New ptyctodontid placoderm from the Famennian (Upper Devonian) of European Russia

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Abstract

Neruchella eichwaldi gen. et sp. nov. is erected on the basis of a head shield found in the Famennian Lebedyanian Regional Stage of the Orel Region, Russia. The new taxon differs from all known ptyctodontids, and is characterized by the central plates in contact along the skull midline, the meeting of the sensory-line canals on the centrals and the loss of the nuchal plate. The structures of the head shields of two Famennian ptyctodontids *Neruchella* and *Chelyophorus* are completely different from the general skull bone pattern of older ptyctodontid taxa.

Keywords: new genus, Ptyctodontida, Placodermi, Famennian, Devonian, Russia

Introduction

Ptyctodontid remains were recorded from the Lower to Late Devonian. They are most taxonomically diverse in the Middle Devonian and Frasnian (Denison, 1978; Long, 1997; Trinajstic, Long, Ivanov, and Mark-Kurik, 2019). Only one ptyctodontid, *Chelyophorus* Agassiz, 1844, is known from the Famennian of the European part of Russia (Obrucheva, 1983).

The first known ptyctodontid taxa were described by Agassiz (1844) from the Famennian of the Orel Region, central part of European Russia, based on isolate dermal plates. He established two species, *Chelyophorus verneuili* Agassiz, 1844 and *C. pustulatus* Agassiz, 1844 but the second species has been attributed to *Asterolepis* (Denison, 1978). Later Eichwald (1860) redescribed *C. verneuili* based on a new material from same region. The Eichwald collection of *Chelyophorus* includes several isolated plates of head and trunk shields, and an articulated skull roof with orbital and occipital ossifications of the endocranium, as well as post-cranial elements. Eichwald defined two new species, C. *primigenius* and C. *posthumus* which are now included in synonymy with *Chelyophorus verneuili* (Denison, 1978). Thus, presently *Chelyophorus verneuili* is the only valid taxon of a Famennian ptyctodontid. The species occurs in the Lebedyanian — Plavskian Regional stages of several localities of Orel and Lipetsk regions, Russia (Esin et al., 2000; Lebedev and Lukševičs, 2017).

A new ptyctodontid genus and species presented in this paper has been found in the Famennian Lebedyanian Regional Stage of the Zalegosch locality in the Zalegosch District, Orel Region, Central Devonian Field (Fig. 1). This locality is an abandoned quarry situated in the north part of the Zalegosch settlement, on the left bank of Neruch River. The specimen of a new taxon collected by amateur and private collector Alexander Popov was found in the yellowish limestones with brachiopods. These beds belong to the Lebedyan Regional Stage correlating with

Citation: Ivanov, A. 2022. New ptyctodontid placoderm from the Famennian (Upper Devonian) of European Russia. Bio. Comm. 67(4): 247–252. https://doi.org/10.21638/spbu03.2022.401

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Manuscript Editor: Pavel Skutschas, Department of Vertebrate Zoology, Faculty of Biology, Saint Petersburg State University, Saint Petersburg, Russia

Received: July 8, 2022;

Revised: August 25, 2022;

Accepted: September 7, 2022.

Funding: The work was partly supported by the Russian Foundation for Basic Research, project No. 20-05-00445a.

Ethics statement: This paper does not contain any studies involving human participants or animals performed by any of the authors.

Competing interests: The authors have declared that no competing interests exist.

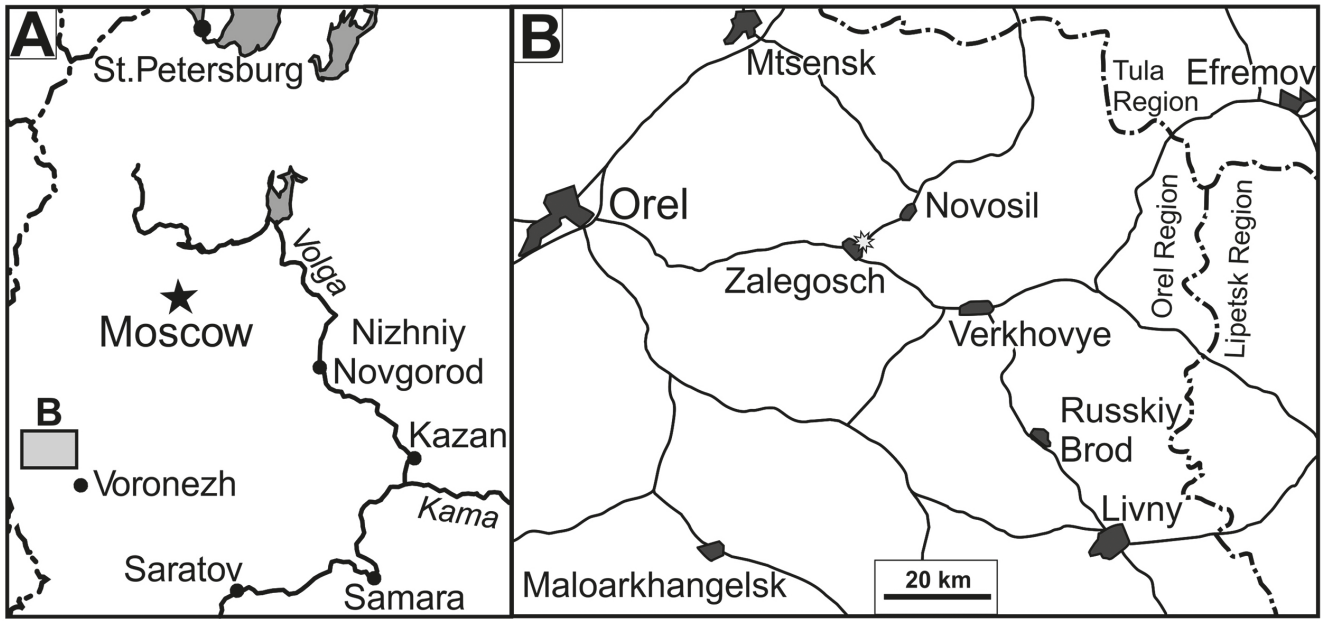

Fig. 1. Sketch-map showing the position of Famennian locality with new ptyctodontid (white asterisk).

the Upper *marginifera* — *trachytera* conodont Zones (Sobolev and Evdokimova, 2008). Apart from this specimen, placoderm plates and dipnoan tooth plates were also recorded from this locality.

Material and methods

The new taxon is represented by a small but perfectly preserved head shield with paired orbital and occipital ossifications of the endocranium. A micro-CT study of the specimen demonstrated that the dermal plates are undeformed with a thin vascular canal and endocranium ossifications.

The new ptyctodontid specimen was scanned using a Bruker-microCT SkyScan 1172 (Centre for X-ray Diffraction Studies of Research Park of — St. Petersburg State University) at 100 kV voltage and 100 μA current, with aluminium and copper filters for a half rotation of 180°. Images of virtual cross-sections were generated from 3D reconstructions by DataViewer, CTAn and CTvox software.

The described specimen is housed in the A. A. Borissiak Palaeontological Institute of the Russian Academy of Sciences, Moscow, Russia (PIN).

Anatomical abbreviations: art.fl — articular flange; c.nch — canal for the notochord; Ce — central plate; f.mag — foramen magnum of endocranium; glen — glenoid condyle of endocranium; Nu — nuchal plate; Occ.oss — occipital ossification of endocranium; Orb. oss — orbital ossification of endocranium; Pi — pineal plate; PNu — paranuchal plate; pp — posterior pitline; ppr — posterior process of the skull roof; PrO — preorbital plate; PtO — postorbital plate; sc — semicircular canals; soc — supraorbital sensory-line canal; suov — supraorbital vault.

Systematic palaeontology

Placodermi McCoy, 1848
Ptyctodontida Gross, 1932
Ptyctodontidae Woodward, 1891
Neruchella gen. nov.

Etymology — From Neruch River.
Type species — *Neruchella eichwaldi* sp. nov.
Diagnosis — As for the type and only known species.
Distribution — Famennian of Orel Region, Russia.

Neruchella eichwaldi sp. nov.
Fig. 2, 3A

Etymology — After E. Eichwald for his outstanding contribution to the study of ptyctodontids.
Holotype — PIN № 3725/1224, well-preserved head shield.
Type locality and horizon — Zalegosch, Neruch River, Orel Region, Russia; Lebedyanian Regional Stage, Famennian, Devonian.

Diagnosis — Small head shield with rounded shape in dorsal view; large, elongated pineal plate with triangular posterior margin; large preorbital plates with supraorbital sensory-line canal; lacking the nuchal plate; large central plates in mesial contact throughout the skull roof, bearing prominent posterior processes and containing the X-shaped connection of posterior pitlines and supraorbital canals; wide postorbital plates

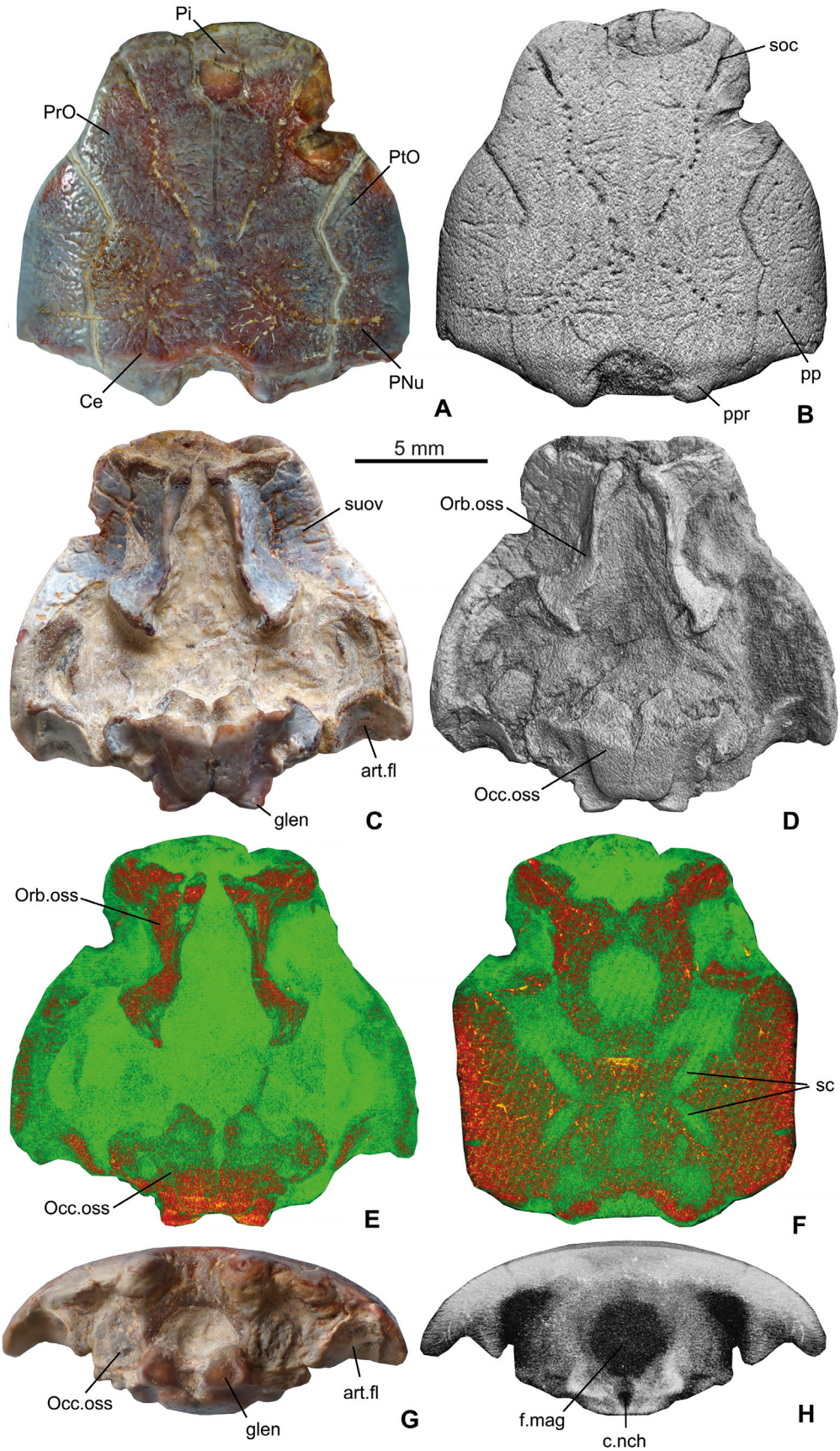

Fig. 2. *Neruchella eichwaldi* gen. et sp. nov, head shield, holotype, PIN № 3725/1224, Zalegosch, Neruch River, Orel Region, Russia; Lebedyanian Regional Stage, Famennian, Devonian. A, B, dorsal view; C, D, visceral view; G, posterior view; B, D–F, H, microtomographic images; F, virtual frontal cross-section; H, virtual transversal cross-sections. Abbreviation — see text.

with long, straight contacts with adjacent plates; short paranuchal plates with deep articular flange; massive endocranium ossifications densely articulated with dermal plates; long orbital ossifications close located anteriorly; short and wide occipital ossifications with round glenoid.

Description — The head shield is small, with almost equal length (16 mm) and width (17 mm); moderately arched; has a rounded outline in dorsal view; with slightly narrowed anterior preorbital part. The large and elongated pineal plate is located anteriorly and possesses a triangular posterior margin, wedged anteriorly between the preorbital plates. The preorbital plates are long and wide, bearing supraorbital sensory-line canals which are incurved in the central part of the plates. The preorbital plates possess wide supraorbital vaults with distinct ridges on the visceral surface. The preorbital and central plates are almost of the same size. The nuchal plate is absent and the central plates have a straight contact along midline of the head shield. The large central plates possess the prominent posterior processes, bearing the posterior pitline and posterior portion of the supraorbital canal. These canals form their X-shaped connection in the anterior portion of central plates, near the contact of preorbital and central plates (Fig. 2B, 3A). The sensory-line canals are recognized as a series of round large pores over a longer distance with sections of short grooves in places. The broad postorbital plates are a trapezoid shape in dorsal view, and have long, straight contacts with the preorbital and paranuchal plates. The paranuchal plates are quite short, bearing a deep articular flange. The middle part of the posterior margin of the head shield is strongly convex in dorsal view. The dermal plates are ornamented with tiny pits or meandering grooves.

The perfectly preserved paired ossifications of endocranium are massive, with extensive articulation of the dermal plates of skull roof (Fig. 2C–H). The orbital ossifications are elongated along the long axis of the head shield, also having an extended contact with the supraorbital vault (Fig. 2C, D). The anterior parts of those ossifications are located closely to each other but divergent from the midline of the head shield. The dense occipital ossifications are short and wide, closely contacting with each other, and possessing the round glenoid condyles and a large foramen magnum (Fig. 2D). The microtomography of the endocranium demonstrates the presence of anterior and posterior seimcir-

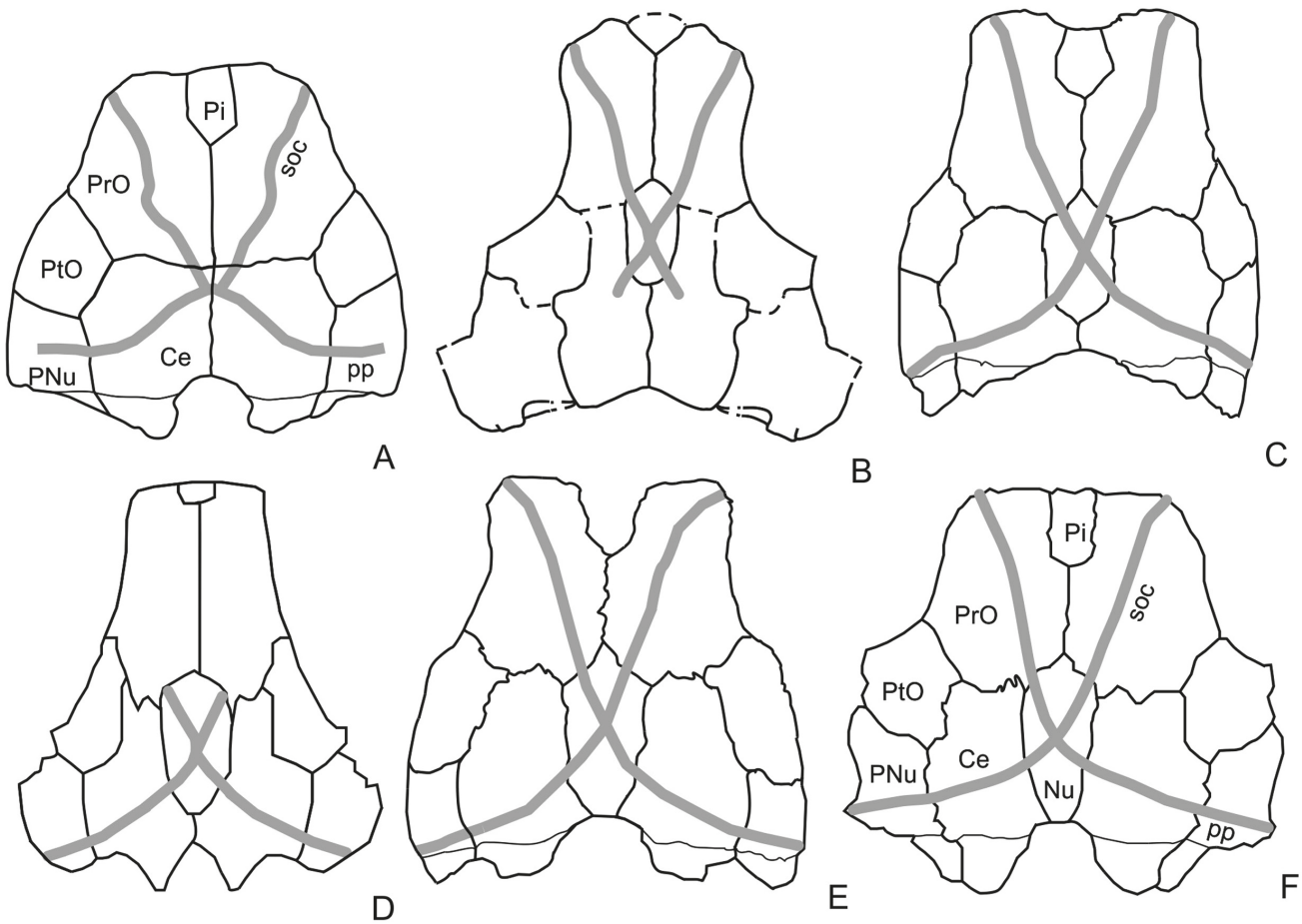

Fig. 3. Comparison in the reconstructed skull roofs of some ptyctodontids: A, *Neruchella* gen. nov.; B, *Denisonodus*; C, *Ctenurella*; D, *Ptyctodopsis*; E, *Kimbryandus*; F, *Meeksiella.* B, redrawing from Johnson and Elliott, 1996; C–F, modified from Trinajstic, Long, Ivanov, and Mark-Kurik, 2019.

cular canals (Fig. 2F), and a narrow canal for the notochord (Fig. 2H), but these will be described elsewhere in further detail once the CT data has been analysed in full.

Discussions

The head shield of *Neruchella eichwaldi* gen. et sp. nov. (Fig. 3A) possesses unique features, such as a skull missing the nuchal plate, a feature previously unknown among the ptyctodonts. The skull roof of *Neruchella* also differs from other ptyctodontids in the straight contact of central plates along the skull midline; in the position of X-shaped connection of sensory-line canals on that contact; in the large pineal and postorbital plates; short paranuchal plates. The head shield of *Meeksiella pskovensis* (Obruchev, 1947) is similar to that of the new taxon in the proportions of skull plates and the large pineal and postorbital plates, but differs in the presence of a long nuchal plate (Trinajstic, Long, Ivanov, and Mark-Kurik, 2019).

The head shields of the most known ptyctodontids such as *Austroptyctodus*, *Campbellodus*, *Desmoporella*, *Kimbryandus*, *Materpiscis*, *Meeksiella*, *Rhynchodus* (Fig. 3E, F) possess the same pattern with a long nuchal plate separating the central plates from each other, and with the X-shaped connection of sensory-line canals presented in the nuchal plate (Denison, 1978; Long 1997; Trinajstic et al., 2012; Trinajstic, Long, Ivanov, and Mark-Kurik, 2019). The central plates in the head shields of *Ctenurella* (Fig. 3C) and *Ptyctodopsis* (Fig. 3D) have a contact posteriorly with the nuchal plate (Denison, 1985; Long, 1997). The head shield of *Denisonodus plutonensis* Johnson et Elliott, 1996 (Fig. 3B) has a small nuchal plate in the middle part of the skull roof and a long contact with the central plates (Johnson and Elliott, 1996). Finally, the head shield of *Neruchella* has a unique mesial contact of the central plates along the entire skull midline without the nuchal plate, but the other skull plates resemble those of some other ptyctodontids.

The other Famennian ptyctodontid *Chelyophorus verneuili* Agassiz, 1844 is characterized by short and broad preorbital plates with a transversal pit line and supraorbital sensory-line canal; small pineal plate surrounded by preorbital plates anteriorly and posteriorly; and narrow central and paranuchal plates with posterior sensory-line canal; small, rounded postorbital plates; elongated marginal plates; and large paired orbital and occipital ossifications with well-developed glenoid condyles (Ivanov, 2020). The nuchal plate of *Chelyophorus* is unknown but it can be assumed from the suture outlines of adjacent plates that the nuchal plate was large and missing the sensory-line canals. These structure of the *Chelyophorus* head shield is easily distinguished from all other ptyctodontids including a new taxon. Thus, two completely different structures of head shields are observed in the Famennian ptyctodontids in the contrast with the general pattern of all other taxa.

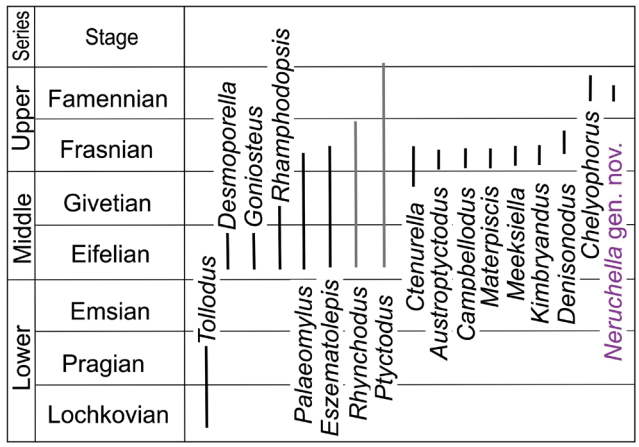

Fig. 4. Distribution of the ptyctodontid taxa in the Devonian. Grey line — verification required.

The oldest ptyctodontid, *Tollodus*, was reported from the Lochkovian — Pragian, Early Devonian (Mark-Kurik, 1977). The radiation of ptyctodontid taxa began in the Eifelian (Fig. 4). The diversity of ptyctodontid taxa has peaked in the Frasnian. There are now 11 genera known from the Early Frasnian. The number of taxa thus decreased in the Late Frasnian and by the Famennian only two ptyctodontid taxa existed.

Conclusions

The new genus and species, *Neruchella eichwaldi,* has been found in the Lebedyanian Regional Stage, Famennian, of the Zalegosch locality of the Orel Region, European Russia. The head shield of *Neruchella* possesses some unique features such as the complete contact of central plates with X-shaped connection of sensory-line canals and the missing nuchal plate. The Famennian ptyctodontids of the Orel Region include two taxa. The Famennian ptyctodonts demonstrate diversity in the morphology of head shield unknown in other taxa, and are considerably different from the general pattern of older species. The maximum ptyctodontid diversity is observed in the Early Frasnian.

Acknowledgments

The author is grateful to Alexander Popov (Moscow, Russia) for presenting the studying specimen; to John Long (Flinders University, Adelaide, Australia) for valuable comments and corrections of the text; to Sergey Nilov (Institute of Earth Sciences, St. Petersburg State University, St. Petersburg, Russia) for microtomographic sections and reconstruction; to Oleg Lebedev (Palaeontological Institute, Moscow, Russia) for the data on locality and stratigraphy, as well as to the anonymous reviewers for the useful comments.

This paper has been supported by the Kazan Federal University Strategic Academic Leadership Program (PRIORITY-2030). Scientific research was performed at the Centre

for X-ray Diffraction Studies and the Centre for Geo-Environmental Research and Modelling (GEOMODEL) of the Research Park of St. Petersburg State University.

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