Anatolepis from the Early Ordovician of East Greenland – not a fishy tail

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Fragments from the Cape Weber Formation (Early Ordovician) of East Greenland assigned to the supposed vertebrate *Anatolepis* are illustrated. The presence of a well preserved terminal spine suggests arthropod rather than vertebrate affinities.

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The occurrence of fragments of *Anatolepis* Bockelie & Fortey, 1976 in samples from the Cape Weber Formation (Early Ordovician) of East Greenland was reported by Peel & Higgins (1977). Bockelie & Fortey (1976) interpreted *Anatolepis* as a primitive heterostracan fish, but Peel & Higgins suggested that the presence of a telson-like spine in their material indicated that *Anatolepis* was most probably an arthropod. This paper illustrates the terminal, telson-like spine (fig. 1E, G, I), together with other fragments, and briefly reviews the continuing debate surrounding the systematic position of *Anatolepis*.

History of *Anatolepis*

Possible fragments of *Anatolepis* were illustrated, but not named, by Nitecki, Gutschick & Repetski (1975) from the Early Ordovician El Paso Group of Texas. They commented that some of their figured material resembled dermal elements of the ostracoderm fish *Astraspis*, while other specimens appeared similar to merostome arthropods.

Bockelie & Fortey (1976) isolated and named *Anatolepis heintzi* from the Early Ordovician Valhallfonna Formation of Spitsbergen, seemingly in ignorance of Nitecki *et al.* (1975). They suggested that the remains were those of a heterostracan fish and that they predated the previously oldest known vertebrates by 20 m.y. Worthy of note is the striking resemblance between fig. 4 of Nitecki *et al.* (1975) and fig. 1 g, h of Bockelie & Fortey (1976), which the latter authors considered to be a second species of *Anatolepis*. The specimen from the El Paso Group was one of the specimens which Nitecki *et al.* (1975) considered to show similarity to the merostomes. Bockelie, Bruton & Fortey (1977) gave additional illustrations of *Anatolepis* from Spitsbergen.

In 1977, Ritchie & Gilbert-Tomlinson described two new genera of heterostracan fishes, *Arandaspis* and *Porophoraspis,* from Northern Territory, Australia. Both genera were collected from rocks of similar age to the Spitsbergen *Anatolepis,* which was accepted by Ritchie & Gilbert-Tomlinson as the "oldest confirmed vertebrate fossil". The Australian specimens are relatively complete, unlike the comminuted material from elsewhere, and permit reasonable reconstruction of *Arandaspis* (Ritchie & Gilbert-Tomlinson, 1977, fig. 8).

Peel & Higgins (1977) noted the occurrence of *Anatolepis* in samples from the upper Cape Weber Formation on Ella Ø, northern East Greenland, associated with rich and diverse marine faunas of conodonts, articulate and inarticulate brachiopods. Peel & Higgins compared a small spine with the hollow telson spine of merostomes figured by Raash (1939), and concluded that *Anatolepis* was not a vertebrate.

Repetski (1978) extended the known range of *Anatolepis* back into the Late Cambrian, noting new Cambrian and Early Ordovician occurrences in Wyoming, Oklahoma, Utah, New York State, Arkansas, Washington, Idaho and Alaska. Repetski presented histological arguments in support of the interpretation of *Anatolepis* as a vertebrate. Repetski's paper formed the basis of an anonymous contribution in *Geotimes* (September 1978, p. 27) which illustrated specimens from the Late Cambrian of Wyoming.

It is this widespread acceptance of the vertebrate affinities of *Anatolepis* that gives the terminal spine from East Greenland its significance.

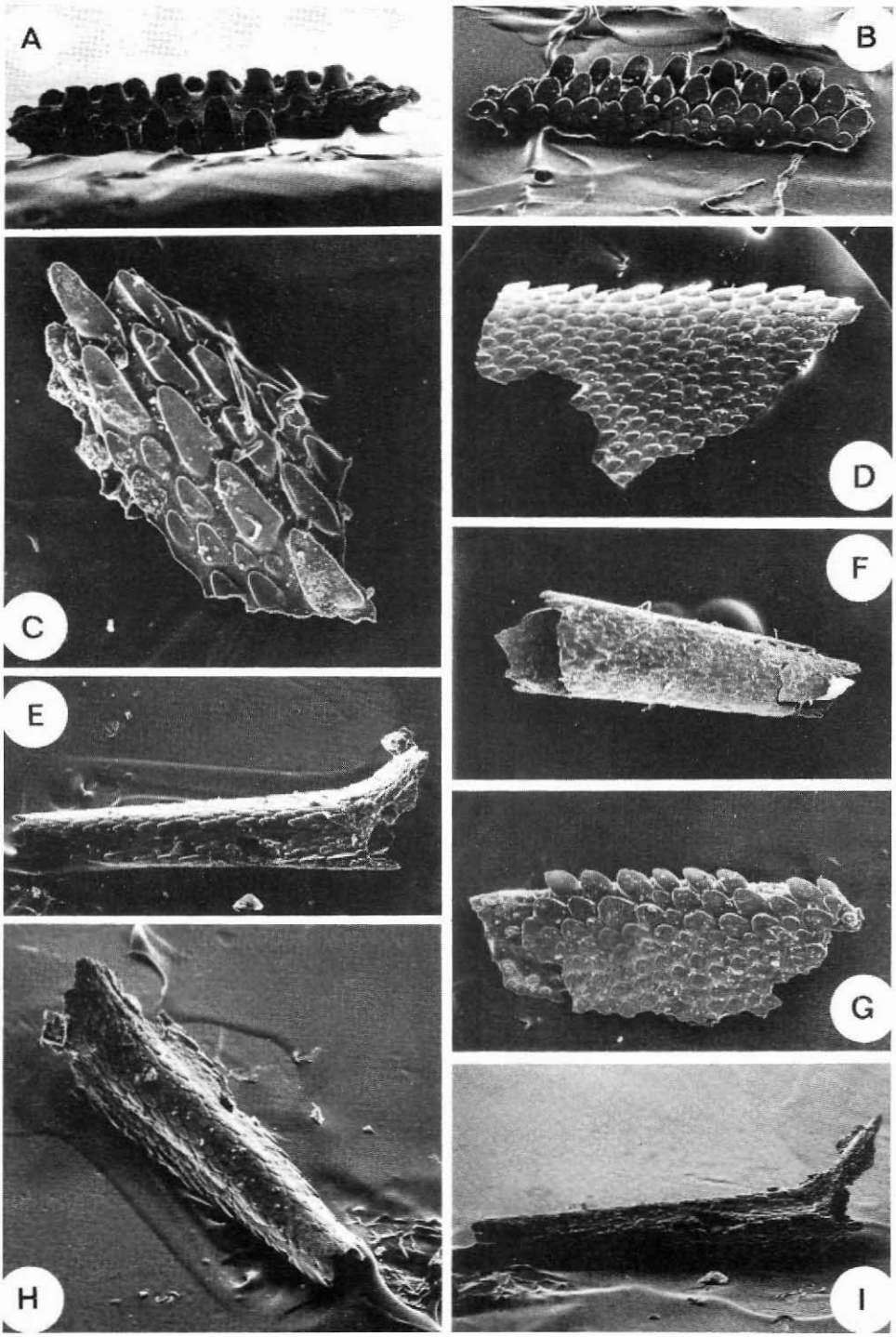
Anatolepis from East Greenland

More than fifty fragments identified as *Anatolepis* have been recovered by acetic acid digestion and tetrabromoethane separation of limestone samples GGU 236425 and 236426 from the Cape Weber Formation, Antiklinalbugt, Ella Ø, northern East Greenland. They are generally translucent, often almost transparent, and pale greenish brown in colouration. The largest fragments are slightly more than 2 mm long, but it is not possible to ascertain the true dimensions of undamaged exoskeletal elements. Flat or gently convex fragments are the most common (fig. 1C) but many of these show a strongly recurved margin (fig. 1A, B, D, G).

Two less frequent, spine-like remains are significant. The first of these is a gently tapering, hollow, terminal spine (fig. 1E, H, I), the telson spine of Peel & Higgins (1977), which is represented by three fragments – a fourth example very similar to the illustrated specimen was unfortunately destroyed while mounting it for stereoscan microscopy. The figured terminal spine is about 1.5 mm long, but a larger fragment from GGU 236426 was more than twice this length when complete.

The second type of spine is known from three fragments, all of which are circular in cross-section and gently tapering (fig. 1F). All the fragments identified as *Anatolepis* are ornamented with imbricated ellipitcal scales. These scales become thicker and spine-like along the recurved margins of the fragmented plates (fig. 1A).

Fig. 1. *Anatolepis* from northern East Greenland. Scanning electron micrographs of specimens from GGU sample 236425. A, B, MGUH 14269, × 45; C, MGUH 14270, × 80; D, MGUH 14271, × 40; E, H, I, MGUH 14272, × 40; F, MGUH 14273, × 45; G, MGUH 14274, × 45. All magnifications approximate.


A
B
C
D
E
F
G
H
I

Discussion

An obvious prerequisite to any comparison of the various records of *Anatolepis* is the assumption that all the material in question is congeneric. However, after very brief examination of some North American and Spitsbergen material, in addition to the Greenland specimens, I do not feel justified in making this assumption. Superficially, the resemblance between specimens from Spitsbergen and Greenland is striking, although the terminal spines and spines with circular cross-section reported here were not noted by Bockelie & Fortey (1976). Similarly, an elongate fragment with U-shaped cross-section and small rhomboidal scales illustrated by Bockelie & Fortey (1976, fig. 1 d) and Bockelie *et al.* (1977, figs 1, 2) does not occur in the Greenland samples.

The terminal spine clearly supports comparison of *Anatolepis* with the arthropods rather than with the heterostracan fishes. At least some aglaspidan arthropods are phosphatic (Raasch, 1939; Størmer, 1955), in common with vertebrates, and many members of this arthropod class possess a well developed terminal spine of similar appearance to the Greenland specimens. Bockelie & Fortey (1976) and Repetski (1978) illustrated three layer structure in the exoskeleton of *Anatolepis* which they considered to be similar to that described in heterostracan fishes. However, Raasch (1939) has also reported triple layering in aglaspidans, although it is not known how this compares to that described from *Anatolepis*.

The tubes with circular cross-section (fig. 1F) could represent appendages, although aglaspidan appendages described by Raasch (1939) and Briggs, Bruton & Whittington (1979) appear to be relatively wider and less uniformly tapering. The abundant plate fragments with recurved brims (the edge pieces of Bockelie & Fortey) may be fragments of pleural segments. Raasch noted that the pleural margins in several aglaspidans are recurved, also along their posterior margin.

Conclusion

The terminal spine and possible appendage fragments suggest that the specimens from Greenland identified as *Anatolepis* are arthropods. Tentative assignment to the Order Aglaspida is suggested, although detailed morphological comparison with members of this group has not been attempted. Aglaspidans have generally been placed within the chelicerate Class Merostomata (Størmer, 1955; 1959). However, Briggs *et al.* (1979) excluded the Aglaspida from the merostomes, but preferred not to suggest an alternative location. Aglaspidans occur in marine deposits of Cambrian to Ordovician age (Flower, 1968).

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