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„European“ ammonites in the Lower Cretaceous of Antarctica

By

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With 2 text figures

ABSTRACT

Lower Cretaceous sedimentary rocks in south-eastern Alexander Island, Antarctica contain a variety of ammonites which bear striking similarities to European species. Two groups, one dominated by small heteromorphs and the other by non-heteromorph species, occur side by side in the same rock sequence and yet seem to indicate stratigraphical ages that differ by approximately one stage. Aconeceratids, eotetragonitids and some large heteromorphs favour an early Aptian-early Albian age that is generally consistent with the

normally accepted ranges of associated bivalve and belemnite genera. However, acrioceratids, crioceratids and silesitids closely parallel the faunal succession seen in Europe and suggest a late Hauterivian-late Barremian age for the same 1200 m thick part of the succession. Although the younger age has been favoured in recent geological literature on the area, there appears to be no independent evidence which might resolve the problem conclusively.

KURZFASSUNG

Sedimentäre Unterkreide-Abfolgen im Südosten von Alexander Island in der Antarktis enthalten verschiedene Ammoniten, die eine verblüffende Ähnlichkeit mit europäischen Arten zeigen. Zwei Gruppen, einerseits kleine heteromorphe Ammoniten und andererseits nicht-heteromorphe Formen, kommen zusammen in der gleichen Gesteinsabfolge vor und zeigen ein unterschiedliches stratigraphisches Alter an, das bis zu einer Stufe differieren kann. Aconeceratiden, Eotetragonitiden und einige große heteromorphe Formen weisen auf ein Unter-Apt- bis Unter-Alb-Alter hin, dies in

Übereinstimmung mit den allgemein angenommenen Reichweiten der sie begleitenden Bivalven- und Belemniten-Gattungen. Acrioceratiden, Crioceratiden und Silesitiden, mit vergleichbaren Faunenabfolgen wie in Europa, zeigen jedoch ein Spät-Hauterive- bis Spät-Barrême-Alter an für den gleichen 1200 m mächtigen Abschnitt dieser Folge. Obwohl das jüngere Alter allgemein in der neueren geologischen Literatur für dieses Gebiet angegeben wird, scheint es keinen zwingenden Grund zu geben, der dieses Problem schlüssig löst.

I. INTRODUCTION

The first ammonites collected from the late Jurassic-early Cretaceous Fossil Bluff Formation of Alexander Island (Fig. 1; TAYLOR et al., 1979) were described by HOWARTH (1958), who identified the presence of Aptian strata on the basis of "*Ancyloceras*" *patagonicum* STOLLEY, *Sanmartinoceras patagonicum* BONARELLI and *Silesites* aff. *trajani* (TIETZE). Beds containing *Sanmartinoceras* were more specifically referred to the Upper Aptian. Subsequent collections of the early Cretaceous faunas contained a number of poorly preserved species which, nevertheless, showed close similarities to European Hauterivian, Barremian and Aptian genera (THOM-

SON, 1972). Although these did not all occur in the same stratigraphical order as their supposed counterparts in Europe, it was believed that the presence of complex thrust zones (ADIE, 1964; HORNE, 1967) could account for these apparent inconsistencies. However, it is now recognized that the so-called thrust zones, some of which exceed 100 m in thickness, were caused by slumping (BELL, 1975; TAYLOR et al., 1979) and that this has not caused any widespread repetition of strata or apparent reversals of the stratigraphical succession. Further confusion arises because the heteromorph groups in particular on the one hand, and most other ammonite groups on the other, seem to indicate conflicting biostratigraphical ages, even though they occur in the same beds. What then is the significance of the faunas?

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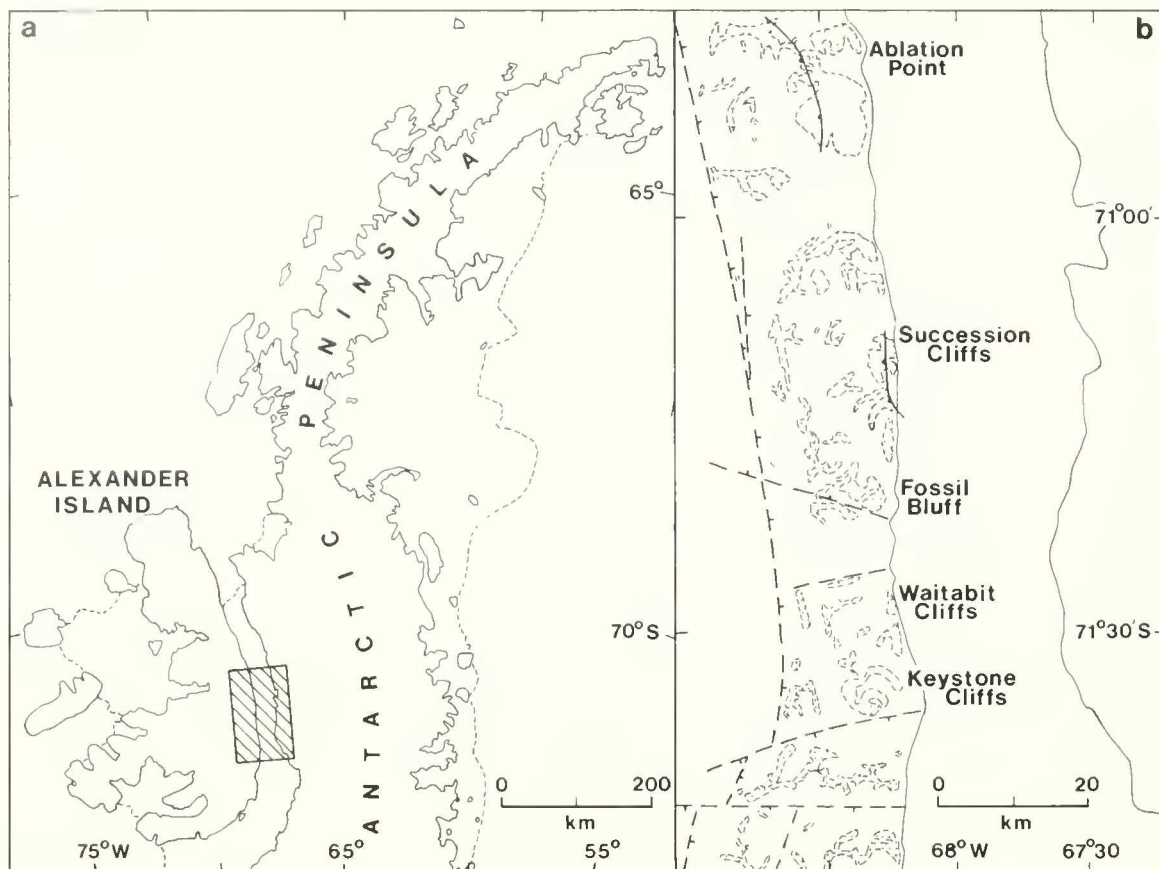


Fig. 1. a) Location map showing the position of Alexander Island in relation to the Antarctic Peninsula. The area discussed (Fig. 1b) is shaded. – b) Sketch map of part of eastern Alexander Island, showing outcrops of the late Jurassic-early Cretaceous Fossil Bluff Formation and the localities mentioned in the text. Heavy dashed lines are faults, solid lines are thrust faults (triangles indicate the overthrust sheet).

The principal species involved in this enigmatic faunal succession are summarized schematically in Fig. 2, which represents a composite, 1200 m thick biostratigraphical succession for Lower Cretaceous strata exposed at Fossil Bluff, Waitabit

Cliffs and Keystone Cliffs (Fig. 1). Detailed accounts of the stratigraphy are given in TAYLOR et al. (1979) and descriptions of most of the ammonite species involved appear in THOMSON (1974).

II. HETEROMORPH FAUNAS

The first heteromorph fauna occurs about 320 m above the base of the section at Fossil Bluff (Fig. 2) and consists of *Acrioceras* and *Crioceratites*. The *Acrioceras* differs from most European species of the genus by its lack of tuberculate ribs on the shaft and hook and it was originally compared to an American form, *A. voyanum* ANDERSON (THOMSON, 1974). Like the Antarctic species, the latter shows little increase in whorl height after the spire and, although it has tubercles on the shaft, they are small and inconspicuous (ANDERSON, 1938; IMLAY, 1960). However, one European species, *A. meriani* (OOSTER), lacks tubercles on the shaft and hook and in retrospect it is probably a better match with the Antarctic form. OOSTER's (1860, pl. 39, fig. 6) example is the closest in that it shows less increase in whorl height on the shaft and hook than is apparent in his illustrations of other specimens (cf. OOSTER, 1860, pl. 39, figs 1 and 2). A section of body chamber from the same beds shows a striking resemblance to that of species in the *Crioceratites nolani* (KILIAN)-

C. duvali LEVEILLE group. Its ornament of moderately sized trituberculate ribs, separated by up to eight, sometimes bifurcate ribs accords well with the characteristics of the European forms as outlined by THOMEL (1964) and IMMEL (1978). Unfortunately the early whorls are preserved as a faint incomplete impression only, and a confident identification is not possible without them. *Acrioceras meriani* occurs in the late Hauterivian and Barremian of Europe (SARKAR, 1955) and *A. voyanum* in the middle Hauterivian of California and Oregon (IMLAY, 1960); *Crioceratites nolani* and *C. duvali* are widely distributed in the early Hauterivian-early Barremian of the Tethyan realm (THOMEL, 1964; IMMEL, 1978).

Approximately 300 m stratigraphically higher in the section at Waitabit Cliffs occurs a coarsely ribbed crioceratid that is reminiscent of species of *Paracrioceras* SPATH. First known from some small inner whorls with trituberculate ribs and almost no intermediate ribs, it was compared to *Emerioceras* SARKAR (THOMSON, 1974). Further collecting produced a

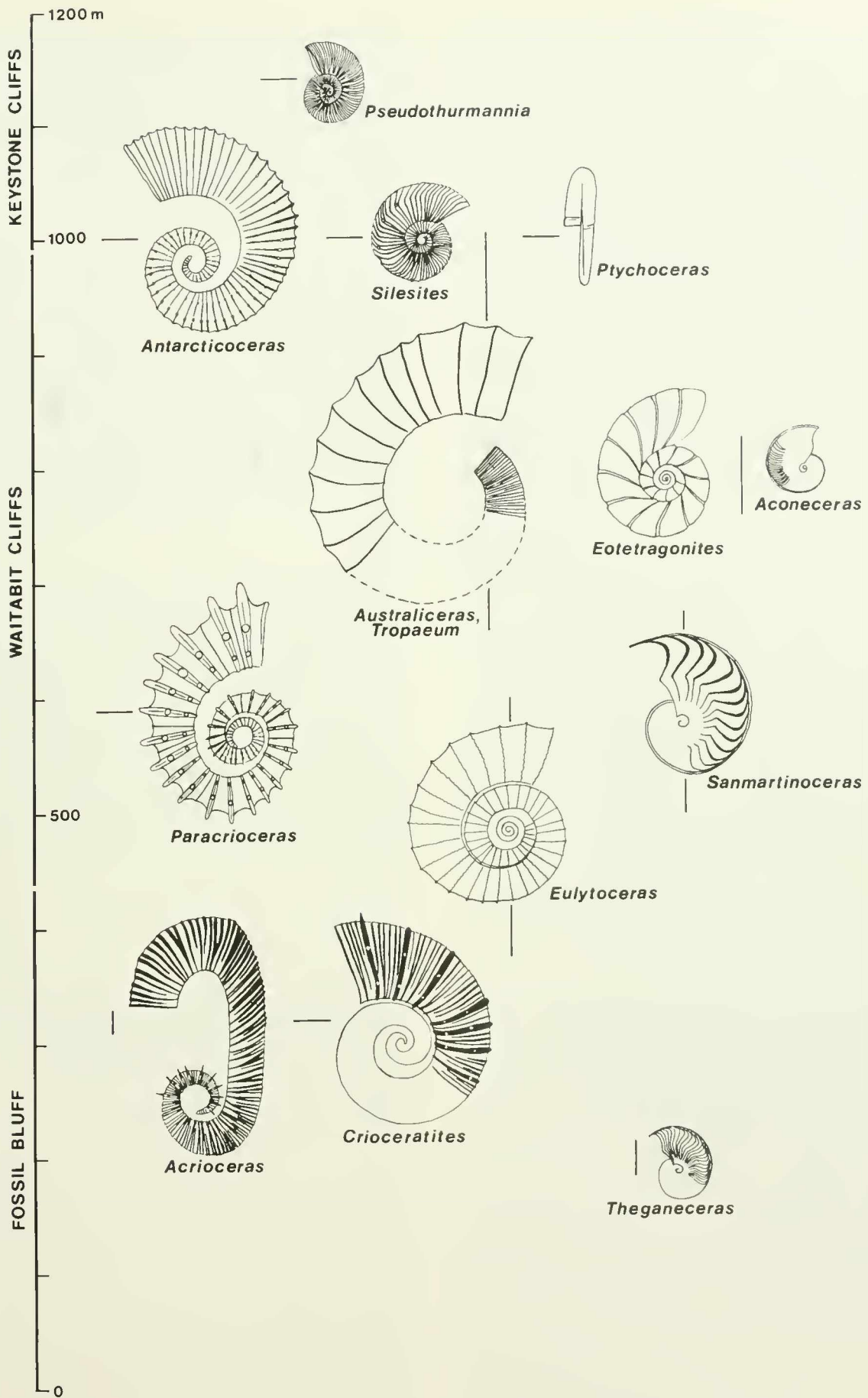


Fig. 2. Diagram depicting the ammonite succession in part of the Lower Cretaceous of Alexander Island. The section is a composite one, based on measured sections that were cross-correlated in the field. All ammonites are depicted at half natural size, except for the *Australiceras/Tropaeum*-like form which is one eighth natural size.

crushed mould, approximately 70 mm in diameter. Although poorly preserved, it shows the same basic ornament at all growth stages and clearly exhibits the coarse ribs and massive spinose tubercles depicted in the cartoon (Fig. 2) – a style of ornament that is well developed in *Paracrioceras elegans* (KOENEN, 1902, pl. 24, fig. 2). In several instances the coarse ribs have a median groove and on the early whorls some ribs are clearly double (THOMSON, 1974, pl. IIe). This may be analogous to the looping of major ribs with an adjacent minor rib, described by RAWSON (1975) in specimens of *P. occultum* (SEELEY) from eastern England. *P. elegans* occurs in the mid Barremian of northern Germany (IMMEL, 1978) and probably also in eastern England (SPATH, 1924).

The succeeding 300 m of the sequence lack age-diagnostic heteromorphs. Many fragments of small ancyloceratids with stout ribs all of one size and originally compared to “*Ancyloceras*” *patagonicum* STOLLEY from South America (HOWARTH, 1958) are known from this interval, but no complete examples have been found and their systematic status is uncertain (THOMSON, 1974). In addition there are sporadic occurrences of fragments from large crioceratid-coiled species whose original shells must have been in the range of 40–60 cm diameter. Their finely ribbed inner whorls were compared to those of *Australiceras* and *Tropaeum* (THOMSON, 1974). Further collecting in southern Alexander Island has produced associated pieces of large body chambers with a modified ornament of very coarse, widely separated simple ribs only, similar to that on body chambers of these two Aptian ancyloceratid genera (cf. CASEY, 1960, 1961a). Comparable shell forms and ornament also occur in late Hauterivian-mid Barremian crioceratids of the *Hoplocrioceras fissicostatum* (ROEMER)-*H. aequicostatum* (KOENEN) group (cf. KOENEN, 1902, pl. XXII, fig. 2, pl. XXX, fig. 3). However, in that group the denser ribbing of the earlier whorls tends to be bundled at umbilical tubercles – a feature not present on the Antarctic specimens.

III. NON-HETEROMORPH FAUNAS

Non-heteromorph ammonites occur lower in the section at Fossil Bluff than the *Acriceras-Crioceratites* fauna. About 200 m above the base is a 30 m thick zone in which small aconeceratids are common, not only there but also in a correlated sequence 8 km to the north. Characterized by numerous fine but distinct falcoid riblets, intermediate in size between those of *Aconeceras* and *Sanmartinoceras* s. s., they probably represent a species of *Sanmartinoceras* (*Theganeceras*). Hitherto the subgenus would appear to be restricted to strata of early Aptian age only (CASEY, 1961b; KENNEDY & KLINGER, 1979) and yet at Fossil Bluff it occurs below beds containing crioceratid heteromorphs with late Hauterivian affinities. Although the presence of *Theganeceras* argues against the sequence being much older than early Aptian, it should be borne in mind that little is known of early aconeceratids (there is apparently nothing in their fossil record to connect *Protacneceras* of the Hauterivian (CASEY, 1954) and the first *Aconeceras* of the Barremian-Aptian) and this record could be in Antarctica.

The presence of *Eulytoceras* in beds spanning the interval between the *Acriceras-Crioceratites* and *Paracrioceras* fau-

The 1000 m level in the composite section (Fig. 2) is represented at Keystone Cliffs by the lowest undisturbed beds that rest on a major slump zone forming the lower part of the cliffs. The strata contain a varied fauna which includes a distinctive medium-sized crioceratid heteromorph – *Antarcticoceras* THOMSON (1974). It has stout ribs that are trituberculate at first but which successively lose the dorsal tubercle and then the ventro-lateral and ventral ones, resulting in a late stage with non-tuberculate ribs that are more closely spaced than in the early stages. This ammonite shows a striking resemblance to *Spinocrioceras* KEMPER (1973) from the Upper Barremian of Germany, the only differences being that the German form has a greater number of whorls at a given size and has yet to show evidence of a late-stage modification of ornament. An uncommon constituent of the same fauna is a small species of *Ptychoceras* (Fig. 2). As pointed out by YEGOYAN (1968) the genus is not well known but the Antarctic species seems to compare closely with the unusually well preserved specimens he illustrated from the Upper Aptian of the Caucasus. It has a smooth three-limbed shell typical of the genus and shows the apertural contraction on the final chamber. It is even smaller than YEGOYAN's (1968, fig. 1, 7) *P. parvum*.

Finally, the youngest fauna in the sequence occurs approximately 140–150 m above the *Antarcticoceras* fauna. It consists of a few poorly preserved small species including doubtful examples of *Macroscaphites* and *Hemihoplites* and rather better specimens of an evolute form with ribs bundled at umbilical tubercles. Except for the more flexuous course of its ribs, it closely resembles *Pseudothurmannia mortilleti* (PICHET & LORIOL). If this identification is correct, the ammonite appears to be out of place in relation to the other “late Hauterivian-late Barremian” species in the sequence. *P. cf. mortilleti* is a late Hauterivian-early Barremian species, yet at Keystone Cliffs it is the youngest ammonite in the sequence under discussion.

nas is consistent with the late Hauterivian-mid Barremian age suggested by the heteromorphs. The presence of *Sanmartinoceras* s. s. in the 500–670 m interval (fig. 2), however, is more problematical. The age of *Sanmartinoceras* has been the subject of much debate but it was concluded (WATERHOUSE & RICCARDI, 1970; THOMSON, 1974) that the genus indicated a general Aptian age. More recently the genus has been reported from the Upper Barremian of Zululand (KENNEDY & KLINGER, 1979). However, it has long been considered that the *Sanmartinoceras* in Alexander Island is conspecific with *S. patagonicum* BONARELLI of Argentina (HOWARTH, 1958; THOMSON, 1974), still regarded as an Aptian species (RICCARDI & ROLLERI, 1980).

The youngest ammonite fauna in the measured section at Waitabit Cliffs (760–830 m, Fig. 2) includes *Eotetragonites* and *Aconeceras*. In previous stratigraphical interpretations of the Alexander Island faunas, considerable weight was placed on the *Eotetragonites* which resembles late Aptian and early Albian species from California (*E. wintunius* ANDERSON and *E. gardneri* MURPHY) and Europe (*E. balnensis* BREISTROFFER) (THOMSON, 1972, 1974). It has slanting constrictions that

divide the whorl flanks into triangular sections, unlike those of the earlier protetragonitids which are more radial and widely spaced, and it differs from Barremian-early Aptian *Melchiorites* in being more evolute and lacking a ventral projection to the constrictions (cf. AVRAM, 1978, pls I & IV). Species of *Aconeceras* are difficult to separate and *A. nisoides*, which the Antarctic form most closely resembles, has been reported from rocks of Barremian to early Albian age (CASEY, 1961b). No aconeceratids are known in the Fossil Bluff Formation above this occurrence.

Non-heteromorph ammonites are associated with the *Antarcticoceras* fauna of Keystone Cliffs and include a coarsely ribbed phylloceratid that is probably identical with *Phyllopachyceras aureliae* (FERUGLIO) from Patagonia and is also closely similar to the European *P. infundibulum* (D'ORBIGNY) and *P. winckleri* (UHLIG). Also present are a variety of silesitids with affinities to the European *Silesites seranonis* (D'ORBIGNY)–*S. trajani* (TIETZE) complex. These were given a new name – *S. antarcticus* THOMSON (1974) – but further col-

lecting suggests that more than one species may be involved. Amongst the new material are specimens showing ventrolateral tubercles like those present on late stages of *S. seranonis* and *S. trajani*. A specimen with more widely spaced ribs that resembles *S. vulpes* (COQUAND) was found at the same stratigraphical level in Antarctica. All the closest European counterparts of this fauna are late Barremian in age.

Although the *Antarcticoceras*–*Silesites* fauna of Keystone Cliffs has a marked Barremian appearance, it occurs above the *Eotetragonites* beds and might therefore be expected to be Albian in age. There is little likelihood of a faulted relationship with the section at Waitabit Cliffs, because the same sequence is seen at Succession Cliffs (Fig. 1) and the faunal succession must therefore be taken as real. Some doubt is cast on a Barremian age by the presence of *Ptychoceras*. Although the genus has been reported from the Barremian, species of that age typically have some ornament of rudimentary ribbing – smooth species like the Antarctic one are more characteristic of the Upper Aptian and Albian.

IV. DISCUSSION

Taken as a whole the Alexander Island faunas cannot be matched with faunas elsewhere. There appear to be two parallel successions of ammonite species from the same 1200 m sequence of rocks indicating internally consistent progressions of stratigraphical ages that are about one stage out of phase with each other, i. e. the smaller heteromorphs suggesting a late Hauterivian-late Barremian age, and most of the non-heteromorph species suggesting an early Aptian-early Albian age. Bearing in mind the deficient preservation of nearly all the fossils in the Fossil Bluff Formation (they are preserved as moulds and casts and the ammonites usually lack remains of the sutures and inner whorls) it is possible that the picture may be confused by incorrect identifications and the presence of undetected homeomorphs. However, it is unlikely that such explanations would apply to a whole succession of faunas. Precise identifications aside, there are the undeniable gross similarities of the two faunal successions recognized with late Hauterivian-late Barremian species on the one hand and early Aptian-early Albian species on the other.

A more plausible explanation may be that one group of ammonites is recording the true stratigraphical age of the rocks in the European sense, whereas the other represents a number of late arrivals or alternatively a number of earlier stocks which later migrated into Europe.

In any final assessment of the true age of these faunas, other stratigraphically important invertebrate groups must also be taken into consideration. Particularly significant are the inoceramid bivalves (THOMSON & WILLEY, 1972; CRAME, this symposium). About 200 m above the base of the composite section (Fig. 2), i. e. below the *Theganeceras* fauna, inoceramids of the *Inoceramus neocomiensis* (D'ORBIGNY) group are common. Although this group ranges down into the Neocomian, as its name implies, they are commonest in the Aptian, and the Antarctic specimens compare best with Aptian members of the group. Large representatives of the *I. concentricus* (PARKINSON) group occur in the sequence between the *Sanmartinoceras* and *Eotetragonites* faunas. These would

favour a middle to late Albian age – even younger than that suggested by the ammonites. A third fauna from the *Antarcticoceras*–*Silesites* beds consists of a form similar to the Albian *I. anglicus* WOODS.

The bivalve *Aucellina* occurs over the entire range of the sedimentary rocks discussed here. Although normally regarded as an Aptian-Turonian genus (COX in MOORE, 1969, p. N376), there are suggestions that it may range down into the Barremian in the Northern Hemisphere (e. g. JELETZKY, 1970, table XI–8), and in Patagonia it occurs with the Hauterivian-Barremian ammonite *Favrella* (RICCARDI, 1971: 275).

Few belemnites have been collected from the part of the sequence under discussion here but WILLEY (1972) has described a number of dimitobelids. The presence of *Peratobelus* at Waitabit Cliffs between the *Sanmartinoceras* and *Eotetragonites* beds favours an Aptian age for the strata there. *Dimitobelus* appears to be relatively common at Succession Cliffs, where *Eotetragonites* and *Antarcticoceras* faunas are present. The genus is well known in the Albian and Cenomanian of Australasia (WILLEY, 1972: 40), although it has also been reported in beds of possible “late Neocomian” (= pre-Aptian Cretaceous) age in northern Australia (SKWARKO, 1966).

None of this evidence offers overwhelming support for either of the two age alternatives offered here, although previously the author has favoured the younger, early Aptian-early Albian interpretation (THOMSON, 1974; TAYLOR et al., 1979). The non-ammonite groups mentioned above are perhaps more typical of Aptian-Albian strata but almost all appear to have earlier records as well. The inoceramid bivalves represent an excellent tool for stratigraphical correlation within Alexander Island (THOMSON & WILLEY, 1972; CRAME, this symposium) but morphological types repeat themselves many times within the lineage and care must be taken when ascribing them a specific stratigraphical age. In the Ablation point area of Alexander Island there is an excellent Tithonian-Berriasian faunal succession (THOMSON, 1979; CRAME, 1982) and an apparently unbroken sedimentary sequence

which passes up into the sequence discussed here. No conclusive evidence of the Valanginian-Barremian, however, has yet been found. An interpretation favouring a late Hauterivian-late Barremian age for the beds between Fossil Bluff and Keystone Cliffs, suggested by the smaller heteromorph ammonites, would go a long way to spanning this apparent stratigraphical gap.

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