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Fish remains from the Aptian near Bentheim, Germany

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Abstract

The remains of two fossil fishes from the Lower Aptian of the Bentheim area, north-western Germany, are described. A fragment of a large pectoral fin is identified as Pachycormidae indet. It is the first report of a Lower Cretaceous pachycormid in Europe and extends the geographic range of pachycormids to Germany. A trunk of a small teleost fish is identified as Clupeomorpha indet. This extends the range of Lower Cretaceous clupeomorphs to north-western Germany.

Introduction

In the sixties and seventies, the Cretaceous strata around Bentheim in north-western Germany were well exposed in numerous clay pits and some quarries. The guide by Kemper (five editions; the last 1976) presents a detailed description of the local geology and paleontology. Consequently many field parties visited the exposures and much material was collected. Invertebrate fossils were common, but vertebrate fossils were rarely found. An unidentifiable body-fossil of a fish, preserved in a siderite concretion from the Aptian at Alstätte, was collected by J.H. Römer (Nijverdal, the Netherlands) in 1933. The Albian greensands exposed in the bed of the Ölbach at Frankenmühle contained a tooth of *Hexanchus* (Kemper 1976: pl. 33, fig. 4) and a plesiosaur tooth (collected by the second author 1973). Kemper (1976: pls 20, 21, 24, 29, figs 8, 36) furthermore figured a few vertebrate remains from some older (Berriasian, Valanginian and Hauterivian) and younger (Turonian and Santonian) Cretaceous localities near Bentheim.

Both fossils described in this note come from Lower Aptian strata. The first, a pectoral fin, was collected in 1964 in a siderite concretion from the clay pit of the Schneermann brickyard on the northeast slope of the Rothenberg, east of Ochtrup. The second, a compressed fish skeleton, was collected by Kok (1974). This specimen was found in the clay pit of the Borgers brickyard, west of Ochtrup. According to Kemper (1976) it dates from the Lower Aptian.

The pectoral fin

The pectoral fin described in this paper belonged to a fish of the neopterygian family Pachycormidae. The Pachycormidae are a monophyletic group of fossil fishes known from marine deposits from the Jurassic and Cretaceous of Europe (Wenz 1967; Lambers 1988, 1992), North and South America (A. Stewart 1900; Gregory 1923; J.D. Stewart 1988; Arratia 1987; Cione et al. 1987) and Asia (Woodward 1894, 1895a; Taverne 1977).

Patterson (1973) described uroneural-like structures in the tail of *Pachycormus* and considered the pachycormids the most primitive teleostean group. Mainwaring (1978) found certain derived characters and placed them as the sister group of *Ichthyokentema* and succeeding teleosts (see Patterson 1977: fig. 19). Taverne (1977) doubted the interpretation of pachycormids as teleosts. Bartsch (1988) still considered

Fig. 1A. Pectoral fin, Pachycormidae indet. Specimen VU.9720. Lower Aptian, Ochtrup. Scale bar in centimetres. Left lateral side.

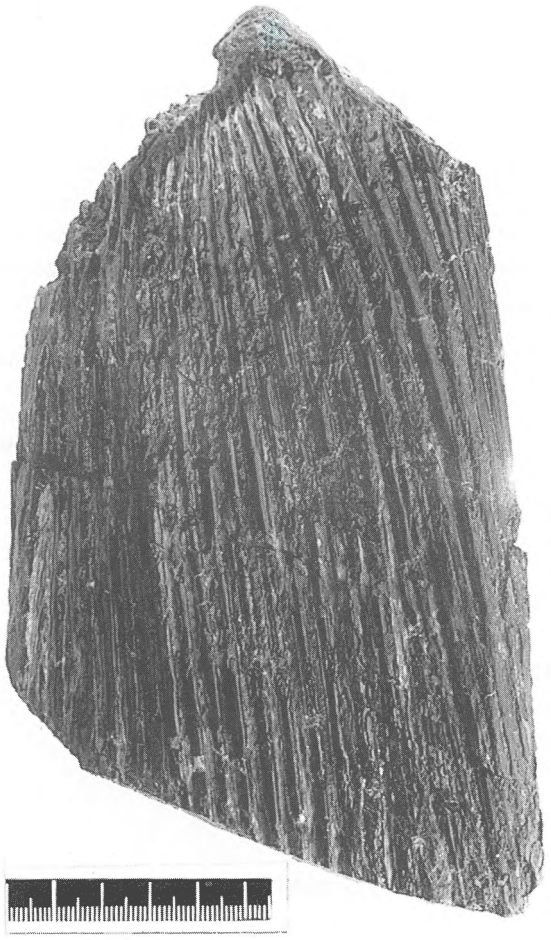

Fig. 1B. Pectoral fin, Pachycormidae indet. Specimen VU.9720. Lower Aptian, Ochtrup. Scale bar in centimetres. Right lateral side.

them caturids. Lambers (1992) doubted Patterson's interpretation of uroneurals in the tail of pachycormids and their classification as basal teleosts. Arratia & Lambers (in press), show that the uroneurals from pachycormids are median, instead of paired bones, as in teleosts, and that pachycormids cannot be regarded as teleosts. The position of this family among the neopterygians remains to be determined.

Pachycormidae gen. indet. *Specimen 9720 in the collection of the Vrije Universiteit, Amsterdam. Fig. 1A, B, C*

The specimen is the upper part of a pectoral fin of an actinopterygian fish. It cannot be determined whether it is a left or right pectoral fin. The maximum length of the fragment is 18 cm, the maximum width 11.5 cm. The leading edge of the fin is complete, posteriorly rays are lacking. Twenty-three rays have been preserved. All the rays are smooth and unsegmented. They are about 0.5 mm wide. The first five rays are complete. They are unbranched. The first three rays are short, they do not reach the distal edge of the fossil. The sixth to the tenth rays dichotomize once. The splitting of the rays is asymmetrical, beginning near the anterior edge of the ray. The remaining rays are imperfectly preserved and splitting is not visible.

Between the two hemitrichia of rays 4 to 7 a large circular bone is preserved. This bone may be the propterygium. Usually the propterygium is associated with one ray only.

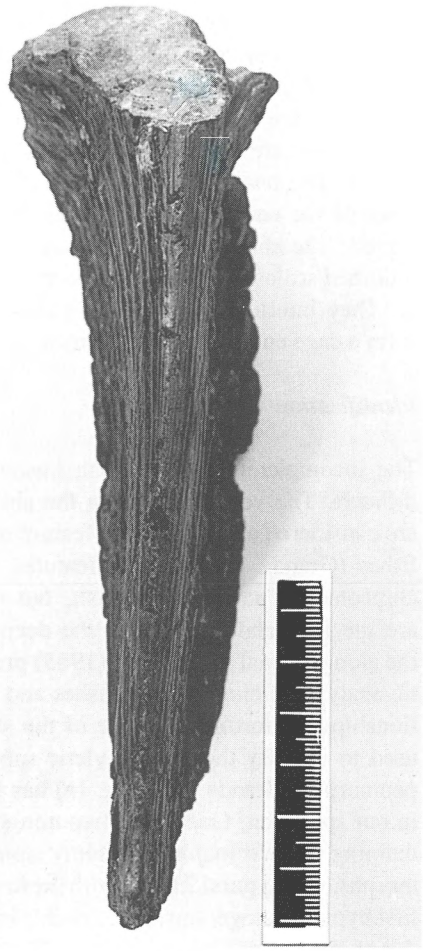

Fig. 1C. Pectoral fin, Pachycormidae indet. Specimen VU.9720. Lower Aptian, Ochtrup. Scale bar in centimetres. Anterior view of the leading edge showing the large propterygium.

Identification

The size of the remains of the fin indicates that the fish must have been big. The length of the complete pectoral fin was probably at least 40 cm. The fish is supposed to have been at least 2 m long.

All rays lack segmentation. This is an uncommon feature, known in pachycormids (Lambers 1992) and some ichthyodectiforms. As in pachycormids, the rays dichotomize asymmetrically and the dichotomy is not associated with segmentation of the rays. This feature is supposed to be a derived character of pachycormids. The rays may have been segmented in the lost distal part of the fin. However, the dichotomization in rays 4 to 7, without the presence of segmentation, makes this less likely. If the fin had been segmented, this would have been so in the upper part as well. The dichotomy of the rays would start at the transverse joints of the rays.

Because of the absence of segmentation and the way in which the rays dichotomize, the fin is of a pachycormid fish.

Neopachycormus and *Protosphyraena* are the only Cretaceous pachycormid genera. The fin does not belong to *Neopachycormus* (Taverne 1977). The pectoral fin of this genus has fulcra on the leading edge and consists of three rays only.

The fin differs from the genus *Protosphyraena* in lacking the peculiar undulating leading edge. Such an edge is supposed to be a derived character of *Protosphyraena* (Lambers 1992). The pectoral fin of *Protosphyraena gladius* also lacks this undulating leading edge, but this species probably belongs to a different pachycormid genus *Ichthypriapus* (see discussions in Schultze et al. 1982 and J.D. Stewart 1988). In size and shape the fin shows resemblance with the fragment of a fin described as *P. gigas* (A. Stewart 1900: pl. LXII), a species considered to be a junior synonym of *P. gladius* (J.D. Stewart 1988). The present specimen, however, lacks a wedge-shaped ossification separating the hemitrichia of the rays. This ossification forms the anterior border of the fin, as known in *P. gladius* (J.D. Stewart 1988). The fin therefore does not belong to this species.

The fin also resembles the remains of a pectoral fin from the Cretaceous of Péronne, northern France, described by Priem (1896: pl. 2, fig. 17) as *Protosphyraena ferox.* However, the pectoral fin described by Priem is too fragmentary to make a generic or specific determination possible. Assignment to the Pachycormidae however, seems plausible.

The fin lacks fulcra. This is in contrast to all other pachycormids of which the pectoral fin is known, except *Protosphyraena* and *Protosphyraena gladius.*

This discovery extends the geographic range of European Cretaceous pachycormids to Germany. It is the first Lower Cretaceous pachycormid fossil from Europe. Until now European Upper Cretaceous pachycormids had been described from England (Woodward 1895b, 1902–1912), Italy (Sorbini 1976; and questionable pectoral remains described by Mariani 1902), France (Priem 1896; Leriche 1902), Belgium (Dollo 1893; Leriche 1927), former Czecho-Slovakia (Frić & Bayer 1902) and Russia (Kiprijanoff 1860; Woodward 1895a). The North-American Cretaceous pachycormids are all Upper Cretaceous, as are the

genus *Neopachycormus* from Burma (Taverne 1977) and an undetermined pachycormid axial skeleton from Lebanon (Woodward 1894; 1895a). Lower Cretaceous pachycormid fossils are known from the Rolling-downs Formation in Queensland, Australia (Lambers 1992).

The thoracic skeleton

The small teleost fish belongs to the primitive teleost superorder Clupeomorpha (herring and herring-like fishes, see Grande 1985). Cretaceous to Recent Clupeomorpha have a world-wide distribution, but Lower Cretaceous occurrences are rare (see below). Grande (1985) proved the monophyly of the Clupeomorpha. Amongst other features the order is characterized by the presence of at least one prepelvic abdominal scute.

Clupeomorpha indet. *Specimen in the collection of Mr. R.J. Kok, Deventer, the Netherlands. Figured in Kok (1974). fig. 2A, B*

The specimen is 4.5 cm in length. The skull, anterior to the opercular bones, and the tail are lacking. The trunk is completely preserved. Some rays of the left pectoral fin and dorsal fin are present; of the pelvic and anal fins only a few rays are incompletely preserved. The dorsal ridge of the fish is damaged; the ventral ridge is more or less complete. Ribs, neural and haemal spines are partly preserved as impressions. Neural spines are only preserved in the caudal region. Few scales are present. The fossil is broken; an oblique crack runs from behind the pectoral fin to the posterior part of the dorsal fin. In front of this crack the vertebral column is distorted and shows a slight sigmoid curve; the vertebrae are poorly preserved. Behind the crack the vertebral column is intact and undistorted.

Remains of the opercular bones are present, but sutures are not visible. The posterior part of the left lower jaw as well as the cleithrum are preserved. Anteriorly to the dorsal fin, remains of about five predorsal bones are present (see Grande 1985). Just in front of the dorsal fin a small piece of bone is visible; it might be the remains of a predorsal scute (Grande 1985). Because of the imperfect preservation of this part of the fish, this identification is uncertain; there is no indication of more dorsal scutes. About 30 vertebrae have been preserved, of these 14 are abdominal vertebrae. The vertebrae appear completely ossified. The abdominal ribs reach almost to the ventral border of the body. The feeble remains of the pectoral fin consist of about 13 delicate rays, preserved partly as impressions in the matrix. In the dorsal fin about 12 rays can be recognized; there are six axonosts, of which the first is the largest. The anal fin appears to have been elongated towards the caudal fin. About 20 axonosts are preserved. The abdominal region shows 13 conspicuous modified scales or scutes, bordering the trunk ventrally. They interlock with the long abdominal ribs and form a cage enclosing the abdomen.

Identification

The incompleteness of the fish makes identification difficult. The ventral scutes in the abdominal region are considered a characteristic feature of clupeomorph fishes (Grande 1985). Other features suggesting the clupeomorph nature of the fish, but not diagnostic, are the long abdominal ribs, the deep abdomen and the elongate anal fin. Grande (1985) presents a cladistic analysis of clupeomorph fishes and their interrelationships. Unfortunately none of the skull characters used to identify the monophyletic subgroups of clupeomorphs (Grande 1985: fig. 1a) has been preserved in our specimen. One of the two non-skull characters defining the first major dichotomy among the clupeomorphs, viz. hypural 2 fused with the first ural centrum, first hypural autogenous, is not visible in our specimen, due to the imperfect preservation. The other character concerns the presence of dorsal scutes. In our specimen the presence of a dorsal scute just in front of the dorsal fin is doubtful. More information is not available, as the dorsal ridge in front of the dorsal fin is poorly preserved. Assignment of the specimen to one of the orders or families of clupeomorphs is therefore not possible with certainty and the fish is considered 'Clupeomorpha indeterminate'.

Recent clupeomorphs in general have a world-wide distribution. In the fossil record they are traced back into the Lower Cretaceous and their distribution is also world-wide (see Grande 1985 for literature), although Lower Cretaceous specimens are relatively rare. Cretaceous clupeomorphs are known from Argentina (Lower Cretaceous), Bolivia (Upper Cretaceous), Brazil (Lower Cretaceous, Aptian, 'Neocomian'; see also Silva Santos & Silva Correa 1985; Silva Santos 1990), Mexico (Albian, Grande 1989; Pantoja-Alor 1990), Canada (Albian), Western Africa (Equatorial Guinea, Aptian-Albian, Gayet 1989), Morocco (Cenomanian), Tunisia (Upper Cretaceous), Zaire (Lower Cre-

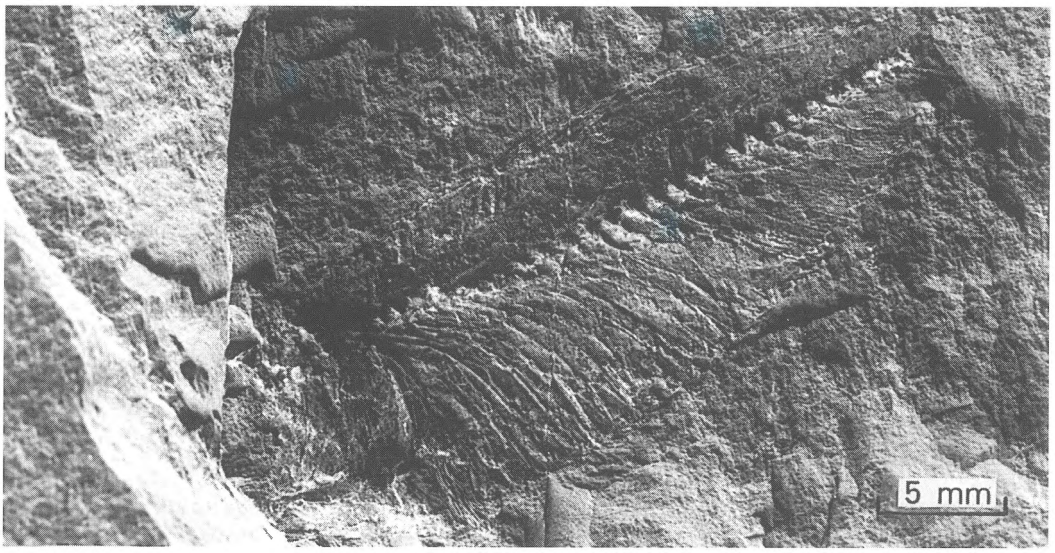

Fig. 2A. Clupeomorpha indet. Specimen in the private collection of R.J. Kok, Deventer, the Netherlands. Lower Aptian, Ochtrup. Photograph.

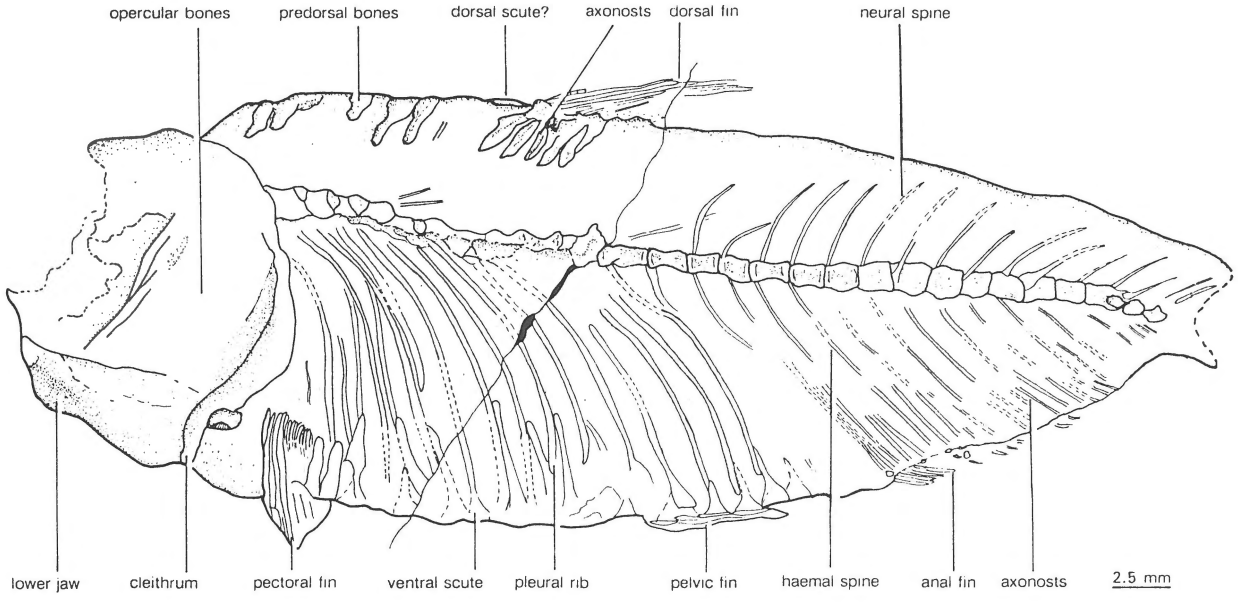

Fig. 2B. Clupeomorpha indet. Specimen in the private collection of R.J. Kok, Deventer, the Netherlands. Lower Aptian, Ochtrup. Line drawing.

taceous), New Zealand (Upper Cretaceous), Lebanon (Cenomanian and Santonian), China (Lower Cretaceous), Japan ('Neocomian'), Kazachstan (Upper Cretaceous), Italy (Aptian or Albian), Portugal (Cenomanian, Jonet 1981), Switzerland ('Neocomian'), former Yugoslavia (Cenomanian) and England (Albian). Taverne & Ross (1973) reported skull remains of a possible clupeid from the Lower Aptian of Helgoland (Germany). It is considered a clupeid because of the shape of the mesethmoid. This isolated specimen is in fact too fragmentary for generic assignment. It does not show any of the skull characters defining clupeomorphs, although it could still be of a clupeomorph fish.

In the European Lower Cretaceous an undoubted clupeomorph was reported from Aptian, or possibly

Albian, deposits in Italy. The other Lower Cretaceous record is from the Albian of England. The reports from Switzerland are 'Neocomian', but these specimens are possibly Barremian in age (Patterson 1993). The non-European Lower Cretaceous finds could apparently not be dated more precisely, with the exception of the Aptian reports from Canada, Brazil and Equatorial Guinea. Some Brazilian and Japanese specimens were dated as 'Neocomian', but might be Barremian or Aptian (Patterson 1993).

The presently described Lower Aptian specimen is therefore one of the oldest known clupeomorphs, and extends the distribution of clupeomorphs during the Aptian in Europe considerably to the north.

Conclusions

The fragment of the pectoral fin belongs to a pachycormid fish. The genus is not determinable. It is the first record of a Lower Cretaceous pachycormid from Europe and extends the distribution of the Pachycormidae to Germany. The small teleost specimen is a clupeomorph indet. It extends the range of Lower Cretaceous clupeomorphs to north-western Germany. Being Lower Aptian, it is one of the oldest clupeomorphs so far known.

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