New records of brachiopods from the Lower Miocene deposits of the Qom Formation of the Isfahan province, Central Iran

Nuevos registros de braquiópodos de los depósitos del Mioceno Inferior de la Formación Qom en la provincial de Isfahan, Irán Central

Maria Aleksandra **Bitner**[1,*], Ali **Bahrami**[2], Mansooreh Sani **Josheghani**[2], Mehdi **Yazdi**[2], Kamil **Zágoršek**[3]

[1] Institute of Paleobiology, Polish Academy of Sciences, ul. Twarda 51/55, 00-818 Warszawa, Poland.

[2] Department of Geology, Faculty of Sciences, University of Isfahan, 81746, Isfahan, Iran.

[3] Department of Geography, Technical University of Liberec, Studentská 2, CZ-461, 17 Liberec, Czech Republic.

* Corresponding author: (M.A. Bitner)
bitner@twarda.pan.pl

ABSTRACT

The study presents new records of brachiopods from the Lower Miocene deposits of the Qom Formation from two sections, Bagh and Ramsheh in the Isfahan province, Central Iran. Three species, i.e. *Argyrotheca bitnerae*, *Joania cordata*, and *Platidia anomioides*, have been identified in the investigated material. All species are present in the Bagh section whereas in the material from Ramsheh *A. bitnerae* was not found. Although the species recognized here were already described from the Miocene of the Qom Formation, this is their first report from the localities of Bagh and Ramsheh, providing new data on the distribution of brachiopods in the Cenozoic of Iran.

Keywords: Brachiopoda, Lower Miocene, Qom Formation, Central Iran.

RESUMEN

Este studio presenta nuevos registros de braquiópodos de depósitos del Mioceno Inferior de la Formación Qom, procedentes de dos secciones: Bagh y Ramsheh en la provincia de Isfahan, Irán Central. Tres especies, i.e. Argyrotheca bitnerae, Joania cordata, y Platidia anomioides, fueron identificadas en el material investigado. Todas las especies están presentes en la sección Bagh, mientras que en el material de Ramsheh, A. bitnerae no fue encontrada. Aunque las especies reconocidas aquí han sido ya descritas del Mioceno de la Formación Qom, este es su primer reporte en las localidades Bagh y Ramsheh, proporcionando nuevos datos de la distribución de brequiópodos en el Cenozóico de Irán.

Palabras clave: Brachiopoda, Mioceno temprano, Formación Qom, Irán Central.

How to cite this article:
Bitner, M.A., Bahrami, A., Josheghani, M.S., Yazdi, M., Zágoršek, K., 2023, New records of brachiopods from the Lower Miocene deposits of the Qom Formation of the Isfahan province, Central Iran: Boletín de la Sociedad Geológica Mexicana, 75 (2), A010523. http://dx.doi.org/10.18268/BSGM2023v75n2a010523

Manuscript received: March 21, 2023.
Corrected manuscript received: April 25, 2023.
Manuscript accepted: April 30, 2023.

Peer Reviewing under the responsibility of Universidad Nacional Autónoma de México.

This is an open access article under the CC BY-NC-SA license (https://creativecommons.org/licenses/by-nc-sa/4.0/)

http://dx.doi.org/10.18268/BSGM2023v75n2a010523

1. Introduction

The Oligo-Miocene Qom Formation of Iran, because of its highly fossiliferous deposits, has been the subject of investigations since very long (Schuster and Wielandt, 1999; Khaksar and Maghfori-Moghaddam, 2007; Reuter *et al.*, 2009; Behforouzi and Safari, 2011; Mohammadi *et al.*, 2011; Yazdi *et al.*, 2012; Mohammadi and Ameri, 2015; Zágoršek *et al.*, 2017; Hyžný *et al.*, 2021). However, brachiopods are still poorly known from the Qom Formation. Although their presence was mentioned from different sections (Nouradini *et al.*, 2014, 2015, 2019; Pedramara *et al.*, 2019), the only taxonomical description of brachiopods from the Qom Formation is that from the Varton section where six micromorphic species, i.e. *Lacazella mediterranea* (Risso, 1826), *Megathiris detruncata* (Gmelin, 1791), *Argyrotheca cuneata* (Risso, 1826), *A. bitnerae* Dulai, 2011, *Joania cordata* (Risso, 1826), and *Platidia anomioides* (Scacchi and Philippi, 1844), were recognized (Pedramara *et al.*, 2019).

In this study, we present the new records of brachiopods from the Lower Miocene deposits of the Qom Formation, collected at two outcrops situated at Bagh and Ramsheh, Central Iran (Figure 1). The brachiopods are of low diversity, represented by three micromorphic species.

2. Geological setting

The Qom Formation was deposited in the interval from late Early Oligocene until the end of the Early Miocene in northern and central Iran (Abaie *et al.*, 1964; Stöcklin and Setudehina, 1991; Reuter *et al.*, 2009; Yazdi *et al.*, 2012). The Qom Formation crops out along the Zagros fold belt and is

Figure 1 Sketch map of Iran showing the location of studied sections, Bagh and Ramsheh, at which the brachiopods were collected. ARM. – Armenia, AZERB. – Azerbaijan, NAKH. – Nakhchivan.

http://dx.doi.org/10.18268/BSGM2023v75n2a010523

mainly composed of marine marls, limestones, gypsum and siliciclastic strata (Reuter *et al.*, 2009). In general, the Lower Red Formation underlies the Qom Formation that is conformably overlain by the Upper Red Formation (Stöcklin and Setudehina, 1991). The Qom Formation was divided by Furrer and Soder (1955) into six members: a) basal limestone, b) sandy marl, c) alternating marl and limestone, d) evaporate, e) green marl, and f) limestone. Reuter *et al.* (2009) recognized two basins for the Qom Formation: the Qom back-arc basin and Isfahan-Sirjan fore-arc basin. Subsequently, Oligocene-Miocene sedimentation in the Qom basin took place along a carbonate ramp including intertidal, shelf lagoon, platform margin and open marine environments (Seyrafian and Toraby, 2005; Daneshian and Ramezani Dana, 2007; Behforouzi and Safari, 2011). During the Early-Middle Miocene periodic connections prevailed between the Mediterranean Sea, Paratethys province, Indo-Pacific region and the Atlantic Ocean (Rögl, 1998; Popov *et al.*, 2004; Harzhauser *et al.*, 2007). Intermittent seaway connections and regional closings were mainly driven by regional and global geotectonics and sea-level fluctuations (Rögl, 1998).

The Lower Miocene carbonate deposits of the Qom Formation are well exposed in the Bagh outcrop, situated at approximately 55 km northeast of Isfahan, Central Iran (Figure 1). The GPS coordinates are 32°57'61"N and 52°0'95"E. The thickness of the Qom deposits in the Bagh section reaches 85 m. Lithologically they are mainly represented by greenish-grey, fissile, fossiliferous calcareous shale interbedded with thin beds of argillaceous limestone. For details see Nouradini *et al.* (2015) and Zágoršek *et al.* (2017).

The Ramsheh section is located approximately 135 km southeast of Isfahan (Figure 1). The WGS coordinates of the base of the section are 31°30'2.85"N and 52°48'48.91"E and the top 31°31'10.41"N and 52°48'52.22"E. The section consists mainly of marly and sandy limestones interbedded by sandstones and black shales (Figure 2).

3. Material and methods

The brachiopods investigated herein were collected in two outcrops situated at Bagh and Ramsheh, Central Iran (Figure 1). All specimens come from the sediment bulk samples collected during the fieldworks carried out in 2014, 2018 and 2019. The samples were washed and/or soaked with solution of hydrogen peroxide if necessary, then wet-sieved. The residuum was checked for brachiopods using a binocular microscope. The total number of specimens collected in the Bagh section is 485, while in the Ramsheh section it is 31 specimens.

Specimens selected for scanning electron microscopy were mounted on stubs, coated with platinum and photographed using a Philips XL-20 microscope at the Institute of Paleobiology, Warszawa. The material studied is housed at the Geology Museum of the University of Isfahan, Iran under UIGM acronym.

4. Results

The Early Miocene brachiopod fauna collected at the Bagh and Ramsheh sections is of low diversity, containing three micromorphic species belonging to two families (Megathyrididae and Platidiidae) and one order (Terebratulida).

Family Megathyrididae Dall, 1870

Argyrotheca bitnerae Dulai *in* Dulai and Stachacz, 2011

Figure 3A–3G

In the material under study this species has been found only at the Bagh section where it is very numerous, represented by 173 articulated specimens, one ventral and four dorsal valves. It is, however, known from the Qom Formation deposits, being identified in the material from the Varton section (Pedramara *et al.*, 2019). The species *A. bitnerae* is characterized by a triangular, weakly biconvex shell with smooth surface and high beak. Its dorsal

http://dx.doi.org/10.18268/BSGM2023v75n2a010523

septum is high, triangular in profile, without serrations (Figure 3G).

Argyrotheca bitnerae was originally described from the Middle Miocene of the Central Paratethys (Dulai and Stachacz, 2011; Hladilová *et al.*, 2014; Dulai, 2015; Kopecká *et al.*, 2018). In Europe, it was also recognized in the Oligocene deposists of France (Bitner *et al.*, 2013a) and Germany (Dulai and von der Hocht, 2020; Bitner and Müller, 2022).

Joania cordata (Risso, 1826)
Figure 3H–3M

This species was identified in both sections; at Bagh it is represented by 146 articulated speci-

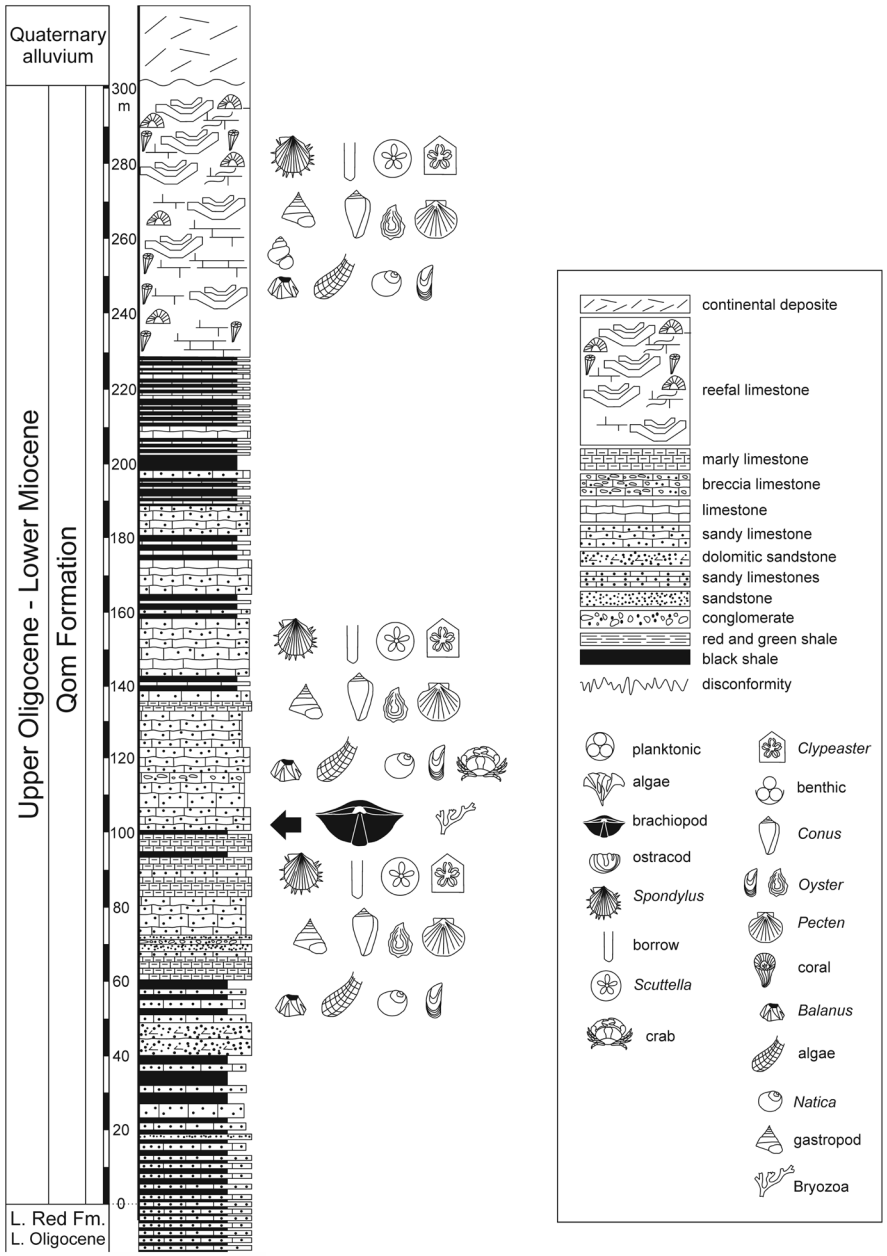

Figure 2 **Lithostratigraphical column of the Ramsheh section with indication of the brachiopod-bearing level.**

http://dx.doi.org/10.18268/BSGM2023v75n2a010523

mens, three ventral and three dorsal valves, while at Ramsheh it is much less numerous, being represented by 28 articulated specimens and two dorsal valves. Recently, *Joania cordata* was recorded in the material collected from the Qom Formation deposits at the Varton section (Pedramara *et al.*,

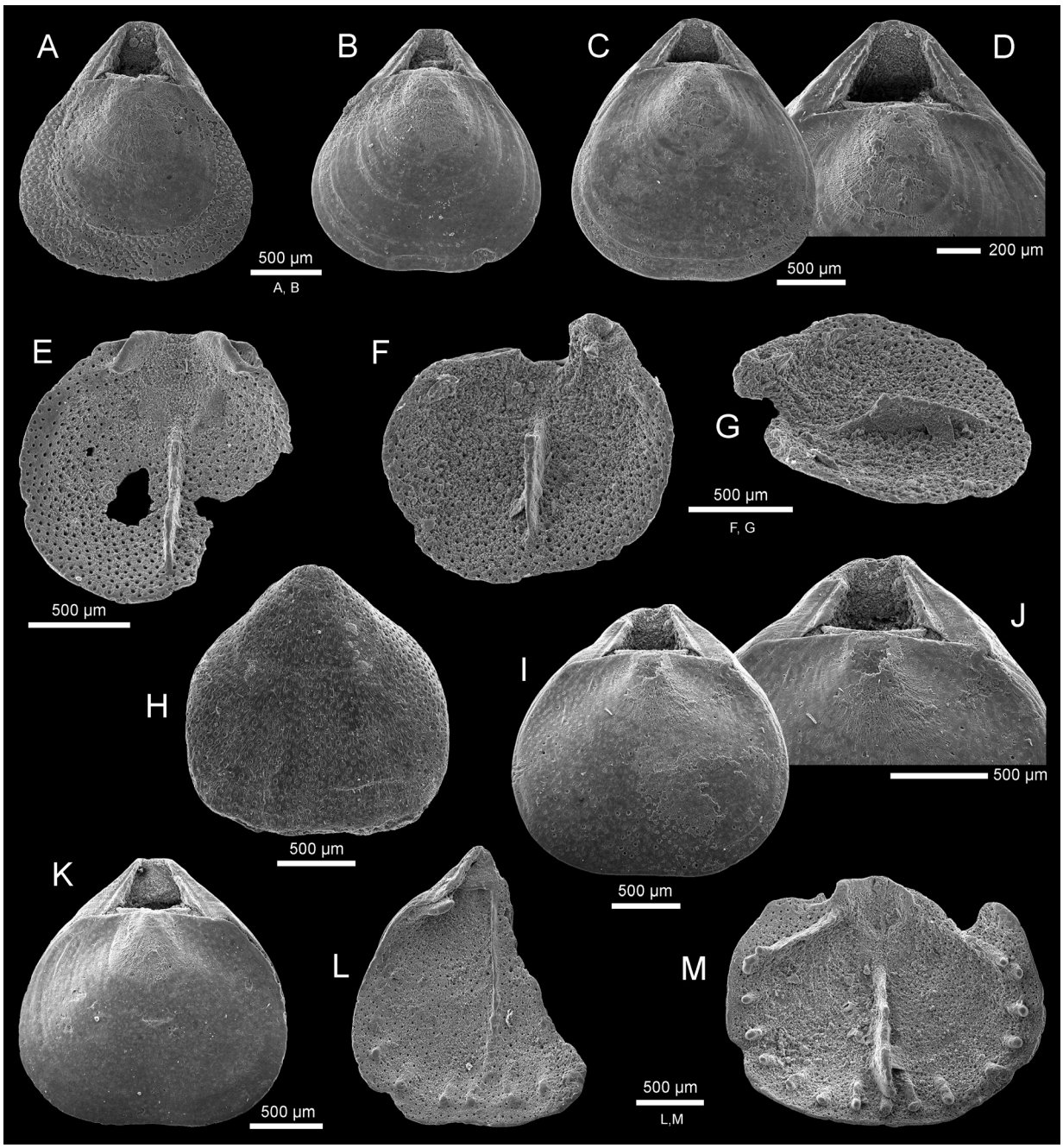

Figure 3 **Brachiopods, Early Miocene, Iran.** A–G. *Argyrotheca bitnerae* **Dulai, 2011, Bagh section; A–D, Dorsal views of articulated specimens (UIGM2026-2028), and enlargement (D) of the umbonal part to show details of foramen and deltidial plates; E–G, inner views of dorsal valves (UIGM2029-2030) and oblique view (G) to show a septum without serrations.** H–M. *Joania cordata* **(Risso, 1826); H, ventral view of articulated specimen (UIGM2031), Ramsheh section; I–K, dorsal views of articulated specimens (UIGM2032-2033) and enlargement (J) of umbonal part to show details of beak, Bagh section; L, inner view of partly broken ventral valve (UIGM2034), visible hooked teeth and marginal tubercles; M, inner view of dorsal valve (UIGM2035), visible high septum and distinct marginal tubercles. All SEM.**

http://dx.doi.org/10.18268/BSGM2023v75n2a010523

2019). The species is small, varying in outline from heart-shaped to rounded subrectangular, weakly biconvex. Its surface is smooth or weakly ribbed; ribs are usually more distinct on the ventral valve (Figure 3H). Internally, it is characterized by a high median septum with numerous serrations and submarginal tubercles on both valves (Figure 3L, M). In the Middle Miocene of the Central Paratethys *J. cordata* is one of the most common species (Bitner, 1990, 1993; Bitner and Pisera, 2000; Bitner and Dulai, 2004; Bitner and Kaim, 2004; Dulai, 2007, 2015; Zágoršek *et al.*, 2012; Bitner *et al.*, 2013b, Bitner *et al.*, 2014; Hladilová *et al.*, 2014; Bitner and Motchurova-Dekova, 2016; Kopecká *et al.*, 2018). Its oldest fossil record is from the Upper Oligocene (Bitner *et al.*, 2013a), and today it lives in the NE Atlantic, Mediterranean Sea and Red Sea, occupying the depth from 3 to 600 m (Logan, 2007; Logan *et al.*, 2008).

Family Platidiidae Thomson, 1927

Platidia anomioides (Scacchi and Philippi *in* Philippi, 1844)

Figure 4A–G

Although found in both outcrops, *Platidia anomioides* is very rare in the material from the Ramsheh section, represented by one specimen only. In the Bagh section, however, it is very common, with 152 articulated specimens, two ventral and one dorsal valves. This species was already described from the Qom Formation deposits from the Varton section (Pedramara *et al.*, 2019). The characteristic feature of *Platidia* is a large, subcircular foramen of amphithyrid type. *Platidia anomioides* is small, oval to subcircular in outline with smooth surface. Its hinge line is straight and very short.

Known since the Late Eocene (Dulai, 2011), *P. anomioides* is widely distributed in the Miocene

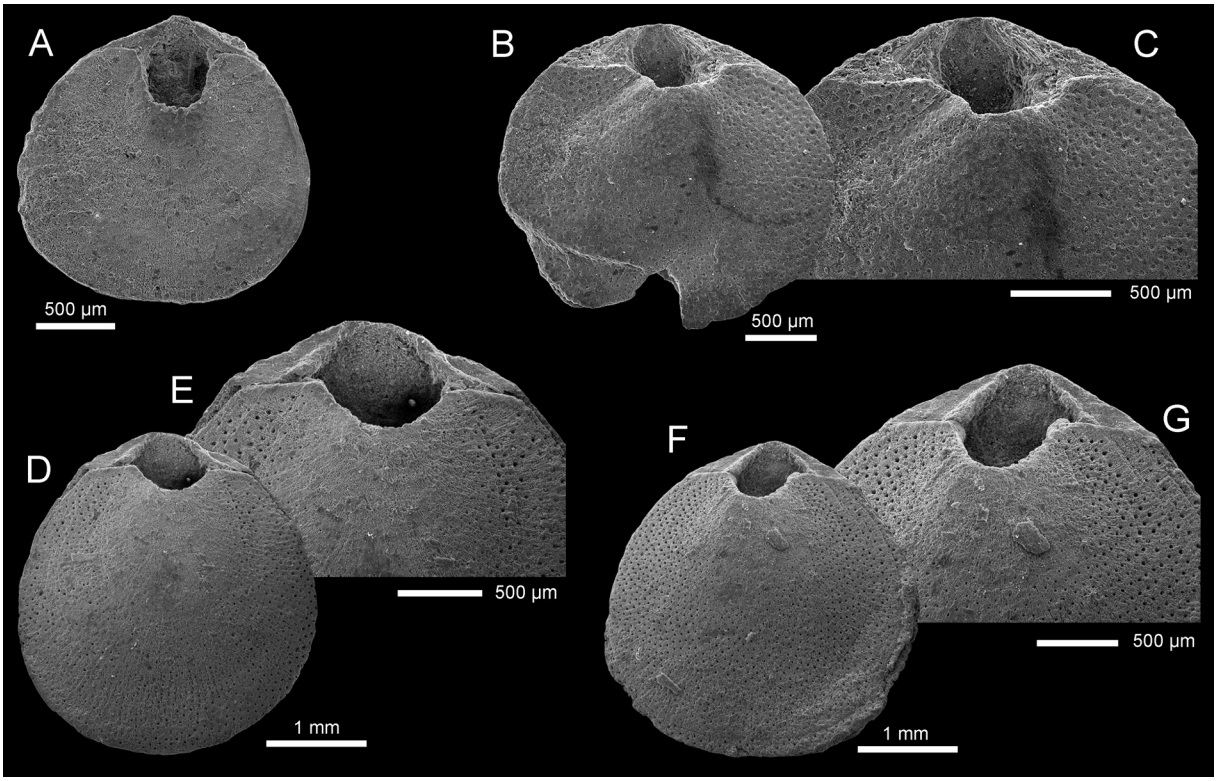

Figure 4 *Platidia anomioides* **(Scacchi and Philippi, 1844), Early Miocene, Iran. A. Dorsal view of young individual (UIGM2036), Bagh section; B, C. Dorsal view of articulated specimen (UIGM2039) and enlargement (C) of umbonal part, Ramsheh section; D–G. Dorsal views of articulated specimens (UIGM2037-2038) and enlargement (E, G) of umbonal part to show details of amphithyrid foramen, narrow interarea and deltidial plates, Bagh section. All SEM.**

http://dx.doi.org/10.18268/BSGM2023v75n2a010523

of the Central Paratethys (Bitner, 1990; Bitner and Dulai, 2004; Bitner *et al*., 2013b; Bitner and Motchurova-Dekova, 2016). In modern waters this species is known from all oceans having a wide depth range from 8 to 2190 m (Logan, 2007).

5. Final remarks

The brachiopod fauna collected in the Lower Miocene Qom Formation deposits at two outcrops, Bagh and Ramsheh, Isfahan province, Central Iran contains three and two species, respectively. The species *Joania cordata* and *Platidia anomioides* were found in both sections, while *Argyrotheca bitnerae* is present only in the material from the Bagh section. All three species were already reported from the Qom Formation deposits at the Varton section (Pedramara *et al*., 2019), however, in the species composition the Varton assemblage differs from those of Bagh and Ramsheh. At Varton the predominant species is thecideide *Lacazella mediterranea* (Risso, 1826), absent in the Bagh and Ramsheh material. Also two other species, *Megathiris detruncata* (Gmelin, 1791) and *Argyrotheca cuneata* (Risso, 1826), present at Varton were not found at Bagh and Ramsheh. Those differences in the taxonomic composition are difficult to explain, however, we can speculate that the absence of *L. mediterranea* might be caused by the absence of light-poor, cryptic habitats at both studied localities, preferable environment for this species (Logan, 2008). Additionally, *Lacazella mediterranea* is a shallow water species with maximum occurrence from 20 to 60 m (Logan, 1979), whereas the presence of *Platidia anomioides* in significant amount may indicate deeper water environment for the studied deposits. Although having a very wide depth range (Logan, 2007), *P. anomioides* is considered a deeper water brachiopod, being most common at the depth below 200 m (Logan, 1979; Logan *et al*., 2008).

All species identified herein are well known from many localities in the Paleogene and Neogene of Europe. Until the closure of the Tethyan Seaway (Harzhauser *et al*., 2007; Reuter *et al*., 2009) Central Iran was a part of the Western Tethys Region, including the proto-Mediterranean and the Paratethys seas, and the connection with the Indian Ocean, thus the great faunistic similarities between the Qom Basin and the proto-Mediterranean and the Paratethys are observed among many groups (e.g. Nouradini *et al*., 2014; Zágoršek *et al*., 2017; Pedramara *et al*., 2019; Hyžný *et al*., 2021).

Contributions of authors

MAB: conceptualization, paleontological descriptions and paleoecological interpretations, fieldwork, writing of original manuscript. AB: geological description and paleoecological interpretations, fieldwork, writing of the original manuscript. MSJ: fieldwork, paleoecological interpretations. MY: geological description, fieldwork, correction and edition of the manuscript. KZ: fieldwork, correction and edition of the manuscript.

Financing

This specific work was not funded by any institution.

Acknowledgements

The authors are grateful to the Vice Chancellor for Research and Technology at University of Isfahan for financial and logistic supports. We thank the reviewers, Alfréd Dulai (Hungarian Natural History Museum, Budapest) and Miguel A. Torres-Martínez (Universidad Nacional Autónoma de México, Mexico City) for their valuable suggestions.

Conflicts of interest

The authors declare no conflicts of interest.

References

Abaie, I., Ansari, H.J., Badakhshan, A., Jaafari, A., 1964, History and development of the Alborz and Sarajeh fields of Central Iran: Bulletin of Iranian Petroleum Institute, 15, 561–574.

Behforouzi, E., Safari, A., 2011, Biostratigraphy and paleoecology of the Qom Formation in Chenar area (northwestern Kashan), Iran: Revista Mexicana de Ciencias Geológicas, 28, 555–565.

Bitner, M.A., 1990, Middle Miocene (Badenian) brachiopods from the Roztocze Hills, south-eastern Poland: Acta Geologica Polonica, 40(3/4), 129–157.

Bitner, M.A., 1993, Middle Miocene (Badenian) brachiopods from coral reefs of north-western Bulgaria: Acta Geologica Polonica, 43, 147–155.

Bitner, M.A., Dulai, A., 2004, Revision of Miocene brachiopods of the Hungarian Natural History Museum, with special regard to the Meznerics collection: Fragmenta Palaeontologica Hungarica, 22, 69–82.

Bitner, M.A., Kaim, A., 2004, The Miocene brachiopods from the silty facies of the intra-Carpathian Nowy Sącz Basin (Poland): Geological Quarterly, 48, 193–198.

Bitner, M.A., Motchurova-Dekova, N., 2016, Middle Miocene (Badenian) brachiopods from Yasen, northwestern Bulgaria: taxonomic composition and biogeographical significance: Neues Jahrbuch für Geologie und Paläontologie, Abhandlungen, 279(1), 7–22. https:// doi: 10.1127/njgpa/2016/0536

Bitner, M.A., Müller, A., 2022, Early Oligocene brachiopods from the rocky shore deposists at Mammendorf, central Germany: Annales Societatis Geologorum Poloniae, 92, 87–107. https://doi.org/10.14241/asgp.2022.02

Bitner, M.A., Pisera, A., 2000, Brachiopod fauna from the Middle Miocene deposits of Niechobrz, south-eastern Poland: Tertiary Research, 20, 7–15.

Bitner, M.A., Lozouet, P., Cahuzac, B., 2013a, Upper Oligocene (Chattian) brachiopod fauna from the Aquitaine Basin, southwestern France and its paleoenvironmental implications: Geodiversitas, 35(3), 579–606. https://doi.org/10.5252/g2013n3a4

Bitner, M.A., Zágoršek, K., Hladilová, Š., 2013b, Deep-water brachiopod assemblage from the Middle Miocene of Kralice nad Oslavou, Moravia, south-eastern Czech Republic: Comptes Rendus Palevol, 12, 81–89. https://doi.org/10.1016/j.crpv.2013.01.004

Bitner, M.A., Zágoršek, K., Halásová, E., Hudáčková, N., Jamrich, M., 2014, Brachiopods and bryozoans from the Sandberg section (Vienna Basin, Central Paratethys) and their significance for environmental interpretation of the Early Sarmatian (= Middle Miocene) Sea: Neues Jahrbuch für Geologie und Paläontologie Abhandlungen, 273, 207–219. https://doi.org/10.1127/0077-7749/2014/0424

Dall, W.H., 1870, A revision of the Terebratulidae and Lingulidae, with remarks on and descriptions of some recent forms: American Journal of Conchology, 6(2), 88–168.

Daneshian, J., Ramezani Dana, L., 2007, Early Miocene benthic foraminifera and biostratigraphy of the Qom Formation, Deh Namak, Central Iran: Journal of Asian Earth Sciences, 29, 844–858. https://doi.org/10.1016/j.jseaes.2006.06.003

Dulai, A., 2007, Badenian (Middle Miocene) micromorphic brachiopods from Báand and Devecser (Bakony Mountains, Hungary): Fragmenta Palaeontologica Hungarica, 24–25, 1–13.

Dulai, A., 2011, Late Eocene (Priabonian) micromorphic brachiopods from the Upper Austrian Molasse Zone: Memoirs of the Association of Australasian Palaeontologists, 41, 295–313.

Dulai, A., 2015, Central Paratethyan Middle Miocene brachiopods from Poland, Hungary and Romania in the Naturalis Biodiversity Center (Leiden, the Netherlands): Scripta Geologica, 149, 185–211.

http://dx.doi.org/10.18268/BSGM2023v75n2a010523

Dulai, A., von der Hocht, F., 2020, Upper Oligocene brachiopods from NW Germany, with description of a new Platidiinae genus, *Germanoplatidia* n. gen.: Rivista Italiana di Paleontologia e Stratigrafia, 126(1), 223–248.

Dulai, A., Stachacz, M., 2011, New Middle Miocene *Argyrotheca* (Brachiopoda; Megathyrididae) species from the Central Paratethys: Földtani Közlöny, 141, 445–468.

Furrer, M.A., Soder, P.A., 1955, The Oligo–Miocene marine formation in the Qom region (Central Iran): Proceedings of the 4th World Petroleum Congress, Rome, Section I/A/5, 267–277.

Harzhauser, M., Kroh, A., Mandic, O., Piller, W.E., Göhlich, U., Reuter M., Berning, B., 2007, Biogeographic responses to geodynamics: A key study all around the Oligo–Miocene Tethyan Seaway: Zoologischer Anzeiger, 246, 241–256. http://dx.doi.org/10.1016/j.jcz.2007.05.001

Hladilová, Š., Nehyba, S., Zágoršek, K., Tomanová Petrová, P., Bitner, M.A., Demény, A., 2014, Early Badenian transgression on the outer flank of Western Carpathian Foredeep, Hluchov area, Czech Republic: Annales Societatis Geologorum Poloniae, 84, 259–278.

Hyžný, M., Bahrami, A., Yazdi, M., Torabi, H., 2021, Decapod crustaceans from the lower Miocene Qom Formation of the Isfahan area, Central Iran: Boletín de la Sociedad Geológica Mexicana, 73(3), A140521. http://dx.doi.org/10.18268/BSGM2021v73n3a140521

Khaksar, K., Maghfori-Moghaddam, I., 2007, Paleontological study of the echinoderms in the Qom Formation (Central Iran): Earth Sciences Research Journal, 11, 57–79.

Kopecká, J., Holcová, K., Nehyba, S., Hladilová, Š., Brzobohatý, R., Bitner, M.A., 2018, The earliest Badenian *Planostegina* bloom deposit: reflection of an unusual environment in the westernmost Carpathian Foredeep (Czech Republic): Geological Quarterly, 62, 18–37. http://dx.doi.org/10.7306/gq.1398

Logan, A., 1979, The Recent Brachiopoda of the Mediterranean Sea: Bulletin de l'Institut Océanographique, Monaco, 72, 1–112.

Logan, A., 2007, Geographic distribution of extant articulated brachiopods, in Selden, P.A. (Ed.), Treatise on Invertebrate Paleontology. Part H. Brachiopoda Revised. Vol. 6, 3082–3115. Geological Society of America and University of Kansas, Boulder, Colorado and Lawrence, Kansas.

Logan, A., 2008, Holocene thecideide brachiopods from the north-western Pacific Ocean: systematics, life habits and ontogeny: Systematics and Biodiversity, 6, 405–413. http://dx.doi.org/10.1017/S1477200008002739

Logan, A., Tomašových, A., Zuschin, M., Grill, B., 2008, Recent brachiopods from the Red Sea and Gulf of Aden: Fossils and Strata, 54, 299–309. https://doi.org/10.18261/9781405186643-2008-33

Mohammadi, E., Ameri, H., 2015, Biotic components and biostratigraphy of the Qom Formation in northern Abadeh, Sanandaj–Sirjan fore-arc basin, Iran (northeastern margin of the Tethyan Seaway): Arabian Journal of Geosciences, 8, 10789–10802. https://doi.org/10.1007/s12517-015-1948-7

Mohammadi, E., Safari, A., Vaziri-Moghaddam H., Vaziri M.R., Ghaedi, M., 2011, Microfacies analysis and paleoenvironmental interpretation of the Qom Formation, south of the Kashan, Central Iran: Carbonates and Evaporites, 26, 255–271. https://doi:10.1007/s13146-011-0059-0

Nouradini, M., Ashouri, A.R., Yazdi, M., Rahiminejad, A.H., 2019, Palaeoecology and distribution of upper Oligocene–lower Miocene foraminifera in the Qom Formation, the Bagher-Abad section, NE Isfahan, Central Iran: Carbonates and Evaporites, 34, 563–579. https://doi 10.1007/s13146-017-0389-7

Nouradini, M., Azami, S.H., Hamad, M., Yazdi, M., Ashouri, A.R., 2015, Foraminiferal

paleoecology and paleoenvironmental reconstructions of the lower Miocene deposits of the Qom formation in Northeastern Isfahan, Central Iran: Boletín de la Sociedad Geológica Mexicana, 67(1), 59–73. http://dx.doi.org/10.18268/BSGM2015v67n1a5

Nouradini, M., Yazdi, M., Ashouri, A., 2014, Systematic notes on Burdigalian Echinoids from the Qom Formation in the Bagher Abad area, Central Iran: Geopersia, 4(2), 155–167. http://dx.doi.org/10.22059/JGEOPE.2014.52716

Pedramara, A., Zágoršek, K., Bitner, M.A., Yazdi, M., Bahrami, A., Maleki, Z., 2019, Bryozoans and brachiopods from the lower Miocene deposits of the Qom Formation in north-east Isfahan (central Iran): Neues Jahrbuch für Geologie und Paläontologie, Abhandlungen, 294, 229–250. http://dx.doi.org/10.1127/njgpa/2019/0852

Philippi, R.A., 1844, Enumeratio molluscorum Siciliae cum viventium tum in tellure tertiaria fossilium quae in itinere suo observavit. Vol. 2: E. Anton, Halle, 303 p.

Popov, S.V., Rögl, F., Rozanov, A.Y., Steininger, F.F., Scherba, I.G., Kováč, M., 2004, Lithological-paleontological maps of Paratethys. 10 maps Late Eocene to Pliocene: Courier Forschungsinstitut Senckenberg, 250, 1–46.

Reuter, M., Piller, W., Harzhauser, M., Mandic, O., Berning, B., Rögl, F., Kroh, A., Aubry, M.P., Wielandt-Schuster, U., Hamedani, A., 2009, The Oligo-/Miocene Qom Formation (Iran): evidence for an early Burdigalian restriction of the Tethyan Seaway and closure of its Iranian gateways: International Journal of Earth Sciences, 98, 627–650. https://doi.org/10.1007/s00531-007-0269-9

Risso, A., 1826, Histoire naturelle des principales productions de l'Europe méridionale, et particulièrement de celles des environs de Nice et des Alpes maritimes. IV: F.-G. Levrault, Paris, 439p.

Rögl, F., 1998, Palaeogeographic considerations for Mediterranean and Paratethys seaways (Oligocene to Miocene): Annalen des Naturhistorischen Museums in Wien, Serie A, 99, 279–310.

Schuster, F., Wielandt, U., 1999, Oligocene and Early Miocene coral faunas from Iran: palaeoecology and palaeobiogeography: International Journal of Earth Sciences, 88, 571–581. https://doi.org/10.1007/s005310050285

Seyrafian, A., Toraby, H., 2005, Petrofacies and sequence stratigraphy of the Qom Formation (Late Oligocene-Early Miocene?), north of Nain, southern trend of central Iranian Basin: Carbonates and Evaporites, 20, 82–90. https://doi.org/10.1007/BF03175451

Stöcklin, J., Setudehina, A., 1991, Stratigraphic lexicon of Iran: Geological Survey of Iran, Tehran, Republic 18, Third edition, 376 p.

Thomson, J.A., 1927, Brachiopod morphology and genera (Recent and Tertiary): New Zealand Board of Science and Art, Manual, 7, 338 p.

Yazdi, M., Parvanenejad Shirazi, M., Rahiminejad, A.H., Motavalipoor, R., 2012, Paleobathymetry and paleoecology of colonial corals from the Oligocene-early Miocene(?) Qom Formation (Dizlu area, central Iran): Carbonates and Evaporites, 27, 395–405. http://dx.doi.org/10.1007/s13146-012-0122-5.

Zágoršek, K., Nehyba, S., Tomanová-Petrová, P., Hladilová, Š., Bitner, M.A., Doláková, N., Hrabovský, J., Jašková, V., 2012, Local catastrophe caused by tephra input near Přemyslovice (Moravia, Czech Republic) during the mid-Miocene: Geological Quarterly, 56, 269–284. https://doi.org/10.7306/gq.1021

Zágoršek, K., Yazdi, M., Bahrami, A., 2017, Cenozoic cyclostomatous bryozoans from the Qom Formation (Chahriseh area northeast of Isfahan, central Iran): Neues Jahrbuch für Geologie und Paläontologie, Abhandlungen, 283, 109–118. http://dx.doi.org/10.1127/njgpa/2017/0631