Middle Devonian thelodont *Australolepis* sp. (Thelodonti) from the Skały Formation, Holy Cross Mountains, Poland

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ABSTRACT:


Sparse fish microremains have been found in marine limestones from the Middle Devonian (Givetian) Skały Formation (Sitka Coral-Crinoid Limestone Member and Sierżawy Member), Świętomarz-Śniadka section, Bodzentyn Syncline, Łysogóry Region, northern Holy Cross Mountains, associated with conodonts of the *hemiansatus* to *ansatus* zones. Thelodont scales referred here to *Australolepis* sp. cf. *A. seddoni* came from near Śniadka village, from samples dated as *hemiansatus* to *rhenanus/varcus* zones. This increases the known range for the genus from its original find in Western Australia. The presence of a thelodont in the late Middle Devonian in Poland extends the known distribution of turiniids around the peri-Gondwana shorelines of Palaeotethys.

Key words: Vertebrate palaeontology; Taxonomy; Biostratigraphy; Thelodonti; Turiniidae; Givetian; Northern Gondwana; Poland.

INTRODUCTION

There are relatively few records of mid to later Devonian thelodonts, the longest-lived Palaeozoic agnathans and most come from North and East Gondwana (NG, EG); *Australolepis seddoni* Turner and Dring, 1981 was first found in the late Givetian to early Frasnian Gneudna Formation of the Canning Basin, Western Australia and then appeared in further localities in Australia as well as in central Iran (Märrs et al. 2007). The youngest thelodonts, therefore, belong to the turiniid clade with recent finds of scales of *Australolepis* species, *Neoturinia* and *Arianalepis* extending their range into the later Famennian (Hairapel et al. 2015, 2016).

Various agnathans remains, including thelodont scales, are known from older rocks in Poland including a Silurian erratic and 14 core samples from the north and east (Halstead and Turner 1970; Märrss 1997). Halstead and Turner’s (1970) few scales are now identified as late Silurian *Thelodus laevis* and *Th. admirabilis* or *Th. sculpilis*; Märrss (1997, pl. 4) found latest Silurian (Pridoli) thelodonts *Th. parvidens* including costatus and trilobatus forms, *Th. sculpilis, Th. truaquairi, Goniporus alatus(?), Loganellia cuneata, “Loganellia” kummerovi(?) and Loganellia sp. from the Miahtko-I borehole. Bremer et al. (2017a, b) introduced the first Late Silurian vertebrate microfossils from the Holy Cross Mountains, including a *Thelodus parvidens* fauna (sensu Gross 1967; Turner 2000) including *Th. trilobatus* and *Paralogania ludlowiensis*, typical of late Ludlow to early Pridoli elsewhere in Europe (Märrss et al. 2007).

Younger Devonian microvertebrates of gnathostomes from Poland were noted by Liszkowski and Racki; they (1993, fig. 6A–F) described scales from the Givetian of the Holy Cross Mountains, which they assigned to *Acanthoids? dublinensis* Stauffer,
1938 and *Cheiracanthoides comptus* Wells, 1944. J. Kłossowski collected Middle Devonian samples from the Świętomarz–Śniadka section, Bodzentyn Syncline in the Lysogóry Region, northern Holy Cross Mountains in 1976; he prepared rocks for conodonts, also finding fish remains (Kłossowski 1976, 1985). This material was later given by Professor M. Szulczewski to one of us (Ginter 1994), and examples were later shown to the senior author (ST), who identified the thelodont scales. Woroncowa-Marcinowska (2012) later re-studied this section and found further sparse fish microremains, from which we also identified a thelodont scale.

The aim of this paper is to give the first formal description of the thelodont scales found in these Middle Devonian rocks from Poland.

**GEOLOGY AND MATERIAL**

Six thelodont scales were found in limestones from the Middle Devonian (Upper Givetian) Skały Formation of the Świętomarz–Śniadka section, Bodzentyn Syncline in the Lysogóry Region, northern Holy Cross Mountains (Text-fig. 1), by J. Kłossowski (1976, samples 42/38 and 51/55). The scales come from the Sierzawy Member, most probably from a marine black, thin-bedded micritic limestone. According to Kłossowski (1976), sample 42/38 was collected in the northern part of the section, near Śniadka village, north of the Sitki gorge, and contained conodonts *Icriodus regularicrescens* and *I. obliquimarginatus*, the co-occurrence of which indicates the early Givetian (*hemiansatus–rhenanus/varcus* Conodont zones; see, e.g., Bultzynck 2003; Liao and Valenzuela-Ríos 2008). However, Woroncowa-Marcinowska (2012), based on her recent re-examination of the section, placed almost all the lower part of the Sierzawy Member, including the dark-coloured limestones, in the *rhenanus/varcus* Zone, so it is reasonable to conclude that sample 42/38 also represents this zone. Sample 51/55 comes from a small section on the northern side of the valley of a western tributary of the Psarka river, between Śniadka II and III. Kłossowski (1976) reported conodonts with rather long ranges from the same section, comprising *Polgnathus linguiformis linguiformis*, *Icriodus aff. obliquimarginatus* and *I. curvatus*. However, as in the former case, the lithology also suggests the *rhenanus/varcus* age.

The work by Kłossowski (1976) is an unpublished M.Sc. thesis and, although it is available in the archives of the Faculty of Geology, University of Warsaw, the locality maps attached to it are missing, so the detailed positions of his collected outcrops (given herein 42 and 51, Text-fig. 1C) are only tentative, based on Kłossowski’s descriptions in the text.
These descriptions do not indicate precisely from which part of an outcrop a particular sample was collected, and so there is a slight possibility that sample 42/38 does not come from the black limestones, but from the underlying grey shales with limestone intercalations. This placement would still date the sample from the same, rhenanus/varcus Zone.

Further new evidence of thelodonts was found by Woroncowa-Marcinowska (2012) in the Skały Formation of Świętomarz–Śniadka section. A single scale was reported by her from the Sitka Coral-Crinoid Limestone Member, hemiansatus Conodont Zone, cropping out near Śniadka village (Text-fig. 1C, section II, sample 4a). Woroncowa-Marcinowska (2012) gave full details of the stratigraphy and sedimentology of the Skały Formation in that area and, in addition to the thelodont scale, which she did not identify beyond ‘fish remains’ (her fig. 8H; re-illustrated by us in Text-fig. 2F), she figured several ichthyoliths, which we note comprise a canthodian scales (figs 8F, I, L–N), a gnathostome spinelet?, teeth? (fig. 8G, J), and an osteichthyan lepidotrichium (fig. 8O). The residue of these Middle Givetian samples also contained semi-spherical problematic forms, sponge spicules, scleriform elements, tentaculite fragments and leiospheres.

SYSTEMATIC PALAEOONTOLOGY

Class Thelodonti Jaekel, 1911
Order Thelodontiformes Kiera, in Kiera and Heintz
1932
Family Turiniidae Obruchev, 1964

Genus Australolepis Turner and Dring, 1981

TYPE SPECIES: Type and only species Australolepis seddoni Turner and Dring, 1981.


(Material Examined: Six scales from samples 42/38 and 51/55, Middle Devonian (Upper Givetian: hemiansatus Conodont Zone), Skały Formation, Sierżawy Member, Świętomarz–Śniadka section at Śniadka village, Bodzentyn Syncline, Lysogóry Region, Holy Cross Mountains, Poland. The specimens are housed at the Geological Museum of the Polish Geological Institute – National Research Institute, Warsaw, Poland (MUZ PIG 1818.II.24).

ADDITIONAL MATERIAL: One possible head or cephalopectoral scale figured by Woroncowa-Marcinowska (2012, fig. 8H) from sample 4a, Middle Devonian (Upper Givetian: hemiansatus Conodont Zones), Skaly Formation, Sitka Coral-Crinoid Limestone Member, Świętomarz–Śniadka section, Śniadka village, Bodzentyn Syncline, Lysogóry Region, Holy Cross Mountains, Poland. The specimen is housed at the Geological Museum of the Polish Geological Institute – National Research Institute, Warsaw, Poland (MUZ PIG 1818.II.24).

DESCRIPTION: The six scales from samples 42/38 and 51/55 (Text-fig. 2A–E) each have fragile elongate crowns with raised ridges. There are four to six ridges at the rim and small spines can developed along the
lateral ridges. One scale has some six spinelets on the lateral rim (Text-fig. 2A). Spinelets can also be found on the underside of the posterior crown (Text-fig. 2B); all crowns end in a long posterior point. The crown-base interface is very shallow and narrow in all (e.g. Text-fig. 2A, B, D). The scale from sample 4a (Text-fig. 2F) has a thin crown that rises to a high point towards the posterior with around 15–20 ridges, some bi- or trifurcated at the rim.

The bases are thin, which can have many small tuberosties (e.g. Text-fig. 2A, B). All have open pulp cavities. The basal view of the scale from sample 4a has not been seen but appears to be an open pulp cavity.

There are no details of histology as there are too few scales. However, the general thinness of the crowns and wide-open pulp cavities (Text-fig. 2B, D) and the thin bases with tuberose thickenings concur with the turiniid type seen in the genus Australolepis.

REMARKS: For now, we are comparing the Polish scales to those of the type species, particularly the scale figured by Woroncowa-Marcinowska (2012; Text-fig. 2F).

DISCUSSION: Based on the fragile elongate crowns with spinelets and thin bases with small tuberosties, the few thelodont scales so far discovered in the Holy Cross Mountains are referred to the genus Australolepis Turner and Dring, 1981 and probably A. seddoni (Turner and Dring 1981). When first Dring sent samples collected during his thesis work, ST thought they were all immature scales, i.e. they all had wide open concave pulp cavities with extremely thin bases and almost no neck; this became a main character of the genus and may well relate to the paedomorphic nature of these scales, retaining the first stage of morphogenesis in their bases.

Later detailed work on Australolepis seddoni revealed the scale variation and extent to Iran (Tri- najstic 2001; Turner 1997; Turner et al. 2002). As in Poland, only rare Australolepis scales have so far been discovered in Iran, in the Late Devonian (early Frasnian: Middle falsiovalis–hassi Conodont zones) mixed carbonate–siliciclastic succession exposed in the Chariseh section, Kaftari Mountains, north-east of Esfahan and Sanadaj Sirjan (Turner et al. 2002; Hairapetian et al. 2015).

Recent work in the Canning Basin has further widened the stratigraphic and geographic distribution of Australolepis seddoni in Australia (e.g. Trinajstic and George 2009; Chow et al. 2013; Trinajstic et al. 2014; Roelofs et al. 2015, see their text-fig. 1 for local- ities). Australolepis is now known to extend its range into the later Devonian in Western Australia and Iran (Hairapetian et al. 2015, 2016).

Rare Australolepis-like scales also occur with Jesslepis in the Givetian Papilio Formation (varcus– hermanni Conodont zones) of the Broken River ‘em- burment’ or terrane, northern Queensland (Turner 1997; Turner et al. 2000). A detailed search in all po- tential Givetian to Famennian limestones around the Paleotethyan shoreline is now necessary to confirm more regarding the taxonomy.

As yet, however, there are no known articulated remains of turiniid thelodonts from Gondwana and so as yet it is difficult to judge the range of variation. For this reason, we leave the Polish scales as an undeter- mined species of Australolepis.

PALAEOGEOGRAPHIC SIGNIFICANCE: The Polish Australolepis scales are found in limestones with associated marine fauna such as sponges, ten- taculites, conodonts, acanthodians, and osteichthyans and this supports the known palaeoenvironmen- tal setting of other Australolepis scales from continen- tal shelf locales. Liszkowski and Racki (1993) pointed the similar presence of microvertebrates in offshore, open shelf carbonate (peri-reef) settings. They (Liszkowski and Racki 1993) also noted a large mid-Givetian deepening pulse (base of T-R Cycle IIa) that probably resulted in colonization of the Holy Cross Mountains carbonate banks by diverse benthic communities. There are strong cosmopi-
tan ranges for many chondrichthyans and gnathostomes around Palaeotethys at this time (e.g. Burrow et al. 2010; Klug et al. 2010; Young et al. 2010) and new thelodont occurrences in Morocco, Turkey and Pakistan (Turner 2017). This Givetian event would also have allowed expansion of the thelodont range, as seen in other taxa such as Neoturinia (e.g. Turner 1997; Hairapetian et al. 2016). Interestingly, as the Polish example is the oldest record of the genus, we need to determine if Australolepis occurs elsewhere at this time in Laurussian terranes or whether it appears first in Gondwana.

From their now wider-known distribution it seems that these turiniid thelodonts were inhabiting and crossing or at least moving around the Palaeotethyan waterway. They have now been found in peri-Gondwanan Poland, in a region that is close to the northern shore of Palaeotethys, in Iran, along the southern NG shoreline, and in the Carnarvon and Canning basins of Western Australia in EG (Text-fig. 3). This area constitutes what Hairapetian et al. (Text-fig. 3) termed the later Devonian ‘Thelodont Realm’, from where we might expect further new evidence of thelodont diversification before their final demise in the later Famennian (Hairapetian et al. 2016).

We provide here a general palaeogeographic setting showing Australolepis distribution during the mid- to late Devonian (Text-fig. 3).

CONCLUSION

This is the first record of a mid-Devonian thelodont from Poland and the first, and earliest, of Australolepis scales within current European borders from an area that might have been close to the northern NG shoreline, where other younger records of Australolepis are known. There are now Australolepis species known from three main regions: EG (Western Australia) where they were first found; the NG southern shoreline (localities in central Iran); and the material described here from the Lysogóry Region (Skaly), Holy Cross Mountains (presumed Palaeotethys northwestern shoreline). The Polish Australolepis sp. cf. A. seddoni indicates that the Holy Cross Mountains should be included within
Hairapetian et al.’s (2015) Late Devonian Thelodont Realm and thus far extends the temporal range of the genus further back in time.

The find extends the geographic range of Australolepis from East Gondwana (western Australia) and the northern Gondwana shoreline (in Iran) further around Palaeotethys (Text-fig. 3). Consideration of this general palaeogeography indicates that a more determined search for thelodont scales is needed in these respective regions, especially in Poland.

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