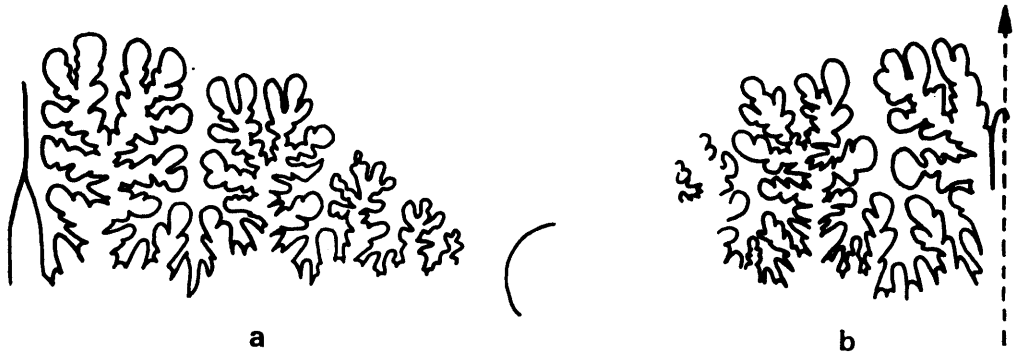


FIGURE 3

a. *Phyllopachyceras* cf. *baborense* (Coquand). Suture; ×5 (KG.1.672).
b. *Hypophylloceras* sp. Suture of specimen KG.103.124 showing the unusual asymmetrical external saddle; ×2.

on the flanks are smooth. The suture (Fig. 3a) has tetraphyllic saddles and trifurcate lateral lobes; the ventral lobe is divided by a simple large median leaflet. A line joining the anterior extremities of the saddles curves backward towards the umbilicus such that its curvature increases considerably, dorsally of the second lateral saddle. Numerous auxiliary elements are present.

*Measurements*

$D_{max.} = 18{\cdot}5$ mm. At $D = 16{\cdot}0$ mm., $h = 10{\cdot}0$ mm. and $w = 9{\cdot}5$ mm.

*Remarks*

In the past, many examples of *Phylloceras s.l.* with whorls which were as wide, or nearly as wide, as high and with tetraphyllic saddles in the suture were referred to the species *P. rouyanum* (d'Orbigny). However, Collignon (1937, p. 112–17) has pointed out that this species has been misinterpreted and that the name *rouyanum* has been used for a number of quite distinct species. He believed that *P. rouyanum* [= *P. rouyi* of Collignon] *s.s.* was a Hauterivian species and that the so-called species from the Barremian and Aptian could be collected together under the species *P. baborense* (Coquand). Collignon did not describe this species as he interpreted it but the present specimen compares favourably with his illustrations of it (Collignon, 1937, pl. XVI, figs. 4–6), and the two forms could be conspecific. Possibly the whorl section is not quite as circular as in the Malagasy Republic specimens illustrated by Collignon but this might be a function of difference in size. The distinctions between many species of *Phylloceras s.l.* are often rather subtle and, in the absence of comparable material, it is thought best to leave the identification open. *P. rogersi* Kitchin (1908, p. 179, pl. VIII, fig. 19) from the Neocomian Uitenhage Series of South Africa has a slightly narrower whorl section, finer ornament and a broader umbilical funnel.

The inflated whorl section, minute umbilicus and tetraphyllic external and first lateral saddles place this species in the genus *Phyllopachyceras* Spath.

### *Phyllopachyceras* (*?*) sp.

*Phyllopachyceras* (*?*) sp.; Thomson, 1971*b*, p. 158.

Five poorly preserved external and internal moulds (KG.401.91, 183, 319, 653 and 676) from locality Z have the boldly ribbed ornament found on several species of the genus *Phyllopachyceras*. Specimens KG.401.653 and 676 have narrower, more prominent ribs than the others and they may belong to a distinct species.

## Genus *Hypophylloceras* Salfeld 1924

### *Hypophylloceras* spp. (*?*)

Plate Id, f and g; Fig. 3b

*Hypophylloceras* sp.; Thomson, 1971*b*, p. 159

*Material*

Three incomplete external and internal moulds of adult specimens and also a juvenile, all from locality T. KG.103.124 was collected 175 m. above the base of the section, KG.103.189, 191 and 216 came from 212–257 m. higher up.

*Description*

The largest example (KG.103.189; Plate Ig) is an incomplete external mould of a crushed specimen with a distinctive ribbing pattern. It bears numerous fine sinuous ribs which are clearly developed on the ventral third of the flank but become rapidly fainter towards the umbilicus until they are barely perceptible. On the juvenile (KG.103.191; Plate If) the ornament is similar except that the ribs are straight and the dorsal half of the flank is completely smooth. Specimen KG.103.124 (Plate Id) is a fragment of *Hypophylloceras* which may or may not belong to the same species. It is only a little smaller than the larger of the above-described specimens but the ventral part of the ribbing is almost straight and not sinuous. This specimen has parts of the suture preserved (Fig. 3b); the lobes are trifurcate and the first lateral saddle

at least is tetraphyllic. An unusual feature of this suture is the asymmetrical external saddle and the ventral lobe reduced to a mere slit between the external saddle and the median leaflet.

*Remarks*

None of the specimens included here is preserved well enough for it to be identified specifically and there is also a possibility that more than one species is present. However, all have a ribbing pattern which shows general similarities to that of the *H. onoense/velledae* group. *H. onoense* is a Lower Aptian species from the west coast of North America and *H. velledae* is an Albian species from Europe and the Malagasy Republic. The fragment from Fossil Bluff, referred to by Howarth (1958, p. 3) as *Phylloceras* sp. indet., has an ornament which is similar to the above-described specimens. Examples of probable Upper Albian age, from the Lago San Martín area of Patagonia, were described by Leanza (1970, p. 200, fig. I1) under the name of *H. lestai* sp. nov. It is quite possible that at least some of the Alexander Island material may be conspecific with that species but it is too poorly preserved to make a definite identification. The unusual form of the suture in one of the present specimens (Fig. 3b) may have been due to some pathological condition but the specimen as a whole is too poorly preserved to be certain.

## Family Lytoceratidae Neumayr 1875

## Genus *Eulytoceras* Spath 1927
### *Eulytoceras* aff. *polare* (Ravn 1911)

Plate Ih–j

aff. *Lytoceras polare* Ravn, 1911, p. 485, pl. XXV, fig. 9a–c.
aff. *Lytoceras polare* Ravn; Frebold, 1935, p. 96, pl. I, figs. 1–3.
aff. *Lytoceras* sp. indet. aff. *polare* Ravn; Frebold, 1935, p. 98, pl. I, figs. 4 and 4a.
*Eulytoceras* aff. *polare* (Ravn); Thomson, 1971*b*, p. 159.
"*Lytoceras*" sp. juv. (?) *Eulytoceras* aff. *polare*; Thomson, 1971*b*, p. 159.

*Material*

Three internal and external moulds: specimen KG.1.891 from a height of 374 m. in the section at locality R, specimen KG.103.12 from a height of 175 m. at locality T and specimen KG.58.2 from locality Y. A fourth fragment (KG.2.212) from locality H may represent a very early stage of the same species.

*Description*

The most complete specimen (KG.58.2; Plate Ii) is a part external, part internal mould. The shell form is multispiral and loosely coiled with the whorls only just in contact. The body chamber of the above specimen, which is preserved as an internal mould, occupies about two-thirds of the outer whorl and probably had a rather inflated cross-section. The septate inner whorls, however, are preserved as an external mould and a latex cast of these (Plate Ij) shows them having a more compressed cross-section than the outer whorl; crushing during fossilization probably accounted for at least some of the relative decrease in whorl width. Ornament consists of fine radial threads, and strong periodic flares which are straight or gently sinusoidal and finely crinkled on their outer edges, especially when seen on the external moulds (Plate Ih). On specimen KG.58.2 this ornament is crossed by a series of very faint spiral threads but these are scarcely visible on the other two specimens. No clearly defined sutures are preserved on any of the specimens.

*Measurements*

Specimen KG.58.2 has the following dimensions: $D = 63$ mm., $u = 31{\cdot}5$ mm., $h = 18{\cdot}0$ mm.

*Remarks*

The form of the shell and the ornament of these specimens recall those of the species *Eulytoceras polare* (Ravn), and especially those examples illustrated by Frebold (1935, pl. I, figs. 1–3) from the Aptian of north-east Greenland. However, they differ from the latter in having more regularly spaced and slightly

sinuous flares. Ravn's original specimen came from a loose block but those described by Frebold were collected *in situ* and, in one case, came from the same bed as *Sanmartinoceras* (Frebold, 1935, p. 25). When Ravn (1911) discussed the affinities of *E. polare* he appears to have overlooked a similar Barremian species, *E. phestus* (Matheron). Uhlig (1883, p. 187, pl. V, figs. 1–4) described several specimens of this last species from Wernsdorf which are similar to the present examples and those from Greenland but differ in having a greater number of flares per whorl and in having a more compressed whorl section than either of the latter.

*E. mikadiense* (Krenkel, 1910*b*, p. 223, pl. XXII, fig. 5) from the Neocomian of East Africa has a more rapidly increasing whorl height and more closely spaced flares. The latter are very fine and are feebly convex towards the aperture or even straight; close to the umbilical margin they are more strongly recurved.

These specimens also resemble some of the Crioceratitidae (e.g. *Aegocrioceras* Spath and *Parancyloceras* Spath) but are readily distinguished from the latter by the complete lack of tuberculate ornament and the flares with typically lytoceratid crinkled edges.

## Genus *Lytoceras* Suess 1865
### "*Lytoceras*" spp.

**Plate Ik and l**

"*Lytoceras*" sp. α; Thomson, 1971*b*, p. 159.
"*Lytoceras*" sp. β; Thomson, 1971*b*, p. 160.

Several incomplete and poorly preserved specimens from localities H, R and W indicate that *Lytoceras s.l.* is represented in south-eastern Alexander Island by species other than the one just described. Two such specimens are described here in the hope that better-preserved comparable material will be found at a later date.

"*Lytoceras*" sp. α (Plate Il) was collected from the screes covering the small, receding cirque glacier at Fossil Bluff (locality R). It consists of a 70 mm. long non-septate fragment of an outer whorl ornamented with radial riblets spaced at intervals of 3 or 4 mm. Some of the riblets appear to be finely crenulated as is typical of many lytoceratids, and between these are indications of several very fine radial threads. Such ornament suggests possible affinities to the group of *Lytoceras sutile* Oppel.

The same fragment bears five small ovate markings which are probably the impressions of small oyster-like bivalves. The back of the slab containing the fossil has several impressions of small, finely ribbed oppeliids.

The second example, "*Lytoceras*" sp. β (Plate Ik) came from the base of the measured section at locality W, Keystone Cliffs. It is a small specimen (25 mm. in diameter) with whorls which appear to increase quickly in size, although much of the septate whorls has been destroyed by crushing. The body chamber is also crushed but an ornament of extremely fine radial threads is just perceptible; the aperture is bordered by a low rounded rib.

## Family Tetragonitidae Hyatt 1900

## Subfamily Tetragonitinae Hyatt 1900

## Genus *Eotetragonites* Breistroffer 1947
### *Eotetragonites* spp. (*?*)

**Plate IIa and b**

*Eotetragonites* sp. (?) cf. *E. wintunius* (Anderson); Thomson, 1971*b*, p. 158, fig. 3b.
*Eotetragonites* sp. (?) cf. *E. gardneri* Murphy; Thomson, 1971*b*, p. 159.

*Material*

One large internal mould (KG.10.6) from the screes at locality A and four internal and external moulds (KG.103.190, 196, 219 and 220) from between 423 and 431 m. in the section at locality T.

*Description*

All of the specimens have undergone varying degrees of distortion due to crushing so that the shape of the whorl cross-section and the true form of the coiling are not precisely known. The large specimen from locality A (Plate IIa) is multispiral and evolute with the whorls apparently slightly embracing. The septate whorls have been severely crushed but the body chamber, which occupies the last half whorl, is preserved as an internal mould and bears eight deep constrictions that are curved convexly towards the aperture and lean well forward especially in the later growth stages. Examination of the shell around the margins of the mould suggests that, on the external surface, these constrictions were only faintly impressed or may even have appeared as riblets. Between the constrictions are numerous fine lirae. The four specimens from locality T are smaller than the above example and perhaps rather more evolute (Plate IIb). They have an ornament of constrictions and lirae which are similar to those described above.

None of the specimens shows the whorl section clearly but internal moulds indicate that the whorls were inflated and had steep umbilical walls and flat flanks. On the largest specimen, at least, it appears that there was a fairly abrupt change in attitude between the flank and the ventral surface.

*Remarks*

According to Murphy (1967*b*, p. 18), Breistroffer noted that *Eotetragonites* was characterized by having constrictions of a special type and by having sutures with irregularly bifid saddles. Murphy interpreted the special type of constriction as being one which was "convex on the flank and venter with a kneelike bend at the peripheral shoulder that is convex adapically". Only one of the present specimens shows even relict suture markings and the knee-like bend of the constrictions is not clearly visible on any of them. However, on many well-preserved *Eotetragonites* this last feature is not apparent in lateral view and they may be assigned to *Eotetragonites* because of their evolute shell and squarely inflated whorls with sloping convex constrictions and because of their close resemblance to known species; *E. wintunius* (Anderson), *E. gardneri* Murphy and *E. balmensis* Breistroffer. Because of their difference in size, it is difficult to compare the specimens from the two localities especially as the inner whorls of the largest specimen (KG.10.6) are poorly preserved. The more evolute appearance of the smaller specimens from locality T could be due to differences in preservation and all of the examples described above could be regarded as belonging to the same species. However, M. A. Murphy, University of California, kindly examined photographs of the two best specimens (Plate IIa and b; one each from localities A and T, respectively) and he suggested that they may belong to different species.

The larger specimen from locality A (Plate IIa) resembles *E. wintunius* (cf. Murphy, 1967*b*, pl. 3, figs. 4–6) from the Gargasian or possibly Clansayesian of California but the inclination of the constrictions is more like that of the French Albian species *E. balmensis* (cf. Murphy, 1967*a*, pl. 3, figs. 1–5 and 8–11, pl. 4, figs. 9–11); the smaller specimen (Plate IIb) appears to be most closely related to *E. gardneri* (Murphy, 1967*a*, pl. 1, figs. 6–9) from the Upper Aptian (Clansayesian) of California. *E. wintunius* further differs from *E. balmensis* in being more evolute and in having a quadrate, rather than a rounded, whorl section and in this respect it is closer to the Antarctic specimen (KG.10.6). The latter, however, lacks the strong lirate ornament on the venter, ventral shoulder and umbilical shoulder which is typical of *E. wintunius*.

## Family Bochianitidae Spath 1922

### Subfamily Bochianitinae Spath 1922

### Genus *Bochianites* Lory 1898

*Bochianites gracilis* sp. nov.

Plate IIc and f

*Bochianites* sp. nov., Thomson, 1971*b*, p. 158.

*Material*

One rock fragment from 431 m. above the base of the section measured at locality Z and bearing several pieces of internal mould from one fragmented individual (KG.402.85); some of the shell is still preserved.

*Diagnosis*

Shell delicate, acicular; cross-section circular except in very earliest stages where it is depressed. Protoconch barrel-shaped. Ornament of faint, prorsiradiate, periodic ribs which are more strongly marked on venter. Suture with broad, blunt saddles.

*Description*

This is a small delicate species having a long, straight slender shell with a circular cross-section at all but the initial stages of growth. The largest fragment (Plate IIc) is entirely septate but probably represents the anterior end of the phragmocone since the close proximity of the various fragments suggests that the specimen is one fragmented individual whose various pieces have not been widely scattered. The mould is smooth apart from periodic prorsiradiate ribs which are most strongly marked on the ventral half and are almost non-existent on the dorsum; in front of each of these ribs is a shallow constriction. On the external surface of the test the ornament appears to be less clearly marked. The ventral lobe of the suture is obscured but the trifurcate lateral and umbilical lobes and the two broad, blunt bifid saddles conform to the general *Bochianites* pattern.

A minute fragment (Plate IIf) associated with the above mould represents the earliest growth stages of this species and still has the protoconch attached. The protoconch is barrel-shaped and consists of about one complete volution. The initial part of the phragmocone, which here has a depressed cross-section, is broken away to reveal the last septum of the protoconch but its trace on the outside of the whorl is scarcely visible.

*Measurements*

The largest fragment (Plate IIc) is 14 mm. long, 2·9 mm. in diameter at its narrower end and 3·4 mm. in diameter at its wider end. Close to the protoconch the shell is only 0·24 mm. in diameter. Calculations based on these measurements suggest that the shell tapered very gradually at about 2° and that the original length of the phragmocone was about 90 mm.

*Remarks*

Delga (1954) divided *Bochianites s.l.* into three distinct genera, differentiated by means of their sutures. *Bochianites s.s.* has a sutural type typified by that of *B. neocomiensis* (d'Orbigny) (1840–42, pl. 138, fig. 4) which has two broad, blunt bifid saddles, a bifurcate ventral lobe, a trifurcate lateral lobe and a trifurcate dorsal lobe; *Janenschites* Delga has more elongate and more denticulate sutural elements and *Kabylites* Delga has three (not two) bifid saddles. The suture of the present example indicates affinities with *Bochianites s.s.* Comparable species include *B. glaber* Kitchin (1908, p. 181, pl. VIII, figs. 20 and 21) from the Neocomian Uitenhage Formation of South Africa and *B. paskentaensis* Anderson (1938, p. 167, pl. 29, fig. 10) from the Valanginian of the west coast of North America. *B. glaber* differs from *B. gracilis* sp. nov. in its almost complete lack of ornament and its compressed whorl section, also the measurements given by Kitchin suggest that the African species has a slightly less tapered shell. *B. paskentaensis* has ornament on the external surface of the test and not on the internal mould which is rather the opposite of the ornamentation in *B. gracilis*; it also has a more narrowly tapered shell.

## Family Macroscaphitidae Hyatt 1900

## Genus *Costidiscus* Uhlig 1882

### *Costidiscus* (*?*) sp.

Plate IId

*Costidiscus* (*?*) sp.; Thomson, 1971*b*. p. 158.

*Material*

One incomplete external mould (KG.8.60) from a height of 230 m. in the stratigraphical section measured at locality B, and a second very poorly preserved fragment (KG.8.61) from the same level which may belong to the same species.

*Description*

The best specimen comprises about three and a half whorls of an individual which must have had an original maximum diameter of about 40 mm., although now most of the outer whorl is broken away (Plate IId, dotted line). The coiling of the shell is evolute such that the apertural end of the outer whorl appears to be barely touching the penultimate one. The flanks of the whorls are feebly convex and there is a short, steep umbilical wall; the venter is nowhere preserved. Ornament consists of numerous fine straight ribs, most of which are bundled in twos or threes at a row of umbilical tubercles but there are a few which remain simple and extend on to the umbilical wall. About half-way round the outer whorl, the ribs are less distinct and curve forward near the venter, but both of these features are probably due to poor preservation rather than being original. The most anterior fragment of external mould (? the body chamber) is also poorly preserved but here it appears that the tubercles are relatively much coarser and the ribs are less well defined.

*Remarks*

The evolute coiling and the bundled straight ribbing of this specimen recall those of the species *Costidiscus nodosostriatus* (Uhlig, 1883, p. 197, pl. IX, figs. 2–4) except that the present specimen is smaller than Uhlig's examples and has three rather than two ribs bundled at each tubercle. The known distribution of this genus is largely confined to the Barremian and Lower Aptian of Europe and Sinai (Wright *in* Arkell and others, 1957, p. *L*205) but a doubtful specimen of *C.* aff. *recticostatus* (d'Orbigny) has been recorded from Mexico by Burckhardt (1912, p. 197, pl. XLVI, figs. 8 and 10).

## Genus *Macroscaphites* Meek 1876

### *Macroscaphites* (*?*) sp.

**Plate IIg**

*Macroscaphites* (*?*) sp.; Thomson, 1971*b*, p. 160.

*Material*

One incomplete and poorly preserved external mould (KG.106.37) from 143 m. above the base of the section measured at locality W, Keystone Cliffs.

*Description*

This incomplete specimen (Plate IIg) is a 33 mm. diameter impression of a crushed, evolute multispiral shell whose final section of outer whorl appears to be straightening out. The whorl flanks bear periodic constrictions, the most pronounced of which occurs just before the straighter section of shaft, and between these is a series of sharp, closely spaced radial ribs. Some ribs are simple but others are paired at a row of ventro-lateral tubercles; less frequently the ribs bear umbilical tubercles at which they may also be paired or even looped. The specimen is too poorly preserved to ascertain if there is any set pattern to this ornament.

*Remarks*

The apparent straightening out of the outer whorl, with the possibility that it may have become detached from the main spire, and the unusual ornament suggest affinities with some species of *Macroscaphites* Meek. The presence of ventro-lateral as well as umbilical tubercles suggests a relationship to the Barremian species *M. binodosus* Uhlig (1883, p. 207, pl. IX, fig. 7) but the ribbing is finer and more regular on the last species. Coarser ribbing and umbilical tubercles on many of the ribs are found in the species *M. yvani* Puzos.

## Family Crioceratitidae Wright 1952

### Subfamily Crioceratitinae Wright 1952

## Genus *Emericiceras* Sarkar 1954

### *Emericiceras* (*?*) sp.

**Plate IIe; Fig. 4a**

*Emericiceras* (*?*) sp.; Thomson, 1971*b*, p. 159, fig. 3h.

*Material*

Four fragments (KG.103.127, 130, 131 and 132) from locality T, all from the same bed 195 m. above the base of the measured section.

*Description*

The best example (KG.103.132; Plate IIe) consists of almost one complete volution of a small, openly coiled *Crioceratites*-like heteromorph. The whorl height increases only gradually and, although the specimen is now partly flattened, it appears that the cross-section was ovate. On the first half whorl the shell is ornamented with stout rounded ribs bearing lateral and ventro-lateral tubercles; the interspaces are smooth or may be ornamented with up to two non-tuberculate ribs. Closer to the aperture the tuberculate ribs are furnished with a third tubercle placed in a low dorso-lateral position. Some of the better preserved tubercles are distinctly spinose. Numerous fine growth lines are present on the last third of the whorl.


FIGURE 4

a. *Emericiceras* (*?*) sp. Suture; locality T, ×10 (KG.103.127).
b. "*Ancyloceras*" *patagonicum* Stolley. Suture of lectotype (Stolley, 1912, pl. 1, fig. 3); ×3. (Riksmuseum, Stockholm No. Mo.117877.)

A second specimen (KG.103.127) is a counterpart of the one described above and, at a position equivalent to about one-third of the distance round the spire, it bears clear traces of the suture (Fig. 4a). This is incomplete but it has a well-dissected form even at such a small size.

*Measurements*

Specimen KG.103.132 has a diameter of 26·5 mm.; the height of the whorl increases from nearly 2 mm. at the beginning of the preserved spire to 6 mm. at the aperture.

*Remarks*

It has not been possible to identify these specimens with any degree of certainty but they appear to be allied to a group of essentially Upper Neocomian ammonites which Sarkar (1955, p. 74) separated from the genus *Crioceratites* Leveillé under the name of *Emericiceras*. The latter was differentiated from the former by having more numerous and more prominently tuberculate ribs and fewer intermediary ribs. In particular, the present examples most closely resemble a specimen identified by Sarkar (1955, p. 93, pl. VII, fig. 1) as *E.* cf. *thiollieri* (Astier) but differ in having fewer intermediary ribs (0–2 as opposed to 2–3). *E. ottohaasi* var. *tuberculata* (Sarkar, 1955, p. 95, pl. VI, fig. 6) has an early stage with few but prominent intermediary ribs, although soon from three to six are present between each pair of trituberculate ones. Sarkar (1955, p. 75) gave the stratigraphical range of this genus as "Barrémien, rarement Hauterivien" but elsewhere (Sarkar, 1955, p. 26, table 2) he clearly indicated the persistence of two species, *E. lardyi* (Ooster) and *E. ottohaasi*, into the Lower Aptian.

An alternative possibility that these might represent the early stages of *Ancyloceras* is thought less likely on account of their slowly expanding whorls, their probable rounded as opposed to angular cross-section and the positioning of the dorso-lateral tubercles very low on the flank, a feature of the Crioceratitidae (Casey, 1960, p. 18).

SUBFAMILY UNCERTAIN

## Genus *Pseudothurmannia* Spath 1923

### *Pseudothurmannia* cf. *mortilleti* (Pictet and Loriol 1858)

Plate IIi and j

For early synonymy see Sornay, 1968, p. 4.
cf. *Pseudothurmannia mortilleti* (Pictet and Loriol); Sornay, 1968, p. 4, pl. I, fig. 1.
*Pseudothurmannia* cf. *mortilleti* (Pictet and Loriol); Thomson, 1971*b*, p. 160, fig. 3i.

*Material*

One adult specimen (KG.106.41) and a juvenile (KG.106.40) from locality W, Keystone Cliffs, 153 m. above the base of the measured section.

*Description*

The shell (Plate IIi and j) is evolute and paucispiral with the whorls only slightly embracing. The whorls are high and have flat flanks, a steep umbilical wall and a venter which appears to be bluntly rounded, although it is crushed and largely obscured in the fossil. Ornament consists of numerous gently falcate ribs that are bundled in twos, or sometimes threes, at a row of small umbilical bullae. Between the bundled ribs there are usually one or two intercalated ribs which taper and terminate a little short of the umbilical margin. The juvenile (KG.106.40) has falcate ribs from a diameter of about 10 mm. but on the innermost whorls the ribs appear to be almost straight. The suture is not preserved.

*Remarks*

The adult specimen is similar to examples of *Pseudothurmannia mortilleti* (Pictet and Loriol) from Majorca described by Wiedmann (1962). The author is indebted to J. Wiedmann for examining a latex cast of specimen KG.106.41 and confirming its general similarities to *P. mortilleti*, except for the more sinuous ribs in the present species. Close similarities to the lectotype of *P. mortilleti* (Sarasin and Schöndelmayer, 1901, pl. 11, fig. 5) were noted from an examination of a plaster cast kindly supplied by J. Wiedmann. This is the first record of the genus *Pseudothurmannia* in the Southern Hemisphere.

## Genus *Hemihoplites* Spath 1924

### *Hemihoplites* (*?*) sp.

Plate IIh

*Hemihoplites* (*?*) sp.; Thomson, 1971*b*, p. 160.

*Material*

One external mould (KG.106.34) and its counterpart from the screes 146 m. above the base of the section measured at locality W.

*Description*

The specimen (Plate IIh) is not very well preserved but has a distinctive ornament which permits a tentative identification. The shell is evolutely coiled and has flat-sided whorls which have an ornament of fine wiry ribs. On the inner whorls the ribs are straight, closely spaced and tuberculate at the umbilical margin; some ribs appear to be paired at the umbilical tubercles. Half-way round the outer whorl the ribs are falcoid, tuberculate at their umbilical extremities and more widely spaced. Long intercalated ribs, which terminate a little short of the umbilical margin, are occasionally present and a few ribs are again paired at the umbilical tubercles. On the latest stage of the outer whorl the ribs are almost straight or slightly convex. The suture is incompletely preserved but it can be established that the lobes are trifurcate and the saddles broad and fairly complex; there appear to be no auxiliary elements.

*Remarks*

The evolute coiling and the irregular pattern of the ornament on this specimen recalls those of the species *Hemihoplites soulieri* (Matheron) (cf. Arkell and others, 1957, fig. 241, 2a), although the ribbing is

coarser on the latter. The venter on the present specimen is obscured and it is not possible to determine whether it is flattened as is typical in *Hemihoplites*. The suture with its trifurcate lobes and probable lack of auxiliary elements is also in accordance with the tentative placing of the specimen in the genus *Hemihoplites*.

The uncertain subfamilial position of the above two genera indicated here is due to the conflicting opinions expressed in recent papers, and the consideration that it would be unwise to criticize these opinions too closely on the evidence of three incomplete specimens from the Antarctic. Wright (*in* Arkell and others, 1957, p. *L*212) included *Pseudothurmannia* in the family Hemihoplitidae Spath within the superfamily Ancyloceratacea; an apparently similar genus, *Balearites* Sarkar, he included in the subfamily Crioceratitinae. Wiedmann (1962), on the contrary, regarded *Balearites* as a synonym of *Pseudothurmannia* and classified the latter as a subgenus of *Crioceratites* Leveillé. His reasons for including the Hemihoplitidae within the Crioceratitinae were based largely on features of the genus *Pseudothurmannia*. More recently Sornay (1968) has argued that *Balearites* and *Pseudothurmannia* are really distinct and that the latter should be generically separate from *Crioceratites*, although "le placement de *Pseudothurmannia* par L. F. SPATH dans une famille indépendente de celle des *Crioceratidae* était peut-être abusif".

There can be little doubt of the close crioceratitid affinities of Spath's Hemihoplitidae as was noted by Wright (*in* Arkell and others, 1957, p. *L*212) even though he placed the two groups in separate families. The author favours Wiedmann's inclusion of *Balearites* as a synonym of *Pseudothurmannia* but is undecided as to the exact placing of the hemihoplitids. In a morphological classification of the Ammonoidea, the inclusion of *Pseudothurmannia* as a subgenus of *Crioceratites* seems a little cumbersome when the latter is already a morphologically diverse genus. Perhaps the hemihoplitids as a group might be considered as a subfamily of the Crioceratitidae in any further attempt at a classification of the heteromorph ammonites.

## FAMILY ANCYLOCERATIDAE MEEK 1876

Casey (1960, p. 12) has already remarked on the difficulties of producing a sound classification of the heteromorph ammonites, largely because of the fragmentary condition in which many of the species are found. He modified the classification of the Ancyloceratinae as used by Wright (*in* Arkell and others, 1957) and elevated the group to full family status. The Crioceratitidae were regarded as a separate family. Two subfamilies were recognized within the Ancyloceratidae:

Ancyloceratinae—large shells with coarsened sculpture on the body chamber

Helicancylinae—small and with simplified body chambers.

*Uhligia* Koenen and *Dirrimoceras* Hyatt were removed to the Heteroceratidae and *Aspinoceras* Anderson and *Tonoceras* Hyatt were also excluded. Manolov (1962, p. 529) modified Casey's classification further by separating off *Leptoceras* Uhlig from the Helicancylinae and including it in a new subfamily, the Leptoceratinae, together with *Eoleptoceras* Manolov, *Karsteniceras* Royo y Gomez and *Veleziceras* Wright.

Any genetic merits which this resultant classification may or may not have are open to discussion but, because it reduces the Ancyloceratidae to a number of subfamilies which have a reasonable degree of *morphological* homogeneity, it is of particular use when dealing with faunas of fragmented heteromorphs and is therefore adopted here. A similar revision of the Crioceratitidae might also be beneficial.

## SUBFAMILY ANCYLOCERATINAE MEEK 1876

### Genus *Lithancylus* Casey 1960

*Lithancylus* (*?*) sp.

Plate III

*Lithancylus* (*?*) sp.; Thomson, 1971*b*, p. 159.

*Material*

One incomplete internal mould (KG.103.232) from the screes at locality T, Waitabit Cliffs. The back of the specimen bears an example of the brachiopod *Discinisca variabilis* Thomson, at this locality known only from the sedimentary rocks 193–206 m. above the base of the measured section.

*Description*

The specimen (Plate III) is part of the internal mould of a long straight section of shaft with fragments of the test adhering to it. Ornament on the external surface of the shell consists solely of numerous, relatively fine, oblique ribs and on the internal mould these are less strongly marked. There appears to be a very gradual increase in the size of the ribs on the later part of the shaft. On the earlier part of the shaft the internal mould shows clear but incomplete suture markings (Plate III); these have a distinct ancyloceratid pattern with the individual folioles supported on zig-zag stems.

*Remarks*

When Casey (1961*a*, p. 70) reviewed the occurrences of his new genus *Lithancylus*, its known distribution was confined to the Barremian and Aptian of the Northern Hemisphere (i.e. England, the Tyrol and California) but its presence has recently been noted in the Southern Hemisphere (Upper Aptian of Queensland) by Day (1967). A small fragment from the Aptian of Argentina was subsequently referred to this genus under the name of *L. guanacoensis* by Leanza (1970, p. 204, fig. III, 1–4).

Although the sutures of the present specimen are not well enough preserved to show the extreme formation of zig-zag stems described by Casey (1961*a*, p. 70; text-fig. 27a), the length and straightness of this piece of shaft make it unlikely that it belongs to any other of the large ancyloceratids. The ornament of the Queensland species, *Lithancylus australis* Day (1967, pl. 2), is coarser than that on the present specimen and in this respect the latter is more like the earlier part of the shaft in *L. grandis* (Casey, 1961*a*, pl. XX, fig. 1a).

### Large ancyloceratids

Plate IIk and m

Apart from the above fragmentary example of *Lithancylus* (*?*) sp., described in detail because of its interest value, fragments of other large ancyloceratids occur frequently at some localities and especially along the length of Waitabit Cliffs. At certain times they must have formed an important part of the fauna but their incomplete preservation in the fossil state prevents them from being satisfactorily identified. Two of the better-preserved fragments are briefly described here for the sake of completeness.

The first (Plate IIm) from locality A, Succession Cliffs, is an internal mould of an arcuate piece of a whorl bearing numerous, closely spaced, slightly sinuous ribs. The whorl section is oval, the flanks are only feebly convex and there is no impression of an inner whorl on the dorsum. The suture is incomplete but it shows a complex and rather wide first lateral lobe. This fragment appears to come from a loosely coiled specimen and the ornament recalls that seen on some species of *Australiceras*; it could thus be interpreted as the outer whorl of a crioceratitid *Australiceras* or as the last part of the spire from an ancyloceratid form. With regard to ancyloceratid species, the ornament on the present fragment is similar to that on species of the *A. gigas* group (Casey, 1961*a*, pl. XI–XIV), and with regard to crioceratitid forms, it is similar to that on *Australiceras* (*?*) *leptus* (Etheridge, 1909, p. 143, pl. XXX, figs. 1–3) from Queensland or perhaps that on *A. rabenjanharyi* from the Clansayesian of the Malagasy Republic (Collignon, 1962*b*, pl. CCXXVI, fig. 969).

A second specimen (Plate IIk) from locality V, southern Waitabit Cliffs, differs from the above example in its more rapidly increasing whorl height and its finer straighter ribbing. The ornament on this fragment recalls that seen on some species of *Tropaeum* Sowerby (e.g. T. *drewi* Casey, 1960, p. 35, pl. VIII, fig. 1; or better *T. bowerbanki* Sowerby var. *densistriatum* Casey, 1960, p. 30, pl. VI, fig. 1) but this identification is very tentative. The whorl height appears to increase more rapidly than is normal for the genus and the large (?) first lateral lobe is unusually close to the dorsum.

### Subfamily Helicancylinae Hyatt 1894

### Genus *Toxoceratoides* Spath 1924

*Toxoceratoides* sp. nov.

Plate IIIa and d

*Toxoceratoides* sp. nov.; Thomson, 1971*b*, p. 159.

*Material*

Two moulds from the screes of locality T and believed to have come from beds 219·5–230 m. above the base of the measured section; specimen KG.103.233 shows the final hook and specimen KG.103.226 the initial curve. A third specimen (KG.103.122) may also belong to the same species.

*Description*

The final hook is represented by part of an internal mould of a crushed specimen (Plate IIIa); it is tightly bent and ornamented with fine wiry ribs which are prorsiradiate on the shaft and radially sinuous on the bend. Only the dorsal part of the shaft is preserved and here most of the ribs bear a small tubercle in the dorso-lateral position. The ribs are crowded around the hook and they appear either to have bifurcated from minute dorso-lateral tubercles or else the major ribs are alternated with long intercalated ribs which terminate close to the tubercles. On the shaft some of the ribs appear to be composed of two closely juxtaposed ones on the ventral side of the dorso-lateral tubercles. These unusual double ribs suggest a relationship between this specimen and a second J-shaped fragment (KG.103.226; Plate IIId), believed to represent the early stages of the same species. This fragment is ornamented with ribs, many of which appear double in the later stages, and fine growth lines. At first the ribs are relatively thick and radial but later they become finer and prorsiradiate. In the early stages, ribs bearing perhaps two tubercles are separated by one or two non-tuberculate ones; later the major ribs are trituberculate and are separated by other ribs which are non-tuberculate or have ventro-lateral tubercles only. The ventro-lateral tubercles at least are moderately spinose but the dorso-lateral ones are only weakly developed.

*Remarks*

The fragment of the final hook compares favourably with an example from the Lower Aptian of northern Germany figured by Koenen (1902, pl. XLI, fig. 10b) as *Ancyloceras ? biplex* except that there does not appear to be any trend towards double ribbing in the latter and the ornament is probably coarser on the Alexander Island specimen. Similar differences can be found with a fragment from the Lower Aptian of Kent illustrated by Casey (1961*a*, pl. XX, fig. 6) as *Toxoceratoides* cf. *biplex* (Koenen). The delicate ornament and periodic tuberculate ribs of the J-shaped fragment are typical of species of *Toxoceratoides* (for example, cf. *T. royerianus* and *T. emericianus*, d'Orbigny, 1840–42, pl. 118, fig. 7, pl. 120, fig. 5, respectively) but it differs from all previously described species by the peculiar double form of the ribs.

Because of the deficient preservation of the material available, this species is not formally described under a new name.

Previous records of *Toxoceratoides* in the Southern Hemisphere are confused. Casey (1961*a*, p. 78) noted that it occurs in East Africa but that the Australian species, *Ancyloceras taylori* Etheridge, which was referred to *Toxoceratoides* by Whitehouse (1926, p. 216), was doubtful. Casey suggested that Krenkel's (1910*a*, pl. XVII, figs. 12 and 13) East African *Ancyloceras royerianum* was too coarsely ribbed on the final bend for reference to *T. royerianus* (d'Orbigny) but was perhaps more closely allied to the so-called "cf. *Tonohamites royerianus*" from Portuguese East Africa described by Haughton and Boschoff (1956, pl. II, fig. 3). In a more recent paper, Wachendorf (1967, p. 281) assigned Haughton and Boschoff's specimen to *Acrioceras dissimilis* (d'Orbigny) along with three other fragments from southern Moçambique. Specimens from Moçambique assigned to *T. royerianus* by Wachendorf (1967, pl. 35, figs. 1, 4 and 5) are much more coarsely ribbed than any of the other specimens of this species with which they were compared and it is doubtful whether those specimens can be satisfactorily referred to the genus *Toxoceratoides*. According to Casey (1961*a*, p. 77), the final hook on *Toxoceratoides* has "close, narrow, sharp ribbing which bifurcates or trifurcates irregularly from an umbilical tubercle"; the Moçambique specimens have coarse trituberculate ribs which spring from every third one of a series of fine ribs on the dorsum.

A possible occurrence of *Toxoceratoides* in Patagonia is the *Leptoceras* sp. ind. of Bonarelli (*in* Bonarelli and Nágera, 1921, p. 19, fig. 4) which came from a loose block in the bed of Río Fósiles at the northern end of Bahía de la Lancha, Lago San Martín. The illustration is not a good one but it shows an imperfectly preserved heteromorph with labeceratid coiling and an ornament similar to that of *Toxoceratoides*. The shaft is ornamented with strong prorsiradiate triangular ribs, which appear in the figure to bear small tubercles, alternated with pairs of finer sharp ribs. On the hook, the ribs are all of the same size and non-tuberculate except perhaps near the dorsal margin where several appear to be bundled in pairs. Bonarelli

believed that the specimen came from the beds with "*Crioceras*" (? Upper Neocomian). Leanza (1970, p. 206) has referred this same specimen to the genus *Acrioceras* under the new specific name of *A. nagerai.*

## Genus *Acrioceras* Hyatt 1900 emend. Sarkar 1955
### *Acrioceras* (*?*) aff. *voyanum* Anderson 1938

Plate IIIb, e and f

aff. *Acrioceras voyanum* Anderson, 1938, p. 206, pl. 59, fig. 1.
aff. *Acrioceras voyanum* Anderson; Imlay, 1960*a*, p. 198, pl. 26, figs. 2–4.
*Acrioceras* (*?*) aff. *voyanum* Anderson; Thomson, 1971*b*, p. 159, fig. 3j.

*Material*

Three external moulds from locality R; specimen KG.1.782 was collected 309·5 m. above the base of the measured section, and specimens KG.1.714 and 801 came from the screes.

*Description*

The coiling of the shell is ancyloceratid to aspinoceratid (Plate IIIe); the early whorls (Plate IIIf) form an open spiral of about two and a half whorls and then pass into a straight shaft which terminates in an openly bent hook. The whorls of the spire increase rapidly in size and then, after the commencement of the shaft, the increase in whorl height is minimal. The only indications of the shape of the shell cross-section are preserved on the outer whorl of the initial spire (KG.1.782; Plate IIIb), where it is high and narrow with almost flat flanks, a steep umbilical wall and a narrowly arched venter. Ornament on the spire begins with a series of broad trituberculate ribs which are later separated from each other by up to three straight non-tuberculate wiry ones. The tubercles are borne in the dorso-lateral, ventro-lateral and ventral positions, those in the ventral position being markedly spinose. After about one and a half to two volutions only wiry ribs remain. Many of these are joined in twos and threes at small umbilical bullae and then cross the dorsal surface as a single enlarged rib; each rib-bundle is separated from the next by a long, radiate simple rib which may or may not cross the dorsum. All of the ribs cross the venter. On the shaft all but the earliest few ribs are simple and prorsiradiate; some may bear insipient dorsal tubercles. Round the final hook they become more widely spaced and assume a radiate attitude with the result that a few are paired at the dorsal margin and others terminate on the dorsal half of the flank. The suture is not known.

*Measurements*

The maximum length of specimen KG.1.714 from spire to hook is 75 mm., the distance across the final hook is 45 mm., and the diameter of the spire (KG.1.782) is 33 mm.

*Remarks*

With reservations, it is thought best to include the present specimens in the genus *Acrioceras* Hyatt *s.l.*, although it has been differently interpreted by various authors. Sarkar (1955, p. 100) emended Hyatt's genus and re-defined it in very broad terms to include the following as subgenera: *Acrioceras* Hyatt *s.s.*, *Paraspinoceras* Breistroffer, *Aspinoceras* Anderson and *Paracrioceras* Sarkar. Wright (*in* Arkell and others, 1957, p. *L*211) used a more restricted definition of the genus; he excluded the last three subgenera and yet included *Dissimilites* Sarkar which has a long *Hamites*-like recurved limb. The present specimens fall within the broad limits set by Sarkar (1955) but the disappearance of trituberculate ribs before the end of the spire, rather than somewhere on the shaft, differentiates them from all of the species included by Sarkar with the possible exception of *Ancyloceras meriani* Ooster.

Perhaps the most similar described species is *Acrioceras voyanum* Anderson (1938, p. 206, pl. 59, fig. 1) from the Hauterivian of the Pacific coast states of North America. The spire on Anderson's specimen is incomplete and it does not show the stage with bundled ribbing as on the present example, but the initial part of the spire, with its periodic trituberculate ribs, and the ornament on the shaft compare tolerably well. A specimen from Oregon, attributed to this species by Imlay (1960*a*, p. 198, pl. 26, figs. 2–4), has dorsal tubercles on the shaft at which some of the ribs appear to be paired; there are also faint ventral tubercles and the ribbing is rather denser than on the Antarctic specimens.

A second species which shows a moderate degree of similarity to the present one is "*Ancyloceras*" *meriani* (Ooster, 1860, p. 35, pl. 39, figs. 1–7) from the Upper Hauterivian and Barremian of Europe (Sarkar, 1955, p. 26, table 3). It differs in having whorls which are still appreciably increasing in size along the length of the shaft (cf. Ooster, 1860, pl. 39, figs. 1 and 2) and in having a proportionally longer shaft. Although the ornament on the initial part of the spire on the present species is incompletely preserved, the ornament of the European and Antarctic species appears to be basically the same; Ooster's examples differ slightly in having fewer prorsiradiate ribs on the shaft and in having ribs which are less frequently paired at the dorsal margin.

The collection of better material from Alexander Island will almost certainly warrant the inclusion of the present material in a new species and perhaps even a new genus.

## Genus uncertain
## Group of "*Ancyloceras*" *patagonicum* Stolley 1912

Plate IIIc, g and h

*Ancyloceras patagonicum* Stolley, 1912, p. 11, pl. I, figs. 2 and 3.
*Ancyloceras patagonicum* Stolley; Piatnizky, 1938, p. 80, pl. VI, figs. 31 and 32.
*Ancyloceras patagonicum* Stolley; Howarth, 1958, pl. I, fig. 4.
Heteromorphs of the "*Ancyloceras*" *patagonicum* Stolley group; Thomson, 1971*b*, p. 159.

At three localities (B, T and W) in south-eastern Alexander Island, fragments of heteromorph ammonites have been collected of a type which was identified by Piatnizky (1938, p. 80) and Howarth (1958, p. 4) as *Ancyloceras patagonicum* Stolley. The specimens (Plate IIIc, g and h) are believed to come from different stratigraphical levels but they have a number of features in common:

i. All bear strong ribs which are prorsiradiate on the shaft and radial on the hook.
ii. The shaft sections are all gently curved, suggesting aspinoceratid coiling.
iii. Each rib bears a ventral tubercle and sometimes another in a high ventro-lateral position.
iv. The hook has not been fully preserved but the anterior ends of the more complete shafts appear to have started bending over in an open curve.

Sometimes the specimens may be differentiated from each other by variations in the size and density of the ribbing and by the prominence of the tubercles, of which the ventro-lateral is often very faint.

Specimen KG.106.24 (Plate IIIg) compares favourably with the example from the southern end of Succession Cliffs (locality B) illustrated by Howarth (1958, pl. I, fig. 4). Both have rounded ribs which are only feebly tuberculate, the present example probably having ventral tubercles only, although that from Succession Cliffs appears to have ventro-lateral tubercles as well, and both have a quadrate whorl section with flat flanks. Other examples from locality T (Plate IIIc) differ in having sharper, more widely spaced ribs, gently convex flanks and perhaps a more rounded cross-section. Yet another specimen from locality W (Plate IIIh), which has faint ventral tubercles only, is almost identical to one of the two fragments illustrated by Piatnizky (1938, pl. VI, fig. 32) from Río Cardiel in Argentine Patagonia. Because the initial spire of none of these specimens is known and because of their fragmentary preservation, it is difficult to assess exactly how many species are present and how far any of them really compares with the true "*Ancyloceras*" *patagonicum* Stolley. Until better material is found which will enable these fragments to be differentiated and identified more precisely, it is thought best to place them together in a group which is probably allied to Stolley's "*Ancyloceras*" *patagonicum*.

Further problems arise because Stolley designated no holotype. The original description of *Ancyloceras patagonicum* was based on two specimens, one of which was a spindly J-shaped piece of shaft and the other a stout U-shaped fragment comprising the anterior part of the shaft and the hook. Stolley (1912, p. 12) admitted that these two might belong to two separate species. After examining the original specimens, the author is of the opinion that this is so and furthermore that, with the now accepted sub-division of so-called *Ancyloceras* into many separate forms, Stolley's two fragments probably belong to different genera. It is therefore necessary to select a lectotype and, because the large U-shaped fragment is better preserved, shows the sutures and corresponds most closely to the fragments which have been judged to be conspecific with this species (Piatnizky, 1938; Howarth, 1958), this specimen (Stolley, 1912, pl. I, figs. 3 and 3a; Riksmuseum, Stockholm No. Mo.117877) is chosen.

While some authors have accepted the generic position of "*Ancyloceras*" *patagonicum* without comment, others have questioned it. Whitehouse (1926, p. 229) noted that in the Upper Aptian there is a group "typified by *Ancyloceras patagonicum* Stolley which also has ventro-lateral tubercles only. This group extends into the Lower Albian at least to the *mammillatum* zone . . .". Unfortunately, he did not say which he thought the other members of the group were and his statement further suggests that *A. patagonicum* is an Upper Aptian species, a proposition for which there is questionable evidence; Stolley suggested that it probably indicated an Upper Neocomian or Lower Aptian horizon. Leanza's (1970, p. 206, 257) suggestion that one of Stolley's original specimens also had a *Sanmartinoceras* in the adhering matrix, is not confirmed by examination of the actual material. The "*Sanmartinoceras*" (= ? *Oppelia* (*Adolphia*) sp., Stolley, 1912, p. 14) is very poorly preserved and cannot be more precisely identified than probably being some form of oppeliid.

Anderson (1938, p. 215) believed that the fragments included by Gabb in his species *Helicancylus* belonged to more than one genus. He therefore restricted the name *Helicancylus* to one spirally coiled fragment and included the remainder in a new genus, *Hamiticeras*, which had the outward aspect of *Hamites* Parkinson, *s.s.* but had trituberculate ribs and trifid sutural lobes which seemed to place them among the Ancyloceratidae. He suggested that *A. patagonicum* Stolley might also belong to this genus and in particular noted its similarity to *Hamiticeras philadelphium*. Casey (1961*a*, p. 77) has pointed out that, because of nomenclatorial complications, *Hamiticeras* Anderson is a subjective synonym of *Helicancylus* Gabb.

Whitehouse's (1926) remark about the presence of ventro-lateral tubercles only in his *A. patagonicum* group (above) is interesting because Stolley noted the presence of trituberculate ribs in his species. Reference to the lectotype shows that each rib has a distinct tubercle on the ventral shoulder and another in a ventro-lateral position but that the third so-called tubercle is very indistinct. It occurs in a low dorso-lateral position and is formed at a change in slope between the flat flank and the rounded dorsum; as the whorl section becomes more inflated and rounded on the hook, this feature disappears.

The lectotype has several well-preserved sutures which Stolley alluded to briefly but unfortunately did not illustrate. These sutures (Fig. 4b) are relatively simple and have two broad bifid saddles which are separated by a deep trifid first lateral lobe, a ventral lobe bisected by a small square median leaflet, and a trifid dorsal lobe. In contrast, the suture of "*Hamiticeras*" is more complex and has a narrow external saddle, a broad trifid first lateral lobe and a slightly smaller second lateral lobe (Anderson, 1938, pl. 79, fig. 6).

The small size, complete lack of intermediary ribs, feeble development of trituberculation and simplification of ornament on the hook exclude *A. patagonicum* and its Antarctic allies from the genus *Ancyloceras* d'Orbigny 1842 and place them in the subfamily Helicancylinae Hyatt. A comparison of sutures suggests that their affinities to *Hamiticeras* Anderson [= *Helicancylus* Gabb] are doubtful and it is difficult to find any well-known species at all with which to compare them. Stolley suggested comparisons with *A. fustiforme* Koenen, which is more like his smaller fragment and is now classified as a *Toxoceratoides*, and *A. obovatum* Koenen which is more like the lectotype but is not a true *Ancyloceras*. In all probability the "*Ancyloceras*" *patagonicum* group represents a hitherto undescribed genus.

### Family Uncertain

## Genus *Antarcticoceras* gen. nov.

This new genus is represented by six, possibly seven, specimens all of which may be included within the one new species. Specimens have been collected from two localities in south-eastern Alexander Island (locality B, Succession Cliffs, and Stephenson Nunatak), and available evidence (p. 37) suggests that at locality B they occur in sediments of probable Lower Albian age. The type species is *Antarcticoceras anatarcticum* sp. nov. described below.

*Diagnosis*

Shell coiled on the crioceratitid pattern and of small to moderate size for a heteromorph ammonite (the largest specimen has a diameter of 70 mm.). Whorls slowly expanding, inflated to almost circular in cross-section. Ornament of coarse radial ribs only, all of which are tuberculate; the earlier ones are

trituberculate and the later ones bituberculate. Suture incompletely known, having a trifurcate lateral lobe and broad, blunt saddles with a median indentation.

The most noticeable features of the genus are the complete lack of minor ribbing and the presence of tubercles on all ribs. Similarities to some of the Crioceratitidae are apparent but it differs significantly from known genera and probably occurs at a higher stratigraphical level than its morphologically nearest forms which are of Upper Neocomian age. *Crioceratites* Leveillé itself differs in having minor ribbing in addition to coarse ribbing, in its more lowly placed dorso-lateral tubercles and in its more complex suture. *Hoplocrioceras* Spath has a persistent early stage of bundled, relatively fine ribs, while *Paracrioceras* Spath has an early stage with non-tuberculate ribs and has minor ribbing in addition to the coarse trituberculate ribs of the later stages.

The present new form has previously been referred to as an "unknown genus of the subfamily Helicancylinae" Thomson (1971*b*, p. 158). At that time the species was known from only two specimens (Plate IIIj and k) which gave the impression that the shell was not only of relatively small size but also had aspinoceratid coiling such as is typical of several subgenera within that subfamily. However, the collection of more material indicates that the shell typically has crioceratitid coiling and shows no modification of ornament other than the loss of the dorso-lateral tubercle. Thus, in terms of shell form, the genus appears to be more closely allied to the Crioceratitidae than the Ancyloceratidae and yet has several non-crioceratitid features: a high dorso-lateral tubercle, ribs of only one size and an apparently simpler suture.

### *Antarcticoceras antarcticum* sp. nov.

Plate IIIi–k, m and n

*Material*

Four specimens from locality B, Succession Cliffs (KG.8.1 and 55, 759.2 and 5), all of which were collected from the screes, and two, possibly three specimens from below the conglomerate on the north-western side of Stephenson Nunatak (KG.1351.1 (?), 6 and 8). Specimen KG.8.1 is designated as the holotype.

*Description*

Most of the specimens (Plate IIIi, j, m and n) display a loose crioceratitid shell form, although one (KG.8.55; Plate IIIk) suggests that in some individuals the coiling may have been less regular and more open, even aspinoceratid. All of the specimens have been crushed to varying degrees during fossilization but part of specimen KG.1351.6 (Plate IIIm) is preserved as an internal mould and indicates an inflated, almost circular whorl cross-section. Ornament is limited to coarse ribs, all of which bear tubercles. The earliest whorls preserved are too crushed to be certain of the exact number of tubercles per rib but, on the holotype, three tubercles are clearly visible on a rib at a whorl height of less than 3 mm. The tubercles are placed in ventral, ventro-lateral and dorso-lateral positions and the latter one moves up the flank with an increase in whorl height; at the same time, it becomes less distinct and finally disappears. The ventral and ventro-lateral tubercles are well pronounced at all stages of growth and that part of the rib between them is flatter and broader than on the flank. There is a variation in the density and coarseness of the ribbing among the specimens, with the aberrantly coiled fragment (KG.8.55) having the coarsest. Faint growth striae are visible on parts of some of the specimens.

Incomplete suture markings are preserved on the internal mould part of specimen KG.1531.6 and, by some accident of preservation, also on the external mould of specimen KG.8.55. The most noticeable feature is a trifurcate lateral lobe (just below the ventro-lateral tubercle of the ornament) and this is flanked by broad blunt saddles which are little divided except by a median indentation. The ventral and dorsal parts of the suture, as well as of the external ornament, is not known.

*Remarks*

Major differences from previously described genera have already been outlined but there is one crioceratitid species, *Emericiceras coheni* Sarkar (1955, p. 86, pl. VII, fig. 2) from the Upper Barremian of France, which shows a superficial resemblance to the present one. It differs in its tighter coiling, coarser trituber-

culate ribs and in having interspersed minor ribs with ventral and ventro-lateral tubercles only. The dorso-lateral tubercles are all placed low on the flank.

FAMILY PTYCHOCERATIDAE MEEK 1876

## Genus *Ptychoceras* d'Orbigny 1842

*"Ptychoceras"* sp.

Plate IIIl and o; Fig. 5

*Material*

Two internal moulds (KG.17.12 and 13) from locality C, 124·2 m. above the base of the measured section.

*Description*

The larger of the two specimens (Plate IIIl) is an internal mould of a straight section of a gently tapering shaft (28 mm. long and about 6 mm. high) which is just beginning to curve round at its wider end. It is ornamented with a few coarse prorsiradiate ribs interspersed with several less prominent ones. On the earlier part of the shaft fragment, the ribs are reduced towards the dorsum but on the later part they continue across the dorsum with undiminished prominence. The second specimen (Plate IIIo) is a fragment consisting of a very small tightly bent hook with the two shafts in contact. It is smooth except for one low rib on the earlier section.

*Remarks*

The smaller of these two fragments is clearly a piece of a ptychoceratid ammonite and, because of their close association in the field, the larger fragment is considered to represent a later stage of the same species (Fig. 5). It is not possible to be certain to which precise genus of ptychoceratid these fragments belong as the smaller fragment with its smooth tightly bent hook recalls the genus *Ptychoceras* d'Orbigny *s.s.* and the oblique ribbing of the larger fragment is perhaps more typical of *Anahamulina* Hyatt.

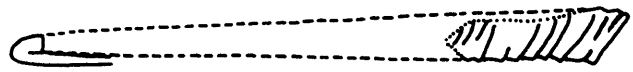

FIGURE 5

*"Ptychoceras"* sp. A suggested reconstruction showing the relationship between the two described fragments; ×1.

Despite the poor preservation and inexact identification of these fragments, they are worth describing because records of true ptychoceratids in the Southern Hemisphere are uncommon. Etheridge (1904, p. 36, pl. XV, figs. 6–9) described fragments of a smooth three-limbed species from Australia, in which the second and third limbs completely enveloped the first, under the name of *Ptychoceras* (*?*) *closteroides*. He suggested that it showed affinities to the Indian *P.* (*?*) *forbesianus* Stoliczka, and Wiedmann (1962, p. 89) regarded the two as identical. Modern authors consider Whitehouse's (1928, p. 278) genus *Tricoloceras*, based on Etheridge's species, as synonymous with *Ptychoceras* d'Orbigny. The Australian specimens, which came from Point Charles near Darwin (Northern Territory), are probably Upper Albian in age. More recently, Vella (1961) has described some small specimens of *Ptychoceras* (*?*) sp. from the upper Awatere Valley, New Zealand; associated Bivalvia suggest that they are also Albian in age. A single example from the Upper Aptian (Clansayesian) of the Malagasy Republic (Collignon, 1962*b*, pl. CCXXI, fig. 963) is a fragmentary internal mould of a tightly bent hook which was compared to *P. puzosi* d'Orbigny. No examples appear to have yet been described from South America.

FAMILY OPPELIIDAE BONARELLI 1894

SUBFAMILY STREBLITINAE SPATH 1925

## Genus *Substreblites* Spath 1925

*Substreblites* (*?*) sp.

Plate IVa

*Substreblites* (*?*) sp.; Thomson, 1971*b*, p. 158.

*Material*

One fragmentary external mould (KG.401.62) of a laterally flattened oxycone from 21·4 m. above the base of the measured section at locality Z; about half of the total specimen is present.

*Description*

The umbilicus, earlier part of the outer whorl, aperture and much of the venter are missing thus making it impossible to accurately assess the true original outline of the shell and hindering a precise identification. However, despite the flattening and incomplete preservation (Plate IVa), it is evident that the outer whorl was very high and compressed, and the umbilicus was correspondingly small; from these considerations, a suggested outline for the shell is superimposed on the illustration of the specimen. The surface of the shell was ornamented with low, falcate ribs, having a distinct forward-facing bend near the middle of the flank, and short intercalated ribs confined to the ventral quarter of the flank. A few of the major ribs appear to bifurcate in the zone of intercalated ribs and all ribs weaken considerably close to the venter. On part of the mould is what appears to be the remains of a ventral keel whose true attitude in relation to the shell has been distorted by crushing. It appears to have had the form of a narrow raised fillet with a smooth flat outer surface.

*Remarks*

The probable involute coiling and oxyconic form of this specimen suggest affinities to the Oppeliidae. Previously described species which have the most comparable rib pattern include some of those from the Upper Tithonian of the Spiti Shales, grouped by Uhlig (1903) under the genus *Streblites* Hyatt. These have since been referred to *Uhligites* Kilian (i.e. *Streblites adolphi* Oppel, pl. II, fig. 1a–d; *S. planopicta* Uhlig, pl. III, fig. 4a–d; and *S. kraffti* Uhlig, pl. IV, fig. 1a–d). *S. planopicta* shows even closer similarities on account of its possessing a keel, although this is narrow and not flattened as in the present example. The presence of a flattened keel or raised fillet on the venter suggests closer affinities to the related genus *Substreblites* Spath.

### Subfamily Aconeceratinae Spath 1923

## Genus *Sanmartinoceras* Bonarelli *in* Bonarelli and Nágera 1921

The genus *Sanmartinoceras* was first introduced by Bonarelli (*in* Bonarelli and Nágera, 1921) for some Aconeceratinae from Lago San Martín, Patagonia, which differed from typical examples of *Aconeceras* by having an ornament of slightly curved and rursiradiate sickle-shaped ribs on the ventro-lateral half of the last whorl in adults. It was noted that such ornament was more or less limited to the actual body chamber. The suture was referred to as being like that of *Aconeceras* and illustrated by an unorientated photograph of an incomplete example.

Workers such as Whitehouse (1926, 1927) and Casey (1954, 1961*b*) have studied the genus more extensively and added much information to Bonarelli's brief description. The differences between the known species are not marked but slight variations in a number of morphological features have been used to define the various species (Whitehouse, 1927; Rosenkrantz, 1934; Howarth, 1958):

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

Casey (1961*b*) also used (i) and (ii) to assist in differentiating the subgenera, *Theganeceras* Whitehouse and *Sinzovia* Sazonova, from *Sanmartinoceras s.s.* Howarth (1958) noted that, unlike other species of *Sanmartinoceras* (i.e. *S. groenlandicum*, *S. olene* and *S. fontinale*), in which ribs first appear at a diameter of about 20 mm., they first appeared in examples from Alexander Island at diameters of 35–42 mm. However, specimens in the present collections suggest that this feature is more variable than was originally thought (see below).

It is suggested here that the four known species of *Sanmartinoceras s.s.* may be satisfactorily differentiated on the shape of the falcate ribbing alone (Fig. 6), whilst also noting that the "presence of denticles on the


FIGURE 6

Diagram showing the differences in the shape of the falcate ornament in the four named species of *Sanmartinoceras s.s.*; all ×1.

a. *S. olene* (from Whitehouse, 1927, pl. XVII, fig. 6).
b. *S. fontinale* (from Whitehouse, 1927, pl. XVII, fig. 4).
c. *S. fontinale* (from Whitehouse, 1927, pl. XVII, fig. 5).
d. *S. groenlandicum* (from Rosenkrantz, 1934, pl. 4, fig. 3).
e. *S. patagonicum* (from Howarth, 1958, pl. I, fig. 9b).
f. *S. patagonicum* (from specimen KG.68.8).

carina and a spiral depression in the adult have yet to be demonstrated" in the Australian species (Casey, 1961*b*, p. 131). The rib forms in *S. olene* and *S. fontinale* are similar but, as was pointed out by Whitehouse (1927, p. 115), *S. olene* has a weaker median flexure. *S. groenlandicum* and *S. patagonicum* differ from the above two species in their sharper median flexures and the more sharply curved ventral half of their ornament; from each other they may be differentiated by the more symmetrically curved form of this part of the ornament in *S. groenlandicum*.

### *Sanmartinoceras patagonicum* Bonarelli *in* Bonarelli and Nágera 1921

Plate IVb–f and h; Fig. 7a

*Sanmartinoceras patagonicum* Bonarelli; *in* Bonarelli and Nágera, 1921, p. 27, pl. V, figs. 3–6.
*non Sanmartinoceras patagonicum* Bonarelli; Piatnizky, 1938, p. 80, pl. IV, fig. 18.
(?) *non Sanmartinoceras* cf. *patagonicum* Bonarelli; Wilckens, 1947, p. 28, pl. 3, fig. 6a and b.
*Sanmartinoceras patagonicum* Bonarelli; Howarth, 1958, p. 5, pl. I, figs. 6–10.
*Sanmartinoceras patagonicum* Bonarelli; Thomson, 1971*b*, p. 159.

#### *Material*

Seven external and internal moulds from the screes of localities H (KG.2.140) and T (KG.6.10 and 11, 68.4–6 and 8), and four specimens (KG.103.55, 93, 97 and 136) collected *in situ* from the sediments 195–270 m. above the base of the measured section at locality T.

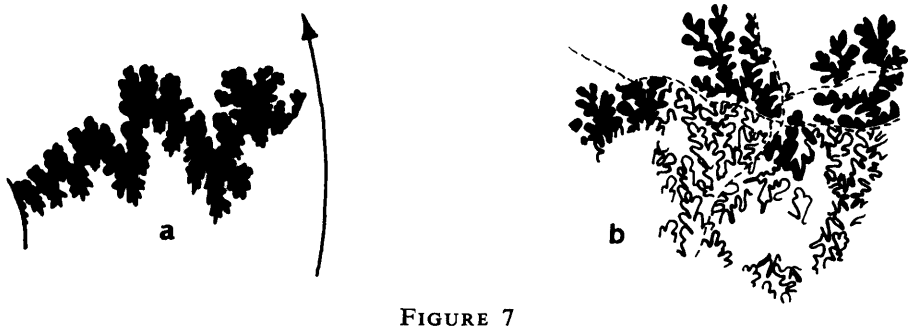


FIGURE 7

a. *Sanmartinoceras patagonicum* Bonarelli. Suture; ×2 (KG.68.4).
b. *Aconeceras* sp. indet. Suture resembling that of *A. nisus* var. *oligophylla* (Sarasin); locality R, ×3 (KG.1.615).

*Description and remarks*

Specimens of this species from Waitabit Cliffs have already been described by Howarth (1958, p. 5) and here it is only necessary to amend and augment his description. The present collections indicate that the size at which definite ribbing (as opposed to growth lines) appears is more variable than was first thought. In specimens KG.2.140 (Plate IVc) and 103.136 (Plate IVd) strong ribbing is clearly visible from diameters of 17 and 21 mm., respectively, while specimen KG.103.93 (Plate IVe), which has a clearly marked median spiral groove and a finely denticulate keel, is still more or less smooth at a diameter of 32 mm. These observations suggest that Casey's (1961*b*, p. 132–33) comparisons of the differing relative smooth juvenile stages in *Sanmartinoceras s.s.*, *Theganeceras* and *Sinzovia*, need careful interpretation. Leanza (1970, p. 217) has further suggested that there are no real grounds for considering *Sinzovia* as a separate subspecies of *Sanmartinoceras*.

The degree to which the median spiral groove is impressed is also subject to considerable variation. In some cases it is quite distinct (Plate IVf), whereas in others it is only poorly marked (Plate IVb), and in the Lago San Martín specimens (Bonarelli and Nágera, 1921, pl. V, figs. 3–5) it even appears to be absent. Thus its absence in the Australian species (see above) is probably not of great importance.

Specimen KG.6.11 (Plate IVh) is interesting because it shows an unusual variation in ornament. To a diameter of about 29 mm. it has typical *Sanmartinoceras* ribbing that is coarsest on the ventral half of the flank but there is no spiral groove. Above this diameter the ribbing is finer, more closely spaced and equally as well marked on the dorsal half as on the ventral half of the flank; a distinct spiral groove is also present. Whether this is a true *Sanmartinoceras patagonicum* or not is open to speculation and will only be proved on the finding of further material to show the true variation of the species.

An otherwise poorly preserved fragment from locality T shows the outlines of the sutures almost perfectly (Fig. 7a). The first lateral lobe is trifurcate and the first lateral saddle projects forward of the external saddle. There are four auxiliary saddles descending to the umbilicus before the suture disappears at the umbilical rim. Successive sutures follow closely and often with some overlap so that in some cases it is difficult to determine the true line. The overall line followed by the suture closely follows that of the falcate ornament.

*Measurements*

| *Specimen number* | *D* (mm.) | *h* (mm.) | *u* (mm.) | *h/D* (per cent) | *u/D* (per cent) |
|---|---|---|---|---|---|
| KG.6.10 | 48·0 | 27·0 | 4·5 | 56 | 9 |
| KG.6.11 | 27·5 | 15·4 | 3·0 | 56 | 11 |
| KG.68.8 | 60·5 | 34·0 | 5·0 | 56 | 8 |
| KG.68.6 | 58·5 | 33·5 | 5·0 | 57 | 9 |
| KG.103.136 | 22·5 | 12·4 | 2·4 | 55 | 11 |

A large fragment (KG.68.5) which probably belongs to this species must have had an original diameter of about 80 mm. and fragmentary specimens seen in the field were perhaps as large as 100 mm. in diameter.

## Subgenus *Theganeceras* Whitehouse 1926

### *Sanmartinoceras* (*Theganeceras*) *grande* sp. nov.

Plate IVg

*Theganeceras* sp. nov., Thomson, 1971*b*, p. 159.

*Material*

One large external mould (KG.3.50) in a good state of preservation from the screes at locality S, Mount Ariel.

*Diagnosis*

Involute oxycone with a small umbilicus and high compressed whorls; large for subgenus. Ornament falcoid, dense, continuous from umbilicus to ventral shoulder but more pronounced on the ventral half of the flank. Keel finely denticulate. No median spiral groove.

*Description*

The shell (Plate IVg) is large for the subgenus and has high compressed whorls with a steep short umbilical wall and a narrow flattened venter surmounted by a finely denticulate keel. The whorl flanks are flat and bear a falcoid ornament which is continuous from the umbilicus to the ventral shoulder. On the dorsal half of the flank this ornament consists of threads but on the ventral half of the flank the threads are fused in groups of two or more and are expanded into coarse C-shaped ribs. The median flexure of the threads and the ventral C-shaped ribs are both symmetrically curved, the former being more acute and less deep than the latter. Towards the anterior end of the body chamber the ornament is reduced.

*Measurements*

$D_{max.}$ = about 60 mm.; $D = 53{\cdot}1$ mm., $h = 33{\cdot}2$ mm., $u = 3{\cdot}5$ mm., $h/D = 62$ per cent and $u/D = 7$ per cent.

*Remarks*

This specimen is distinguished from the examples of *Sanmartinoceras patagonicum* found in the same area by its relatively higher whorls ($h/D = 62$ per cent as opposed to 55–57 per cent for *S. patagonicum*), its denser and more symmetrically curved ornament and perhaps also by the lack of a median spiral groove. Because of the finer, denser ornament, it is thought best to include this specimen in the subgenus *Theganeceras*. From the two known species of the subgenus, *T. falcatum* (Koenen) and *T. scalatum* (Koenen), it is at once distinguished by its greater size, and on closer inspection, also by the shape of the ribbing especially with respect to its less acute median flexure.

*Sanmartinoceras* (*Theganeceras*) (*?*) sp.

Plate IVk

*Theganeceras* (*?*) sp.; Thomson, 1971*b*, p. 159, fig. 3e.

*Material*

Two external moulds (KG.1.616 and 639) from 186 and 193·5 m. above the base of the measured section at locality R, and an internal mould (KG.110.1) from the screes at the same locality.

*Description*

The whorls of this species are compressed and have flat flanks which curve smoothly into a distinct ventral keel; they have an ornament of closely spaced, feebly falcoid riblets (Plate IVk). The riblets are clearly visible on the ventral half of the flank and on both internal and external moulds they fade rapidly on the dorsal side of the median flexure. In places the keel appears to be finely denticulate.

*Remarks*

It has not been possible to match this species with any yet described but the poor state of preservation of the material does not warrant the formal description of a new species. The relatively dense and even ornament suggests possible affinities with *Theganeceras* but the ribbing is much more feebly bent than on known species of this subgenus, including *T. grande* described above.

## Genus *Aconeceras* Hyatt 1903

*Aconeceras* aff. *nisoides* (Sarasin 1893)

Plate IVi and m

For early synonymy see Casey, 1961*b*, p. 125.
aff. *Aconeceras nisoides* (Sarasin); Casey, 1961*b*, p. 125, pl. XXVI, figs. 3–5, text-fig. 41a–c.
aff. *Aconeceras nisoides* (Sarasin); Collignon, 1962*b*, pl. CCXXIX, fig. 973.
*Aconeceras* aff. *nisoides* (Sarasin); Thomson, 1971*b*, p. 158 and 159.

*Material*

Two external moulds (KG.10.85) on a rock fragment from 193·5 m. above the base of the measured

section at locality A and three internal/external moulds (KG.103.192, 194 and 195) from the sediments 395–396·5 m. above the base of the section measured at locality T.

*Description*

The whorls of this small oxyconic species (Plate IVi and m) are high and compressed; the whorl flanks diverge gently away from the keel and then lie parallel to each other for the greater part of the height of the whorl. The umbilicus is small and is bounded by a short steep wall. The keel is low and is not very well preserved on the specimens available but in places it is seen to be minutely beaded. Both internal and external moulds are almost smooth apart from a series of closely spaced and crescent-shaped riblets on the ventral half of the flank. On the examples from locality A (KG.10.85; Plate IVi) the dorsal ends of the riblets are reflexed into feebly prorsiradiate threads, thus giving the ornament an overall sickle-shaped appearance. Above a diameter of 20 mm. the ornament tends to be more feebly marked.

The suture is not preserved.

*Measurements*

The best-preserved example, specimen KG.103.195, has the following dimensions, $D = 22{\cdot}0$ mm., $h = 12{\cdot}7$ mm., $u = 1{\cdot}9$ mm., $h/D = 58$ per cent and $u/D = 9$ per cent.

*Remarks*

The general form and feeble ornamentation of these specimens indicates affinities with the genus *Aconeceras* Hyatt. Similar described specimens include the lectotype *Oppelia nisoides* (Sarasin, 1893, p. 155, pl. IV, fig. 10a, pl. V, fig. 10b, pl. VI, fig. 10c) from the Lower Aptian of France, *Aconeceras* cf. *nisoides* (Sarasin) from the Lower Aptian of the Isle of Wight (Casey, 1961*b*, pl. XXVI, fig. 4a) and *A. nisoides* from the Upper Aptian of the Malagasy Republic (Collignon, 1962*b*, pl. CCXXIX, fig. 973). The present examples differ from the lectotype in the sharper median flexure of their riblets, their proportionally smaller umbilicus and having a less well-defined ventral shoulder. The Malagasy Republic example most closely resembles the Alexander Island examples in having flanks which curve gently toward the venter and in having a proportionally small umbilicus.

*Aconeceras* sp. α

Plate IVl

*Aconeceras* sp. α; Thomson, 1971*b*, p. 159.

*Material*

Two specimens (KG.1.809 and 11.25) from heights of 250 and 189·2 m. in the sections measured at localities R and N, respectively, and possibly a third (KG.2.87) from 250 m. above the base of the section at locality H.

*Description and Remarks*

This small species (Plate IVl) is easily distinguished from the above-described examples of *Aconeceras* aff. *nisoides* by its more inflated whorl section and more feebly falcate ornament. Specimen KG.2.87 is included with reservation on account of its poorly developed keel and its relatively wide umbilicus.

*Measurements*

| *Specimen number* | *D* (mm.) | *h* (mm.) | *u* (mm.) | *h/D* (per cent) | *u/D* (per cent) |
|---|---|---|---|---|---|
| KG.11.25 | 16·5 | 9·0 | 1·5 | 55 | 9 |
| KG.1.809 | 20·5 | 11·0 | 2·0 | 54 | 10 |
| (?) KG.2.87 | 16·2 | 8·4 | 2·3 | 52 | 14 |

*Aconeceras* sp. indet.

Fig. 7b

*Aconeceras* (*?*) sp.; Thomson, 1971*b*, p. 159.

A single poorly preserved example (KG.1.615) from the sediments 186 m. above the base of the section measured at locality R bears faint broad ribs which are not unlike those of *A. haugi* (Sarasin, 1893, pl. IV, fig. 11a, pl. VI, fig. 11c). The suture (Fig. 7b) is partly preserved and has the deeply dissected and phylloid aspect of that seen on *A. nisus* var. *oligophylla* (Sarasin, 1893, p. 153, fig. 2).

## (?) Family Oppeliidae Bonarelli 1894

### Gen. et sp. nov.

Plate IVj

A unique specimen (KG.3.93) from the screes at locality S is too poorly preserved to make a detailed description but it has a distinctive morphology which suggests that it may belong to a hitherto undescribed genus. The specimen (Plate IVj) is an internal/external mould of an evolute oxycone with smooth, gently convex flanks and a coarsely serrate keel even on the inner whorls. There is no ventral shoulder because the flanks curve gradually into the keel. The umbilical wall is steep with a rounded rim.

## Family Berriasellidae Spath 1922

## Subfamily Berriasellinae Spath 1922

### Gen. et sp. indet.

Plate Va and b

Berriasellid gen. et sp. indet.; Thomson, 1971*b*, p. 158.

*Material*

Seven fragments of a very incomplete specimen (KG.401.614) from 218·6 m. above the base of the section measured at locality Z. Most fragments are pieces of external or internal mould from the outer whorl; one piece shows vague impressions of some inner whorls.

*Description*

The fragmentary internal mould (Plate Va and b) from the outer whorl lacks the umbilical margin but nevertheless it appears to be part of a fairly evolute ammonite with a moderately wide umbilicus. The venter is bluntly arched and the flanks are gently convex. Ornament consists of strong radiate to prorsiradiate ribs which bifurcate on the upper half of the flank into ribs of similar size to the primary ones. The secondary ribs are projected and, because of distortion during fossilization, the degree to which they are projected is different on either side of the mould (cf. Plate Va and b). Broad constrictions with the same form as the ribs occur between every three or four primary ribs. The venter has been distorted by crushing but most, if not all, of the secondary ribs appear to be weakened in this region and may even be absent along the centre line.

*Remarks*

The incompleteness of this specimen, especially with regard to the umbilical margin and the lack of knowledge as to the exact form of the shell, make it impossible to identify with any certainty. However, the projected, bifurcate ribbing weakening on the venter is strongly reminiscent of the Berriasellinae and in particular species of the genera *Berriasella* and *Blanfordiceras* such as occur in the Tithonian to Berriasian of the Salt Range, the Malagasy Republic and South America. The presence of constrictions is unusual but not unknown in this subfamily.

## Subfamily Himalayitinae Spath 1925

### Genus *Himalayites* Uhlig *in* Boehm 1904

*Himalayites* (*?*) sp.

Plate IVo

*Himalayites* (*?*) sp.; Thomson, 1971*b*, p. 158.

*Material*

Many small fragments of external and internal mould from one individual collected 322·5 m. above the base of the section measured at locality Z; only two of these (KG.401.686b and h) are usable.

*Description*

Specimen KG.401.686h is an incomplete, somewhat crushed internal mould of the body chamber. The mould of the last septum is imperfectly preserved and the suture is not discernible except for the general outlines of the ventral and dorsal lobes plus a single lateral lobe and two lateral saddles on each flank. This fragment has a sub-ovate cross-section, being a little higher than wide, and it is ornamented with strong ribs, some of which bifurcate near the mid-line of the flank, probably above. The central zone of the venter appears to be free of ornament and is marked by a shallow groove. The second fragment (Plate IVo) is an external mould which has a very distinctive ornament consisting of bold ribs separated by excavated interspaces; these ribs are radial on the dorsal half of the flank but curve gently forward as they approach the venter. One rib bifurcates near the mid-line into two secondary ribs of equal strength to the primary; at the point of bifurcation is a large and very pronounced tubercle. Behind the bifurcate rib are two simple ribs and then probably another bifurcate one but this has been too badly damaged to be certain. The tubercles are less clearly defined on the internal mould.

*Remarks*

The identification of such fragmentary specimens must be tentative, yet the ornament of strong ribbing, sometimes bifurcating at large tubercles, and the smooth ventral groove are typical features of the genus *Himalayites*. The presence of a ventral groove rules out the possibility of affinities with some of the Douvilleiceratidae, such as *Cheloniceras* Hyatt. In particular, the external mould (Plate IVo) recalls the species *H. seideli* (Oppel) from the largely Upper Jurassic Spiti Shales of Himalaya (Oppel, 1863, p. 283, pl. 80, fig. 3a and b) but, whereas the latter has a depressed sub-circular whorl section, the above-described internal mould is slightly higher than wide. How much this is due to crushing is not known.

## Subfamily Neocomitinae Spath 1924

## Genus *Neocosmoceras* Blanchet 1922

### *Neocosmoceras* aff. *sayni* (Simionescu 1900)

Plate IVn

*Neocosmoceras* sp.; Thomson, 1971*b*, p. 158, fig. 3c.

*Material*

One incomplete external mould (KG.401.680) from 317·5 m. above the base of the section at locality Z.

*Description*

The specimen (Plate IVn) measures about 25 mm. in diameter and consists of loosely coiled multispiral shell in which the outer whorl appears to have been free of the penultimate one. During all stages of growth visible on the specimen the whorls have an ornament of prominent ribs which are irregularly, but generally widely, separated by deeply excavated areas; a few ribs approach closely to one another but none actually join. The ribs are straight and sub-radiate to concave and prorsiradiate and appear to be projected at the ventral shoulder. On the outer and penulimate whorls several ribs bear tubercles where they curve sharply round from the convex flank onto the steep umbilical wall; sometimes these tubercles are placed a little higher on the flank. The same ribs usually bear a second spinose tubercle high on the flank near the ventral shoulder. It appears that these (?) ventro-lateral tubercles on the penultimate whorl are projected ventrally outward and act as spacers with respect to the outer whorl such that the two are not in contact. There are usually one to three non-tuberculate ribs interspersed between each pair of tuberculate ones.

*Remarks*

Despite the incomplete preservation of this specimen, especially in the ventral region, its strong resemblance to several species of *Neocosmoceras* Blanchet leaves its identification in little doubt. The type

species is *Hoplites sayni* Simionescu from the Berriasian of France and, of the two examples illustrated by him, the smaller individual (Simionescu, 1900, pl. 1, fig. 8) compares most closely with the present example. Tuberculate ribs on the French species have three tubercles; a feeble one on the umbilical rim, a pronounced but rounded one in the ventro-lateral position, and a long ventral tubercle which is only visible on the external whorl. The main difference is that the ribs of the French species are coarser and more widely spaced.

*N. ampanihyense* Collignon (1962*a*, p. 17, pl. CLXXX, fig. 810) from the Berriasian of the Malagasy Republic has similar sharp ribs but these are more regularly spaced than on the present specimen. A similar point of difference may be made concerning its resemblance to *Neocosmoceras* sp. nov. (Spath, 1939, p. 68, pl. VI, fig. 4a–d, pl. VIII, fig. 4a–d) from the (?) Tithonian of the Salt Range. *Neocosmoceras* sp. indet. cf. *sayni* (Simionescu) (Spath, 1939, p. 70, pl. VII, fig. 3a–d) of the same age has a tendency towards irregular ribbing but it lacks umbilical tubercles.

## Genus *Sarasinella* Uhlig 1905

### *Sarasinella* aff. *hondana* Haas 1960

**Plate Ve**

aff. *Sarasinella hondana* Haas, 1960, p. 32, figs. 75, 81, 83, 85–87, 89–91 and 95.
*Sarasinella* aff. *hondana* Haas; Thomson, 1971*b*, p. 158, fig. 3a.

*Material*

Seven fragments of internal and external mould (KG.401.311a–g), some of which have been pieced together to form an incomplete specimen, from 142·4 m. above the base of the section measured at locality Z.

*Description*

The assembled fragments (Plate Ve) are shown in what is believed to be their approximate relative positions as in the original shell and they indicate that the diameter of the specimen was about 110 mm. in a crushed state. Coiling is evolute with the outer whorl embracing about one-quarter of the preceding one. The whorls are high and compressed with gently convex flanks and a steep umbilical wall. The venter is only preserved in one position corresponding to a shell diameter of about 65 mm. and here it is narrow and flattened. Ornament varies gradually throughout the growth stages of the shell. On the inner whorls there are numerous, closely spaced sharp ribs of which there are two kinds: major ribs, originating at small tubercles on the edge of the umbilical wall and extending across the whole flank of the whorl as far as it can be seen; alternating with these are shorter intercalated ribs which usually terminate only a little short of the umbilical wall. Some of the major ribs may be paired at the umbilical tubercles.

About one-third of the way round the outer whorl, the ribs are relatively coarser and more rounded; they now have a distinctly flexuous form and curve gently forward from the umbilical tubercles (now much more prominent and elongated into bullae) then back before swinging forward again on the ventral half of the flank. Some ribs are paired at the umbilical bullae and others bifurcate near the mid-line of the flank. There appear to be no intercalated ribs, although too little of the mould is preserved to be certain about this. At the ventral shoulder, each rib swells into a small tubercle and then passes straight across the flat ventral surface to the opposite flank.

On the body chamber the ribs are broad and low. The major ones are widely spaced and are alternated with one or two intercalated ones which vary in length from one-quarter to two-thirds of the height of the whorl. None of the major ribs bifurcates. The whole ornament is crossed by numerous lirae with a similar flexuous form to that of the ribs. An unillustrated fragment suggests that there was a constriction just behind the aperture.

*Remarks*

Despite the fragmentary preservation of this ammonite, it shows enough features to allow comparison with other forms. Its affinities to the Neocomitinae are obvious and it is most probable that it belongs to some species of *Sarasinella* Uhlig. The distinct umbilical tubercles or bullae exclude this specimen from *Thurmanniceras* Cossmann, species of which it otherwise bears a general resemblance to, and it is also

excluded from *Neocomites* Uhlig on account of the only sporadic bundling of ribs at the umbilical margin.

It shows an overall resemblance to some similarly preserved material from the Berriasian of Colombia and described by Haas (1960, p. 32) as *Sarasinella hondana*. The lateral aspect of the ornament on the present examples compares favourably with that on two particular fragments illustrated by Haas (1960, figs. 89 and 95) but the ventral ornament is different. On the Colombian species the venter is first smooth and then suddenly the ribs cross the venter in a forward-facing curve; on the present specimen they pass straight across. "*Thurmannia*" aff. *thurmanni* var. *allobrogica* Kilian (Gerth, 1925, pl. V, figs. 2 and 2a) from the Berriasian of Argentina (or Upper Tithonian according to Leanza (1945, table opposite p. 96)) has a greater tendency for pairing of the ribs at the umbilical margin and has an apparently more inflated whorl section but the ribs continue straight across the venter. The example from Cerro de los Fósiles, Lago Argentino, Patagonia, referred to this same variety by Feruglio (1936, pl. V, fig. 7) has an even greater tendency for pairing of the ribs at the umbilical margin and Leanza's (1967*b*, p. 152) revision of this specimen as *Neocomites* sp. indet. is probably more correct.

## Family Desmoceratidae Zittel 1895

Both the specimens, tentatively included here in a desmoceratid genus and those described below under the Silesitidae, are perhaps more difficult to identify than most of the ammonite faunas because of the effects of distortion during fossilization. All of the specimens are small and have fine, often dense, ribbing, interspersed with occasional constrictions, and good preservation is essential in such forms to arrive at a confident identification. These ammonites occur in only two places (Succession Cliffs (B) and Keystone Cliffs) and their potential stratigraphical use is obvious. Differences have been enhanced, and probably also hidden, by distortion due to crushing, and yet as far as may be judged the faunas of the two areas are different from all other ammonite faunas known from Alexander Island, and they appear to be distinct from each other.

### Genus *Callizoniceras* Spath 1923

*Callizoniceras* (*?*) sp.

Plate Vc and d

*Callizoniceras* (*?*) sp.; Thomson, 1971*b*, p. 158, fig. 3d.

*Material*

Six external and internal moulds (KG.8.37, 39, 40, 48, 51 and 54) from the sediments 150·2–164·4 m. above the base of the section measured at locality B, Succession Cliffs. All are in a generally poor state of preservation and indeterminate specimens from the same level may belong to the same species.

*Description*

All of the specimens included here are small and fragmentary (Plate Vc and d). They have slightly involute shell forms and have fine, sharp flexuous ribbing, in which intercalated ribs and bifurcate major ribs occur frequently. The ribs are crowded at the umbilical margin but the specimens are too incompletely preserved to show whether many of the ribs are actually paired; all ribs cross the venter in a rounded, forward-facing chevron. Periodic constrictions are present but the exact number per whorl cannot be determined on any of the examples. Some of the constrictions do not precisely follow the trace of ribbing, with the result that the ribs on either side of a constriction may be truncated.

*Remarks*

Identification of these specimens has proved difficult. Their preservation is poor and they are superficially similar to *Silesites antarcticus* sp. nov. (p. 32) but appear to be distinguished from the latter by their finer and more frequently bifurcating ribbing and more irregular constrictions. Possibly they represent the early stages of the species illustrated by Howarth (1958, pl. I, fig. 5) as *Silesites* cf. *trajani* (Tietze) which came from the same locality. The author is indebted to D. Patrulius (Institutul Geologic, Bucharest) for drawing his attention to some closely similar undescribed material from the eastern Carpathians.

These have a similar *Silesites*-like ornament but have the sutures of *Callizoniceras*, and they were collected from sediments with a Clansayesian fauna including *Eotetragonites* and *Neosilesites*. The present examples appear to be more closely related to these east European forms of *Callizoniceras* than any hitherto described examples of *Silesites*.

FAMILY SILESITIDAE HYATT 1900

## Genus *Silesites* Uhlig 1883

### *Silesites* aff. *vulpes* (Coquand 1878)

Plate Vf

aff. *Ammonites vulpes* Coquand; *in* Matheron, 1878, pl. C-20, fig. 1a and b.
aff. *Silesites vulpes* (Coquand); Uhlig, 1883, p. 235, pl. XVIII, figs. 8, 9, 13 and 14, pl. XIX, fig. 1.
aff. *Silesites vulpes* (Coquand); Haug, 1889, p. 202, pl. XIII, fig. 6, (?) fig. 5.
*Silesites* aff. *vulpes*; Thomson, 1971*b*, p. 160.

*Material*

One part external, part internal mould (KG.109.1) from locality X.

*Description*

The specimen (Plate Vf) comprises about three whorls of an evolute multi-spiral shell, of which about half of the outer one was occupied by the body chamber. The whorls are only slightly embracing and are ornamented with distant, straight or slightly flexuous ribs which are projected forwards at the ventral shoulder. A deep constriction, with the same form as the ribbing, is present on the middle of the body chamber and there are traces of another at the aperture. Perhaps four or five constrictions were originally present in the outer whorl but crushing has removed all remains of ornament on the earlier part of the outer whorl and all of the inner whorls, i.e. the septate part of the shell.

*Measurements*

$D = 32$ mm., $h = 9$ mm. and $u = 14$ mm.

*Remarks*

*Silesites vulpes* is a species which has been widely interpreted and only those variants which are closest to the specimen described here are included in the synonymy. Examples from the Barremian of the Crimea (e.g. those illustrated by Karakasch (1907) and Druschitz and Kudryavtseva (1960)) have much feebler ornament than those included above, and one particular specimen illustrated by Karakasch (1907, pl. XXV, fig. 4) has fine dense ribbing which makes it look more like a *Puzosia*. The original specimen illustrated in Matheron (1878) appears to have relatively smooth early whorls but later more definite ribbing becomes evident. On one of Uhlig's (1883, pl. XVIII, fig. 9) specimens, ribbing appears to commence a little earlier but the example which shows the greatest resemblance to the present one is Haug's (1889, pl. XIII, fig. 6) one in which marked ribbing appears at an early stage of roughly equivalent size to the present specimen. Groeber (1946, p. 186) referred to *S.* aff. *vulpes* in a list of Argentine faunal zones but no specimens seem to have ever been described, and it has not been possible to trace the collection of the relevant material for comparison.

### *Silesites antarcticus* sp. nov.

Plate Vg–j

*Silesites* sp. nov.; Thomson, 1971*b*, p. 160, fig. 3f.

*Material*

Three part external moulds (KG.106.5, 12 and 51) from the basal 4·7 m. of the section measured at locality W, Keystone Cliffs and two (KG.109.2 and 3) from locality X about 1·5 km. north-west of locality W. Specimen KG.106.51 is chosen as the holotype.

*Diagnosis*

Evolute, whorls slightly embracing and compressed, umbilical wall steep; ornament of sharp, crowded convex ribs projected from ventral shoulder and sometimes bundled at the umbilical margin; periodic constrictions.

*Description*

At all stages of growth represented in the present collection (Plate Vg–j), this species has an evolute shell with whorls which are only slightly embracing. The whorls are high and compressed, and they have flat flanks and a short steep umbilical wall; the venter was probably acutely rounded but it is not well preserved in any of the specimens available. On smaller specimens, ornament consists of dense sharp ribs which slope gently forward as they rise from the umbilicus, curve back across the flank and are then projected forward at the ventral shoulder. At the umbilical margin the ribs are crowded together and in some cases bundled in pairs; elsewhere, long intercalated ribs, terminating a little short of the umbilical rim, are present. Short intercalated ribs and bifurcating ribs are uncommon but they sometimes appear in the middle stages of growth. This ornament is periodically interrupted by deep constrictions which have the same general form as the ribs; on the holotype (Plate Vg) there are about seven such constrictions in the outer whorl. Indistinct traces of the suture are preserved on three of the specimens but the exact pattern is not discernible.

It is believed that specimen KG.105.1 (Plate Vj) from locality V may represent the adult stage of this species. The inner whorls of the 50 mm. diameter specimen are unfortunately crushed and incompletely preserved so that it is not possible to observe the ribbing pattern. On the early stages of the outer whorl, corresponding approximately to the largest examples described above, the ribbing is not dissimilar to that of specimen KG.106.5 (Plate Vi); short intercalated ribs are present and some major ribs bifurcate on the ventral part of the flank. Whether the more falcate form of the ribbing is original or caused by crushing is not known. On the body chamber of this example the ribbing is coarser and simpler, resembling that of the small holotype (Plate Vg). About eight or nine constrictions are present in the outer whorl. The aperture carries a rostrum where the ventral part of the ribs is projected forward.

*Remarks*

At first sight, the variation in ornament and shell form allowed within this new species, *Silesites antarcticus*, may seem rather excessive. However, all of the specimens have suffered varying degrees of distortion due to crushing and, while it is not certain that specimen KG.106.51 (holotype; Plate Vg) and KG.105.1 (Plate Vj) belong to the same species, specimens KG.106.5 (Plate Vi) and 109.3 suggest possible intermediate stages.

The nearest previously described species to the present one is *S. trajani* (Tietze) which was first described from a whorl fragment and a small juvenile (Tietze, 1872, pl. IX, figs. 1 and 2) and became better known through Uhlig's (1883) studies on the Barremian fauna of Wernsdorf. The smaller specimens of *S. antarcticus* compare superficially with the specimens described by Uhlig (1883, pp. 233–35, pl. XVIII, figs. 4, 7 and 10) and with others from Pont de Blieux (Basses Alpes), which were kindly loaned to the author by M. Collignon, but they differ in the following respects:

i. *S. antarcticus* is more evolute.
ii. There are no tubercles on the ribs at the ventral shoulder as found in the European species, even on the large specimen from locality V.
iii. Bundling of the ribs at the umbilical margin does not appear to occur in *S. trajani.*

Minor differences in the shape of the ribs should not be accentuated too much because of the effects of distortion in the present specimens; those described by Uhlig show considerable variation for a similar reason but his pl. XVIII, fig. 4 example is closest to the better-preserved forms from the French Alps.

## *Silesites desmoceratoides* (?) Stolley 1912

**Plate Vk**

*Silesites desmoceratoides* Stolley, 1912, p. 7, pl. I, fig. 1, 1a.
*non Gaudryceras desmoceratoides* (Stolley); Bonarelli *in* Bonarelli and Nágera, 1921, p. 22, pl. II, fig. 10.
*non Gaudryceras desmoceratoides* (Stolley); Feruglio, 1936, p. 44, pl. IV, fig. 6a and b.
*non Gaudryceras desmoceratoides* (Stolley); Piatnizky, 1938, p. 80, pl. III, fig. 11; pl. IV, fig. 17.
*Parasilesites desmoceratoides* (Stolley); Leanza, 1967*a*, p. 11.
*Parasilesites desmoceratoides* (Stolley); Leanza, 1967*b*, p. 157.
*Silesites desmoceratoides* (?) Stolley; Thomson, 1971*b*, p. 160.

### *Material*

Two fragmentary external moulds from locality W, Keystone Cliffs, may belong to this species; specimen KG.106.38 was found on the screes 142·5 m. above the base of the measured section and specimen KG.106.41 was found *in situ* at a height of 153 m. and on the same slab as *Pseudothurmannia* cf. *mortilleti*.

### *Description*

The best specimen (KG.106.38; Plate Vk) comprises about one-half of a whorl with a short, steep umbilical slope and gently convex flanks which curve more strongly close to the venter. The ornament of falcate ribs and periodic constrictions is divided into two distinct parts. On the earlier half of the fragment, the ribbing is fine and rather dense with some of the ribs bifurcating on the ventral third of the flank. On the later half there is a sudden change to coarser, more widely spaced ribbing. Intercalated ribs are present but none of the major ribs bifurcates; several of the ribs are bundled in pairs at the umbilical margin. Two constrictions, which are sub-parallel to the ribs, interrupt the coarse ornament and are bounded by prominent falcate ribs on their apertural margins.

### *Remarks*

The fine ornament on the earlier half of the fragment just described resembles that on specimens included in *Silesites antarcticus* above; however, the sudden change to coarser ornament is not present in that species. The compressed whorl section, pairing of ribs at the umbilical rim and frequent occurrence of intercalated and/or bifurcate ribs suggest close affinities with the Patagonian species *Silesites desmoceratoides* Stolley, of which the type specimen (Stolley, 1912, pl. I, figs. 1 and 1a) is here considered as the only specimen hitherto described which can be confidently assigned to that species (see below). The early stages of Stolley's type are not well preserved but the coarser ornament on the Antarctic specimen is similar to that half-way round the former's outer whorl, and the finer ornament appears similar to that visible on the inner whorls. A feature of *S. desmoceratoides* is the sudden change on the outer whorl from relatively coarse ribbing to relatively fine in which three, or even four, ribs are bundled together at a series of minute umbilical bullae. This (?) adult stage is not preserved on the Alexander Island specimens.

Leanza (1967*a*, *b*) considered that Stolley's original *S. desmoceratoides* was better placed in the genus *Parasilesites* Imlay on account of its close resemblance to the type species *P. bullatus* Imlay. However, the finely ribbed late stage in *S. desmoceratoides* is not seen in the species of *Parasilesites* described by Imlay (1959, 1960*b*) nor in *Ammonites laperouzianus* Whiteaves (1876, p. 39, pl. 3, fig. 3) which probably also belongs to this genus. Of the other specimens assigned to Stolley's species, the examples described by Feruglio (1936, pl. IV, fig. 6a and b) and Piatnizky (1938, pl. III, fig. 11, pl. IV, fig. 17) were assigned by Leanza to *Feruglioceras piatnitzkyi* gen. et sp. nov. with Piatnizky's pl. III, fig. 11 as holotype.* The so-called *Gaudryceras desmoceratoides* of Bonarelli (*in* Bonarelli and Nágera, 1921, pl. II, fig. 10) has similar but coarser ribbing to the fragments included in *F. piatnitzkyi*.

In his recent revision of the Lago San Martín faunas, Leanza (1970, p. 224, fig. XXI, 1–6) ascribed a wide range of new specimens to *Parasilesites desmoceratoides*. From the illustrations it would seem that those specimens show a wide variation for one species and none agrees closely with Stolley's type. They have constrictions which appear at a much earlier age, none shows the sudden change from coarse to fine ornament described above, and the ribbing is still well marked on the venter, whereas on Stolley's specimen the venter is almost smooth.

* A careful examination of Piatnizky's (1938, pl. III, fig. 11, pl. IV, fig. 17) illustrations suggest that they are of the same specimen at two different magnifications rather than two different specimens.

## III. STRATIGRAPHICAL DISCUSSION

A BRIEF synopsis of the ammonite faunas of south-eastern Alexander Island and their stratigraphical significance has already been given elsewhere (Thomson, 1971*b*) but here the evidence for the conclusions reached will be discussed in more detail.

The present state of knowledge of the main structural features in south-eastern Alexander Island has been outlined by Horne (1967). When viewed from George VI Sound, the sediments in the coastal cliffs have an apparent gentle southerly dip (its true direction is somewhat west of south-west) and, in the absence of any tectonic disturbance, the general picture would be one of a great thickness of sediments younging steadily towards the south. This simple scheme is complicated by folding about approximately north–south axes, east–west transcurrent faulting and by overthrusting from west to east. At several localities evidence of movement along planes apparently parallel to the bedding has been observed but it has not been established whether such movements have affected the succession or how far they have moved. Probably they represent small differential or adjustment movements associated with larger-scale thrusting.

On the southern side of Pluto Glacier, at the northern end of Succession Cliffs block, is a westerly dipping reverse fault which continues southwards in the cliffs a little inland of localities A and B. It is probably continuous with a 54 m. thick thrust zone exposed at locality C. The amount of movement on this thrust is not known, although the movement on the reverse fault must be at least several hundred metres, because none of the sediments on either side can be correlated and the fault is exposed for a height of 200–300 m. on the southern margin of Pluto Glacier.

An impressive 18 m. thick zone of disturbed sediments at Fossil Bluff (locality R) has been illustrated by Horne (1967, fig. 2). Contorted, and even vertical sediments, pass laterally into an apparently normal and undisturbed sequence. The amount of lateral movement which this zone may represent is as yet unknown and the fossil collections do not indicate any important faunal differences above and below it.

From the point of view of the present discussion, the most important observed "thrust" in this area is the one exposed at Keystone Cliffs. This is discussed in greater detail on p. 39.

In the following discussion of the faunas from each locality, only collected specimens are taken into account. This is regrettable as it means that the vertical range of none of the species is known. However, field identifications were found to be quite unreliable especially with regard to such groups as the Aconeceratinae.

### 1. *Locality Z (coastal cliffs on the northern side of Pluto Glacier)*

Most of the ammonites from locality Z have been broken up by well-developed jointing and only incomplete specimens are known. Furthermore, each species, with the exception of *Phyllopachyceras* (*?*) sp., is represented by one specimen only and therefore nothing is known of its vertical distribution within the outcrop. At this locality every ammonite fragment seen in the field was collected and their paucity in the collection may therefore be assumed as representative of their uncommon occurrence. The Cephalopoda are here represented in far greater numbers by a variety of belemnites. The identifiable ammonite fauna consists of:

*Phylloceras* sp.
*Phyllopachyceras* (*?*) sp.
*Bochianites gracilis* sp. nov.
*Substreblites* (*?*) sp.
*Himalayites* (*?*) sp.
Berriasellid gen. et sp. indet.
*Neocosmoceras* aff. *sayni*
*Sarasinella* aff. *hondana* Haas.

Of these, *Substreblites* (*?*) sp., *Himalayites* (*?*) sp., *Neocosmoceras* aff. *sayni* and *Sarasinella* aff. *hondana* are considered to be the most significant from the stratigraphical point of view.

Doubt as to the precise generic identification of *Substreblites* (*?*) sp. is expressed, because the specimen has the ribbing pattern found on species of *Uhligites* Kilian and yet it has a flattened ventral keel or fillet more typical of *Substreblites* Spath. According to Arkell (*in* Arkell and others, 1957, p. *L*284), both of these genera have a similar age range, Tithonian–Valanginian, and therefore the exact generic position of this specimen does not affect its broad age significance.

The tentative identification of *Himalayites* from the fragments of a poorly preserved individual poses some interesting stratigraphical questions. The specimen concerned occurred 5 m. above a bed containing

*Neocosmoceras* aff. *sayni* and 180 m. above another with *Sarasinella* aff. *hondana*, both of which species are suggestive of a Berriasian age, whereas *Himalayites* itself is usually regarded as a typically Tithonian genus (Arkell *in* Arkell and others, 1957, p. *L*356). The genus *Himalayites* is well diversified in the Spiti Shales of the Himalayas (Uhlig, 1910*a*), although its stratigraphical distribution there is poorly known even now. Uhlig (1910*b*, p. 547) concluded that it was essentially an Upper Tithonian genus but he admitted that many of the Himalayan species came from unknown localities. *H. seideli* and *H. ventricosus* came from the Lochambel Beds which are supposed to be largely Tithonian in age, but the faunal list for these sediments given by Uhlig (1910*b*, p. 561) contains a large number of Lower Cretaceous species. Uhlig also remarked that *Himalayites* came from the *higher* Lochambel Beds.

The presence of *Himalayites* in the supposed Infra-Valanginian of Argentina was first suggested by Gerth (1925, p. 73), who thought that the *Reineckia egregia*, *R. steinmanni* and *R. grandis* of Steuer (1897) could be assigned to this genus. Spath (1939, p. 116) agreed that *R. egregia* Steuer was close to *Himalayites seideli* (Oppel) but both Uhlig (1910*a*, p. 141) and Leanza (1945, p. 51) thought that the two were quite distinct, because the former has umbilical tubercles and no intermediate ribs. However, Collignon (1960, pl. CLXXIV, fig. 745) accepted that *R. egregia* Steuer was a true *Himalayites* and illustrated what he considered to be a new variety of this species from the Upper Tithonian of the Malagasy Republic. With regard to *R. grandis* Steuer, Leanza suggested that it was more like an *Argentiniceras* and Spath (1925, p. 144) proposed *R. steinmanni* Steuer as the type of a new genus, *Hemispiticeras*. This only leaves Gerth's (1925, pl. 2, fig. 7) specimen of so-called *H. egregius* (Steuer) as an undisputed representative of *Himalayites s.s.* in Argentina; Leanza (1945, p. 92) assigned this specimen to a new species, *H. gerthi*.

According to Leanza's (1945, table opposite p. 96) revision of the Upper Jurassic and Lower Cretaceous ammonite faunas of central Argentina, *H. gerthi* came from sediments of uppermost Tithonian age, i.e. he equated Gerth's *Thurmannia fraudans* zone with the top of his own *Substeueroceras koeneni* zone [= zone of *Parodontoceras callistoides*, Leanza, 1947]. The fauna of the *T. fraudans* zone, which includes *H. gerthi*, is poorly known (Leanza, 1945, p. 96) and the evidence for the age assigned to it is inconclusive.

From the specimens available at present, it is not possible to date the faunas of locality Z precisely but most of the identifiable Ammonoidea would favour a Lower Neocomian, probably Berriasian, age. This is supported by further work on the *Hibolithes–Belemnopsis* belemnite faunas (personal communication from L. E. Willey) and new fossil collections from the Ablation Point area which will form the subject of another study. The possibility that at least part of the sequence might have been Tithonian in age (Thomson, 1971*b*) is now considered to be unlikely.

### 2. *Localities A and B (Succession Cliffs)*

Succession Cliffs (Fig. 1) extend for approximately 5 km. along the western margin of George VI Sound and are divided into a northern and a southern half (here referred to as localities A and B, respectively) by a small cirque glacier. The glacier causes a complete break in outcrop between the two halves but the sediments of both outcrops have the same gentle west-south-westerly dip, and a thick bed of sandstone in the middle of the sequence at the southern extremity of locality A appears to be the lateral equivalent of another, but thinner one, seen in the base of the cliff at the northern extremity of locality B (Fig. 2). On field evidence the inference is therefore that locality B is stratigraphically higher than locality A.

At locality A the following species of Ammonoidea have been identified:

*Eotetragonites* sp. (?) cf. *E. wintunius* (Anderson) *Aconeceras* aff. *nisoides* (Sarasin).
*Australiceras* (?) sp.

*Eotetragonites* sp. is represented in the collection by only one specimen which was unfortunately collected from the scree, but fossils of similar appearance were observed *in situ* by B. J. Taylor 134·2 m. above the base of the measured section. The specimen shows closest similarities to *E. wintunius* from the Upper Aptian (Gargasian and possibly Clansayesian) of California but it also has features in common with *E. balmensis* Breistroffer from the Albian of France. *Aconeceras nisoides* (Sarasin) has been recorded from sediments ranging from Upper Barremian to Albian in age, and Casey (1961*b*, p. 126) has suggested that "more than one taxon is involved". The closest match with the present examples is the specimen from the Malagasy Republic, illustrated by Collignon (1962*b*, pl. CCXXIX, fig. 973), from the *Aconeceras nisus* zone of the Upper Aptian (Gargasian). A consideration of these two species would therefore indicate a high Aptian or even earliest Albian zone for the sediments at this locality. This age assessment is supported

by the presence of the belemnite, *Dimitobelus macgregori* (Glaessner), previously described from the Albian and Cenomanian of Australia, New Guinea and New Zealand; the earliest forms of the genus were thought to occur in the Upper Aptian (Stevens, 1965, p. 63) but Skwarko (1966, p. 125) has described a possible species of *Dimitobelus* from sediments of Upper Neocomian age in northern Australia.

At locality B the evidence for age, based on the ammonites so far collected, is inconclusive. Ammonites occur at two distinct levels: 135–165 and 230–275 m. above the base of the measured section. The lower beds contain *Callizoniceras* (*?*) sp. and *Callizoniceras* (*?*) sp. indet. and the upper ones contain *Costidiscus* (*?*) sp. together with several other species which are unfortunately indeterminate. Well-preserved fragments belonging to a new heteromorph form *Antarcticoceras antarcticum* (p. 21) have been collected from the screes. The specimens assigned to *Callizoniceras* (*?*) sp. are similar to others from the Upper Aptian (Clansayesian) of the east Carpathians and the age thus suggested is in better accordance with what would be expected from the stratigraphical position of the beds. The known range of *Costidiscus*, however, is Barremian to Lower Aptian (Wright *in* Arkell and others, 1957, p. *L*204) and the Antarctic species shows closest similarities with *C. nodosostriatus* Uhlig from the Barremian of Europe. Despite the poor preservation of the *Costidiscus* specimen, its identification seems in little doubt, unless it belongs to a new and homeomorphous genus, and it therefore seems necessary to extend its range.

Because of the stratigraphical position of the sequence at locality B (above that at locality A), it must be younger in age than uppermost Aptian–lowest Albian. By inference, therefore, it is probably Lower Albian. The suggestion that at least part of the sequence at Succession Cliffs (locality B) might be Upper Neocomian in age (Thomson, 1971*a*, p. 45) was based on a preliminary investigation of the ammonites from the locality, but it is no longer considered as being likely.

The upper third of the sequence examined at locality B is repeated in the base of the cliffs at locality C beneath a zone of disturbed and thrusted sediments (Fig. 2) but the only ammonite obtained from beneath the thrust at this locality is a generically indeterminate ptychoceratid. This only gives a very broad indication of age: Upper Neocomian to Upper Albian.

### 3. *Localities R and H (Fossil Bluff area)*

Fossil Bluff (locality R) is aptly named and, along with other groups, ammonites are common in the sediments examined:

*Phyllopachyceras* cf. *baborense* (Coquand)
*Phyllopachyceras* (*?*) sp.
"*Lytoceras*" sp. α
*Eulytoceras* aff. *polare* (Ravn)
*Acrioceras* (*?*) aff. *voyanum* Anderson
*Aconeceras* sp. α
*Aconeceras* (*?*) sp.
*Theganeceras* (*?*) sp.

At least two other genera are represented by indeterminate fragments. Collections and field observations suggest that the commonest forms are the Aconeceratinae but many of these are too poorly preserved for specific or even generic identification and the better-preserved examples do not compare closely with known species. *Aconeceras* is known from the Upper Barremian to the Lower Albian but known occurrences of *Theganeceras* are restricted to the Lower Aptian. *Phyllopachyceras* cf. *baborense* and *Eulytoceras* aff. *polare* suggest only a general Aptian age, but the Neocomian affinities of *Acrioceras* (*?*) aff. *voyanum* suggest a low horizon of this stage.

Much of the section examined at locality H is stratigraphically equivalent to that at locality R, although there is some overlap at both ends (Fig. 2). The collection from this locality is smaller and less varied than that of locality R:

*Phyllopachyceras* (*?*) sp.
"*Lytoceras*" sp. juv. (?) *Eulytoceras* aff. *polare*
*Aconeceras* sp. α
*Sanmartinoceras patagonicum* Bonarelli.

The first three species also occur at locality R but no examples of *S. patagonicum* have yet been recognized there, although it is possible that some of the small indeterminate Aconeceratinae referred to above might be juveniles of this species. Only one specimen was collected from locality H and this unfortunately came from the screes. Since the work of Whitehouse (1926) it has been widely held that *Sanmartinoceras* was an Upper Aptian, or even Upper Aptian–Lower Albian, genus but the validity of this is discussed on p. 43, and it is concluded that *Sanmartinoceras* may also occur in the Lower Aptian. The whole sequence examined at locality H may therefore be included within the Lower Aptian.

4. *Locality S (Mount Ariel)*

The only two ammonites to have been collected from Mount Ariel both came from the scree. *Theganeceras grande* sp. nov., a new and unusually large species of the genus, suggests a Lower Aptian age and this is in agreement with the correlations made between this locality and localities R and H. The second species is an indeterminate but new form of oppeliid and is of little stratigraphical use at present.

5. *Locality N (south side of Uranus Glacier) and locality T (Waitabit Cliffs)*

Only one ammonite, *Aconeceras* sp. α has been collected from locality N and this is also known from localities R and H. The lower part of the succession examined is equivalent to that at the top of locality H and the upper part is repeated in the lower half of the sequence measured at locality T (Fig. 2).

At least two distinct faunas can be recognized at locality T. The lower 304 m. of the section examined contains the following species:

*Hypophylloceras* sp.
*Eulytoceras* aff. *polare* (Ravn)
*Emericiceras* (*?*) sp.
*Lithancylus* (*?*) sp.
*Toxoceratoides* sp. nov.
Heteromorphs of the "*Ancyloceras*" *patagonicum* Stolley group
*Sanmartinoceras patagonicum* Bonarelli.

Of these, *Eulytoceras* aff. *polare* indicates a general Aptian age and *Emericiceras* (*?*) sp. is allied to a group of essentially Barremian forms; *Lithancylus* (*?*) sp. has been compared to *L. grandis* from the Lower Aptian of England and *Toxoceratoides* sp. nov. has been compared to Lower Aptian species of that genus. Although it was believed that *Sanmartinoceras* indicated the presence of the Upper Aptian at Waitabit Cliffs (Howarth, 1958), the associated fauna appears to favour a Lower Aptian age.

At Waitabit Cliffs (locality T), the *S. patagonicum* beds are followed by 15·9 m. of mud-flake conglomerates containing very few fossils; two incomplete examples of the Aptian belemnites, *Peratobelus* aff. *australis* and *Neohibolites minimus* var. *submedius* are all that have been identified so far. In the cliffs at locality V, southern end of Waitabit Cliffs, these same conglomerates are at least twice as thick and may well represent a long period of consolidation and re-working. The clasts in the conglomerate are identical in lithology to sediments found lower in the succession and contain the trace fossil known as "vermicular structures" so typical of the Alexander Island sediments. The succeeding 163 m. of sediment examined at locality T contain:

*Hypophylloceras* sp.
*Eotetragonites* sp. (?) cf. *E. gardneri* Murphy
*Aconeceras* aff. *nisoides* (Sarasin)
Heteromorphs of the "*Ancyloceras*" *patagonicum* Stolley group.

The specimens of *Eotetragonites* are smaller and slightly more evolute than those from Locality A and may be interpreted either as juveniles of the same species or as a different species close to *E. gardneri* from the Upper Aptian (Clansayesian) of California (p. 10). In all probability, this fauna is of approximately equivalent age to that of locality A (uppermost Aptian). Specimens of *Aconeceras* aff. *nisoides* from both localities belong to the same species.

6. *Localities W and X (Keystone Cliffs)*

The age of the sedimentary sequence at localities W and X is problematical, and a conclusive answer to the question is hampered by the deficient preservation of some of the material available. It has already been argued (Thomson, 1971*b*, p. 160) that the ammonite faunas indicate an Upper Neocomian (? Barremian) age, and in this report many of the ammonites from these two localities are compared to Neocomian forms:

*Phyllopachyceras aureliae* (Feruglio)
"*Lytoceras*" sp. β
Heteromorphs of the "*Ancyloceras*" *patagonicum* Stolley group
*Macroscaphites* (?) sp.
*Pseudothurmannia* cf. *mortilleti* (Pictet and Loriol)
*Hemihoplites* (*?*) sp.
*Silesites* aff. *vulpes* (Coquand)
*S. antarcticus* sp. nov.
*S. desmoceratoides* Stolley (?)

However, there are several small factors which together suggest that this age assessment needs reconsideration.

i. An indeterminate but distinct gastropod (gastropod II; Thomson, 1971*a*, p. 56) is only known with certainty from locality A (uppermost Aptian) and locality W.
ii. *Inoceramus* sp. $\beta$ from Keystone Cliffs (Thomson and Willey, 1972, p. 11) shows similarities to the Albian species *I. anglicus*.
iii. Heteromorph ammonite fragments of the "*Ancyloceras*" *patagonicum* group from locality W are very similar to those from locality B (Lower Albian).
iv. Although it is suggested (p. 31) that the desmoceratid/silesitid faunas of localities W and X, and B, appear to be distinct, there are still many indeterminate fragments in the collections.

The field relations of the sedimentary rocks containing the silesitid fauna of locality W (Keystone Cliffs) are complicated (Fig. 8). The measured sequence (Fig. 2), from which the ammonites were obtained,

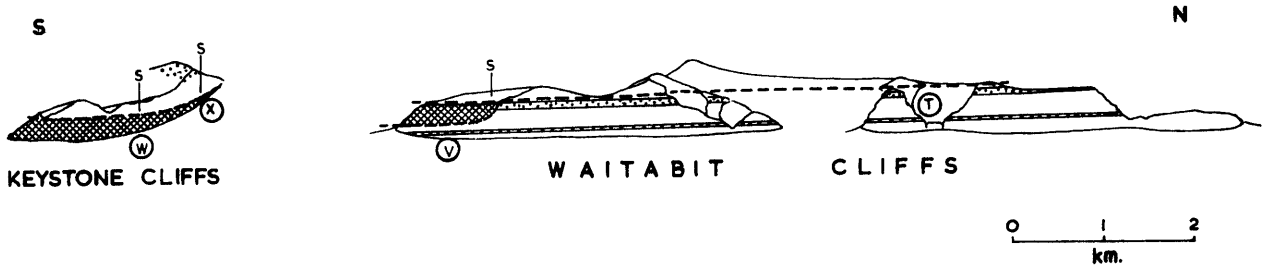


FIGURE 8

A sketch panorama of Waitabit and Keystone Cliffs showing the relationship of the beds with a silesitid fauna (s) to the disturbed zone (cross-hatched and dashed lines). The stippled strata are marker sandstones (cf. Fig. 2).

rests on a thick (? 100 m.) zone of chaotically bedded and folded mudstones and sandstones interpreted by Horne (1967) as a complex thrust zone, an interpretation previously followed by the author (Thomson, 1971*b*, p. 160). This disturbed zone also occurs at locality V (southern Waitabit Cliffs) (Fig. 8), where it is represented by a series of discordant slabs or wedges of mudstone showing a repetition of the local sequence. Farther north (Fig. 8) it is reduced to a thin (5–10 m.) zone in which the dip and strike of the strata vary both vertically and laterally such that it again appears to be built up of variously orientated slabs and wedges of mudstone.

The formation of such disturbed zones is still not fully understood. At Keystone Cliffs and southern Waitabit Cliffs, the presence of sub-horizontal breccias (often veined with quartz and calcite) within the disturbed zone is indicative of some post-lithification tectonic movement. However, the amount of this movement need not have been very extensive and the primary cause of the disturbed zone was possibly associated with some form of gravity sliding. Examination of a similar but much better developed example at Ablation Point led C. M. Bell (personal communication) to conclude that many structures in such zones were probably caused by the down-slope movement of great thicknesses of unlithified sediment, possibly buried at some depth. In particular, it is difficult to reconcile both the unordered structure of the zone and the tight, often re-folded, folds in sandstones (Horne, 1967, fig. 3a) with normal tectonic thrusting of lithified rocks.

Although the disturbed zone is open to interpretation, no field evidence has yet been recognized which might prove the presence of extensive lateral movement that could emplace Upper Neocomian strata on top of late Aptian strata at Keystone Cliffs, as has previously been suggested from faunal considerations (Thomson, 1971*b*). Despite the similarities of several ammonite species in the Keystone Cliffs fauna to European Neocomian forms (notably *Phyllopachyceras aureliae* and *Pseudothurmannia* cf. *mortilleti*), there are a growing number of pieces of evidence suggesting a relationship with the Lower Albian strata of locality B (Succession Cliffs). The latest of these is the recent discovery of the heteromorph ammonite *Antarcticoceras* in mudstones just above the disturbed zone at locality X.

## IV. CONCLUSIONS

1. A study of the ammonite faunas from the east coast of Alexander Island between the northern side of Pluto Glacier (lat. 71°04′S.) and Keystone Cliffs (lat. 71°35′S.) has enabled general correlations to be

made with the stages of the Lower Cretaceous succession established in Europe. Faunas of the following ages are present:

Lower Albian
Uppermost Aptian–earliest Albian
Lower Aptian
Berriasian.

2. The Upper Neocomian (? Barremian) age previously assigned to the sequence at Keystone Cliffs (Thomson, 1971*b*) has been reconsidered. Despite the Neocomian aspect of the ammonite fauna, it is pointed out that there is a growing amount of evidence to suggest a correlation with the sequence at locality B, Succession Cliffs (Lower Albian).
3. The gap between those beds with a Berriasian fauna and those with a Lower Aptian fauna may well be only apparent; no ammonites have been collected from localities C, K, D, L, E, F and G, which lie stratigraphically below the Lower Aptian sequences of localities R, H, S, N and T.
4. In the Aptian sequence there appears to be a gap between a fauna of possible Lower Aptian age and another of uppermost Aptian age. At localities T and V this is represented by a thick development of mudflake conglomerates. These probably indicate a period of non-deposition, perhaps with some uplift, during which consolidation and re-working of earlier deposited sediments took place.
5. The lowest (Berriasian) and highest (uppermost Aptian–Lower Albian) stages represented in this area occur close together on the northern and southern sides of Pluto Glacier at localities Z and A, respectively. This suggests that the glacier must be the site of extensive fault movements, the precise location and nature of which are as yet unknown.

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# APPENDIX

## AGE SIGNIFICANCE OF THE GENUS *Sanmartinoceras*

The genus *Sanmartinoceras* was first described from the Lago San Martín area of Patagonia (Bonarelli *in* Bonarelli and Nágera, 1921, p. 27) by the introduction of a new species *S. patagonicum*. It was found in association with a variety of fossils including *Aucellina coquandia* var. *radiato-striata* (Bivalvia), *Neohibolites ultimus* (*?*) (Belemnoidea) and *Kossmaticeras meseticum* (Ammonoidea). All came from a bed of calcareous sandy tuff, underlain by a sequence of shales containing a fauna of ammonites which were variously identified by Bonarelli as *Beudanticeras*, *Uhligella* and *Cleoniceras* but which were later included by Whitehouse (1926) in a new genus *Aioloceras*. The *Aioloceras* fauna was believed by Bonarelli to be Albian in age and the *Sanmartinoceras*-bearing beds were assigned to the Upper Albian–lowest Cenomanian (Bonarelli and Nágera, 1921, p. 28). However, later authors (Whitehouse, 1926; Howarth, 1958; Casey, 1961*b*) restricted the genus *Sanmartinoceras* to the Upper Aptian and others (Wright *in* Arkell and others, 1957; Leanza, 1967*b*; Skwarko, 1967) accepted its extension into the Lower Albian. While it is agreed that the stratigraphical position assigned to *Sanmartinoceras* in Patagonia by Bonarelli was too high, there also seems little evidence for restricting *Sanmartinoceras* to the Upper Aptian or later and, as indicated above (p. 37), there are suggestions that in some places this genus is of Lower Aptian age.

The precise ages of the Lower Cretaceous Lago San Martín faunas are still questionable because there are no species present which enable a satisfactory correlation to be made with the better-known European successions. Several of the species described from there are still of doubtful generic status, e.g. *Leptoceras* sp. ind. (p. 17), *Crioceras deekei* (regarded by Spath (1924) as a new genus *Peltocrioceras* and by Leanza (1963) as a *Tropaeum*), *Ancyloceras patagonicum* (p. 20), *Kossmaticeras meseticum* which probably belongs to a new genus, and are of little stratigraphical use. The presence of *Aioloceras* suggests a possible correlation with the Queensland succession but this genus occurs *below* the zone of *Sanmartinoceras* in Patagonia and *with it* in Queensland; at present it is therefore of no precise stratigraphical value, although there is evidence for its being of Upper Aptian age in Australia (see below).

The only substantiated occurrence of *Sanmartinoceras s.s.* in the Northern Hemisphere* is that of *S. groenlandicum* Rosenkrantz (1934). Description of this species is restricted to that of the unique type specimen which came from a loose block in a stream bed near Cape Maurer (Kuhn Island, East Greenland) and, although Lower Aptian deshayesitids were found *in situ* close by, it was believed to indicate the presence of the Upper Aptian. However, Maync (1949, p. 261) noted the above association at Cape Maurer and, although he accepted a Gargasian (Upper Aptian) age for *Sanmartinoceras* in Australia and a Cenomanian age for it in Patagonia, he suggested that the range of *Sanmartinoceras* should be extended to include the Lower Aptian. Various small Aconeceratinae of uncertain stratigraphical position have been recorded in East Greenland and referred to "*S.*" *pusillum* (Ravn) [= *Garneria pusilla* Ravn, 1911]. It is conceivable that these may represent the young stages of *S. groenlandicum* but, as the ontogeny of no species of *Sanmartinoceras* is known, this is uncertain and consequently the supposed presence of the Upper Gargasian at Danmarks Havn, based on the evidence of "*S.*" *pusillum* in loose blocks at this locality (Frebold, 1935, p. 53), is very doubtful. It may also be pointed out that *Sanmartinoceras* is

* Other so-called species of *Sanmartinoceras* in the Northern Hemisphere are referred to *Theganeceras* Whitehouse and *Sinzovia* Sazonova, both of which were classified by Casey (1961*b*) as subgenera of *Sanmartinoceras*.

the only fossil which has been regarded as diagnostic of the Upper Aptian in Greenland and Donovan's (1957, p. 150) statement, "Aptian ammonoid faunas from Greenland, with the exception of one or two species, are not well known" is probably still very true.

In Australia, *Sanmartinoceras* occurs in the Roma Formation of Queensland and is best known from the descriptions of Whitehouse (1926, 1927). The Roma Formation has long been dated as Aptian but precise correlation with the European successions is not possible because of the lack of hoplitoids in the Australian sequence (Day, 1969, p. 158). Day (1969, p. 159) has suggested that the association of *Aioloceras* with crioceratid species of *Tropaeum* near Tambo indicated a probable Upper Aptian age for the former. This being so, the occurrence of *Sanmartinoceras* in Australia in the zone of *Aioloceras* (Whitehouse, 1926, p. 196) would be of Upper Aptian age.

Aside from the instances listed above, there are several passing references to *Sanmartinoceras* in the literature which are worth investigating.

Rod and Maync (1954, p. 267) included *Sanmartinoceras* sp. in a list of fossils from the Middle Apón Formation of the Maracaibo Basin, Venezeula. Other fossils from the same formation included *Cheloniceras*, *Colombiceras*, *Douvilleiceras* and *Deshayesites*, and were believed to indicate an Upper Aptian age. A re-examination of some of these ammonites (*Douvilleiceras* and *Deshayesites*) by Casey (1962, p. 263, 1964, p. 295, footnote, respectively) has cast doubt on their exact identifications and it is doubtful whether the Middle Apón Formation can be more precisely dated than simply Aptian. The author has had the opportunity of examining plaster casts of the specimens of so-called *Sanmartinoceras* and he considers their identification to be doubtful. There are three specimens, all of which are fragmentary and appear to be internal moulds. The whorls have a spear-shaped cross-section and a sharply rounded venter; there are no remnants of a keel if one was ever present. Ornament consists of low, weakly falcate ribs and riblets. The more inflated whorl section, probable lack of a keel and weakly falcate ribbing exclude the Venezuelan species from the genus *Sanmartinoceras* and probably also from the Aconeceratinae. It is suggested that these fragments show a much closer resemblance to the genus *Pseudosaynella* whose type species is *Ammonites bicurvatus* Michelin and which has already been identified by Collet (1922, p. 17) in Venezuela. As has been suggested by Casey (1961*b*, p. 172), the authenticity of this last identification is unknown.

A mention of the occurrence of *Sanmartinoceras* in Tierra del Fuego (Camacho, 1966, p. 411) is based on unpublished work by oil-exploration geologists. According to H. H. Camacho (personal communication), it is a different species from *S. patagonicum*.

The specimens from the sub-Antarctic island of South Georgia, which were identified by Wilckens (1947, p. 28) as *Sanmartinoceras* cf. *patagonicum*, are fragmentary and distorted. They are ornamented with coarse ribs which are reminiscent of those of the genus but they are too poorly preserved to be identified with confidence.

Brunnschweiler (1959, p. 14) has dismissed the occurrence of *Sanmartinoceras* in Western Australia (Wright *in* Arkell and others, 1957, p. *L*286) as a misidentification but Skwarko (1967, p. 23, pl. 4, fig. 5) has recorded another specimen from the Gibson Desert which could belong to this genus.

The only outstanding reference to *Sanmartinoceras* known to the author is that made by the Australasian Petroleum Company Proprietary (1961, p. 30) in Papua. Six rock specimens (F16731–16736, collection of the Department of Geology, University of Adelaide) were collected by geologists of the Australasian Petroleum Company from Humaza Creek, Kereru Range, on the northern side of the Gulf of Papua and, through the courtesy of M. F. Glaessner, University of Adelaide, these specimens have been examined by the author.

The largest specimen (Plate Vm) is 29 mm. in diameter but most (Plate Vl and n) are considerably smaller (about 10 mm. in diameter). All of them have been crushed flat and are preserved as partly internal, partly external moulds. The true umbilical margin of the outer whorl is not preserved but, as is common in crushed Aconeceratinae, the venter of the penultimate whorl has been impressed through the outer whorl so that the shell has a pseudo-evolute appearance (Plate Vm). Several specimens show impersistent traces of a finely serrate keel; the serrations are asymmetrical and point forwards. Small individuals are almost smooth except for faint traces of growth lines. These lean gently forward as they rise from the umbilicus and then are reflected near the mid-line of the outer whorl; the ventral part of the flank appears smooth. Sometimes the growth lines are strengthened into low ribs in the vicinity of the median flexure. On the large specimens (Plate Vm) the growth lines are continuous almost to the venter, although they are generally very faint on the ventral half of the flank. Near the keel they appear to be projected forward. At the median flexure the growth lines are again strengthened into low ribs and in the later stages faint falcate ribs appear on the ventral half of the flank. There is also a suggestion of a median spiral groove.

Unfortunately, nothing is known of the ontogeny of *Sanmartinoceras* and it is difficult to appreciate when one is dealing with young forms of this genus. For this reason the identification of the Papuan specimens is doubtful. In *Sanmartinoceras* the strongest part of the ornament is always on the ventral C-shaped part of the sickle-shaped ribs and not at the median flexure as in the case of the present examples. Were it not for the possession of a keel, the smaller specimens might be confused with *Falciferella reymenti* Brunnschweiler (1959, pl. I, fig. 7a); a very small specimen of *Aconeceras* cf. *haugi* (Sarasin) (Casey, 1961*b*, text-fig. 40i) has similar ribbing. The feeble ornament on the larger specimens is also more suggestive of *Aconeceras*.

From the above discussion, it is concluded that of all the identifications of *Sanmartinoceras* only those from East Greenland, Lago San Martín in Patagonia, Alexander Island and Queensland can be upheld and that only in Queensland is there any body of evidence to suggest a possible Upper Aptian age for the genus.

From a careful review of the published data, Waterhouse and Riccardi (1970) came to a similar conclusion about the age significance of the ammonite genus *Sanmartinoceras* and decided that it could only be considered as indicative of a general Aptian age.

## PLATE I

a. *Phylloceras* sp.; locality Z, ×1 (KG.401.151).

b. *Phyllopachyceras* cf. *baborense* (Coquand), ventral view; locality R, ×1 (KG.1.672).

c. *P.* cf. *baborense* (Coquand), lateral view of the same specimen; locality R, ×1 (KG.1.672).

d. *Hypophylloceras* sp., septate internal mould with some test adhering; locality T, ×1 (KG.103.124).

e. *Phyllopachyceras aureliae* (Feruglio); locality W, ×1 (KG.106.4).

f. *Hypophylloceras* sp., small example; locality T, ×2 (KG.103.191).

g. *Hypophylloceras* sp., latex cast from a large incomplete external mould; locality T, ×1, coated (KG.103.189).

h. *Eulytoceras* aff. *polare* (Ravn), latex cast from the external mould of an incomplete example; locality R, ×1, coated (KG.1.189). A serpulid is attached to the anterior part of the outer whorl.

i. *E.* aff. *polare* (Ravn), large specimen; locality Y, ×1 (KG.58.2).

j. *E.* aff. *polare* (Ravn), latex cast from the external mould of the inner whorls of the previous specimen; locality Y, ×1, coated (KG.58.2).

k. "*Lytoceras*" sp. $\beta$, latex cast; locality W, ×1, coated (KG.106.7).

l. "*Lytoceras*" sp. $\alpha$; locality R, ×1 (KG.110.2). The ovate markings are probably the attachment scars of small oysters.

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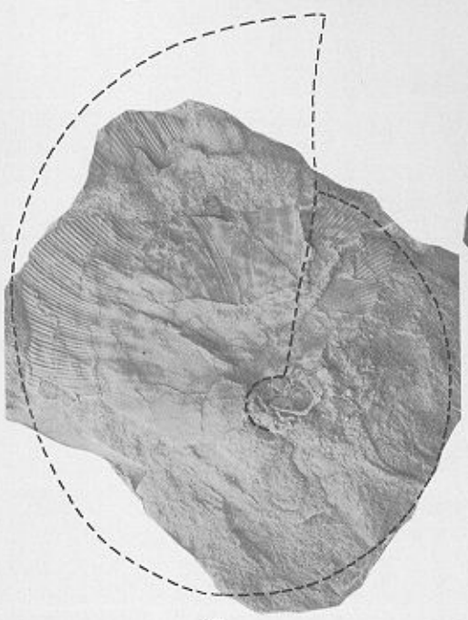

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## PLATE II

a. *Eotetragonites* sp.; locality A, ×1 (KG.10.6).

b. *Eotetragonites* sp.; locality T, ×1 (KG.103.190).

c. *Bochianites gracilis* sp. nov., septate shaft section, holotype; locality Z, ×2 (KG.402.85).

d. *Costidiscus* (*?*) sp., latex cast; locality B, ×1, coated (KG.8.60).

e. *Emericiceras* (*?*) sp., latex cast; locality T, ×2, coated (KG.103.132).

f. *Bochianites gracilis* sp. nov., protoconch of holotype; ×15, coated (KG.402.85).

g. *Macroscaphites* (*?*) sp., latex cast; locality W, ×1, coated (KG.106.37).

h. *Hemihoplites* (*?*) sp.; locality W, ×1 (KG.106.34).

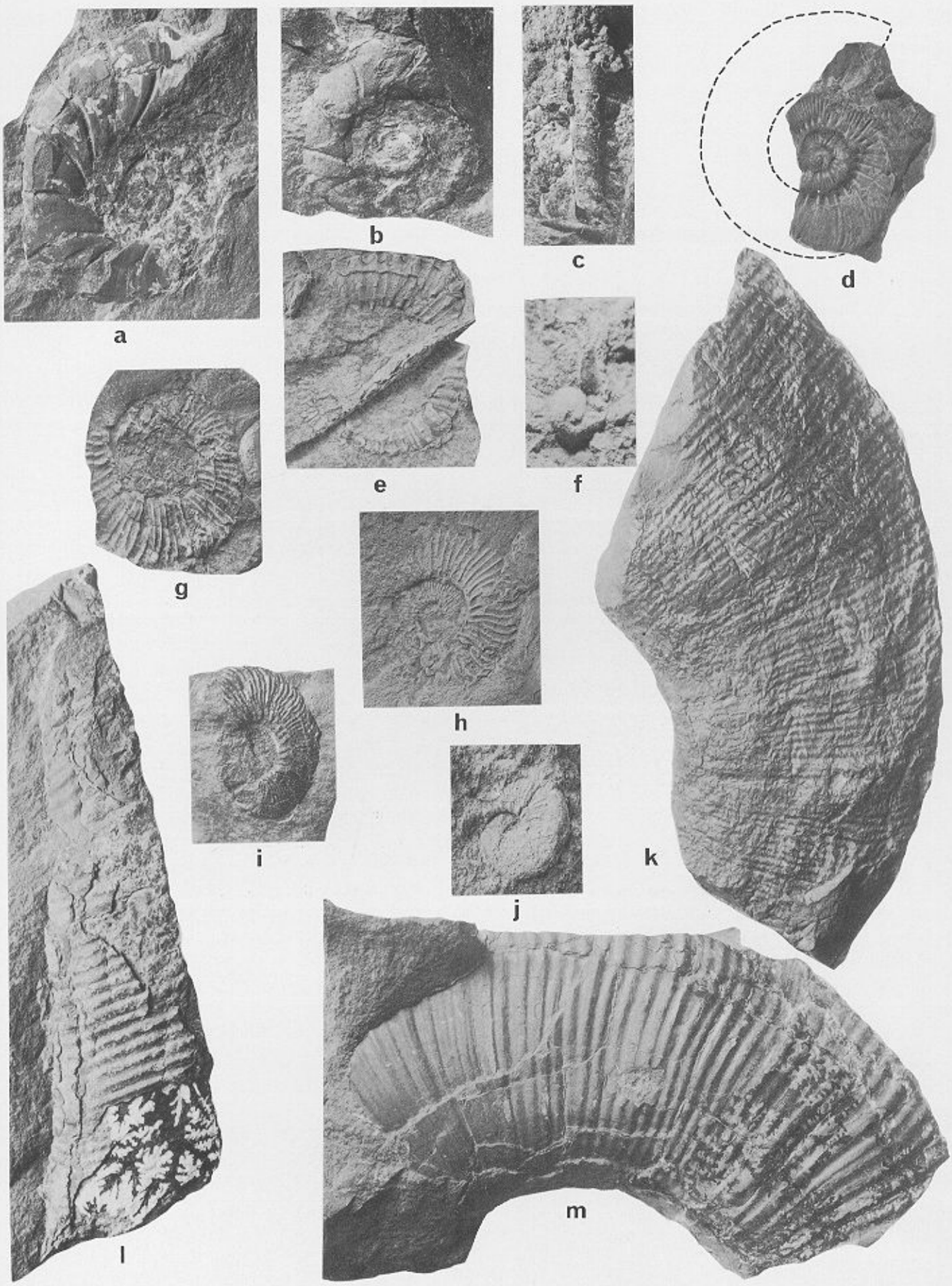
i. *Pseudothurmannia* cf. *mortilleti* (Pictet and Loriol); locality W, ×1 (KG.106.41).

j. *P.* cf. *mortilleti* (Pictet and Loriol), juvenile; locality W, ×2, coated (KG.106.40).

k. *Tropaeum* (*?*) sp.; locality V, slightly reduced (KG.104.22).

l. *Lithancylus* (*?*) sp., a large shaft fragment showing part of the suture; locality T, ×1 (KG.103.233).

m. *Australiceras* (*?*) sp., a curved fragment showing the sutures; locality A, ×1 (KG.10.72).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## PLATE III

a. *Toxoceratoides* sp. nov., internal mould of the hook; locality T, ×1 (KG.103.233).

b. *Acrioceras* (*?*) aff. *voyanum* Anderson, external mould of the initial part of the spire showing periodic trituberculate ribs with spinose ventral tubercles; locality R, ×1 (KG.1.801).

c. "*Ancyloceras*" *patagonicum* Stolley group, latex cast of a fragment; locality T, ×1, coated (KG.103.211).

d. *Toxoceratoides* sp. nov., latex cast of the initial part of the shaft; locality T, ×1, coated (KG.103.226).

e. *Acrioceras* (*?*) aff. *voyanum* Anderson, latex cast from an external mould showing the shaft and hook; locality R, ×1, coated (KG.1.74).

f. *A.* (*?*) aff. *voyanum* Anderson, latex cast of the spire and initial part of the shaft; locality R, ×1, coated (KG.1.782).

g and h. "*Ancyloceras*" *patagonicum* Stolley group,
g. A piece of shaft and the commencement of the hook; locality W, ×1 (KG.106.24).
h. Shaft fragment of a finely ribbed form; locality W, ×1, coated (KG.106.20).

i. *Antarcticoceras antarcticum* gen. et sp. nov., latex cast of a specimen from Stephenson Nunatak; ×1, coated (KG.1351.8).

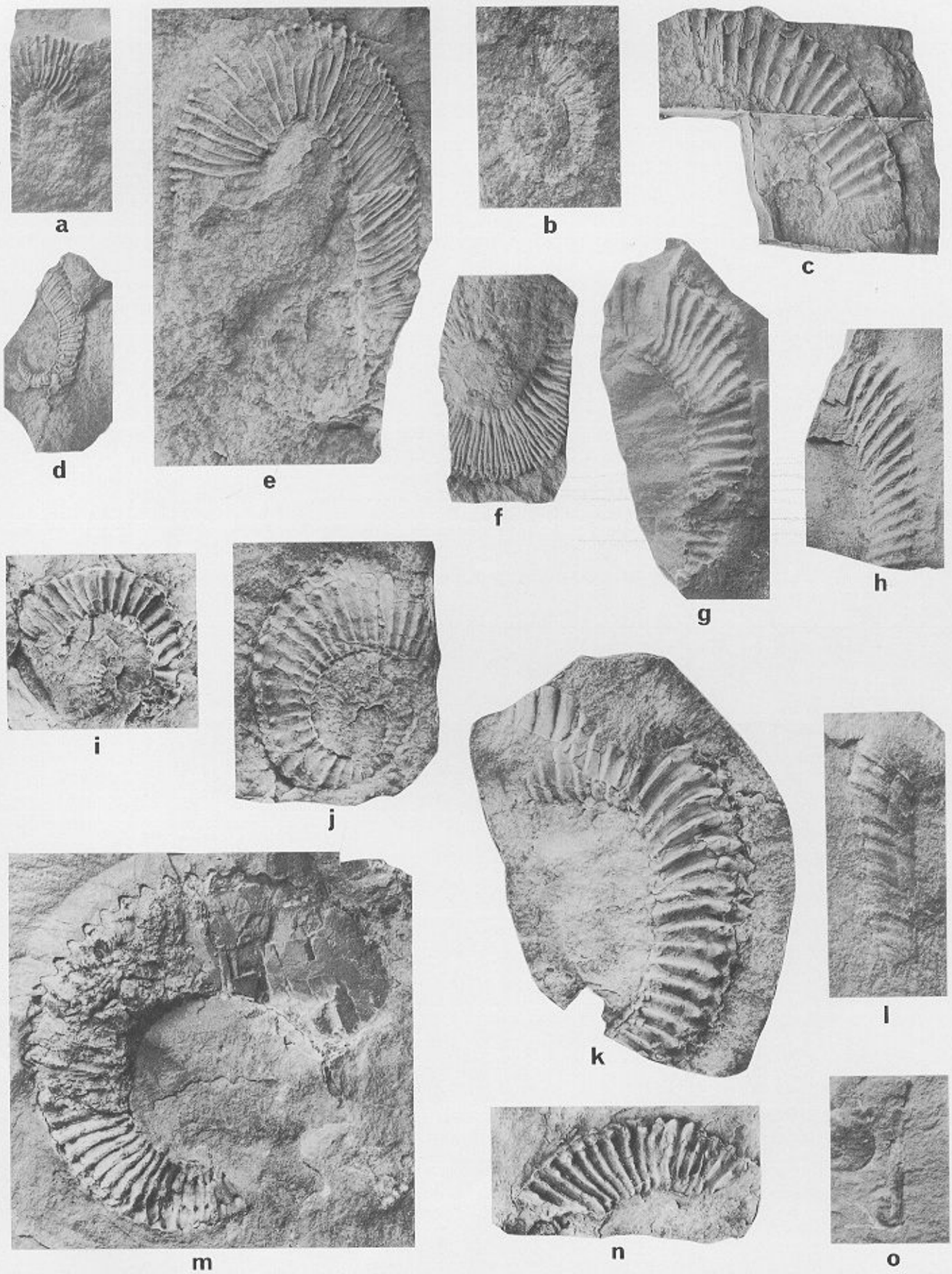
j. *A. antarcticum* gen. et sp. nov., latex cast from the holotype which is preserved as an external mould; locality B, ×1, coated (KG.8.1).

k. *A. antarcticum* gen. et sp. nov. (*?*), latex cast of an exceptionally loosely coiled fragment; ×1, coated (KG.8.55).

l. "*Ptychoceras*" sp., anterior part of the shaft; locality C, ×1·5 (KG.17.13).

m and n. *Antarcticoceras antarcticum* gen. et sp. nov., the largest example (m) with a latex cast (n) of its earlier part; Stephenson Nunatak, both ×1 (KG.1351.6).

o. "*Ptychoceras*" sp., early stage with a tightly bent hook; locality C, ×1·5 (KG.17.13).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## PLATE IV

a. *Substreblites* (*?*) sp., latex cast from an incomplete example and a suggested reconstruction; locality Z, ×1, coated (KG.401.62).

b. *Sanmartinoceras patagonicum* Bonarelli; locality T, ×1 (KG.6.10).

c. *S. patagonicum* Bonarelli, small individual with distinct ribbing; locality H, ×1 (KG.2.140).

d. *S. patagonicum* Bonarelli, shows distinct ribbing at an early stage; locality T, ×1, coated (KG.103.136).

e. (*?*) *S. patagonicum* Bonarelli, latex cast of a medium-sized but almost smooth example; locality T, ×1, coated (KG.103.93).

f. *S. patagonicum* Bonarelli, latex cast from a large well-preserved external mould; locality T, ×1, coated (KG.68.8).

g. *Sanmartinoceras* (*Theganeceras*) *grande* sp. nov., latex cast from the holotype which is preserved as an external mould; locality S, ×1, coated (KG.3.50).

h. (*?*) *Sanmartinoceras patagonicum* Bonarelli, specimen showing a change in ornament; locality T, ×1 (KG.6.11).

i. *Aconeceras* aff. *nisoides* (Sarasin); latex cast of two specimens; locality A, ×1, coated (KG.10.85).

j. (?) Family Oppeliidae, gen. et sp. nov., specifically indeterminate specimen with a very coarsely serrate keel; locality S, ×1 (KG.3.95).

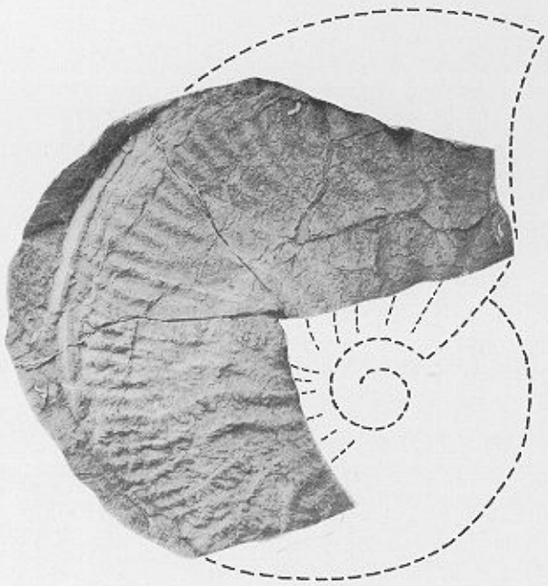
k. *Sanmartinoceras* (*Theganeceras*) (*?*) sp.; locality R, ×1 (KG.110.1).

l. *Aconeceras* sp. α; locality N, ×1·5 (KG.11.25).

m. *Aconeceras* aff. *nisoides* (Sarasin); locality T, ×1 (KG.103.195).

n. *Neocosmoceras* aff. *sayni* Simionescu, latex cast; locality Z, ×1, coated (KG.401.680).

o. *Himalayites* (*?*) sp., latex cast from a fragment of external mould; locality Z, ×1, coated (KG.401.686h).



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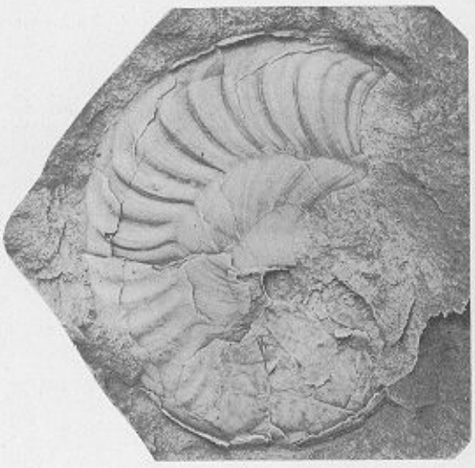

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## PLATE V

a and b. Subfamily Berriasellinae, gen. et sp. indet., two views of the same specimen showing the difference in ornament on each flank caused by crushing; locality Z, ×1, coated (KG.401.614).

c. *Callizoniceras* (*?*) sp., latex cast of the largest and best example; locality B, ×1·5, coated (KG.8.39).

d. *Callizoniceras* (*?*) sp., latex cast of a juvenile; locality B, ×1·5, coated (KG.8.37).

e. *Sarasinella* aff. *hondana* Haas, latex casts from fragments of external mould re-assembled in their probable original positions; locality Z, ×1, coated (KG.401.311).

f. *Silesites* aff. *vulpes* (Coquand); locality X, ×1 (KG.109.1).

g. *Silesites antarcticus* sp. nov., holotype; locality W, ×1·5 (KG.106.51).

h. *S. antarcticus* sp. nov.; locality W, ×1·5 (KG.106.12).

i. *S. antarcticus* sp. nov.; locality W, ×1 (KG. 106.5).

j. (*?*) *Silesites antarcticus* sp. nov., a possible mature example; locality V, ×1 (KG.105.1).

k. *Silesites desmoceratoides* (*?*) Stolley, latex cast of a whorl fragment; locality W, ×1·5, coated (KG.106.38).

l, m and n. Aconeceratids from Papua, previously referred to the genus *Sanmartinoceras* but which are considered to be better placed in the genus *Aconeceras*. The smallest example (n) has a lamellaptychus lodged in the aperture. m, ×1·5; l and n, ×3. The specimens are housed in the Department of Geology, University of Adelaide, Australia.

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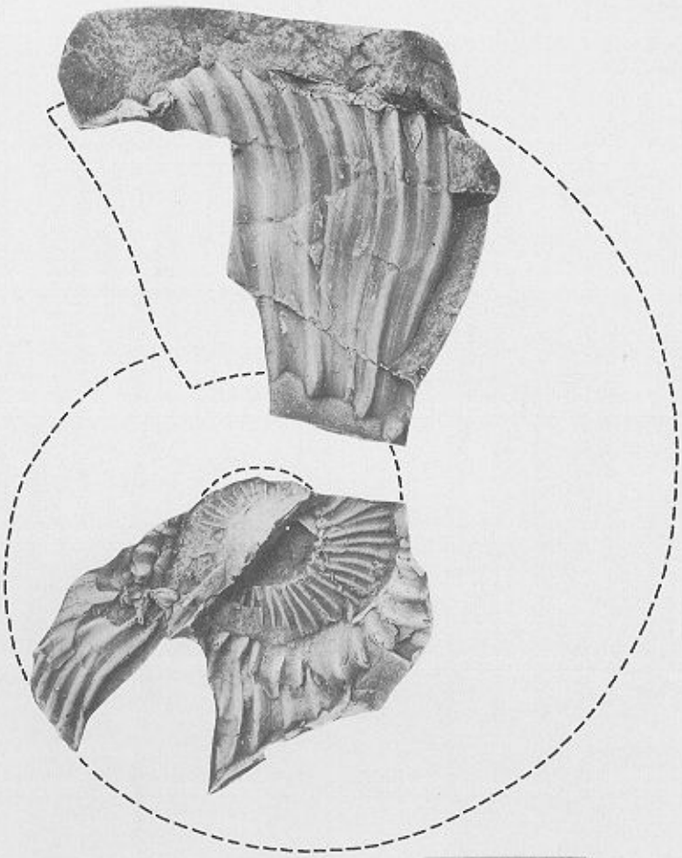

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