

# Middle Volgian ammonites and trace fossils from the Frederikshavn Member of the Bream Formation, northern Jutland

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The lower part of the Frederikshavn Member of the Bream Formation in the central part of the Danish Subbasin (the Aars 1a well) can be referred to the Albani Zone of the Middle Volgian on the basis of ammonites belonging to the genus *Pavlovia*. The cored sediment and the trace fossil assemblage show deposition below wave-base in well-oxygenated water.

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A core from the Upper Jurassic to Lower Cretaceous Frederikshavn Member of the Bream Formation (Michelsen, 1978) has been made available for a study of its ammonites and its trace fossil assemblage.

The Aars 1a well was drilled in the centre of the Danish Subbasin (fig. 1) where the Jurassic formations attain maximal thickness, and rather close to the depocenter for the Frederikshavn Member.

The 7 m long core (core number 2) represents parts of the lowest cycle of the Frederikshavn Member (Michelsen, pers. comm. 1980).

## Lithology

The core consists of clayey, slightly calcareous silstone. The colour changes gradually upwards from olive black to greyish green, as a result of a slight decrease in clay content (fig. 2).

The sediment is intensely bioturbated and primary sedimentary structures are almost obliterated (figs 3,4). The sediment seems to comprise two grain populations, and ghosts of sedimentary structures characteristic of heteroliths are preserved. One narrow level in the upper part of the core contains a few, up to 1 cm thick, layers of silt. These are structureless, without graded bedding and not bioturbated.

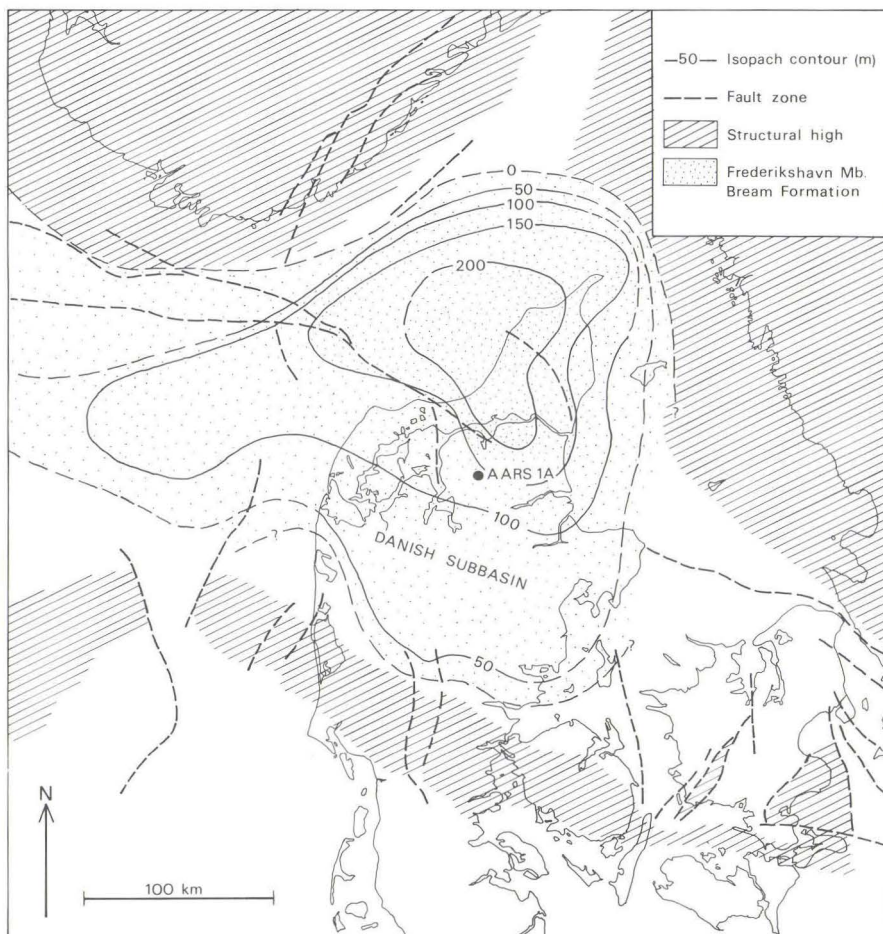


Fig. 1. Location map, also illustrating the geological setting and the extent and thickness of the Frederikshavn Member. Drawn from Michelsen (1978, Fig. 16).

Apart from the ammonites described in the following, the core contains bivalves, including oysters and pectinids, which are either randomly distributed in the sediment or concentrated at certain levels, and apparently do not occur in their growth positions.

Comminuted plant debris is common and one twig was also found.

### Trace fossils

The trace fossil assemblage is characterized by *Chondrites* (figs. 3,4) and *Teichichnus rectus* (fig. 4). *Chondrites* occurs throughout while *Teichichnus*

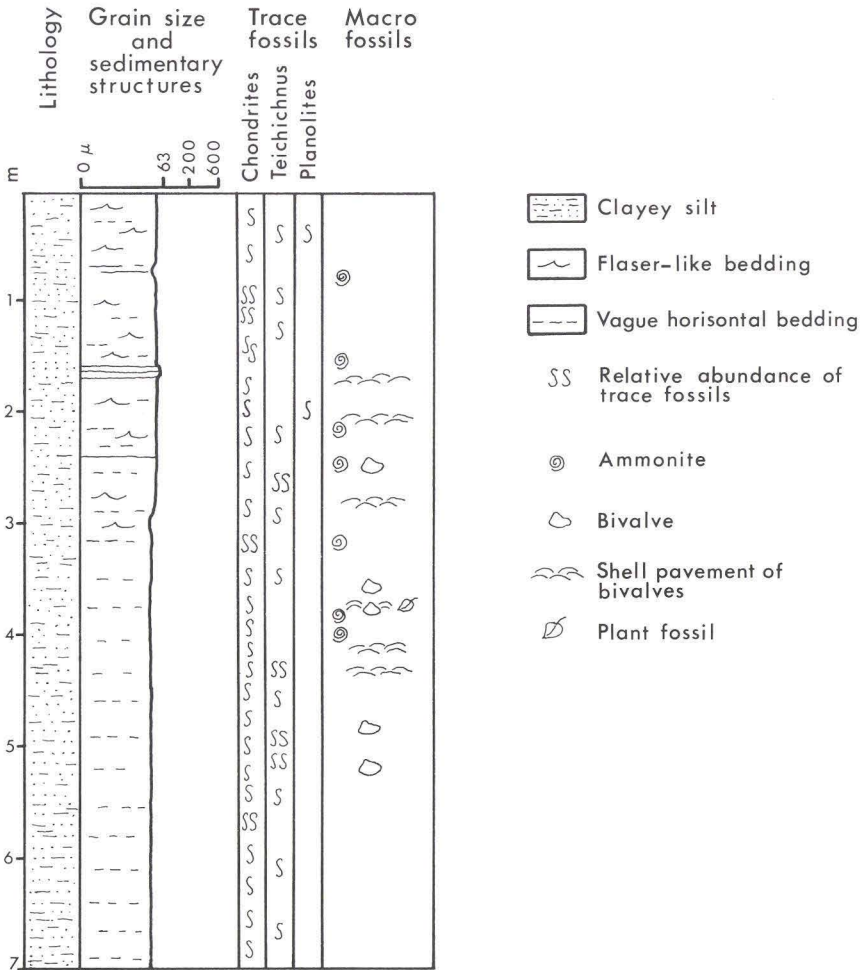


Fig. 2. Core of the Frederikshavn Member in the well Aars. The core is relatively uniform throughout with a slight decrease in clay content upwards accompanied by a gradual change toward paler colours. The whole core is intensely bioturbated and primary sedimentary structures are partly or wholly obliterated.

occurs widespread but not continuously. *Planolites* has been observed in the upper part of the core (figs. 2,3).

*Chondrites* Sternberg, 1833 is typically seen as pale greyish spots or lines about 1 mm wide and 1.5–15 mm long (figs. 3,4). The diagnostic branching pattern (Simpson, 1957) is seen on occasional bedding planes.

*Teichichnus rectus* Seilacher, 1955 occurs as pale cylindrical, sub-horizontal burrows with a diameter of about 0.5 cm and lengths of up to several centimetres, and with retrusive, subvertical spreiten (fig. 4a, b).

*Planolites* Nicholson, 1873 has only been observed in cross sections where it is seen as pale, cylindrical, slightly flattened burrows about 0.5 cm in diameter and apparently subparallel to the bedding (fig. 3).

All these trace fossils are fodinichnia produced by infaunal deposit feeders (Häntzschel, 1975) which seem to be typical for silty clayey marine sediments (Fürsich, 1975, Baldwin, 1977, Pickerill, 1977).

## Depositional conditions

The general fine grain-size of the sediment, the existence of deposit-feeding infaunal benthos and the relatively numerous bivalves and ammonites suggest deposition below wave-base in well-oxygenated low-energy environments. Some degree of reworking is indicated by the shell pavements of bivalves and possibly by the thin, non-bioturbated, well-sorted silt layers.

The outlined depositional conditions are in accordance with the basinal development described by Michelsen (1978).

## Ammonites

Two fairly well preserved specimens have been recovered from the uppermost meter of the core, one 90–100 cm below top and one 60–70 cm below top. Both of them belong to the genus *Pavlovia* and are related to two species occurring together in the Volgian succession of Milne Land, East Greenland, recently, summarized in Birkelund *et al.* (1978a).

*Pavlovia (Epipallasiceras)* cf./aff. *costata* Spath (fig. 5). (Spath, 1936, p. 58, pl. 10, fig. 7; pl. 18, fig. 3).

Level: 300–310 cm below top of the core.

The specimen is rather well preserved. The diameter is 68 mm and the umbilical ratio c. 26 % at a diameter of 52 mm. Sutures are not visible. The whorls are laterally flattened. The ribbing is fine on the inner whorls while the outer whorl shows coarse biplicate ribbing with the two secondaries close together or, in a few cases, triplicate ribbing. The primaries are straight and sharp and they bifurcate high on the whorl side.

The specimen seems to be closely related to *Pavlovia (Epipallasiceras)* aff. *costata* as described by Spath from Milne Land from the upper part of the »Glauconic Series«. The species is also known from Raukelv Formation in Jameson Land (Surlyk *et al.* 1973, pl. 2, fig. 2).

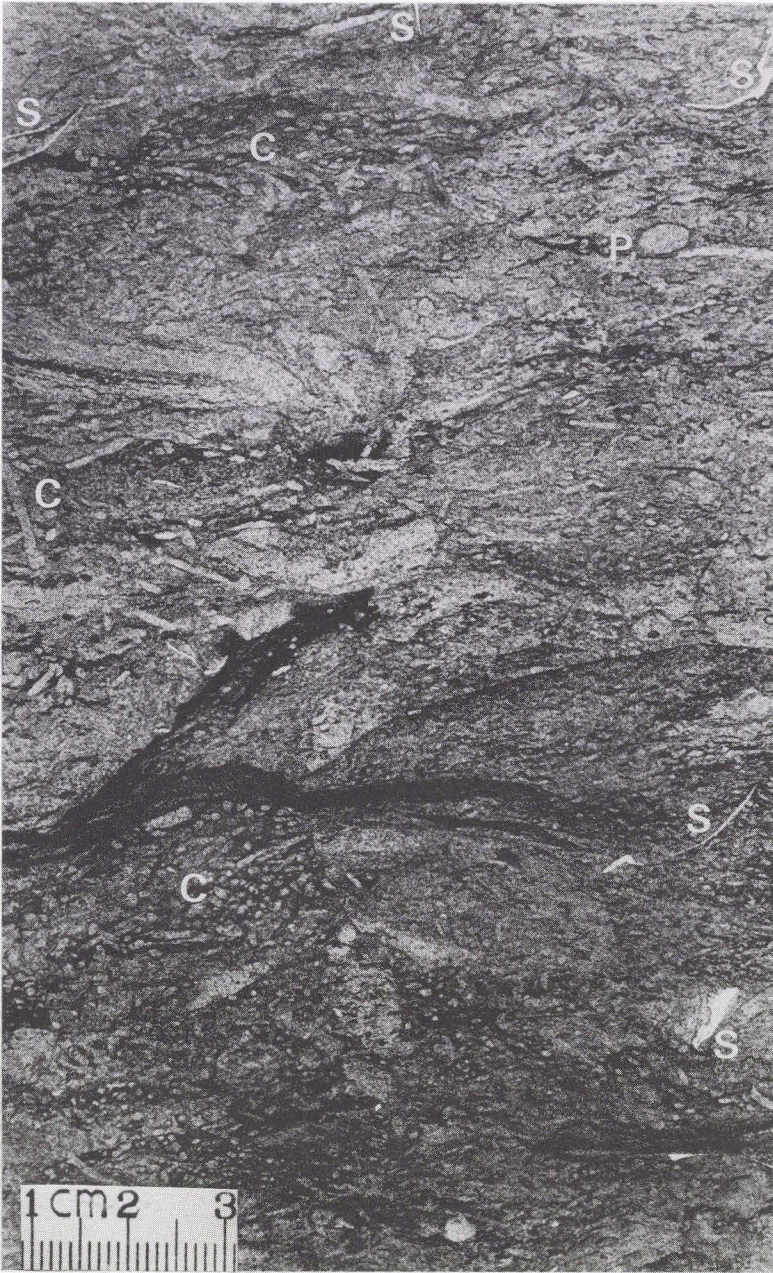


Fig. 3. Part of the core, c. 190–205 cm below top, seen in section. The sediment is fossiliferous (S: bivalve shells) and intensely bioturbated. *Chondrites* (C) is seen in numerous sections and *Planolites* (P) occurs.

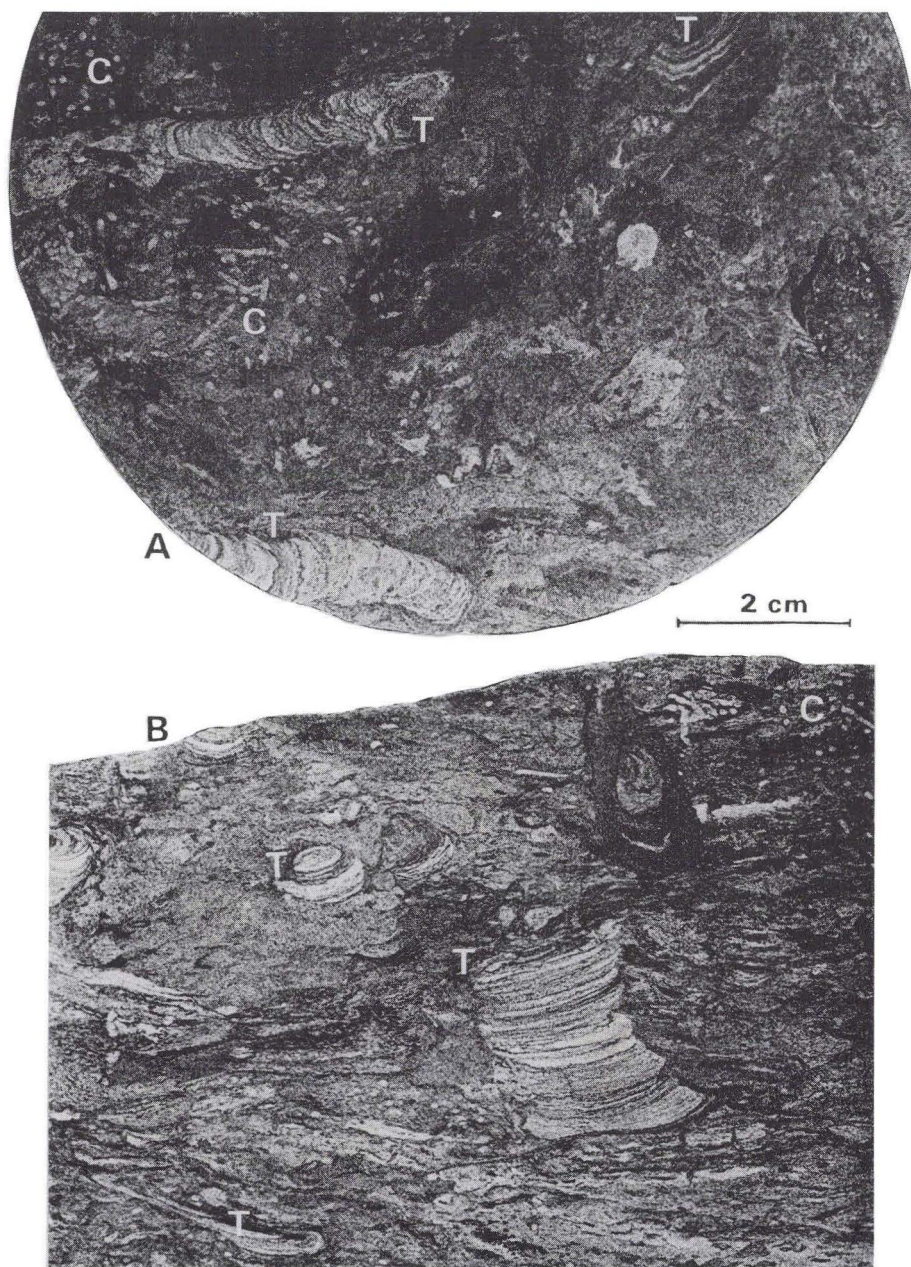


Fig. 4. A: More or less bedding-parallel upper surface. Both *Chondrites* (C) and *Teichichnus rectus* (T) are seen. The latter is retrusive with subhorizontal burrows.  
B: *Teichichnus rectus* (T) cut at various angles.  
Sample 500–510 cm below top of the core.

Fig. 5. *Pavlovia* (*Epipallasiceras*)  
cf./aff. *costata* Spath, 1936.  
300–310 cm below top of  
the core.  $\times 1$ .

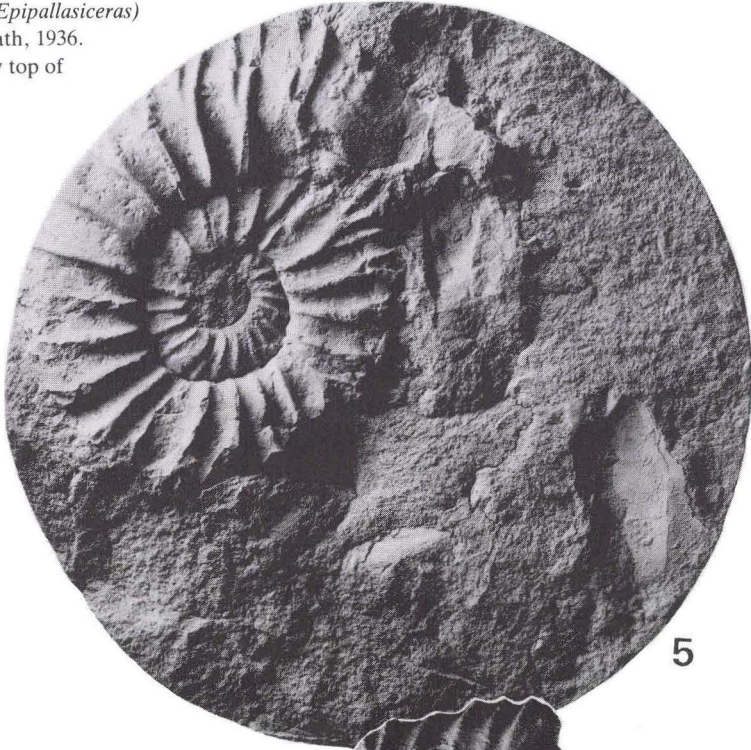


Fig. 6. *Pavlovia*  
(*Epipallasiceras*) aff. *costata*  
Spath, 1936. J. H. C.  
No. 471, 1–3 km N. of Kap Leslie.  
Milne Land.  $\times 1$ . Kept in Geological  
Museum of the University of Copenhagen.





Fig. 7. *Pavlovia* cf./aff. *rotundiformis* Spath, 1936.  
400–410 cm below top of the core.  $\times 1$ .

Bed by bed collecting by J. H. Callomon in 1957 shows that *P. (E.)* aff. *costata* occur in a number of faunas in the »Glauconic Series« on the east coast of Milne Land. The specimen here described shows closest similarity to the earliest forms (fauna 40 in Callomon, Birkelund & Fürsich, in prep.) with the *Epipallasiceras* ribbing pattern very markedly developed: secondaries close together and long primaries. A specimen from fauna 40 from Milne Land is shown in fig. 6 for comparison. The holotype and only figured specimen of *P. (E.) costata* Spath itself came from the same bed as, and falls within the range of variability of *P. (E.) pseudaperta* Spath, which is slightly younger (fauna 42).

*Pavlovia* cf./aff. *rotundiformis* Spath. (fig. 7).  
(Spath, 1936, p. 55, pl. 19, fig. 3 (holotype)).

Level: 400–410 cm below top of the core.

The specimen is partly crushed. The diameter is 80 mm and the umbilical ratio c. 26 % at a diameter of 72 mm. No sutures are visible. The ribbing is fine to a diameter of c. 35 mm, where it changes to a coarser somewhat *Epipallasiceras* like ribbing with paired bifurcating ribs. On the outer whorl the ribbing is typical pavlovid with coarse evenly spaced, biplicate ribs bifurcating on the middle of the flanks.

Spath (1936) described the species *P. rotundiformis* from the upper part of the »Glauconic Series« of Milne Land and figured one specimen, the holotype. Additional collecting by J. H. Callomon in 1957 has revealed the range of variation of the species and the exact stratigraphic range. The ribbing of the specimen from Aars is weaker than that of the holotype but seems to fall within the range of variation of additional material. The species occurs together with *P. (E). aff. costata* at the east coast of Milne Land (faunas 40–41 in Callomon, Birkelund & Fürsich, in prep.).

### Stratigraphic correlation

A detailed stratigraphic work on the zonation of the Volgian of Milne Land is in preparation by J. H. Callomon, T. Birkelund and F. Fürsich. It is now known that the faunas containing *P. (E). aff. costata* and *P. rotundiformis* overlie faunas which can be readily equated with the *P. pallasoides* and *P. rotunda* Zones of Dorset, although the two areas in question belong to different faunal subprovinces having only few species in common.

Cope (1978) divided the Dorset succession above the *P. rotunda* Zone into the *Virgatopavlovia fittoni* and the *Progalbanites albani* Zones and showed that the upper part of the *P. albani* Zone correlates with the *Epivirgatites nikitini* Zone of the Volga Basin. The *V. fittoni* Zone (Hounstout Clay and Marl) is characterized by the new genus *Virgatopavlovia* Cope, 1978. The inner whorls of this genus show closely paired bifurcating ribs with high furcation point as in *Epipallasiceras*, but the outer whorls have an irregular, frequently virgatotome ribbing, which is very different. Fragments belonging to *Virgatopavlovia* were earlier referred to *Epipallasiceras* by Cope (1971, p. 41). *Virgatopavlovia* is not represented in the Milne Land sequence.

The ammonites from the *P. albani* Zone (Parts of Portland Sand with Massive Bed at base in Cope, 1978; Emmitt Hill Beds in Townson, 1975) are poorly known. A fragment from the Massive Bed referred to *Virgatites pallasianus* d'Orb by Buckman, 1926, pl. 693 has been referred to *Epipallasiceras* by Callomon (1961). This specimen may belong to a true *Epipallasiceras* and is, as far as it goes, much more similar to the *Epipallasiceras* specimen here described than early whorls of *Virgatopavlovia* spp. from

the *V. fittoni* Zone. Except from this occurrence and rare occurrences in Andøya, northern Norway and possibly the Boulonnais (Pellat collection), *Epipallasiceras* is only known from East Greenland.

In conclusion, the ammonite level in the Aars well can be correlated with the upper part of the »Glauconic Series« of Milne Land (Member 2g in Birkelund *et al.*, 1978a) and the lower part of the Portland Sand (Emmit Hill Beds, Townson, 1975) in the Dorset area. It is referred to the *P. albani* Zone of the standard ammonite zonation of NW Europe. The presence of the *P. albani* Zone has also been verified in the Ratjønna Member of the Dragneset Formation of Andøya (Birkelund *et al.*, 1978b).

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