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First Aspidorhynchidae (Pisces: Teleostei) from Antarctica

MARTHA RICHTER[1] and M.R.A. THOMSON[2]

[1] *Museu de Ciências, Pontifícia Universidade Católica do Rio Grande do Sul, Av. Ipiranga 6681, CEP: 90620 Porto Alegre, RS, Brazil*

[2] *British Antarctic Survey, Natural Environment Research Council, High Cross, Madingley Road, Cambridge CB3 0ET, UK*

Abstract: A new fossil teleost, belonging to the family Aspidorhynchidae Nicholson & Lydekker, *Aspidorhynchus antarcticus* sp. nov., was obtained from a block of reworked Upper Jurassic tuffaceous mudstone in the lower (Albian) part of the mid-Cretaceous Whisky Bay Formation of James Ross Island, Antarctic Peninsula. Additional material, assignable to *Aspidorhynchus* sp., was collected from *in situ* Upper Jurassic marine rocks (Nordenskjöld Formation) at Longing Gap, northern Antarctic Peninsula. Not only is this the first reported occurrence of the family from Antarctica, it is also the first unequivocal record of *Aspidorhynchus* outside Europe; prior to this discovery, the genus had only been reported with certainty in marine deposits from the Middle Jurassic to Lower Cretaceous of England, France and Germany. This is the earliest neopterygian fish so far recovered from marine rocks in the Antarctic.

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Key words: Teleostei, *Aspidorhynchus*, Upper Jurassic, northern Antarctic Peninsula.

Introduction

During the 1982/83 Antarctic summer field season, one of us (M.R.A.T.) collected the postcranial remains of a fossil fish on James Ross Island, north-east Antarctic Peninsula (Fig. 1). The fossil was found on the cliff top at north Tumbledown Cliffs, in a 70 cm diameter angular block of tuffaceous mudstone within a conglomerate of the Albian–Cenomanian Whisky Bay Formation (Ineson *et al.* 1986). Age-diagnostic fossils are rare in the conglomerates but an ammonite very close, if not identical, to *Tetragonites rectangularis* Wiedmann (Albian) was found in a reworked nodule in the same conglomerate. Interbedded sandstones a few metres below the fish occurrence contain the bivalves *Inoceramus carsoni* M'Coy (Crame 1985) and *Maccoyella*, whereas some 100 m above are coarse sandstones with the heteromorph ammonites *'Mariella'* (see Thomson 1984, fig. 3b) and *Lechites* aff. *gaudini* (Pictet & Campiche), and the inoceramid bivalve *Birostrina concentrica* (Parkinson). These place the age of the conglomerate firmly in the late Albian. However, the fish-bearing block has the lithological characteristics of the Upper Jurassic Nordenskjöld Formation (Farquharson 1983) or Ameghino Formation (Medina & Ramos 1983) and exhibits a distinctive greenish weathering colour, typical of the numerous reworked blocks of this formation found in the conglomerates of the Whisky Bay Formation (Fig. 2). Many of these blocks, some of which are of gigantic proportions (Ineson 1985) contain typical Late Jurassic (Kimmeridgian and Tithonian) ammonites and bivalves. However, the fish-bearing block contained no invertebrate macrofossils, and a sample of the matrix yielded only sparse and poorly preserved palynomorphs, none of which is age-diagnostic. These include miospores, largely bisaccate pollen grains and simple pteridophytic spores (mainly *Cyathidites* spp.). A single specimen of the dinoflagellate cyst *Cyclonephelinum distinctum* Deflandre & Cookson was also recovered. Although this is a long-ranging form (Upper Jurassic and Cretaceous), it is perhaps more typical of Jurassic/Cretaceous boundary assemblages (analysis by J.B. Riding, British Geological Survey, 1988).

Field work on the Nordenskjöld Formation in the Larsen Inlet area by Drs P. Doyle and A.G. Whitham during January 1988, produced several further fragments of fishes, one of them studied here. The remaining material will be described elsewhere.

Apart from some undescribed teleost remains from the type locality of the Nordenskjöld Formation, illustrated by Farquharson (1983, fig. 11), these are the only fossil fishes recorded from James Ross Island and northern Antarctic Peninsula. Elsewhere in Antarctica, Jurassic fishes have been described from localities in the Queen Alexandra Range, Transantarctic Mountains (Schaeffer 1972, Grande & Eastman 1986, Tasch & Gafford 1984, pl. 2, figs 2–6). Lower Jurassic freshwater mudstones and shales, interbedded in the Kirkpatrick Basalt of the Ferrar Group, contain the best preserved Mesozoic fishes from Antarctica, namely the archaeomaenid (neopterygian) fish *Oreochima ellioti* Schaeffer 1972, closely allied to Australian species of the same family (Schaeffer, in Grande & Eastman 1986, p. 132).

Material and methods

The Antarctic specimens were collected by British Antarctic Survey (BAS) geologists in 1982/83 and 1987/88. They

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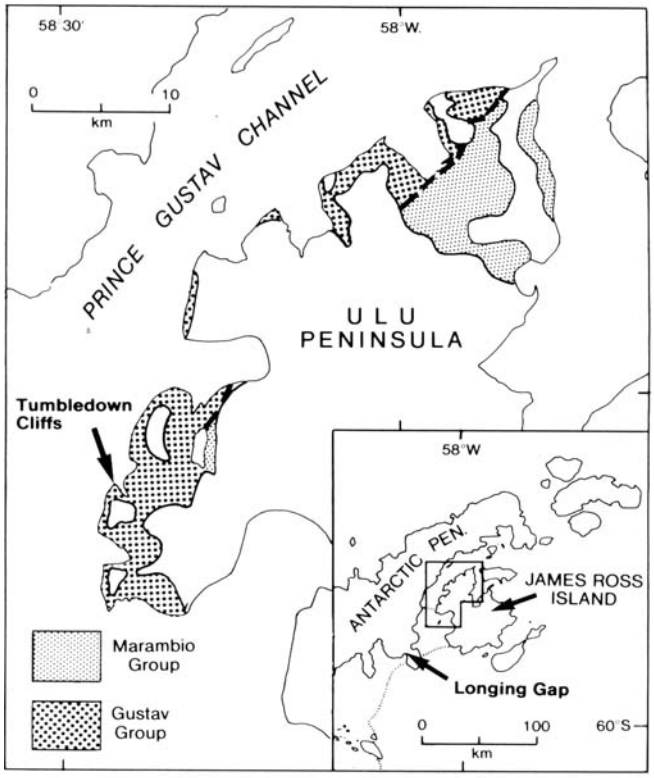


Fig. 1. Sketch map to show the location of Tumbledown Cliffs, western James Ross Island, where the holotype of *Aspidorhynchus antarcticus* sp. nov. was found, and Longing Gap where there are *in situ* exposures of Nordenskjöld Formation containing fragments of *Aspidorhynchus* sp.

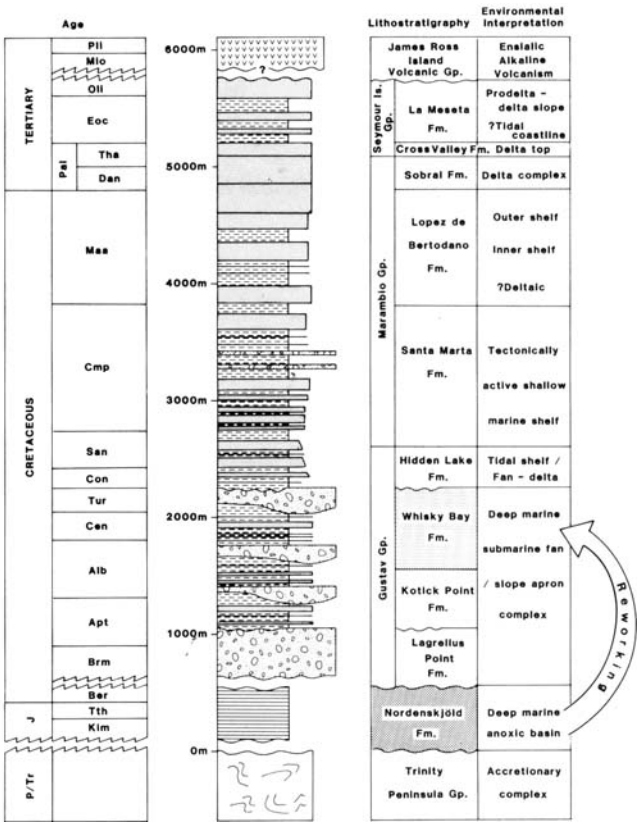


Fig. 2. Lithostratigraphic summary of the bedded rocks of north-eastern Antarctic Peninsula. Clasts of Upper Jurassic tuffaceous mudstone, including that with *Aspidorhynchus antarcticus* sp. nov., in the Lower Cretaceous Whisky Bay Formation were reworked from the Nordenskjöld Formation (modified after Macdonald *et al.* 1988, fig. 3).

were compared (see below) with the following material, housed at the British Museum (Natural History) — BM(NH), in London:

Aspidorhynchus acutirostris (Blainville 1818): P.3807; P.6940; P.7810; P.22657; P.37789; P.37790 (all from the Tithonian of Germany).

Vinctifer comptoni Jordan 1919: P.975a; P.47894; P.54592 (all from the Cretaceous of Brazil).

Meristic and morphometric measurements of some of these specimens and also of the new species described here are given in Table I.

Other specimens housed at the BM(NH) and belonging to about seven species of *Aspidorhynchus* Agassiz 1833 and *Belonostomus* Agassiz 1834, were also examined. However, they are not considered in Table I, because most of them do not have the post-pelvic region preserved, making comparisons with our material difficult.

The systematics of the Aspidorhynchidae badly need review. Although some species, e.g. *Aspidorhynchus acutirostris*, are known from a large number of specimens, no one has really looked at the intraspecific range of morphoanatomical variations of these fishes. Another problem is that not all the species are known as complete skeletons. Considering the current unsatisfactory state of the taxonomy of the genus *Aspidorhynchus*, there is always the risk of over-splitting the group into an unnatural number of species when describing new fossil material. In order to overcome this, our studies were based on both bibliographical data and comparative studies of specimens ascribed to different species of *Aspidorhynchus*, *Belonostomus* and to *Vinctifer comptoni*. The taxonomic value of the characters used in this work to determine different species nevertheless remains provisional and awaits a broader analysis, incorporating completely preserved specimens.

To investigate the presence of ganoin, an apparent key-character in separating *Belonostomus* from *Aspidorhynchus* (see below), fragments of scales of the Antarctic fishes were embedded in Lakeside cement and ground down manually on a glass plate with carborundum. The transverse sections so prepared were then etched in dilute hydrochloric acid (1N) for either 30 s or 60 s, metallized with gold-palladium and examined under the Hitachi S-520 scanning electron

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Table I. Meristic and morphometric measurements (in cm) of aspidorhynchid specimens.

Taxa	Number	A	B	C	D	E	F	G	H	I	J	K	L
A. antarcticus sp. nov.	D.8411.70	18	11	15	3.9	7.5	6.2	1.0	5.0	6.6		24.2%	15.5
A. acutirostris	P.3807	21						2.4					
	P.6940	19			4.7	10.4	8.0	2.2	7.2	7.7	49.6	6.5%	18.8
	P.7810	19			4.9	11.9	8.8	2.0			53.2		23.1
	P.22657	19		16	5.0	10.7	9.4	2.3			52.9		21.1
	P.37789	19		16	5.0		7.1	1.8	6.8	8.0	47.3	15.0%	17.6
	P.37790	21	11				10.1	2.5	9.5	10.0	68.2	5.0%	
Vinctifer comptoni	P.975d	21						2.5					
	P.47894		14	16	3.3		6.9	1.6					
	P.54592	21		16	6.2	9.8	11.1	2.6					

For morphometric measurements refer to Fig. 3. A = number of principal rays of the caudal fin; B = number of dorsal fin rays; C = number of anal fin rays; D = distance between dorsal and anal fins; E = distance between dorsal and pelvic fins; F = length of the caudal peduncle; G = depth of the caudal peduncle; H = length of upper lobe of caudal fin; I = length of lower lobe of caudal fin; J = standard length of the fish; K = percentage of exceeding lower lobe (caudal fin) length over upper lobe length; L = distance between the origin of the pelvic fin and the base of the caudal peduncle.

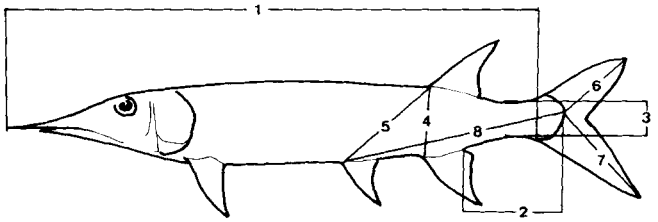


Fig. 3. Idealized sketch of *Aspidorhynchus*, showing the morphometric measurements referred to in Table I. 1 = standard length; 2 = length of the caudal peduncle; 3 = depth of the caudal peduncle; 4 = distance between the origin of the dorsal and anal fins; 5 = distance between the origin of the dorsal and pelvic fins; 6 = length of the upper caudal lobe; 7 = length of the lower caudal lobe; 8 = distance between the origin of the pelvic fin and the base of the caudal peduncle.

microscope of Guy's Hospital, University College of London. Fragmentary scales of the some of the aspidorhynchids housed at the BM(NH) were also prepared in the same way for studies under the scanning microscope. These are *Aspidorhynchus acutirostris* (P.3807) *Aspidorhynchus euodus* (P.40.518), *Belonostomus sweeti* (P.15686) and *Vinctifer comptoni* (P.54.591).

Systematics

The phylogenetic interrelationships of the three constituent genera of Aspidorhynchidae, *Aspidorhynchus*, *Belonostomus* and *Vinctifer*, are unknown. Presently classified among the teleostean fishes, the aspidorhynchids are placed as a sister-group of *Ichthyokentema* plus all higher teleosts (Patterson & Rosen 1977).

So far, all the aspidorhynchid remains obtained from rocks of the Nordenskjöld Formation, can be ascribed to the genus *Aspidorhynchus*.

Infraclass NEOPTERYGII
Division HALECOSTOMI
Subdivision TELEOSTEI
Family ASPIDORHYNCHIDAE
Nicholson & Lydekker 1889
Genus ASPIDORHYNCHUS Agassiz 1833
Aspidorhynchus antarcticus sp. nov.
Figs 4, 5

Holotype: British Antarctic Survey, specimen number D.8411.70, registered at the British Museum (Natural History) as specimen BAS P.1000a & b, preserved as the part and counterpart of pelvic and post-pelvic remains of a fish in lateral view.

Occurrence: Within an angular block of reworked tuffaceous mudstone of presumed Late Jurassic age (corresponding to the Nordenskjöld Formation), in a poorly-sorted conglomerate of the Whisky Bay Formation (Albian), northern Tumbledown Cliffs, James Ross Island, Antarctic Peninsula.

Palaeoenvironment of deposition of the Nordenskjöld Formation: Deep marine, anoxic (Macdonald *et al.* 1988).

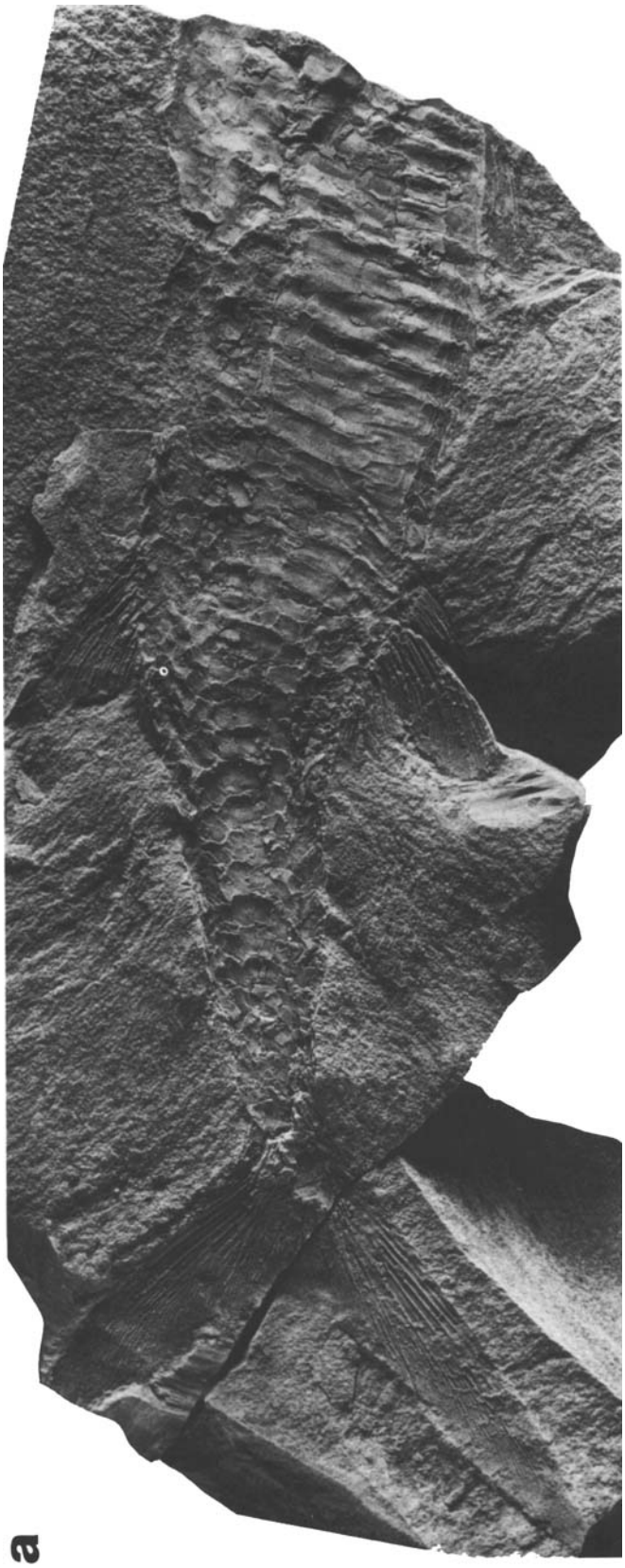
Diagnosis: The new species differs from other species of *Aspidorhynchus* in the following combination of characters: 15 rays in the anal fin and 11 rays in the dorsal fin; caudal fin with 9 principal rays in each lobe; tail externally asymmetrical, the lower lobe of the fin being much longer (24%) than the upper lobe; scales smooth.

Description

The specimen (Figs 4, 5) measures 22 cm from the anterior edge of the pelvic to the tip of the caudal fin. Meristic and morphometric measurements of *Aspidorhynchus antarcticus* and other aspidorhynchid specimens housed in the BM(NH) are provided in Table I.

Judging from the normal body-shape and proportions of

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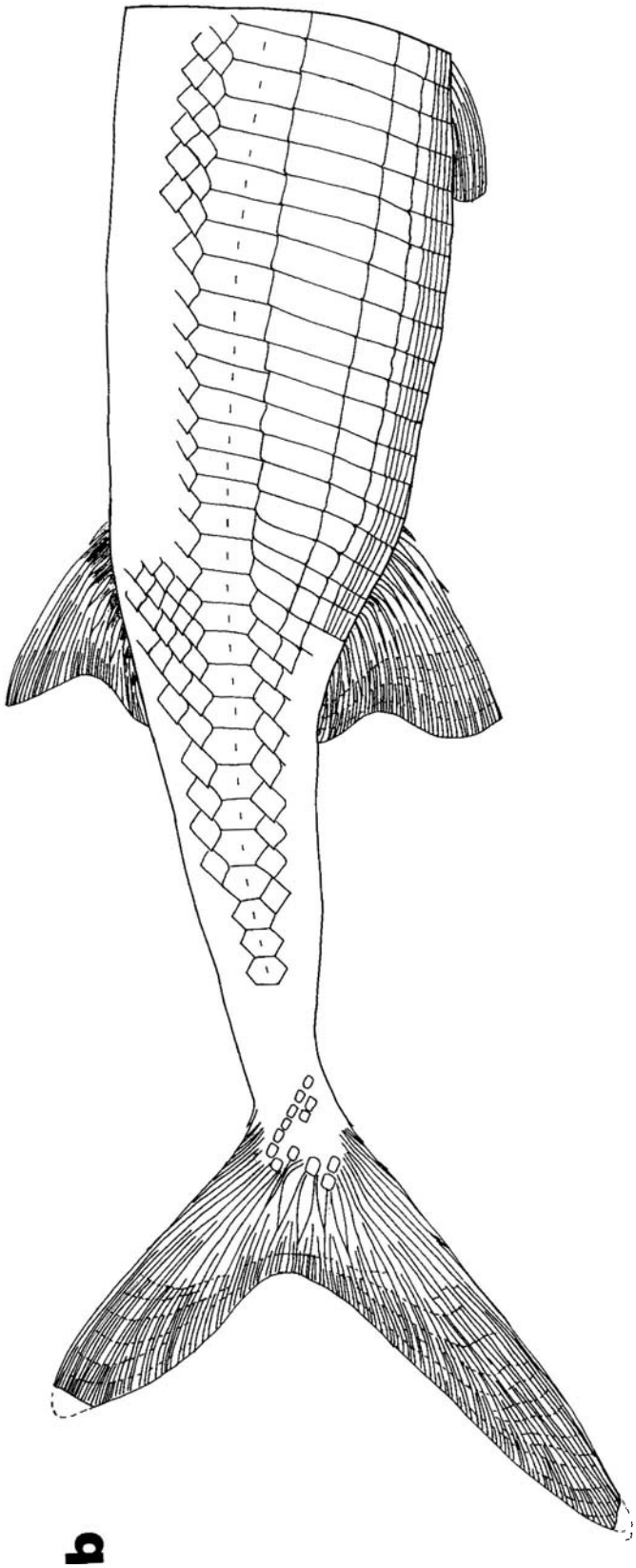


Fig. 4. *Aspidorhynchus antarcticus* sp. nov.; **a.** Left-hand part of the holotype; × 1, coated. [D.8411.70/BM(NH) BAS P.1000a.] **b.** Sketch reconstruction based on features preserved on both halves of the holotype.

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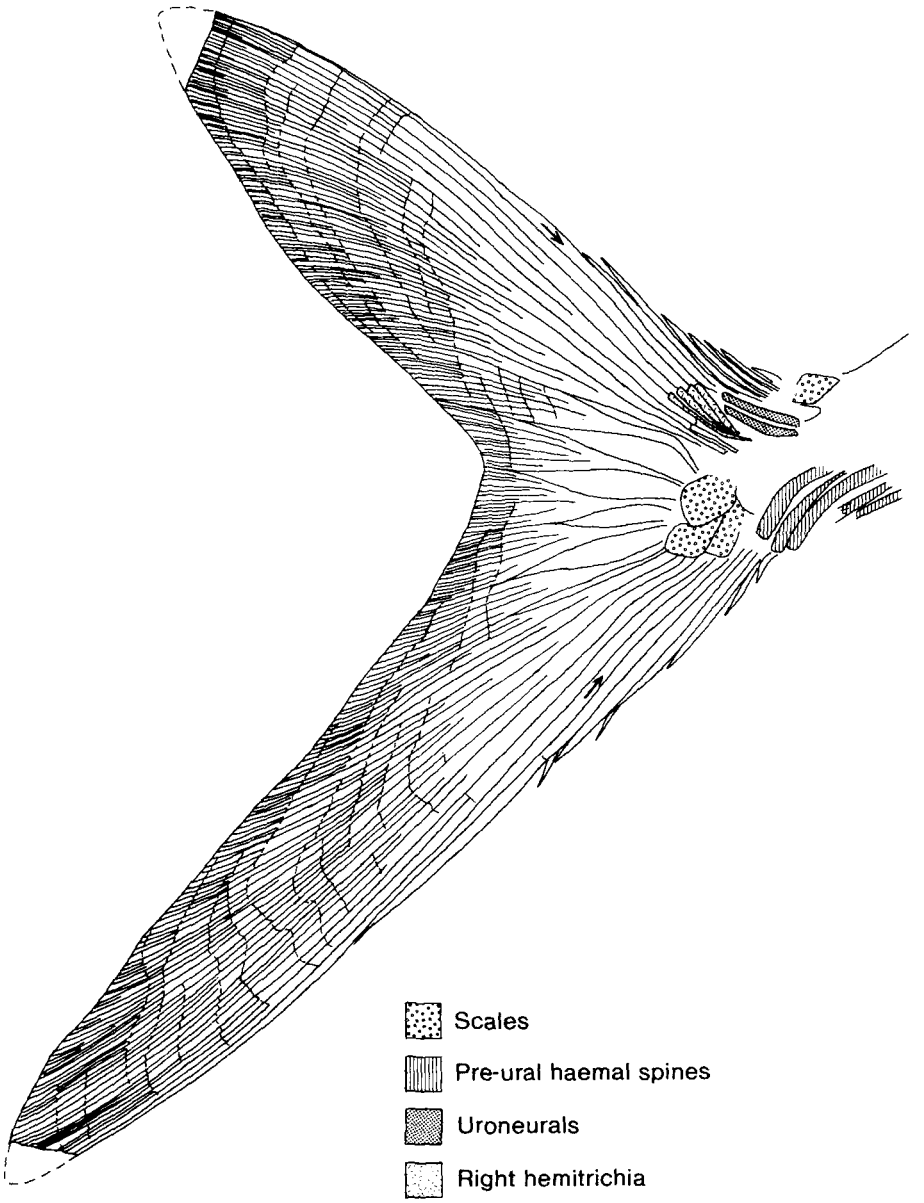


Fig. 5. *Aspidorhynchus antarcticus* sp. nov.; sketch of the caudal skeleton of the holotype; first and18th principal fin rays arrowed, × 2. [D.8411.70/BM(NH) BAS P.1000a.]

the elongated fishes belonging to the family Aspidorhynchidae (e.g. *A. acutirostris*), the region preserved in our specimen probably represents about 50% of the original total length of the fish. About 30 scales carrying the lateral-line canal are preserved (Fig. 4b) but the total number of post-pelvic scales is estimated to be around 40. The scale size diminishes rapidly towards the base of the caudal peduncle, where only a few scales are preserved in impression. Scales are smooth and without ganoin. The fish bears 14 scales longitudinally between the origin of the pelvic and the anal fins. There are three size-series of scales on the flank in each transverse row between the pelvic and anal fins. The first series consists of up to six rows of small, square scales in the dorso-lateral position, and the second contains three rows of deepened scales, of which the uppermost carries the lateral-line canal. This second series of scales occupies almost 75% of the depth of the fish as preserved, and include the deepest ones of all in the row below the one pierced by the lateral canal. The scales in the second series have a well-developed peg-and-socket system. The third series consists of small, elongate scales (5–6) in the ventro-lateral position. The uppermost scales in this series are about twice as high as the more ventral ones.

Pelvic, anal, dorsal and caudal fins are preserved (Fig. 4). Only four rays of the pelvic can be counted, but this fin is not well preserved. The anal has 15 branching rays and the

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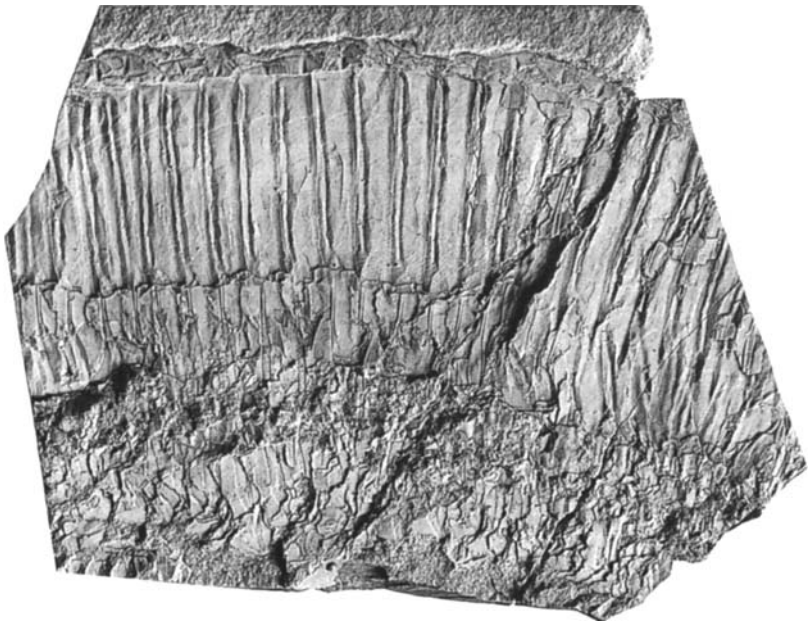


Fig. 6. *Aspidorhynchus* sp.; postcranial remains collected from the Nordenskjöld Formation of Longing Gap, × 1, coated. [D.9013.32/BM(NH) BAS P.1001.]

dorsal, 11. Anal and dorsal fins are triangular and opposed to one another. There is a short, spine-like element in front of the anal and dorsal fins. The caudal fin (Fig. 5) has 18 principal rays, nine in each lobe. Six and about five much shorter and unbranched rays (procurrent rays) are present at the periphery of the lower and upper lobes respectively. The caudal fin rays branch at least 12 times, and the lower fin-lobe is 24% longer than the upper lobe. Therefore, in spite of the similar number of principal fin-rays present in each lobe, the fin is externally asymmetrical. Five pre-ural haemal arches and two uroneurals are the only endoskeletal elements preserved in the caudal region (Fig. 5). Three centra are preserved in the region of the caudal peduncle and two fragmentary ones are visible in the region above the pelvic fin.

Very few fringing fulcra can be observed on the anal and dorsal and caudal fins. Some seem to originate as short branches of the marginal rays which protrude anteriorly and remain articulated. The interpretation of these elements is therefore disputable.

At least four long pterygiophores are connected to the rays of the anal fin.

Aspidorhynchus sp.
Fig. 6

This specimen (D.9013.32/BM(NH) BAS P.1001) belonging to the genus *Aspidorhynchus* was recently collected *in situ* in strata of the Nordenskjöld Formation dated as Tithonian by fossil molluscs (Dr P. Doyle, personal communication 1988). The remains consist of articulated flank scales.

Systematic affinities of Aspidorhynchus antarcticus

There are about five valid species of *Aspidorhynchus* (see below), a predacious, pelagic and apparently strictly marine fish as opposed to the related *Belonostomus*, which may have included anadromous species (Estes 1964, Dumontet & Wenz 1979, Bryant 1987).

Although many of the diagnostic features of the aspidorhynchid species are cranial, it is evident from the examined assemblage that there is a considerable variation in postcranial anatomy of these fishes which has not yet been assessed either within genera or species. It is unclear so far to what extent these variations may be employed as taxonomic characters.

Generic characteristics (cf. Woodward 1895, p. 416) shown by *Aspidorhynchus antarcticus* are as follows: three deepened series of scales on the flank, the lateral line scales not deeper than the scales in the series below. More recently, the absence of ganoin on the scales has been considered as diagnostic for the genus (Schultze 1966, Silva Santos 1985). This is confirmed at least for those aspidorhynchids whose scales were sectioned and studied in this paper (see above). Characters of *Aspidorhynchus antarcticus* which differ from those in other aspidorhynchids (see Table I) are the exceedingly long lower lobe of the caudal fin (24% longer, compared with a maximum of 15% in some specimens of *A. acutirostris*), the smaller number of principal fin rays in the caudal (18) and anal fins (15), and the lack of ornamentation on the scales.

Indeed, *A. antarcticus* is clearly distinct from all of the *Aspidorhynchus* species previously recorded in Europe. *A.*

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acutirostris from the Solnhofen Limestone (Tithonian) of Germany and Kimmeridgian of France reached a length of 1.0 m; the scales are almost smooth in young individuals but strongly ornamented in the adult, which bears 'coarsely though sparsely tuberculated and partly rugose' scales (Woodward 1895). Even small specimens of *A. acutirostris* (e.g. BM(NH) P.6940), measuring half of the maximum size recorded for that species already show the typical ornamentation on the scales (*A. antarcticus* is nevertheless 30% smaller than the referred specimen). The lower lobe of the caudal fin in *A. acutirostris* is 5–15% longer than the upper lobe. Additionally, the larger number of fin rays (19 or 21 principal rays in the caudal and 16 in the anal) do not agree with corresponding structures in the new species. In the new species the lower lobe is considerably longer (24%) than the upper one whereas in *A. acutirostris* the difference in the length of the caudal lobes seems to diminish with increase in size of the individuals an aspect worth considering in future studies of allometric changes during the ontogeny of these fishes.

A. euodus Egerton 1845 is a small fish from the Oxford Clay (Callovian) and the Kimmeridgian of England. That species also differs from the new one by possessing rugose scale ornamentation, albeit somewhat feeble. The caudal fin of *A. euodus* is unknown.

The two other species from the Jurassic of England, namely *A. fisheri* Egerton 1855 (Purbeckian) and *A. crassus* Woodward 1890 (Bathonian: the earliest *Aspidorhynchus* described) are small fishes if compared with, for instance, *A. acutirostris*. The postcranium of *A. crassus* is unknown; the deep flank scales of *A. fisheri* show poorly-developed serration on the posterior margin, a feature already noticed by Woodward (1895).

A. sphekodes Sauvage 1893 (Lower Kimmeridgian of France) is a very elongate fish, with the ratio between body length and body depth much greater than that of the other described species.

A. comptoni (Agassiz) from the Lower Cretaceous of Brazil has recently been reascribed to the genus *Vinctifer* Jordan 1919 (Silva Santos 1985). Among the characters which separate *Belonostomus* and *Vinctifer* from *Aspidorhynchus* is the presence of ganoin-coated scales in the former two genera (see above).

Romer's (1966) reference to a possible *Aspidorhynchus* from Australia seems to be based on unillustrated reports by Etheridge (1872) and Etheridge & Woodward (1892) of fragmentary material (caudal fin and several scales) from the Cretaceous beds of Hughenden, Queensland. A confirmation of this occurrence would be of great interest, considering the fact that the Antarctic fish faunas of the Palaeozoic and Mesozoic show much closer affinities to Australian faunas of the same eras than to faunas of other regions (Grande & Eastman 1986). However, one undoubted member of the Aspidorhynchidae does occur in Australia *Belonostomus sweeti* Etheridge & Woodward 1892. Nevertheless, that species differs from *A. antarcticus* in having huge, ornamented and ganoin-coated scales.

Palaeogeographical considerations

Prior to this discovery in Antarctica, the confirmed palaeogeographical distribution of *Aspidorhynchus* species appeared to be restricted to the Middle Jurassic–earliest Cretaceous of Europe (Bathonian to Purbeckian in England, Kimmeridgian–Tithonian in France and Germany).

The Antarctic species lived in an area which presumably was at a palaeolatitude of about 60°S during the late Mesozoic. Most of Europe at that time occupied palaeolatitudes between 30°N and 60°N (cf. Smith & Briden 1977). While Europe experienced a warm, equable and humid climate (e.g. Hallam 1985), contemporary conditions in Antarctica seem to have been of a temperate, or even cool-temperate climate regime (Crame 1986, D. Pirrie, personal communication 1988) but see competing interpretation by Hallam (1975, 1985) based on palaeoflora.

The presence of *Aspidorhynchus* in the Antarctic Peninsula could be interpreted as evidence of a mild climate similar to that of Europe in contemporary times. Indeed, on the basis of the extensive north–south distribution of Mesozoic dipnoans and certain stem group teleosts (lepidotids, pycnodontids, aspidorhynchids, leptolepids, ichthyodectids and enchodontids) Schaeffer (1969, p. 387) claimed that 'the Mesozoic distributional pattern is best explained by a zone essentially uniform climate that embraced all the continents, including Antarctica, regardless of their relative positions'.

The Antarctic aspidorhynchids alone cannot provide a definite indication of the palaeoclimate in the Antarctic Peninsula, but a more precise picture will hopefully emerge as more information is gathered on the composition of the late Mesozoic biotas of that region.

Acknowledgements

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