GIVETIAN-FRASNIAN BOUNDARY CONODONTS FROM KERMAN PROVINCE, CENTRAL IRAN

HOSSEIN GHOLAMALIAN1, VACHIK HAIRAPETIAN2, NAHID BARFEHEI3, SOHEYLA MANGELIAN4 & PARVANEH FARIDI5

Received: April 12, 2012; accepted: May 21st, 2013

Key words: Iran, Devonian, Givetian - Frasnian boundary, conodonts, biostratigraphy.

Abstract. The Middle - Late Devonian boundary is investigated based on twenty-two conodont species and subspecies from three sections in the north and west of Kerman, southeastern central Iran. Upper Givetian - lower Frasnian carbonates of the basal part of the Bahram Formation transectively overlie the sandstone beds of the top of (?) Early - Middle Devonian Padcha Formation. These massive skeletal limecones encompass the G-F boundary. The base of Frasnian is identified by the appearance of early forms of Anacyroidea rotundiloba. It helps to compare our biozones to those of global stratotype in southern France. A new species, Polygnathus hojedki n. sp. is described here. New range is suggested for P. paeplum.


Introduction
The Global Stratotype Section and Point (GSSP) of the Givetian - Frasnian boundary is located in the Col du Puech de la Suque section E of Montagne Noire, southern France (Feist & Klapper 1985; Klapper et al. 1987). This boundary is designated at the base of bed 42a in which early forms of Anacyroidea rotundiloba appear and mark the base of the Lower asymmetric Zone, the base of Late Devonian in the scheme of Ziegler (1962) (Klapper 1985; Kirchgasser 1994). A few years later, Klapper (1989) and Ziegler & Sandberg (1990) presented separated new zonation schemes for the Late Devonian based on the pelagic genera. Klapper (1985; 2000); Feist & Klapper (1985) and Klapper et al. (1987) endorsed the DDS decision for the base of Frasnian at the first occurrence of Anacyroidea rotundiloba. Whereas Sandberg et al. (1989) and Ziegler & Sandberg (1996; 2000) rejected the GSSP definition of the Givetian - Frasnian boundary, by stating that “Anacyroidea rotundiloba is a shallow water species with unknown ancestor”. Consequently they proposed to substitute the first occurrences of two other species, An. pristina and An. soluta (instead of An. rotundiloba) as biomarkers for the base of Frasnian.

Despite the stratotype section in Montagne Noire, recent studies on the Middle - Late Devonian boundary have been performed in some regions in North Africa, Europe, North America and East Asia (Aboussalam & Becker 2007; Gouwy et al. 2007; Nariewicz & Bultynck 2007). Miller (2007) studied the

1 Department of Geology, Faculty of Sciences, Hormozgan University, Po. Box 3995, Bandar Abbas, I.R. Iran. E-mail: hossein.gholamalian@yahoo.com
2 Department of Geology, Islamic Azad University, Khorasan (Esfahan) Branch, Esfahan, I.R. Iran. E-mail: vachik@khuisf.ac.ir
3 Department of Geology, Islamic Azad University, Zarand Branch, Zarand (Kerman Province), I.R. Iran. E-mail: nahi67@yahoo.com
4 Department of Geology, Islamic Azad University, Zarand Branch, Zarand (Kerman Province), I.R. Iran. E-mail: soheylamangelian@yahoo.com
5 Department of Geology, Faculty of Sciences, Hormozgan University, Po. Box 3995, Bandar Abbas, I.R. Iran. E-mail: parvaneh.faridi@yahoo.com
ontogenetic lineage of some index conodont species in Sub-Polar areas of Russia. Develeschouwer et al. (2010) have examined the parastratotype of the G-F boundary in Belgium by means of magnetic susceptibility. Kirchgasser (1994) and Kralick (1994) analyzed the Anicyrodella species occurrence in some Middle - Late Devonian boundary successions of New York (USA). Hou et al. (1986) documented dacryocrinids and conodonts of the boundary interval in China. Until now, there was no precise diagnostic investigation on the Givetian - Frasnian boundary interval in the Middle-East, except for some limited information from Iran such as Ashouri (2004, 2006).

In the present paper, we examined several conodont collections and their biostratigraphic implications on the exact position of the G-F boundary in the Hojedk, Baghin and Sardar localities in the North and West part of Kerman district, in the southeastern sector of East-Central Iran.

All of studied samples are stored in the Department of Geology, Faculty of Sciences, Hormozgan University, Bandar Abbas.

Geographic position

The Hojedk section is located in 65 km North of Kerman, 4 km West of Heruz village (next to Kerman - Ravar road) at N30°43'45.5", E57°00'54" (Fig. 1). The base of Baghin section, 25 km west of Kerman (5 km northeast of Baghin city) is studied at: N30°13'9.8", E56°51'7.7" (Figs 1, 2). The Sardar section is located at N30°38'8.77", E56°59'54.1" in 45 km north of Kerman. The best way to this section is a sidetrack that separates from the main road near the Khorasani cervix (Figs 1, 2).

Palaeogeography

East-central Iran microplate including its southeastern sector, Kerman region, constituted a part of the Peri-Gondawana shallow shelf margin in the Devonian (e.g. Sengör 1990; Stampfli 2000; Torsvik & Cocks 2004; Wendt et al. 2005; Muttoni et al. 2009). Biostratigraphic data on Late Devonian biotas (e.g. brachiopods, Brock & Yazdi 2000) in accordance with earlier data, display strong affinities to those on other neighbor Middle Eastern Peri-Gondwanan terranes at 30-45°S palaeolatitude.

Stratigraphic setting

Four lithostratigraphic units have been recognized in the Devonian strata of central Iran: the Padeha, Sibzar, Bahram and Shishetu formations. Because of the very scarce palaeontological information, the age of the Padeha Formation is based on its stratigraphic position in the general succession and it is not well known in the most parts of Iran. Stöcklin & Setudehnia (1991) placed this formation in the Early Devonian. Nasehi (1997) studied this formation in the Shabjereh section near Zarand (Kerman Province) and based on conodonts, he attributed it to an Emsian - Givetian interval. The age of unfossiliferous dolostones of Sibzar Formation can only be estimated on the basis of its stratigraphic position in the all succession. This formation is absent in the most parts of the Kerman area; such as Hojedk, Hutk, Baghin, Sardar sections and etc. In these areas, the Bahram Formation limestones directly cover the sandstones and shales of the Padeha Formation in the mentioned areas. So the Sibzar Formation dolostones seem to be the lateral equivalent of limestones of the lower part of the Bahram Formation in the most parts of Kerman area, except for the Gerik section (Wendt et al. 2002).

Analysis of the Bahram Formation stratotype in Ozbak-Kuh (N Tabas) and its equivalent successions in the Esfahan and Kerman regions shows that this formation is diachronous. It is Eifelian in the Zafreh section in NE Esfahan (Brice et al. 2006), Givetian in the Soh section in N Esfahan (Adhamian 2003), late Givetian - early Frasnian in the Ozbak-Kuh section (Khaksar et al. 2006),
late Givetian - early Famennian in the Hojedk section (Gholamalian & Kebriaei 2008) and late Frasnian - early Famennian in the Shams Abad section, W Kerman (Bahrami et al. 2011a). The boundary between the Bahram and the overlying Shishtu Formation is not described or cannot be easily observed in the most of sections; so Wendt et al. (2002; 2005) would prefer to use the name of Bahram Formation for all of Middle to Late Devonian carbonate successions. Despite the recent works on the Late Devonian of central Iran, it seems that a comprehensive and precise conodont research on the Early to Middle Devonian deposits is really needed.

**History of the G-F boundary studies in Iran**

Among recent studies on central Iran, there are some papers on the Devonian strata e.g. Yazdi (1999), Ashouri (2002), Gholamalian (2007), Gholamalian et al. (2009), Bahrami et al. (2011a, 2011b); but only a few of authors refer to the Middle Devonian (Adhamian 2003; Brice et al. 2006; Wendt et al. 2002, 2005). The G-F boundary was studied by Ashouri (2004, 2006) who identified it in the bed S241 in the middle part of the Member 3 of the Khoshyeilaq Formation (Eastern Alborz, northern Iran) on the basis of presence of *Anicyrodella pristina* and *An. binodosa*. Wendt et al. (2002; 2005) recognized this boundary in the lower part of the Bahram Formation in several sections of Central Iran (e.g. Howz-e-dorah, Anarak, Hutk, Hojedk and Gerik), and in the Khoshyeilaq Formation in northern Iran (Khoshyeilaq and Mighan). Identification was generally based on scarce paleontological data from poor conodont samples.
Fig. 3 - Lithostratigraphic columns with localization of the investigated samples and correlation of the G-F boundary studied successions in the Kerman Province, SE Iran. L. fassoulii = lower part of Lower fassoulii. * B1 - hirmanii Zone. Productive samples are shown in bold, and italic ones are studied by Gholamalian et al. (2011) and Gholamalian & Kebrab (2008).

**Studied successions**

**Hojedk section** (Figs 3, 4)

Conodont biostratigraphy and lithology of the Bahram Formation succession in the Hojedk area were described by Gholamalian & Kebrab (2008). The lowermost part of this section is reassessed in this work for a more precise positioning of G-F boundary. The base of the measured succession begins with 3.4 m of dolomitic sandstone above the top of the Padeha Formation and continues by 2.75 m thin bedded limestone and 13.85 m shale, sandstone, dolomite and nodular lime-
stone. The overlying 11.15 m red to grey massive skeletal packstone contains abundant brachiopod shells. The sequence continues upwards with limestones, shales and sandstones (mostly in the lower half of the section). Two biostromes (rugose and tabulate corals and bryozoa) occur here. Gholamian & Kebriaei (2008, p. 175) thoroughly discussed the age of these diachronic biostromes in the Kerman area and other parts of central Iran.

**Baghin section** (Figs 3, 5)
This section consists of 102.5 meters of shale, limestone and sandstone; and was recently studied by Gholamian et al. (2011). The lowermost quartzarenite (16.8 m) of the top of Padeha Formation is conformably covered by a 1.8 m of thin bedded skeletal limestone defining the base of the Bahram Formation. These beds are overlain by 1.35 m of medium bedded skeletal limestones. A coral bed of 0.85 m thick underlies 24.5 m of early Frasnian dolostones and shales (Gholamian et al. 2011). The rest of the succession is mostly composed of middle to late Frasnian medium and thick bedded limestones.

**Sardar section** (Figs 3, 6)
The carbonates of the basal part of the Bahram Formation transgressively overlie 5.4 m key quartzarenite of the Padeha Formation. The contact between
the Padeha and Bahram formations is obviously sharp and the Sibzar Dolomite Formation is missing in this area. The base of the Bahram Formation begins with a 3.6 m alternation of dolostones and shales and continues with 15.8 m of thin bedded limestone, dolostone and an alternation of limestone and shale. A thickness of 32 m of thin bedded limestones and 16.4 m marly limestones overlie the mentioned beds. These beds underlie a coral and bryozoan dominated biostrome reef. The top of the Bahram Formation is referred to the Famennian (Molaehadi et al. 2012). It is disconformably overlain by the Early Carboniferous grey limestones and massive dolostones of the Hutm Formation (Molaehadi et al. 2012).

**Biostratigraphy**

This work is based on 28 productive out of 39 acid-leached samples taken from three sections (Tabs 1-3). Positions of these samples are shown on the Fig. 3. Six samples: Ba4, Ba5, Bg9, Bg10 (Baghin section), K8 (Hojeidk section) and S12 (Sardar section) belong to the MN4 Zone (transitions Zone) or are even younger according to earlier studies (Gholamalian & Kebriaei 2008; Gholamalian et al. 2011). Twenty-two species and subspecies belonging to five genera enabled us to use the global zonations of Klapper (1989), Klapper & Johnson (1990) and Ziegler & Sandberg (1990) (in some cases). The presence of the early form of _An. rotundiloba_...
loba, the index species for the base of the Late Devonian is an important discovery that allows us to correlate our biozones with those of the GSSP in the Montagne Noire, France (Fig. 3). Abbreviations used here are: An. = Anacyrorella, T. = Tortiodus, I. = Icriodus, P. = Polygnathus, Schm. = Schmidtognathus.

Hojeckd section
- hermanni - lower MN1 zones (A4 to A7)

The age of this interval is based on the first appearance of Polygnathus dubius that first occurs at the base of the Lower hermanni Zone (Narkiewicz & Bultyck 2010) and the age of the next interval (upper MN1 - MN2).

Other associated species are: Polygnathus alatus, P. aff. dubius, P. aff. xylus, P. hojeckdi n. sp., Icriodus excavatus and I. aff. subterminus.

Polygnathus alatus that was assumed to be restricted to the Frasnian, is recently reported from the ansatus Zone (Klapper & Johnson 1980, Tab. 10; Narkiewicz & Bultyck 2007).

- Upper MN1- upper MN2 zones (A8 - A10)

This interval is characterized by the total range of Anacyroella binodosa (Narkiewicz & Bultyck, 2010). The presence of Anacyrorella rotundiloba early form is also important here, being the index for the base of Frasnian (Klapper et al. 1987; Klapper 1985, 1989).


Polygnathus praepolitus that had previously known from Upper falsovalvis - Lower rhenana zones (MN3 - MN11) (Ovrananova & Kononova 2001, 2008), appears in this interval, so we suggest new range; MN1-MN11.

- Upper MN3 Zone (A11-A13)

The base of this interval is defined by the first appearance of An. africana ranging from the upper MN3 to MN6 zones. The top is limited by the presence of P. aequalis in the sample K8 (see Gholamalian & Kebriaei 2008). According to Ji & Ziegler (1993), this species appears at the base of transits Zone (MN4).

Other associated species are: Icriodus aff. subterminus, P. alatus, P. dubius.

---

<table>
<thead>
<tr>
<th>Zones</th>
<th>hermanni - norrisi</th>
<th>MN1 - lower MN2</th>
<th>upper MN3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Species</td>
<td>Bg1</td>
<td>Bg2</td>
<td>Bg3</td>
</tr>
<tr>
<td>An. rotundiloba early form</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>An. africana</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I. excavatus</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>P. alatus</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P. dubius</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P. praepolitus</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>P. aff. webbi</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>P. xylus</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P. linguiformis linguiformis</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gen. et sp. indet.</td>
<td>1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Tab. 3 - Range chart of conodonts in the Sardar section.
Sardar section

- *hermanni - norrisi* zones (S2-S10)

The base and top of this interval are recognized due to presence of *P. dubius* and the age of the next interval (MN1 - MN2).

Other associated species are: *Polynathus alatus, P. dubius, P. aff. dubius, P. aff. webbi, P. xylus, P. denisbriceae, P. hojedki* n. sp., *P. sp. A, Tortodus aff. weddigei, Icriodus excavatus and I. aff. subterminus.*

- MN1 - lower MN2 zones (samples M1 - M2)

The age of the interval is based on the first occurrence of *Ancriodella rotundiloba* early form in sample M1 (Tab. 3).

Other associated species are: *Ancriodella bimodalosa, Polynathus alatus, P. dubius, P. aff. dubius, P. aff. webbi, P. praepolitus, P. xylus, Icriodus excavatus and I. aff. subterminus.*

- Upper MN3 Zone

The lower limit can be defined by the entrance of *Ancriodella africana,* the top by the first appearance of *P. aequalis* in the sample S12 (Gholamalian et al. in prep.).

Other associated species are: *P. praepolitus, P. aff. webbi, P. alatus, I. aff. subterminus.*

Baghin section

- *hermanni - norrisi* zones (Bg1 and Bg2)

The age of *hermanni Zone* for sample Bg1 is proved, based on the first appearance of *P. dubius* and the last occurrence of *P. linguiformis linguiformis* (Narkiewicz and Bultynck 2007: 425-427, 2010). The age of sample Bg2 with no index species is *hermanni - norrisi* zones on the basis of its stratigraphic position.

- MN1 - lower MN2 zones (Bg3)

The base of this interval is recognized by the first appearance of *An. rotundiloba* early form. The top is coincident with the base of the next zone.

Other associated species are: *Polynathus praepolitus, P. aff. webbi* and *Icriodus excavatus.*

- Upper MN3 Zone (Bg8)

The lower limit of this zone is indicated by the entrance of *An. africana;* the upper one by the presence of *P. aequalis* at the base of the next zone in the sample Bg4 (Gholamalian et al. 2011).

Systematic palaeontology

Order Ozarkodinida Dzik, 1976

Family Polynathidae Bassler, 1925

Genus Polynathus Hinde, 1879

Type species: *Polynathus dubius* Hinde, 1879

Polynathus hojedki* n. sp.

Pl. 3, Figs 8-13

Holotype: HUIC532, sample A4, Hojedk section, Pl. 3, Figs 10-12.

Paratype: HUIC530, sample A10, Hojedk section, Pl. 3, Figs 8-9.

Material: One specimen from sample A4, 2 from A8, 1 from A9, 4 from A10 (Hojedk section); one from S3 and 1 from M1-1 (Sardar section).

Etymology: This species is named after the Hojedk village where the first specimens were found.

Diagnosis: This polynathid species is characterized by an asymmetric platform with nodes that are arranged in short transverse ridges and a high carina reaching the posterior end. Adcarinal troughs are deep and extend to the platform posterior end. The inner margin of platform is straight and parallel to the carina. The outer part of the platform is triangular. Its outer margin is straight and longer from the anterior geniculation point to the angle of refraction, that is rounded and straight to slightly concave and shorter from the angle to the posterior end.

Description. This species is characterized by an asymmetric triangular platform. The platform is constricted in the anterior part, widest in the middle part, and progressively narrowing in the posterior part. The posterior end is semi-rounded to weekly sharp. Coarse separate nodes are arranged in longitudinal rows. These nodes can be connected forming short transversal ridges which do not reach the carina. The high carina reaches the posterior end. It is smooth in the anterior half and is composed of separate denticles in the posterior half. Adcarinal troughs are deep and extend to the posterior end. The free blade is composed of 9 to 10 isometric denticles and equal to one third of the total length of the unit. A small basal cavity is located beneath the anterior third of the platform. The keel is distinct.

Remarks. *Polynathus hojedki* can be distinguished from *P. webbi* by having longitudinal rows of nodes in addition to short transversal ridges. Other recently defined species, *Polynathus vachki* Gholamalian, can be recognized from *P. hojedki* by complete lack of longitudinal rows of nodes and disappearance of deep adcarinal troughs in the mid-platform. *Polynathus hojedki* can be discriminated from *P. nodocostatus* by having transversal ridges on the surface and deeper adcarinal troughs and from *P. strictus* by separated denticles on the anterior half of platform, shorter blade and very short adcarinal troughs.

Range. *hermanni* - upper MN2 zones, according to associated species (Tabs 1, 3).

Conclusions

The presence of the early form of *Ancriodella rotundiloba* as key biomarker for the base of Late Devonian enabled us to define the G-F boundary in southeast Iran and correlate it to the GSSP in Montagne Noire (France). The following biozones are recognized: *hermanni; hermanni - norrisi; MN1 - MN2;* and MN3. In all studied sections, characterized by shallow marine faunas, the base of Bahram Formation belongs to a late Givetian – early Frasnian time interval. A new late Gi-


---

**Acknowledgements.** Authors are grateful for all helps from Prof. G. Klapper (USA) who provided useful comments on primary identification of polygnathid and ancyrodellid species. Authors express sincerely gratitude to Drs. K. Narkiewics and S. Gouwy for their critical comments on the early version of paper. We thank Dr. M.J. Hassani, I. Turkzadeh (High Technology Education University of Kerman), Dr. A. Bahrami (Esfahan University), M. Momeni (Islamic Azad University, Zarrind Branch) and Z. Khorsavi (Damghan University) for their useful helps in technical supports and field works. Dr. Khodaei (Islamic Azad University, Majlesi Branch, Esfahan) is appreciated for providing SEM micrographs.
PLATE 1

Figs 1-2 - *Ancyrodella ratumidaiba* (Bryant, 1921) early form, HUIC418, sample S11, Sardar section, x 30.

Figs 3-4 - *Ancyrodella ratumidaiba* (Bryant, 1921) early form, HUIC461, sample A9, Hojedk section, upper and lower views, x 30.

Fig. 5 - *Ancyrodella ratumidaiba* (Bryant, 1921) early form, HUIC463, sample A9, Hojedk section, upper view, x 30.

Figs 6-7 - *Ancyrodella ratumidaiba* (Bryant, 1921) early form, HUIC465, sample A9, Hojedk section, upper and lower views, x 41.

Figs 8-9 - *Ancyrodella ratumidaiba* (Bryant, 1921) early form, HUIC468, sample A9, Hojedk section, upper view, x 31.

Figs 10-11 - *Ancyrodella ratumidaiba* (Bryant, 1921) early form, HUIC472, sample A8, Hojedk section, upper and lower views, x 34.

Figs 12-13 - *Ancyrodella ratumidaiba* (Bryant, 1921) early form, HUIC480, sample A9, Hojedk section, upper and lower views, x 35.


Figs 16-17 - *Ancyrodella binodosa* Uyeno, 1967, HUIC478, sample A9, Hojedk section, upper and lower views, x 45.


PLATE 2

Figs 1 - Gen. et sp. indet., HUIC560, sample Bg3, Baghin section, upper view, x 30.

Figs 2, 4, 6-8 - *Iridiodus excava* Weddige, 1984. 2) HUIC486 sample A4, Hojedk section, upper view, x 49; 4) HUIC687 sample A8, Hojedk section, upper view, x 61; 6) HUIC490, sample A9, Hojedk section, upper view, x 60; 7) HUIC688 sample A10, Hojedk section, upper view, x 68; 8) HUIC547, sample M1-1, Sardar section, upper view, x 51.

Figs 3 - *Iridiodus aff. subterminus* Youngquist, 1947, HUIC542, sample S3, Sardar section, upper view, x 61.

Fig. 5 - *Iridiodus vixium* Nazarova, 1997, HUIC489, sample A9, Hojedk section, upper view, x 47.

Fig. 9 - *Iridiodus sp.* HUIC491, sample A8, Hojedk section, upper view, x 53.


Figs 14, 16-17 - *Polygnathus dubius* Hinde, 1879. 14) HUIC515, sample A4, Hojedk section, upper view, x 31; 16-17) HUIC503, sample A4, Hojedk section, upper and lower views, x 40.

Fig. 18 - *Polygnathus polluci* Druce, 1976, HUIC507, sample A10, Hojedk section, upper view, x 36.

Figs. 19-22 - *Polygnathus aff. xylus* Staufler, 1940. 19) HUIC500 sample A4, Hojedk section, upper view, x 49; 20-21) HUIC573, sample S3, Sardar section, upper and lower views, x 50; 22) HUIC576, sample A4, Hojedk section, upper view, x 48.

Figs 23-26 - *Polygnathus alatus* Huddle, 1934. 23) HUIC571, sample M1, Sardar section, upper view, Sardar section, upper view, x 30; 24) HUIC559, sample M2, Sardar section, upper view, x 35; 25) HUIC577, sample M1-1, Sardar section, upper view, x 33; 26) HUIC578, sample M1, Sardar section, upper view, x 31.

PLATE 3

Figs 1, 2, 6, 7 - *Polygnathus praepolitus* Kononova, Alekseev, Barskov and Reimers, 1996. 1) HUIC550, sample M1-1, Sardar section, upper view, x 45; 2) HUIC551, sample M1-1, Sardar section, upper view, x 56; 6) HUIC552, sample S11, Sardar section, upper view, x 52; 7) HUIC525, sample A11, Hojedk section, upper view, x 52.

Figs 3-5 - *Polygnathus alatus* Huddle 1934. 3) HUIC555, sample S9, Sardar section, upper view, x 40; 4) HUIC561, sample Bg8, Baghin section, upper view, x 40; 5) HUIC553, sample S8, upper view, x 38.

Figs 8-13 - *Polygnathus hojedki* n. sp. 8-9) HUIC530, sample A10, Hojedk section, upper and lower views, x 40; 10-12) HUIC532, sample A6, Hojedk section, upper and lower views, x 35; 13) HUIC574, sample S3, Sardar section, upper view, x 33.

Figs 14 - *Polygnathus sp. C* HUIC562, sample M1-1, Sardar section, upper view, x 40.

Figs 15-16 - *Polygnathus alatus* Huddle, 1934, HUIC498, sample A4, Hojedk section, upper and lower views, x 33.

Figs 17-18 - *Polygnathus aff. wehbi* Branson & Mehl, 1934, 17) HUIC563, sample M1-1, Sardar section, upper view, x 40; 18) HUIC564, sample M1-1, Sardar section, upper view, x 40.

Figs 19 - *Polygnathus linguaforma* linguaforma Hinde, 1879, HUIC565, Sample Bg1, Baghin section, upper view, x 35.

Figs 20 - *Polygnathus sp. A* HUIC534, sample A9, Hojedk section, upper view, x 32.

Fig. 21 - *Polygnathus densiradiata* Bulyunya, 1979, HUIC535, sample A9, Hojedk section, upper view, x 45.

Figs 22-26 - *Tortodina aff. weddigei* Aboussalam, 2003. 22) HUIC536, sample A10, Hojedk section, upper view, x 39; 23-26) HUIC537, sample A10, Hojedk section, upper and lateral views, x 40; 25-26) HUIC538, sample A10, Hojedk section, upper and lower views, x 33.
PLATE 2