New Silurian nostolepids (Acanthodii, Pisces) of Lithuania

Juozas Valiukevičius

Valiukevičius J. New Silurian nostolepids (Acanthodii, Pisces) of Lithuania. *Geologija*. Vilnius. 2003. No. 42. P 51–68. ISSN 1392-110X.

Four new scale taxa of Silurian nostolepids are introduced. Three of them, *Nostolepis amplifica, N. consueta* and *N. musca,* are derived from the *Nostolepis* ex gr. *striata* (*sensu lato*). *N. amplifica* trunk scales have a high median crown area and a sculpture of 2–6 parallel ridges fading out at a quarter of crown length, narrow lateral crown steps and oblique neck ridges; the *Stranggewebe* in crowns is covered with a mantle of highly cellular simple mesodentine and is distinguished by short and narrow *Stranglacunae*; osteocytes are present in primordial lamella only; large principal vascular canals develop in each growth lamella. *Nostolepis consueta* scales have a sculpture of 8–12 short, parallel, low, symmetric ridges with a characteristic anterior centralward curvature; crowns are not inclined, overhanging bases; the *Stranggewebe* has long lacunae and is covered with a simple "*vermiculate*", less cellular mesodentine; the principal vascular system in crowns contains large arcade canals. *Nostolepis musca* is defined on scales having a wide median crown area with asymmetric ridgelets and/or deep longitudinal groove; lateral crown slopes are present, but the marginal ridges do not lower to the neck; simple mesodentine with typical and numerous osteocytes and *Stranggewebe* with dense, complicated lacunae and no strips of simple mesodentine. *N. magnicostata* scales have stout, relief, parallel 4–8 ridges along the entire crown and high necks not characteristic of nostolepids, thus a separate genus may be supposed. The diagnostic histologic characters are close to the above nostolepids: principal enlarged vascular canals in crowns developed, the *Stranggewebe* with long but medium dense lacunae not covered with simple mesodentine in the posterior crown, poorly oriented and moderately cellular mesodentine of the anterior crown, and the crown/base gradual transition from mesodentine to bone tissue.

Key words: Climatiida, nostolepids, morphology, histology, Silurian, Lithuania

Received 24 February 2003, accepted 10 March 2003
Juozas Valiukevičius. Institute of Geology and Geography, T. Ševčenkos 13, LT-2600 Vilnius, Lithuania

INTRODUCTION

The collection of Silurian acanthodians from Lithuania was compiled during a long time, starting with the pioneering work of V. Karatajūtė-Talimaa on the taxonomy and biostratigraphy of Siluro-Devonian thelodonts in the early 1970s. Acanthodian scales, as an integral part of vertebrate microremains acidized from rocks of different lithology, have been found in numerous samples and frequently dominate among the vertebrates, particularly in the topmost Silurian. This reason, basically grounded by T. Märss and V. Karatajūtė-Talimaa on the Baltic basin, has caused an insertion of acanthodians for

the Pridoli time slice (Каратаюте-Талимаа,1978; Мярсс, 1986; Talimaa, 2000; Märss et al., 1996; Märss, 2000; Blieck & Turner, 2000) into a global thelodont-dominated vertebrate standard of the Silurian. However, these studies have particularly involved only acanthodians from the northern part of the Baltic (Estonia and partly West Latvia), represented by a comparatively short geological series of the shallow nearshore marine facies. The deepest basin part (Southwest Lithuania) remained not studied in detail until the recent time. Lithuanian acanthodians have only been represented in the overviewing vertebrate publications with their localities at several stratigraphic levels and indications of the preliminar taxonomic composition. Such often incomplete data are found in the biostratigraphic records representing the distribution of vertebrates or debates on the completeness of Siluro-Devonian boundary beds in the Baltic (Каратаюте-Талимаа и др., 1987; Karatajūtė-Talimaa & Brazauskas, 1994; Karatajūtė-Talimaa et al., 1999).

The present initiation of a detailed acanthodian study is aimed to clarify the taxonomic composition and to carry out a strict biostratigraphic control of taxa and their assemblages, to elaborate the zonal stratigraphic chart of the Silurian in Lithuania, attached to the International Stratigraphic Scheme and applicable for more precise interregional correlations. For the time being, there are identified about 40 acanthodian taxa (most based on scales, rarely on fin spines) from about 20 borehole cores covering the time span from the mid-Wenlock to the top Pridoli. The collection has recently been considerably increased owing to the samples kindly donated by A. Brazauskas (Vilnius University), taken for the Silurian conodont study. Nevertheless, the Llandovery and lower Wenlock are still lacking acanthodian characteristics in Lithuania.

The location of boreholes with the most completely and stratigraphically uninterruptedly studied Silurian acanthodians of Lithuania is shown in Fig. 1.

This publication is the second one devoted to the description of new Silurian acanthodian taxa from Lithuania. In the first paper (Valiukevičius, *in press*), five new monotaxonic genera have been covered, of which two were ascribed to climatiids and three to ischnacanthids. Now we present four new species of the genus *Nostolepis* (Climatiida).

The taxonomic position of all new species within climatiids and attribution to the genus *Nostolepis* are based on morphologic affinities (the type of crown sculpture, arrangement of ridgeness according to the median and lateral areas, the crown/neck/base proportions, etc.) and microstructure of composing tissues (definitive characters and portioning of simple and oriented mesodentine = *Stranggewebe* of Gross,

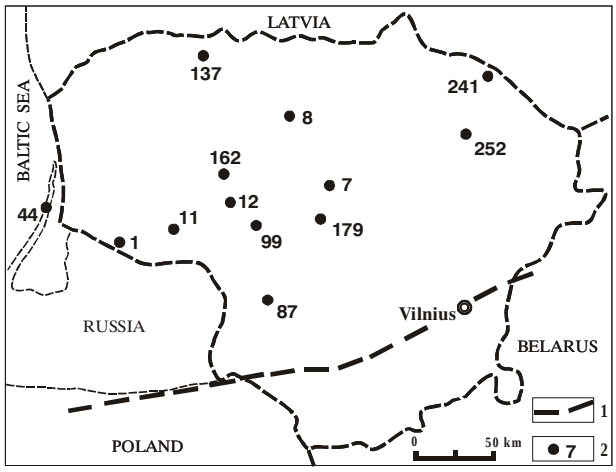

Fig. 1. Sketch map showing location of the boreholes that yielded the majority of the material studied. *1* – outcrop-boundary of Silurian rocks; 2 – borehole and its original number: 44 – Nida, 1 – Stoniškiai, 11 – Šešuvis, 137 – Liepkalnis, 162 – Kurtuvėnai, 12 – Kunkojai, 99 – Gėluva, 87 – Sutkai, 179 – Ledai, 7 – Krekenava, 8 – Stačiūnai, 241 – Butkūnai, 252 – Svėdasai
1 pav. Schema, iliustruojanti gręžinių, kurių kerne rasta daugiausia akantodų, išsidėstymą. *1* – silūro uolienų paplitimo riba, *2* – gręžinio originalus (pirminis) numeris

1971 in crowns and cellular bone in bases) studied by the sectioning of scales.

The acanthodian collection is housed at the museum of the Institute of Geology and Geography (LIGG), Vilnius, and is numbered 25-A.

Systematic palaeontology

Climatiida Berg, 1940

Climatiidae Berg, 1940

***Nostolepis* Pander, 1856**

Type species. Nostolepis striata Pander, 1856; Ohesaare Cliff, Saaremaa, Estonia; Ohesaare Regional Stage, Pridoli Series, Upper Silurian.

Diagnosis. See Denison, 1979.

***Nostolepis amplifica* sp. nov.**

Figs. 2 A–H, 3 A–I

Derivation of name. *Amplificus* (Latin) – decorated, magnificent, referring to the scale crown sculpture of the prominent ridges.

Holotype. LIGG 25-A-2400, trunk scale (Fig. 2 D). Ledai-179 borehole, depth 535 m. Upper Silurian, Pridoli, the Lapės Formation.

Type locality. Ledai-179 borehole, depth 535–545.7 m.

Type horizon. Upper Silurian, Pridoli, the Vievis and Lapės formations.

Range. Upper Silurian, Ludlow to Pridoli, Pagėgiai, Minija and Jūra regional stages.

Material. More than 4500 scales.

Diagnosis. *Nostolepis* having large trunk scales with a well developed high and wide median area with a

sculpture of two–six parallel anterior riblets fading out at a quarter of crown's length; narrow lateral crown steps outlined by the oblique neck ridges and porose necks present; the *Stranggewebe* in crowns has short, narrow and medium dense *Stranglacunae* and contains large mesodentine-type osteocytes in the primordial lamella only, and is covered with a thick mantle of simple mesodentine in each growth lamella; mesodentine of the anterior crown is slightly cellular, netty, with the superficial dentine tubules more regularly oriented upwards, but remaining winding and short.

Description

Tessera-like head scale-platelets (Fig. 2 B) have rhomboidal to round crowns 1.0–1.3 mm long and up to 1.0 mm wide. The crown sculpture is of centrally

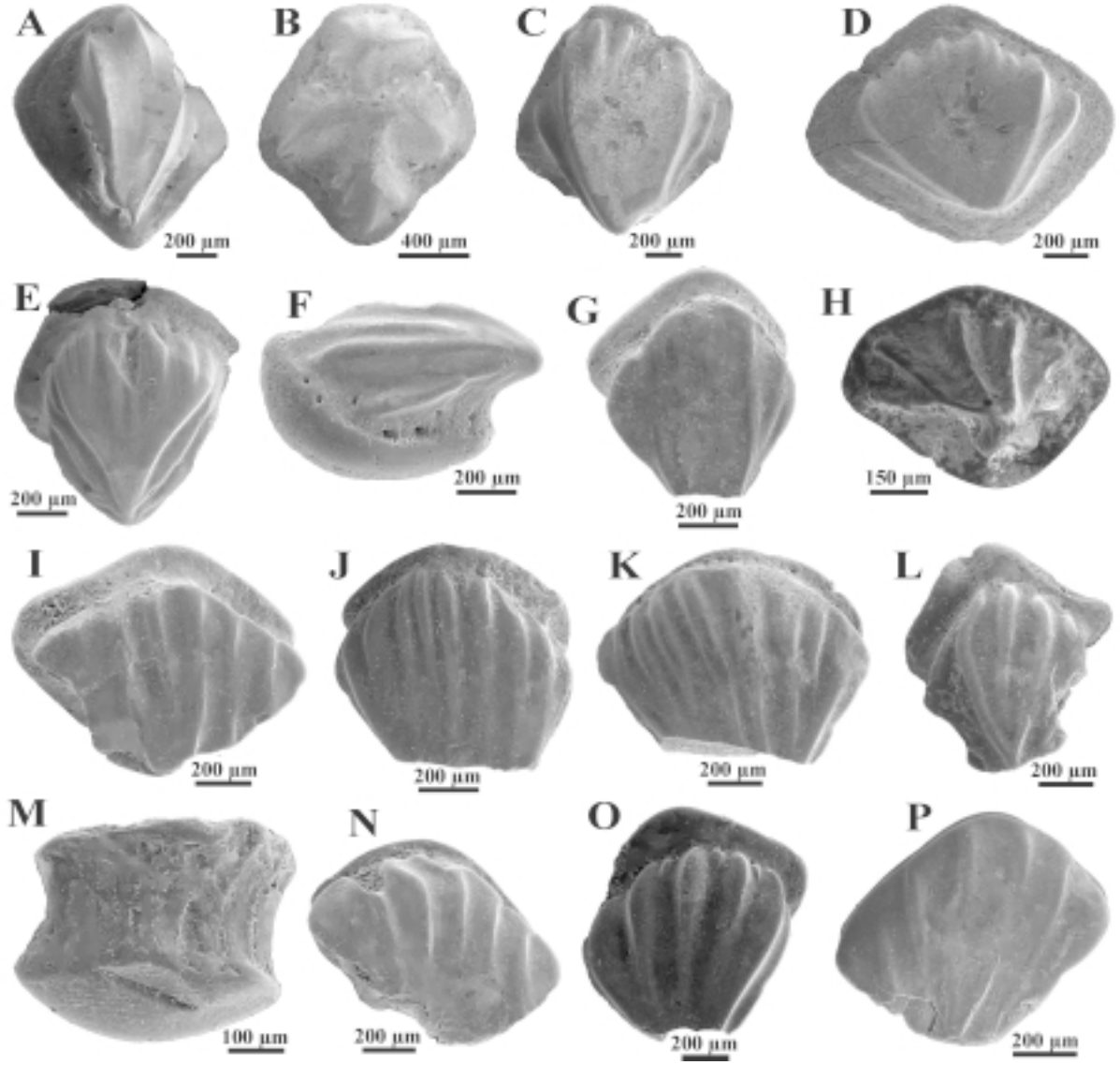

Fig. 2. SEM photos of acanthodian scales and tesserae. A–H – *Nostolepis amplifica* sp. nov. Trunk scales, except for B (tessera-like head scale-platelet) and H (head scale). Crown views, except for F (lateral view). A – LIGG 25-A--2397; B – LIGG 25-A-2398; C – LIGG 25-A-2399; D – holotype, LIGG 25-A-2400; E – LIGG 25-A-2401; F – LIGG 25-A-2402; G – LIGG 25-A-2541; H – LIGG 25-A-2519. A–F – Ledai-179 borehole, depth 535 m. Upper Silurian, Pridoli, Jūra Regional Stage, Lapės Formation; G – Nida-44 borehole, depth 1213 m; H – Kurtuvėnai-162 borehole, depth 1024.5 m. G–H – Upper Silurian, Pridoli, Jūra Regional Stage, Jūra Formation. I–P – *Nostolepis magnicostata* sp. nov. Trunk scales, except for L (tail scale). Crown views, except for M (posterior side view). I – LIGG 25-A-2412; J – holotype, LIGG 25-A-2537; K – LIGG 25-A-2538; L – LIGG 25-A-2539; M – LIGG 25-A-2540; N – LIGG 25-A-2411; O – LIGG 25-A-2542; P – LIGG 25-A-2543. Nida-44 borehole, depth 1213 m. Upper Silurian, Pridoli, Jūra Regional Stage, Jūra Formation.
2 pav. Akantodų žvynų ir teserų nuotraukos. A–H – *Nostolepis amplifica* sp. nov.; I–P – *Nostolepis magnicostata* sp. nov.

joined star-like tubercles-folds (*Tesserae stellatae* of Gross, 1971), their number being mostly four, but sometimes reaching six–eight on the largest rounded examples. Tubercles are vertical, without inclination but not high. Most of them have not sharp pointing centrally radial ridges (up to three). Sometimes dominate single median ridges, which may converge. Tubercle margins usually are incised or sculptured by short radial ridgelets. Each tubercle is clearly outlined, but some are centrally grown together, forming a slightly elevated tip. The rhomboidal platelets have a little convex base, whereas rounded ones have them mostly flat. The neck is absent, and the crown sits directly on the flattened and porous base plate.

Head scales (Fig. 2 H) are isometric rhomboidal, rarely their width slightly exceeds the length. The crowns inclined to the anterior do not exceed 0.6 mm. Their sculpture consists of three–four pronounced, sharp radial ridges, which slope down widening to the base anteriorly and pointing at the posterior crown tip. Rarely the scales have a lowered small posterior crown step (Fig. 2 H) similar to that of *Gomphonchus hoppei* (Gross), but without pores. The only posterior neck is distinct in scales. The moderately convex base is protruding beyond the crowns on all sides.

Trunk scales (Fig. 2 A, C–G) are large. Crown length is 0.7–1.4 mm, width 0.65–1.1 mm. The crowns are slightly inclined or almost flat (Fig. 2G), broad, sculptured by uneven longitudinal ridges. The two most prominent of them prolong radially the entire crown's length, point posteriorly distinguishing a clearly elevated medial area, which may be very wide in the anterior (Fig. 2 D–E). This area, depending on the width, carries two (Fig. 2 A) to six (Fig. 2 D) short, parallel, differently long anterior riblets fading out at a quarter of the crown length. The lowered narrow lateral steps are present in crowns, their margins are treated as the oblique neck ridges (Fig. 2 F). Crown ridges slope down anteriorly to the base, so there is no anterior neck, except for one variety (Fig. 2 G) with a flat crown plate and a moderately high neck on all faces. The neck is porous basally. Scale bases are large, rhomboidal, deeply centrally convex, extending crowns. The minority belong to scales whose crowns slightly overhang the bases to the posterior.

Histology

Up to four superpositional growth lamellae in crowns are composed slightly differently as compared to the trunk and head scales. Trunk scales (Fig. 3 A–G) are composed of *Stranggewebe* and simple net-like mesodentine, whereas the head scales (Fig. 3 H–I) lack the former tissue. The *Stranggewebe* composes the posterior part of the crown beginning with the primordial lamella, which is particularly large (Fig. 3 B–C). The *Stranglacunae* are medium dense, sometimes rare, small and narrow, radiating short interspersed processes (Fig. 3 C, G). Alongside them, there are osteocyte spaces typical of mesodentine, but in the primordial lamella only. Their number considerably increases in the neck area, the basal parts of lamellae (Fig. 3 C). A thick mantle of simple mesodentine with the net-like tubules and frequent lacunae and osteocyte spaces covers the *Stranggewebe* in the primordial scale (Fig. 3 F–G). Similar tissue, but with more straight, superficially (to one direction) oriented dentine tubules, composes the anterior crown part. The crown has a developed system of principal vascular canals, widened centripetally radially over the base and ascending, having few branchings (Fig. 3 C). The medium-high pyramidal base is composed of cellular bone arranged in thin lamellae and contains plenty of osteocytes displaced along the growth lines (Fig. 3 B).

The crown of the head scale (Fig. 3 H–I) is composed of only simple mesodentine with interspersed dentine tubules and embraced osteocytes, but the indistinct enlarged canals of the principal system.

Remarks. In terms of morphology, *Nostolepis amplifica* is similar to *N. striata* Pander or belongs to the *striata* group that involves several scale morphotypes *sensu* W. Gross (1947: pl. 26 (7), figs. 5–15; 1971: pl. 5, figs. 1–7 and pl. 6, figs 1–2). The trunk scales of a new species differ principally from *N. striata* in flat horizontal crowns, the more pronouncedly developed median area and porose necks with oblique neck ridges, whereas the compared scales are always more inclined and neck pores are only reported as an exceptional character (Gross, 1971: pl. 5, fig. 3a). Histologically, the scales under consideration are similar by the presence of the principal system of enlarged vascular canals, *Stranggewebe* and osteocytes in crowns and bases (Gross, 1947: figs. 19–23). If compared more precisely, *N. amplifica* has a finer, more complicated mesodentine net with a larger number of osteocytes in the anterior crown, not as regular and distinctly oriented ascending vascular canals, and shorter, less dense *Stranglacunae* in the *Stranggewebe* of the crown, containing large osteocytes in the primordial growth lamella only. The principal vasculars compose a denseer system in the scales of *N. striata*.

Comparable or quite similarly looking specimens attributed to *N. striata* (*sensu* Gross 1947, 1971 as taken) are figured by J. Vergoossen (2002 b: pl. 14, figs. 85–87) obtained from the Öved Ramsåsa Sandstone Formation of Skåne, South Sweden, considered

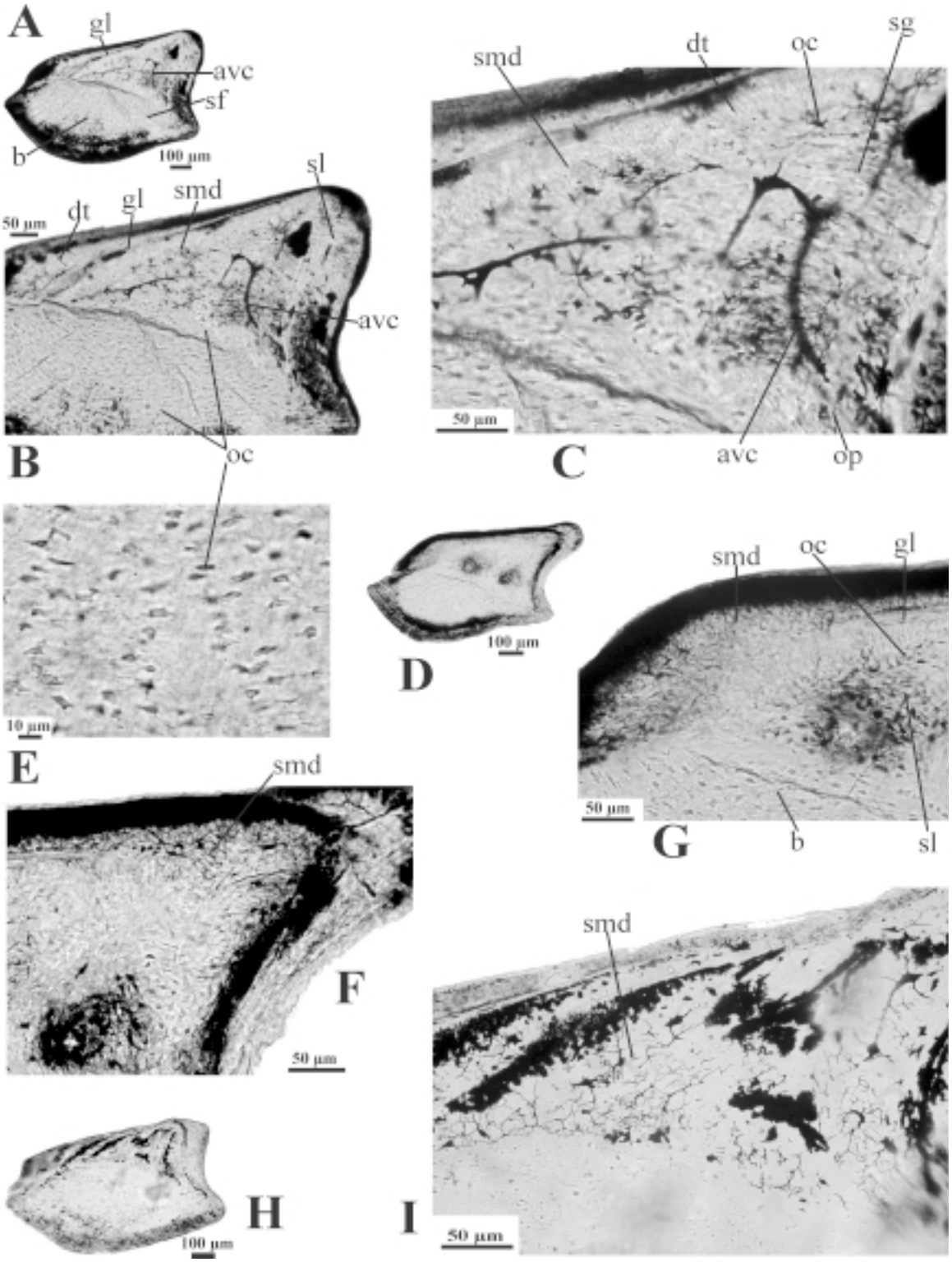

Fig. 3. *Nostolepis amplifica* sp. nov. Histological microstructure of trunk (A–G) and head (H–I) scales in vertical longitudinal sections. A – thin section 3713, general view; B – crown of the same scale, in more detail; C – primordial growth lamella of the same scale, in more detail; D – thin section 3714, general view; E – detail of the base of the same scale; F and G – details of the posterior (F) and anterior (G) crown parts of the same scale; H – thin section 3716 of a scale as that positioned in Fig. 2 H; general view; I – the central crown part of the same scale, more detail. Ledai-179 borehole, depth 535 m. Upper Silurian, Pridoli, Jūra Regional Stage, Lapės Formation;
avc – ascending vascular canal, *b* – base, *dt* – dentine tubule, *gl* – growth lamella, *oc* – osteocyte cavity, *op* – osteocyte process, *sf* – Sharpey's fibres, *sg* – *Stranggewebe*, *sl* – *Stranglacunae*, *smd* – simple mesodentine
3 pav. *Nostolepis amplifica* sp. nov. Liemens (A–G) ir galvos (H–I) žvynų histologinė mikrostruktūra vertikaliuose išilginiuose pjūviuose

as the transitional Ludlow-Pridoli beds, and Siluro-Devonian of the Welsh Borderland, the Ludlow Bone Bed to Dittonian Group (Vergoossen, 2000: pl. 1, figs 4–5 and 7–8), but the scales are not histologically tested, thus a precise comparison is impossible. No pore canals are observed in the scales of either localities.

Occurrence. Kurtuvėnai-162 borehole, depth 1054.5–1076 m; Ledai-179: 535–545.7 m; Sutkai-87: 609.3–622 m; Gėluva-99: 681.6–690 m; Liepkalnis-137: 899.5 m; Jočionys-299: 115.8 m; Svėdasai-252: 366–368.6 m.

***Nostolepis magnicostata* sp. nov.**

Figs. 2 I–P, 4 A–G

Derivation of name. *Magnus* (Latin) – large and *costatus* (Latin) – ridged, referring to a scale sculpture of long relief ridges.

Holotype. LIGG 25-A-2537, trunk scale (Fig. 2 J). Nida-44 borehole, depth 1213 m. Upper Silurian, Pridoli, Rietavas Beds of the Jūra Formation.

Type locality. Nida-44 borehole, depth 1213 m.

Type horizon. Upper Silurian, Pridoli, Rietavas Beds of the Jūra Formation.

Range. Found at the type horizon only.

Material. 61 scales.

Diagnosis. *Nostolepis* having large high scales ornamented with four–eight parallel, stout ridges of quadrangular or rarely triangular transverse form, extending over the entire crown or exceptionally fading out mid-length. Four growth lamellae in the crowns are composed of *Stranggewebe* containing osteocyte spaces and moderately long *Stranglacunae* (in primordial scale) and a simple cellular mesodentine net (in a restricted anterior area of the later growth lamellae). Both tissues are pierced by a principal system of enlarged widened vascular canals. The high-pyramidal base of scales is composed of cellular bone with long Sharpey fibres.

Description

Two morphological varieties of *trunk scales* are clearly defined. To the first one (Fig. 2 J–M and O) there are ascribed holotype-like scales that dominate in the samples. Their crowns are slightly wider than long (0.75–1.2 mm and 0.7–0.9 mm, respectively) and overhang bases posteriorly with one–third of their length. The crown plate is flat, horizontal, rounded rhomboidal, elongated to the posterior. Its sculpture is of four (Fig. 2 O) to eight (Fig. 2 J–K) stout longitudinal ridges, which prolong parallelly or fan-likely all crown, a little lowering to the posterior or rarely are near to fade out at the posterior tip (Fig. 2 O). The ridges are of round to quadrangular form in transverse section, frequently with double crests and slightly slope basewards to the anterior (Fig. 2 K). Grooves between the ridges are of similar width, but may be considerably wider anteriorly. Rare specimens have short additional ridgelets in the grooves along the anterior crown margin (Fig. 2 O). Scale necks are high and linearly porous on all faces. Pores of the posterior neck open in the vertical grooves, sometimes forming fossae (Fig. 2 M). Scale bases are moderately convex, well rhomboidally outlined and project with the deepest point at the anterior crown.

The second variety of trunk scales (Fig. 2 I, N, P) have rhomboidal, often asymmetric crowns without the base overhang. The crowns are 0.6–0.85 mm long and 0.75–1.0 mm wide, sculptured by five–six sharp but not high longitudinal ridges of triangular transverse form extending over the entire crown's length (Fig. 2 I, P) or fading out half-way (Fig. 2 N). Ridges do not slope basewards and prolong parallelly or sub-parallelly. Two central ones rarely point to the posterior crown tip (Fig. 2 P). Shallow and wide grooves separating the ridges are slightly narrowed to the posterior. Scale necks and bases do not differ from those of the first variety.

Tail scale (Fig. 2 L) is flattened, distinctly narrowed and elongated, with a low neck and base displaced in the advance of the crown. The rhomboidal crown 0.58 mm long and 0.49 mm wide is ridged by three prominent stout ridges, of which two lateral extend subradially on the entire crown and point at the posterior tip. The median ridge is straight and fades out at the crown's mid-length. The ridges are of a round quadrangular transverse form and do not slope down towards the base. The scale base is wider than long, moderatelly convex, well rhomboidally outlined, with the deepest point displaced centrally. The base / neck junction is clear because of the thickened antero-lateral rims.

Histology

Four thick lamellae in crowns of superpositional growth are composed of simple mesodentine and *Stranggewebe*. The holotype-like scales (Fig. 4 A–F) have a well developed complicated system of principal enlarged and widened vascular canals, a little branchy centripetal radial displaced just over the base, circular and ascending ones consisting of some main branches per lamella and arcades connecting them (Fig. 4 D, F). The canals are evenly piercing both crown parts composed of simple mesodentine and *Stranggewebe*. The *Stranggewebe* composes the posterior crown part beginning with the primordial scale. *Stranglacunae* are moderately long, dense, with short processes (Fig. 4 B, E). Apart of lacunae, the *Stranggewebe* contains osteocyte spaces, their num-

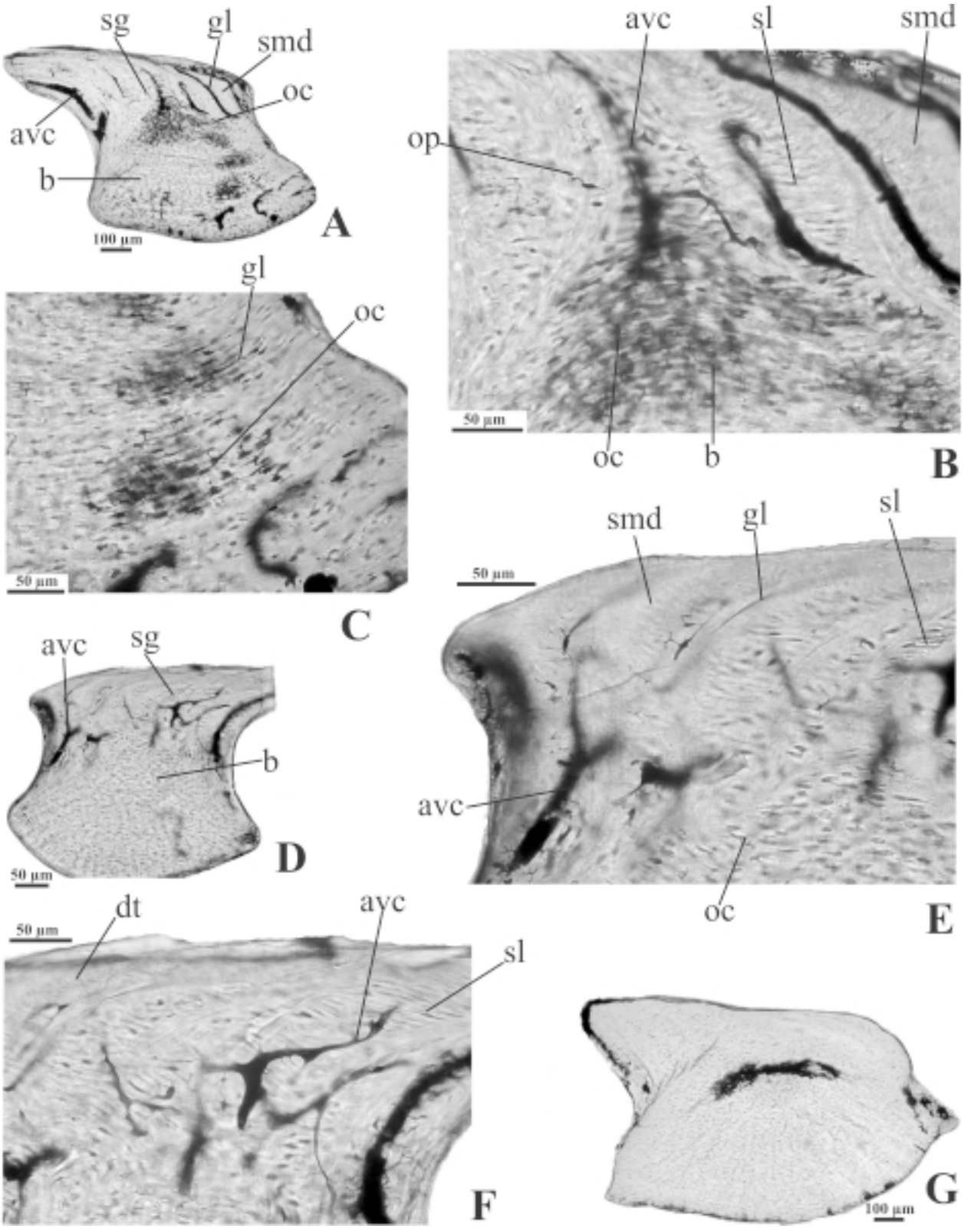

Fig. 4. *Nostolepis magnicostata* sp. nov. Histological microstructure of trunk scales in vertical longitudinal sections. A–F – the holotype-like scales, G – scale-like positioned in Fig. 2 P. A – thin section 3698, general view; B – detail of a pimordial growth lamella (crown/base junction strip); C – the base detail of the same scale; D – thin section 3700; E – detail of the anterior crown of the same scale; F – the same, posterior crown; G – thin section 3697. Nida-44 borehole, depth 1213 m. Upper Silurian, Pridoli, Jūra Regional Stage, Jūra Formation;
avc – ascending vascular canal, *b* – base, *dt* – dentine tubule, *gl* – growth lamella, *oc* – osteocyte cavity, *op* – osteocyte process, *sg* – *Stranggewebe*, *sl* – *Stranglacunae*, *smd* – simple mesodentine
4 pav. *Nostolepis magnicostata* sp. nov. Liemens žvynų histologinė mikrostruktūra vertikaliuose išilginiuose pjūviuose

ber increases basewards. The *Stranggewebe* is not covered by simple mesodentine. Simple mesodentine of the anterior crown seems merging gradually to the *Stranggewebe* owing to the principal orientation of the dominant dentine tubules (Fig. 4 E). Their net is including osteocyte spaces basally in the lamellae. A comparatively high-pyramidal base is composed of cellular bone arranged in thin, dense growth lamellae containing plenty of osteocyte spaces and pierced by long Sharpey fibres (Fig. 4 C).

The trunk scales of the second morphotype (like those positioned in Fig. 2 I, P) are also composed of simple mesodentine and *Stranggewebe* in the crowns, but the principal system of vascular canals is not developed, either, and only short segments of radial and ascending vasculars have been observed (Fig. 4 G).

Remarks. Typical, holotype-like scales of *Nostolepis magnicostata* sp. nov. have no closely related taxa as compared morphologically. No one nostolepid has the crown ridged similarly to those that have ridges extending over the entire crown, together with a high and porous neck. *Nostolepis gracilis* Gross (1947: pl. 26 (7), figs 1–4; 1971: pl. 4, figs 1–8), first described from the Baltic Upper Silurian *Beyrichienkalk* erratics and perhaps belonging to the same phylogenetical lineage, is sculptured by regular parallel, sharp and high longitudinal ridges along the entire crown; part of them may bifurcate to the anterior; large pores are opening superficially in the grooves between ridges of the anterior crown. The crown/base proportions look also different. In *N. gracilis* the crowns are perfectly rhomboidal, with a larger base overhanging posteriorly; their bases are small and necks narrow and tall. The scales of the new species are more massive and the crowns considerably thicker. The histological structure of the species compared is quite similar, except for a character of simple mesodentine net of the anterior crown, which is much more cellular and dense even superficially in *N. gracilis*, without a dominant orientation of dentine tubules (Gross 1971: fig. 18 A, D, E). The *Stranggewebe* is similarly to the new species not enveloped by the layers of simple mesodentine, but the *Stranglacunae* are longer and osteocyte spaces rarer.

Nostolepis magnicostata scales of the second variety are most similar to the least sculptured *Vesperalia perplexa* Valiukevičius (*in press*: figs. 2–4) from the topmost Silurian in Lithuania. The latter are characterized by the interrupted crown ridges, which are different and often not continuous on the anterior and posterior parts. The histological differences concern the growth patterns (both superpositional and areal types in *V. perplexa*), lack of mesodentine strips covering the *Stranggewebe* and shorter *Stranglacunae* in *N. magnicostata*.

Occurrence. Stoniškiai-1 borehole, depth 1211-1217 m; Šešuvis-11: 1007.8 m; Nida-44: 1213 m.

***Nostolepis consueta* sp. nov.**

Figs. 5 A–I, 6 A–G, 7 A–G

1997 *Gomphonchus sandelensis*? (Pander); Märss, Pl. 3, Fig. 5.
1998 *Nostolepis minima* Valiukevičius; Valiukevičius, Pl. 1, Fig. 5.
1998 *Nostolepis* sp. or *Cheiracanthoides* sp.; Valiukevičius, Pl. 1, Figs. 10–15.

Derivation of name. *Consuetus* (Latin) – usual, ordinary, referring to the stability of crown ridgeness.
Holotype. LIGG 25-A-2427, trunk scale (Fig. 5A). Ledai-179 borehole, depth 508.5 m. Upper Silurian, Pridoli, the Lapės Formation.
Type locality. Ledai-179 borehole, depth 508.5–541.7 m.
Type horizon. Upper Silurian, Pridoli, the Lapės Formation.
Range. From the Lower Silurian, Wenlock, Gėluva Regional Stage, through the Upper Silurian, Ludlow and Pridoli, Dubysa, Pagėgiai, Minija and Jūra regional stages, to Lower Devonian, Lochkovian, Tilžė Regional Stage.
Material. More than 40,000 of trunk scales and a few head scales.
Diagnosis. *Nostolepis* having trunk scales of the medium size, rhomboidal, flat, not inclined, posteriorly narrowed and elongated crowns overhang the bases by one–third of the crown's length. The crowns are sculptured by 8–12 short, parallel, low anterior ridges making symmetric pairs and fading out at one–third of the crown's length. Ridges slope basewards to the anterior with a characteristic median curvature or prolong straight. Scale crowns are composed of *Stranggewebe* with long oriented lacunae and covered in growth lamellae with the strips of a simple "*vermiculate*" mesodentine network. This type of tissue forms the anterior part of the crown. The principal vascular system contains large arcade canals. There is no strong border between the mesodentine and cellular bone of scale bases.

Description

Head tesserae (*tesserae coronatae* of Gross, 1971). Most of specimens have small, very inclined (to 42°) crowns sitting on the large polygonal and flat base plates, which only rarely are scale-like and convex. The crowns are rhomboidal to having rounded anterior margins, whereas the posterior ones are always straight. The crowns are 0.6–0.82 mm long and 0.6–0.9 mm wide and have 3–5 short radial anterior

ridges extending to half of the crown's length. The ridges are wide, with flattened crests, which may shortly bifurcate. The grooves between the ridges deepen to the anterior, forming wide incisions basally (Fig. 5 D). The base is most polygonal, 1.0–1.3 mm long and 0.9–1.5 mm wide, from flat to moderately convex in the scale-like tesserae. It protrudes beyond the crown to all sides. The flat platelets are always densely porous, characterising a highly vascular bone tissue present. On the contrary, the scale-like tesserae have bases almost analogous to those of scales.

Trunk scales (Fig. 5 A–C, E–I) are particularly morphologically uniform. Crown length varies from 0.4

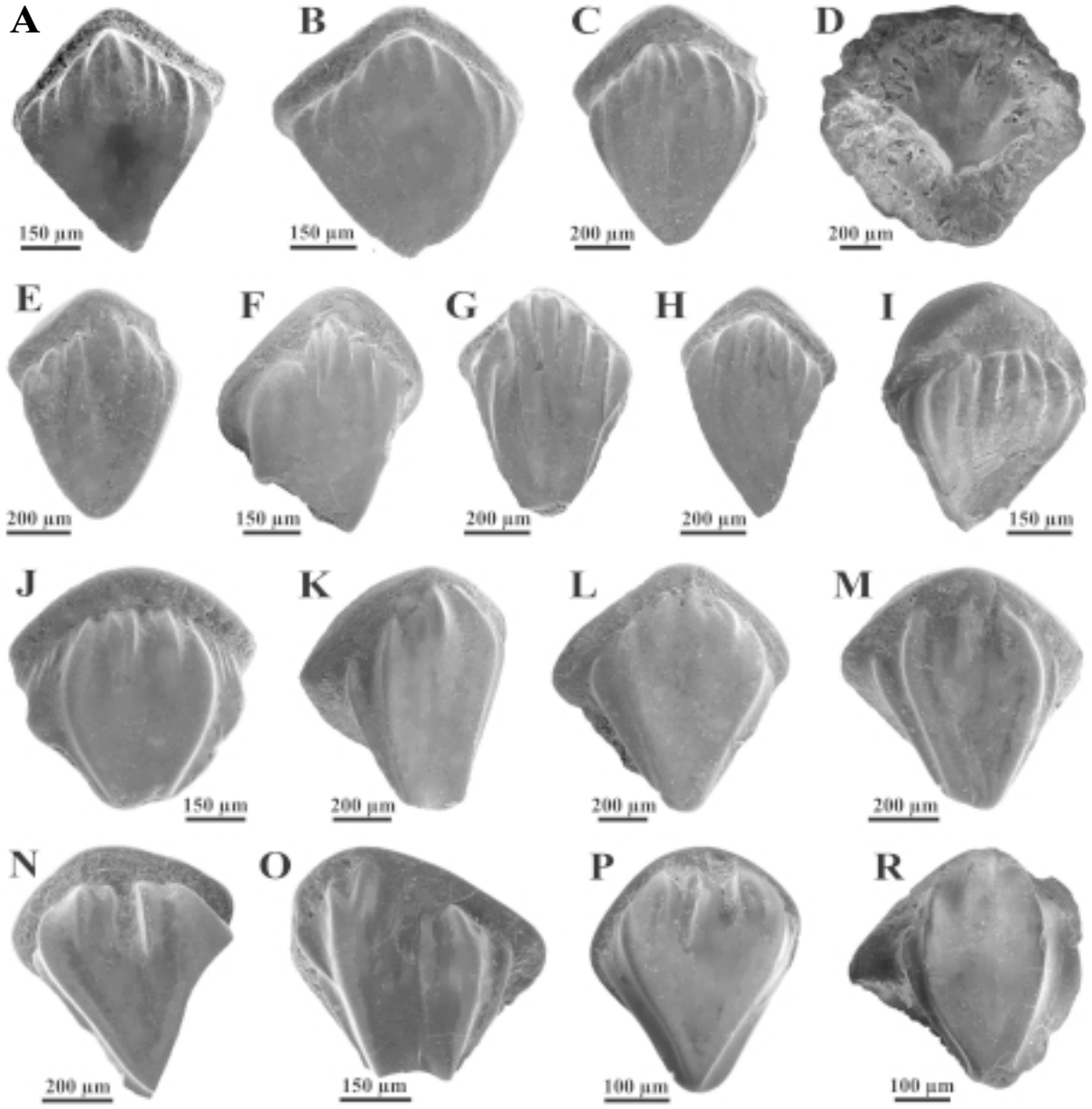

Fig. 5. SEM photos of acanthodian scales. A–I – *Nostolepis consueta* sp. nov. Trunk scales, except for D (head tessera). Crown views. A – holotype, LIGG 25-A-2427; B – LIGG 25-A-2428; C – LIGG 25-A-2429; D – LIGG 25-A-2531; E – LIGG 25-A-2430; F – LIGG 25-A-2434; G – LIGG 25-A-2524; H – LIGG 25-A-2525; I – LIGG 25-A-2433. Ledai-179 borehole, depth 508.5 m (A–C) and 523.7 m (E–F, I). Upper Silurian, Pridoli, Jūra Regional Stage, Lapės Formation. Kurtuvėnai-162 borehole, depth 1007 m (G–H) and 1017.4 m (D). Upper Silurian, Pridoli, Jūra Regional Stage, Jūra Formation. J–R – *Nostolepis musca* sp. nov. Trunk scales, crown views. J – holotype, LIGG 25-A-2435; K – LIGG 25-A-2436; L – LIGG 25-A-2437; M – LIGG 25-A-2438; N – LIGG 25-A-2492; O – LIGG 25-A-2493; P – LIGG 25-A-2494; R – LIGG 25-A-2467. J–M – Nida-44 borehole, depth 1213 m; N–P – Ledai-179 borehole, depth 541.7 m; R – Kurtuvėnai-162 borehole, depth 1063.4 m. Upper Silurian, Pridoli, Jūra Regional Stage, Jūra Formation (J–M and R) and Lapės Formation (N–P)

5 pav. Akantodų žvynų ir teserų nuotraukos. A–I – *Nostolepis consueta* sp. nov.; J–R – *Nostolepis musca* sp. nov.

to 0.73 mm and width from 0.35 to 0.55 mm. Crowns are flat, without inclination, from well rhomboidally outlined (Fig. 5 A–B) to rhomboidal elongated, with the narrowed posterior part, which may overhang the base by one–third of crown length (Fig. 5 E, H). Two only slightly different morphological variations are distinguished in crown ridgeness. The first variation (Fig. 5 A–C, I and also Valiukevičius, 1998: pl. 1, figs 5, 11–12, 15 and Märss, 1997: pl. 3, fig. 5) has 8–12 parallel, symmetric, unevenly sharp and high anterior crown ridges fading out at one–third of crown length, but sometimes ornamenting only the anterior crown margins. The marginal pair of ridges is up to double longer (Fig. 5 A, C). Characteristic is the form of the ridges. Symmetric pairs of them curve medially at the extreme anterior slightly sloping neckwards.

Another morphological variation of scales has straight ridges without anterior curvature (Fig. 5 E–H). Their number does not exceed 6. The marginal pair of ridges usually does not differ from the others (Fig. 5 E–F, H), but occasionally is considerably longer (Fig. 5 G).

The scales of both varieties have moderately deep rhomboidal bases projecting with the deepest point centrally or anteriorly, just opposite the crown margin. Scale necks are moderately high. Some have pores (up to six) opening on each neck face (Fig. 5 A).

Histology

Four to six growth lamellae in the cowns of trunk scales are composed of simple mesodentine and *Stranggewebe*. Both areas are not clearly distinguished, and the tissues merge gradually to one another. The holotype-like scales (Fig. 6 A–D, 7 A–C) demonstrate *Stranggewebe* developed posteriorly beginning with the primordial scale and consisting of moderately dense but long *Stranglacunae*, which are connected by plenty of winding "*vermiculate*" dentinal processes (Fig. 7 B). Simple mesodentine strips cover *Stranggewebe* in all growth lamellae except the last one. The anterior crown is composed of a dense mesodentine network incorporating frequent osteocytes (Fig. 7 C). Both crown tissues are pierced by principal radial, ascending and circular vascular canals (Fig. 6 A, B). Wide arcade canals (Fig. 6 B, D) connecting the ascendings are present.

The scales with straight crown ridges are composed analogously (Fig. 7 D–G), having a system of principal vascular canals including wide arcades (Fig. 7 G), but the *Stranggewebe* distinguishes by a less clear and long *Stranglacunae* as compared to the first variety. The development area of the *Stranggewebe* is indistinct, because one scale demonstrates it to be present in the posterior crown embracing the earliest growth lamella (Fig. 7 D, E), whereas the second scale shows it absent (Fig. 7 F, G), and a very dense simple mesodentine net with osteocyte spaces is clearly forming the entire crown.

The flat-pyramidal base in scales of both varieties is composed of a cellular bone with numerous large osteocyte cavities and pierced by long Sharpey fibres.

The head scale (Fig. 6 E–G) has two growth lamellae, of which the earliest occupies the principal crown area. The *Stranggewebe* with horizontally oriented lacunae is only fragmentarily seen (Fig. 6 G), and the cellular bone of the base merges gradually into cellular simple mesodentine. The principal vascular canals, ascending, radial and arcade, are present and not differ from the trunk scales.

Remarks. *Nostolepis consueta* is separated from a wide scope of the morphological varieties of scales, usually attributed to *N. striata* Pander. The recent understanding of *N. striata* is really too broad, as compared to other acanthodian scale taxa. We cannot exactly compare our specimens with that illustrated in Pander's work (1856: pl. 6, fig. 7a), but as the general differences crown inclination, presence of a symmetrical pair of protruding neck ridges and a more or less developed shallow medial depression along the crowns of *N. striata* might be indicated. These diagnostic characters have been well grounded and published by W. Gross (Gross, 1947: pl. 26, figs. 5–11). In our opinion, this taxon has to be constrained, having trunk scales only similar to those illustrated in the mentioned two publications. Many of scale varieties ascribed to *N. striata* in the recent publications need a revision and reappraisal.

N. consueta sp. nov. differs from *N. striata* of such a narrow understanding in all the mentioned diagnostic features. Some histologic differences are also present. *N. striata* (Gross, 1947: figs. 19–23) has clearly separated two tissue types in scales, highly cellular lamellar bone in bases and typical mesodentine and *Stranggewebe* in crowns, which are characterized by the medium long *Stranglacunae*, enveloped in each growth lamella by a thick layer of simple mesodentine. The anterior mesodentine is formed of a regular net of narrow dentinal canals, the main part of which is oriented perpendicularly to the outer margin of the growth lamella. The system of wide principal dentine canals, radial, circular and ascending, is perfectly developed in *N. striata*, in contrast to *N. consueta* in which only canal fragments are observed. The arcade crown canals are present in *N. consueta*, but have never been defined in *N. striata*. As a characteristic difference is the "*vermiculate*" type of dentine canaliculies observed

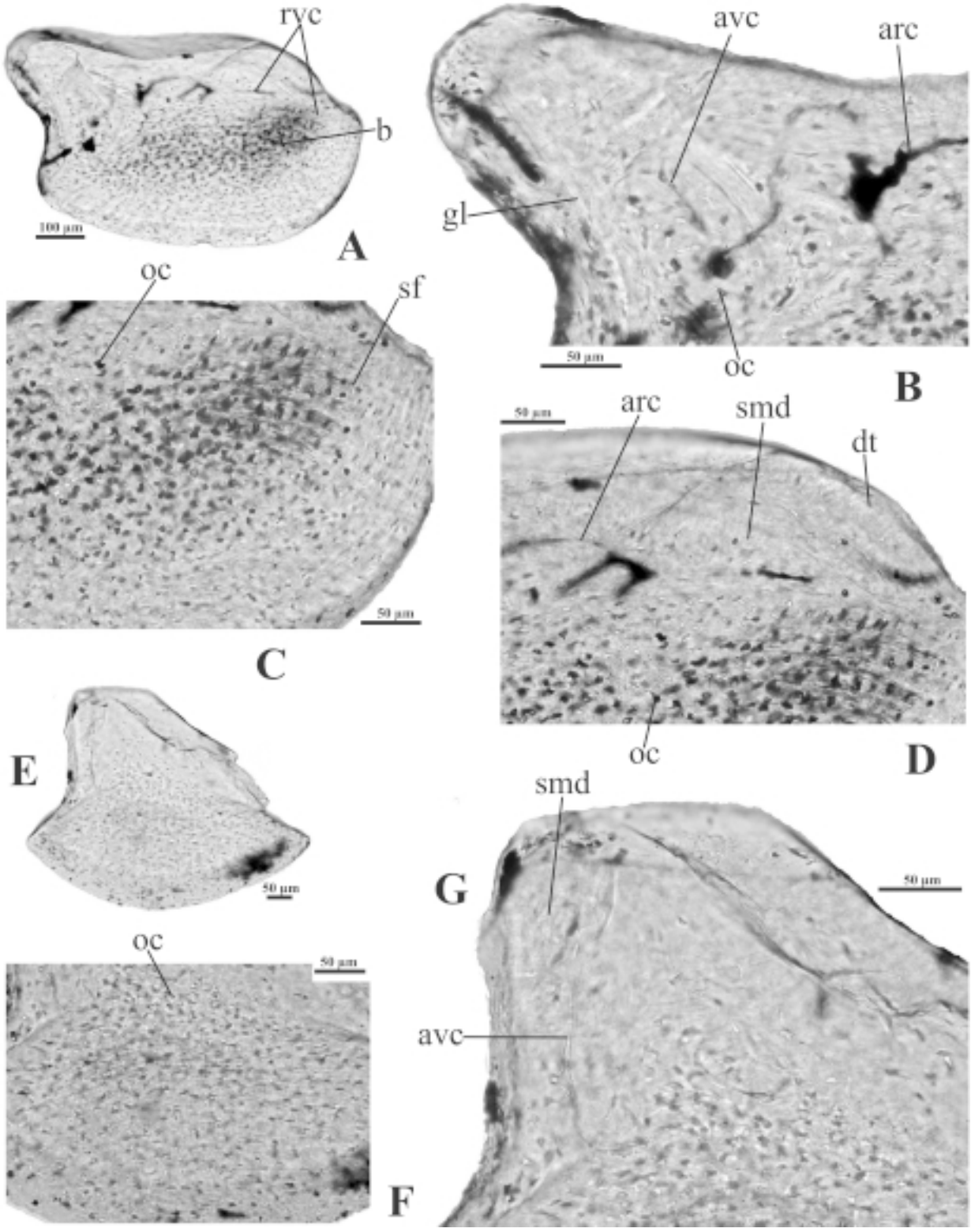

Fig. 6. *Nostolepis consueta* sp. nov. Histological microstructure of a trunk scale (as that shown in Fig. 5 E–G) in vertical longitudinal section (A–D) and a head scale in vertical transverse section (E–G). A – thin section 3723, general view; B – detail of the posterior crown of the same scale; C – magnified area of the base of the same scale; D – detail of the anterior crown of the same scale; E – thin section 3724, general view; F – magnified base area of the same scale; G – detail of crown of the same scale. Nida-44 borehole, depth 1213 m. Upper Silurian, Pridoli, Jūra Regional Stage, Jūra Formation;
arc – arcade vascular canal, *avc* – ascending vascular canal, *b* – base, *dt* – dentine tubule, *gl* – growth lamella, *oc* – osteocyte cavity, *rvc* – radial vascular canal, *sf* – Sharpey's fibres, *sg* – *Stranggewebe, smd* – simple mesodentine
6 pav. *Nostolepis consueta* sp. nov. Liemens (A–D) ir galvos (E–G) žvynų histologinė mikrostruktūra

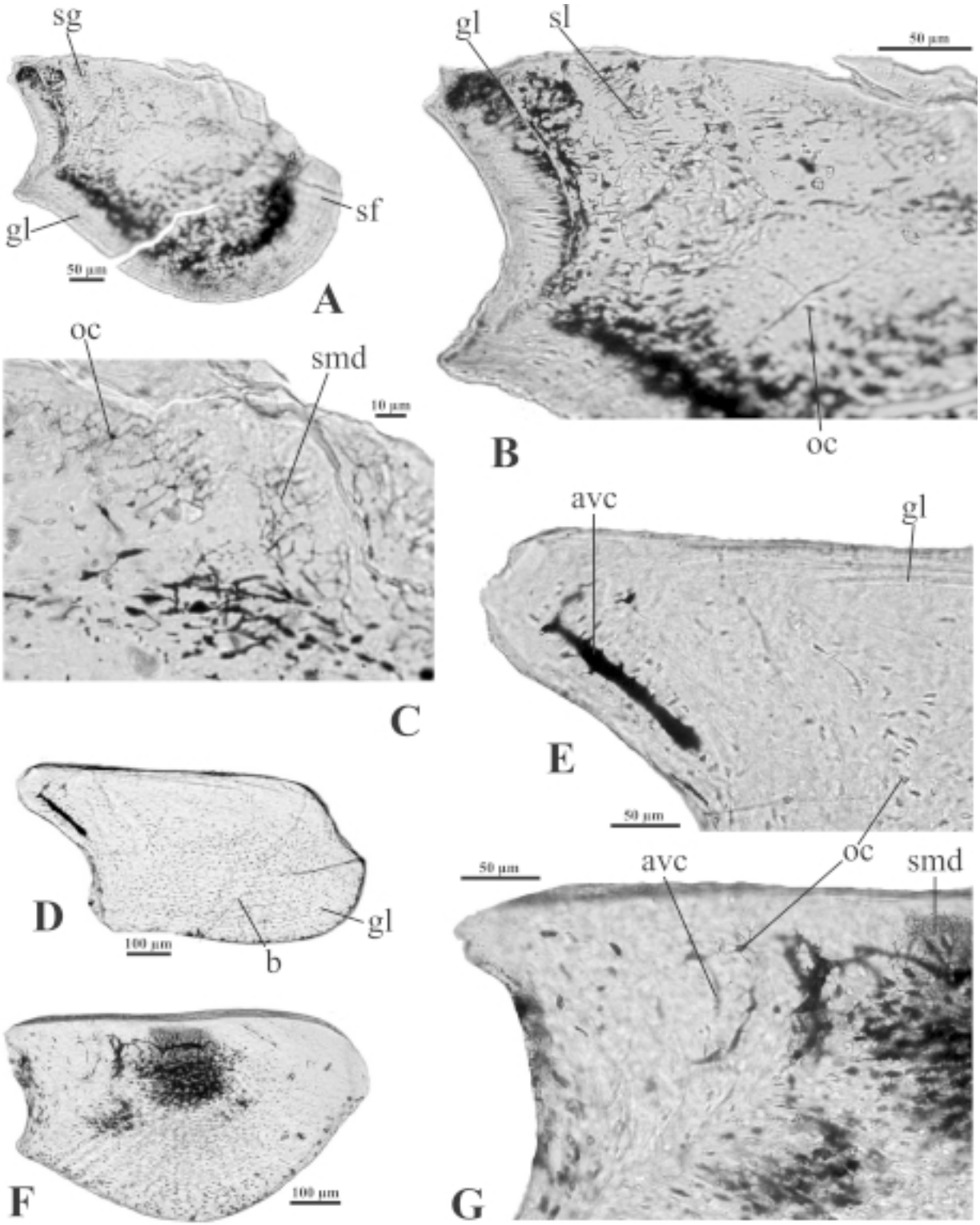

Fig. 7. *Nostolepis consueta* sp. nov. Histological microstructure of a holotype-like trunk scale (A–C) and the scales like those shown in Fig. 5 E–G (D–G) in vertical longitudinal sections. A – thin section 3719, general view; B – detail of the posterior crown of the same scale; C – the same, anterior crown part; D – thin section 3721, general view; E – detail of the posterior crown part of the same scale; F – thin section 3722, general view; G – detail of the posterior crown part of the same scale. Kurtuvėnai-162 borehole, depth 1007 m (A–C) and Nida-44 borehole, depth 1213 m (D–G). Upper Silurian, Pridoli, Jūra Regional Stage, Jūra Formation;
avc – ascending vascular canal, *b* – base, *gl* – growth lamella, *oc* – osteocyte cavity, *sf* – Sharpey's fibres, *sg* – *Stranggewebe, smd* – simple mesodentine
7 pav. *Nostolepis consueta* sp. nov. Liemens žvyno, analogiško holotipui (A–C), ir žvynų, analogiškų 5 pav. E–G (D–G), histologinė mikrostruktūra

both in the *Stranggewebe* and simple anterior mesodentine of *N. consueta*.

Later, W. Gross has published some photos of *N. striata* scales (1971: pl. 5, figs. 1–7) from the *Beyrichia*-limestone erratics derived from the Baltic region, which are similar to *N. consueta* by the presence of converging uniform crown ridges and absence of both medial depression and oblique neck ridges, all definitive features consistent to *N. consueta*. To this new taxon belong also scales (see synonymy list) published by T. Märss (1997: pl. 3, fig. 5) coming from the Ohesaare Stage (=Jūra) of Kaliningrad district and representing geological series of the same basin.

Comparable specimens that might be attributed to *N. consueta*, close mophologically but not histologically examined, have been recently studied from the Silurian of Sweden and Welsh Borderland. All of them are identified as *N. striata*. Some scales from the British Isles (Vergoossen, 2000: pl. 1, figs 4, 7) having short anterior crown ridges sloping downwards to the base resemble the second morphotype of *N. consueta*. They are attached to the Ludlow Bone Bed of the early Pridoli in the Manbrook 7 locality. The scales from Sweden are not as well preserved as the Baltic ones, but they also have all morphologic elements characteritic of *N. consueta* (Vergoossen, 2002 a: pl. 3, figs 31–33; Vergoossen, 2002 b: pl. 14, figs 85–86). They are identified from the Klinta 2 locality in the first case and from the Ramsåsa, site D of Skåne in the second case, and correlate biostratigraphically with the *Thelodus sculptilis* thelodont zone (late Ludlow to the earliest Pridoli).

Occurrence. Stoniškiai-1 borehole, depth 1211–1308.9 m; Šešuvis-11: 1005–1137.8 m; Nida-44: 1213–1273.8 m; Krekenava-7: 540.6–553.5 m; Stačiūnai-8: 856.5–861.2 m; Kunkojai-12: 891.9–912 m; Liepkalnis-137: 879.8–903.2 m; Kurtuvėnai-162: 1007–1072.4 m; Gėluva-99: 639.1–661 m; Sutkai-87: 571–622 m; Ledai-179: 502.1–541.7 m; Svėdasai-252: 359.3–368.6 m; Butkūnai-241: 457 m; Jočionys-299: 115.8 m; Lygumai-45: 1011.8–1030.4 m.

Nostolepis musca sp. nov.

Figs. 5 J–R; 8 A–G

Derivation of name. *Musca* (Latin) – fly; bore, nuisance, regarding to a very common occurrence almost in all samples yielding Silurian acanthodians.
Holotype. LIGG 25-A-2435, trunk scale (Fig. 5 J). Nida-44 borehole, depth 1213 m. Upper Silurian, Pridoli, the Jūra Formation.
Type locality. Gėluva-99 borehole, depth 639.6–752 m.
Type horizon. Upper Silurian, Pridoli, the Jūra Formation.
Range. Upper Silurian, Ludlow to Pridoli, Pagėgiai, Minija and Jūra regional stages.
Material. Over 100,000 scales.
Diagnosis. *Nostolepis* having rhomboidal, posteriorly elongated scales of medium size; the clear and wide median area carrying up to four short ridgelets on crowns present, formed by two symmetric and posteriorly pointed ridges; narrow lateral crown slopes present; another scale variety has a deep and sharp longitudinal groove on the median area. Up to six superposed growth lamellae in crowns are composed of simple networked mesodentine (anterior part) and *Stranggewebe* (posterior crown, primordial lamella including) with dense, complicated *Stranglacunae* and no strips of simple mesodentine; both tissue types contain large osteocytes even in the superficial layers.
Description. Two morphotypes of trunk scales have been defined. The first one (Fig. 5 J–M and R) is distinguished by isometrically rhomboid scales (crown length and width vary from 0.4 to 0.6 mm) or having rhomboidally outlined anterior margins only, whereas the posterior ones are clearly elongated, forming a narrow posterior tip. The crown length of this variety of scales exceeds the width (0.5–0.9 and 0.35–0.75 mm, respectively). The crown plate is slightly inclined, overhanging the base to the posterior. The overhang may be negligible (Fig. 5 L) up to one-fourth of the crown length (Fig. 5 K, M). The elevated median area is distinguished on crowns formed by two longest and most prominent symmetric ridges pointed or near to point at the posterior. This area is of elongated elypsoidal (Fig. 5 J, M) to triangular form (Fig. 5 L) and is sculptured by rounded, short, subparallel anterior ridgelets, their number varying from one–two (Fig. 5 K, M) to four (Fig. 5 J). The lateral lowered slopes outlined by the marginal ridges are of different width. The marginal and median ridges point at the posterior crown. The lateral slopes are usually unsculptured, but may have one–two short ridgelets (Fig. 5 J), which are finer and lower as compared to those of the median area.

The second type of trunk scales (Fig. 5 N–P) is distinguished by triangular, strongly elongated crowns 0.36–0.8 mm long and 0.3–0.6 mm wide, a wide triangular median area and narrow lateral slopes. The sculpture of the median area consists of uneven in length and height anterior ridges, which prolong up to one–third of crown length (Fig. 5 N). Their number is not less than four. The ridges slope down basewards deeper as compared to the first type of scales. A deep and wide longitudinal groove between the two central ridges is characteristic (Fig. 5 N, O), forming an incised anterior crown margin. The arrangement of ridges and the shape of scales are frequently asymmetric.

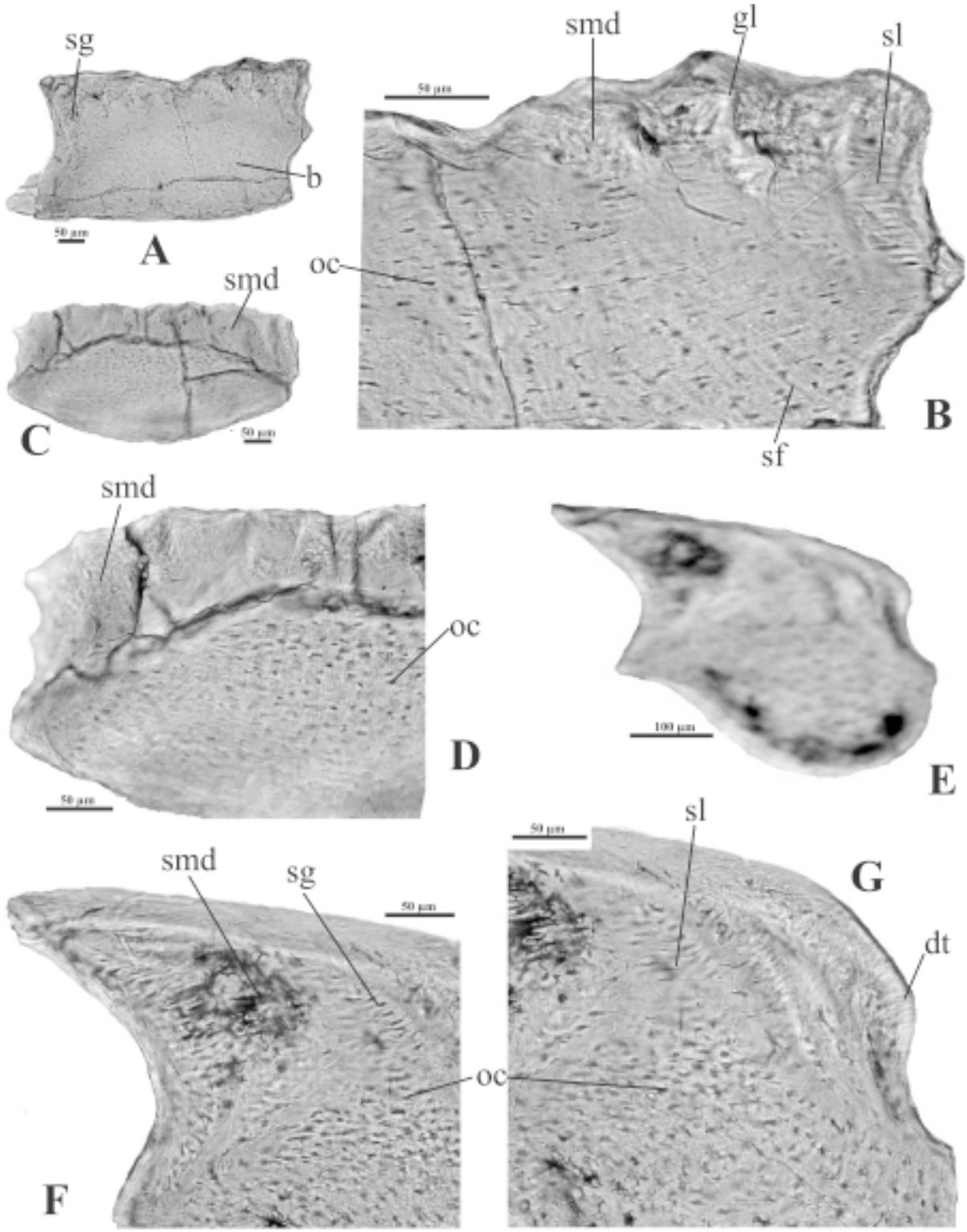

Fig. 8. *Nostolepis musca* sp. nov. Histological microstructure of trunk scales of the second (A–B) and the first morphotype (C–G) in vertical transverse (A–D) and longitudinal (E–G) sections. A – thin section 3689, general view; B – detail of the right part of the same scale; C – thin section 3690, general view; D – detail of the left part of the same scale; E – thin section 3691; F – detail of the posterior crown and the crown/base junction strip of the same scale; G – the same, anterior crown. Gėluva-99 borehole, depth 643 m. Upper Silurian, Pridoli, Jūra Regional Stage, Jūra Formation;

b – base, *dt* – dentine tubule, *gl* – growth lamella, *oc* – osteocyte cavity, *sf* – Sharpey's fibres, *sg* – *Stranggewebe, sl* – *Stranglacunae*, *smd* – simple mesodentine

8 pav. *Nostolepis musca* sp. nov. Antro (A–B) ir pirmo (C–G) morfotipo liemens žvynų histologinė mikrostruktūra vertikaliame skersiniame (A–D) ir išilginiame (E–G) pjūvyje

Scale bases of both morphotypes are from isometric to asymmetric rhomboid, sometimes wider than long, situated slightly ahead of the crown, moderately deep to deep, projecting with the deepest point just below the anterior crown.

Histology

The structure of tissues is analogous in scales of both morphotypes. The first of them is represened in Fig. 8 C–G and the second in Fig. 8 A, B. Scale crowns are composed of simple mesodentine and *Stranggewebe* portioned in growth lamellae, their number reaches six. The primordial lamella distinguishes by the measurements occupying the large central area of a scale. A simple mesodentine network incorporating numerous osteocyte cavities and a very complicate style of short and winding dentine canaliculies compose the anterior crown part (Fig. 8 C, D). Only in rare cases the prevalence of outerward oriented dentine tubules in the last two growth lamellae has been observed (Fig. 8 G). Osteocyte cavities are obtained to be present in all lamellae, with a similar frequency, even in the latest ones. The *Stranggewebe* is developed in the posterior crown beginning with the primordial lamella, thus, if the transverse section is centrally positioned, this tissue type may represent all the crown space (Fig. 8 A, B). The *Stranglacunae* are dense, large and long, occupying the whole volume of lamellae, leaving no place for a simple mesodentine layer (Fig. 8 A–B, F). The latter was only observed in the restricted extreme superficial lamella portions (Fig. 8 B). The crown tissues lack the principal system of enlarged vascular canals, though rarely they may be supposed to develop, for example, radial and ascending canals (Fig. 8 F, G).

The flat-pyramidal bases of scales are composed of a highly cellular lamellar bone pierced by short to medium-long Sharpey fibres. Large, multi-angular osteocytes, particularly in the topmost base parts, are emanating short processes for connections to each other (Fig. 8 D, F–G).

Remarks. *Nostolepis musca* sp. nov., similarly to the above described *N. consueta*, is a *Nostolepis* ex gr. *striata* derived taxon, and all said in remarks to the former is suitable for the latter one. Further differences concern an elevated, prominent, wide median area with narrow lateral steps and a sharp central longitudinal groove (the second morphotype) developed in *N. musca*, whereas in *N. striata* these are absent, but the oblique neck ridges are well distinguished. Histological characters differ clearly both of the *Stranggewebe* and simple mesodentine, as *N. striata* has a well developed system of main radial, circular and ascending vascular canals and the *Stranggewebe* enveloped by the layers of simple mesodentine. The *Stranglacunae* in *N. musca* are more densely positioned, wider and longer, of another style in sum. *N. musca* scales differ from those of *N. consueta* in the ridgeness sloping lower downwards to the anterior and in a clear and wide medial area, which may be divided into two parts by a deep and sharp longitudinal groove. According to the tissue structure in crowns, *N. musca* lacks a system of principal vasculars including arcades of ascendings, which are fragmentarily seen in *N. consueta*, shows another style of dentine tubules in a simple mesodentine (no "*vermiculate*" tubules) and more numerous osteocytes in the superficial crown layers.

Occurrence. It is taken separately for each morphotype, as the first is present in almost all samples studied, whereas the second one is much rarer and attached to the restricted stratigraphic horizons.

First morphotype: Stoniškiai-1, depth 1214–1318.8 m; Ledai-179: 508.3–539.7 m; Gėluva-99: 639.6–752 m; Sutkai-87: 571.8–612.9 m; Šešuvis-11: 1005–1137.8 m; Nida-44: 1213–1273.8 ; Krekenava-7: 540.6–547.8 m; Stačiūnai-8: 856.5–861.2 m; Kunkojai-12: 903–910 m; Liepkalnis-137: 879.8–915.9 m; Kurtuvėnai-162: 1007–1072.4 m; Jočionys-299: 102.8–115.8 m; Svėdasai-252: 365.6–373.6 m.

Second morphotype: Stoniškiai-1: 1338.8–1351 m; Ledai-179: 541.7–543.7 m; Gėluva-99: 643 and 735.2 m; Sutkai-87: 620.7 m; Nida-44: 1213 m; Kurtuvėnai-162: 1063.4 m.

CONCLUSIONS

The morphologic and histologic affinity and attribution to the genus *Nostolepis* of at least three species, *N. amplifica, N. consueta* and *N. musca*, is not doubtful in a sence that all of them are derived from the *Nostolepis striata* group, in which the first species (Pander, 1856) have been proposed typical of the genus (Denison, 1979). Lately, particularly in the recent time, to this group or to the *N. striata* species, specimens distinctly differing in crown sculpture have been attributed without their histologic examination. This has lead to the situation when one species comprised a very wide scope of varieties, *e. g.*, of the most diagnostic trunk scales, and this is in great contrast to the remaining acanthodian species showing less differences in the squamation, what is proved by the study of articulated specimens (classical Great Britain, MOTH in Arctic Canada or Severnaya Zemlya localities in Russia). Returning to the earlier understanding of the *N. striata* species (*sensu* Pander, 1856 and Gross, 1947) might be helpful not only for clarification of the

taxonomy of nostolepids, but also contribute to more precise biostratigraphic zonation.

Nostolepis amplifica sp. nov. is diagnosed on large trunk scales having a wide median area sculptured by two–six parallel anterior ridges fading out at a quarter of crown length, narrow lateral crown steps outlined by prominent oblique neck ridges and porose necks. The *Stranggewebe* in crowns is distinguished by short and narrow *Stranglacunae* and osteocytes in the primordial lamella only. This layer is covered by a thick mantle of simple mesodentine. Both tissues are cellular, incorporating dense and large osteocytes of mesodentine type. Mesodentine of the anterior crown is less cellular, but netty, with the superficial dentine tubules more linear and longer, oriented upwards. The crown tissues are pierced by large radial, ascending and circular vascular canals.

Nostolepis consueta sp. nov. has trunk scales of medium size with well rhomboidally outlined, not inclined, posteriorly narrowed and elongated crowns overhanging the bases. Crown sculpture is of 8–12 slightly sloping basewards short, parallel, low anterior ridges making symmetric pairs and fading out at one–third of crown length. All ridges are of almost the same length and have a characteristic anterior centralward curvature. Scale crowns in the primordial lamella and the later ones added to the posterior are composed of *Stranggewebe* with long oriented lacunae and covered by the strips of simple "*vermiculate*" mesodentine, which is less cellular as compared to the other new species. This type of tissue is completely forming the anterior part of the crown. The principal vascular system in the crown has large arcade canals. The mesodentine of crowns merges gradually into the cellular bone of scale bases.

Nostolepis musca sp. nov. is defined on rhomboidal, strongly elongate trunk scales of medium size having a prominent, wide median area formed by two symmetric and posteriorly pointed ridges. This area may carry up to four anterior ridgelets of uneven length, which are frequently asymmetrical. Narrow lateral crown slopes are present, but the marginal ridges (edges) do not lower as obliquely to the neck. The second scale variety has a deep and sharp longitudinal groove on the median area, often dividing the crown into two asymmetric folds. Up to six superposed growth lamellae in crowns are composed of simple networked mesodentine with typical and numerous osteocytes (the anterior part) and *Stranggewebe* (posterior crown primordial lamella included) with dense, complicated, long and wide *Stranglacunae* and no strips of simple mesodentine. The species is characterized also by the lack? (not observed, but might be supposed to develop) of large vascular canals.

The holotype-like trunk scales of *Nostolepis magnicostata* sp. nov. is characterised by stout, rounded, relief, parallel four–eight ridges dominantly prolonging the entire crown length and high, porose necks, not characteristic of nostolepids. One may suppose attribution to a separate genus. For the being, we grounded our opinion on the diagnostic histologic characters of tissues close to the above nostolepids: a system of large vascular canals in crowns developed, the *Stranggewebe* with long and medium dense *Stranglacunae* not covered by the mantle of simple mesodentine in the posterior crown, a poorly oriented and moderately cellular mesodentine network of the anterior crown, and the crown/ /base gradual transition from mesodentine to bone tissue.

ACKNOWLEDGEMENTS

I am greatful to Dr Habil. V. Karatajūtė-Talimaa (Vilnius) for help in taxa identification problems, particularly for discussions on scale histology and definition of morphologic sets characteristic of each species, and for the majority of the collection kindly donated for this study. Dr. A. Brazauskas (Vilnius) is acknowledged for acanthodian material from some recently studied borehole cores and also for providing information on lithostratigraphy, conodont zonations and the revised age of some localities. I thank Dr. T. Märss (Tallinn) for helpful discussions in the determination of taxa and for the possibility to compare the species with the material stored in Tallinn. I am also indebted to Dr. V. Mikli (Tallinn Technical University) for SEM micrographs of scales and thin section photography.

References

Blieck A. & Turner S. 2000. IGCP 328: Palaeozoic Microvertebrates final scientific report – Introduction. Blieck A. & Turner S. (eds). *Palaeozoic Vertebrate Biochronology and Global Marine/Non-Marine Correlation*. *Courier Forschungsinstitut Senckenberg*. ***223***. 1–67.

Denison R. 1979. Acanthodii. *Handbook of Paleoichthyology*. ***5***. Stuttgart, New York. 62 p.

Gross W. 1947. Die Agnathen und Acanthodier des obersilurischen Beyrichienkalks. *Palaeontographica. A*. ***96***. 91–161.

Gross W. 1971. Downtonische und Dittonische Acanthodier-Reste des Ostseegebietes. *Palaeontographica. A*. ***136***. 1–82.

Karatajūtė-Talimaa V. & Brazauskas A. 1994. Distribution of vertebrates in the Silurian of Lithuania. *Geologija*. ***17***: 106–114.

Karatajūtė-Talimaa V., Brazauskas A. & Valiukevičius J. 1999. Vertebrate assemblages of the Silurian / Devonian

boundary beds and the section completeness in the Baltic Syneclise. Lukševičs E., Stinkulis G. & Kalnina L. (eds.). *The Fourth Baltic Stratigraphical Conference. Problems and Methods of Modern Regional Stratigraphy. Abstracts*. 42–43. Riga.

Märss T. 1997. Vertebrates of the Pridoli and Silurian-Devonian boundary beds in Europe. *Modern Geology*. ***21***. 17–41.

Märss T. 2000. Silurian vertebrate studies during 1990–1997. Blieck A. & Turner S. (eds.). *Palaeozoic Vertebrate Biochronology and Global Marine/Non-Marine Correlation. Courier Forschungsinstitut Senckenberg*. ***223***. 81–90.

Märss T., Fredholm D., Talimaa V., Turner S., Jeppsson L. & Nowlan G. 1996. Towards the Silurian Vertebrate Biozonal Standard. *The James Hall Symposium – Second International Symposium on the Silurian System. Program and Abstracts.* 73–74. University of Rochester.

Pander Ch. 1856. Monographie der fossilen Fische des silurischen Systems der russisch-baltischen Gouvernements. 37–91. St. Petersburg.

Talimaa V. 2000. Significance of thelodonts (Agnatha) in correlation of the Upper Ordovician to Lower Devonian of the northern part of Eurasia. Blieck A. & Turner S. (eds.). *Palaeozoic Vertebrate Biochronology and Global Marine/Non-Marine Correlation. Courier Forschungsinstitut Senckenberg*. ***223***. 69–80.

Valiukevičius J. 1998. Acanthodians and zonal stratigraphy of Lower and Middle Devonian in East Baltic and Beloruss. *Palaeontographica. A*. ***248***. 1–53.

Valiukevičius J. (*in press*). New Wenlock–Pridoli acanthodian fishes from Lithuania. *Acta Geologica Polonica*. Warszawa.

Vergoossen J. M. J. 2000. Acanthodian and chondrichthyan microremains in the Siluro-Devonian of the Welsh Borderland, Great Britain, and their biostratigraphical potential. Blieck A. & Turner S. (eds.). *Palaeozoic Vertebrate Biochronology and Global Marine/Non-Marine Correlation. Courier Forschungsinstitut Senckenberg*. ***223***. 175–199.

Vergoossen J. M. J. 2002a. Late Silurian fish microfossils from Klinta and Rinnebäks Bro (Scania, south Sweden), with remarks on the morphology of *Nostolepis striata* trunk scales. *Scripta Geologica*. ***123***. 71–92.

Vergoossen J. M. J. 2002b. Late Silurian fish microfossils from Ramsåsa (sites D and 'south of church'), Skåne, south Sweden. *Scripta Geologica*. ***123***. 93–158.

Берг Л. С. 1940. Система рыбообразных и рыб, ныне живущих и ископаемых. *Труды Зоологического института. **5(2)***. 85–517. Москва–Ленинград.

Каратаюте-Талимаа В. Н. 1978. Телодонты силура и девона СССР и Шпицбергена. Вильнюс: Мокслас. 334 с.

Каратаюте-Талимаа В. Н., Валюкявичюс Ю. Ю., Бразаускас А. З. 1987. Распространение конодонтов и позвоночных в силурийских отложениях Литвы. *Lietuvos aukštųjų mokyklų mokslo darbai. Geologija. **8***. 59–71.

Мярсс Т. 1986. Позвоночные силура Эстонии и Западной Латвии. Таллинн: Валгус. 104 с.

Juozas Valiukevičius

NAUJI LIETUVOS SILŪRO NOSTOLEPIDAI (AKANTODAI, ŽUVYS)

S a n t r a u k a

Aprašytos keturios naujos *Nostolepis* genties akantodų rūšys. Trys iš jų – *N. amplifica, N. consueta* ir *N. musca* yra išskirtos iš pastaruoju metu labai plačiai (daugybė morfologinių variacijų) traktuojamos *Nostolepis striata* grupės. Šios grupės susiaurinimas kiek priartina ją prie kitų rūšių, taip pat diagnozuotų vien žvynų pagrindu, taksonominio supratimo. *Nostolepis amplifica* žvynų karūnoje išsiskiria pakelta plati centrinė dalis, ornamentuota 2–6 išilginėmis lygiagrečiomis keteromis, besitęsiančiomis nuo karūnos priekio iki ketvirtadalio jos ilgio. Laipto formos žemėjantys pakraščių arealai apriboti įstrižomis kaklo keteromis. Šlifuose ištirtai histologinei mikrostruktūrai būdingas orientuotas mezodentinas su trumpomis ir siauromis lakūnomis (apytakos kanalų išplatėjimais), kurį dengia paprastas tinkliškas mezodentinas su gausiomis kaulinėmis ląstelėmis. Karūnoje gerai išvystyta pagrindinių apytakos kanalų sistema. *Nostolepis consueta* žvynai karūnoje turi 8–12 trumpų, žemų, lygiagrečių keterų, sudarančių simetrines poras bei pasižyminčių būdingu užlenkimu centro link. Orientuotas mezodentinas karūnoje išsiskiria ilgomis lakūnomis, o jį dengiantis paprastas mezodentinas – sudėtinga „kirmėliška" tinklo struktūra bei gerokai mažesniu kaulinių ląstelių kiekiu. Apytakos kanalų sistemoje susidaro sudėtingi arkų formos kanalai. *Nostolepis musca* žvynų karūnose, panašiai kaip minėtų, yra suformuota centrinė dalis, tačiau su asimetrinėmis nevienodo ilgio keteromis ir kartais gilia išilgine griova. Pakraščių arealai siauri, nėra kaklo keterų. Paprastas karūnos mezodentinas, kaip ir orientuotas, pasižymi gausiomis kaulinėmis ląstelėmis. Orientuotą mezodentiną augimo plokštelėse nedengia paprastojo sluoksnis. *Nostolepis magnicostata* žvynai yra aukštais kaklais bei per visą karūną einančiomis 4–8 stambiomis suapvalintomis keteromis. Tai nebūdinga *Nostolepis* genčiai. Histologiniai požymiai, priešingai, yra artimi nostolepidams: išvystyta pagrindinių apytakos kanalų sistema karūnoje, orientuoto mezodentino su ilgomis lakūnomis nedengia paprastas mezodentinas, paprastojo mezodentino struktūroje nedaug osteocitų. Būdingas laipsniškas perėjimas nuo kaulinio audinio žvyno į karūnos mezodentinius.

Юозас Валюкявичюс

НОВЫЕ НОСТОЛЕПИДЫ (АКАНТОДЫ, РЫБЫ) ИЗ СИЛУРА ЛИТВЫ

Р е з ю м е

Описаны четыре новых вида рода *Nostolepis*, из которых *N. amplifica, N. consueta* и *N. musca* выделены из широкого понимания (множество морфологических вариаций) группы *Nostolepis striata. Nostolepis amplifica* чешуи имеют на кроне приподнятый, широкий медиальный отдел, орнаментированный 2–6 параллельными гребешками, протягивающимися до четверти длины кроны. Латеральные пониженные

ступени кроны обрамлены отчетливыми шейными гребнями. Ориентированный мезодентин в кроне покрыт слоем простого сетчатого мезодентина, а также содержит короткие и узкие лакуны. Костные клетки установлены лишь в первичной пластине роста. Развита система крупных сосудистых каналов. На кроне чешуй *Nostolepis consueta* насчитывается 8–12 коротких, низких, параллельных гребешков, образующих симметричные пары. Их концы на переднем крае кроны характерно загнуты к центру чешуи. Ориентированный мезодентин в кроне с длинными лакунами и покрыт слоем простого сетчатого „червячкообразного“ мезодентина. В систему крупных сосудистых каналов кроны входят аркадные ветви. *Nostolepis musca* описан по чешуям, имеющим на кроне медиальный отдел, орнаментированный асимметричными гребешками разной длины и глубокой срединной бороздой. Латеральные ареалы узкие, и крайние гребни не опускаются в шейку. Простой сетчатый мезодентин типичный, с множеством костных клеток, а ориентированный мезодентин включает плотные, сложные лакуны и не покрыт простым. *Nostolepis magnicostata* чешуи имеют на кроне 4–8 крупных, высоких, округленных гребней, протягивающихся через всю крону, и высокую шейку, что не характерно для ностолепид. Однако диагностические гистологические признаки близки к ностолепидам: развита система крупных сосудистых каналов, ориентированный мезодентин с длинными лакунами и не покрыт простым сетчатым. Последний, развитый в передней части кроны, выделяется отсутствием ориентировки у дентиновых канальцев и содержит среднее количество костных клеток. Характерен постепенный переход от костной ткани в основании чешуй к мезодентиновым тканям кроны.