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New Data on the Famennian Conodonts from Esfahan Area, Central Iran

Hossein Gholamalian
Department of Geology, University of Hormozgan, Bandar Abbas, I.R. of Iran.
E-mail: h_gholam@yahoo.com
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Abstract

New investigations on a Late Devonian outcrop near Esfahan (Chahriseh section) revealed new data about the *Polygnathus bouckareti*, *Polygnathus communis* group and genus Clydagnathus. The feature differentiation related to the recovered species shows the exigency of a few changes in the age and variety of morphotypes of *P. communis* group. Some identified species in this paper are: *Polygnathus communis communis, P. communis mugodzharicus, P. bouckaerti, P. pomeranicus, P. lanceolus, P. inconcinnus, Icriodus alternatus alternatus* and *I. cornutus.* By considering the conodont associations, changes in the age of *P. bouckaerti* and *P. communis mugodzharicus* are the other results. In addition, two morphotypes of *P. communis mugodzharicus* and more detailed explanation of *P. communis* group are presented.

Keywords: *Famennian, Polygnathus communis group.*

Introduction

Chahriseh section is located on the west of Chahriseh village 55 km north-east of Esfahan. The best way for going to section is to get 40 km toward the north in the Esfahan-Ardestan road and then15 km to east on a carriage road (Fig. 1). The whole section has been considered by Gholamalian (1998, 2003a). There are some other works on both conodonts and vertebrate remains of this section (Hairapetian and Gholamalian, 1998; Turner *et al.*, 2002). Mistiaen *et al.* (2000), and Mistiaen and Gholamalian (2000) studied Frasnian stromatoporids and corals of this area. All of these works confirm the age of Early Frasnian to Late Famennian for the complete section. Gholamalian (2003b) has

determined the Frasnian-Famennian boundary above the coral biostroms. New thirty-nine geological samples are collected from Chahriseh section for recognition of Early-Middle Famennian boundary. Recent new sampling in the Famennian portion and punctual work on collected elements caused new suggestions about the evolutionary pattern and the age of some polygnathid species.

The materials are hosted in the Department of geology, University of Hormozgan. The abreviations in this paper are: *I. =Icriodus, P. =Polygnathus.*

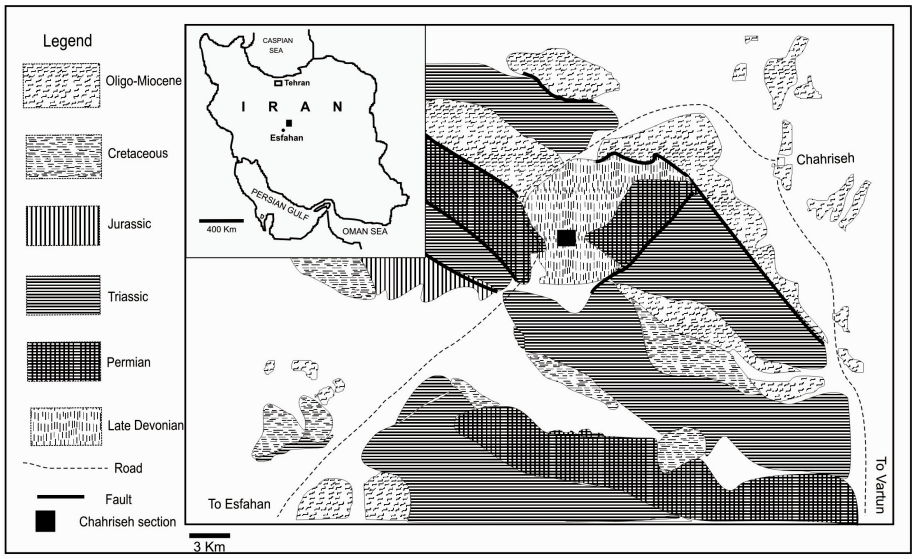

Figure 1. Geological map of Chahriseh area (after Yazdi *et al*.), the quadrangle shows the situation of section.

Stratigraphic remarks

The whole thickness of Late Devonian sediments in the Chahriseh area reaches 502.5 meters but 30.87 meters of that is considered. This portion was concerned to the age of Late Frasnian by Gholamalian (1998), but new investigations show Famennian age (Middle *crepida* Zone to Late *trachytera* Zone).

Conodont fauna in this study are composed of icriodid-polygnathid and pelekysgnathid–polygnathid biofacies. This faunal composition and

the absence of *Palmatolepis* show a very shallow water environment situation in the Late Devonian sequence of Esfahan. In addition, most of Late Devonian sequences in central Iran have the same position, shallow water environment governs on the most of them (Wendt *et al*., 1997). Application of shallow water conodont zonation (Sandberg & Dreesen, 1984) may allow us to compare our collection to biofacies III and IV, but standard conodont zonation (Ziegler & Sandberg, 1990) is used to biostratigraphic divisions.

Biostratigraphy

New conodont collection revealed the presence of five genus and sixteen species and subspecies in our samples from Chahriseh section. Standard conodont zonation of Ziegler and Sandberg (1990) forms the basis of our biozonation. More precise identification of these conodonts and the situation of samples on the stratigraphic column had us to erect two conodont associations but there is a barren interval between them (Fig. 2).

Middle to Latest *crepida* Zone: This part contains the association of these species: *Icriodus alternatus alternatus, I. cornutus, Polygnathus communis communis, P. inconcinnus, P. semicostatus, P. bouckaerti, P. lanceolus, Pele. inclinatus.* This association confirms the age range of Middle – Latest *crepida* Zone.

Barren portion: There is not any fossil in this terrigenous part, but on the basis of stratigraphic situation the most probable age is *rhomboida* Zone.

Early *marginifera* to Late *trachytera* Zone: This part contains the assemblage of *I. cornutus, P. communis communis, P. communis mugodzharicus, P. pomeranicus, P. bouckaerti, P. mutabilis, Pele. inclinatus.* By considering the age-range of mentioned species, the association has the age of Early *marginifera* to Late *trachytera* Zone (Sandberg & Dreesen, 1984; Matyja, 1993; Khalymbadzha *et al*., 1992). Gagiev *et al.* (1987) have reported *P. communis mugodzharicus* from the Famennian/Turnaisian boundary (*praesulcata - sulcata* Zone), but it is associated with other species in an assemblage that shows the age of Early *marginifera* – Late *trachytera* Zone as the oldest observation of this subspecies.

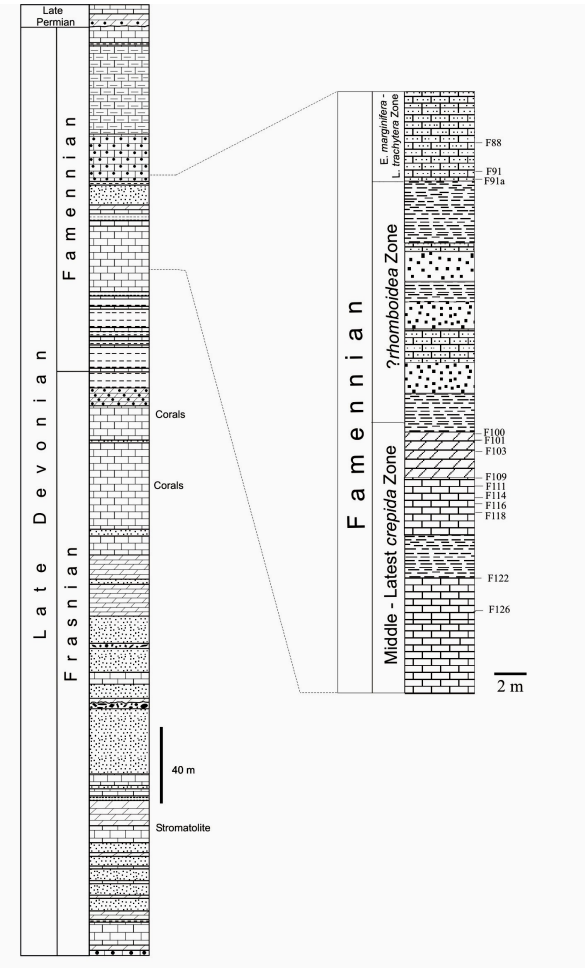

Figure 2. Stratigraphic column of Chahriseh section north-east of Esfahan. *I=Icriodus, P=Polygnathus, al. al.=alternatus alternatus.*

Table 1. Distribution chart of Famennian conodonts from Chahriseh section.

Samples	F126	F125	F124	F123	F122	F116	F115	F114	F113	F111	F109	F104	F103	F101	F100	F91a	F91	F90	F89	F88
I. alternatus al.	1		1					1		4			2							
I. cornutus		7						3		27	1	3		2	1	2	4	3		8
Mehlina sp.	1					3		2		17	1					3			1	2
Pele. inclinatus	2	2		1	2	11		4	3	55		3	4	3	1	19		5	4	22
P. bouckaerti				1		4		2		6			3	2	1	1				
P. com. com. morph. 1	1	3	2		1	2	2	2	1	13	1			2	1					
P. com. com. morph. 2										6	1	1		1		1	2			7
P. com. mugodzharicus																	12	1		15
P. inconcinnus													1	2						
P. lanceolus						1	1			5				3						
P. mutabilis																		1		
P. pomeranicus																	7	1		
P. semicostatus								1		6				1						
P. sp.																				2
Clydagnathus sp.																				3
Total	5	12	3	2	3	21	3	15	4	149	4	7	10	16	4	26	25	11	5	59

Systematic Palaeontology

Order PRIONIODONTIDAE DZIK, 1976

Family ICRIODONTIDAE MÜLLER & MÜLLER, 1957

Genus *Icriodus* BRANSON and MEHL, 1938

Type species.- Icriodus expansus Branson & Mehl, 1938

Icriodus alternatus alternatus BRANSON and MEHL, 1934

Pl. 1, Fig. 2

Description: See Ji and Ziegler (1993), p. 55 for description.

Age-range: According to Ziegler and Sandberg (2000), this subspecies has the age-range of Early *rhenana* to Late *crepida* Zone.

Material: One I element from sample F114 and four from F 111.

Icriodus cornutus SANNEMANN, 1955

Pl. 1, Fig. 1

Description: This species can be recognized by having a medial row of denticles that is as high as lateral ones. There is a large cusp at the posterior end of platform and this cusp is connected to the medial row. The I element is unarched in side view but is down-curved beneath the large cusp.

Age-range: according to Sandberg and Dreesen (1984) this species has an age-rage from Middle *triangularis* Zone to Late *trachytera* Zone.

Material: Seven elements from sample F125, three from F114, twenty seven from F111, One from F109, three from F104, two from F103, one from F100, two from F91, four from F91a, three from F90 and eight from F88.

Order OZARKODINIDAE DZIK, 1976
Family POLYGNATHIDAE BASSLER, 1925
Genus *Polygnathus* HINDE, 1879

Type species: Polygnathus dubius HINDE, 1879

Polygnathus bouckaerti DREESEN & DUSAR, 1974
Pl. 1, Figs 4-8

Description: This species is characterized by having a free short blade without arched downward lower margin and rows of nodes on the platform. Free blade and the platform are in the same plane. The platform is covered by longitudinal rows of separated nodes. The carina is composed of denticles and reaches to the posterior end. Two collar ridges can be observed on the anterior of platform.

Age-range: According to Matyja (1993), this species has the age range of *rhomboidea* to *expansa* Zones, but in Chahriseh section it is associated with some conodonts such as *I. alternatus alternatus, I. cornutus, P. inconcinnus* and *P. lanceolus*. By considering to all of these data, it seems to appear in *crepida* Zone.

Material: One Pa element in sample F123, four in sample F116, two in sample F114, six in sample F111, two in sample F103, one in sample F101, one in sample F100 and one in sample F91a.

Polygnathus communis communis morphotype 1 BRANSON & MEHL, 1934
Plate 1, Figs 16-17, 21-22, Plate 2, Figs 23-24

Description: Some of polygnathid specimens are collected which are comparable with *Polygnathus communis communis* Branson & Mehl, 1934. These specimens are characterized by smooth platform surface. Free blade is about one-third of complete element and consists of six denticles. Adcarinal troughs are deep in anterior and become shallow and wider in posterior. The basal cavity is formed of a small pit behind a deep depression.
Age-range: According to Ji and Ziegler (1993, fig. 21), this morphotype has the age rang of Middle *crepida* to *sulcata* Zones.

Material: One Pa element in sample F126, three in F125, two in F124, one in F122, two in F116, two in F115, two in F114, one in F113, thirteen in 111, one in F109, two in F101, one in F100.

Polygnathus communis communis morphotype 2 BRANSON & MEHL, 1934
Plate 1, Figs 18-19

Description: Platform is approximately oval in shape and small. The surface is smooth without any ornamentation. Carina is smooth and reaches to the posterior end and makes a sharp tip. Basal cavity is a small pit just behind the depression. Keel is sharp and reaches to the posterior tip. Yazdi (1999, pl. 7) has determined some polygnathid elements as P. communis communis. Their upper sureface is similar to P. communis communis morphotye 2, but the lower sureface (the basal cavity specially) seems to be very similar to P. zikmondovae (Zhuravlev, 1991).

Age-range: According to Ji and Ziegler (1993, fig. 21), this morphotype has the age rang of Early *marginifera* to *isosticha* Zones but it seems to begin in *crepida* Zone.

Material: Six Pa element in sample F111, one in F109, one in F104, one in F101, one in F91a, two nF91, seven in f88.

Polygnathus communis mugodzharicus GAGIEV, KONONOVA and PAZUKHIN, 1987
Pl. 3, Fig 2-9, Pl. 4, Figs 1-9

Description: Large elements of some polygnathid conodonts those resemble to *P. communis mugodzharicus* are found in Chahriseh section and they are characterized by their semi-symmetric shape and smooth surface. The specimens of morphotype 1 have a narrow platform at the anterior, but become expand toward posterior. There is not any ornamentation on the platform. The inner margin of platform has a small lobe in posterior, but the outer one is incurved in the posterior of some elements. Carina is smooth and may reach to the posterior end. Basal cavity is a narrow elongate pit with a depression behind it.

The new morphotype 2 is characterized by large specimens and broad asymmetric platform with marginal nodes or weak transverse ridges on the aboral surface. Anterior part of platform is narrow but the posterior is expand and incurved in one side. Carina is smooth and reaches to the posterior end. Basal cavity is a very narrow elongate pit and there is a depression behind it.

Age-range: According to Gagiev *et al*. (1987), these elements are reported from Famennian-Turnaisian boundary (*praesulcata-sulcata* Zones). This morphotype is associated with *P. pomeranicus, P. mutabilis* and *I. cornutus* in the second conodont association of Chahriseh section, therefore the age of *trachytera* Zone is proved for the appearance of this morphotype.

Material: Twenty Pa elements in sample F91 and six in sample F88 for morhpotype 1 and seven pa elements in sample F88 for morphotype 2.

Polygnathus inconcinnus KUZMIN and MELNIKOVA, 1992
Pl. 2, Figs 1-3

Description: This species can be known by having an asymmetric platform with two longitudinal ridges. The platform is arched in both lateral and downward sides. Carina and longitudinal ridges are composed of highly fused denticles and extend to sharp posterior tip. The basal cavity can be observed as a very narrow and long furrow. Very broad rim is present around the basal cavity.

Age-range: according to Kuzmin and Melnikova (1992) this species has the age range of Late *triangularis* – Latest *crepida* Zone.

Material: One Pa element in sample F103 and two in F101.

Polygnathus lanceolus VORONTSOVA, 1993

Pl. 1, Figs 12-13

Description: this species has a platform with lanceolate shape and smooth surface. Carina is high and reaches to a posterior sharp tip. Adcarinal troughs are deep and extend from anterior to posterior. The basal cavity has small flanges and is located at the uppermost part of platform just behind the free blade.

Age-range: According to Vorontsova (1993) this species has the age range of *crepida* – *rhomboidea* Zone.

Material: One Pa element in sample F114, five in F111 and one in F 101.

Polygnathus mutabilis KHALYMBADZHA, SHIANKARYOV, and GATOVSKY, 1991

Pl. 3, Figs 10-13

Description: This species has a depression behind the basal pit as the master character of *P. communis* group. Weak transversal ridges cover the platform surface. The posterior part of platform becomes narrow and sharp to make a short blade. The carina is very low and composed of fused denticles. Two coarse denticles can be seen on the posterior blade.

Age range: According to Khalymbadzha *et al.* (1991), this species has the age range of Late *rhomboida* – Early *expansa* (*striacus*) Zone.

Material: One Pa element in sample F90 and six in F88.

Polygnathus pomeranicus MATYJA, 1993
Pl. 2, Figs 10-12

Description: This species can be identified by having a free blade that is shorter than platform. The platform is long, narrow and smooth in surface. The margins of platform are upturned and thickened. Adcarinal troughs are deep and narrow. The carina is composed of highly fused nodes and extends to posterior tip. The basal cavity is located at the anterior end of platform and broad rims are around it.

Age range: According to Matyja (1993) this species has the age range of Early *marginifera* – Early *expansa* Zone.

Material: Seven Pa elements in sample F91.

Polygnathus semicostatus BRANSON and MEHL, 1934
Pl. 1, Figs 9-11

Description: See Ji and Ziegler (1993), p.43 and 84 for description.

Age range: According to Ji and Ziegler (1993), this species has the age range of Middle *crepida* to Late *expansa* Zone.

Material: One pa element in sample F114, six in F111 and one in F103.

Family CAVOSGNATHIDAE RHODES, AUSTIN and DRUCE, 1969
Genus Clydagnathus *RHODES, AUSTIN and DRUCE, 1969*

Type species: *Scaphignathus* velifer HELMS, 1959
Clydagnathus sp
Pl. 4, Figs 11-12

Description*:* After description of genus *Clydagnathus* by Rhodes *et al*. (1969), the species of *Clydagnathus ormistoni* erected in a revision of some shapes of *Scaphignathus* by Beinert *et al*. (1971). They declared *Clydagnathus ormistoni* as an intermediate species between *Scaphignathus velifer* and Early Carboniferous species of *Clydagnathus* (Beinert *et al*., 1971, p. 81-84). They described all of differences between two species of *Clydagnathus ormistoni* and *Scaphignathus velifer*.

In the Chahriseh samples, there are rare *Clydagnathus* elements those have some specifications similar to both two species mentioned above, but it is different from them in some characters. This species is narrow and almost long in shape. Weak transversal ridges cover the upper surface of platform and there is a denticle on each of ridges to make a middle row of denticles. The basal cavity is formed of a shallow and symmetric pit with two more or less broad flanks. The free blade joints to fix blade and platform just at the right side of platform. Transverse ridges and middle row of denticles are some of diagnostic characters of *Scaphignathus velifer*. On the other hand broad symmetric basal cavity and the junction of blade to the right side of platform shows the similarity to *Clydagnathus ormisoni*, so our specimens may belong to an intermediate form between those species. There are few specimens of this form in the sample of Chahriseh area and we need to have more specimens for clarifying its diagnosis as a new species.

Age-range: This species is associated with other conodonts such as *P. mutabilis, P. pomeranicus* and *I. cornutus.* Therefore the age-range of Early *marginifera* - Late *trachytera* Zone is proved for it.

Material: Three Pa elements from sample F88.

Conclusion

We can express some new idea about the *Polygnathus communis* group on the basis of variation in platform ornamentation. For example smooth or ornamented platform can be an important character for errection the new morphotypes of *P. communis mugodzharicus.*

Association of *P. communis mugodzharicus* with other species shows the age of Early *marginifera* – Late *trachytera* Zone for the first appearance of this subspecies.

According to Matyja (1993), *P. bouckaerti* has the age range of *rhomboidea* to *expansa* Zones, but presence of this species with other conodonts shows Middle - Latest *crepida* Zone as the oldest record.

The species of *Clydagnathus* sp. that is collected in the Chahriseh samples may be an intermediate species between *Spathognathodus velifer* and *Clydagnathus ormistoni*. This species is observed in an association with other conodonts that has the age of Early *marginifera*-Late *trachytera* Zone.

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Plate 1

Fig. 1 x45; Fig. 2 x52; Figs 3, 20 x37; Figs 4-6 x25; Figs 7-9 x44; Fig 10 x42; Fig. 11 x32; Fig. 12 x72; Fig. 13 x75; Figs 14-15 x45; Figs 16-17 x25; 18-19 x57; 21-22 x34.

***Icriodus cornutus* Sanemmann, 1955**

Fig. 1, Upper view, HUIC100, Middle – Latest *crepida* Zone, sample F111.
***Icriodus alternatus alternatus* Branson and Mehl, 1938**
Fig. 2, Upper view, HUIC101, Middle – Latest *crepida* Zone, sample F114.
***Pelekysgnathus inclinatus* Thomas, 1949**
Fig. 3, Lateral view, HUIC102, Middle – Latest *crepida* Zone, Sample F111.
***Polygnathus bouckaerti* Dreseen and Dusar, 1974**
Fig. 4, Upper view, HUIC104, Middle – Latest *crepida* Zone, sample F111.
Figs 5, Lateral view, HUIC103, Middle – Latest *crepida* Zone, Sample F114.
Fig. 6, Lower view, HUIC105, Middle – Latest *crepida* Zone, Sample F111.
***Polygnathus inconcinnus* Kuzmin and Melnikova, 1991**
Figs 7-8, Upper and lower view, HUIC110, Middle – Latest *crepida* Zone, Sample F101.
Fig. 9, Lateral view, HUIC111, Middle – Latest *crepida* Zone, Sample F101.
***Polygnathus semicostatus* Branson and Mehl, 1934**
Fig. 10, Upper view, HUIC107, Middle – Latest *crepida* Zone, sample F111.
Fig. 11, Upper view, HUIC108, Middle – Latest *crepida* Zone, sample F111.
***Polygnathus lanceolus* Vorontsova, 1993**

Figs 12-13, Upper and lower view, HUIC109, Middle – Latest *crepida* Zone, Sample F111.

***Polygnathus pomeranicus* Matyja, 1993**

Figs 14-15, Upper and lower view, HUIC113, Early *marginifera* – Late *trachytera* Zone, Sample F91.

Fig. 20, Upper view, HUIC114, Early *marginifera* – Late *trachytera* Zone, sample F91.

***Polygnathus communis communis* (morphotype 1) Branson and Mehl, 1934**

Figs 16-17, Upper and lower view, HUIC112, Middle – Latest *crepida* Zone, sample F111.

Fig. 21-22, Upper and lower view, HUIC115, Early *marginifera* – Late *trachytera* Zone, Sample F88.

***Polygnathus comunis communis* (morphotype 2) branson and Mehl, 1934**

Figs 18-19, Upper and lower view, HUIC114 Middle – Latest *crepida* Zone, Sample F111.

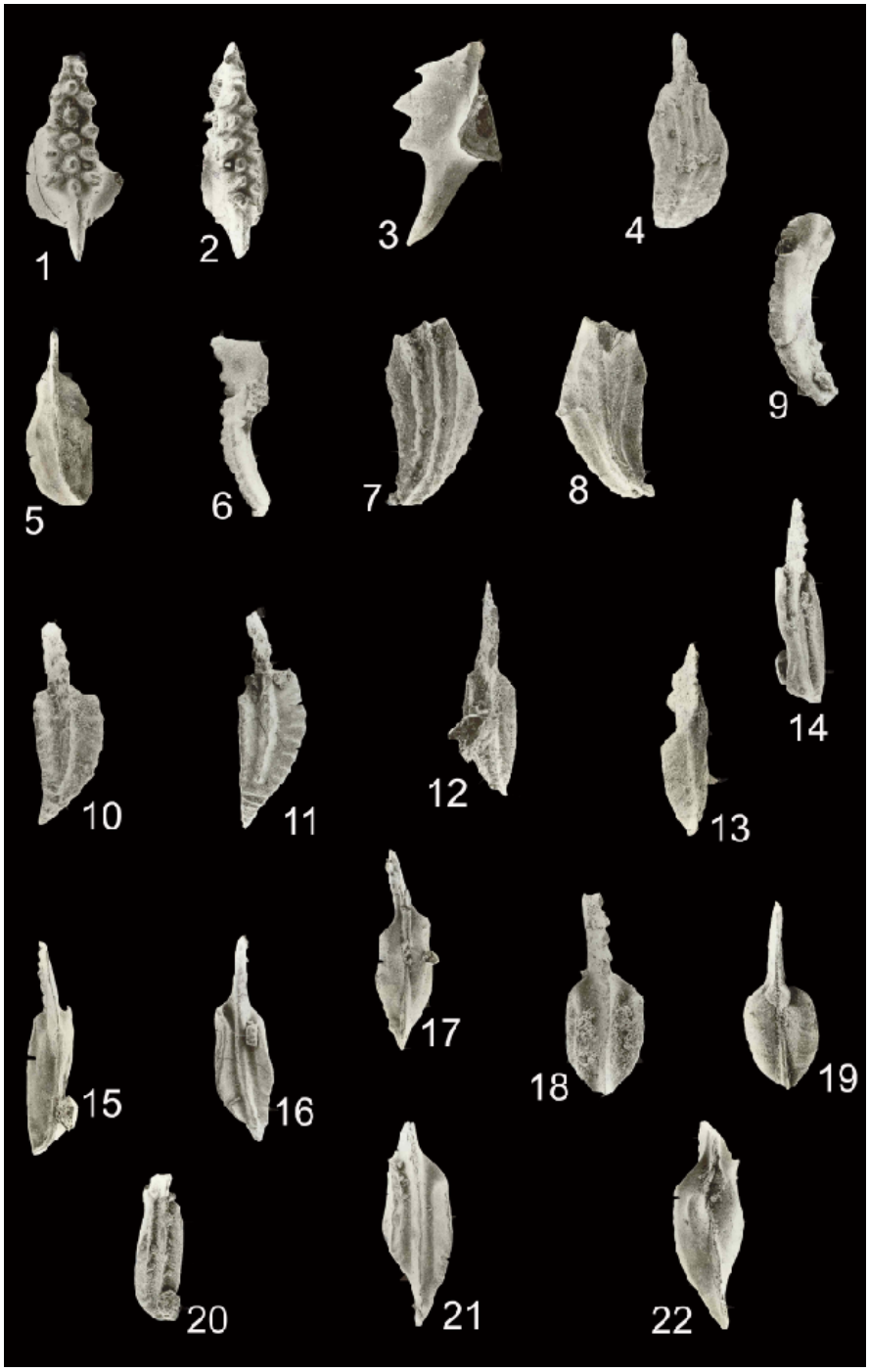
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Plate 2

Figs 1-2 x23; Fig. 3 x30; Fig. 4 x24; Figs 5-6 x28; Figs 7-10 x32; Figs 11-12, 14, 21-22 x26; Fig. 13 x21; Figs 15, 20 x17; Figs 16-19 x22; Fig. 23 x24; Figs 24-25 x21.

***Polygnathus communis mugodzharicus* (morphotype 1) Gagiev, Kononova and Pazukhin, 1987**

Figs 1-2, Upper and lower view, HUIC116, Fig. 4-5, Upper and lower view, HUIC117, Early *marginifera* – Late *trachytera* Zone, Sample F91.
Figs 3-4, Upper and lower view, HUIC118, Early *marginifera* – Late *trachytera* Zone, Sample F90.
Figs 5-6, Upper and lower view, HUIC120, Early *marginifera* – Late *trachytera* Zone, Sample F88.
Figs 11-12, Upper and lower view, HUIC123, Early *marginifera* – Late *trachytera* Zone, Sample F88.
Figs 13-14, Upper and lower view, HUIC124, Early *marginifera* – Late *trachytera* Zone, Sample F88.
Figs 15, 20 Upper and lower view, HUIC125, Early *marginifera* – Late *trachytera* Zone, Sample F88.

***Polygnathus communis mugodzharicus* (morphotype 2) Gagiev, kononova and Pazukhin, 1987**

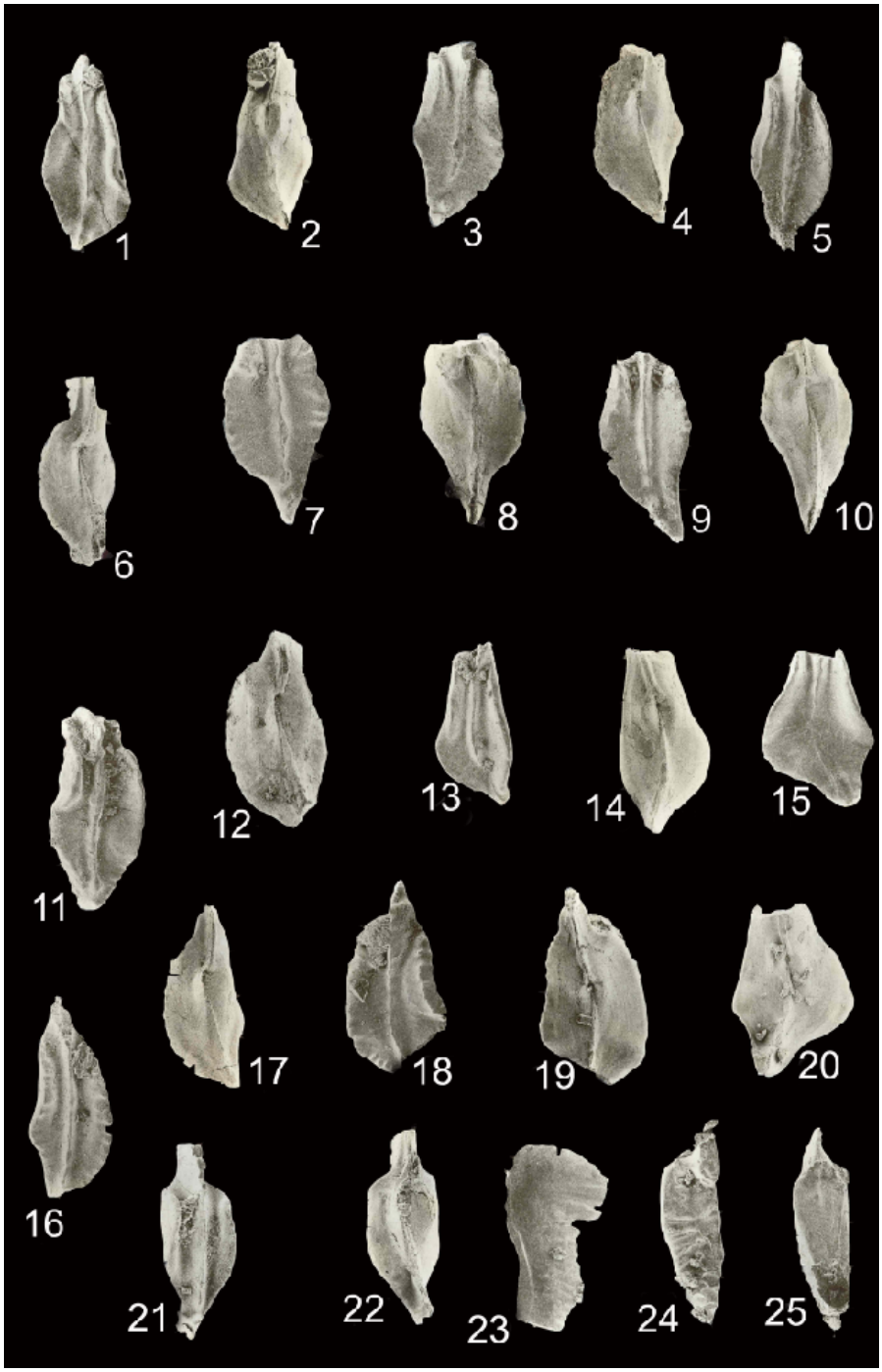
Figs 16-17, Upper and lower view, HUIC126, Early *marginifera* – Late *trachytera* Zone Sample F88.
Figs 18-19, Upper and lower view, HUIC127, Early *marginifera* – Late *trachytera* Zone, Sample F88.

***Mehlina* sp.**

Fig. 23, Lateral view, HUIC128, Middle – Latest *crepida* Zone, Sample F111.

***Clydagnathus* sp.**

Figs 24-25, Upper and lower view, HUIC129, Early *marginifera* – Late *trachytera* Zone Sample F88.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