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New genus of chondrichthyans from the Silurian – Devonian boundary deposits of Tuva (Russia)

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ABSTRACT:

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A new genus of Chondrichthyes from the uppermost Silurian–lowermost Devonian deposits of central Tuva (Russia) is described on the basis of the microremains (scales). A sample from the Khondergei Formation of the Bazhyn-Alaak locality in the Tchadan region contained scales of a new chondrichthyan, *Tuvalepis schultzei* gen. et sp. nov., together with another chondrichthyan, *Elegestolepis grossi* KARATAJŪTĖ-TALIMAA, 1973, as well as numerous scales of the thelodont *Helenolepis navicularis* KARATAJŪTĖ-TALIMAA, 1978. The scales of *T. schultzei* display significant morphological variation and are characterized by a very fine, comparatively wide and flat crown with longitudinal ribs and a small and short neck. The growth pattern of *T. schultzei* scales is very different from that of elegestolepids described so far – the scales grew by appositional addition of layers towards the distal side of the crown, in contrast to the scales of *Elegestolepis grossi* which lack any kind of concentric growth lines.

Key words: Chondrichthyans, Elegestolepids, Silurian, Devonian, Tuva.

INTRODUCTION

Sections through the Silurian-Devonian boundary beds in the Bazhyn-Alaak locality in the Tchadan region of central Tuva have yielded various vertebrate microremains, including the new genus and species of Chondrichthyes described herein. One of the samples collected in the area (number 119R), from the Khondergei Formation (Tauganteli Regional Stage, Upper Silurian – Khondergei Regional Stage, Lower Devonian), contained scales of the new chondrichthyan taxon (KARATAJŪTĖ-TALIMAA & RATANOV 2002), together with another chondrichthyan *Elegestolepis grossi* KARATAJŪTĖ-TALIMAA, 1973, as well as numerous scales of the thelodont *Helenolepis navicularis* KARATAJŪTĖ-TALIMAA, 1978.

The samples were collected by L.S. RATANOV (Novosibirsk, SNIIGGiMS, Russia) in 1987, and the fossil material was loaned to one of us [V. K.-T.] by L. M. AKSENOVA (SNIIGGiMS, Novosibirsk, Russia) in 1988. Currently it is stored in the Institute of Geology and Geography, Vilnius, Lithuania, under the collection numbers LGI T-130 – LGI T-180.

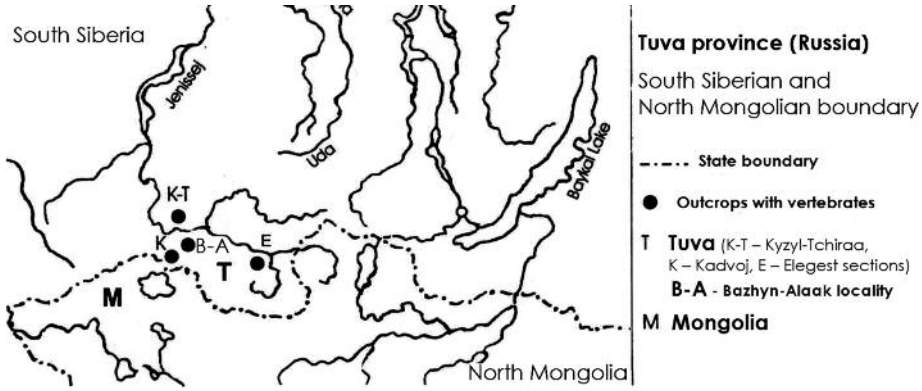

Fig. 1. Vertebrate-bearing localities of central Tuva (Russia)

GEOLOGICAL SETTING

The material studied comes from the Bazhyn-Alaak Silurian–Devonian locality near the river Tchadan in central Tuva (Russia). The outcrop is located near other well-known vertebrate-bearing Silurian and Lower Devonian localities, such as Kyzil-Tchiraa, Kadvoj, and Elegest (Text-fig. 1). Sample 119R, containing the new chondrichthyan genus and species described herein, was collected from terrigenous deposits of the lowermost Khondergei Formation, referred roughly to the Silurian–Devonian (Pridoli–Lochkovian) boundary interval, within the boundary beds between the Tauganteli (S_2) and Khondergei (D_1) Regional Stages (KARATAJŪTĖ-TALIMAA & RATANOV 2002).

SYSTEMATIC PALAEONTOLOGY

Class Chondrichthyes HUXLEY, 1880
Subclass Elasmobranchii BONAPARTE, 1838
Order Incertae Sedis
Family Incertae Sedis
Genus *Tuvalepis* gen. nov.

Tuvalepis gen. nov.

TYPE SPECIES: *Tuvalepis schulzei* sp. nov.

ETYMOLOGY: After the region of Tuva.

DIAGNOSIS: The scales distinguished by fine, flat crown, very low and flat base, and reduced neck. Distal part of crown characterized by concentric growth lines. Longitudinal ribs present on proximal surface of crown.

Tuvalepis schultzei sp. nov.
(Text-figs 2-3)

ETYMOLOGY: In honour of Prof. Hans-Peter Schultze (Kansas, USA).

HOLOTYPE: (Text-fig. 2C). Collection number T-122 (Lithuanian Institute of Geology and Geography, V. Karatajūtė-Talimaa collection).

TYPE LOCALITY: River Tchadan, Bazhyn-Alaak locality, Tuva (Russia).

TYPE HORIZON: Terrigenous deposits of the Tauganteli (S_2) and Khondergei (D_1) Regional Stages, lowermost Khondergei Formation, sample Nr. 119R.

STRATIGRAPHIC RANGE: The Silurian – Devonian (Pridoli–Lochkovian) boundary interval, within the boundary beds of the Tauganteli and Khondergei Regional Stages, lowermost Khondergei Formation.

MATERIAL: About 50 well preserved scales.

DIAGNOSIS: Same as for the genus.

DESCRIPTION: The scales show a significant morphological variety, and are characterized by a comparatively wide and flat, very fine crown, which is connected to the comparatively small, thin, flat base by a small and short neck. The pulp cavity is poorly expressed, as the scales are extremely flat.

MORPHOLOGY: The morphological set of the *T. schultzei* scales contains several distinct morphological types (Text-fig. 2). The first type is characterized by symmetrical scales with a very simple smooth crown

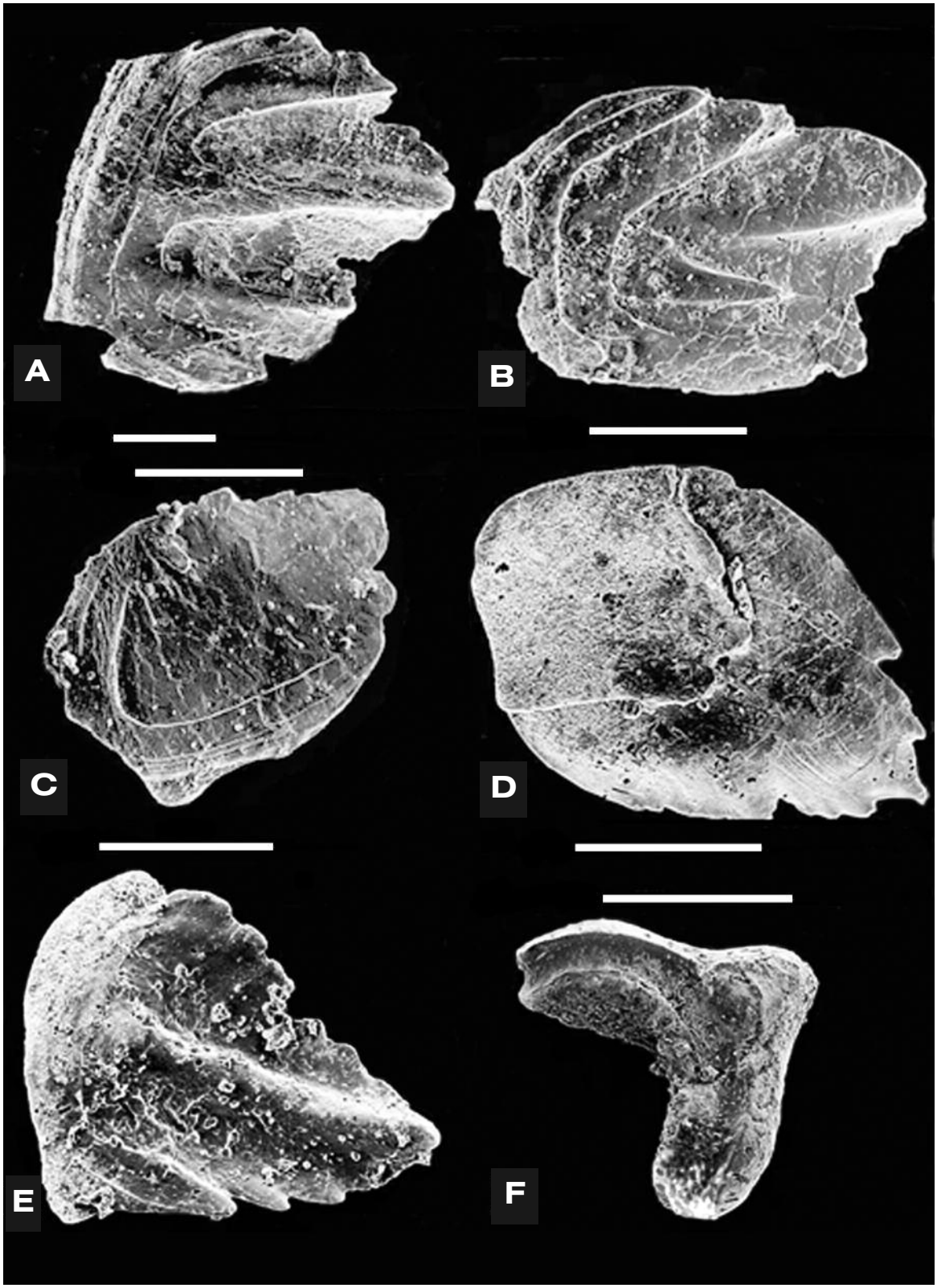

Fig. 2. Morphological set of the scales of *Tuvalepis schultzei* gen. et sp. nov. A – ribbed type body scale, T-120, × 106; B – ribbed type body scale, T-121, × 169; C – holotype, smooth crown type body scale, T-122, × 201; D – smooth crown type body scale, ventral view, T-123, × 195; E – asymmetrical body scale, T-124, × 172; F – keel-shaped scale, T-125, × 93,7. Scale bars equal 200 μm., except Fig. F - 500 μm

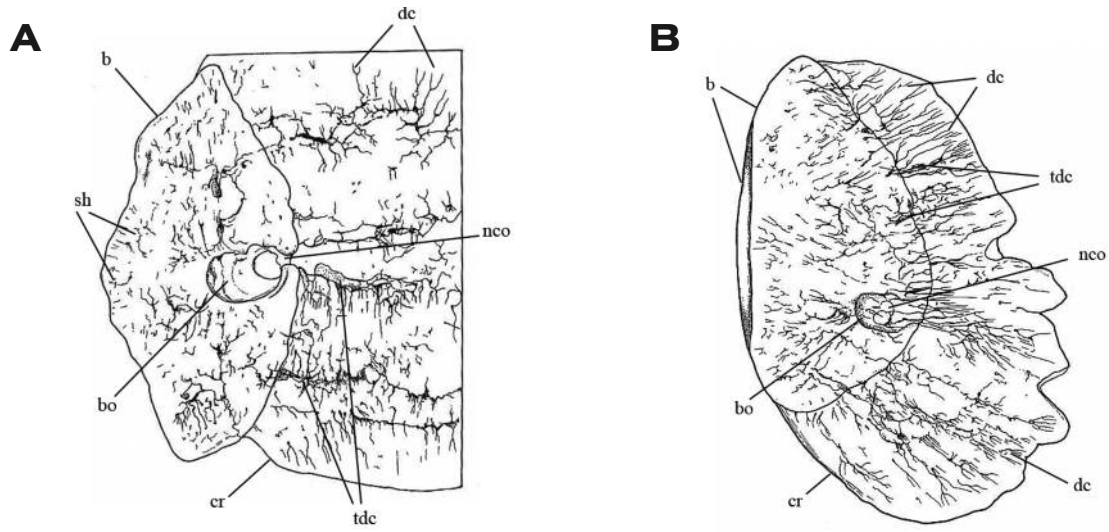

Fig. 3. Histology of the scales of *Tuvalepis schultzei* gen. et sp. nov. (anise oil microscopy). A – Proximal part of an asymmetrical body scale (ventral view). B – Complete ventral view of an asymmetrical body scale. Abbreviations: b – base; bo – base opening; cr – crown; dc – dentine canals; nco – neck canal opening; sh – Sharpey's fibres; tdc – thick dentine canals

with one or several concentric growth lines, and a sharp distal part (Text-fig. 2C, 2D). Longitudinal ribs are present on the distal part of the crown surface in some cases. Another scale type shows a crown with complex sculpture. In the proximal part of the scales several growth lines can be distinguished. The main part of the crown is ornamented by several longitudinal ribs – a long central rib, and two or three pairs of shorter lateral ribs (Text-fig. 2A, 2B). The distal part of the scales is strongly sharpened. The crown is still symmetrical in overall shape. The third scale type is represented by several scales with a similar complex sculpture of the crown to that of the previous type, but the scales are strongly asymmetric (Text-fig. 2E).

The *T. schultzei* microremains additionally contain keel-shaped scales of uncertain affinity (Text-fig. 2F), with a very thick longitudinal central rib, and fine narrow lateral ribs.

HISTOLOGY: The relatively good preservation and general construction of the scales give the possibility of analyzing the internal structure without thin-sectioning. The histology of the scales can be studied in anise oil. The internal structure of the crown is characterized by a few rather short and thick dentine canals in the anterior part of the scale, and by a branching network of numerous thin dentine canals in the remainder of the scale. Mesodentine lacunae are not developed. The scales possess two pulp canal openings: the wider one is on the base, and the narrower opening is on the side of the neck (Text-fig. 3A, 3B). Both neck and base canals are very short, and open close to each other.

COMPARISON: These vertebrate microremains were first ascribed to elegestolepids (KARATAJŪTĖ-TALIMAA & RATANOV 2002; ?*Elegestolepis* gen. nov.). However, although *Tuvalepis schultzei* shows some similarity to elegestolepids, there are also fundamental differences in growth pattern, histology, and morphology. The scales of *Elegestolepis grossi* have a high crown with a thick base and a well developed high neck. In contrast, the base of the *Tuvalepis schultzei* scales is very flat and low, the neck is reduced, and the space between the crown and the base is very narrow. The sculptured crown type scales of *T. schultzei* have fewer longitudinal ribs on the crown (up to two or three pairs), in contrast to those of *E. grossi*, which usually have more than three pairs of longitudinal ribs.

The internal structure of the crown of *T. schultzei* scales is characterized by thick dentine canals, similar to those of *E. grossi* scales, but the canals are much shorter. The network of thin dentine canals of *T. schultzei* scales is branched and well developed in contrast to the more regular pattern of the thin dentine canals in *E. grossi* scales, which spread only close the surface of the crown. *T. schultzei* scales possess two pulp canal openings: the wider one is on the base, while the narrower opens on the side of the neck; both are very close to each other because of the flatness of the scales. In contrast, in *E. grossi* scales these two canals extend at a right angle to each other, open at a sharp right angle, and open at a significant distance from each other, one on the side of the high neck, and the other in the central part of the base.

The growth pattern of *T. schultzei* scales is very different from that of elegestolepid scales – the scales grow by appositional addition of layers towards the distal side of the crown, in contrast to *E. grossi* scales, where an initial monodontodium just grows inwards and deep into the soft tissues, due to enlargement of the base solely, and any appositional growth is absent (KARATAJŪTĖ-TALIMAA 1973; ØRVIG 1977; KARATAJŪTĖ-TALIMAA 1998).

DISCUSSION: The differing morphologies of the scales of *Elegestolepis* and *Tuvalepis* may have some palaeoecological and palaeobiological implications. The high and sculptured scales of *E. grossi*, with a well expressed neck, could correspond to a more or less rounded body shape and a nektonic mode of life, as in the case of other early vertebrates – for example, the high, massive, and elevated scales of the actively swimming acanthodians (JANVIER 1996). In contrast, the flattened fine scales of *T. schultzei* most probably correspond to a flattened body, and probably to a benthic palaeoecological niche, as in the case of most of the benthic thelodont species possessing a dorsoventraly flattened body and a flattened general shape of the scales (MÄRSS & *al.* 2007).

The most problematic of all the types of *T. schultzei* scales are the keel-shaped ones. The asymmetric scales of *T. schultzei* should be attributed to special functions and corresponding parts of the exoskeleton, while the symmetrical ones should represent the main scale cover of the body (KARATAJŪTĖ-TALIMAA 1973, 1998). However, the keel-shaped scales are very different from the rest of of the *T. schultzei* scale types, and therefore both their function and position on the body are open to question. If the assumption of *T. schultzei*'s benthic life style and flattened shape of the body is correct, such scales with a strong and high keel may not have had any use on the back of the body. Nevertheless the keel-shaped scales are histologically comparable to the rest of the *T. schultzei* scales, as they possess a comparable short neck and base canals, opening close to each other. Another reason for the assignment of these special scales to *T. schultzei* is that the rest of the vertebrate micromaterial in the sample belongs to two thelodont species of the genus *Helenolepis*, the above-mentioned *Elegestolepis grossi*, and osteostracans (KARATAJŪTĖ-TALIMAA & RATANOV 2002). None of the species mentioned above could have possessed keel-shaped scales with this kind of histology.

CONCLUSIONS

Scales of *Tuvalepis schultzei* gen. et sp. nov. have a flat and fine general morphology, which is the main feature of the exoskeleton microremains that separates this new species from elegestolepids. The growth pattern of *T. schultzei* is also very different from that of elegestolepids – the scales grow by appositional addition of layers towards the distal side of the crown. The morphological and histological differences and especially the distinct growth patterns are the main reasons for describing these scales not as a new species of the genus *Elegestolepis*, but as a new genus and species of chondrichthyans.

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