Rivista Italiana di Paleontologia e Stratigrafia	volume 117	no. 2	2 pls.	pp. 199-209	July 2011

UPPER DEVONIAN CONODONT BIOSTRATIGRAPHY OF SHAMS ABAD SECTION, KERMAN PROVINCE, IRAN

ALI BAHRAMI [1], HOSSEIN GHOLAMALIAN [2], CARLO CORRADINI [3] & MEHDI YAZDI [4]

Received: October 25, 2010; accepted: April 05, 2011

Key words: Frasnian, Famennian, Conodonts, Biostratigraphy, Bahram Fm., Shams Abad, Kerman Province, Iran.

Abstract. The study of the conodont fauna from the Upper Devonian Shams Abad section provides new data on the stratigraphy of the Bahram Formation in the Kerman province, in southeastern Iran. The fauna includes twenty-four species, mainly belonging to genera *Polygnathus* and *Icriodus*, and gives evidence of a late Frasnian to middle Famennian age, in contrast to previous interpretation of the same unit. The shallow water conodont biofacies confirms an inner shelf to foreshore shallow marine depositional environment.

Riassunto. Lo studio della fauna a conodonti del Devoniano Superiore nella sezione di Shams Abad ha fornito nuovi dati sull'età della Formazione di Bahram nella Provincia di Kerman, Iran sud-orientale. La fauna comprende ventiquattro taxa, principalmente appartenenti ai generi *Polygnathus* e *Icriodus*, e consente di datare la sezione al Frasniano superiore-Famenniano medio, in contrasto con precedenti interpretazioni, che limitavano l'età al Frasniano. La fauna a conodonti caratteristica di mare basso conferma l'ambiente deposizionale dell'unità.

Introduction

The Upper Devonian and Lower Carboniferous sequences in the Kerman province are dominantly represented by limestones (with interbeds of sandstones and shales) of the Bahram Formation. The regional geology and stratigraphy of the Kerman area have been described by Huckriede et al. (1962) and Wendt et al. (2002). The fossil content have been illustrated by various authors: crinoids (Webster et al. 2003), brachiopods (Dastanpour & Bassett 1998) and trilobites (Morzadec et al. 2002). Gholamalian (2006) and Gholamalian & Kebriaei (2008) illustrated the conodont faunas from the Hutk and Hojedk sections, about 85 km northeast of the area studied in this paper.

The Shams Abad section is located 40 km North-East of Kerman, along the road of Kerman-Cheshmeh Gaz, about 1 km north of the Shams Abad village (Fig. 1). The area is mapped in the geological map of Baghin (Djokovic et al. 1972) and structurally belongs to the Central-East Iran Microplate.

Several authors studied sections in the Shams Abad area (i.e.: Huckriede et al. 1962; Dastanpour 1996; Wendt et al. 1997; Webster et al. 2003); all these authors agree on the infra-Cambrian age of the base of the sections and on a Carboniferous age for the upper part, but provided different interpretations for the Devonian part: Wendt et al. (2002) suggested an Eifelian age on the basis of a scarce, not figured, conodont fauna, whereas Dastanpour (1996) and Webster et al. (2003) referred this part of the succession to the Frasnian.

This paper provides evidence of a late Frasnian to middle Famennian age for the Bahram Formation in the Shams Abad area.

Geological setting

Sequences from Precambrian to Cretaceous with several sedimentary interruptions, are exposed in the Shams Abad area. The oldest stratigraphic unit of the area is represented by the volcano-sedimentary deposits of the Rizu Series. It consists of up to 800 metres of dolostone, sandstones and volcanic rocks (Huckriede et

1 Department of Geology, University of Isfahan, Isfahan, I.R. Iran. E-mail: Bahrami_geo@yahoo.com
2 Department of Geology, Faculty of Sciences, Hormozgan University, I.R. Iran. E-mail: hossein.gholamalian@yahoo.com
3 Dipartimento di Scienze della Terra, Università di Cagliari, via Trentino 51, 09127 Cagliari, Italy. E-mail: corradin@unica.it
4 Department of Geology, University of Isfahan, Isfahan, I.R. Iran. E-mail: yazdimehdi@yahoo.com

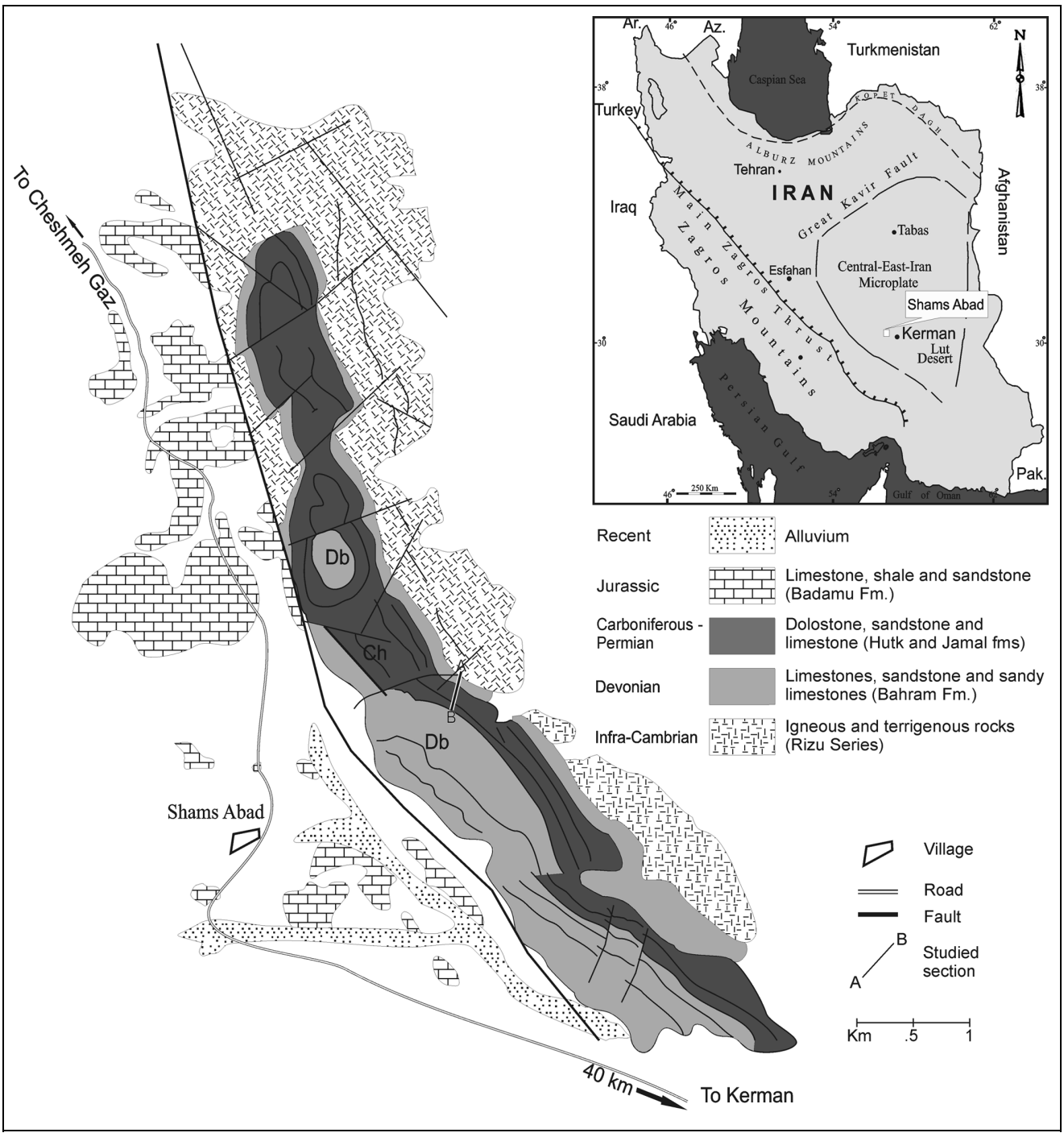

Fig. 1 - Geological map of the area around the Shams Abad village, Kerman Province, with indication of the studied section (redrawn and simplified after Djokovic et al. 1972).

al. 1962), deposited in a shallow marine environment. The age is still unclear due to the poorness of fossil remains and the unit is attributed to an undefined "infra-Cambrian"; however, Glassner (1955) claims of a Late Precambrian age on the basis of recovery of poorly preserved fossils similar to genera *Charnia* and *Rangea*. The Rizu Series is unconformably overlain by the Upper Devonian-Carboniferous sequence. The hiatus which comprises a time span of up to 200 Ma can be explained by a widespread emersion (Wendt et al. 2002).

The Upper Devonian is represented by the Bahram Formation, a shallow water unit consisting of a very heterogeneous succession of skeletal packstones and grainstones, massive or laminate dolostones, medium- to coarse-grained sandstones, and shales (Wendt et al. 2002). In general, the limestones and dolostones of the Bahram Fm. are very fossiliferous. The age of the unit spans from the late Middle Devonian to the entire Late Devonian, even if in the studied area the lower part is not exposed, and its thickness ranges from 100 to over

Fig. 2 - Aerial view of the section (from Google Earth).

300 m (Wendt et al. 2002). In places, at the base of the Bahram Fm. there are several metres of conglomerates, which have been differently interpreted by authors: Dastanpour (1996: 166) considered them as alluvial fan deposits at the base of the Bahram Fm., whereas Webster et al. (2003: fig. 2) refer them to a Middle Devonian Sibzar Formation. However, the Sibzar Fm. is a dolomitic unit and our field observation demonstrate that the conglomerate consists of volcanic clasts belonging to the Rizu Series, and therefore it was deposited during the early Paleozoic emersion claimed by Wendt et al. (2002).

The Bahram Fm. is conformably overlaid with the Tournaisian-Visean Hutk Formation, that consists of well bedded massive dolostones and crinoidal limestones, with intercalations of sandstones. It deposed in a carbonate platform environment with an intermittent siliciclastic influx (Wendt et al. 2002). The Hutk Fm. is overlain, with erosional boundary, by the platform carbonates of the Permian Jamal Formation.

In the Shams Abad area an important NNE-SSW fault separates the Palaeozoic sequence on the west from the Jurassic Badamu Formation (Fig. 1).

The Shams Abad section

The Shams Abad section is located about 1 Km northeast of the Shams Abad village (Figs 1-2) at coordinates: base 30°21'50.87"N - 56°46'49.97"E and top: 30°21'43.91"N - 56°46'45.69"E. It is accessible by a unpaved road off the Kerman-Cheshmeh Gaz road.

The section exposes sediments of the Devonian Bahram Formation and the Lower Carboniferous Hutk Formation (Figs 3-4). It starts with 4 m of red-brown sandstones, transgressive over the Rizu Series, with rare ripple marks, large scale cross-bedding and wavy lamination (Fig. 4b). This peculiar sandstone is variable in thickness, up to 20 m, and seems to be missing in some places. Dastanpour et al. (2005) reported Frasnian acritarchs from this unit.

In the Bahram Formation it is possible to distinguish four thick carbonate parts, separated by thick shale intervals. In the lower carbonate unit (Fig. 4d), samples from Sh1-1 to K79 have been collected. This interval starts with a thick sandy limestone, with evident large scale ripple-marks (Fig. 4a) and intense bioturbation and abundant trace fossils in the upper part (Fig. 4c), and continues with massive to bedded, cream to yellow limestones sometimes interbedded with dolomite layers, and rare grey shales. Fossils are abundant: beside conodonts, brachiopods are very common, often fragmented and packed together by currents (Fig. 4e); echinoderm debris, ostracods, fish remains (placoderms, dipnoans; Fig. 4g) and poorly preserved bryozoans are present. The other carbonate intervals are mainly represented by alternating yellow dolostones and dark shales (Fig. 4f), and sandstones, with some limestone interbeds.

The Lower Carboniferous Hutk Formation unconformably overlies the thin bedded limestones of the topmost part of the Bahram Formation. The rocks of this unit are dark thick bedded biosparites, originally micrites, recrystallized in a post diagenetic phase. They were dolomitized in places and even silicified (it is possible to observe chalcedony filling intragranular pores and fossils shells). These dolomitic rocks are common in lower parts of the unit and forms evident cliffs (Fig. 4h). Fossils are very rare in this part of the section.

Conodont data

Forty-seven conodont samples (3-4 kg each) were collected from the Shams Abad section and processed with the conventional acetic and/or formic acid technique. Unfortunately only twenty six samples yielded conodonts, being the other barren. More than six hundred conodont elements were collected (Tab. 1). The abundance is quite scarce, only in a few samples it reaches 30 elements/kg, with maximum of 178 elements/kg in sample K79. In general, the state of preservation of the fauna is good, and only in some dolomitized levels (i.e.: samples K83 and K91) most of specimens are broken and incomplete. A few samples were collected from the Hutk Formation, but they did not provide any conodont. The general scarcity of the fauna and the poor preservation can be explained with the shallow water depositional environment.

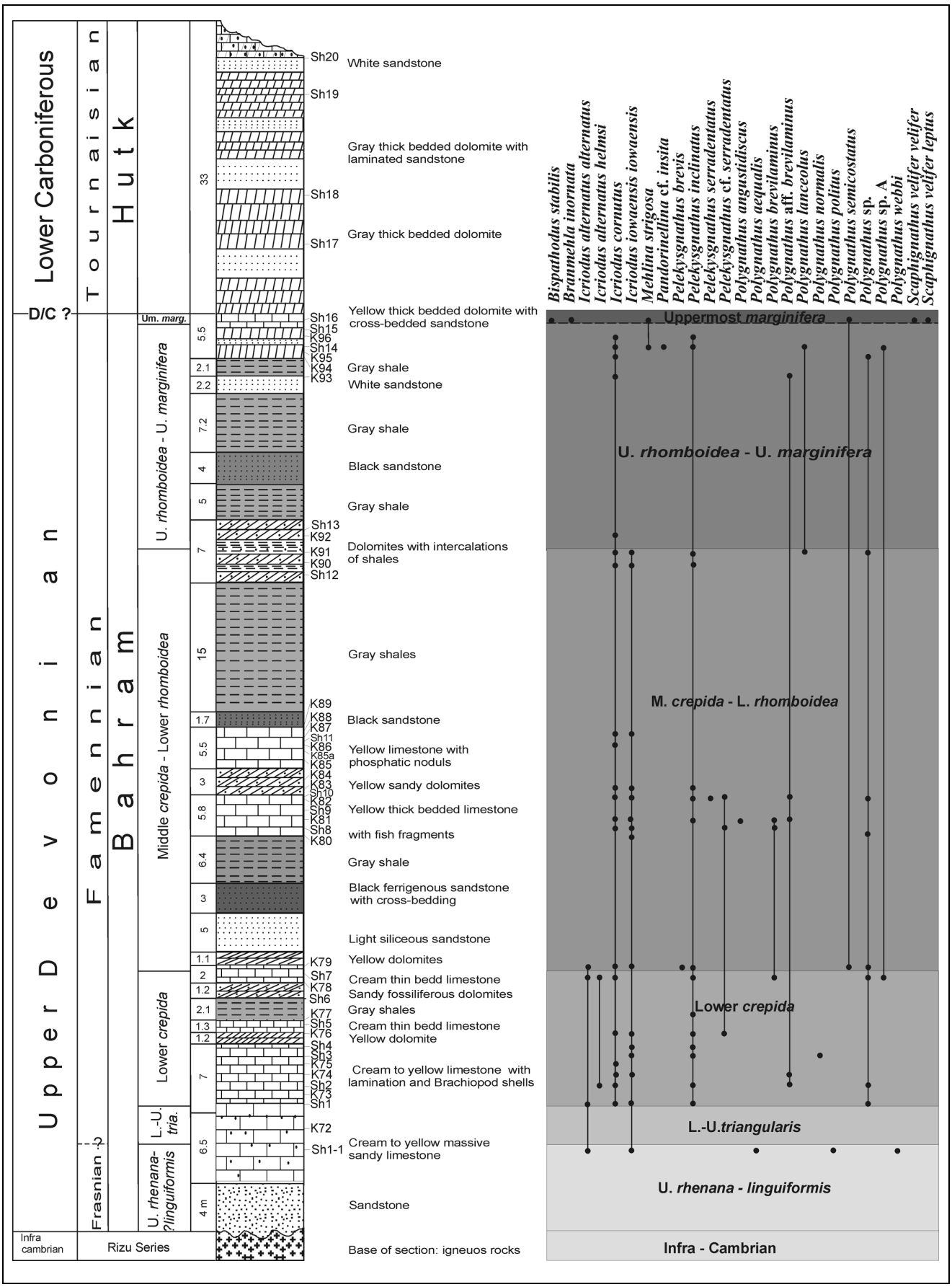

Fig. 3 - Stratigraphic log, samples position, conodont occurrences and biozonation of the Shams Abad section.

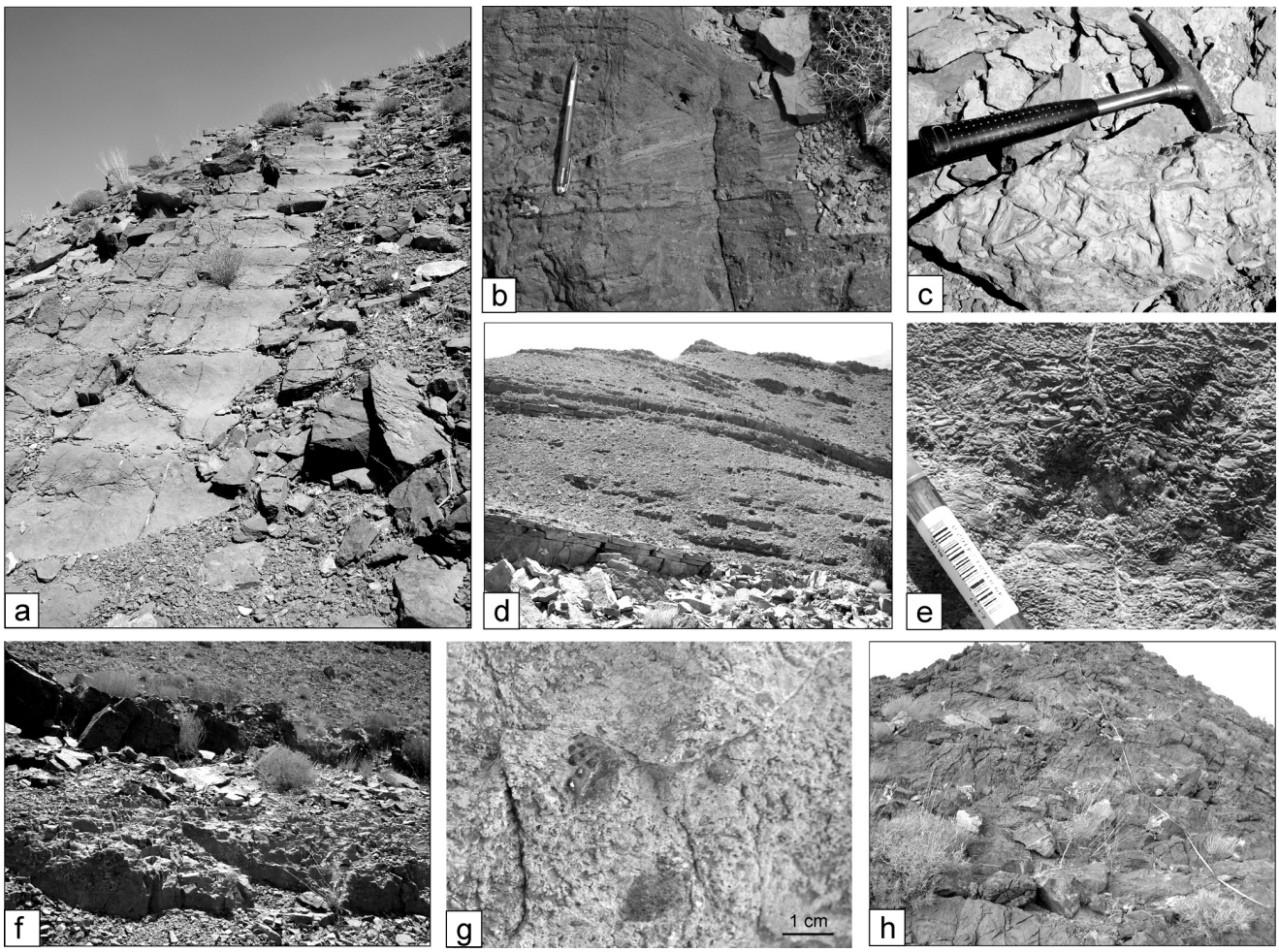

Fig. 4 - Selected views of the Shams Abad section. a) Large scale ripple marks at the base of lower carbonate unit in the Bahram Formation (below sample Sh 1-1); b) Crossbedded red sandstones in the basal sandstone unit (Frasnian) at the base of the Bahram Formation; c) Trace fossils at the top beds of large scale ripple-marks; d) Lower carbonate unit of Bahram Formation, where samples from Sh1 to K79 have been collected; e) Skeletal limestones crowded with current oriented brachiopod shells in the lower carbonate unit of Bahram Formation; f) Alternation of yellow dolostones and black sandstones in upper unit of the Bahram Formation, approximately around samples K83-K89; g) Fish fragments (Dipnoans) in Grey Skeletal limestones of Bahram Formation (around bed K81). h) Cliff forming dolostones of Hutk Formation, in the upper part of the section.

Zones	U. *rh. -ling.*	Lower *crepida*									Middle *crepida* - Lower *rhomboidea*											U. *rhomboidea* - U. *marginifera*					Um. *marg.*	TOTAL
Species	Sh 1-1	Sh 1	Sh 2	K74	K75	Sh 3	Sh 4	K76	K77	Sh 7	K79	K80	Sh 8	K81	K82	K83	K85a	K86	K87	K90	K91	K92	K93	K94	Sh 14	K96	Sh 16	
Bispathodus stabilis																										1	1
Branmehla inornata																										8	8
Icriodus alternatus alternatus	5	2								2	2																11
Icriodus alternatus helmsi			1							4																	5
Icriodus cornutus		1	7	7	1			3		16	44		5	7	1	1		4	2	5	2	1	2	2	1	1		113
Icriodus iowaensis iowaensis	2	19		2		4	4	1			7	1	6	5	2	1			2	2	1							59
Mehlina strigosa																										3	2	5
Pandorinellina cf. insita																									1			1
Pelekysgnathus brevis											2																	2
Pelekysgnathus inclinatus		4	1			1	1	2	1	2	10			1	1	1				2	1				4	1		33
Pelekysgnathus serradentatus															1													1
Pelekysgnathus cf.serradentatus								3					3		2													8
Polygnathus aequalis	5																											5
Polygnthus angustidiscus													2															2
Polygnathus aff. *brevilaminus*			2	4										3	1								2					12
Polygnathus brevilaminus										5		2	4															11
Polygnathus lanceolus																					2				3			5
Polygnathus normalis						2																						2
Polygnathus politus	3																											3
Polygnathus semicostatus											3															9		12
Polygnathus sp.		7	1							2	5	1			1						1			2				20
Polygnathus sp. A										4															2			6
Polygnathus webbi	12																											12
Scaphignathus velifer leptus																										8		8
Scaphignathus velifer velifer																										10		10
Ramiform elements	9	10	4	15	2	3		33		9	98	5		20	5	2	6	1	3	10	3	5	2	4		6		255
Unassigned elements	2			5				2			7				2				2	11		1		2				34
Total	38	43	16	33	3	10	5	44	1	44	178	9	20	36	16	5	6	5	9	30	10	7	6	10	11	11	38	644

Tab. 1 - Range chart of conodont species in the Shams Abad Section. Abbreviations: U. *rh-ling.* =Upper *rhenana – linguiformis*, Um. *marg.* = Uppermost *marginifera*.

The colour of conodonts is dark black (C.A.I. 5) in the lower part of the section, up to sample K96, then suddenly turn to brown (C.A.I. 3.5-4) in sample Sh 16.

Twenty-four species and subspecies belonging to 8 genera (*Bispathodus*, *Branmehla, Icriodus, Mehlina, Pandorinellina*, *Pelekysgnathus, Polygnathus, Scaphignathus*) were discriminated (Fig. 2; Tab. 1). The association is dominated by shallow water genera, being icriodids always dominant.

The collection is stored in the Department of Geology of the Isfahan University. Repository numbers of the figured specimens can be obtained from the plate captions.

Biostratigraphy

The "Late Devonian standard conodont zonation" (Ziegler & Sandberg 1990) is the main conodont zonation scheme in use in the Late Devonian, even if recently some alternative scheme were proposed for selected regions (i.e.: Corradini 2008) or time frame (Kaiser et al. 2009). All these zonal schemes are based on pelagic index species, mainly of genus *Palmatolepis*, that is missing in the shallow water sediments of the Shams Abad section. Therefore icriodids and polygnathids are used to identify the zonal boundaries. Five biointervals were discriminated, allowing to date the Bahram Formation in the Shams Abad section to an upper Frasnian-middle Famennian age. Beside the intervals recognized, it is possible to approximate the position of Frasnian/Famennian boundary (Fig. 3).

Upper *rhenana* – *linguiformis* interval (Sample Sh1-1)

The assemblage of *Polygnathus politus, P. webbi, P. aequalis, Icridous iowaensis iowaensis* and *I. alternatus alternatus* can be seen here. The age is limited by the first occurrence of *Icriodus iowaensis iowaensis*, that ranges from the upper part of the Upper *rhenana* Zones to the Lower *rhomboidea* Zones (Ziegler & Sandberg 1990: 21) and the last occurrence of *Polygnathus politus* and *P. webbi*, that became extinct in the *linguiformis* Zone (Ovnatanova & Kononova 2001, 2008; Bultynck 2003; Ziegler & Sandberg 2000). Therefore, this assemblage belongs to an upper Frasnian "Upper *rhenana* – *linguiformis* interval".

Barren interval (Lower-Upper *triangularis* interval)

Between samples Sh1-1 and Sh1 there is an interval which did not yield any conodont element; however it is possible to assign it tentatively to an undifferentiated Lower-Upper *triangularis* interval, according to the age assignment of strata immediately below and above.

Lower *crepida* Zones (samples Sh1 – Sh7)

The base of this interval can be recognized by the entry of *Pelekysgnathus inclinatus*, the top by the entry of *Polygnathus semicostatus* at the base of the next zone. In fact, *Pelekysgnathus inclinatus* ranges from the Lower *crepida* into the Upper *praesulcata* zone (Sandberg & Dreesen 1984), and *P. semicostatus* ranges from the Middle *crepida* to the Upper *expansa* zone (Ji & Ziegler 1993).

Pelekysgnathus cf. *serradentatus* is an important associated species. *Icriodus alternatus helmsi, I. alternatus alternatus, I. iowaensis iowaensis, I. cornutus*, *P. brevilaminus*, *P. normalis* and *P.* aff. *brevilaminus* are also present.

Middle *crepida* – Lower *rhomboidea* interval (Samples K79 – K91)

The assemblage of *Polygnathus semicostatus, P. brevilaminus, P.* aff. *brevilaminus, Icriodus cornutus, I. altenatus alternatus, I. iowaensis iowaensis, Pelekysgnathus inclinatus* and *Pel. brevis* can be seen in this interval. The lower limit of this interval can be recognized by the first occurrence of *P. semicostatus*, ranging from the Middle *crepida* to Upper *expansa* zones (Ji & Ziegler 1993). The upper limit is identified by the last occurrence of *I. iowaensis iowaensis* that ranges from the upper part of the Upper *rhenana* to the Lower *rhomboidea* zones (Sandberg & Dreesen 1984; Ziegler & Sandberg 1990). *Pelekysgnathus* cf. *serradentatus* occur in the lower part of this interval.

Upper *rhomboidea* – Upper *marginifera* interval (Samples K92 – K96)

The base of this interval can be recognized by the last occurrence of *Icriodus iowaensis iowaensis* at the top of previous interval; the top is identified by the entry of *Scaphignathus velifer velifer* at the base of the next Zone. This interval is very poor of conodonts and the only associated species are *Pelekysgnathus inclinatus, Polygnathus* sp. A, *Polygnathus lanceolus*, *P.* aff. *brevilaminus,* and *Mehlina strigosa*.

Uppermost *marginifera* Zone (Sample Sh 16)

This interval can be discriminated by the occurrence of *Scaphignathus velifer velifer* that is the marker of the Uppermost *marginifera* Zone (Ziegler & Sandberg, 1984). *Sc. velifer leptus* is an important associate species; *Mehlina strigosa*, *Branmehla inornata, Bispathodus stabilis* and *P. semicostatus* are also present.

Systematic palaeontology

Since most of the taxa found in the Shams Abad section are well known in literature, systematic notes are restricted to necessary taxonomic remarks.

Genus *Pelekysgnathus* Thomas, 1949

Type species: *Pelekysgnathus inclinathus* Thomas, 1949

Pelekysgnathus cf. **serradentatus** Capkinoglu, 1991

Pl.1, Figs 18-21

2007 *Pelekysgnathus serradentatus* Capkinoglu - Gholamalian, p. 468, Figs 10E-F.

Remarks. Capkinoglu (1991) described a new species of *Pelekysgnathus* from the Taurides of Turkey. The species is characterized by lacking a prominent posterior cusp, a very broad expanded basal cavity and a peculiar irregular shape of denticles, that are somehow irregularly laterally expanded.

In our material only one specimen fit exactly the description by Capkinoglu (1991), whereas others differs in the shape of the denticulation, because the denticles are laterally compressed. Since the denticulation pattern is a diagnostic feature of the species, those ele-

PLATE 1

Figs 1-4 - *Polygnathus webbi*, Stauffer, 1938.
1) Upper view of EUIC 5736, sample Sh1-1; 2) Upper view of EUIC 5755, sample Sh1-1; 3)Upper view of EUIC 5767, sample Sh1-1; 4) Upper-oblique view of EUIC 5784, sample Sh1-1.

Fig. 5-8 - *Polygnathus aequalis* Klapper & Lane, 1985.
5) Upper view of EUIC 5737, sample Sh1-1; 6) Upper view of EUIC 5739, sample Sh1-1; 7) Upper view of EUIC 5786, sample Sh1-1; 8) Upper view of EUIC 5785, sample Sh1-1.

Fig. 9-10 - *Polygnathus politus* Ovnatanova, 1969.
9) Upper view of EUIC 5740, sample Sh1-1; 10) Upper view of EUIC 5756, sample Sh1-1.

Fig. 11 - *Polygnathus angustidiscus* Branson & Mehl, 1934. Upper view of EUIC 5741, sample Sh8.

Fig. 12 - *Polygnathus* aff. *brevilaminus* Branson & Mehl, 1934. Upper view of EUIC 5802, Sample Sh-2.

Fig. 13 - *Polygnathus* cf. *brevilaminus* Branson & Mehl 1934. Upper view of EUIC 5803, Sample Sh-2.

Fig. 14-17 - *Polygnathus brevilaminus* Branson & Mehl, 1934.
14) Upper view of EUIC 5744, sample Sh8;. 15) Upper view of EUIC 5804, Sample Sh7; 16) Upper view of EUIC 5745, sample Sh8; 17) Upper view of EUIC 5799, sample Sh8.

Fig. 18-21 - *Pelekysgnathus* cf. *serradentatus* Capkinoglu, 1991.
18) Upper view of EUIC 5768, sample Sh8; 19) Upper view of EUIC 5800; sample Sh 8; 20) Upper view of EUIC 5805, sample Sh8; 21) Lateral view of EUIC 5801, Sample Sh 8.

Fig. 22-23 - *Pelekysgnathus inclinatus* Thomas, 1949.
22) Lateral view of EUIC 5793, sample Sh14; 23) Upper view of HUIC 152. Sample K76.

Fig. 24 - *Polygnathus normalis* Miller & Youngquist, 1947. Upper oblique view of EUIC 5742, sample Sh3.

Fig. 25 - *Polygnathus semicostatus* Branson & Mehl, 1934. Upper view of EUIC 5791, sample Sh16.

Fig. 26 - *Scaphignathus velifer leptus* Ziegler & Sandberg, 1984. Upper view of EUIC 5788, sample Sh16.

Fig. 27-28 - *Scaphignathus velifer velifer* Helms, 1959.
27) Lateral view of EUIC 5789, sample Sh16. 28) Oblique lateral (a) and upper views of EUIC 5738, sample Sh16.

Fig. 29a, b - *Pandorinellina* cf. *insita* (Stauffer, 1940) *sensu* Sandberg & Ziegler, 1979. Upper (a) and lower-oblique (b) views of EUIC 5795, sample Sh14.

Fig. 30 - *Polygnathus* sp. Upper view of EUIC 5787, sample Sh7.
Scale bar = 100 μm, unless differently stated.

PLATE 2

Fig. 1 - *Branmehla inornata* (Branson & Mehl, 1934). Lateral view of EUIC 5792, sample Sh16.

Fig. 2 - *Mehlina strigosa* (Branson & Mehl, 1934). Lateral view of EUIC 5806, sample Sh16.

Figs. 3-6 - *Icriodus alternatus alternatus* Branson & Mehl, 1934a.
4) Upper view of EUIC 5766, sample Sh1-1; 5)Upper view of EUIC 5807, sample Sh1-1. 6) Upper view of EUIC 5771, sample Sh7.

Figs. 7-8 - *Icriodus alternatus helmsi* Sandberg & Dreesen, 1984.
7) Upper view of EUIC 5760, sample Sh2; 8) Upper view of EUIC 5764, sample Sh7.

Fig. 9-14 - *Icriodus cornutus* Sannemann, 1955.
9) Upper view of EUIC 5761, sample Sh7; 10) Upper view of EUIC 5762, sample Sh2; 11) Upper view of EUIC 5763, sample Sh2; 12) Upper view of EUIC 5776, sample Sh2; 13) Upper view of HUIC 153, Sample K92; 14) Upper view of EUIC 5749, sample Sh1.

Fig. 15-18, 22 - *Icriodus iowaensis iowaensis* Youngquist & Peterson, 1947.
15) Upper view of EUIC 5778, sample Sh4; 16) Upper view of EUIC 5797, sample Sh4; 17) Upper view of EUIC 5798, sample Sh3; 18) Upper view of HUIC 155. Sample K81; 22) Upper view of EUIC 5750, sample Sh8.

Fig. 19-20 - *Polygnathus* sp. A.
19) Upper (a) and Lower (b) views of EUIC 5781, sample Sh7; 20) Upper view of EUIC 5781, sample Sh14.

Fig. 21a, b - *Icriodus* sp. Upper (a) and lateral (b) views of EUIC 5794, sample Sh14.

Fig. 23a, b - *Polygnathus lanceolus* Vorontsova, 1983. Upper (a) and lower (b) views of HUIC 161; sample K91.

Fig. 24a, b - *Polygnathus* sp. Upper (a) and Lower (b) views of EUIC 5783, sample Sh7.
Scale bar = 100 μm unless differently stated.

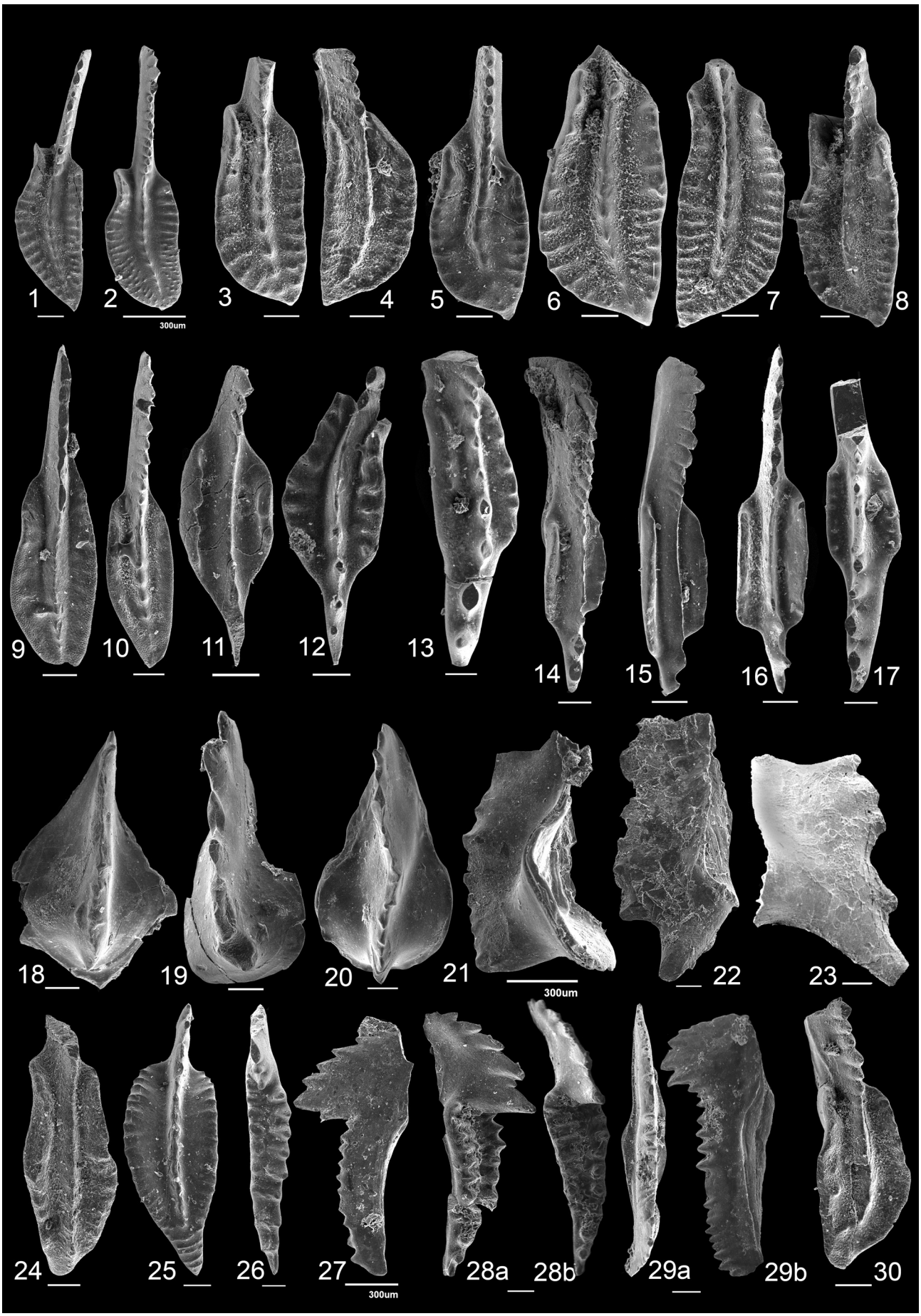
1
2
300um
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
300um
22
23
24
25
26
27
300um
28a
28b
29a
29b
30

PLATE 1

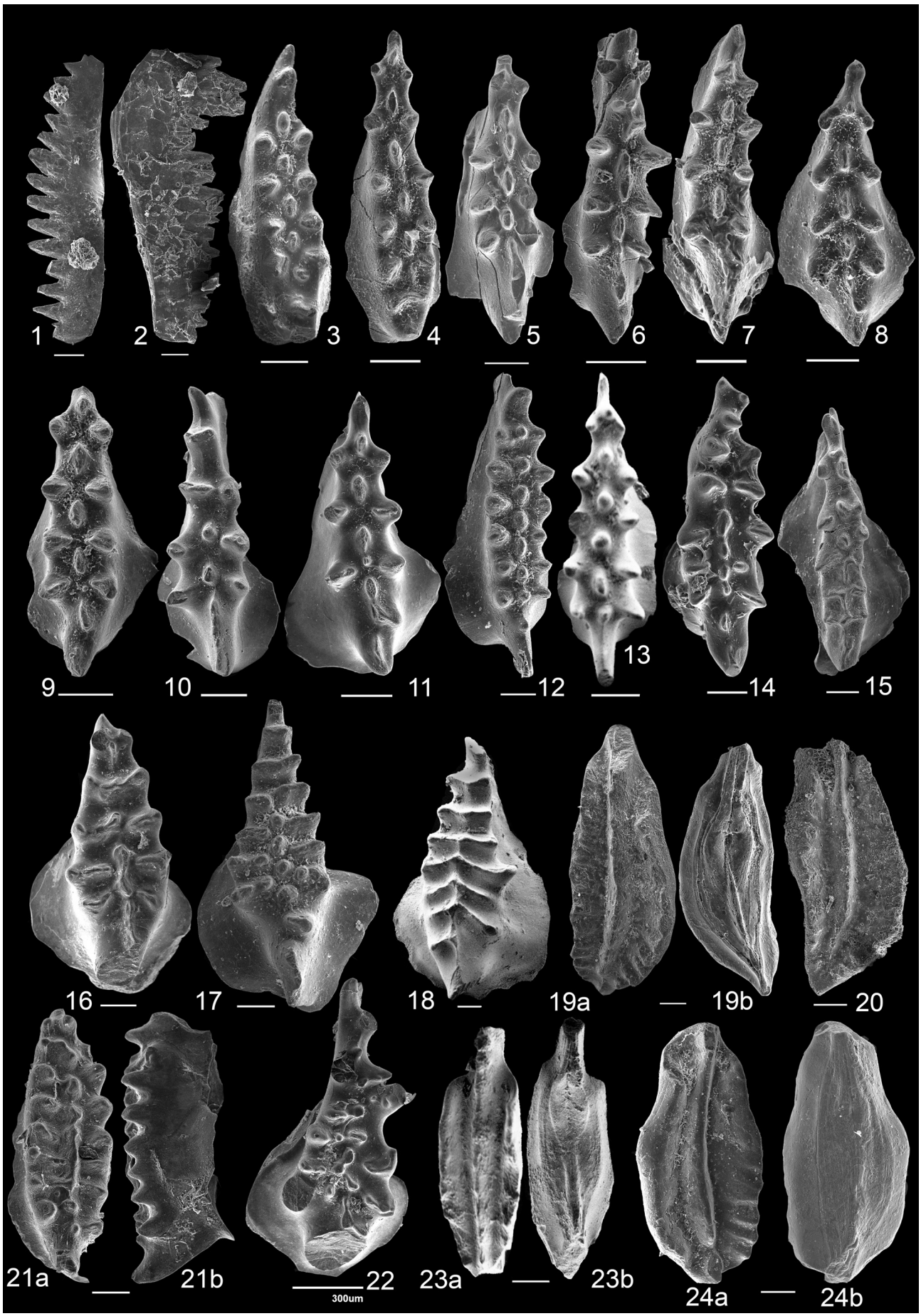
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19a
19b
20
21a
21b
22
300um
23a
23b
24a
24b

PLATE 2

ments are here reported as *Pelekysgnathus* cf. *serradentatus*.

Studied material. Eight specimens from samples K76, Sh8 and K82.

Age. All the studied specimens are from the Lower *crepida* – Lower *rhomboidea* interval in the Shams Abad section.

Genus *Polygnathus* Hinde, 1879

Type species: *Polygnathus dubius* Hinde,1879

Polygnathus sp. A

Pl. 2, Figs 19a, 19b, 20

Remarks. Elements of *Polygnathus* assigned to this taxon are relatively small with an asymmetrical thick platform divided by gently curved carina, that do not reach the posterior end. The outer side is more developed than inner one. The ornamentation consists of weakly developed, irregular transverse ridges that may not reach the carina. The basal cavity, located at the anterior end of the platform, is rather small, and is followed by a keel reaching the posterior tip.

Polygnathus sp. A is different from all other lower-middle Famennian polygnathids, because of the thick platform and the irregular ornamentation pattern.

Studied material. Six specimens from samples Sh7 and Sh 14.

Age. Lower *crepida* – Upper *marginifera*.

Conclusions

The conodont fauna collected in the Shams Abad section allows to assign a late Frasnian-middle Famennian age to the Bahram Fm. in this area, expanding the range previously established for this unit by other authors.

Acknowledgements. This study was completed at the University of Isfahan and supported by the Office of Graduate Studies: the authors are grateful to the office for their support. We also wish to thank Mr. Hassani, PhD student at the "Shahid Bahonar" University of Kerman, for his assistance during the field trips and sampling the Shams Abad section.

Hanna Matyja (Warsaw), Catherine Girard (Montpellier) and Maurizio Gaetani (Milano) provided useful suggestions that improved the quality of this paper. This is a contribution to IGCP 596 "Climate change and biodiversity patterns in the Mid-Paleozoic (Early Devonian to Late Carboniferous)".

REFERENCES

Bultynck P. (2003) - Devonian Icriodontidae: biostratigraphy, classification and remarks on paleoecology and dispersal. *Rev. Esp. Micropaleontol.*, 35(3): 295-314.

Capkinoglu S. (1991) - A new *Pelekysgnathus* species from the Lower Famennian of the Taurides, Turkey. *Boll. Soc. Paleontol. It.,* 30: 349-353.

Corradini C. (2008) - Revision of Famennian-Tournaisian (Late Devonian-Early Carboniferous) conodont biostratigraphy of Sardinia, Italy. *Rev. Micropaleontol.*, 51: 123-132.

Dastanpour M. (1996) - The Devonian System in Iran: a review. *Geol. mag.,* 133(3): 159-170.

Dastanpour M. & Bassett M. (1998) - Palaeozoic sequences in Kerman Region. In: R. Mawson, J.A. Talent & G. Wilson (Eds) - UNESCO-IGCP Project 421, North Gondwanan mid-Palaeozoic bioevent/biogeography patterns in relation to crustal dynamics, Esfahan meeting (17-20 December, 1998), Abstract book, 21 pp., Shahid Bahonar University, Kerman, Iran.

Dastanpour M., Vaziri M. R., Ameri H. & Arab A. (2005) - Stratigraphy of Late Devonian Acritarchs from Kerman. Proceedings on 24th Symposium of Geoscience. Geological survey of Iran. 8 pp. [in Persian].

Djokovic I., Dmitrijevic M.N., Cukucan M., Grabeljsek V., Martinovic D., Milosakovic R., Skuletic T., Halaviati J. & Markovic B. (1972) - Geological map of Baghin (1/100000): Geological Survey of Iran, sheet no. 7350.

Gholamalian H. (2006) - Biostratigraphy of Late Devonian sequence in Hutk section (North of Kerman) based on conodonts. *Geosci. Sci. Quart. J,* 15(59): 94-101, (in Persian with English abstract).

Gholamalian H. (2007) - Conodont biostratigraphy of the Frasnian-Famennian boundary in the Esfahan and Tabas areas, central Iran. *Geol. Quart.*, 51: 453-476.

Gholamalian H. & Kebriaei M.R. (2008) - Late Devonian conodonts from the Hojedk section, Kerman Province, southeastern Iran. *Riv. It. Paleontol. Strat.*, 114(2): 171-181.

Glassner H. (1955) - New aspects of the geology in Central Iran. Proceeding 4th World Petroleum Congress, Rome, Section. I/A/5, paper 2: 280-300.

Huckriede R., Kürsten M. & Venzlaff H. (1962) - Zur Geologie des Gebietes zwischen Kerman und Saghand (Iran). *Beihefte Geol. Jahrb*., 51: 197 pp.

Ji Q. & Ziegler W. (1993) - The Lali section: an excellent reference section for Late Devonian in south China. *Cour. Forschungstinst. Senckenb*., 157: 1-183.

Kaiser S.I., Becker R.T., Spalletta C. & Steuber T. (2009) - High-resolution conodont stratigraphy, biofacies and extinctions around the Hangenberg Event in pelagic

successions from Austria, Italy and France. *Palaeontographica Americana*, 63: 97-139.

Morzadec P., Dastanpour M. & Wright A.J. (2002) - Asteropygine trilobites from the Late Devonian of the Kerman region, Iran. *Alcheringa*, 26: 143-149.

Ovnatanova N.S. & Kononova L.I. (2001) - Conodonts and Late Devonian (Frasnian) biostratigraphy of central regions of Russian platform. *Cour. Forschungstinst. Senckenb.*, 233: 1-115.

Ovnatanova N.S. & Kononova L.I. (2008) - Frasnian conodonts from the Eastern Russian Platform. *Paleontol. J.*, 42(10): 997-1166.

Sandberg C.A. & Dreesen R. (1984) - Late Devonian icriodontid biofacies models and alternate shallow water conodont zonation. In: Clark D.L. (Ed.) – Conodont biofacies and provincialism. *Geol. Soc. America Spec. Pap.*, 196: 143-178.

Webster G.D., Maples C.G., Mawson R. & Dastanpour M. (2003) - A cladid-dominated Lower Mississipian crinoid and conodont fauna from Kerman Province, Iran, and revision of the glossocrinids and rhenocrinids. *J. Paleontol.*, 77 (3, suppl): 1-35.

Wendt J., Hayer J. & Karimi Bavandpur A. (1997) - Stratigraphy and depositional environment of Devonian sediments in northeast and east-central Iran. *Neues Jahr. Geol. Paläontol. Abh.*, 206: 277-322.

Wendt J., Kaufmann B., Belka Z., Farsan N. & Karimi Bavandpur A. (2002) - Devonian/Lower Carboniferous stratigraphy, facies patterns and palaeogeography of Iran, part I, southeastern Iran. *Acta Geol. Pol.*, 52(2): 129-168.

Ziegler W. & Sandberg C.A. (1984) - *Palmatolepis*-based revision of upper part of standard Late Devonian conodont zonation. *Geol. Soc. America Spec. Pap.*, 196: 179-194.

Ziegler W. & Sandberg C.A. (1990) - Late Devonian standard conodont zonation. *Cour. Forschungstinst. Senckenb.*, 121: 1-115.

Ziegler W. & Sandberg C.A. (2000) - Utility of palmatolepids and icriodontids in recognizing Upper Devonian series, stages and possible substage boundaries. *Cour. Forschungstinst. Senckenb.*, 225: 335-437.