

Short note

First report of the rugose coral *Hexagonaria davidsoni* from the Khoshyeilagh Formation (Devonian), Alborz Mountains, Northeastern IranMostafa **Falahatgar**, Andreas **May**, Mehdi **Sarfi****Mostafa Falahatgar**

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ABSTRACT

The Middle to Late Devonian Khoshyeilagh Formation successions are here reported from the Khoshyeilagh neck, Alborz Mountains, Northeastern Iran. This formation is very fossiliferous. The rugose coral *Hexagonaria davidsoni* occurs within Frasnian strata and is the first report of this species from the Khoshyeilagh Formation.

Keywords: Devonian, Frasnian, rugose corals, Anthozoa, Alborz Mountains, Iran.

RESUMEN

En este trabajo se reportan las secuencias del Devónico Medio a Tardío de la Formación Khoshyeilagh en el cuello de Khoshyeilagh. Dicha formación es muy fosilífera en el área estudiada. La especie de coral rugoso *Hexagonaria davidsoni* de los estratos del Frasniano de esta formación es el primer reporte de esta especie en el Devónico de Irán y se describe aquí sistemáticamente.

Palabras clave: Devónico, Frasniano, corales rugosos, Anthozoa, Montañas Alborz, Irán.

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1. Introduction

The Khoshyeilagh Formation is scattered in eastern parts of the Alborz Mountains, northern Iran. Devonian corals in the Khoshyeilagh Formation have been studied by several paleontologists over the last several decades. Ghods (1982) studied four sections in the Alborz Range, northern Iran from the northwest to eastern parts of the Alborz. Wendt *et al.* (2005), reported rugose corals from the Upper Devonian Geirud Formation in the central Alborz. Ashouri *et al.* (2008), Abbasi *et al.* (2014a), and Abbasi *et al.* (2014b) described and studied some Givetian to Frasnian rugose corals from the Khoshyeilagh Formation in the eastern Alborz. Abbasi *et al.* (2014a) studied Givetian and lower Frasnian rugose corals at Till Abad village NE of Shahrood in NE Iran. Other fossil groups

have been investigated in the Khoshyeilagh Formation by several researchers, such as Bozorgnia (1973), Ahmadzadeh Heravi (1975), Jenny, (1977), Stampfli (1978), Ashouri (1994) and Ghavidel Syooki (1975, 2007). Up to now, the investigations on rugose corals from the Khoshyeilagh Formation have focused more on solitary forms and descriptions of colonial corals are rare. The aim of this study is to systematically describe specimens of the colonial rugose coral *Hexagonaria* from the Khoshyeilagh Formation.

2. Geological setting

The studied section is situated in the eastern Alborz Mountains, northern Iran and is located in the Khoshyeilagh neck along the main road

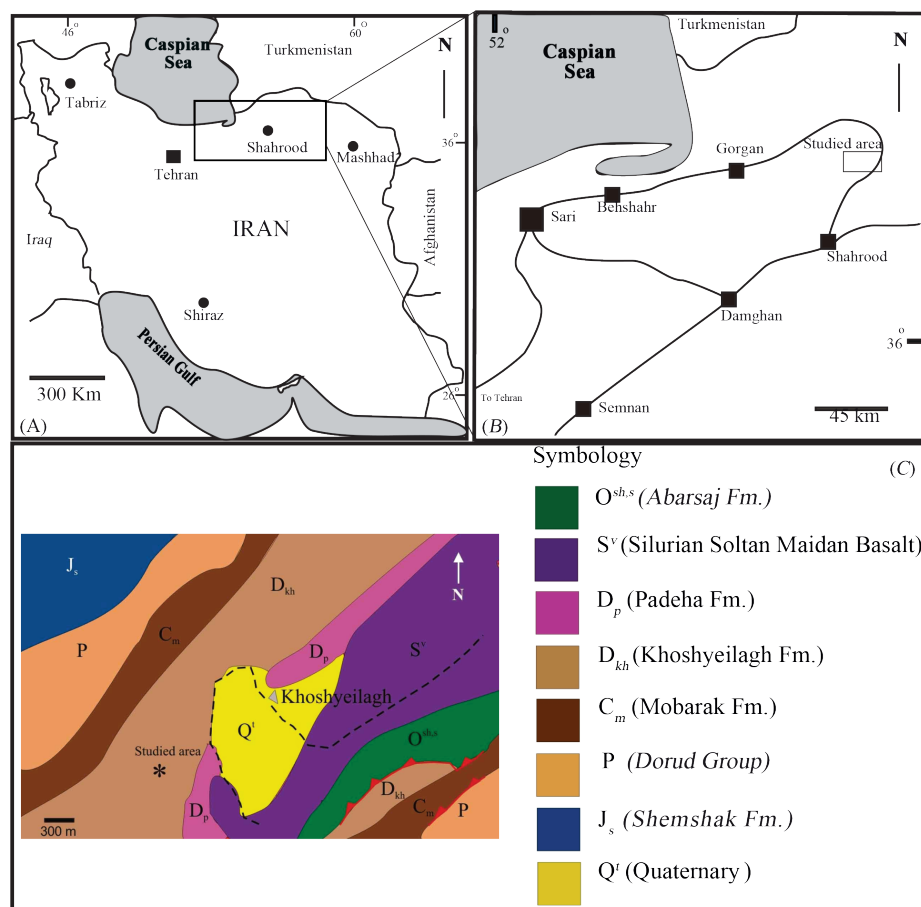


Figure 1 (A, B) Geographical map of the studied area. (C) Geological map of the studied area. Abbreviations: O^{sh,s} (Ordovician), S^v (Silurian Soltan Maidan Basalt), D_p (Padeha Fm.), D_{kh} (Khoshyeilagh Fm.), C_m (Mobarak Fm.), P (Permian), J_s (Jurassic), Q^t (Quaternary).

between Shahrood and Azad Shahr cities in NE Iran (Figure 1). This section is near the type section (Khoshyeilagh valley). The geographical coordinates of the studied section are 36° 50' 44" N and 55° 20' 05" E. At this section, the older rocks of the sequences consist of Silurian basalt of the Soltan Maidan Formation, the Early Devonian Padeha Formation, and younger overlying formations that rest on the Khoshyeilagh Formation respectively called the Mobarak, Dorud, and Ruteh formations (Figure 1).

3. Materials and methods

The studied collection of corals contains 2 samples of *Hexagonaria*. Five thin sections were prepared for this study which are housed at the Earth Science School of the Damghan University, Iran (acronym DKH1-5).

4. Stratigraphy

The Khoshyeilagh Formation is scattered in the eastern parts of the Alborz Mountains, northern Iran, and was first described by Bozorgnia (1973). This formation is the thickest and most fossiliferous formation of the Devonian sequences of Alborz Mountains (Aghanabati, 2008). The Khoshyeilagh Formation is subdivided into four parts including the lower terrigenous member, the lower carbonates member, the upper terrigenous member and the upper carbonates member (Aghanabati, 2008), however locally these respective members are changed. In this study, the Middle to Upper Devonian successions of the Khoshyeilagh Formation were measured and described in the Khoshyeilagh neck near the type section (Khoshyeilagh village). This formation is about 1235 m thick divided into 11 rock units from below to top including: Unit 1-47 m, which consists of conglomerate grading upwards into sandstone overlies the Padeha Formation. Unit 2-76 m, consists of alternating thin- to medium bedded limestones and shales; Unit 3- 82

m, consist of medium to thick-bedded limestones with brachiopods, solitary corals and bryozoans; Unit 4-147 m, consists of thin-to medium-bedded dolomitic limestones with minor debris of brachiopods and crinoids; Unit 5- 58 m, consists of alternating limestone and shale containing bryozoans, brachiopods, tentaculites and solitary corals with small fragments of bryozoans; Unit 6-152 m, consists of bedded limestones with a variety of fauna such as solitary corals, tentaculites, crinoid debris and bryozoans with a few molds of trilobites; Unit 7- 158 m, alternating medium bedded limestones with interbedded shales with brachiopods solitary corals, crinoids and the rugose coral *Hexagonaria* collected from two beds of this unit. This unit corresponds to a Frasnian age because these two levels can be compared with those sequences that Ashouri (2006) assigned a Frasnian age based on a conodont *falsiovalis* Zone; Unit 8-147 m, consists of sandstones; Unit 9-117 m, consists of limestones interbedded with shales containing brachiopods and crinoids; Unit 10-99m, consists of thin-bedded sandy limestones with bryozoans and crinoids; Unit 11-152 m, consists of alternating inter bedded limestones and shales with brachiopods, bryozoans and solitary corals. The Khoshyeilagh Formation is overlain conformably by lower Tournaisian limestones of the Mobark Formation. (Figure 2).

5. Systematic paleontology

For terminology and systematic classification see Hill (1981), Birenheide (1978) and May (1993).

Phylum CNIDARIA Hatschek, 1888

Class ANTHOZOA Ehrenberg, 1834

Subclass Zoantharia Blainville, 1830

Superorder Rugosa Milne-Edwards and Haime, 1850

Order Stauriida Verrill, 1865

Suborder Columnariina Soshkina, 1941

Family Disphyllidae Hill, 1939

Subfamily Hexagonariinae Bulvanker, 1958

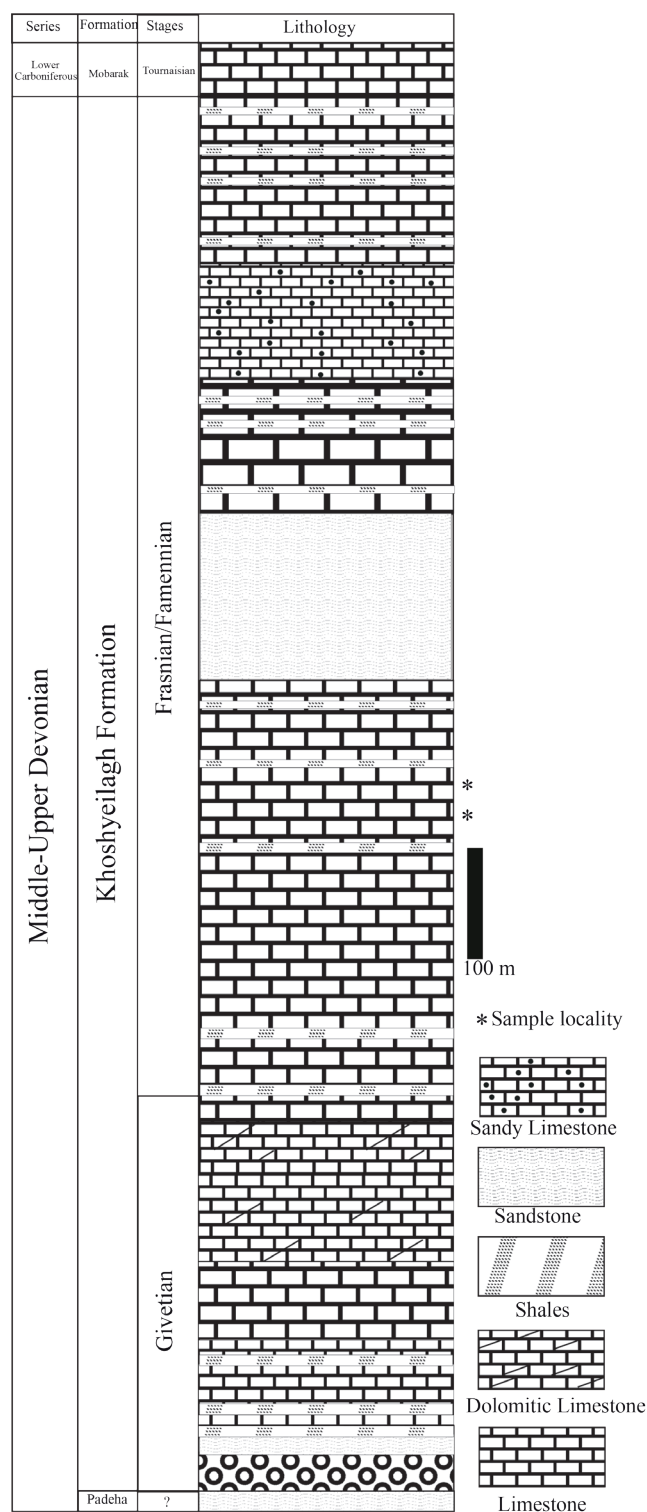


Figure 2 Stratigraphic column of the Khoshyeilagh Formation in the Khoshyeilagh neck, eastern Alborz, Northern Iran.

Genus *Hexagonaria* Gürich, 1896

Type species: *Cyathophyllum hexagonum* Goldfuss, 1826

Hexagonaria davidsoni (Milne-Edwards and Haime, 1851)

Figure 3

1851 *Acervularia davidsoni* Milne-Edwards and Haime, p.418, pl. 9 figs. 4, 4a, 4b.

1924 *Acervularia bassleri* Webster and Fenton, in Fenton and Fenton, p. 58-59, pl. 13 fig. 2, pl. 14 fig. 4-5.

1981 *Hexagonaria davidsoni* (Milne-Edwards and Haime) Rohart and Semenoff-Tian-Chansky, p. 4-12, pl. 1-3.

1993 *Hexagonaria davidsoni* (Milne-Edwards and Haime) Wrzolek, p. 240-243, fig. 16-17.

1994 *Hexagonaria davidsoni* (Milne-Edwards and Haime) Coen-Aubert, p. 33-34, pl. 2 fig. 1.

1998 *Hexagonaria bassleri bassleri* (Webster and Fenton, in Fenton and Fenton) Sorauf, p. 64-67, pl. 3 fig. 7, pl. 30 fig. 1-6, pl. 31 fig. 1-6; pl. 32 fig. 1.

2010 *Hexagonaria davidsoni* (Edwards and Haime) McLean, p. 63-66, pl. 27 fig.3-4, pl.28-30; cum syn.

Diagnosis. See McLean (2010: p. 65).

Type material see Rohart and Semenoff-Tian-Chansky (1981: p. 4-12, pl. 1-3).

Material. Two corallites with 5 thin sections (Figure 3).

Description. The Corallum is cerioid. Coralla have a diameter ranging from about 50 mm to 200 mm. Calices are bell-shaped and deep. Within transversal sections, large corallites have a 15-17 mm diameter and small corallites have a 7-13 mm diameter. Large corallites contain 18-20 x 2 septa. The septa are clearly differentiated into major and minor. Major septa meet each other in the axis of the corallite. Minor septa have $\frac{1}{2}$ to $\frac{3}{4}$ of the length of the major septa. Septa are thin at the margin of the corallite and in the center of the corallite. Between the margin and the center of

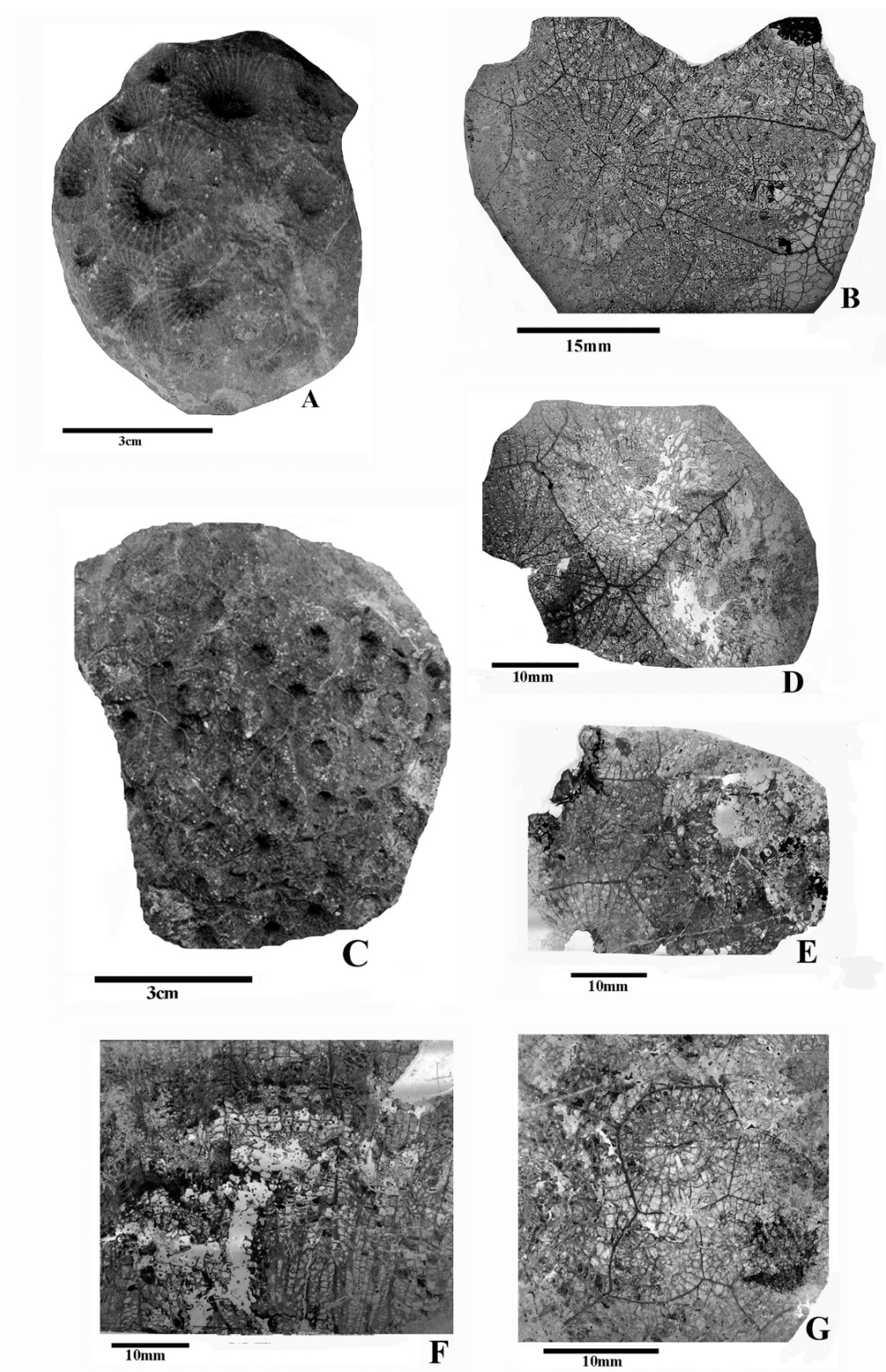


Figure 3 (A, C) External view of colonies. (A) DKH01. (B) DKH02. (B, D, E, G) Transverse sections. (B) DKH 1. (D) DKH 2. (E) DKH 3. (G) DKH 4. (F) Longitudinal section DKH 5. DKH is abbreviation of The Devonian Khoshyeilagh Formation.

the corallite, septa are slightly thickened. Swollen septal trabeculae are developed occasionally resulting in septa that show dispersed carinae-like structures.

Within transversal sections, the width of the tabularium reaches from 3 mm to 55 mm.

Within longitudinal sections, the tabularium displays both a flat-topped axial row of tabulae and periaxial sagging tabulae. The dissepimentarium is filled with small dissepiments. Within a corallite of about 14 mm in diameter, the width of the tabularium is about 4-5 mm.

The microstructure of the skeletal elements shows diagenetic alterations as is usual for Devonian corals; thickened skeletal elements often are shine brighter in transmitted light and sometimes the delimitation of skeletal elements is a bit vague. However, these alterations are not very strong, because a dark middle line is observable in many places.

Discussion. Our material is very similar to *Hexagonaria hexagona* (Goldfuss, 1826), the type species of the genus *Hexagonaria* Gürich, 1896. Descriptions and illustrations of typical specimens of *Hexagonaria hexagona* are given by Pickett (1967, p. 58-60, pl. 4 fig. 15), Birenheide (1969, p. 40-41, pl. 1 fig. 1, pl. 4 fig. 11), Birenheide (1978, p. 95-96, pl. 13 fig. 3) and Sorauf (1994, p. 323-327, pl. 1 fig. A-D). Differences with typical specimens of *Hexagonaria hexagona* are the thinner septa and fewer carinae in our material. Furthermore, in typical *hexagona* the major septa extend only nearly up to the axis and do not meet each other. Our material fits very well with the holotype and the additional material of *Hexagonaria bassleri bassleri* (Webster and Fenton, in Fenton and Fenton, 1924) from the Frasnian of Iowa described and illustrated by Sorauf (1998, p. 64-67, pl. 3 fig. 7, pl. 30 fig. 1-6, pl. 31 fig. 1-6; pl. 32 fig. 1). There is no doubt that *Hexagonaria bassleri* and our material are conspecific. McLean (2010, p. 66) considers *Hexagonaria bassleri* as synonymous with *Hexagonaria davidsoni* (Milne-Edwards and Haime, 1851). The material of *Hexagonaria davidsoni* (Milne-Edwards and Haime, 1851) from the mid-late Frasnian of western Canada described

and illustrated by McLean (2010: p. 63-66, pl. 27 fig. 3-4, pl. 28-30) is very similar to our material. Nevertheless, there are some transversal sections figured by McLean (2010), which show a remarkable open space at the axis of the corallite. However, in other corallites figured by McLean (2010), the major septa meet each other in the axis. This demonstrates, that the open space at the axis should not be overestimated. Consequently, we agree with McLean (2010) in synonymizing *Hexagonaria bassleri* (Webster and Fenton, in Fenton and Fenton, 1924) with *Hexagonaria davidsoni* (Milne-Edwards and Haime, 1851). Rohart and Semenoff-Tian-Chansky (1981, p. 4-12, pl. 1-3) described and figured the types of *Hexagonaria davidsoni* (Milne-Edwards and Haime, 1851) from the Frasnian of northern France. Based on this description, we have no reason to doubt, that our material is conspecific with *Hexagonaria davidsoni* (Milne-Edwards and Haime, 1851). Furthermore, the *Hexagonaria davidsoni* (Milne-Edwards and Haime, 1851) described by Coen-Aubert (1994, p. 33-34, pl. 2 fig. 1) from the middle Frasnian of Belgium is conspecific with our material.

The material of Wrzolek (1993, p. 240-243, fig. 16-17) described as *Hexagonaria davidsoni* from the Devonian Kowala Formation of Poland, is conspecific too. Following McLean (2010, p. 66), Polish material of *Hexagonaria davidsoni* is of latest Givetian to early Frasnian age.

Occurrence. *Hexagonaria davidsoni* is a cosmopolitan species, which is known from the Frasnian of western Canada, Iowa, northern France, Belgium, Poland and China (McLean, 2010: p. 66). Our material is the first evidence of this species from Iran.

6. Palaeobiogeography

Hexagonaria davidsoni is a cosmopolitan species, known from the Old World Realm as well as from the Eastern Americas Realm (see Pedder and Oliver, 1990). This is a clear confirmation for the observation, that within the marine benthos, the

level of provincialism decreased to zero in the Frasnian (May, 1996: p. 41). Taking into account that within the Frasnian it was no longer possible to distinguish between an Old World Realm and an Eastern Americas Realm, it can be stated only, that within the Frasnian, the Alborz Mountains belonged to a very broad tropical to subtropical belt with corals and reef development.

7. Conclusions

The finding of *Hexagonaria davidsoni* (Milne-Edwards and Haime, 1851) in the Khoshyeilagh Formation allows for some interesting conclusions because of the fact that the earliest occurrences of *Hexagonaria davidsoni* are of latest Givetian to early Frasnian age, and the vast majority of its occurrences are definitely of Frasnian age. These findings confirm a Frasnian age for the middle part of the Khoshyeilagh Formation. Furthermore, these findings document that during the Frasnian, the Alborz Mountains belonged to a very broad tropical to subtropical belt with corals and reef development.

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