

THE BASHKIRIAN CONODONTS OF THE ASKYN SECTION, BASHKIRIAN MOUNTAINS, RUSSIA

by

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ABSTRACT

The stratotype of the Bashkirian Stage is located on the western slope of the Urals, Bashkiria, Russia, and is represented by a carbonate sequence that shows the gradual deepening of a marine basin. The Lower Moscovian consists of limestones with interbedded cherts.

The Bashkirian Stage in its type locality now begins at the base of the Homoceras Zone and not, as was previously the practice, the Reticuloceras Zone. The boundary between the Bashkirian and Moscovian stages in this area is still uncertain.

The Bashkirian Stage is subdivided into seven conodont zones, and the Lower Moscovian into two. The conodont zonal boundaries do not correspond precisely to fusulinid zonal boundaries but are close to them at some levels. The interregional and intercontinental correlations of these deposits with other conodont sequences are made with varying degrees of confidence. The most precise correlations are made for the Lower Bashkirian.

KEY WORDS

Conodonts, Namurian, Bashkirian, Russia, stratigraphy, systematic paleontology.

1. INTRODUCTION

The Bashkirian Stage is one of not many subdivisions of high rank established in Russia, and it is included in the International Unified Classification of the Carboniferous because of intensive study.

The stage was proposed by S.V. Semikhatova (1934) in the South Urals, Bashkirian Mountains, as the Carboniferous beds underlying the Moscovian Stage and characterised by a specific group of brachiopods called «coarse-ridged Choristites». The scope and the boundaries of the Bashkirian Stage were the subject of much discussion.

The Bashkirian Stage was included in the Soviet Carboniferous Stratigraphic Scale and has an established reputation. It is well characterised by foraminifers, brachiopods, corals and other fossils in its type locality. All of these groups are of relatively little correlation potential and that is why the

correlation of the Bashkirian with the coeval deposits of Western Europe and North America is still not sufficiently reliable. Conodonts are becoming increasingly important in Carboniferous stratigraphy and correlation. The Late Carboniferous (or Pennsylvanian) conodonts are not so widely known as those of the Early Carboniferous worldwide. They have been studied in the United States, China, Ukraine and other areas. In the Bashkirian type locality conodont studies are preliminary.

The Bashkirian conodonts were described in general outline, for the first time, by R.S. Furduj (1975-79) but the published data was insufficient for global correlation of the Bashkirian deposits.

The present study attempts to fill this information gap by studying the Askyn section, one of the most complete of the Bashkirian Stage and the section which is considered the stratotype of this stage.

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2. THE BASHKIRIAN STRATOTYPE

The section which should be accepted as the Bashkirian Stratotype is not clear although it is of considerable importance. S.V. Semikhatova (1934) recognising «the Bashkirian Beds» mentioned three sections where these beds were first designated. One of them is located near the village of Bolshye Luky along the River Yuryuzan and the other two, along the rivers Zilim (Theodorovich) and Zigan (V.N. Krestovnikov) respectively. Thus no specific type section was named by the original author. Nevertheless, S.V. Semikhatova (1941) described in detail «the type locality of the Bashkirian beds of the western slope of the Urals» cropping out on the left side of River Yuryuzan near the village of Bolshye Luky.

As this section was designated by the original author of this unit it should be regarded as the stratotype of the Bashkirian Stage. It is important that *Choristites bisulcatiformis* Semikhatova that is a brachiopod of the Bashkirian Stage, was recovered only from this locality.

In the 1950-70 period Soviet stratigraphers thought that a stratotype had to be represented by the most complete section and supported by detailed palaeontology. Consequently, it was possible to change the type locality several times as new information accumulated. Following this concept a number of workers in general, and S.V. Semikhatova in particular, proposed a number of outcrops among the studied ones in the large territory of the Bashkirian Mountains, as a type locality of the Bashkirian Stage. There were several decisions of the interdepartmental Stratigraphic Committee of the USSR on this problem.

For many years, S.V. Semikhatova (1965, 1971) and other specialists used a series of outcrops along the Zilim River as the Bashkirian type locality. Later, because of insufficient outcrop and poor documentation of the Lower Bashkirian Substage, they abandoned these exposures in favour of the sequences along the Askyn River (Semikhatova *et al.*, 1978 ; Sinitsyna, 1975). Taking into account that a stratotype cannot be rejected because of its incompleteness, the Askyn Section has the status of a hypostratotype as the most suitable and better documented section.

3. THE ASKYN SECTION

The Askyn Section is located near the village of Solontsy (Askyn), Arkhangelsky district, Bashkiria, on the right side of the River Askyn, a left tributary of the River Inzer (Fig. 1). It consists of several rocky outcrops on the southern slope of the small mountain of Asatau. The intervals between the rocky outcrops were covered by taluses, forests, and being poorly

exposed were excavated by trenches. The beds are dipping westwards at an angle of 60-80 degrees into the Urals Foredeep.

At the base of the section the Serpukhovian dolomites and limestones with *Striatifera* are present. They are overlain by thick strata of Bashkirian and Moscovian limestones with very little erosion. On the outskirts of the Solontsy Village, in the uppermost part of the section, one can probably observe the contact between the Middle and Upper Carboniferous that has been seen in a borehole (Sinitsyna, 1975).

The lithologies of the Bashkirian (223 m thick) and Moscovian (135 m thick) are rather monotonous and consist of detrital clastic limestones with dessication fissures in its lower part and detrital, clastic and micritic limestones with cherty interlayers in its upper part. The strata grade from very shallow, shelf to outer shelf, slope facies. An indication of the deepening of the marine basin is seen as one ascends the section.

Although the section was described several times (Kireeva, 1971 ; Kireeva *et al.*, 1975 ; Theodorovich *et al.*, 1959) it was best documented by Z.A. and I.I. Sinitsyn (1975, 1984, 1987) who marked the beds and excavated the covered intervals by trenches. A little different subdivision of the section into layers was made by a group of scientists led by Prof. Dr O.L.

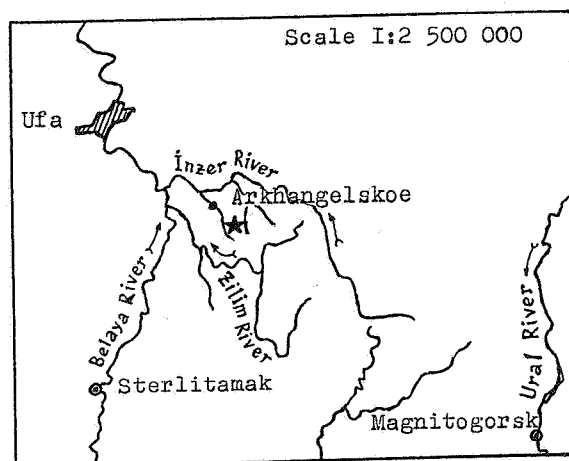
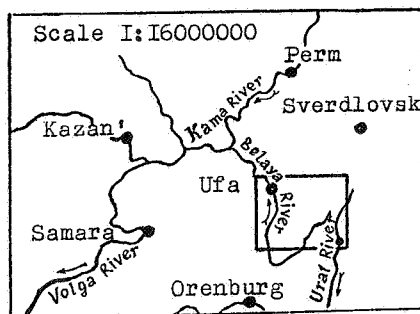


Figure 1. Location of the Askyn Section (*), South Urals, Bashkiria, Russia.

Einor. They published the Palaeontological Atlas (1979) but a detailed description of the section remains to be done.

Here we use the numbering of the layers given in the Guidebook of the 27th International Geological Congress (Sinitsyna *et al.*, 1984) and in the paper of the Sinitsyns (1987) (Fig. 2).

The Askyn Section was demonstrated to the participants of a number of international and all-Union meetings. Foraminifers (Sinitsyns, 1987 ; Groves, 1988), algae (Atlas, 1979), corals (Atlas, 1979), brachiopods (Semikhatova, 1971 ; Atlas, 1979), ostracods (Atlas, 1979) were described from this section. Small assemblages of ammonoids (Sinitsyna, 1975) were identified. Conodonts were studied by R.S. Furdud (1975, 1979).

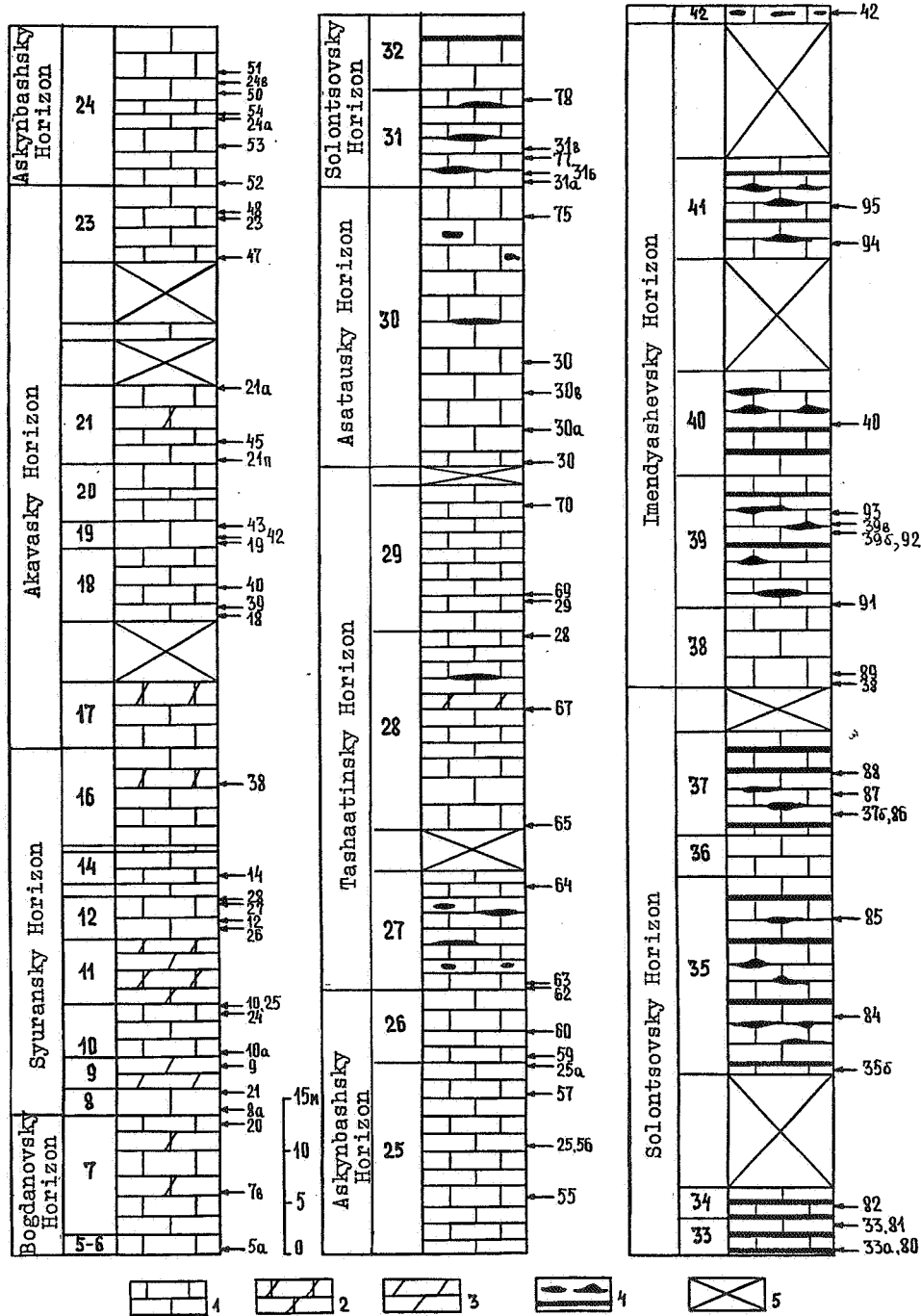


Figure 2. Columnar section of the Askyn Section, Bashkirian and Lower Moscovian, South Urals, Bashkiria, Russia. Numbers of Nemirovskaya's samples coincide with numbers of units, the sample of Alekseev were numbered in ascending order. Explanation : 1. limestones - 2. limestones dolomitized - 3. dolomites - 4. cherts/nodules and layers - 5. covered intervals.

3.1. Conodont Recovery

Sampling of the section was started by T.I. Nemirovskaya in 1980 under the leadership of Prof. O. L. Einor. After the first results she collected additional samples to acquire more information. 80 samples, each of 4-5 kg weight were treated. At the same time A.S. Alekseev with the participation of Dr V. Khalymbadga collected 107 samples, each of 1 kg weight. 84 samples were collected from the Bashkirian deposits. The Serpukhovian through Moscovian were sampled by Nemirovskaya and Alekseev.

The conodonts were extracted using acetic acids. 85 samples from two collections contained about 1500 elements including more than 900 platform ones. About 80 samples were barren.

3.2. Distribution of Conodonts

Conodonts are not very common in the Bashkirian limestones of the Askyn section. 48 of 85 samples contain 1-5 Pa-elements. About one half of all the samples were barren. Conodonts are most common in the upper part of the Askynbashsky and lower part of the Tashastinsky (units 25-27) and Solontsovsky horizons (units 33-35) where several dozen Pa-elements per sample occur. They are distributed irregularly throughout the lower part of the section and more regularly in the upper part. Thus all of the horizons and the majority of the units are characterised by conodonts. The units 6, 11, 13, 15, 17, 20, 22, 32 and 36 were barren (Tab. 1).

Almost all the genera known from the coeval deposits of the other areas are recovered. These are the following genera: *Rhachistognathus*, *Declinognathodus*, *Idiognathoides*, *Idiognathodus*, *Neognathodus*, *Streptognathodus*, *Adetognathus*, *Hindeodus* and *Diplognathodus*. *Declinognathodus* and *Neognathodus* dominate within the Lower Bashkirian whereas *Idiognathoides* became common only from the end of the Lower Bashkirian (middle of the Askynbashsky Horizon). *Adetognathus*, regarded as an index of extremely shallow water environment of high salinity, is not common throughout the section although it occurs in the lower part of the Bashkirian.

Underlying deposits of the Brazhkinsky Horizon of the Serpukhovian Stage with *Striatifera* contain only some ramiform elements like *Hindeodella*. The Bogdanovsky Horizon (units 5-7) contains rare *Rhachistognathus minutus minutus* (Higgins & Bouckaert) and *Hindeodus minutus* (Ellison). The conodont association of the Syuransky Horizon (units 8-16) is much more diverse.

Declinognathodus noduliferus (Ellison and Graves), *Decl. lateralis* (Higgins & Bouckaert) and *Adetognathus lautus* (Gunnell) occur at the base of this horizon. *Idiognathoides corrugatus* (Harris and Hollingsworth) and *Id. sulcatus* Higgins & Bouckaert were recovered for the first time in unit 12. At the base of the unit 19 (15 m above of the Akavasky Horizon) *Neognathodus symmetricus* and *N. askynensis* sp. nov. appeared. These species together with *Decl. noduliferus*, dominate in the middle and upper parts of the Akavasky Horizon. The first representatives of the genus *Idiognathodus* appeared within the Askynbashsky Horizon (units 24-26). *Idiognathodus sinuosus* Ellison and Graves and *I. primitivus* sp. nov. occur within the unit 24, 4 m above the base and *I. delicatus* Gunnell within the same unit, 6.5 m above the base. In the middle of this horizon *Streptognathodus bashkiricus* sp. nov., *Idiognathoides sinuatus* Harris and Hollingsworth, abundant *Id. sulcatus* Higgins and Bouckaert and very few specimens of *Str. suberectus* Dunn occur.

The assemblage became impoverished from the middle of the Tashastinsky Horizon (units 27-29). *Declinognathodus noduliferus* and *Decl. lateralis* disappeared. At the top of the Askynbashsky Horizon (top of the unit 26) *Decl. marginodosus* (Grayson) appeared and together with *I. sinuosus* dominate in the upper half of the Tashastinsky Horizon. The Asatausky Horizon (unit 30) contains rare *I. delicatus*, *I. sinuosus*, *Streptognathodus parvus* Dunn, *Diplognathodus orphanus* Merrill, and *D. coloradoensis* Murray and Chronic. The occurrence of *Neognathodus atokaensis* Grayson, *Idiognathoides fossatus* (Branson and Mehl), 8 m above the base of this horizon, and *Id. tuberculatus* Nemirovskaya, 27 m above the base is important.

The conodont assemblage of the lower part of the Solontsovsky Horizon is identical to that of the Asatausky one. It changes slightly at unit 33 where *Neognathodus uralicus* sp. nov. and *Str. einori* sp. nov. appeared. The latter species was not found higher.

The Imedyashevsky Horizon (units 38-41) is characterised by an impoverished association of conodonts, including *Decl. marginodosus* (base of the unit 39 only), *I. delicatus*, *I. sinuosus*, *Id. corrugatus*, *Id. sinuatus*, *Id. fossatus*, *Neognathodus uralicus*, *N. aff. karshiriensis* Goreva, sp. nov. 1 and sp. nov. 2. At the base of the Zilimsky Horizon (unit 42) *Idiognathoides planus* Furduj was recovered, that is characteristic of the overlying Moscovian deposits.

3.3. Conodont Zonation

Although the conodont assemblages of the Bashkirian and Lower Moscovian of the Askyn Section are identical to other coeval conodont sequences at generic level their species composition differs from that of other sections to a considerable extent as the newly described species play a substantial role. This fact is the reason why the zonations made for the coeval deposits of Great Britain (Higgins, 1975), North America (Webster, 1964 ; Dunn, 1970 ; Lane, 1977), Donbas (Nemirovskaya, 1987, 1990) and Moscow Basin (Barskov *et al.*, 1984) cannot be used here. For example, such common index species of the Moscovian deposits like *Neognathodus bothrops* Merrill, *N. medadultrimus* Merrill, *N. medexultimus* Merrill, and *Streptognathodus dissectus* Kossenko used in the zonation of the Moscow Basin do not occur in the Askyn section. Besides there is reason to suppose that the levels of appearance and disappearance of species (especially Late Bashkirian-Early Moscovian) of the Askyn section do not always reflect evolutionary events but are controlled by ecological changes in the paleobasin. Correlation of the ranges of many species with those of the Donets Basin is therefore misleading.

Nevertheless, taking into account the importance of the Askyn Section for the subdivision and intercontinental correlation of the Bashkirian Stage, and sufficient completeness of conodont information it is important to give the conodont zonal subdivision of this stage in its type locality. Obviously it will be necessary in future to improve this scale after studies of other areas of the South Urals but there is a common feature in any stratigraphic scale.

The zones were determined by the first appearance of the index species as is generally practised in conodont stratigraphy. Seven conodont zones were distinguished within the Bashkirian Stage and two zones in the Lower Moscovian. The conodont zonal boundaries do not coincide with the horizon boundaries and boundaries of the fusulinid zones either but they are sufficiently close to the latter in places to allow their use for correlation (Fig. 3).

Rhachistognathus minutus Zone (units 5-7). The lower boundary is defined by the first appearance of *Rh. minutus*. The upper boundary coincides with the first appearance of *Declinognathodus*. The range of *Rh. minutus* is restricted to the interval of units 5-7. This zone correspond to the Bogdanovsky Horizon.

Declinognathodus noduliferus Zone (units 8-11). Its lower boundary is determined by the first appearance of *Declinognathodus noduliferus* s.l. and by the disappearance of *Rh. minutus*. The upper boundary of this zone is defined by the appearance of *Idiognathoides*.

Decl. noduliferus and *Decl. lateralis* are considered diagnostic of this zone. *Adeotgnathus lautus* and *Ad. gigantus* are present. The *Decl. noduliferus* Zone corresponds to the lower part of the Syuransky Horizon.

Idiognathoides corrugatus Zone (units 12-18). The lower boundary of this zone is defined by the first appearance of *Idiognathoides corrugatus*, the upper boundary coincides with the appearance of *Neognathodus*. The index species is very rare and was found in only one sample (12). *Declinognathodus noduliferus* and *Decl. lateralis* dominate. *Idiognathoides sulcatus* is also very rare within this zone. Such rare occurrences of *Idiognathoides* can be explained by strong ecological control ; the environments were unfavourable for this genus. The *Id. corrugatus* Zone corresponds to the upper part of the Syuransky Horizon (units 21-16) and lower part of the Akavasky Horizon (units 17-18).

Neognathodus askynensis Zone (units 19-24). The lower boundary of this zone is defined by the appearance of *Neognathodus askynensis* sp. nov. The upper boundary coincides with the appearance of *Idiognathoides*. The zone is distinguished by the occurrence of *N. askynensis*, *N. symmetricus*, small conodonts referred to *N. aff. symmetricus* Lane, *Decl. noduliferus*, *Decl. lateralis*, *Adetognathus lautus* and rare *Streptognathodus* aff. *nodosus*. *Decl. lateralis* occurs only within the lower part of the zone. The *N. askynensis* Zone corresponds to the upper part of the Akavasky Horizon (units 19-23) and the base of the Askynbashsky Horizon (lower m of the unit 24).

Idiognathodus sinuosus Zone (units 24-26). Its lower boundary is determined by the first appearance of *Idiognathodus sinuosus*, and the upper one by the appearance of *Declinognathodus marginodosus*. Besides the index species this zone contains *Idiognathodus primitivus* sp. nov., *I. delicatus*, *Decl. noduliferus*, *Decl. aff. lateralis*, *N. aff. symmetricus*, *Id. sinuatus*, *Id. corrugatus*, *Id. sulcatus*, *Str. bashkiricus* sp. nov. and *Str. suberectus*. The *I. sinuosus* Zone corresponds to most of the Askynbashsky Horizon (upper part of the unit 24 through the unit 26). The *I. sinuosus* Zone corresponds to the most of the Askynbashsky Horizon (upper part of the unit 24 through the unit 26).

Declinognathodus marginodosus Zone (units 26-30). The lower boundary of this zone is marked by the first appearance of *Decl. marginodosus* and the upper boundary by the appearance of *Neognathodus atokaensis* Grayson. The conodonts are rather rare within this zone. Only *Idiognathodus sinuosus* is common. *Str. bashkiricus* sp. nov., *Id. sinuatus*, *Id. corrugatus* and *Id. fossatus* occur in the lower part of this zone. Its

upper part contains *Str. parvus* and *D. coloradoensis*. The *Decl. marginodosus* Zone corresponds to the uppermost of the Askynbashsky Horizon through the Tashastinsky and lower part of the Asatausky horizons (units 26-unit 30, lower 8 m).

Neognathodus atokaensis Zone (units 30-32). The lower boundary of the zone is defined by the first appearance of *N. atokaensis*, the upper boundary by the first appearance of *N. uralicus* sp. nov. The index species is very rare. The assemblage contains *I. delicatus*, *Id. corrugatus*, *Id. sulcatus*, *Id. tuberculatus* Nemirovskaya, *I. sinuosus*, *Str. parvus*, *D. coloradoensis* and *D. orphanus*. The *N. atokaensis* Zone corresponds to most of the Asatausky Horizon (the greater part of unit 30) and the lower part of the Solontsovsky Horizon (units 31-32).

Neognathodus uralicus Zone (units 33-34). This zone is new. Its lower boundary is defined by the first appearance of *N. uralicus* sp. nov. The upper boundary is determined by the first appearance of *Idiognathoides planus* Furduj. The zonal assemblages is diverse. It contains *N. uralicus*, *Decl. marginodosus*, *Id. corrugatus*, *Id. sulcatus*, *Id. sinuatus*, *Id. tuberculatus*, *Id. fossatus*, *I. sinuosus*, *I. delicatus*, *Streptognathodus einori* sp. nov., *N. aff. kashiriensis*, and *D. orphanus*. The *N. uralicus* Zone corresponds to most of the Solontsovsky Horizon (units 33-37) and Imendyashevsky Horizon (units 38-41) that is almost all of the Lower Moscovian Substage.

Idiognathoides planus Zone (units 42-51 ?). This zone is new. Its lower boundary is defined by the first appearance of *Id. planus*. The zone was not studied in detail but *Id. planus* is known to occur up to the unit 51. It probably corresponds to the Zilimsky Horizon.

4. CORRELATION

The zonal sequence distinguished within the Bashkirian and Moscovian deposits of the Askyn Section and the conodont assemblages characteristic of these zones permit correlation of these deposits with those of other areas. The correlation is more reliable in the lower half of the Bashkirian where assemblage changes are almost identical to those of other regions. In the Upper Bashkirian and the Lower Moscovian, correlation is complicated by the presence of endemic species and different ranges of known species. We should take into account that the Late Bashkirian and Early Moscovian conodonts are less studied globally than older ones.

The **Rhachistognathus minutus Zone** correlates to the same named zone of Western Europe that corresponds to the base of the Homoceras Zone and perhaps also to the uppermost of the Eumorphoceras ammonoid zones (Higgins, 1975). In North America *Rh. minutus* occurs within the Idiognathoides sinuatus-Rhachistognathus minutus Zone (Baesemann and Lane, 1987) that is younger than the Decl. noduliferus Zone in this area. In the Donets Basin, *Rh. minutus declinatus* Baesemann and Lane was recovered higher than the first *Decl. noduliferus* (upper part of the Zapaltyubinsky Horizon, Limestone D⁹₅, about 9 m above the first *Decl. noduliferus*, Lm D⁸_{5u}) (Nemirovskaya, 1987). This fact suggests that either the appearance of *Decl. noduliferus* in the Askyn Section was late due to ecological control or the south Urals Zone is older than the North American one. The former is more likely.

Correlation of the **Decl. noduliferus Zone** with the same zone of the Donets Basin (upper part of the Zapaltyubinsky and Voznesensky horizons) (Nemirovskaya, 1987) and with the Declinognathodus noduliferus-Streptognathodus lateralis Zone of western Europe (Higgins, 1975, 1982) and with the upper part of the Declinognathodus noduliferus-Rhachistognathodus primus Zone of North America (Lane, 1977) is reliable. Thus the lower part of the Syuransky Horizon corresponds to most of the Homoceras Zone of Western Europe and the lowermost part of the Morrow (Lower Pennsylvanian) of North America. This zone is correlated also with the same named zone of China (Wang *et al.*, 1987).

The **Idiognathoides corrugatus Zone** can be correlated with the lower part of the Idiognathoides sinuatus-Neognathodus symmetricus Zone of the Donets Basin, Krasnopolyansky Horizon, limestones D⁷₇-E⁶₆ (Nemirovskaya, 1987) and the lower part of the Idiognathoides corrugatus - *Id. sulcatus* Zone (Reticuloceras Zone) of western Europe (Higgins, 1975). It probably corresponds to the Idiognathoides sinuatus - Rhachistognathus minutus Zone, Lower Pennsylvanian, Morrow, of North America (Lane, 1977) but this correlation is rather questionable. This zone also can be compared to the *Id. corrugatus* - *Id. sinuatus* Zone of China (Wang *et al.*, 1987). The appearance of single specimens of *Id. corrugatus* and *Id. sulcatus* within the unit 12 and their absence up to unit 25 is possibly controlled ecologically. It means that the first appearance of the species could be later in the shallow water facies of the Askyn Section in comparison to much deeper water sections of western Europe, Middle Asia, etc.

The **Neognathodus askynensis Zone** is distinguished for the first time. It does not contain correlative species except *N. symmetricus* but *N. askynensis* is not known outside of the Urals. Some similar forms were recovered in the Krasnolyansky Horizon, limestone E₆, of the Donets Basin, that is higher than the first appearance of *N. symmetricus*. Because of that we could not distinguish the *N. symmetricus* Zone. The position of the *N. askynensis* Zone below beds with *Idiognathodus* and above the appearance of *Idiognathoides* (that is close to the first appearance of *N. symmetricus* in other areas) is significant. We believe that the *N. askynensis* Zone can be compared with the upper part of the *Id. sinuatus*-*N. symmetricus* Zone of the Donets Basin (limestone E₆-F₁), the upper part of the Krasnolyansky Horizon through Prikamsky Horizon (Nemirovskaya, 1987) and upper part of the *Id. corrugatus*-*Id. sulcatus* Zone of western Europe (Higgins, 1975). It probably corresponds to the *N. bassleri* Zone of North America (Lane, 1977).

The **I. sinuosus Zone**, because of its position below the Decl. *marginodosus* Zone and because of the presence of the index species as well as *S. suberectus*, can be correlated with two zones of the Bashkirian of the Donets basin: the *I. sinuosus* and *Str. expansus* - *Str. suberectus* Zone (limestones F₂-H³). It is possible that the upper part of the above mentioned zone corresponds to the lower part of the *Id. tuberculatus* Zone of the Donets Basin (Nemirovskaya, 1990). The *I. sinuosus* Zone of Bashkiria can correspond to the *I. sinuosus* and *I. klapperi* zones of North America (Lane, 1977) and most of the *I. delicatus*-*I. sinuosus* Zone of North China (Wang *et al.*, 1987).

The **Decl. marginodosus Zone** is compared with the same zone of the Donets Basin (Limestone I₃-K₂) (Nemirovskaya, 1990). A similar conodont assemblage was recovered from the Aegiranum Marine Band of the Westphalian C of Western Europe (Van den Boogard and Bless, 1985). Correlation of these deposits with North America is unclear. This zone probably corresponds to the Decl. *marginodosus* Zone of North America (Grayson, 1984). At the same time we can assume that two underlying zones in North America: *Idiognathoides* n. sp. - *Diplogna-thodus* spp. and *Neognathodus* sp. A - *Id. ouachitensis* correspond to the Bashkirian Decl. *marginodosus* Zone as well.

The **Neognathodus atokaensis Zone** can be compared with the Decl. *donetzianus* Zone of the Donets Basin, found in limestone units K₂-K₇ of the Vereisky Horizon (Nemirovskaya, 1990). Taking into account that Decl. *donetzianus* Nemirovskaya is common in the Alyutovskaya strata of the Vereisky Horizon of the Moscow Basin, we suggest that the correlation by conodonts of the Asatausky and the Vereisky horizons is rather reliable. *Diplogna-thodus coloradoensis*, *Idiogna-*

thoides tuberculatus and *Id. fossatus* are characteristic species of the Decl. *donetzianus* Zone of the Donets Basin and the Asatausky Horizon of Bashkiria.

The **Neognathodus uralicus zone** which comprises a greater part of the Lower Moscovian Substage of the Askyn Section does not contain any correlative species. *Id. corrugatus* and *Id. sinuatus* are still common. Nevertheless the position of this zone within the sequence permits to correlate it with the *Neognathodus* bothrops, *N. medadulimus* and probably *N. medexultimus* zones of the Moscow Basin (Kashirsky and Podolsky Horizons ?) (Barskhov *et al.*, 1984).

The correlative value of the **Idiognathoides planus Zone** is very restricted. Its index-species under the name *Idiognathoides pacificus* Savage et Berkeley was described from the Desmoinesian of Alaska (1987). This species is unknown in the other areas. So this zone can be correlated with some part of the Desmoinesian of Alaska.

5. THE MAIN STRATIGRAPHIC RESULTS

Conodont studies of the Askyn Section which is the type locality of many horizons of the Bashkirian Stage allow the elucidation of several stratigraphic problems, pointing at the same time to remaining problems.

The base of the Bashkirian Stage in the Askyn Sections (units 5-7) corresponds to the Homoceras ammonoid Zone, more precisely to its lower part and should be regarded as Bogdanovsky not Syuransky Horizon as it was considered before. Thus the conodont data support the Sinitsyn's point of view on the base of fusulinid data (Sinitsyna *et al.*, 1984). But one should remember that the scope of the Bogdanovsky Horizon is not yet determined in its type locality which makes the proposed correlation conjectural to some degree. But in any case it is clear that the Bashkirian Stage starts from the Homoceras and from the Reticuloceras Zone. Therefore the boundary between the Serpukhovian and Bashkirian corresponds to the Mississippian/Pennsylvanian or Mid-Carboniferous boundary.

The upper boundary of the Bashkirian Stage is not very clear on the basis of brachiopod and foraminifer data nor on conodont information. The situation is more complicated because the lower boundary of the Moscovian Stage in the Moscovian type locality is unclear since the underlying deposits of the Vereisky Horizon are terrestrial and are also included in the Moscovian Stage by some workers (Solovieva, 1985, 1986; Shyk, 1984).

The Vereisky Horizon of the Moscow Basin is characterised by conodonts in its middle part (Aljutovskaya strata). The co-occurrence of *Id. tuberculatus*, *Decl. donetzius* and *Decl. marginodosus* allows correlation of these deposits with the *Decl. donetzius* Zone of the Donets basin (Nemirovskaya, 1990) as was mentioned above. Direct correlation with the South Urals is complicated because of the absence of *Decl. donetzius* in the Askyn Section. The bridge between the Moscow Basin and South Urals can be made with only two species, *Id. tuberculatus* and *N. atokaensis*. The range of the former species is limited to the Vereisky Horizon in the Moscow Basin, the second species appeared within the Vereisky Horizon but became common in the Zilimsky and lower part of the Kashirsky Horizons. If we use *N. atokaensis* for correlation we should accept that the Vereisky Horizon is analogous to the Asatausky of Bashkiria. *Id. tuberculatus* appeared at the top of the Asatausky Horizon and occurred as high as the middle of the Solontsovsky Horizon (unit 35). Thus the Vereisky Horizon should correspond to the Asatausky and the lower half of the Solontsovsky horizons. The boundary between the Bashkirian and Moscovian in the Askyn Section is drawn between the Asatausky and Solontsovsky horizons according to the fusulinid data.

As was mentioned above representatives of *Idiognathoides* were not found above the Vereisky Horizon in the Moscow Basin while in the South Urals they are common in much younger strata (equivalents of the Kashirian and even Podolian horizons). As the distribution of *Idiognathoides* is known to be strongly controlled ecologically it is impossible to fix that version of the boundary between Bashkirian and Moscovian at the top of the Vereisky Horizon as proposed by Barskov *et al.* (1980).

In spite of these difficulties, we have to conclude that the conodont studies of the Bashkirian hypostratotype have shown that conodonts are very important for detailed correlation of the Bashkirian deposits with coeval rocks of the Donets Basin, Western Europe and North America. However, the species composition and their ranges are sufficiently different to preclude the use of a standard conodont zonation for interregional correlations.

6. SYSTEMATIC PALAEOLOGY

The following are descriptions of new species. Illustrated specimens are deposited in the Institute of the Geological Sciences of the Ukrainian Academy of Sciences, Kiev, Ukraine (IGSU) under the number 83. Occurrences of stratigraphically important conodonts at the Askyn Section are illustrated on table 1.

GENUS IDIOGNATHODUS GUNNELL, 1931

Type species : *Idiognathodus claviformis* Gunnell, 1931

Idiognathodus primitivus sp. nov.

Plate 3, figs. 2, 3, 7

Holotype - Plate 3, fig. 2, left Pa-element, sample 25, unit 25, 10.5 m above the base of the unit, Askyn Section, South Urals, Bashkirian Stage, Askynbashsky Horizon, *Idiognathodus sinuosus* Zone.

Derivation of Name - L., primitivus - primitive.

Description - The platform shape of the Pa-elements is lanceolate and it is slightly wider in the middle part. The platform is covered by 7-9 tightly spaced, straight transverse ridges. Carina is very long, reaching the middle of the platform and being slightly declined to the outer side. Only the inner side bears an additional lobe consisting of one row of nodes (3-4). The platform is gently arched laterally.

Remarks - *Idiognathodus primitivus* sp. nov. differs from *I. primulus* Higgins, 1975 in having a wider platform, longer carina and only one additional lobe. It differs from the very similar *I. sinuosus* Ellison and Graves, 1941, in having a straight platform ornamented by straight transverse ridges.

Occurrence - The Bashkirian Stage, lower substage, Askyn Section, units 24-25, South Urals.

GENUS NEOGNATHODUS DUNN, 1970

Type species : *Polygnathus bassleri* Harris and Hollingsworth, 1933

Neognathodus askynensis sp. nov.

Plate 2, figs. 9, 10, 13, 15

Holotype - Plate 2, fig. 9, specimen IGSU - 83/31 : left Pa-element, sample 21, base of the unit 21, Askyn Section, South Urals, Bashkirian Stage, Akavasky Horizons, *Neognathodus askynensis* Zone.

Derivation of name - From the Askyn River, Bashkiria, South Urals, Russia.

Description - The platform of the Pa-element is tongue-like, elongate. The middle part of the platform is the widest. The posterior end is lowered and round or pointed. Carina is high, mostly nodular, the nodes can be fused into one compact ridge. In the anterior third of the platform the carina is as high as the para-

pets but reduces in height posteriorly. It may or may not reach the posterior end of the element. Parapets are parallel to each other and to the carina almost all of their length. They are narrow, nodular, bearing short ridges on their posterior part in places. They are slightly convergent in the anterior part. The inner parapet can be a little higher than the outer one. The parapets are separated from the carina by narrow longitudinal grooves, the depths of which vary strongly, they can be very shallow in the middle of the platform. The platform is high, gently arched laterally.

Remarks - *Neognathodus askynensis* sp. nov. is very similar to *N. symmetricus* Lane, 1967. It is distinguished from the latter in having a higher carina, rather nodular than ridged parapets, shallower grooves, lowered posterior end and being more arched laterally. It differs from *N. higginsii* Grayson, 1985, being narrower and having parapets of equal length.

Occurrence - Bashkirian Stage, lower substage, Askyn Section, units 19-23, South Urals.

Material - 32 specimens.

Neognathodus uralicus sp. nov.

Plate 4, figs 1, 5

Holotype - Plate 4, fig. 5, specimen IGSU - 83/87, right Pa-element, sample 33a, unit 33, 0.2 m above the base of the unit, Askyn Section, South Urals, Moscovian Stage, Solontsovsky Horizon, *Neognathodus uralicus* Zone.

Derivation of Name - From the Urals Mountains.

Description - The platform of the Pa-element is massive, subtriangular in shape, long with pointed posterior end. Carina is much lower than the parapets in its anterior third. It becomes higher, wider and more nodular towards the posterior end where it deviates to outer parapet and almost fuses with its reduced part. The parapets are prominent in their anterior part and covered by short distinct ridges along the whole length. The parapets are separated from the carina by narrow grooves which become deeper in the anterior part of the platform. The outer parapet is very reduced up to its anterior widened part that makes up to about one half of the inner parapet length. Towards the posterior end of the element it disappears completely or continues along the very margin of the platform as a row of very small nodes fused with the carina. The ridges of the parapets radiate in the anterior part of the platform. Laterally the highest portion of the platform is in its anterior quarter due to the prominent parapets. It becomes lower posteriorly.

Remarks - *Neognathodus uralicus* differs from the similar *N. medadulimus* Merrill, 1972, being much wider in its anterior quarter because of the thick parapets, having a carina which becomes deeper anteriorly but prominent posteriorly. It differs from *N. kanumai* Igo, 1976, in having parapets of equal height and a reduced outer, not inner parapet as is common for *N. kanumai*.

Occurrence - Moscovian Stage, lower substage, Askyn Section, units 33-40, South Urals.

Materials - 9 specimens.

GENUS *STREPTOGNATHODUS* STAUFFER AND PLUMMER, 1932

Type species : *Streptognathodus excelsus* Stauffer and Plummer, 1932

Streptognathodus bashkiricus sp. nov.

Plate 4, figs. 7, 8, 11.

Holotype - Plate 4, fig. 11, specimen IGSU - 83/49, left Pa-element, sample 64, unit 27, 10 m above the base of the unit, Askyn Section, South Urals, Bashkirian Stage, Tashastinsky Horizon, *Declinognathodus marginodosus* Zone.

Derivation of Name - From Bashkiria, province of Russia.

Description - The platform of the Pa-element is broad, subtriangular. A short smooth carina enters a narrow median groove extending the length of the platform. The platform is ornamented by numerous (up to 9) straight transverse ridges interrupted by a median groove. Two additional lobes are slightly shifted posteriorly and separated indistinctly from the main platform. Each lobe consists of 1-3 semiconcentric rows of large nodes. The number of rows and nodes increases according to the growth of the conodont. The platform is very arched laterally.

Remarks - *Streptognathodus bashkiricus* sp. nov. is similar to *Str. suberectus* Dunn, 1966, but differs from the latter in having a much wider and convex platform and much greater area occupied by transverse ridges. The platform shape of *Str. bashkiricus* is close to that of the representatives of the genus *Idiognathodus* but the distinct median groove extending to the end of the platform forces us to refer this species to the genus *Streptognathodus*.

Occurrence - Bashkirian Stage, upper substage, Askyn Section, units 25-27, South Urals.

Material - 12 specimens.

Streptognathodus einori sp. nov.

Plate 3, figs 13, 15

Holotype - Plate 3, fig. 15, specimen IGSU - 83/43, right Pa-element, sample 33a, unit 33, 0.2 m above the base of the unit, Askyn Section, South Urals, Moscovian Stage, Solontsovsky Horizon, Neognathodus uralicus Zone.

Derivation of Name - In honour of the outstanding Carboniferous stratigrapher, Dr Olgerd L. Einor, Professor of Kiev State University.

Description - The platform is lanceolate, elongate, covered by transverse ridge interrupted by a narrow not deep median groove. A carina is in the median groove and occupies one third of the anterior part of the platform. Generally, the carina is lower than the parapets and consists of fused nodes, the posterior one can be discrete. The parapets are covered by short transverse ridges. The latter become nodelike anteriorly. One small inner lobe consists of 4-5 nodes forming an arch which is convex outwardly. Laterally the platform is high, gently arched.

Remarks - *Streptognathodus einori* sp. nov. differs from *Str. bashkiricus* sp. nov. in being narrower and bearing only one lobe. From *Str. suberectus* Dunn, 1966, it differs mainly by the anterior position of the lobe whereas *Str. suberectus* has the lobe (or two lobes) situated close to the midline of the platform.

Occurrences - Moscovian Stage, lower substage, Askyn Section, unit 33, South Urals.

Material - 4 specimens.

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Horizon	Bogdanovsky		S y e r a n s k y				A k a v a s k y				Askynbashsky			
	5	7	8	9	IO	I2	I4	I6	I8	I9	2I	23	24	
Conodonts	0, I, 3, 8 IO	0, I, 2	0, I, 2	0, 2	4	4, 8, 4, 8	I, I, 5, 2, 8, 3, 8	0, 4	6	0, I, 0, 7, 2, 7	0, I, 0, 5	2	0, I, 2, 7, 5	0, I, 4, 3, 5
Above the base (m)	7c	20	8a	2I	9	IOa	24	25	IO	26	I2	27	28	I4
Sample														
Rhachistognathus minutus minutus	I	6	I											
Hindeodus minutus		I												
Declinognathodus noduliferus			4	I	9									
Adetognathus lautus			I											
Adetognathus gigantus														
Declinognathodus lateralis														
Idiognathoides corrugatus														
Idiognathoides sulcatus														
Streptognathodus askynensis														
Neognathodus symmetricus														
Neognathodus aff. symmetricus														
Streptognathodus aff. nodosus														
Idiognathodus sinuosus														
Idiognathodus primitivus														
Idiognathodus delicatus														

A k a v a s k y

S y e r a n s k y

Bogdanovsky

Askynbashsky

Horizon	A s k y n b a s h s k y					T a s h a s t i n s k y					A s a t a u s k y		S o l o t s o v s k y			
	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
Conodonts	7 9 IO II	5,5 IO,5 IO,5 I5,3 I8,3	0,2 2,5 0,1 0,5 IO 0,1 II I8,5	0,1 0,5 IO 0,1 II I8,5	3 3,5 I2	0,6 3,5 8 IO 27	0,2 I,4 3 4									
Sample	54 50 24c5I	55 25 56 57 25a	59 60	62 63 64 65 67 28	29 69 70	30 30a 30b 30c75	3Ia 3Ib 77 3Ic									
<i>Declinognathodus noduliferus</i>	I 3	2 23 4 5 4	II													
<i>Declinognathodus lateralis</i>	3	II 2	3	2 I												
<i>Neognathodus aff. symmetricus</i>	2 2	I I2 7 30		I4 3	I											
<i>Idiognathoides sinuatus</i>																
<i>Idiognathodus delicatus</i>				3												
<i>Idiognathoides corrugatus</i>		9 7 IO		27 I 4												
<i>Idiognathoides sulcatus</i>		30 45		3												
<i>Idiognathodus primitivus</i>		I														
<i>Streptognathodus bashkiricus</i>		I		II												
<i>Idiognathodus sinuosus</i>		3 2 I		2 3 I I I I												
<i>Hindæodus minutus</i>		I		I												
<i>Streptognathodus suberectus</i>	I															
<i>Adetognathus gigantus</i>		2	I													
<i>Adetognathus lautus</i>		2	I													
<i>Declinognathodus marginodosus</i>			I													
<i>Streptognathodus parvus</i>				9	I 2											
<i>Diplognathodus orphanus</i>																
<i>Neognathodus atokaensis</i>																
<i>Idiognathoides fossatus</i>																
<i>Idiognathoides tuberculatus</i>																
<i>Diplognathodus coloradoensis</i>																

Horizon	S o l o n t s o v s k y										Imendyshevsky						Zilim-						
	31	33	34	35	37	38	39	40	41	42	31	32	33	34	35	36	37	38	39	40	41	42	
Conodonts	8,4	0,2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Unit	8,4	0,2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Above the base (m)	8,4	0,2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Sample	78	80	33a	33	81	82	35b	84	85	37b	86	87	88	38	89	91	39b	92	39c	93	40	94	95
<i>Declignathodus marginodosus</i>	5					3	I	3	3	I	I	4				2	2	2		I			
<i>Idiognathoides corrugatus</i>	2	I7	2	7	I	I7	2	7	I														
<i>Idiognathoides sulcatus</i>	I			2		3		2		I													
<i>Idiognathodus sinuosus</i>		I 4	4	2		3		2															
<i>Idiognathodus delicatus</i>		7		2		2		2		I	2	2											
<i>Idiognathoides sinuatus</i>		I2	I	2		II		2		I	2	2											
<i>Streptognathodus einori</i>		4		2		I		2															
<i>Streptognathodus einori</i>		I	I	I		I		I															
<i>Neognathodus uralicus</i>		I	I	I		I		I															
<i>Hindeodus minutus</i>																							
<i>Idiognathoides tuberculatus</i>																							
<i>Idiognathoides fossatus</i>																							
<i>Streptognathodus</i> sp.		2																					
<i>Neognathodus aff. kashiriensis</i>																							
<i>Diplognathodus orphanus</i>																							
<i>Idiognathoides planus</i>																							
<i>Neognathodus</i> sp. I																							
<i>Neognathodus</i> sp. 2																							

Table 1. Distribution of conodonts within the Bashkirian and Moscovian deposits of the Askyn section.

PLATES

PLATE 1

All illustrated specimens are Pa-elements from the Askyn Section, South Urals and housed in the Institute of Geological Sciences (IGSU), Ukrainian Academy of Sciences, Kiev, Ukraine.

Figure 1. *Rhachistognathus minutus minutus* (Higgins & Bouckaert).

1. IGSU-83/1, unit 5, sample 5a, Bogdanovsky Horizon, Bashkirian Stage, X 100.

Figures 2-4, 7. *Declinognathodus noduliferus* (Ellison & Graves) s.l.

2. IGSU-83/50, unit 8, sample 8a, Syuransky Horizon, Bashkirian Stage, X 100.
3. IGSU-83/51, unit 16, sample, 16/38, Syuransky Horizon, Bashkirian Stage, X 100.
4. IGSU-83/52, unit 12, sample 12, same locality, X 100.
7. IGSU-83/53, unit 9, sample 9, same locality, X 100.

Figures 9, 10, 19 - *Declinognathodus marginodosus* Grayson

9. IGSU-83/54, unit 26, sample 26/59, Askynbashsky Horizon, Bashkirian Stage, X 100.
10. IGSU-83/55, unit 35, sample 35B, Solontsovsky Horizon, Moscovian Stage, X 100.
19. IGSU-83/56, same locality and magnification.

Figures 5, 6, 8 - *Declinognathodus lateralis* Higgins & Bouckaert

5. IGSU-83/32, unit 12, sample 12, Syuransky Horizon, Bashkirian Stage, X 100.
6. IGSU-83/57, same locality, X 100.
8. IGSU-83/58, unit 9, sample 9, same locality, X 100.

Figures 11, 13, 15 - *Idiognathoides corrugatus* Harris & Hollingsworth

11. IGSU-83/59, unit 35, sample 35B, Solontsovsky Horizon, Moscovian Stage, X 90.
13. IGSU-83/3, unit 12, sample 12, Syuransky Horizon, Bashkirian Stage, X 100.
15. IGSU-83/60, same locality and magnification.

Figures 12, 17, 19 - *Idiognathoides sulcatus* Higgins & Bouckaert

12. IGSU-83/61, unit 25, sample 25, Askynbashky Horizon, Bashkirian Stage, X 100.
17. IGSU-83/62, unit 31, sample 31/71, Solontsovsky Horizon, Moscovian Stage, X 100.
19. IGSU-83/63, unit 35, sample 35B, Solontsovsky Horizon, Moscovian Stage, X 100.

Figure 18 - *Idiognathoides planus* Furduj

18. IGSU-83/9, unit 42, sample 42, Zilimsky Horizon, Moscovian Stage, X 100.

Figures 14, 16 - *Idiognathoides sinuatus* Harris & Hollingsworth

14. IGSU-83/64, unit 33, sample 33a, Solontsovsky Horizon, Moscovian Stage, X 90.
16. IGSU-83/13, unit 25, sample 25, Askynbashsky Horizon, Bashkirian Stage, X 100.

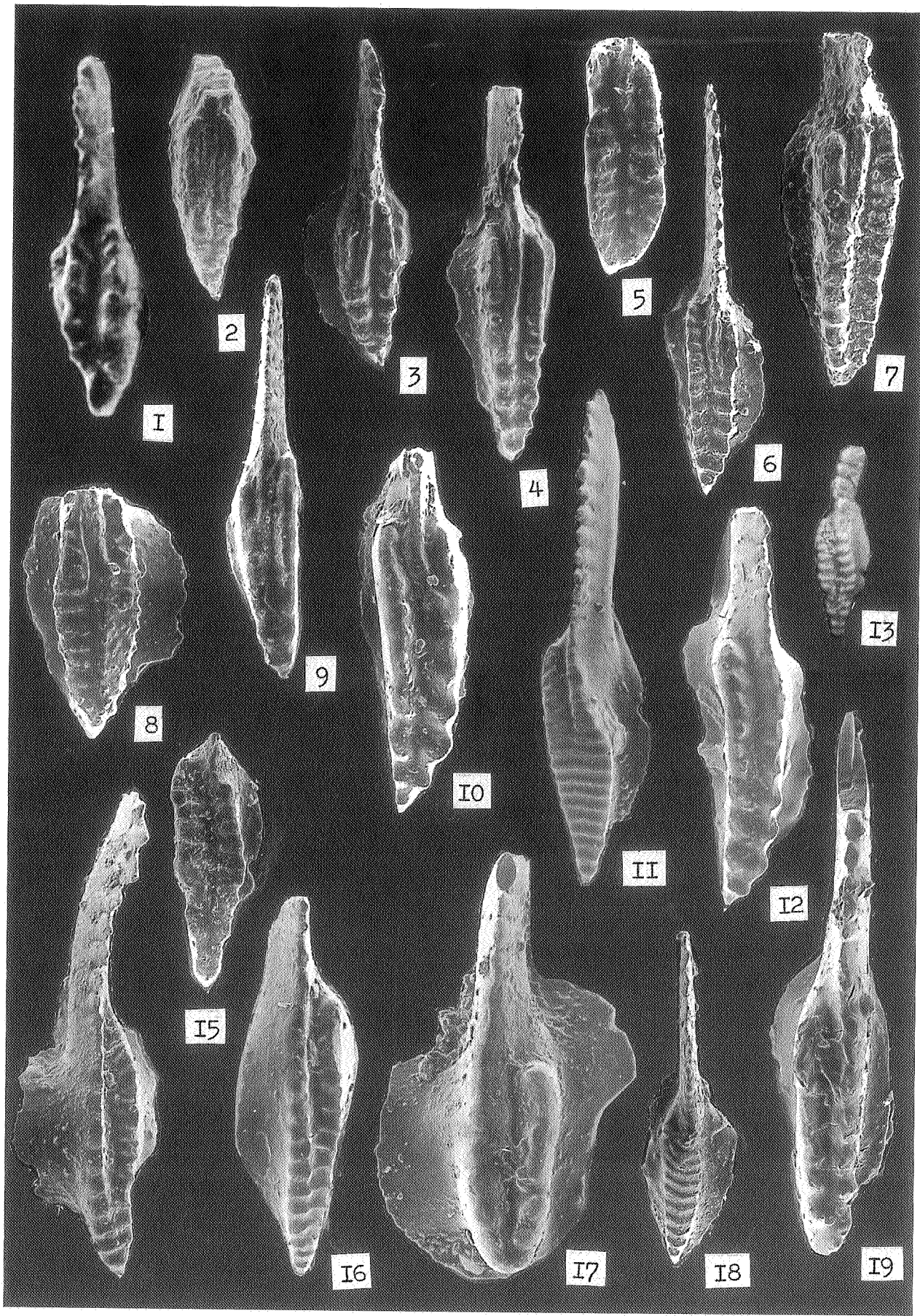


PLATE 2

All illustrated specimens are Pa-elements from the Askyn Section, South Urals and housed in the Institute of Geological Sciences (IGSU), Ukrainian Academy of Sciences, Kiev, Ukraine.

Figure 1 - *Declinognathodus* sp.

1. IGSU-83/35, unit 33, sample 33a, Solontsovsky Horizon, Moscovian Stage, X 100.

Figure 2 - *Declinognathodus* aff. *lateralis* Higgins & Bouckaert

2. IGSU-83/65, unit 31, sample 31/78, Solontsovsky Horizon, Moscovian Stage, X 90.

Figure 3 - *Diplognathodus coloradoensis* Murray & Chronic

3. IGSU-83/23, unit 31, sample 31B, Solontsovsky Horizon, Moscovian Stage, X 50.

Figures 4, 5 - *Idiognathoides fossatus* (Branson & Mehl)

4. IGSU-83/24, unit 39, sample 39B, Imendyashevsky Horizon, Moscovian Stage, X 90.
5. IGUS-83/66, the same locality, X 100.

Figure 6 - *Adetognathus lautus* (Gunnell)

6. IGSU-83/26, unit 29, sample 29, Tashastinsky Horizon, Bashkirian Stage, X 90.

Figures 7, 12 - *Idiognathoides tuberculatus* Nemirovskaya

7. IGSU-83/17, unit 35, sample 35B, Solontsovsky Horizon, Moscovian Stage, X 60.
12. IGSU-83/16, unit 30, sample 30/75, Asatausky Horizon, Bashkirian Stage, X 100.

Figures 8, 14 - *Neognathodus symmetricus* Lane

8. IGSU-83/67, unit 19, sample 19/42, Akavassky Horizon, Bashkirian Stage, X 100.
14. IGSU-83/27, unit 19, sample 19, same locality, X 100.

Figures 9, 10, 13, 15 - *Neognathodus askynensis* n. sp.

9. Holotype, IGSU-83/31, unit 21, sample 21n, Akavassky Horizon, Bashkirian Stage, X 100.
10. IGSU-83/68, unit 19, sample 19, same locality, X 100.
13. IGSU-83/69, unit 21, sample 21, same locality, X 100.
15. IGSU-83/70, unit 19, sample 19/42, same locality, X 100.

Figure 11 - *Adetognathodus gigantus* (Gunnell)

11. IGSU-83/71, unit 30, sample 30/75, Asatausky Horizon, Bashkirian Stage, X 100.

Figure 16 - *Neognathodus* aff. *kashiriensis* Goreva

16. IGSU-83/25, unit 35, sample 35B, Solontsovsky Horizon, Moscovian Stage, X 90.

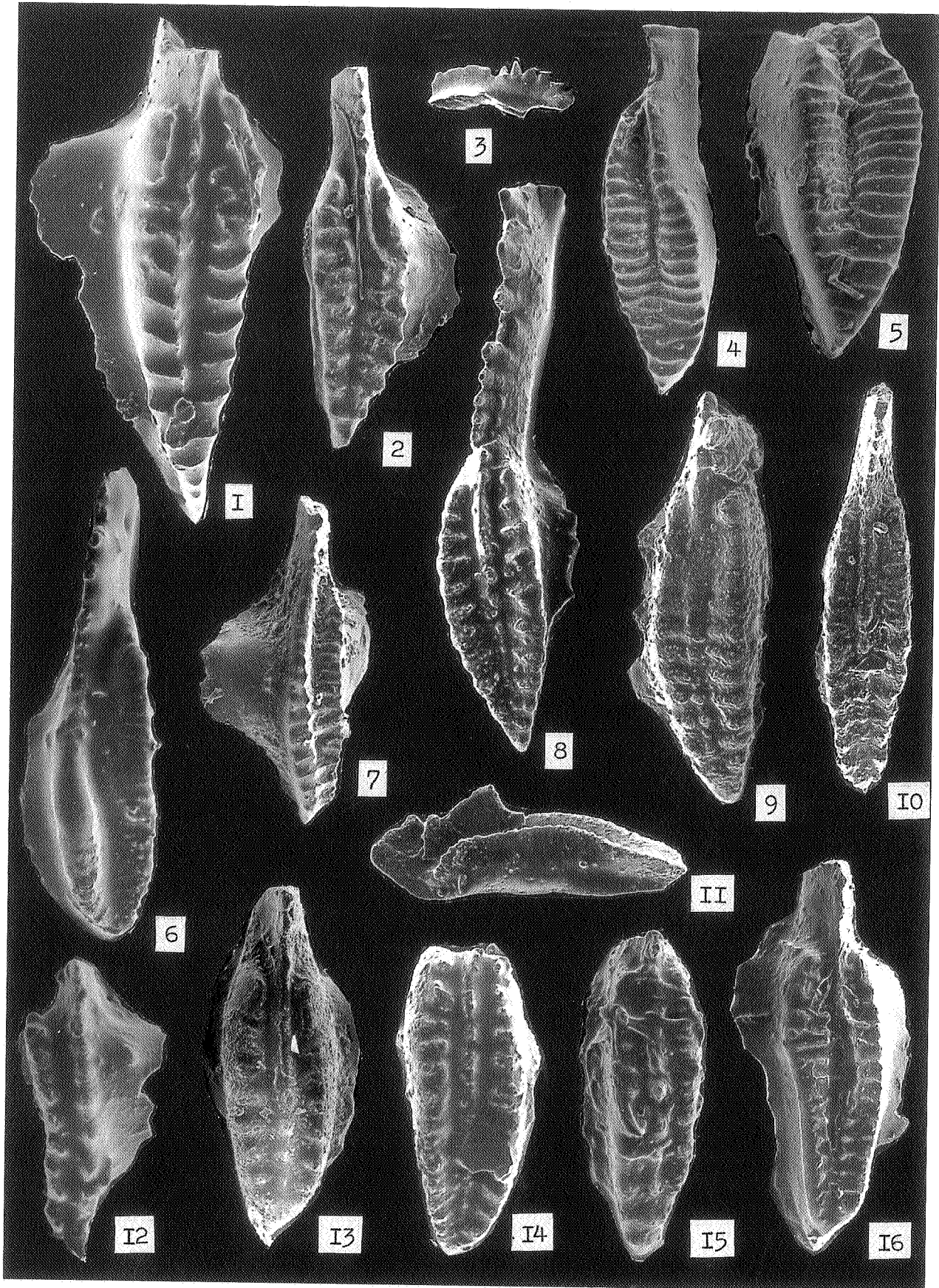


PLATE 3

All illustrated specimens are Pa-elements from the Askyn Section, South Urals and housed in the Institute of Geological Sciences (IGSU), Ukrainian Academy of Sciences, Kiev, Ukraine.

Figures 1, 12 - *Idiognathodus delicatus* Gunnell

1. IGSU-83/72, unit 28, sample 28, Tashastinsky Horizon, Bashkirian Stage, X 70.

Figures 2, 3, 7 - *Idiognathodus primitivus* n. sp.

- 2, 3. Holotype, IGSU-83/21, unit 25, sample 25, Askynbashsky Horizon, Bashkirian Stage, X 100 and X 50.
7. IGSU-83/73, unit 30, sample 30B, Asatausky Horizon, Bashkirian Stage, X 100.

Figures 4, 6, 8, 9, 11 - *Idiognathodus sinuosus* Ellison

4. IGSU-83/74, unit 27, sample 27/64, Tashastinsky Horizon, Bashkirian Stage, X 90.
6. IGSU-83/75, unit 33, sample 33/80, Solontsovsky Horizon, Moscovian Stage, X 90.
8. IGSU-83/76, unit 27, sample 27/64, Tashastinsky Horizon, Bashkirian Stage, X 90.
9. IGSU-83/78, unit 24, sample 24/53, same locality, X 70.
11. IGSU-83/77, unit 24, sample 24/53, Askynbashsky Horizon, Bashkirian Stage, X 70.

Figures 5, 10 - *Streptognathodus parvus* Dunn

5. IGSU-83/15, unit 30, sample 30, Asatausky Horizon, Bashkirian Stage, X 60.
10. IGSU-83/79, same locality, X 100.

Figures 13, 15 - *Streptognathodus einori* n. sp.

13. IGSU-83/80, unit 33, sample 33a, Solontsovsky Horizon, Moscovian Stage, X 100
15. Holotype, IGSU-83/43, same locality, X 90.

Figure 14 - *Streptognathodus suberectus* Dunn

14. juvenile specimen, IGSU-83/81, unit 24, sample 24/54, Askynbashsky Horizon, Bashkirian Stage, X 100.

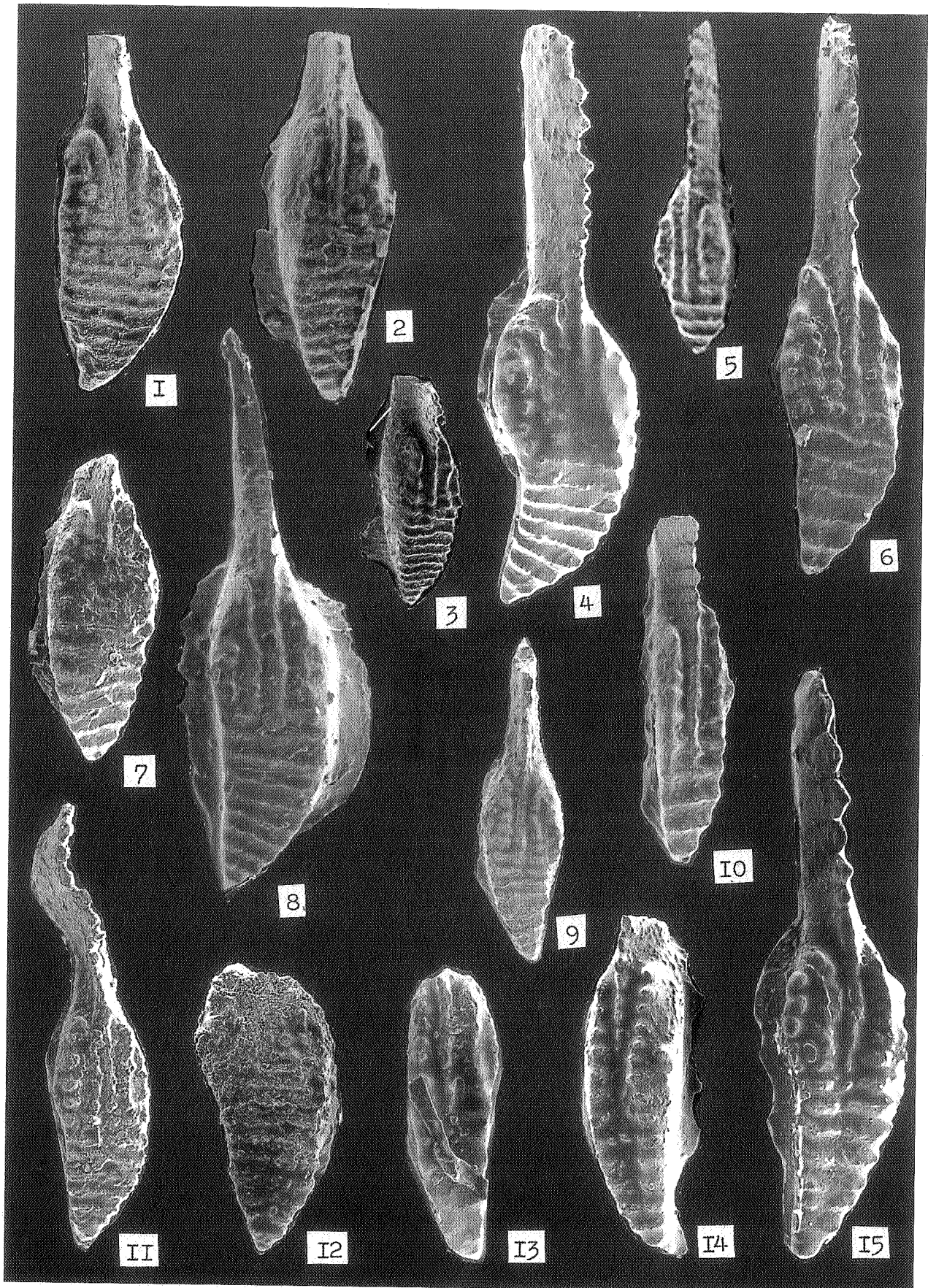


PLATE 4

All illustrated specimens are Pa-elements from the Askyn Section, South Urals and housed in the Institute of Geological Sciences (IGSU), Ukrainian Academy of Sciences, Kiev, Ukraine.

Figures 1, 5 - *Neognathodus uralicus* n. sp.

1. IGSU-83/38, unit 40, sample 40, Imendyashevsky Horizon, Moscovian Stage, X 90.
5. Holotype, IGSU-83/37, unit 33, sample 33a, Solontsovsky Horizon, Moscovian Stage, X 90.

Figures 2, 3, 6 - *Neognathodus* sp. 2

2. IGSU-83/32, unit 41, sample 41/95, Imendyashevsky Horizon, Moscovian Stage, X 90.
3. IGSU-83/40, unit 39, sample 39B, same locality, X 100.
6. IGSU-83/83, unit 39, sample 39/93, same locality, X 100.

Figures 4, 10 - *Neognathodus* sp. 1

4. IGSU-83/84, unit 38, sample 38, Imendyashevsky Horizon, Moscovian Stage, X 90.
10. IGSU-83/85, unit 35, sample 35/85, Solontsovsky Horizon, Moscovian Stage, X 90.

Figures 7, 8, 11 - *Streptognathodus bashkiricus* n. sp.

7. IGSU-83/48, unit 27, sample 27/64, Tashastinsky Horizon, Bashkirian Stage, X 90.
8. IGSU-83/86, unit 25, sample 25/56, Askynbashsky Horizon, Bashkirian Stage, X 90.
11. Holotype, IGSU-83/49, unit 27, sample 27/64, Tashastinsky Horizon, Bashkirian Stage, X 90.

Figure 9 - *Neognathodus atokaensis* Grayson

9. IGSU-83/45, unit 31, sample 31B, Solontsovsky Horizon, Moscovian Stage, X 90.

