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The Succession of Frasnian Conodont Assemblages in the Type Sections of the Southern Timan-Pechora Province (Russia)

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ABSTRACT – A succession of 11 conodont assemblages, covering the entire interval of the Frasnian Stage, Upper Devonian, is established according to reference sections of Southern Timan (northeastern East European Platform). The conodont assemblages are correlated with the regional stages. The Lower Frasnian assemblages characterize shallow-water lithofacies and are based on the evolution of *Ancyrodella* and *Polygnathus*. The Middle and Upper Frasnian assemblages are established in the sections of slope and basinal lithofacies, with *palmatolepids* prevailing. The levels of the greatest changes of conodont assemblages are determined. Problems, arising in correlating the Timan-Pechora succession with the Standard Frasnian conodont Zonation, as well as with the Montagne Noire zonation, are discussed.

RIASSUNTO – [La successione delle associazioni a conodonti frasniani nelle sezioni tipo della parte meridionale della Provincia del Timan-Pechora (Russia)] – Nelle sezioni di riferimento del Timan meridionale (parte nord-orientale della Piattaforma dell'Est europeo) viene individuata una successione di undici associazioni a conodonti, che coprono l'intero Frasniano, Devoniano superiore. Tali associazioni sono correlate con le unità cronostatigrafiche regionali. Le associazioni del Frasniano inferiore sono tipiche di ambienti di acqua bassa e sono basate sull'evoluzione dei generi *Ancyrodella* e *Polygnathus*. Le associazioni del Frasniano medio e superiore sono invece di ambiente di scarpata o di bacino, con una prevalenza di *palmatolepidi*. Sono stati individuati i livelli corrispondenti alle maggiori variazioni nelle associazioni a conodonti. Vengono discussi i problemi legati al tentativo di correlare la successione del Timan-Pechora con la Biozonatura Standard del Frasniano e con la biozonatura della Montagne Noire.

INTRODUCTION

The Timan-Pechora (TP) Basin occupies the northeastern margin of the East European Platform. It is located between the Timan Ridge and the Urals. Various Frasnian lithofacies are developed here: terrigenous and carbonate-clay deposits of shallow-water shelf, reefs, banks, sediments of deeper intra – shelf basins – bituminous thin-bedded carbonate and siliceous-carbonate rocks of “domanikoid” type, clay and carbonate sequences of shallow shelf lateral growth. The Frasnian conodont assemblages are represented by shallow-water – polygnathid – and deep-water (slope and depression facies) – *palmatolepid* – biofacies. The standard Frasnian conodont zonation (Ziegler, 1962, 1971) has been used in the region (Ovnatanova, 1978; Ovnatanova & Kononova, 1984; Khalymbadzha, 1981; Ovnatanova & Kuzmin, 1991; Menner *et al.*, 1992, Khrushcheva & Kuzmin, 1996) for a long time, with inconsiderable changes in the lower Frasnian, where the local zones, *Ancyrodella rotundiloba* (= Lower *asymmetrica*) and *Polygnathus timanicus* (= Middle + Upper *asymmetrica*), were established. Those, who use the revised version of the zonation (Ziegler & Sandberg, 1991), encounter difficulties that are due to the peculiarities of facies of the section in the lower Frasnian Stage, as well as to the diagnosis and range of the zonal species, *Palmatolepis hassi* Muller & Muller, *Pa. jamieae* Ziegler & Sandberg. Direct correlation of Timan –

Pechora conodont assemblages with the standard Frasnian Zonation was not always possible. It was necessary to develop a detailed stratigraphic succession of local Frasnian conodont assemblages, assigned to the regional stratigraphic chart, and to correlate these with the current zonal scales. This paper deals with the stratigraphic succession of conodont assemblages in sections of mostly deep-water deposits (*Palmatolepis* biofacies), except for the lowermost beds of the Frasnian Stage, where it is represented only by the polygnathid biofacies. To study this, the sections of boreholes (1003, 1B, 3B, 2023, 2068) and outcrops (in the Ukhta, Yarega, Chut', Domanik, Lyaiol, and Vezha-Vozh rivers) in the Ukhta Region, Southern Timan, were chosen (Text-fig. 1). These include the stratotypes of most of the Timan Frasnian regional stages. Considerable parts of the sections are composed of basinal (domanikoid) facies rocks with rich conodont assemblages. The uppermost Frasnian Stage is represented all over the Ukhta region by shallow-water sulphate-clay-carbonate deposits with scarce conodonts (*Polygnathus* biofacies). To characterize the succession of conodont assemblages in this interval, the data on conodonts from slope and basinal facies deposits, exposed in boreholes of the adjacent Tebuk-Viss Region, which is situated 60 km northeast of the town of Ukhta, were used.

Thus, a succession of conodont assemblages, covering the entire Frasnian Stage (TP-I-XI), correlated

with local and regional units of the TP Basin, was developed. We consider this a preliminary stage in the development of a local conodont zonation. Moreover, an attempt was made to preliminarily correlate the local assemblages with the standard Frasnian zonations: former (Ziegler, 1962, 1971) and revised (Ziegler & Sandberg, 1990), and with the Montagne Noire zonations (Klapper, 1989; Klapper & Foster, 1993).

STRATIGRAPHIC SETTING

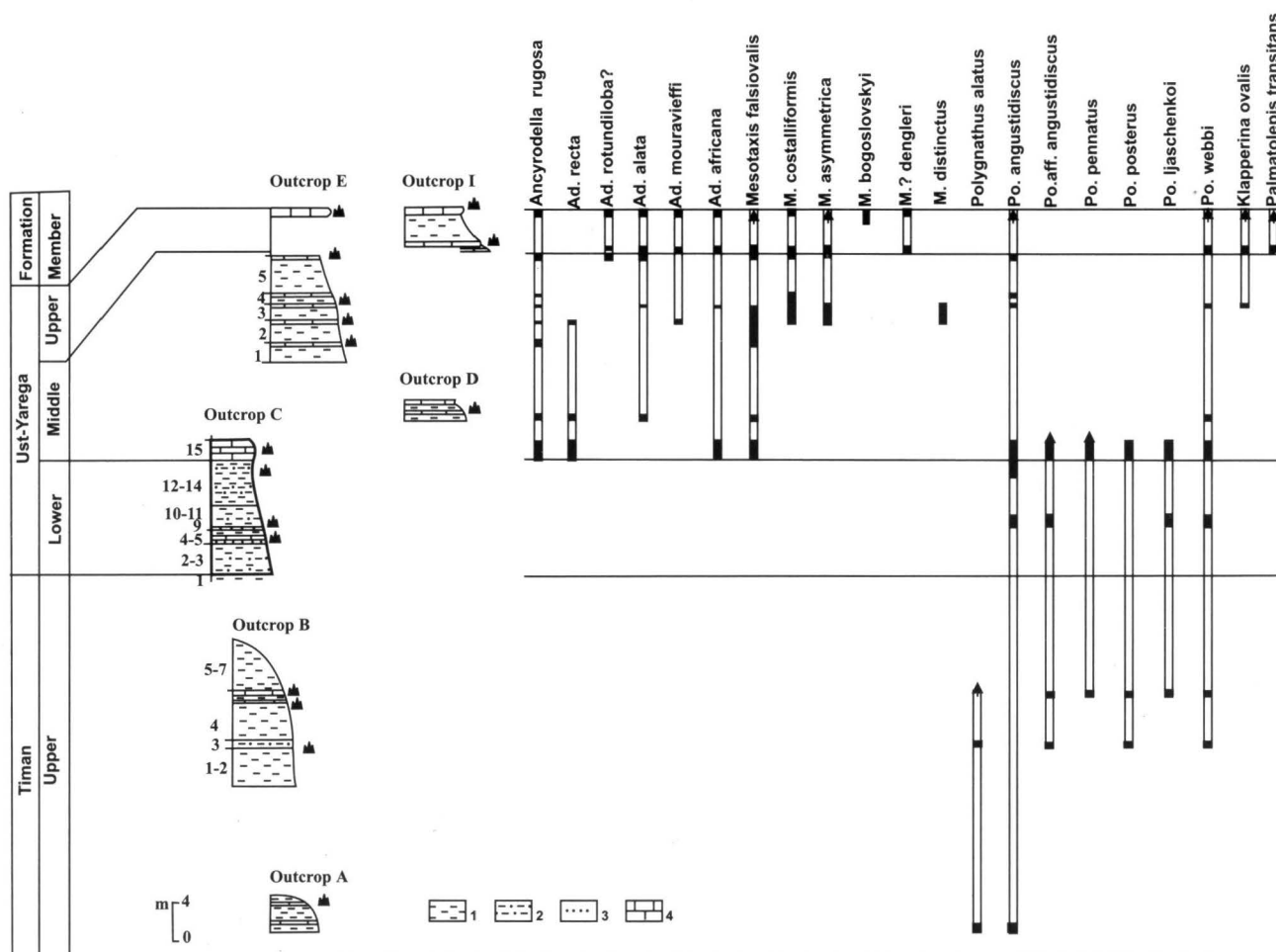
The Frasnian stratigraphy of Southern Timan is discussed in a number of publications (Lyashenko, 1956; Fokin, 1977; Kushnareva & Raskatova, 1980; Khalymbadzha, 1981; Menner *et al.*, 1992; Ovnatanova, 1978; Ovnatanova & Kuzmin, 1991; Kuzmin, 1995, 1998; Kuzmin & Ovnatanova, 1989). Several most important Frasnian outcrops of the Ukhta Frasnian deposits are described in the Guide (Yudina & Moskalenko, 1997). Their correlation with the

sections studied in this paper, is shown in the legend to Text-fig. 1.

Seven regional stages are distinguished in the TP Frasnian deposits (upwards): Timanian, Sargaevian, Domanikian, Vetlasyanian, Sirachoyian, Evlanovian, and Livnyian. In the shallow-water facies sections, the Sargaevian Regional Stage is correlated with the Ust'-Yarega Formation, the Evlanovian and Livnyian Regional Stages – with the Ukhta Formation. In the slope and basinal facies deposits, the Vetlasyanian, Sirachoyian, and lower Evlanovian Regional Stages are correlated with the Lyaol Formation, the middle Evlanovian stage – with the Sed'yu Formation.

CONODONT FAUNA

The Timan and Ust'-Yarega Formations (Timanian and Sargaevian Regional Stages) in the Ukhta Region are composed of the shallow-water facies deposits – siltstone and clay with rare limestone beds, containing



Text-fig. 2 - Distribution of key Conodont species in the Timan and Ust-Yarega Formation sections.
Legend: 1 - clay; 2 - siltstone; 3 - sandstone; 4 - limestone.

brachiopods, ostracodes, and conodonts (Text-fig. 2). The Timan Formation (up to 150 m thick) is subdivided into two members: lower (up to 60 m) and upper (up to 90 m). We draw the boundary between the Timan and Ust'-Yarega formations at the base of bed 2 in outcrop C (Text-fig. 2). The Ust'-Yarega Formation is subdivided into three units: lower (15 m), middle (20 m) and upper (5 m). The TP-0 conodont assemblage is defined at the top of the Lower Timan member (borehole 1-B, depth 239.5-241 m). This contains only *Polygnathus xylus* Stauffer and *Po. alatus* Huddle. The assemblage is assigned to the Givetian time according to the location of the section and the absence of typical Frasnian forms.

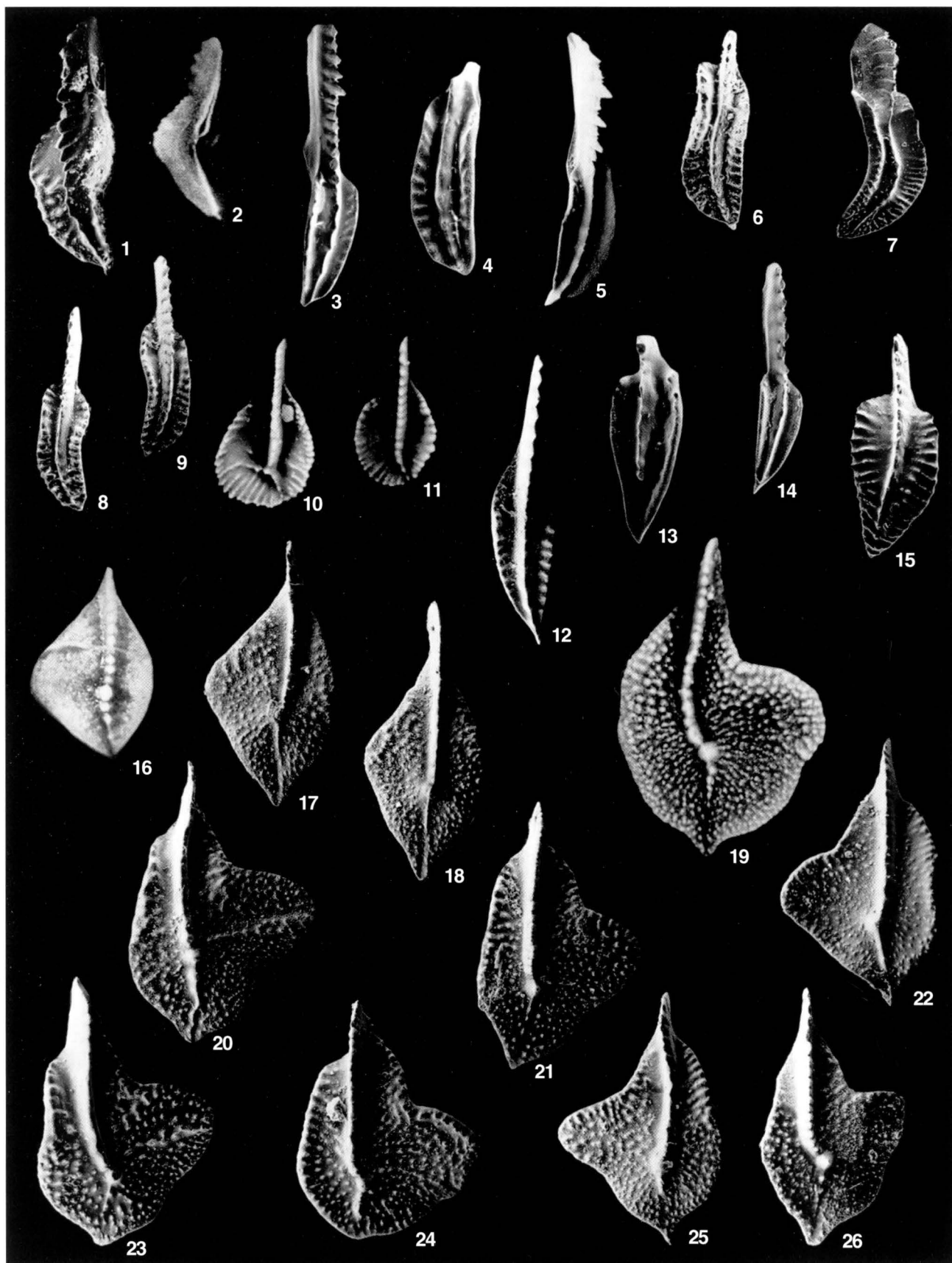
The TP-I assemblage is reported from the Upper Timan and the lowermost Ust'-Yarega formations (Text-fig. 2, outcrops A, B and the lowermost outcrop C). It contains numerous late Givetian - Frasnian

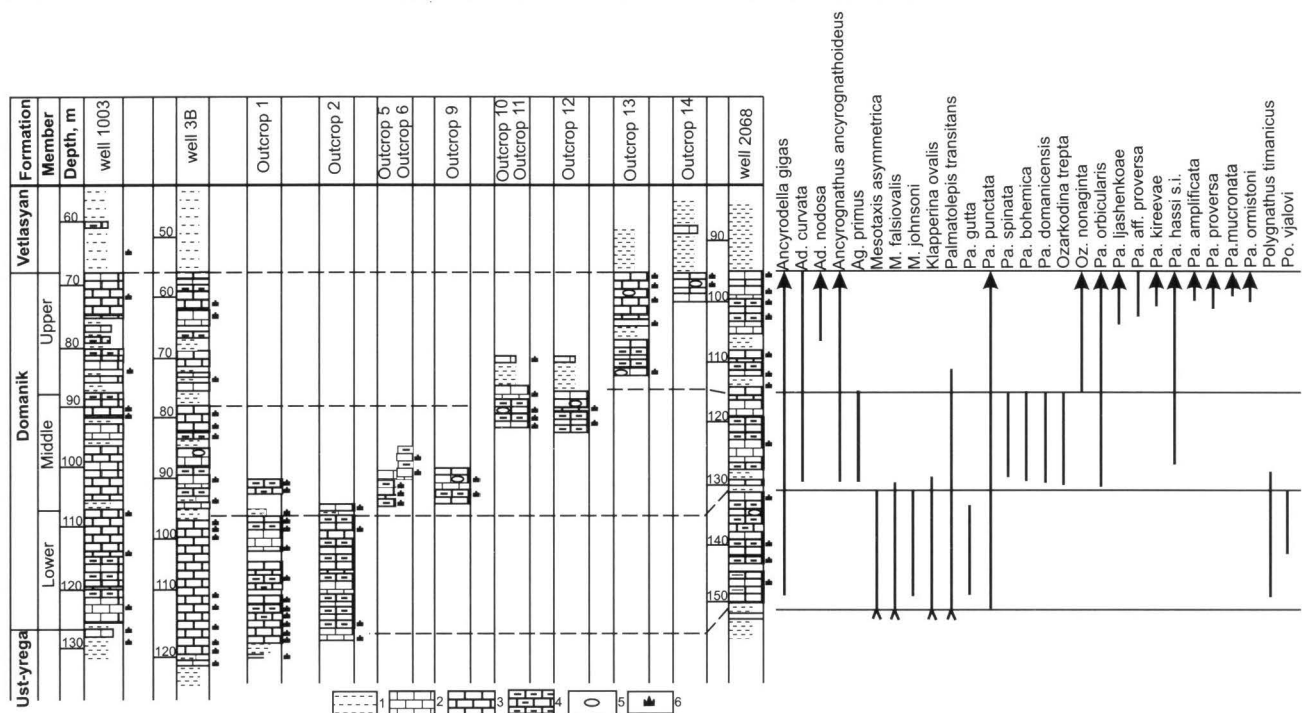
polygnathids, including *Polygnathus xylus* Stauffer, *Po. webbi* Stauffer, *Po. angustidiscus* Youngquist, *Po. aff. angustidiscus* sensu Klapper & Lane, 1985; *Po. pennatus* Hinde, and in the upper part of the interval – *Po. posterus* Kuzmin and *Po. ljaschenkoi* Kuzmin appear. The lower boundary of the Frasnian Stage is drawn approximately, conditionally at the boundary between the Lower and Upper Timanian members. This problem needs to be specified.

The TP-II assemblage is identified in the outcrops of the Ukhta and Yarega rivers, covering the middle Ust'-Yarega Formation (Text-fig. 2, outcrops D, E). Representatives of the genera *Ancyrodelia* (*Ad. alata* Glenister & Klapper, *Ad. africana* Garcia-Lopez, *Ad. rugosa* Branson & Mehl, *Ad. recta* Kralick, *Ad. rotundiloba* ? (Bryant), and *Mesotaxis* (*M. asymmetrica* (Bischoff & Ziegler), *M. falsiovalis* Ziegler, Sandberg & Bultynck, *M. costalliformis* Ji) appear in this

EXPLANATION OF PLATE 1

- Figs. 1-2 - *Polygnathus timanicus* Ovnatanova.
1) Upper view, Chut River, outcrop 7A, sample 1, No.40/525, x 90;
2) lower view, borehole 2051, sample 1, No.40/526, x45, Domanik Formation, Lower member.
- Fig. 3 - *Polygnathus xylus* Stauffer. Upper view, Chut River, outcrop 1, sample 94, No.40/527, x 85, Domanik Formation, Lower member.
- Fig. 4 - *Polygnathus pseudoxylus* Kononova, Alekseev, Barskov & Reimers. Upper view, Chut River, outcrop 1, sample 94, No.40/528, x 70, Domanik Formation, Lower member.
- Fig. 5 - *Polygnathus praepolitus* Kononova, Alekseev, Barskov & Reimers. Upper view, Ukhta River, left bank, outcrop 9, sample 2, No.40/529, x 70, Domanik Formation, middle member.
- Fig. 6 - *Polygnathus webbi* Stauffer. Upper view, Ukhta River, left bank, outcrop 9, sample 3, No.40/530, x 70, Domanik Formation, middle member.
- Fig. 7 - *Polygnathus krestovnikovi* Ovnatanova. Upper view, outcrop 1906, bed 13, No. 40/ 531, x 27, Lyaiol Formation, member 2.
- Figs. 8-9 - *Polygnathus uchtensis* Ovnatanova & Kuzmin. Upper view, Chut River, outcrop 7k, sample 1. 8) No.40/531, x 55; 9) 40/532, x55.
- Figs. 10-11 - *Polygnathus vjalovi* Zvereva. Upper view, borehole 2023, sample 1B, 1A, No. PIN 4551- 29, 30, x 40, Domanik Formation, Lower member.
- Fig. 12 - *Polygnathus lodinensis* Pölsler. Upper view, Vezha-Vozh River, outcrop 9, sample 2a, No 40/ 533, x 80, Lyaiol Formation, member 2.
- Fig. 13 - *Polygnathus subincompletus* Ovnatanova & Kononova. Upper view, Lyaiol River, outcrop 1359, bed 1, No 40/534, x 80, Lyaiol Formation, member 4.
- Fig. 14 - *Polygnathus macilentus* Kuzmin. Upper view, Lyaiol River, outcrop 1360, sample 1, No 40/535, x 70, Lyaiol Formation, member 4.
- Fig. 15 - *Polygnathus brevis* Miller & Youngquist. Upper view, Lyaiol River, outcrop 1359, bed 1, No 40/536, x 55, Lyaiol Formation, member 3.
- Fig. 16 - *Palmatolepis gutta* Kuzmin. Upper view, borehole 2051, sample 1, No.40/537, x45, Domanik Formation, Lower member.
- Figs. 17-18 - *Palmatolepis keyserlingi* Kuzmin. Upper view, Chut River, outcrop 1, sample 97, No.40/538-539, 17 -x 70, 18 -x 30, Domanik Formation, Lower member.
- Fig. 19 - *Palmatolepis orbicularis* Ovnatanova & Kuzmin. Upper view, borehole 2023, sample 5, PIN 4551- 66, x 40, Domanik Formation.
- Figs. 20-21, 23-24 - *Palmatolepis punctata* (Hinde). Upper view;
20) Upper view; Chut river, outcrop 2, No 40/539, x 50;
21) Upper view; Ukhta river, left bank, outcrop 9, sample 1, 40/540, x 55;
23) Upper view; outcrop 1905, No 40/ 541, x 45;
24) Upper view; unusual hugh specimen, Ukhta river, left bank, outcrop 9, sample 1, x 60, No.40/542, Domanik Formation.
- Fig. 22 - *Palmatolepis domanicensis* ? Ovnatanova. Upper view, Chut river, outcrop 2, sample 6, No 40/543, x 45, Domanik Formation, middle member.
- Fig. 25 - *Palmatolepis hassi* Müller & Müller s.l. Upper view, borehole 2021, sample 6a, No 40/544, x 50. Domanik Formation, middle member.
- Fig. 26 - *Palmatolepis ljaschenkoae* Ovnatanova. Upper view, quarry 13, No. 40/545, x 70. Domanik Formation, upper member.





Text-fig. 3 - Distribution of key Conodont Species in the Domanik Formation sections.

Legend: 1 = clay; 2 = limestone; 3 = limestone of domanikoid type; 4 = limestone with chert; 5 = carbonate concretions; 6 = levels where conodonts are found. Abbreviations: Ad.= *Ancyrodella*, Ag.= *Ancyrognathus*, Kl.= *Klapperina*, M.= *Mesotaxis*, Oz.= *Ozarkodina*, Pa.= *Palmatolepis*.

assemblage. *Polygnathus xylus*, *Po. webbi* and *Po. angustidiscus* are also present.

The composition of the TP-III assemblage from the upper Ust'-Yarega Formation (Text-fig. 2, outcrops E and 1 at the Yarega and Chut' rivers) points to the basin's further deepening. It is characterized by the appearance of *Palmatolepis transitans* Müller, *Mesotaxis bogoslovskyi* Ovnatanova & Kuzmin, and the presence of *Ancyrodella alata*, *A. africana*, *Mesotaxis asymmetrica*, *M. falsiovalis*, *M. costalliformis*, *Klapperina ovalis* (Ziegler & Klapper), *Polygnathus webbi* and *Po. angustidiscus*.

Conodonts from the overlying Frasnian deposits (Domanikian, Vetlasyan, Sirachoyian, lower Evlanovian regional stages) are defined from the basal and slope facies deposits.

Conodonts of the Domanik Formation were studied in detail in outcrops and cores (Text-fig. 3). The Domanik Formation is represented by intercalations of dark-gray thin-bedded laminated limestone, siliceous limestone, chert, bituminous shale, and rare marker beds of clay. The lower boundary of the Domanik Formation is drawn at the top of the marker limestone bed with the ammonoid of *Komioceras stuckenbergi* (Holz), upper - at the top of the uppermost thick limestone bed, overlain by the Vetlasyan Formation clay.

In full sections of boreholes, the Domanik Formation is determined to be subdivided into three members, with which the known outcrops at the

Yarega, Chut', Ukhta, Domanik, and Lyaiol rivers are correlated (Text-fig. 3). The lower member is 22 to 24 m, the middle member - 17 to 22 m, the upper member - 20 to 23 m, thick.

The TP-IV conodont assemblage occurs in the lower member and in the basal clay bed of the middle member. It is characterized by the appearance of *Palmatolepis punctata* (Hinde) above the lower boundary of the formation, and still slightly above - *Ancyrodella gigas* Youngquist, *Palmatolepis gutta* Kuzmin, *Mesotaxis johnsoni* Klapper, *Polygnathus timanicus* Ovnatanova and *Po. vjalovi* Zvereva. *Mesotaxis asymmetrica*, *M. falsiovalis*, and *Palmatolepis transitans* are associated species, continuing from the underlying TP-III assemblage. Of the polygnathids, *Polygnathus brevilariformis* Ovnatanova and *Po. strictus* Kuzmin & Yurchenkova appear, while *Polygnathus xylus* and *Po. webbi* persist. The basal clay bed of the middle member contains *Klapperina ovalis*, *Mesotaxis falsiovalis* and *Palmatolepis punctata*. Above, the representatives of *Mesotaxis* disappear, and *Palmatolepis* prevails in the assemblage.

The TP-V assemblage occurs in the middle member of the Domanik (except for the basal clay bed) and is recognized in a number of outcrops (1, 2, 3, 4) in the lower reaches of the Chut' River, in the quarries and outcrops near the Ukhta River, below the Chut' and Krokhal' rivers mouth (outcrops 5, 6, 9), at the Ukhta River near the hospital of the Shudayag Village (outcrop

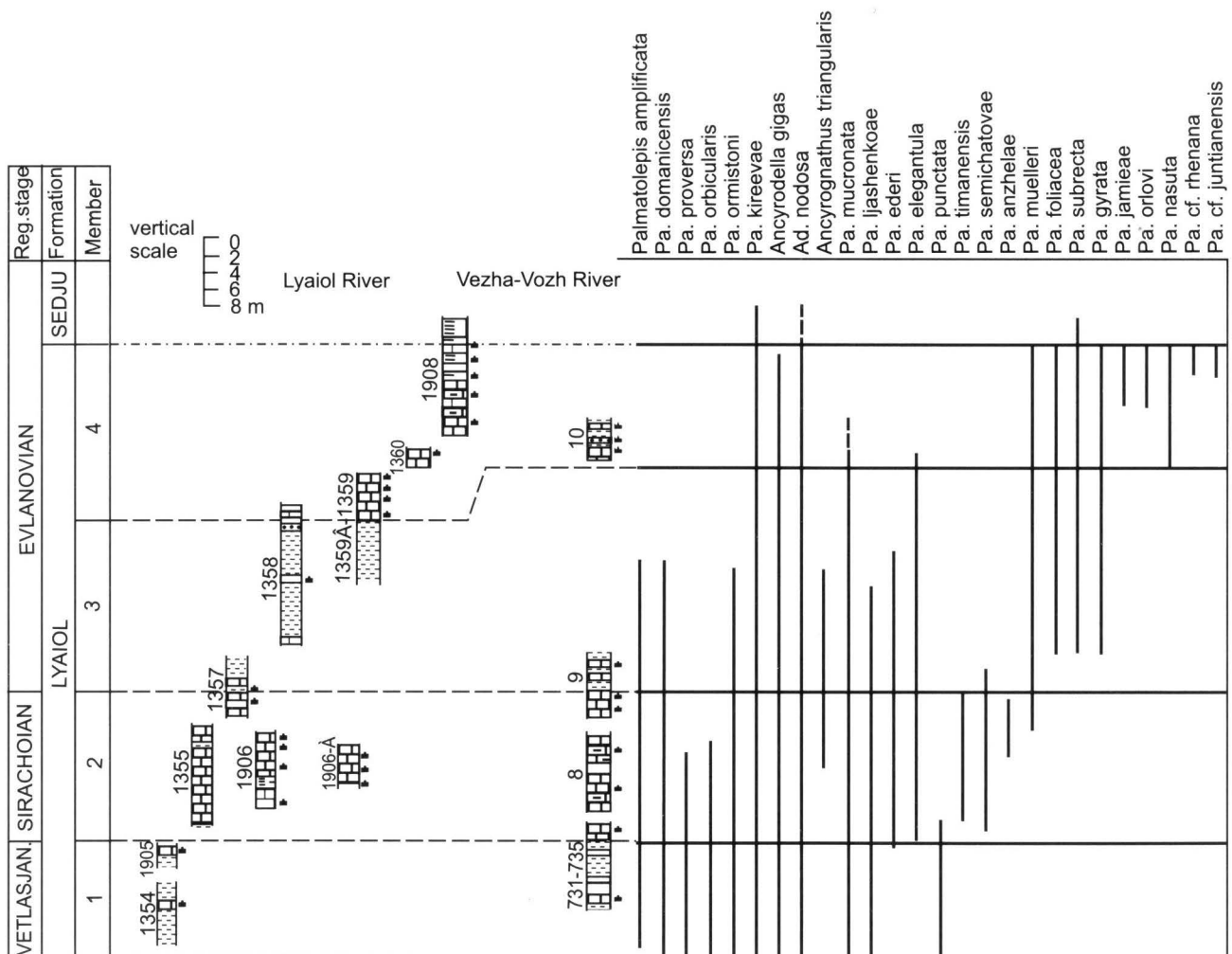
12), at the Domanik River (outcrops 10, 11), and in boreholes 2068, 1003, 3B. TP-V is distinguished by the first appearance of *Ancyrodella curvata* Branson & Mehl, *Ancyrognathus ancyrognathoides* (Ziegler), *Ag. primus* Ji, *Palmatolepis bohémica* Klapper & Foster, *Pa. orbicularis* Ovnatanova & Kuzmin, *Pa. spinata* Ovnatanova & Kuzmin, *Pa. domanicensis* Ovnatanova, and *Ozarkodina trepta* Ziegler. *Palmatolepis punctata* and *Pa. transitans* occur together with this assemblage. *Mesotaxis* representatives are entirely absent. Polygnathids are represented by *Polygnathus webbi*, *Po. xylus*, *Po. breviamiformis*, as well as by the first appearance of *Po. uchensis* Ovnatanova & Kuzmin and *Po. lodinensis* Polsler.

The upper member of the Domanik Formation, well distinguished in borehole sections, was little known in outcrops until recently. Particular parts of the upper member were exposed and became accessible on the right bank of the Ukhta River below the

Domanik River mouth at the ski depot only after the excavation had been carried out in the process of the water intake construction at the Ukhta River above the Shudayag Village and the road building within the village.

The section of the upper member is (upwards): 1 - clay (3-4 m), 2 - interbedded siliceous limestone, limestone, and bituminous shale (4 to 6 m), 3 - clay with thin limestone interbeds (up to 4.5 m), 4 - limestone, siliceous limestone with carbonate concretions, rarely - bituminous shale (6 to 8 m). The TP-VI conodont assemblage is reported from bed 2. It contains *Ozarkodina nonaginta* Klapper, Kuzmin & Ovnatanova, while *Palmatolepis spinata* and *Pa. bohémica*, common below in TP-V, are absent. *Ancyrognathus ancyrognathoides*, *Pa. orbicularis*, *Pa. punctata*, and *Pa. domanicensis* persist from below.

The next, TP-VII assemblage is assigned to the upper carbonate bed 3 (Text-fig. 3). Upwards from the bed's



Text-fig. 4 - Distribution of key Conodont Species in the Lyaiol Formation.
Abbreviations: Pa. = *Palmatolepis*, Ad. = *Ancyrodella*, I. = *Icriodus*.

base, *Palmatolepis* aff. *proversa* Ziegler, *P. provera* Ziegler, and at the top - *Pa. amplificata* Klapper, Kuzmin, & Ovnatanova, *Pa. mucronata* Klapper, Kuzmin & Ovnatanova and *Pa. ormistoni* Klapper, Kuzmin & Ovnatanova, appear.

Conodont assemblages from the Upper Frasnian are identified from Lyaiol Formation outcrops (the Lyaiol, Vezha-Vozh rivers; Text-fig. 4) and the core 2068. The Lyaiol Formation consists of four members, differing in the ratio of interbedded carbonate and clay rocks. The deposits of the lower members 1 and 2 belong to basinal facies, and members 3 and 4 - to slope facies. In clay member 1 (Verlasyan regional stage - 18 to 30 m), *Palmatolepis plana* Ziegler & Sandberg, *Pa. provera*, *Pa. amplificata*, *Pa. punctata*, *Pa. cf. orbicularis*, *Pa. kireevae*, *Ancyrodella gigas* and *Polygnathus brevilamiformis* are reported from carbonate interbeds. This association is similar to the TP-VII assemblage.

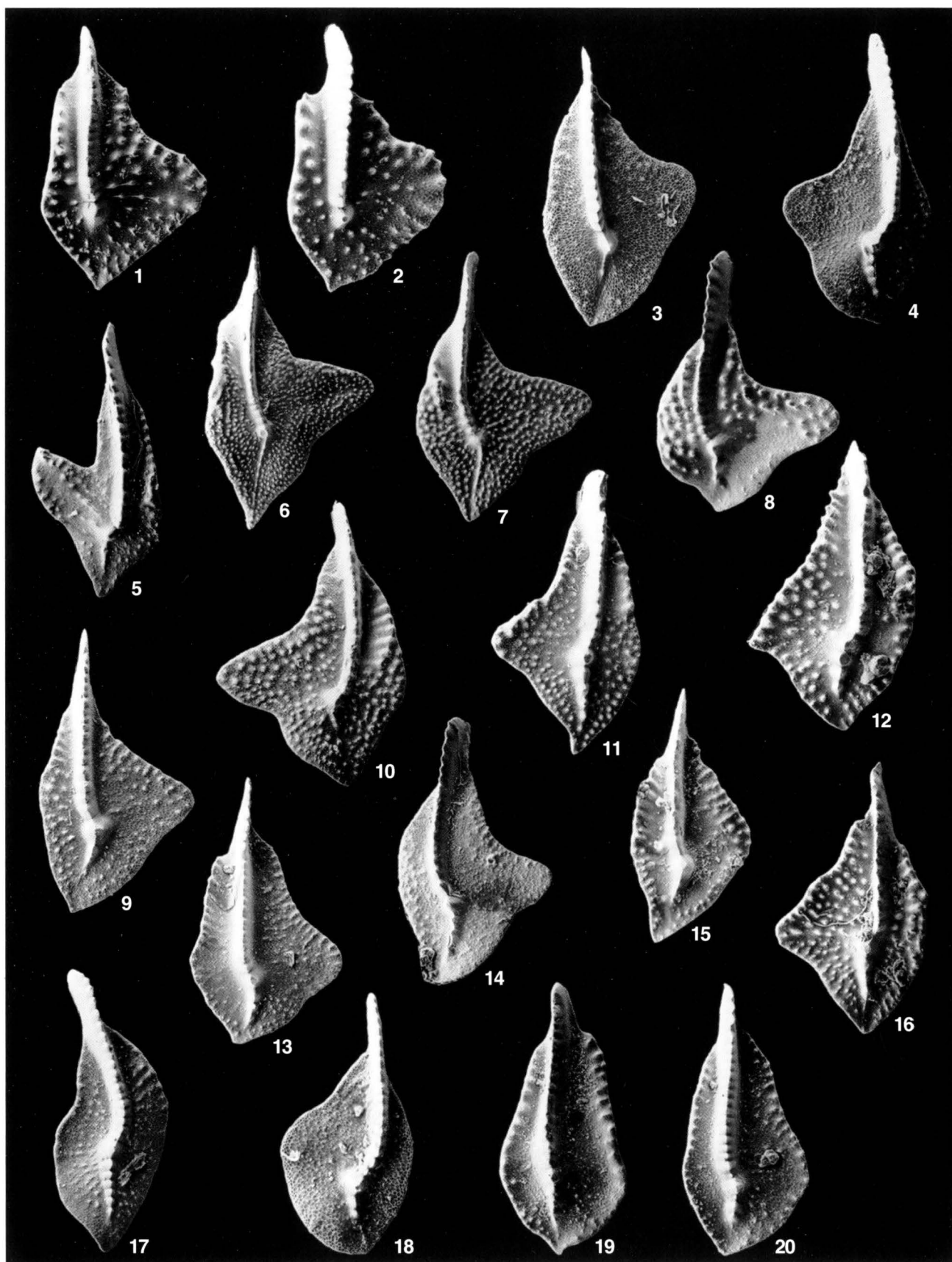
The TP-VIII assemblage is identified from the carbonate member 2 and the lowermost beds of the carbonate-clay member 3 (the Sirachoyian regional stage). This contains *Ancyrognathus triangularis* Youngquist and palmatolepids (prevailing): *Palmatolepis*

elegantula Wang & Ziegler and *Pa. ederi* Ziegler & Sandberg. From the middle bed of member 2 - *Palmatolepis semichatovae* Ovnatanova, *Pa. timanensis* Klapper, Kuzmin & Ovnatanova, and *Pa. anzhelae* Khrusheva & Kuzmin appear (Text-fig. 4). *Palmatolepis plana*, *P. kireevae*, *Pa. ormistoni*, *Pa. amplificata*, etc. are also present.

The TP-IX assemblage characterizes the considerable part of member 3 and the clay-carbonate member 4 (the lower Evlanovian regional stage). In the uppermost part of member 3, *Palmatolepis gyrata* Kuzmin & Melnikova, *Pa. foliacea* Youngquist, *Pa. subrecta* Miller & Youngquist, and *Pa. hassi* s.s. occur. Above the base of member 4, *Pa. jamieae* Ziegler & Sandberg, *Pa. nasuta* Muller, and *Pa. orlovi* Khrusheva & Kuzmin, appear. *Palmatolepis elegantula*, *P. amplificata* etc. are also present (Text-fig. 4). The absence of *Pa. semichatovae* in TP-IX is typical, whereas *Ancyrodella nodosa*, *Ad. ioides*, *Ancyrognathus amana*, and *Icriodus interjectus* Kuzmin & Ovnatanova are rare. The slope facies is characterized by the appearance of various polygnathids in TP-IX: *Polygnathus lodinensis*, *Po. brevis* Müller & Youngquist, *Po. politus* Ovnatanova, *Po. macilentus* Kuzmin, *Po. alvenus* Ovnatanova &

EXPLANATION OF PLATE 2

- Figs. 1-2 - *Palmatolepis spinata* Ovnatanova & Kuzmin. Upper view;
1) quarry 12, No. 40/ 546, x 75;
2) Ukhta river, left bank, outcrop 9, sample 1, No. 40/ 547, x 75, Domanik Formation, Middle member.
- Figs. 3-4 - *Palmatolepis ljaschenkoi* Ovnatanova. Upper view;
3) quarry 13, No. 40/548, x 80. Domanik Formation, upper member;
4) Vezha-Vozh River, outcrop 735, sample k-6, No. 40/549, x 80. Lyaiol Formation, member 2.
- Fig. 5 - *Palmatolepis barba* Ziegler & Sandberg. Upper view, Vezha - Vozh river, outcrop 735, sample k-6, No. 40/550, x 55. Lyaiol Formation, member 2.
- Fig. 6 - *Palmatolepis mucronata* Klapper, Kuzmin & Ovnatanova. Upper view, quarry 12, No. 40/551, x 28. Domanik Formation, upper member.
- Figs. 7, 10 - *Palmatolepis amplificata* Klapper, Kuzmin & Ovnatanova. Upper view, Vezha - Vozh river, outcrop 8, No. 40/552, 553, x 55. Lyaiol Formation, member 2.
- Fig. 8 - *Palmatolepis semichatovae* Ovnatanova. Upper view, Vezha - Vozh river, outcrop 735, sample k-6, No. 40/554, x 70. Lyaiol Formation, member 2.
- Fig. 9 - *Palmatolepis kireevae* Ovnatanova. Upper view, Vezha - Vozh river, outcrop 9, sample 5, No. 40/555, x 70. Lyaiol Formation, member 3.
- Fig. 11 - *Palmatolepis subrecta* Miller & Youngquist. Upper view, Vezha - Vozh river, outcrop 9, sample 5d, No. 40/556, x 48. Lyaiol Formation, member 3.
- Fig. 12 - *Palmatolepis* aff. *subrecta* Miller & Youngquist. Upper view, Vezha - Vozh river, outcrop 9, sample 5 d, No. 40/557, x 48. Lyaiol Formation, member 3.
- Fig. 13 - *Palmatolepis jamieae* Ziegler & Sandberg. Upper view, Vezha - Vozh river, outcrop 10, bed 7, No. 40/558, x 55. Lyaiol Formation, member 4.
- Fig. 14 - *Palmatolepis orlovi* Khrusheva & Kuzmin. Upper view, Vezha - Vozh river, outcrop 10, bed 7, No. 40/559, x 55. Lyaiol Formation, member 4.
- Fig. 15 - *Palmatolepis gyrata* Kuzmin & Melnikova. Upper view, Vezha - Vozh river, outcrop 9, sample 2a, No. 40/560, x 70. Lyaiol Formation, member 3.
- Fig. 16 - *Palmatolepis muelleri*? Klapper & Foster. Upper view, Vezha - Vozh river, outcrop 9, sample 2a, No. 40/561, x 48. Lyaiol Formation, member 3.
- Fig. 17 - *Palmatolepis ederi* Ziegler & Sandberg. Upper view, Vezha - Vozh river, outcrop 735, sample k-6, No. 40/562, x 70. Lyaiol Formation, member 2.
- Fig. 18 - *Palmatolepis timanensis* Klapper, Kuzmin & Ovnatanova. Upper view, Vezha - Vozh river, outcrop 735, sample k-6, No. 40/563, x 85. Lyaiol Formation, member 2.
- Figs. 19-20 - *Palmatolepis foliacea* Youngquist. Upper view, Vezha - Vozh river, outcrop 10, bed 7; 19) No. 40/564, x 60. 20) 40/564, x 70, Lyaiol Formation, member 4.



Kononova, and *Po. subincompletus* Ovnatanova & Kononova.

The appearance of *Palmatolepis juntianensis* Han and *Pa. cf. rhenana* Bischoff & Ziegler in the uppermost part of member 4 of the Lyaiol Formation allows us to assign these beds, as well as the overlying Sed'yu clay sequence (with the Upper Evlanovian spore assemblage) to the following assemblage (TP-X).

The stratigraphic range of conodont assemblage X is mainly correlated with the upper Evlanovian regional stage. A more detailed characterization of its composition is made in the sections of slope and basal facies from the boreholes of the Tebuk-Viss Region (Kuzmin *et al.*, 1998). Thus, the borehole 909 (depth 1817-1823 m) contains *Palmatolepis juntianensis*, *Pa. rhenana*, *Pa. subrecta*, *Pa. cf. nasuta*, *Pa. praetriaangularis* Sandberg & Ziegler, and *Polygnathus macilentus*.

The uppermost Frasnian conodont assemblage TP-XI seems to be correlated mainly with the Livnyian regional stage. It is identified in boreholes 881 (depth 1716-1722 m) and 888 (depth 1815-1817 m) in the Tebuk-Viss Region by the following association: *Palmatolepis linguiformis* Müller, *Pa. subrecta*, *Pa. boogaardi* Klapper & Foster, *Pa. rhenana*, *Pa. rotunda* Ziegler & Sandberg, *Ancyrodella ioides*, and *Polygnathus macilentus*.

Above, in the Tebuk-Viss sections, the conodont assemblages belonging to the lower Famennian *Palmatolepis triangularis* to Lower *crepida* zones are identified.

The TP-X-XI assemblages are identified also in boreholes drilled in the Bagan area in the northern part of the TP Basin (Kuzmin & Melnikova, 1991).

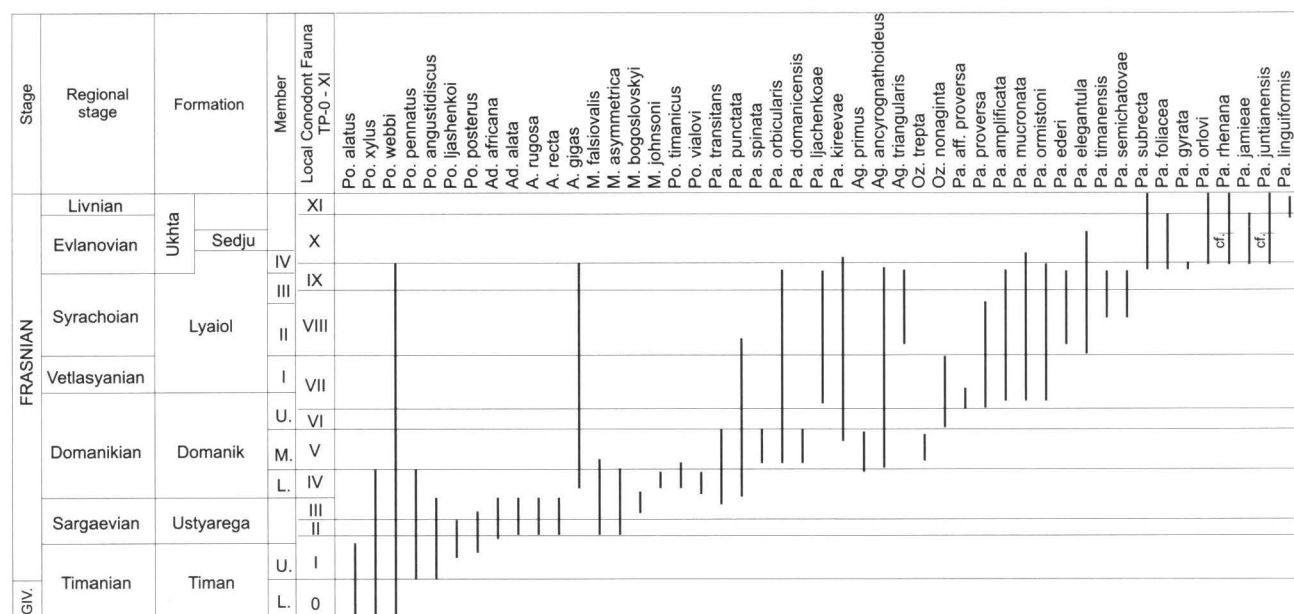
The distribution of the most important species of the TP-I-XI conodonts is given in Text-fig. 5.

CORRELATION OF THE LOCAL T-P CONODONT SUCCESSION WITH OTHER ZONATIONS

The correlation of the succession of local assemblages from the TP Basin with the former (Ziegler, 1962, 1971) standard zonal scale of the Frasnian Stage is as follows: TP-I, II, III are correlated with the Lower *asymmetrica* Zone, TP-IV – with the Middle + Upper *asymmetrica* zones. TP-V, VI probably belong to the “unzoned” interval after *Mesotaxis* disappears, and the TP-VII interval possibly correlates with the *Ancyrognathus triangularis* Zone. The TP-VIII assemblage is correlated with the Lower *gigas* Zone by the presence of *Palmatolepis semichatovae*, TP-IX and X - with the Upper *gigas* Zone, and TP-XI - with the Uppermost *gigas* Zone.

The correlation with the revised standard Frasnian zonation (Ziegler & Sandberg, 1990): TP-I-II - Early-Late *falsiovalis* Zone; TP-III - *transitans*, TP-IV - *punctata*; the correlation of TP-V-VIII with the zonal interval *hassi-jamieae*-Early *rhenana* is uncertain; TP-IX, X is correlated with the Late *rhenana* Zone, TP-XI - with the *linguiformis* Zone.

Some years ago we began cooperating with Professor G. Klapper, who developed a zonation for the Montagne Noire sequence (MN zones 1-13, (Klapper, 1989, Klapper & Foster, 1993). The MN zonation was later integrated with a composite standard developed from graphic correlation. The first attempt to use the



Text-fig. 5 - Succession of Frasnian Conodont Fauna (TP I–XI) in the Timan Pechora region.

zonation for the TP Basin was made by Klapper, Kuzmin, & Ovnatanova (1996). It is now necessary to revise some of those conclusions. This is mainly due to the fact that specimens identified as *Palmatolepis domanicensis* in strata equivalent to MN 10-lower 11 (upper Domanik – Lower Lyaiol) are not the same as the true *Palmatolepis domanicensis*, which is restricted to the Middle Domanik (equivalent to MN Zone 6; rare specimens including the holotype of the species). The higher specimens from the Upper Domanik and Lower Lyaiol should be identified as *Pa.plana* in a restricted sense. With these change being taken into consideration, the correlation of local TP-I-XI assemblages with the MN zonal scale is as follows: TP-I is correlated with MN-1, 2, TP-II with MN-3, TP-III with MN-4, TP-IV with MN-5, TP-V with MN-6, TP-VI with MN-7; TP-VII is approximately correlated with the MN-8-10 interval. The correlation of TP-VIII with MN-11, TP-IX with MN-12, and TP-X, XI with MN-13 is established without any doubt.

CONCLUSIONS

1. The study of Frasnian conodonts in the reference sections of the Southern Timan and adjacent areas made it possible to establish a succession of 11 assemblages (TP-I-XI). Further, it provides the basis for a Frasnian zonal scale of the TP Basin, which can be then correlated with the regional stages.
2. In the Southern Timan sections, the level with sharp changes of conodont composition is associated with the disappearance of *Mesotaxis* from the middle part of the Domanik Formation. Several local assemblages, that seem to be correlated with the “unzoned” interval of the former standard zonal scale, are distinguished above this level. The upper level of change in the conodont assemblages is assigned to the top of the Domanik Formation; here, *Palmatolepis* with a long lateral lobe appears. The nomenclature of this conodont group should be specified.
3. The “unzoned” interval and *Ancyrognathus triangularis* of the former zonal scale, appear most questionable for current zonations. In correlating with the revised standard Frasnian zonal scale, the greatest difficulties arise in the *hassi-jamieae* zonal interval. When correlating with the Montagne Noire zonal scale, the correlation of the Timan local assemblages with the MN-8-10 interval should be specified and further studied in detail.

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