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Original article

Middle Devonian conodonts of the Southern Verkhoyansk Region

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Abstract
Givetian conodonts demonstrate a wide geographical distribution and are instrumental in establishing biostratigraphic correlations at both regional and global levels. Nevertheless, their study in the Southern Verkhoyansk Region has only recently begun. I initially identified these conodonts in Tikhii Creek basin situated on the right bank of the first left tributary of Komar Creek, adjacent to the Vostochnaya Khandyga River, the Sette-Daban Range. In this area, the gypsum-bearing sediments of the Tikhiiskaya Suite underlie the carbonate Zagadochninskaya Suite. During a state-funded geological survey, these suites were classified as the Burkhalinskaya series. Geologists assigned the conglomerates at the base of the Tikhiiskaya Suite and the variegated sediments overlain by basalt to the Givetian Stage. This study suggests that the boundary between the Lower and Middle Devonian periods should be delineated at the base of the conglomerate strata, while the variegated volcanic strata capped by basalt should be classified within the Emsian Stage of the Lower Devonian. The findings related to five taxa of conodonts, which belong to two successive complexes originating from the boundary deposits of the Eifelian and Givetian Stages found along Komar Creek, are reported for the first time. The lower complex, distinguished by the presence of conodonts such as *Dvorakia* sp., *Icriodus expansus* Branson and Mehl (1938), *Polygnathus parawebbi* Chatterton (1974), *P. costatus* subspecies A, *P. parawebbi*, and *Neopanderodus pearleneatus* (Ziegler and Lindström 1971), is identified within the Upper Eiffelian Stage. Conversely, the upper complex, which includes subspecies *Polygnathus linguiformis linguiformis* Hinde (1879) and P. *xylus xylus* Stauffer (1940), is indicative of the Givetian Stage. The boundary between the Eiffelian and Givetian Stages in the Tikhii-Komar section is likely situated between beds 5 and 6. Consequently, based on the conodont data, the Tikhiiskaya Suite should be classified as Eiffelian in age. Presumably, the basal layers of the Zagadochninskaya Suite correspond to this same geological stage.
Keywords: conodonts, Upper Eifelian, Lower Givetian, Zagadochninskaya Suite, South Verkhoyansk Region
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Оригинальная статья

Среднедевонские конодонты Южно-Верхоянского региона

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Аннотация
Живетские конодонты обладают очень широким географическим распространением и используются при создании биостратиграфической основы для региональной и глобальной корреляций. В Южном Верхоянье они практически не изучались. Живетские конодонты впервые обнаружены в бассейне руч. Тихий на правом бере-

гу первого левого притока руч. Комар (правобережье р. Восточная Хандыга, хребет Сетте-Дабан). Здесь, на гипсоносных отложениях тихийской свиты согласно залегает карбонатная загадочнинская свита. При государственной среднемасштабной геологической съемке эти свиты картировались под названием бурхалинская серия. Конгломераты, залегающие в основании тихийской свиты, а также пестроцветные отложения базальтового покрова относились геологами-съемщиками к живетскому ярусу. Наши исследования показали, что границу между нижним и средним девоном следует проводить по подошве толщи конгломератов, а пестроцветную вулканогенную толщу с базальтовым покровом следует относить к эмсскому ярусу нижнего девона. В данной статье из пограничных отложений эйфеля и живета по ручью Комар впервые описаны пять таксонов конодонтов, относящиеся к двум последовательным комплексам. Нижний комплекс, характеризующийся конодонтами *Dvorakia* sp., *Icriodus expansus* Branson and Mehl, 1938, *Polygnathus parawebbi* Chatterton, 1974, *P. costatus subsp*. A., *P. parawebbi* Chatterton, 1974 и *Neopanderodus perleneatus* (Ziegler et Lindström, 1971), известен в верхнем эйфеле. Верхний комплекс, представленный подвидами *Polygnathus linguiformis linguiformis* Hinde, 1879 и *P. xylus xylus* Stauffer, 1940, характерен для живетского яруса. Граница между эйфельским и живетским ярусами в разрезе Тихий–Комар, вероятно, проходит между пачками 5 и 6. Таким образом, возраст тихийской свиты по конодонтам следует считать эйфельским. По всей видимости, к этому же ярусу относятся базальные слои загадочнинской свиты.

Ключевые слова: конодонты, верхний эйфель, нижний живет, загадочнинская свита, Южно-Верхоянский регион
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Introduction

The Middle Devonian conodonts exhibited a broad distribution across the marine paleobasin shelves in various regions of the Earth. A zonal conodont sequence has been established based on the identification of conodont complexes. Within the boundary interval separating the Eifelian and Givetian stages, the following conodont zones are currently recognized: *australis, kockelianus, eiflius, ensensis* (Upper Eifelian), *hemiansatus*, and *timorensis* (Lower Givetian) [1, 2]. A comprehensive section of the Middle Devonian "Tikhii-Komar" has been identified in the Southern Verkhoyansk Region, where conodonts, in conjunction with brachiopods and tabulatomorphic corals, have been documented. This section is situated in the northern area of the Sette-Daban Ridge, along the right bank of the Vostochnaya Khandyga River, adjacent to Tikhii Creek (Fig. 1 and 2). A detailed layer-by-layer account of this section has been presented by V.V. Baranov [3], while descriptions of certain Givetian brachiopod species have been disseminated in two separate publications [4, 5]. The subsequent analysis examines the conodont assemblages identified within the specified section.

Materials and Methods

The data presented herein was obtained from the Southern Verkhoyansk Region, specifically from the Tikhii-Komar section [3], situated along the right bank of Komar Creek, which serves as the first left tributary of Tikhii Creek, a right tributary of the Vostochnaya Khandyga River (see Figs. 1 and 2). The dissolution of limestone samples was carried out utilizing a 7 % acetic acid solution. Following this, conodont elements were isolated from the sediment using bromoform. In total, approximately 250 kg of carbonate rock samples were processed, resulting in the recovery of 20 conodont elements.

The collection of conodonts is housed at the Diamond and Precious Metals Geology Institute of the Siberian Branch of the Russian Academy of Sciences (DPMGI) under catalog number 253.

Results and discussion

In previous work, the author established the boundary between the Eifelian and Givetian stages at the base of the basal conglomerate pack within the Tikhiiskaya Suite [3]. This classification was derived from indirect evidence, specifically the initiation of the global Givetian transgression, which was thought to be represented across all sections in northern Asia by a basal conglomerate layer. Above this conglomerate, lagoonal deposits containing gypsum and anhydrite inclusions were observed, although no faunal remains were present. A comparable scenario is evident in the "Tikhii-Komar" section, where conglomerates are succeeded by a layer rich in gypsum. Notably, the first conodonts are recorded at a depth of 69 meters from the base of the Tikhiiskaya Suite, represented by *Coelocerodontus* sp., *Dvora-*

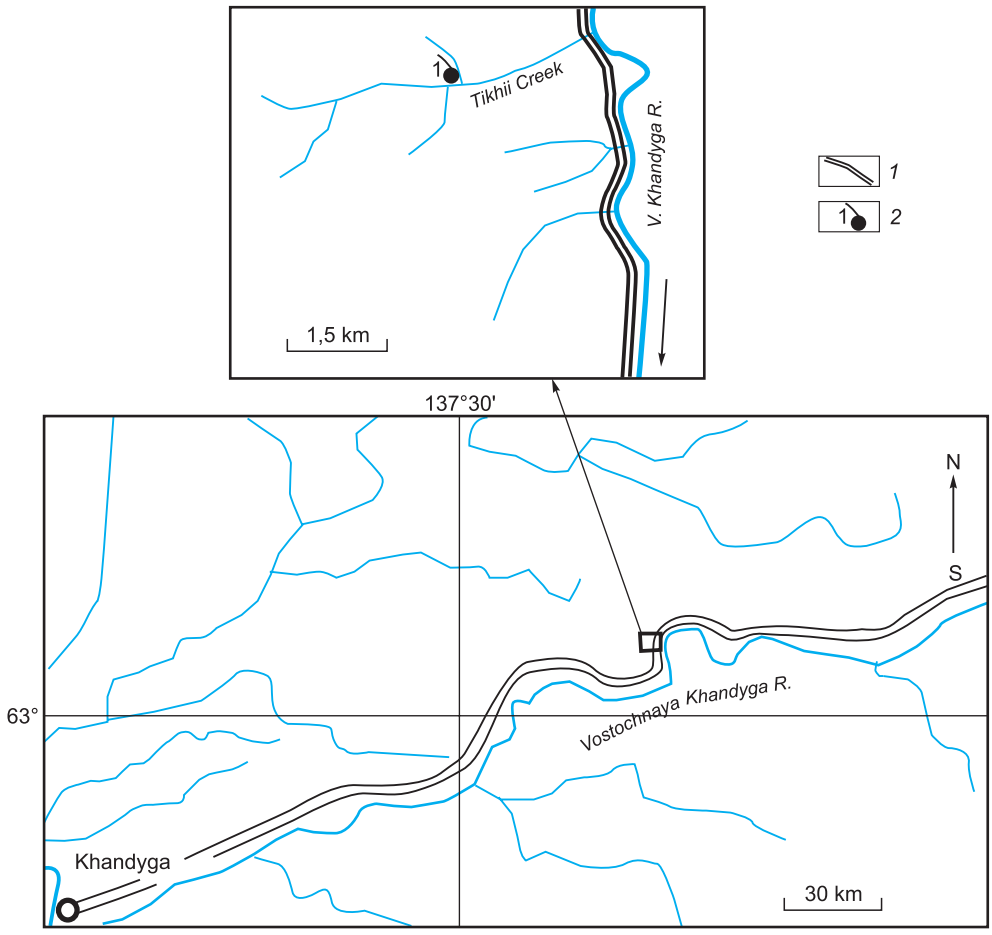

Fig. 1. Location of the Tikhii-Komar section: *1* – Kolyma road, *2* – section.

Рис. 1. Местонахождение разреза Тихий-Комар, из которого описываются конодонты: *1* – автотрасса «Колыма», *2* – разрез

kia sp., *Icriodus expansus* Branson et Mehl, 1938, *Neopanderodus perleneatus* (Ziegler et Lindström, 1971), *Polygnathus parawebbi* Chatterton, 1974, and *P. costatus* subsp. A. Notably, the latest finds of *Neopanderodus perleneatus* were discovered in the Eifelian deposits of Turkey [6]. *Icriodus expansus* and *Polygnathus parawebbi* first appear in the Eifelian and extend into the overlying sediments [7]. The conodont assemblage of unit 5 is indicative of a transitional Late Eifelian-Early Givetian age. The overlying unit 6 contains no conodonts but features a representative assemblage of brachiopods: *Striatoproductella tungusensis* Krylova, 1962, *Davoustia verkhojanica* Baranov, 2007, *Emanuella takwanensis* (Kayser, 1883), *Ambocoelia ectypa* Baranov and Alkhovik, 2006, *Echinocoelia tikhiensis* Baranov and Alkhovik, 2006, and *Ladjia sitta* Baranov and Alkhovik, 2006. The stratigraphic range of *S. tungusensis* and *E. takwanensis* is limited to the Early Givetian. Therefore, the upper boundary of the Eifelian in this section can presumably be drawn at the base of unit 6.

Systematic paleontology

Order Conodontophorida Eichenberg, 1930

Family Belodellidae
Khodalevich and Chernyak, 1973

Genus *Dvorakia* Klapper & Barrick, 1983

***Dvorakia* sp.**

Plate I, figure 12

Description: The Sb element, thin, smoothly curved. It features small anterior and posterior, symmetrical keels, with the anterior part being lens-shaped in cross-section. The surface of the element is adorned with longitudinal ribs.

Remarks: *Dvorakia* sp. exhibits a structure similar to the Sb element of D. *chattertoni* Klapper and Barrick [8], p. 1227, fig. 8, O and D. *klapperi* (Chatterton, 1974) [8], p. 1229, fig. F) from the Hume

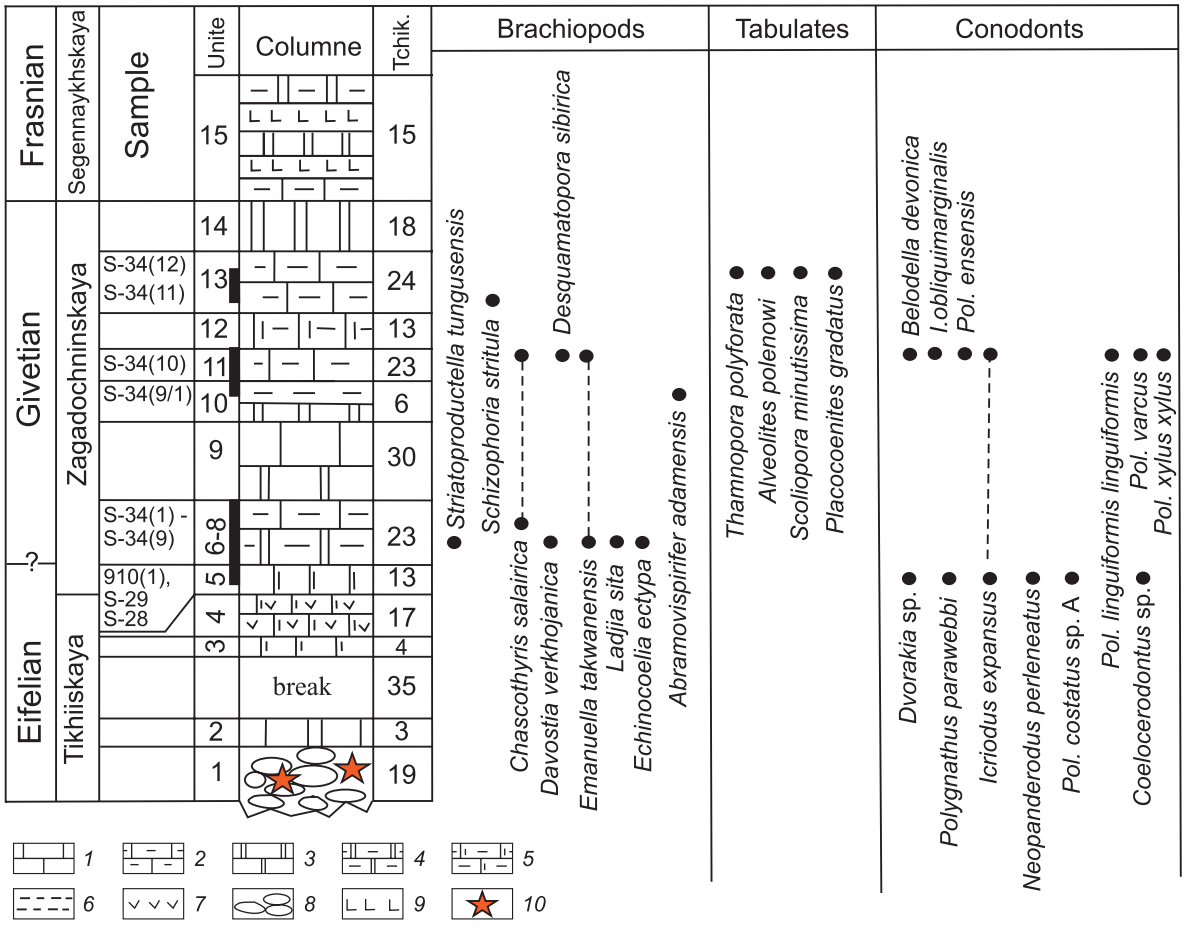

Fig. 2. Distribution of brachiopods, tabulates, and conodonts in the Tikhii-Komar section: *1* – limestone, *2* – clayey limestone, *3* – dolomite, *4* – clayey dolomite, *5* – dolomitized silty, *6* – shales, *7* – gipsium, *8* – conglomerates, *9* – basalts, *10* – reddish gray cement.

Рис. 2. Распределение брахиопод, табулят и конодонтов в разрезе Тихий-Комар: *1* – известняк, *2* – глинистый известняк, *3* – доломит, *4* –доломит глинистый, *5* – доломит алевритистый, *6* – сланцы, *7* – гипсы, *8* – конгломераты, *9* – базальты, *10* – красноцветный цемент

Formation (late Eifelian, kockelianus and ensensis zones) in central Mackenzie Valley, western Northwest Territories of Canada.

Occurrence: Middle Devonian, Late Eifelian to Early Givetian, kockelianus to Lower Varcus zones; cosmopolitan.

Material: 1 Sb element from lower part of the Tikhiiskaya Suite, sample S-28.

Family Icriodontidae Muller and Miller, 1957

Genus *Icriodus* Branson and Mehl, 1938

***Icriodus expansus* Branson and Mehl, 1938**

Plate I, figures 1–6

Icriodus expansus: [9], p. 448; Uyeno, [10], p. 396, pl. 2, figs 20, 21.

Description: I element, when viewed from above, has an oval-triangular shape with a rounded posterior end and a pointed anterior end. In lateral profile, it is slightly convex in the middle. The denticles are uniform in size; the middle ones are characterized by an oval shape in the transverse plane, while the lateral ones are transversely elongated, often with pointed apices. The last pair of denticles is usually bent backward at a slight angle relative to the axial ridge. Occasionally, they merge with the median denticles, forming transverse rows. The number of lateral denticle pairs ranges from 4 to 5. The main tooth is poorly developed. The basal cavity is wide, asymmetrical, and open, occupying the entire basal part of the platform and extending beyond its limits in the posterior region. An oval lateral lobe is developed on the inner side.

Remarks: It differs from *Icriodus expansus* Branson and Mehl, found in the Hume Formation (late

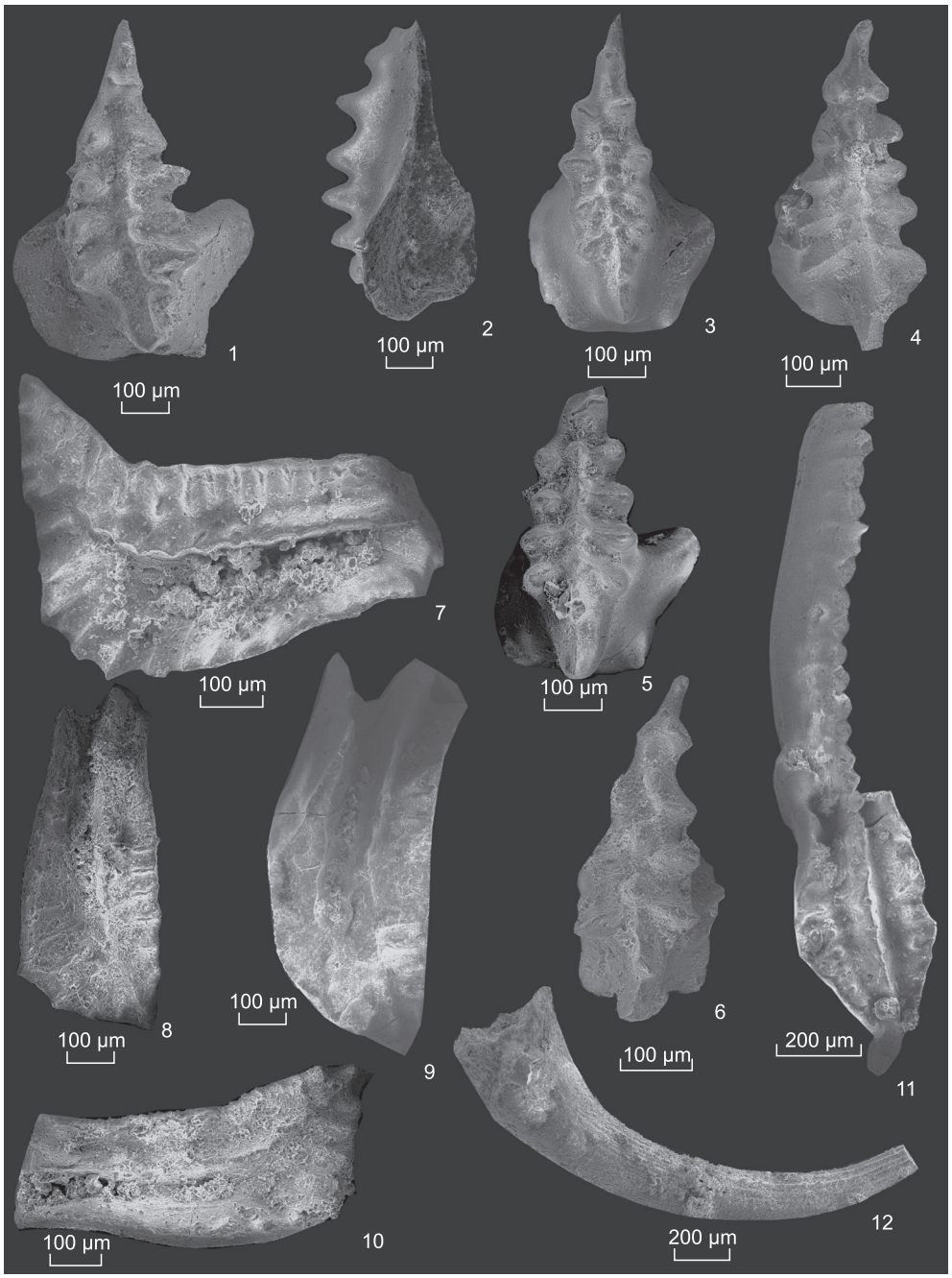

Plate I. Givetian conodonts of the South Verkhoyansk Region: 1–6 – *Icriodus expansus* (Branson and Mehl, 1938), P_1 elements, upper views: 1 – DPMGI 1/253, sample S-28(2), 2 – DPMGI 2/253, sample S-28(2), 3 – DPMGI 3/253, sample S-28(2), 4 – DPMGI 4/253, sample S-28(2), 4 – DPMGI 4/253, sample S-28(2), 5 – DPMGI 5/253, sample S-28(2), 6 – DPMGI 6/253, sample S-28(2); 7 – *Polygnathus linguiformis linguiformis* Hinde, 1879, P_1 element, upper view, DPMGI 7/253, sample S-29; 8–10 – *Polygnathus parawebbi* Chatterton 1974, P_1 elements, upper views: 8 – DPMGI 8/253, sample S-29, 9 – DPMGI 9/253, sample S-28(2), 10 – DPMGI 9/253, sample S-28(2); 11 – *Polygnathus xylus xylus* Stauffer, 1940, P_1 element, upper view, DPMGI 11/253, sample S-34(10); 12 – *Dvorakia* sp., Sb element, outer view, DPMGI 12/253, S-28(2). Sette-Daban Ridge, Tikhii Creek Basin, right side of Komar Creek, Givetian Stage, Zagadochninskya Suite (Zagadochnyi Formation)

Таблица 1. Живетские конодонты Южного Верхоянья: 1–6 – *Icriodus expansus* (Branson and Mehl, 1938), P_1 элементы, вид сверху, обр. S-28(2): 1 – ИГАБМ 1/253, 2 – ИГАБМ 2/253, 3 – ИГАБМ 3/253, 4 – ИГАБМ 4/253, 4 – ИГАБМ 4/253, 5 – ИГАБМ 5/253, 6 – ИГАБМ 6/253; 7 – *Polygnathus linguiformis linguiformis* Hinde, 1879, P_1 элемент, вид сверху, ИГАБМ 7/253, обр. S-29; 8–10 – *Polygnathus parawebbi* Chatterton, 1974, P_1 элементы, вид сверху: 8 – ИГАБМ 8/253, обр. S-29, 9 – ИГАБМ 9/253, обр. S-28(2), 10 – ИГАБМ 9/253, обр. S-28(2); 11 – *Polygnathus xylus xylus* Stauffer, 1940, P_1 элемент, вид сверху, ИГАБМ 11/253, обр. S-34(10); 12 – *Dvorakia* sp., Sb элемент, внешний вид, ИГАБМ 13/253, обр. 12/253, S-28(2). Сетте-Дабан, басс. руч. Тихий, правый борт ручья Комар, живетский ярус, загадочнинская свита

Eifelian, kockelianus and ensensis zones) in central Mackenzie Valley, western Northwest Territories of Canada ([11], p. 402, pl. 2, figs. 20, 21), by having a smaller number of denticles and the merging of the lateral and median denticles into transverse rows. It is practically indistinguishable from the species *I.* sp. nov. described by Narkiewicz, Bultynck, and Narkiewicz ([11], p. 396, pl. 2, figs. 22, 23) from the same formation. In contrast to *I. retrodepressus* ([12], p. 110–111; [13], p. 291; 8), it differs from the Couvinian of Ardennes due to the greater separation of the median and lateral denticles.

Occurrence: Middle Devonian, Late Eifelian to Early Givetian, kockelianus to Lower Varcus zones; cosmopolitan.

Material: 6 Pa elements from the lower part of the Zagadochninskaya Suite, samples S-28 and S-34(10).

***Polygnathus xylus xylus* Stauffer, 1940**

Plate 1, figure 10

Polygnathus xylus: [12], p. 430, pl. 60, figs. 54, 66, 72–74 (not figs. 42, 50, 65, 67, 69, 78, 79 = *Polygnathus* sp. indet.); [13], pl. 3, fig. 4; [14], pl. 1, figs. 1–6, 9; pl. 6, fig. 6; pl. 8, fig. 3 (only); pl. 9, fig. 6; pl. 10, figs. 1 and 2; [15], p. 48, pl. 1, figs. 5–7, 11; [16], p. 1158, pl. 17, figs. 1–7; [17], pl. 1, fig. 10. *Polygnathus xylus xylus*: [18], p. 125, pl. 3, fig. 1; [19], pl. 1, fig. 25; [20], pl. 2, fig. 2.

Description: Pa element is lanceolate in shape, elongated with a slightly narrowed rear part of the platform. The lateral margins are subparallel and raised in the posterior part above the median ridge, which is formed by fused denticles. The straight median ridge extends to the end of the platform and bends sharply downward. The free blade is toothed, and its length exceeds that of the platform. The troughs are deep and sharply sloping downward at the rear. The sculpture features thin transverse ridges and nodes, which are weakly defined at the edges of the platform. The majority of the platform is smooth.

Remarks: *Polygnathus xylus xylus* can be distinguished from the similar *P. ansatus* Ziegler and Klapper, 1976, by its longer free blade and a greater number of denticles (15 versus 10) on a free sheet. Additionally, it features distinct nodes on the middle ridge and edges of the platform, as well as a curved rear end.

Occurrence: Middle Devonian, Late Eifelian to Lower Frasnian, kockelianus – Ancyrodella rotundiloba zones; cosmopolitan.

Material: 2 Pa elements from the middle part of the Zagadochnskaya Suite, sample S-34(10).

***Polygnathus linguiformis linguiformis* Hinde, 1879**

Plate 1, figure **7**

Polygnathus linguiformis [21], p. 367, pl. 17, fig. 15. *Polygnathus linguiformis linguiformis* Hinde: [22], p. 162, pl. 12, figs. 2, 3, 20; pl. 14, figs. 12, 13. [23], p. 10, fig. 3, C–D. [24], p. 14–15, pl. 3, figs. 1–6.

Description: Pa element *Polygnathus linguiformis linguiformis* Hinde is characterized by a wide, asymmetrical platform that expands posteriorly and is strongly curved in the posterior part and with deep adcarinal grooves. The lateral margins of the platform and the short tongue are adorned with transverse ridges. The basal cavity has not been studied.

Remarks: *Polygnathus linguiformis linguiformis* Hinde is characterized by significant morphological variability in the external structure of its platform. [25] identified four morphotypes of *P. l. linguiformis*: delta, epsilon, eta, and zeta morphotypes. [26] also recognized these morphotypes. Subsequently, [24] designated them using a combination of letters and numbers: γ1a, γ1b, γ2, and γ3. In the northern Appalachian Basin, these morphotypes are predominantly found in the Eifelian–Early Givetian (Hamilton Group) [14].

Occurrence: Middle Devonian, Late Eifelian to Early Givetian, kockelianus to Lower varcus zones; cosmopolitan.

Material: 6 Pa elements from the lower part of the Tikhiiskaya Suite, sample S-28.

***Polygnathus parawebbi* Chatterton, 1974**

Plate 1, figures 8–10

Polygnathus parawebbi [27], p. 1473–1478, pl. 1, figs.12, 15–19, 25–27; pl. 2, figs. 1–9. [7], p. 111, pl. 2, figs. 12–13. [28], p. 129–130, pl. 11, figs. 1–15; pl. 12, figs. 1–19; pl. 13, figs. 1, 2. [29], p. 170–171, pl. 1, fig. 11. [10], p. 396, pl. 2, figs 20, 21.

Description: Pa element *Polygnathus parawebbi* Chatterton features a long, asymmetrical, and weakly curved platform characterized by deep adcarinal grooves and subparallel lateral margins. The lateral margins of the platform are adorned with transverse ridges, while the tongue is marked by semicrossed transverse ridges.

Remarks: Chatterton [27] described two morphotypes of the Pa element of *Polygnathus parawebbi*: the alpha morphotype and the beta morphotype. In the Zagadochninskaya Suite of the Sette-Daban Ridge, a transitional form between the alpha and beta morphotypes was encountered. *Po. parawebbi* occurs within the costatus Zone and extends

into the australis Zone (Middle Eifelian) in the lower part of the ridge section Deserters Formation of the Road River Group, located in northeastern British Columbia [7].

Occurrence: Middle Devonian, Middle Eifelian to Early Givetian, costatus to Lower varcus zones; cosmopolitan.

Material: 5 Pa elements from the lower part of the Tikhiiskaya Suite, sample S-28(2).

Conclusion

The biostratigraphic distribution of conodonts, in conjunction with brachiopods and tabulates, has elucidated the location of the Eifelian-Givetian boundary within one of the most comprehensive and well-defined faunal sections in the Southern Verkhoyansk Region, particularly along the Vostochnaya Khandyga River in proximity to Tikhii Creek. The identification of cosmopolitan species within the assemblages of conodonts, brachiopods, and tabulates indicates the presence of extensive biogeographical linkages between the marine basins of the Boreal and Tethyan superregions.

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Conflict of interest

The author declares no conflict of interest.

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