On the systematics of the families Bazaricrinidae, Anthinocrinidae and Facetocrinidae (Crinoidea, Middle Paleozoic)

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Poorly known and new material represented by stem fragments of the Middle Paleozoic crinoids of the families Bazaricrinidae, Anthinocrinidae and Facetocrinidae (order Angulata, group Pentamerata) is systematized. In the classification of these families, special emphasis is placed on characteristics of their generic composition. New genera *Wenjukowicrinus* Stukalina, gen. n., *Shishkinaecrinus* Stukalina & Kurilenko, gen. n. and *Blandicrinus* Stukalina & Yu. Dubatolova, gen. n. and new species *Bazaricrinus umbonatus* sp. n., *Anthinocrinus levis* sp. n. and *Facetocrinus quinqueangulatus* sp. n. are described.

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Introduction

In the classification of Paleozoic crinoids known from stem remnants (Stukalina, 1965b, 1966, 1967, 1968b, etc.), the families Bazaricrinidae Stukalina, 1982, Anthinocrinidae Schewtschenko, 1966 and Facetocrinidae Stukalina, 1968 are included in the order Angulata Stukalina, 1967, of the group Pentamerata Stukalina, 1966. Representatives of these families occur in the Silurian and Devonian (Middle Paleozoic) of the Russian and Siberian platforms, the Urals, Northeast and Far East of Russia, Salair, Altai, Kazakhstan, Central Asia, Transcaucasus, Tuva and Mongolia.

New collection material gathered in the last years allows us to establish the position of these families in the classification of angulate crinoids of the group Pentamerata and their composition.

The abbreviation CNIGR Museum is used for Central Scientific Research Geological Exploration Museum, St.Petersburg.

Morphofunctional types of Bazaricrinidae, Anthinocrinidae and Facetocrinidae stems and their evolution

The families Bazaricrinidae, Anthinocrinidae and Facetocrinidae are represented by stems of easily recognizable morphofunctional types. Specific features of their structure enables genetic links between these families and crinoid stems of primitive pentamerous morphofunctional types widespread in the Ordovician and Early Silurian (Stukalina, 1967, 1968, 1986b, etc.) to be established.

Diagnostic features of Bazaricrinidae, Anthinocrinidae and Facetocrinidae primarily concern articular facets of stem columnals. Three main structural elements are distinguished in their structure: (1) axial canal; (2) ligamentary field rosette and (3) crenulated zone of articular facet.

(1) *Axial canal.* In stem columnals of all the three families, the axial canal is narrow or very narrow ($d_c \leq 1/5$ D). It is located in the centre of articular facets. In the cross section, the canal has a quinquelobate or a pentagonal outline. In case of a lobate structure of the canal, its lobes are gentle, low, slightly dissected.

(2) *Ligamentary field rosette.* It is located in a deepened smooth central part of the articular facets of stem columnals and served as an attachment site for elastic ligaments (ligamentary tissue) joining the columnals. In Bazaricrinidae and Anthinocrinidae, the ligamentary field rosette is subdivided into

five lobes dactylate in Bazaricrinidae and semicircular, round, clavate or trapeziform in Anthicrinidae. In Facetocrinidae, the ligamentary field rosette has a pentagonal and stellate outline in plan. Irrespective of the form and type of subdivision, the ligamentary field rosettes of Bazaricrinidae, Anthinocrinidae and Facetocrinidae always develop from the axial canal walls: the lobes, corners and apices of the ligamentary field rosette of these forms do not coincide in their direction with the axial canal corners and lobes. This feature diagnoses the three families and provides grounds for their placement in the order Angulata of pentamerate crinoids.

(3) *Crenulated zone of articular facet*. Outside the limits of pits on the smooth ligamentary field rosette, the surface of the articular facets of stem columnals is crenulated. In the interlobe areas of the ligamentary field rosette, crenulae are, as a rule, located in a pinnate pattern relative to lobes or corners of the rosette; sometimes they are located radially, similar to those on the peripheral margin of facets. Crenulae, or ridges, are arranged into intercrenulae grooves and hollows of articular facets of adjacent columnals, forming a "hinge".

Morphofunctional types of stem columnals of Bazaricrinidae, Anthinocrinidae and Facetocrinidae species and genera are connected by the evolutionary succession of morphological changes. Changes affect all the main structural elements of articular facets of stem columnals. The axial canal is narrowed to the minimum ("point"). The ligamentary field rosette, on the contrary, abruptly increases in size, extends, deepens and gradually covers almost the entire articulation area of columnals. Correspondingly, the size of the crenulated zone of articular facets is reduced: crenulae are gradually displaced towards the peripheral margin of articular facets of stem columnals, becoming larger and relief.

Changes in the main structural elements of articular facets of stem columnals control the change in the contour proper (outline) of columnals: in articular facets with a well-developed broad ligamentary field, the outline of columnals seems to repeat that of the ligamentary field rosette. Often, a change in the outline of columnals is accompanied by a more enhanced relief of the lateral surface of columnals: projections and tubercles at their corners become more abrupt and expressive; they emphasize and enhance the outline of stem columnals.

Within the successive evolutionary changes of structural elements of the articular facets of stem columnals, the leading role is played by changes in the ligamentary field rosette. It should be also emphasized, that in the process of ligamentary field morphogenesis a rather stable shape of the ligamentary field rosette is retained, irrespective of whether it has a lobate structure or not.

Remarks on classification of Bazaricrinidae, Anthinocrinidae and Facetocrinidae

Family **BAZARICRINIDAE** Stukalina, 1982

The family Bazaricrinidae is monotypic. Its type genus is *Bazaricrinus* Stukalina, 1968 described from Silurian material from Kazakhstan and Siberia (Stukalina, 1968, 1975, 1982a, 1986a). Bazaricrinidae are represented by distinct pentahedral stem columnals. Their diagnostic features concern the structure of the articular facets: a well-developed ligamentary field rosette subdivided into five narrow lobes of a dactylate shape and simple radial crenulation in interlobe areas and peripheral zone of articular facets. The genus *Bazaricrinus* comprises five species: the type species *B. bazarensis* Stukalina, 1968 (Lower Silurian, Wenlockian, Kazakhstan), *B. parvulus* Stukalina, 1982 (Lower Silurian of Siberia), *B. stellatilobatus* Stukalina, 1986 (Upper Silurian, Pridolian, Kazakhstan), *B. tersus* Stukalina, 1975 (Lower Devonian, Lower Lochkovian, Kazakhstan) and *B. umbonatus* sp. n. (Malinovets Horizon (Ludlovian) of Upper Silurian on the Russian Platform). These species are connected by an evolutionary succession of morphological changes in articular facets ligamentary field proceeding along two trends. One of them is illustrated by *B. parvulus*, *B. bazarensis* and *B. umbonatus*, the other one, which is more progressive, by *B. stellatilobatus* and *B. tersus* (Fig. 1).

Bazaricrinus umbonatus sp. n.
(Figs 1, *3*; 4, *1*)

Holotype. 1/13016, CNIGR Museum; Russian Platform, Podolian, Dniester River; Upper Silurian, Malinovets Horizon, Grintchuk Beds.

Paratypes. 34 specimens, as holotype, but partly from the Konov and Sokol Beds.

Description. Monolithic, very small (D = 1 mm), pentagonal stem columnals. Corners distinct in proximal columnals and vague in

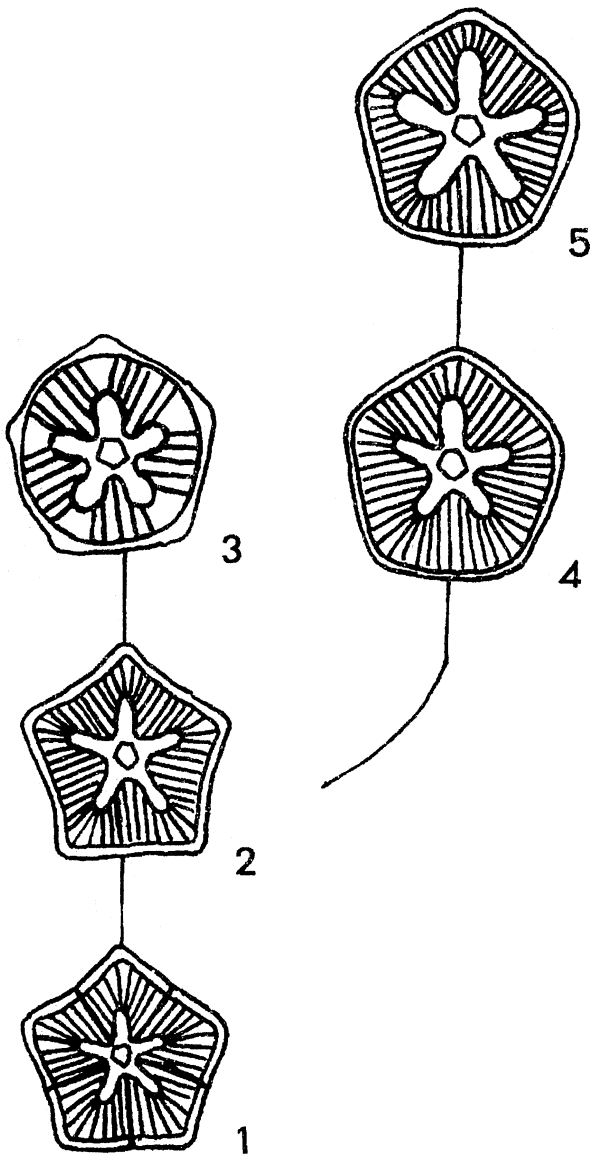

Fig. 1. *Bazaricrinus*, articular facets of proximal columnal showing morphogenesis of crinoid stem (6×): **1**, *B. parvulus* Stukalina; **2**, *B. bazarensis* Stukalina; **3**, *B. umbonatus* sp. n.; **4**, *B. stellatilobatus* Stukalina; **5**, *B. tersus* Stukalina.

distal ones. Lateral surface of columnals convex. In the proximal part, columnals arranged following the scheme I-II-I-II-I. Nodals differing from internodals in greater height, larger diameter, and greater convexity. Minor, acute tubercles located at corners of nodals. Axial canal of stems pentagonal, d_c = 1/7-1/8 D. On articular facets of columnals, there is a well-developed ligamentary field divided into five lobes. Lobes broad, of dactylate and clavate shape, fused in the central part of the ligamentary field rosette. In distal columnals, length of lobes 2/3 of the stem facet radius. In proximal columnals, apices of lobes reaching the edge of facet. In interlobe areas of articular facets, large, sparse, abrupt, straight crenulae occur normal to the facet faces.

Comparison. The described species is most close to the Early Silurian species *B. bazarensis* Stukalina, 1968 and *B. parvulus* Stukalina, 1982. It differs from them in the monolithic, non-pentamerous structure of columnals and abrupt sparse crenulae in interlobe areas of the ligamentary field on articular surfaces of columnals.

Distribution. South-west Russian Platform, Dniester River; Upper Silurian, Malinovets Horizon, Konov, Sokol and Grintchuk Beds.

Family **ANTHINOCRINIDAE** Schewtschenko, 1966

The family Anthinocrinidae is considered by the author as comprising six genera: *Anthinocrinus* Stukalina, 1981, *Kotanocrinus* Stukalina, 1977, *Urushicrinus* Stukalina & Shishkina, 1979, *Floricrinus* Stukalina, 1977, *Wenjukowicrinus* gen. n. and *Shishkinaecrinus* gen. n.

Anthinocrinus Stukalina, 1961

It is the type genus of the family Anthinocrinidae. Remarks on erection of the genus and its nomenclature are given by Stukalina (1991). The first diagnoses of the genus *Anthinocrinus* were published by Stukalina (1961), Dubatolova (1964, 1967) and Schewtschenko (1966); they were further refined by Dubatolova (1971), Yeltyschewa & Sizova (1973) and Stukalina (1975, 1986a, 1986b, 1991). Diagnostic features of the genus concern the structure of articular facets of columnals: the ligamentary field rosette subdivided into five round

Table 1. Comparison of diagnoses of the genera of Anthinocrinidae

Genus	Characters
Anthinocrinus	Lobes of the ligamentary field rosette broad, round or clavate. Crenulae in interlobe areas of the rosette and on the peripheral margin of articular facets simple, radial. Articular facets pentagonal, almost round
Kotanocrinus	Lobes of the ligamentary field rosette broad and trapeziform. Crenulae in interlobe areas of the rosette and on the peripheral margin of articular facets simple, radial. Articular facets pentagonal, almost round
Urushicrinus	Lobes of the ligamentary field rosette broad, dactylate, deep. Crenulae in interlobe areas of the rosette and on the peripheral margin of articular facets simple, radial, very coarse, high, sparse. Articular facets pentagonal, almost round
Floricrinus	Ligamentary field rosette broad, round or clavate. Crenulae in interlobe areas and on the peripheral margin of articular facets fine, pinnate. Articular facets pentagonal, almost round
Wenjukowicrinus	Lobes of the ligamentary field rosette broad, dactylate, deep. Crenulae in interlobe areas and on the peripheral margin of articular facets fine, pinnate. Articular facets pentagonal, almost round
Shishkinaecrinus	Lobes of the ligamentary field rosette narrow, lanceolate, almost slit-like. Crenulae in interlobe areas and on the peripheral margin of articular facets coarse, pinnate. Articular facets pentagonal and stellate

or clavate lobes and simple radial crenulae in interlobe areas and peripheral zone of articular facets. We consider the genus *Anthinocrinus* as comprising ten species: the type species, *A. ludlowicus* Stukalina, 1961 (Lower Devonian in Kazakhstan), *A. rozmanae* Stukalina, 1994 (boundary Wenlockian/ Ludlovian beds in Mongolia), *A. tuvaensis* Yeltyschewa, 1982 (Upper Silurian of Tuva and Mongolia), *A. levis* sp. n. (Malinovets Horizon of Ludlovian on the Russian Platform), *A. luchi* Yeltyschewa, 1968 (Skala Horizon of Upper Silurian on the Russian Platform; Eigus Beds of the Upper Silurian Kaugatuma Horizon in Estonia), *A. podolicus* Yeltyschewa, 1968 (Rashkov and Dzvinogorod Beds of the Skaly Horizon on the Russian Platform; Upper Greben Horizon in Vaigach Island; post-Ludlovian in Poland, according to Gluchovski (1981)), *A. substellaris* Yeltyschewa & Stukalina, 1977 (Greben Horizon in Vaigach Island), *A. costatus* Stukalina, 1986 (Tokrau Horizon of Upper Silurian in Kazakhstan), *A. radialis* Stukalina, 1975 (age equivalents of Lochkovian and Lower Pragian in Kazakhstan) and *A. cognatus* Yu. Dubatolova, 1964 (Krekov Horizon of the Lower Devonian in Salair). Species of the genus *Anthinocrinus* are connected by the evolutionary succession of morphogenetic changes in articular facets of stem columnals. It shows up in increasing size of the quinquelobate ligamentary field rosette and in a successive displacement of crenulae towards the peripheral margin of stem columnals (see: Stukalina, 1994, Fig. 1).

Two trends of articular facets morphogenesis are established, and, respectively, two groups of species, which illustrate them: (1) evolution trend of ligamentary field rosette subdivided into five round lobes (*A. rozmanae* – *A. tuvaensis* – *A. levis* – *A. luchi* – *A. podolicus*) and (2) evolution trend of ligamentary field rosette subdivided into five clavate lobes (*A. costatus* – *A. radialis* – *A. cognatus* – *A. ludlowicus*). The second group of species signifies more progressive morphological changes in articular facets.

Anthinocrinus levis sp. n.
(Fig. 4, *2*)

Anthinocrinus levis sp. n. (nom. nud.): Stukalina, 1994: 56, 57.

Holotype. 7/13016, CNIGR Museum; Russian Platform, Podolian, Dniester River; Upper Silurian, Malinovets Horizon, Grintchuk Beds.

Paratypes. 56 specimens, as holotype but partly from the Konov and Sokol Beds.

Description. Monolithic stem columnals. D = 2-5 mm (mean 3.5 mm). Columnals with a pentagonal, almost round outline.

Lateral surface of columnals slightly convex. Stem ossicles in proximal part composed of alternating nodals and internodals. Their alternation scheme is I-II-I-II-I or III-II-I-II-II-I. Nodals differing slightly from internodals in their height and diameter. There are very small tubercles at the corners of nodals enhancing a pentagonal contour of columnals. Axial canal narrow, quinquelobate or pentagonal in cross section (d_c = 1/4-1/5 D). Articular facets of columnals characterized by a relief quinquelobate rosette of ligamentary field. Rosette lobes narrow, dactylate. Their length in proximal columnals almost equal to half of the radius of articular facet of columnals. Outside the ligamentary field, simple radial crenulae occur on articular facets. In some specimens, crenulae are pinnate relative to the ligamentary field. In 1/4 of the articular facet there are 14-18 crenulae.

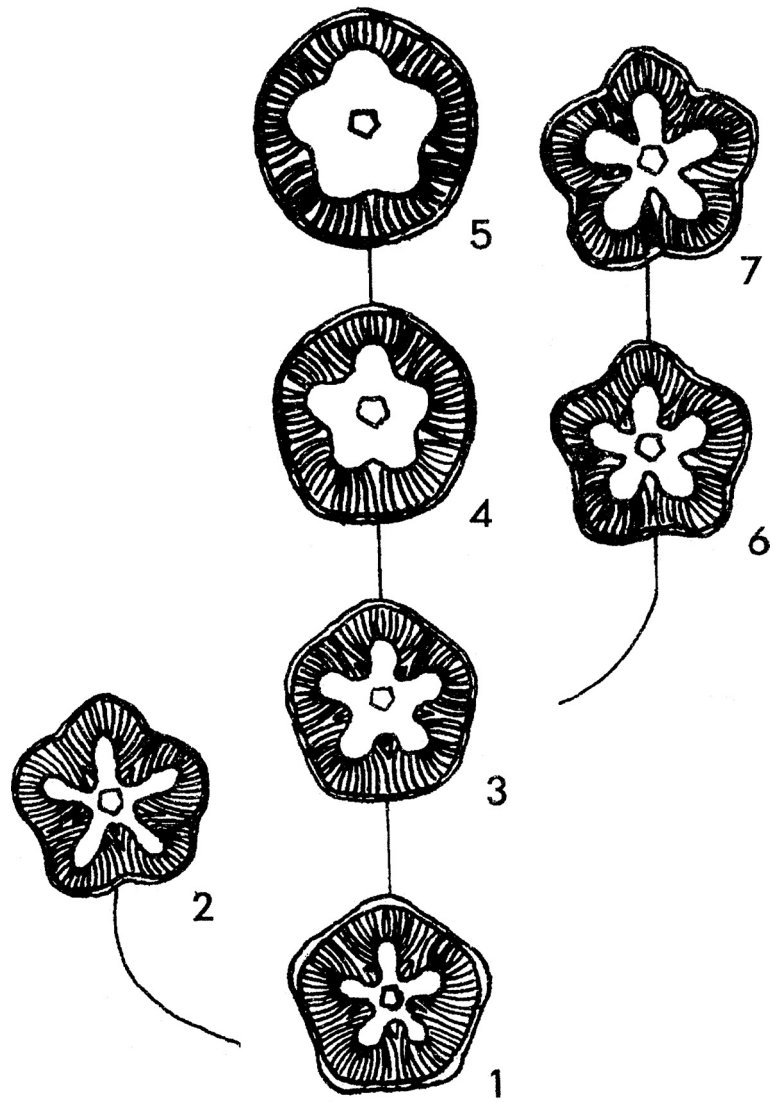

Fig. 2. *Floricrinus*, articular facets of proximal columnal showing morphogenesis of crinoid stem (5×): **1**, *F. floreus* (Yeltyschewa); **2**, *F. gracilis* (Yeltyschewa & Yu. Dubatolova); **3**, *F. primaevus* (Sisova); **4**, *F. proteus* Stukalina; **5**, *F. rotundus* (Yeltyschewa & Sisova); **6**, *F. sogdianus* Schewtschenko; **7**, *F. grandilobatus* (Yu. Dubatolova).

Comparison. In the structure of the articular facet, the described species holds an intermediate position between *A. tuvaensis* Yeltyschewa, 1982, and *A. luchi* Yeltyschewa, 1968 (see Stukalina, 1994). It differs from them in larger size of the ligamentary field rosette. In the lateral surface structure, *A. levis* is most similar to *A. tuvaensis*, but differs from it in the cylindrical shape of columnals and less developed small tubercles located at the corners of columnals.

Distribution. South-west Russian Platform, Dniester River; Upper Silurian, Malinovets Horizon, Konov, Sokol and Grintchuk Beds.

Kotanocrinus Stukalina, 1977

Monotypic genus, with the type species *K. balaensis* Stukalina, 1977, the type material of which is taken from the Sardzhal Horizon

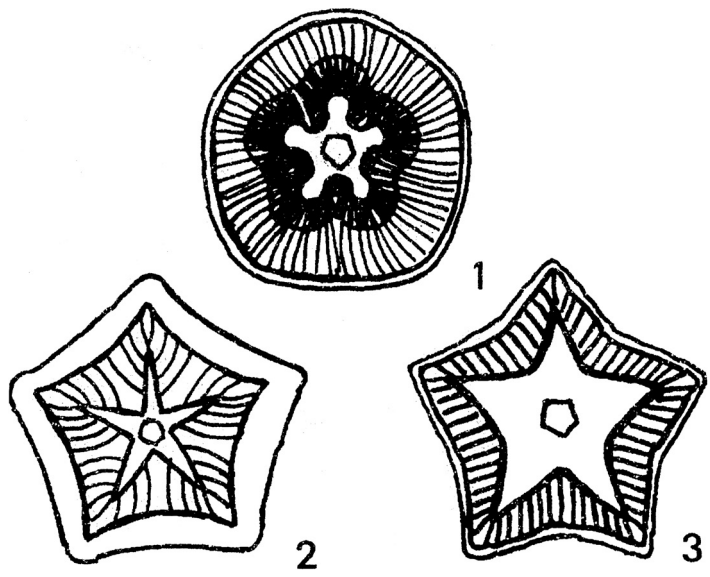

Fig. 3. Morphotypes of crinoid stems (5×): **1**, *Wenjukowicrinus* Stukalina, gen. n.; **2**, *Shishkinaecrinus* Stukalina & Kurilenko, gen. n.; **3**, *Blandicrinus* Stukalina & Yu. Dubatolova, gen. n.

(Pragian) of the Lower Devonian in North Balkhash area in Kazakhstan (Stukalina, 1977, 1986b, 1991, fig. 14). Diagnostic features of the genus concern the structure of articular facets: a well-developed ligamentary field rosette having five broad trapeziform lobes and simple radial crenulae on peripheral margin of facets. The genus *Kotanocrinus* is probably related to *Anthinocrinus* (group of species *A. costatus* – *A. radialis* – *A. ludlowicus*). Noteworthy is the reiteration of the morphofunctional type of articular facets of *Kotanocrinus*-type stem columnals in other phylogenetic lineages of Paleozoic crinoids not associated by common origin with the Silurian and Devonian *Anthinocrinus* known to us. Such an example of parallel evolution is illustrated by the Early Carboniferous genus *Tchironocrinus* Stukalina, 1973.

Urushicrinus Stukalina & Shishkina, 1979

Stem columnals of *Urushicrinus* are characterized by a well-developed quinquelobate ligamentary field rosette on articular facets of stem columnals and very coarse crenulae in interlobe areas of articular facets (Stukalina & Shishkina, 1979; Stukalina, 1991, fig. 14). The genus adjoins *Anthinocrinus* and *Kotanocrinus*, but is rather distinctly separated: unlike *Anthinocrinus* and *Kotanocrinus*, the stem articular facets have larger, almost pear-shaped, well-developed lobes of the ligamentary field rosette and a relief crenulated zone. *Urushicrinus* includes two species: the type species *U. eugeniae* (Yeltyschewa & Yu. Dubatolova, 1967) (age equivalents of Emsian (Lower Devonian) in the Far East and Kazakhstan) and *U. raricostatus* (Yeltyschewa & Yu. Dubatolova, 1967) (Emsian of the Far East). Both species were described within the genus *Anthinocrinus* (Dubatolova, Yeltyschewa & Modzalevskaja, 1967; Yeltyschewa, 1969).

Floricrinus Stukalina, 1977

The genus comprises the type species *F. proteus* Stukalina, 1966 (Lower Devonian of Kazakhstan), *F. floreus* (Yeltyschewa in Yu. Dubatolova, Yeltyschewa & Modzalevskaja, 1967) (Lower to Middle Devonian of Kazakhstan, the Urals, Altai, Salair, South Tien Shan and Far East), *F. primaevus* (Sisova in Yu. Dubatolova, Yeltyschewa & Modzalevskaja, 1967) (Middle Devonian, Eifelian of Kazakhstan, Altai and Far East), *F. rotundus* (Yeltyschewa & Sisova, 1973) (Upper Devonian of Kazakhstan), *F. grandilobatus* (Yu. Dubatolova, 1971) (Kireev Horizon of Middle Devonian in Gorny Altai), *F. sogdianus* Schewtschenko, 1989 (Eifelian, Middle Devonian in South Tien Shan) and *F. gracilis* (Yeltyschewa & Yu. Dubatolova, 1961), **comb. n.** (Givetian, Middle Devonian of Gorny Altai). The species *F. floreus*, *F. primaevus*, *F. rotundus* and *F. grandilobatus* were earlier considered within the genus *Anthinocrinus* (Dubatolova, Yeltyschewa & Modzalevskaja, 1967; Dubatolova, 1971; Yeltyschewa & Sisova, 1973), *F. gracilis* within the collective generic group *Pentagonopentagonalis* (Dubatolova & Yeltyschewa, 1961) and the genus *Anthinocrinus* (Dubatolova, Yeltyschewa & Modzalevskaja, 1967). Diagnostic features of *Floricrinus* concern the structure of the articular facet of stem columnals: ligamentary field subdi-

vided into five round and clavate lobes and crenulae of interlobe area and peripheral margin of articular facet pinnate (Stukalina, 1977; 1991, fig. 14). *Floricrinus* is related to *Anthinocrinus*, but is more evolutionary advanced. Two groups of species are distinguished among *Floricrinus*. The first group, of an earlier origin, comprises *F. floreus* and *F. gracilis*. The second group, which is later in terms of its existence period, comprises species represented by more progressive morphofunctional types: *F. primaevus, F. proteus, F. sogdianus, F. grandilobatus, F. rotundus* (Fig. 2).

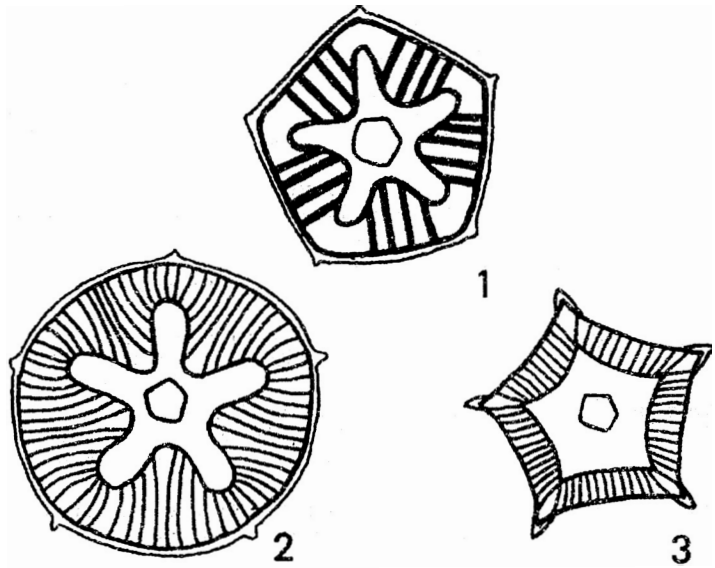

Fig. 4. Proximal stem columnals: **1**, *Bazaricrinus umbonatus* sp. n.; **2**, *Anthinocrinus levis* sp. n.; **3**, *Facetocrinus quinqueangulatus* sp. n.

Wenjukowicrinus Stukalina, gen. n.

Wenjukowicrinus (nom. nud.): Stukalina, 1977: 66.

Type species *Anthinocrinus wenjukowi* Yeltyschewa in Yeltyschewa & Stukalina, 1977.

Description. Stem columnals of a soft pentagonal, almost round outline. Their axial canal narrow ($d_c \leq 1/6$ D), pentagonal or quinquelobate in cross section. Diagnostic features of the genus concern the structure of articular facets of columnals. Their central, larger part is occupied by well-developed ligamentary field markedly divided into five lobes. Lobes merging in proximal part, markedly widened in distal part, becoming of almost clavate shape. Direction of lobes not coinciding with that of angles and lobes of axial channel. Interlobe areas and marginal part of articular facets with fine crenulae pinnately arranged relative to lobes of the ligamentary field. Proximal and distal stem fragments composed of alternating nodals and internodals of two, three and four orders. Angular nodal columnals bearing large long cirri (Fig. 3, *1*).

Included species. The genus comprises the type species *W. wenjukowi* (Yeltyschewa in Yeltyschewa & Stukalina, 1977) (Frasnian of the Upper Devonian in the Russian Platform, Timan and Novaya Zemlya) and *W. incisus* (Yeltyschewa in Yu. Dubatolova, 1964), **comb. n.** (Frasnian of the Upper Devonian in the Russian Platform and Kuznetsk Basin). *W. incisus* was named in R.S. Yeltyschewa's collection in the 50's. It was described by Yeltyschewa in Dubatolova (1964) within the genus *Anthinocrinus*. *Wenjukowicrinus* is related to *Floricrinus* (group of species *F. floreus – F. gracilis*).

Comparison. The described genus is related to the genus *Floricrinus* characteristic of all Middle Devonian deposits. Stem articular facets of *Floricrinus* and *Wenjukowicrinus* have a well-dissected quinquelobate ligamentary field, their interlobe areas and peripheral zone are characterized by fine pinnate crenulae. Unlike *Floricrinus*, the stem columnals of *Wenjukowicrinus* have a more developed ligamentary field rosette and are higher.

Distribution. Russian Platform, Timan, Novaya Zemlya, Kuznetsk Basin; Upper Devonian, Frasnian.

Etymology. The genus is named after P.N. Wenjukow, outstanding Russian researcher and initiator of Devonian studies on the Russian Platform.

Shishkinaecrinus Stukalina & Kurilenko, gen. n.

Shishkinaecrinus (nom. nud.): Stukalina, 1997: 66.

Table 2. Comparison of diagnoses of the genera of Facetocrinidae

Genus	Characters
Gregariocrinus	Ligamentary field rosette pentagonal, very narrow ($d_l \leq 1/3$ D), not deep. Crenulae on articular facets radial, fine, dichotomizing. Articular facets pentagonal, almost round
Kasachstanocrinus	Ligamentary field rosette pentagonal, narrow ($d_l = 1/3$ D), not deep. Crenulae on articular facets radial, simple. Articular facets pentagonal, almost round
Facetocrinus	Ligamentary field rosette pentagonal or stellate, broad ($d_l > 1/3$ D), deep. Crenulae on articular facets radial, simple. Articular facets pentagonal and stellate
Karakolocrinus	Ligamentary field rosette stellate, very broad ($d_l < 1/2$ D) and deep. Crenulae on articular facets radial, coarse, high. Articular facets pentagonal and stellate
Blandicrinus	Ligamentary field rosette stellate, dissected; rays-lobes short, dactylate; the main field of rosette pentagonal, very broad ($d_l \geq 1/2$ D) and deep. Crenulae on articular facets pinnate and radial, coarse, high. Articular facets pentagonal and stellate
Formosocrinus	Ligamentary field rosette stellate, abruptly dissected. Lobes-rays cone-shaped, long, abruptly narrowed distally. Crenulae on articular facets simple, radial. Articular facets abruptly pentagonal and stellate
Nuracrinus	Ligamentary field rosette stellate, abruptly dissected. Lobes-rays narrow, long, lanceolate and slit-like. Crenulae on articular facets coarse, radial. Articular facets markedly pentagonal and stellate

Type species *Anthinocrinus petalatus* Yeltyschewa & Yu. Dubatolova in Dubatolova, Yeltyschewa & Modzalevskaja, 1967.

Description. Stem columnals of a pentagonal and stellate outline. Their axial canal very narrow ($d_c \leq 1/7$ D), pentagonal, stellate or quinquelobate in cross section. Diagnostic features of the genus concern specific features of structure of articular facets of columnals. Their central part bears a quinquelobate, abruptly dissected ligamentary field rosette. Lobes of rosette very narrow, markedly widening distally, with acute apices, not coinciding in their direction with the axial canal corners and lobes. Articular facet surface outside the ligamentary field with pinnate coarse crenulae most relief in interlobe areas. Proximal stem fragments composed of alternating nodals and internodals following the scheme I-II-I-II-I. Nodals differing markedly from internodals in larger diameter and height and strongly convex lateral surface (Fig.3, *2*).

Included species. The genus is monotypic. It includes *Sh. petalatus* (Yeltyschewa & Yu. Dubatolova, 1967) (Lower Devonian of the Far East) originally described in the genus *Anthinocrinus* (Dubatolova, Yeltyschewa & Modzalevskaja, 1967; Yeltyschewa, 1969).

Comparison. The described genus is most similar to *Floricrinus* Stukalina, 1977. These genera are similar due to a characteristic pinnate arrangement of crenulae on articular facets of stems. However, the structure of the ligamentary field rosette is markedly different in the compared genera: the new genus is characterized by very narrow ligamentary field lobes with acute apices; *Floricrinus* are noted for a broad ligamentary field rosette with semirounded lobes fusing at the base.

Distribution. Far East; Middle Devonian, Eifelian, Upper Imachin Formation.

Etymology. The genus is named after Mrs. G.R. Shishkina, geologist and paleontologist.

Family **FACETOCRINIDAE** Stukalina, 1968

The family Facetocrinidae is considered by us as comprising seven genera: *Gregariocrinus* Stukalina, 1968, *Kasachstanocrinus* Schewtschenko, 1966, *Facetocrinus* Stukalina, 1968, *Karakolocrinus* Stukalina, 1982, *Blandicrinus* gen. n., *Formosocrinus* Stukalina, 1975 and *Nuracrinus* Stukalina, 1991.

Gregariocrinus Stukalina, 1968

The genus is monotypic. Its type species *G. forus* (Stukalina, 1961), was originally described within the collective generic group *Pentagonocyclicus* (Stukalina, 1961, 1965a). The genus is characteristic of the boundary

Silurian/Devonian beds in Kazakhstan (Stukalina, 1975, 1991). Articular facets of *Gregariocrinus* stem columnals illustrate the simplest morphotype of crinoid stems of Facetocrinidae (ligamentary field of articular facets of a pentagonal outline; crenulae on facets simple, radial). It can be considered initial morphotype in the series of morphological changes of stem facets in *Gregariocrinus – Kasachstanocrinus – Facetocrinus.*

Kasachstanocrinus Schewtschenko, 1966

The diagnosis of the genus given by Schewtschenko (1966) was revised by Dubatolova (1971), Sisova (Yeltyschewa & Sisova, 1973) and Stukalina (1986b, 1991). Characteristic features of the genus are the non-broad ligamentary field of articular facets of stem columnals, which has a pentagonal outline, and radial crenulae on facets. We include in this genus the type species *K. asperum* Schewtschenko, 1966 (Lower Devonian of South Tien Shan), *K. multigenus* Yu. Dubatolova, 1971 (Lower Devonian of Salair) and *K. torosus* Yu. Dubatolova, 1968 (Middle Devonian of Salair). Possibly, the genus includes also the species described as *Anthinocrinus quinquefidus* by Dubatolova (1968, 1971). The genus *Kasachstanocrinus* is adjoining *Gregariocrinus* and illustrates progressive alterations of the morphology of articular facets of *Facetocrinus*-type columnals.

Facetocrinus Stukalina, 1968

The genus comprises the type species *F. facetus* (Stukalina, 1961), *F. ajnasuensis* (Stukalina, 1961) and *F. quinquespinosus* (Stukalina, 1961), earlier described within the collective generic group *Pentagonopentagonalis* (Stukalina, 1961, 1965a, 1968), *F. pentagonus* Stukalina, 1977 and *F. stellatus* (Yeltyschewa & Sisova, 1973), the later was originally described in the genus *Kasachstanocrinus* (Yeltyschewa & Sisova, 1973). All the above species originate from the Lower Devonian of Kazakhstan (Stukalina, 1975, 1991). Besides, we assign the following species to the genus *Facetocrinus*: *F. subisodentatus* (Yu.Dubatolova, 1971), **comb. n.** (Middle Devonian of Gorny Altai), *F. acutulus* (Yu. Dubatolova, 1964), **comb. n.** (Lower Devonian of Salair), *F. conspicuus* (Yu. Dubatolova, 1964), **comb. n.** (Lower Devonian of Salair), *F. quinqueangularis* (Yu. Dubatolova, 1964), **comb. n.** (Middle Devonian of Salair and Minusinsk Depression). Dubatolova (1964, 1971, 1975) assigned these species to the genus *Anthinocrinus*. Some species of *Facetocrinus* were described by Schewtschenko (1966, 1989) from the Lower and Middle Devonian of South Tien Shan: *F. tuberculifer* (Schewtschenko, 1966), **comb. n.**, *F. alveolatus* (Schewtschenko, 1966), **comb. n.**, *F. sangulus* (Schewtschenko, 1966), **comb. n.**, *F. terminalis* (Schewtschenko, 1966), **comb. n.**, *F. abditus* (Schewtschenko, 1966), **comb. n.**, and *F. menakovae* Schewtschenko, 1989. Except *F. menakovae*, the species described by T.V. Schewtschenko were considered within the genera *Vasocrinus* (first two species) and *Anthinocrinus*. *Facetocrinus* is adjoining *Kasachstanocrinus* and illustrates the most progressive changes in morphology of articular facets of stem columnals. They are characterized by a broad, well-developed ligamentary field of a pentagonal and stellate outline.

Facetocrinus quinqueangulatus sp. n.
(Fig. 4, *3*)

Holotype. 13/13016, CNIGR Museum; Russian Platform, Podolian, Dniester River; Upper Silurian, Malinovets Horizon, Grintchuk Beds.

Paratypes. 72 specimens, as holotype, but partly from the Konov and Sokol Beds.

Description. Stem columnals monolithic, of a pentagonal and stellate outline. Corners of proximal columnals oblong and acute. Edges of columnals abruptly concave. D = 2.5-6 mm (mean 4-4.5 mm). Lateral surface of columnals convex. Columnals biserial and triserial. In the proximal part, they are arranged according to the scheme I-II-I-II-I or I-III-II-III-I. Large nodals ornamented at corners by acute, downhanging tubercles enhancing the sharpness of the columnals outline. On the surface of columnals, they occur one under another as relief vertical series. Axial canal of columnals narrow ($d_c \leq 1/6$ D), pentagonal or quinquelobate in cross section. The central part of articular facets is occupied by a well-developed ligamentary field of a marked stellate outline. Acute angles of the ligamentary field directed to the corners of columnals; in proximal columnals, they almost reach the corners of columnals. Direction of ligamentary field corners and the corners of columnals does not coin-

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