DISCOVERY AND SIGNIFICANCE OF THE AMMONITE GENUS *FAVRELLA* IN THE ANTARCTIC PENINSULA AREA

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Abstract. Ammonite fragments referable to the South American species *Favrella wilckensi* (Favre) are reported from Antarctica for the first time. They occur in a conglomerate-dominated sequence at Pedersen Nunatak (64° 56′ S, 60° 44′ W) on the east coast of Graham Land, from which a late Cretaceous microfauna has been extracted. However, *Favrella* is an early Cretaceous (probably Hauterivian) genus and its anomalous occurrence in the Antarctic rocks suggests that the fragments are derived. A slump-induced turbidite origin for the conglomerates provides a mechanism for the mixing of the faunas.

Introduction

Ammonite fragments, referable to the South American genus *Favrella* Douvillé, were discovered in a loose block of pebble conglomerate at Pedersen Nunatak, north-east Graham Land (Fig. 1) in February 1981. Measuring approximately 1.5 km

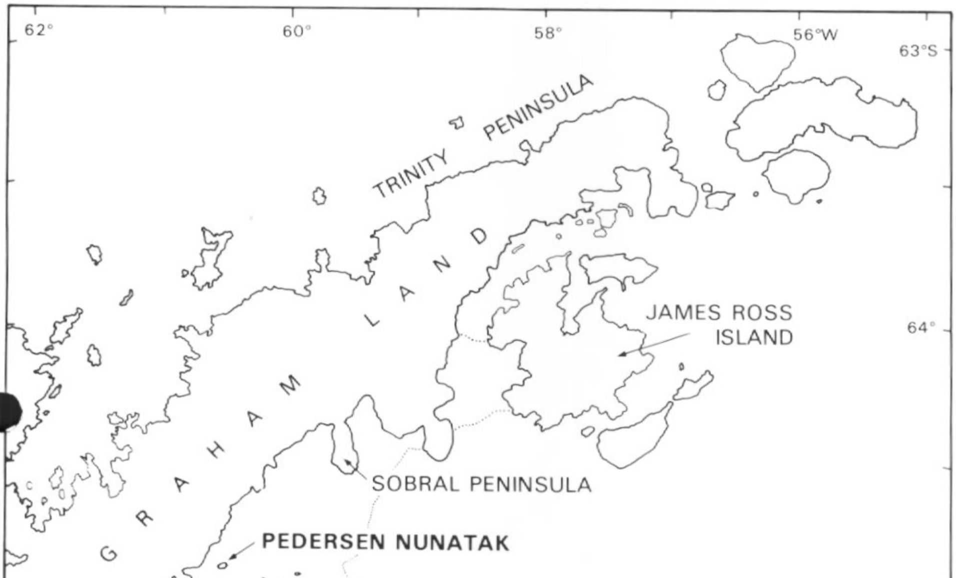

Fig. 1. Locality map of the northern Antarctic Peninsula indicating the position of place names mentioned in the text.

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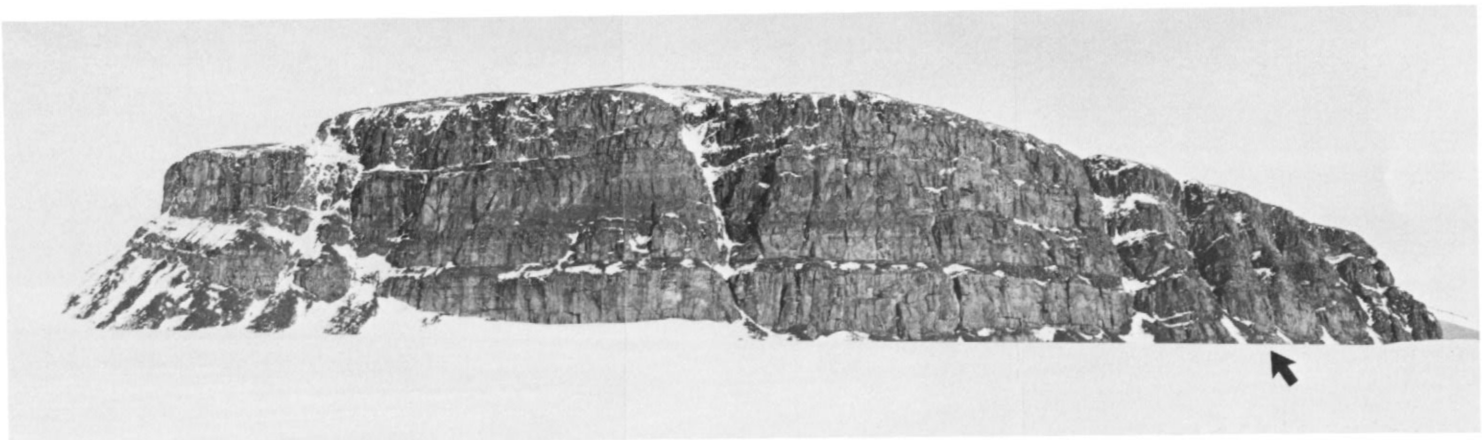

Fig. 2. The north-west cliff face of Pedersen Nunatak is approximately 150 m high and 1 km long. The photograph illustrates the general appearance of the conglomerate/sandstone alterations and their flat-lying attitude. Arrow indicates where the ammonite-bearing conglomerate block was found.

square with a maximum height of 209 m, the nunatak is largely scree-covered, except for a vertical cliff 1 km long and 150 m high that forms the north-west face (Fig. 2). The exposed rock succession was first described by Elliot (1966) who referred to it as a sequence of five conglomerate-sandstone units. Although he stressed the lack of palaeontological control, Elliot suggested that, since similar conglomerates of probable early to middle Campanian age were present on the north-west side of James Ross Island (Fig. 1), it was likely that those of Pedersen Nunatak were of the same age. However, this argument is no longer valid since the marine conglomerates exposed in the north-east Graham Land area are known to date from the early Cretaceous (Farquharson, 1982).

Although the fossils described here were found in a loose block of pebble conglomerate, the lithology of the latter can be matched with the rocks *in situ* and there can be no doubt that the block came from the exposed sequence.

Palaeontology

Family BERRIASELLIDAE Spath 1922
Subfamily NEOCOMITINAE Spath 1924
Genus *Favrella* Douvillé 1909
Favrella aff. *wilckensi* (Favre 1908)
Fig. 3a–c

Material. Three fragmentary moulds in a loose block of pebble conglomerate (R.1379.14a–c), from the foot of the north-west face of Pedersen Nunatak.

Description and remarks. The two best specimens (Fig. 3a–c) are arcuate whorl fragments (about 40 mm long) with an ornament of distinct, regularly spaced simple ribs. The ribs are straight and more or less radial as they cross the flank but they curve forwards at the ventral shoulder and cross the venter in a forward-facing V. The whorl cross section is moderately inflated.

Simple strongly projected ribbing is reminiscent of a number of Neocomitinae, particularly the genera *Favrella* Douvillé (cf. Favre, 1908; Riccardi and others, 1971) and *Pseudofavrella* Leanza and Leanza. Other neocomitids with projected ribbing include *Lissonia* Gerth and *Endemoceras* Thiermann but the first has bifurcate ribs and a deep ventral groove, and the second has a tabulate venter and flexuous ribs that are bifurcate and sometimes paired at umbilical tubercles. *Patagoniceras* Wetzel (*non* Leanza), based on *Neocomites patagoniensis* Favre, is doubtfully distinct from *Favrella* Douvillé and was regarded as a junior synonym of the latter by Riccardi (1970).

Among Berriasellinae with projected ribbing, *Raimondiceras* Spath has periodic flared and tuberculate ribs, and in *Jabronella* Nikolov the ribs may be slightly projected but they are frequently bifurcate and paired at the umbilical rim. At a comparable size to the present fragments the perisphinctid *Kossmatia* Uhlig generally has much finer and denser ribbing which is also bifurcate.

The Antarctic fragments can be matched best with elements of the original *Favrella* fauna, described by Favre (1908) from Meseta Belgrano, western Santa Cruz Province, Argentina. Because of their simple ribbing, it was first suggested (Thomson, 1982) that the present fragments were most closely allied to *F. americana* (cf. Favre, 1908, pl. XXXIII, figs. 1–4). However, on that species the ribbing is more robust and *F. wilckensi* (Favre, 1908, pl. XXXII, figs. 1–5) (which has an early stage with thin bifurcate ribs and periodic tubercles, and a late stage with spaced simple and intercalated ribs) has an intermediate stage with a remarkably similar ornament

Fig. 3a. *Favrella* aff. *wilckensi* (Favre); silicone cast from a natural external mould, ×1 (R.1379.14a).
b. *F.* aff. *wilckensi* (Favre); lateral view of a natural internal mould fragment, ×1 (R.1379.14b).
c. *F.* aff. *wilckensi* (Favre); ventral view of a natural internal mould fragment, showing strongly projected ribbing, ×1 (R.1379.14b).
d. *F. wilckensi* (Favre); ventral view of the specimen in Fig. 3d. (cf. Favre 1908, pl. XXXII, fig. 2).
e. *Favrella wilckensi* (Favre); lateral view of a specimen illustrated by Favre (1908, pl. XXXII, fig. 2) [illegible] ventral view only (specimen 18086, University of Freiburg). Compare the ornament on the initial part of the outer whorl (arrowed) with that of the Antarctic specimens.

to the fragments described here. This was confirmed by reference to Favre's type material in the University of Freiburg and particularly to the example shown in his pl. XXXII, fig. 1 (Fig. 3d and e); the strength, density and projection of the ribbing are virtually identical.

Age. The stratigraphical age of *Favrella* has been the subject of considerable debate, ages ranging from late Jurassic to Aptian having been suggested (cf. Riccardi, 1970). Difficulties arise mainly because few occurrences of *Favrella* have been well documented and many seem to be in strata whose ages are poorly constrained. An exhaustive review of the literature by Riccardi (1970), whose concept of *Favrella* embraced species from Colombia, the Andean and Magallanes/Austral basins of Patagonia, and possibly Mexico, led him to conclude that its age lay somewhere in the Hauterivian–Barremian interval, as was originally argued by Favre (1908). However, assuming that the genus has been correctly assigned to the Neocomitinae (Superfamily Perisphinctaceae) the possibility that it may range into the Barremian is unlikely since no other representative of the group is known to be younger than mid-Hauterivian. This apparent anomaly was noted by Riccardi (1970, p. 135) who suggested that *Favrella* might be one of the last representatives of the Perisphinctaceae.

By contrast, Leanza (1970) argued that occurrences of *Favrella americana* and *F. wilckensi* in the lower part of the Formación Lago San Martín [= Formación Río Mayer of other authors] in Patagonia were early Aptian in age (see below). Part of Riccardi's (1970) argument for a Hauterivian–Barremian age for *Favrella* was based on two stratigraphically better known species, *F. angulatiformis* (Behrendsen) from the Andean Basin of west-central Argentina and *F. colombiana* Haas from Colombia. However, Leanza and Leanza (1973) considered that these last two species belonged to a genus separate from *Favrella* Douvillé *s.s.*, which they named *Pseudofavrella* with *'Hoplites' angulatiformis* Behrendsen as type. At the same time they described a new species, *P. garatei* from the Lower Hauterivian of Neuquén, which included an example previously placed by Riccardi and others (1971) in *F. angulatiformis*. According to Leanza and Leanza (1973) *Pseudofavrella* differs from *Favrella* in its more compressed subtrapezoidal whorl cross-section, its slightly more involute shell form, the course of the ribs, presence of intercalated ribs and presence of tubercles in the adult. They defended the argument for an early Aptian age for *Favrella s.s.*, whilst accepting a Hauterivian age for *Pseudofavrella*, pointing out that *Favrella* is restricted to the Magallanes basin, whereas *Pseudofavrella* occurs in the Andean Basin and northern South America.

Leanza's (1970) argument for an early Aptian age for *Favrella s.s.*, in the Lago San Martín area was based on its occurrence beneath the zone of *Sanmartinoceras patagonicum* (late Aptian) and in association with the so-called *Tropaeum deekei*. However, it is doubtful whether the late Aptian age often ascribed to *Sanmartinoceras* can be upheld (Waterhouse and Riccardi, 1970; Thomson, 1974), and the placing of *'Crioceras' deekei* (Favre, 1908) in the Aptian genus *Tropaeum* Sowerby is debatable. Furthermore, at Lago San Martín *Favrella* occurs a little below (Leanza, 1970) or with (Riccardi, 1971) belemnites listed as *Belemnopsis patagoniensis*. *Belemnopsis* appears to be a largely middle–late Jurassic genus, although it certainly ranges into the Lower Neocomian in Alexander Island (Willey, 1973). Assuming that the generic assignment of these forms is correct it is unlikely from our present understanding of the genus that it occurs as high as the Aptian. Two papers by Blasco and others (1980) and Aguirre Urreta and Ramos (1981) shed further light on the early Cretaceous biostratigraphy of the area north of Lago San Martín. Those studies confirm that *Favrella* occurs beneath the *Hatchericeras* fauna, as was first noted by

Favre (1908), and favour a Barremian age for *Hatchericeras*. Furthermore, strata beneath the *Hatchericeras* fauna have yielded a Valanginian–Hauterivian microfauna (Aguirre Urreta and Ramos, 1981, pp. 105 and 107) from the same level as *Favrella americana*. Thus, although *Hatchericeras* has not yet been reported from the critical locality of Lago San Martín, a late Neocomian (Hauterivian) age for *Favrella* Douvillé *s.s.*, now seems the most probable. This view was subsequently subscribed to by Leanza (1981) in a review of the late Jurassic and early Cretaceous ammonite faunas of South America.

Significance

Ammonite faunas from the James Ross Island area were once thought to indicate that the Cretaceous sequence was exclusively Campanian (Spath, 1953; Howarth, 1958, 1966). However, the recognition of Albian–Campanian *Inoceramus* (Bivalvia) faunas (Crame, 1980, 1981), the discovery of *Favrella* at Pedersen Nunatak, and the identification of Hauterivian–Barremian microfossils in the Cretaceous strata on Sobral Peninsula (Farquharson, 1982), point to the existence of a stratigraphically more extensive Cretaceous sequence on the eastern margin of Graham Land than was previously envisaged. These discoveries narrow significantly the apparent biostratigraphical gap between the late Cretaceous strata and the underlying late Jurassic Nordenskjöld Formation (Farquharson, 1982).

Marine nannofossils obtained from a fine-grained sandstone halfway up the Pedersen Nunatak succession include *Micula stauropha, Kamptnerius magnificus, Cribrosphaera ehrenbergi, Watznaueria* cf. *barnesae* and *Broinsonia* cf. *enormis*. These forms are indicative of a late Cretaceous age and thus conflict with the early Cretaceous age of *Favrella*. This paradox may be resolved by reference to the sedimentology of the Pedersen Nunatak sequence.

For the most part the strata are flat-lying but in places they are gently flexed in open folds. The 142-m-thick succession (Fig. 2) is dominated by five conglomeratic units, each 10–20 m thick. Four of these units are composite, comprising several pebble to cobble grade beds generally 1–2 m thick. Some constituent beds display large-scale cross-stratification indicative of deposition by bed load traction, whereas others are normally graded with planar stratified upper parts, features suggestive of high-density turbidity current deposition. The remaining conglomeratic unit is a 14 m thick normally graded bed uniformly varying from boulder grade at the base to pebble at the top. Despite its thickness, this unit is a single coherent bed that is traceable across the face of Pedersen Nunatak; it is probably the result of a single high-density turbidity current.

Between the conglomeratic units lie typically thin-bedded fine- to very coarse-grained sandstones in units 3–25 m thick. These finer grained intervals are probably the combined result of background sedimentation and turbidity currents. Definite turbidites are common and take the form of laterally continuous graded beds 10–100 cm thick. The bulk of the fine intervals consists of planar laminated sandstone deposited by the settling out of suspended debris, although the rare development of rippled horizons suggests that dilute turbidity currents or contour currents may also have contributed to their deposition.

Measured sections through the composite conglomerates reveal several thinning- and fining-upward sequences. Such vertical sequences are almost invariably interpreted to be the result of progressive channel filling and abandonment (e.g. Ricci-Lucchi, 1975). However, in the case of Pedersen Nunatak this is difficult to reconcile with lateral continuity of the conglomerate units over 1 km. Although deposition within a channel over 1 km wide cannot be ruled out, it is unlikely that this north-west face exposes a section parallel to a channel axis since palaeocurrent measurements (Farquharson, 1982) indicate a mean transport direction towards the south-east. The fining-upward cycles and the overall alternation of conglomerate units with finer grained, thinner bedded layers may be the result of periodic episodes of large-scale slumping interspersed with periods of quiescent sedimentation. The composite conglomerates themselves are similar to units ascribed to retrogressive slumping by Hendry (1973), Surlyk (1978) and Pickering (1979). Large-scale slumping also provides a feasible mechanism for the generation of the large high-density turbidity current believed to be responsible for the deposition of the graded conglomerate unit. The strata at Pedersen Nunatak are proximal deposits within a fault-bounded back-arc basin and thus a slump-induced origin is compatible with their palaeogeographic setting (Farquharson and others, in press).

This proposed mode of emplacement for the Pedersen Nunatak strata resolves the conflict between the ages yielded by the macro- and microfossils. The late Cretaceous microfossils were extracted from a fine-grained sandstone interbed whereas the early Cretaceous ammonite fragments were found in a loose block fallen from a conglomerate unit. Thus the true age of the deposit appears to be late Cretaceous but the debris comprising the resedimented conglomeratic units was presumably initially deposited during the early Cretaceous.

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