INTRODUCTION

Lower Carboniferous corals in the North of Iran have been studied in detail by Flügel (1963) and Khaksar (1996). Flügel (1963) studied mainly the upper Visean corals from the Talartal and Semnan sections. From the lower Visean he indicated only three taxa: *Siphonophyllia cylindrica* (McCoy, 1844), *S. cylindrica latitabulata* (Gorsky, 1932), and *Caninophyllum archaici* (Milne Edwards & Haime, 1852).

Later Khaksar (1996) studied corals in eight outcrops of the Mobarak Formation that were mainly considered as Tournaisian corals. For sections of Visean age, he indicated only three species, also known in the Tournaisian sediments of the central Alborz Mountains: *Amplexizaphrentis iranensis* Khaksar, 1996, *Kueichouphyllum alborensen major* Khaksar, 1996 and *Zaphriphyllum mobarakense* Khaksar, 1996. Derakhshan et al. (2012) also published preliminary data on Tournaisian-Visean coral associations of the Mobarak Formation from the Gerd-kuh section in Eastern Alborz. Thus, prior to this study, sparse information on the lower Visean corals of Iran has been published. Unlike the upper Visean coral assemblages widely known in different regions of the Western and Eastern Europe, North Africa, Central Asia, China, Australia, North America (Fedorowski, 1981), the lower Visean corals are much less abundant, and therefore have received less attention. Sections of the Kiyasar area, where a rich complex of corals exists, offer a unique opportunity to examine coral communities that existed on the northern Gondwana shelf during the early to middle Visean.

GEOLOGICAL SETTING AND STRATIGRAPHY

The Kiyasar section is located in Northern Iran and on the eastern limit of the Alborz Mountains (Figure 1). The Mobarak Formation exposed in this section includes alternating thin to thick-bedded limestone, and dolomitic limestone with interbedded shale and dark marl. A facies analysis of this formation indicates shallowing upward cycles deposited on a ramp type carbonate platform. Geological data have shown that the Alborz Mountains were once part of the Gondwana margin during the early Carboniferous (Brenckle et al., 2009).
The Mobarak Formation conformably overlies the sandy limestone of the older Geirud Formation (Upper Devonian age) and is overlain unconformably by sandstones of the younger Dorud Formation (Lower Permian age). The Mobarak Formation in the Kiyasar area is 250 m thick and divided into four units based on the lithology (Figure 2).

The studied corals were collected from Unit 3 and from the lower parts of Unit 4. Unit 3 is 106 m thick starting at the base with a thick-bedded limestone that is overlain by medium-bedded limestone alternating with a layer of ichnofossils, which is then overlain by black shale, followed by marls. The limestones of this unit contain bioclasts of brachiopods, ostracods, and crinoids. The lower part of Unit 4 consists of dark marls and medium-bedded dolomitic limestone. The upper part of Unit 4 is dominated by medium-bedded limestone with interbedded shale. The thickness of Unit 4 is 50 m.

Among the limestone bioclastic packstone and wackestone/packstone are predominant. Coral framestone, bioclastic rudstone and mudstone/wackestone are less often found. Study of the limestone microfacies has shown that they were formed in shallow marine carbonate ramp platform environment (Falahatgar & Mosaddegh, 2012). Most corals were found in the barrier facies (shoal), which formed above the fair weather wave base. Some microfacies of Unit 3 and Unit 4 are interpreted as intertidal, lagoonal and open marine facies.

Falahatgar et al. (2012) studied of the foraminiferal assemblages from the Kiyasar area and indicated a lower and early-middle Visean age for Unit 3 and Unit 4 (Foraminiferal assemblage zones 3, 4) (Figure 2).

MATERIAL AND METHODS

The studied collection of corals included 75 specimens. The Geological Museum of Taras Shevchenko National University of Kyiv, Ukraine (Acronym TSNUK 3P267/KC), houses 46 fragments of corallites, 150 thin sections and 24 acetate peels. The Paleontology Museum, Earth Science Department, Damghan University, Iran (Acronym DUI KC) houses 29 specimens and 48 thin sections. Digital photographs were taken from thin sections and an external view was captured using an Olympus camera.

The following abbreviations are used for description of corals: n:d, septal ratio (n, number of major septa; d, corallite diameter); ds, diameter of the axial structure.
SYSTEMATIC PALAEONTOLOGY

Phylum COELENTERATA Frey & Leuckart, 1847
Class ANTHOZOAA Ehrenberg, 1834
Subclass TABULATA Milne-Edwards & Haime, 1850
Order FAVOSITIDA Wedekind, 1937
Suborder FAVOSITINA Wedekind, 1937
Family MICHELINIIDAE Waagen & Wentzel, 1886, emend. Sokolov, 1950

Michelinia de Koninck, 1841, emend. Lafuste & Plusquellec, 1985

**Type species.** Calamopora tenuisepta Phillips, 1836.

**Diagnosis.** See Lafuste & Plusquellec (1985, p. 15-16).

Michelinia aff. M. tenuisepta (Phillips, 1836) (Figures 3A, B)

**Material.** Three fragments (TSNUK 3P267/KC24, KC40E; DUI KC29.22) of colonies with holotheca but without proximal parts. Inner morphology well preserved, but microstructure of walls diagenetically altered. Seven thin sections were available for study.

**Description.** Incomplete conical colonies, higher than 5 cm; lateral surfaces are covered by thin (0.1-0.15 mm) holotheca with continuous growth striae (Figure 3B). Corallites polygonal, generally 7-8 mm in diameter. Corallite walls are thick (0.8-1.0 mm) with a slightly sinuous median line with an unclear microstructure.

Intramural pores rounded, irregularly arranged in the walls, 0.2-0.25 mm in diameter. The inner surface of corallites is uneven. It is covered by poorly marked low and rounded septal spines.

Tabulae thin, in some cases thickened, complete and incomplete, convex, locally oblique. At the periphery of the colony near holotheca, tabulae form vesicles that are parallel to the holotheca surface.

**Remarks.** The specimens from Kiyasar area are similar to *Michelinia tenuisepta* (Phillips, 1836), which was described in Belgium, France, UK, Poland, Russia, Kazakhstan. The holotype of *Michelinia tenuisepta* was studied in detail by Lafuste & Plusquellec (1985) and shows clear and sharp septal spines. Other researchers studied this species in different areas and pointed out the septal spines in their structure (Fomichev, 1931; Sajutina, 1966; Noviński, 1976). Unlike the holotype, the specimens show only the presence of low rounded septal spines.

The present material is very similar to specimens described as *Michelinia konincki* (Vaughan in Reynolds & Vaughan, 1911), differing from typical *Michelinia tenuisepta* (Phillips) by massive colonies that are oval shaped in cross-section. Note that Tourneur *et al.* (1989) do not indicate the presence of *Michelinia tenuisepta* in the Belgian Carboniferous, and they include the species previously described as *Michelinia tenuisepta*, in *Beaumontia* (?)* konincki* (Vaughan, 1911) and “Michelinia” sp. 4. Among species described in Belgium, the most similar to the Iranian specimens are “*Michelinia megastoma*” sensu de Koninck 1872 (Tourneur, Conil & Poty, 1989, p. 416-417, pl. 6, fig. 3).

**Occurrence.** Visean, Northern Iran, Kiyasar area.

**Tournacipora** Lafuste & Plusquellec, 1985

**Type species.** Calamopora megastoma Phillips, 1836.

**Diagnosis.** See Lafuste & Plusquellec (1985, p. 27-28).

**Tournacipora? megastoma** (Phillips, 1836) (Figure 3C)

1836 *Calamopora megastoma* Phillips, p. 201, fig. 29.
Tourneur, Conil & Poty, p. 416-417, pl. 6, fig. 4.
1989 “*Michelinia megastoma*” sensu Delépine 1911. Tourneur, Conil & Poty, p. 421, pl. 9, fig. 1; pl. 6, fig. 1.
?1989 “*Michelinia*” sp. 5. Tourneur, Conil & Poty, p. 424, pl. 11, fig. 3.

**Material.** One fragment (TSNUK 3P267/KC29.9) of mature growth stages of the colony without external surface. Microstructure of skeletal elements is diagenetically altered. Six thin sections were available for study.

**Description.** Form of the colony is unknown. Corallites polygonal, generally 12-14 mm in diameter. Walls of corallite, thick, to 1 mm; near calices thinned. Median line indistinct, perhaps by many pores and positions of spines and secondary alteration. It appears only in some parts of the walls in the longitudinal section (Figure 3C),. The walls are penetrated by unevenly spaced round mural pores 0.2 mm in diameter. The inner surface of the wall is made uneven by short septal spines. Spines are also observed on the tabulae. Tabulae numerous, slightly convex, incomplete and vesicular near the walls.

**Remarks.** The described fragment of the colony is similar to specimens found in Visean of the UKrestudied by Lafuste & Plusquellec (1985) and related to the genus *Tournacipora* on the base of the fine microstructure of the walls. The degree of preservation of the specimens does not allow studying the microstructure of the walls, so the present authors could only relate them to *Tournacipora*.

Among the species reported from Belgium, it is very similar to “*Michelinia megastoma*” sensu Delépine 1911 and some other (Tourneur *et al*., 1989). However, “*M. megastoma*” is a problematic taxon that requires revision. In particular the specimens, described from Kuznetsk Basin (Tolmachov, 1924; Fomichev, 1931; Sajutina, 1966) as *Michelinia megastoma* is different from the specimens of Belgium, the UK and Iran by the presence of much thinner wall (0.6-0.2 mm). Septal spines in specimens from the Kuznetsk Basin is also not specified. So, perhaps, these specimens belong to separate species, as previously proposed Gabunia (1919).The Iranian specimen
Figure 3. A-B, *Michelinia* aff. *M. tenuisepta* (Phillips, 1836): A, specimen TSNUK 3P267/KC24, A₁ transverse sections of colony, A₂ longitudinal section; B, specimen TSNUK 3P267/KC40E, external view of colony, holotheca with continuous growth striae. C, *Tournacipora? megastoma* (Phillips, 1836), specimen DUE KC29.9, C₁ transverse section of colony, C₂ longitudinal section, C₃ diagenetically altered wall in longitudinal section with poorly visible median line. Scale bars: A₁-A₃, B, C₁-C₂ = 10 mm; C₃ = 1 mm.
was found in the Visean. Derakhshan et al. (2012) mentioned
*Tournacipora megastoma* in the lower part of the Mobarak Formation (Tournaisian).

**Occurrence.** Visean, Northern Iran, Kiyasar area.


_Rotiphyllum_ Hudson, 1942

**Type species.** *Densiphyllum rushianum* Vaughan, 1908.

**Diagnosis.** See Fedorowski (2009, p. 9).

_Rotiphyllum cf. R. omaliusi* (Milne-Edwards & Haime, 1851) (Figures 4A,B)

**Material.** Two corallites (TSNUK 3P267/KC37O, KC38E) without proximal part with deformed calices. The surface of the external wall is not preserved. Four thin sections available for description.

**Description.** Ceratoid corals, length 16 and 24 mm. In transverse sections n:d value 4:20 and 8.5:26. Septa thickened near the wall; their inner ends thickened and joined in the center. Cardinal septum long, located on the convex side of the corallites, reaches the axis during all growth stages except for sections near calice. Counter septum longer than the other septa of counter quadrants, placed in slightly manifested pseudofossula. Other septa curved in its middle part and concave toward cardinal septum. Alar pseudofossulae with short septa are marked, connected with adjacent ones. No minor septa seen in the corallite lumen and within the external wall. The external wall is average in thickness reaching 0.6 mm. The inner margins of major septa join a external wall. The external wall is average in thickness without proximal ends. Ten thin sections, three polished for description.

**Remarks.** The present specimens are similar to the holotype and typical *Rotiphyllum omaliusi* described from the Upper Tournaisian and Lower Visean of Western and Eastern Europe, Urals, Kuznetsk Basin (de Koninck, 1872; Carrührers, 1908; Fomichev, 1931; Dobrolyubova & Kabakovich, 1966; Flügel, 1963; Weyer, 1993; Poty & Hanney, 1994), and differ from them by some displacement of the stereocolumn from the axis toward the counter septum. Khaksar et al. (2012) mentioned *Rotiphyllum omaliusi* in the upper part of the Mobarak Formation (? Lower Visean).

**Occurrence.** Visean, Northern Iran, Kiyasar area.

Suborder CANINIINA Wang, 1950

Family ADAMANOPHYLLIDAE Vassilyuk, 1959

_Alborzia_ gen. nov.

**Type species.** _Alborzia concavitabulata_ gen. et sp. nov.

**Etymology.** For occurrence in the Alborz Mountain, Northern Iran.

**Species assigned.** _Adamanophyllum buskuskanense_ Dobrolyubova, 1966; _Adamanophyllum vassilyukae_ Dobrolyubova, 1966; _Alborzia concavitabulata_ gen. et sp. nov.

**Diagnosis.** Solitary corals, five major septa – cardinal, two alar and two counter-laterals – are the longest. Dissepimentarium consists only concentric dissepiments or both concentric and lonsdaloid dissepiments. Tabulae are complete and almost horizontal slightly concave or convex.

**Remarks.** By the same septal patterns, _Alborzia_ gen. nov. is similar to the _Adamanophyllum_ Vassilyuk, 1959 established from the Serpukhovian of the Donets Basin (Vassilyuk, 1959). Two species, _Adamanophyllum buskuskanense_ and _Adamanophyllum vassilyukae_ (Dobrolyubova & Kabakovich, 1966), have been described from uppermost Tournaisian-lowermost Visean of the Kuznetsk Basin. _Adamanophyllum abukttinaense_ is probably represented in the upper Visean of Japan Minato & Minoura (1976). Incomplete tabulae and clinotabulae are considered diagnostic features of the _Adamanophyllum_. These features are absent in the Kuznetsk and Iranian species. So according to Minato & Minoura (1976), species described in the Kuznetsk Basin should belong to independent genus of _Adamanophyllum_. By establishing _Alborzia_ gen. nov., the present authors follow their idea.
Figure 4. A-B. Rotiphyllum cf. R. omaliusi (Milne-Edwards & Haime, 1851): A, specimen TSNUK 3P267/KC37O, A1, external view, A2, transverse section; B, specimen TSNUK 3P267/KC38E, B1-2 transverse sections. C-E. Alborzia concavitabulata gen. et sp. nov., C, paratype TSNUK 3P267/ KC43, C1, external view, C2, transverse sections, C3, transverse section of septa, probably fibro-lamellar types of microstructure; D, holotype TSNUK 3P267/KC37B, D1, external view, D2, transverse section, D3, longitudinal section, D4, fragment of longitudinal section; E, specimen DUI KC36, transverse section of calice area. Abbreviations: c, cardinal septum; d, dissepiments. Scale bars: A = 5 mm; B1-2, C1-4, D1-2, E = 10 mm; D3 = 0.5 mm; D4 = 2 mm.
The section of 6.2 mm shows that septa do not reach the center of corallite (Figure 5B). Counter septum is short. Cardinal septum, alar and one of counter-lateral septa are elongated; counter septum is not different in length. Septa of counter quadrants are more thickened then septa of cardinal quadrants. Counter septum became shortened with increasing of diameter of corallite (Figures 4C2-C4).

Fully mature morphology (Figure 4E) show that cardinal, two pairs of adjacent to the counter, alar and adjoined to alar septa are longer and thicker than other major septa.

Minor septa become visible in sections about 12 mm in diameter. In the counter quadrants of calice area are short spikes on the external wall. They merged their bases with major septa and formed moderately thickened external wall in the early growth stages. N:d value: 25-27:6,5-9 mm; 32-36:12-17 mm.

Dissepiments appear in sections with a diameter greater than 12 mm. Dissepiments in transverse sections rectangular. In longitudinal sections 1-2 rows of rather large, flat dissepiments located along the walls (Figures 4D3-D4; 5). Complete tabulae are dominant. They are concave in the central part of the tabularium, and convex near dissepimentarium. The average distance between the tabulae is 0.5 mm.

Remarks. On the sporadically developed concentric interseptal dissepiments and concave tabulae, Iranian specimens are most similar to Adamanophyllum vassiijukae. Nonetheless very long minor septa (from one-two to three-third of length of major septa) and presence of lonsdaleoid dissepiments allow us to distinguish the Iranian species from Kuznetsk.

Occurrence. Visean, Northern Iran, Kiyasar area.

Family CYATHOPSIDAE Dybowski, 1873

Siphonophyllia Scouler, 1844

Type species. Siphonophyllia cylindrica Scouler in Mc Coy, 1844.


Siphonophyllia hettonensis (Wilmore, 1910)

(Figure 6A)

1910 Caninia hettonensis Wilmore, p. 567, pl. 39, fig. 6.
1930 Caninia cylindrica Scouler emend. Delépine, p. 30, pl. 3, fig. 1.
1932 Caninia cylindrica Scouler var. hettonensis Gorsky, p. 17, pl. 2, fig. 2-3.

Material. Five fragments DUI KC29.2, KC29.5, KC29.12, KC29.15, and KC 29.23, and four transverse thin sections.

Description. Fragments of corallites conic-cylindrical in shape. Major septa long, make up about three-fourth of the radius of corallites, leaving the inner zone in central part of corallites. Its diameter is about 20 mm. Minor septa are also long, with their length reaching two-third of the length of major septa and penetrate quite far into tabularium. Major and minor septa are thickened in the tabularium. In the dissepimentarium they are thin and winding; do not reach the outer wall, stopping at the periphery by large dissepiments. Cardinal septa shortened and placed in a clear open fossula. Septal value n:d 66-68:42-44 mm.

Dissepimentarium narrow (up to 6 major septa at diameter, 43 major septa), consists of two subzones. The inner subzone is composed by interseptal dissepiments and the external subzone by larger lonsdaleoid dissepiments. Dissepiments commonly have septal spikes. The thickness of each subzone is approximately 3 mm. Tabulae are not studied.

Remarks. By the structure of the dissepimentarium and length of the minor septa the present specimens are similar to the holotype and specimens described in other areas. Some differences concern septal value. In the holotype n:d value 73:51 mm, is close to the specimens described here which are 66-68:42-45 mm. But in specimens from Armorican massif (Vuillemin & Semenoff-Tian-Chansky, 1987) the number of septa is lesser, n:d value 67:55 mm. The species described is similar to Siphonophyllia iranica Khaksar, 1996, but differs by the presence of a large number of septa at close diameters. In the species Siphonophyllia iranica n:d 52-63:45-88 mm.
Occurrence. Tournaisian and Lower Visean, France (Armoricain massif); Lower Visean UK (Yorkshire), Visean, Central Kazakhstan; Visean, Northern Iran, Kiyasar area.

*Siphonophyllia* sp.

(Figures 6B,C)

**Material.** Five specimens (TSNUK 3P267/KC29.6; DUI KC25.2, KC26, KC29.1, KC29.6), six thin sections.

**Description.** Conic-cylindrical fragments up to 5.5 cm long. Major septa long and thick, commonly with thin pointy end. Septa do not reach the axis, leaving a free zone, representing about one-third the diameter of the transverse sections. Minor septa developed unevenly, commonly thickened, short (Figure 6B); but sometimes not visible (Figure 6C).

Cardinal septum and one or two septa adjacent with cardinal major septa are short. Counter septum and different in length from the other major septa of counter quadrants. On the periphery of corallites all septa interrupted by large lonsdaleoid dissepiments. In the studied sections n:d value 60-64:32-33 mm.

Dissepimentarium narrow (3-4 mm in diameter of coral 34 mm). It consists of 2-3 rows, composed of unequal size lonsdaleoid dissepiments. The thickness of the wall up to 1 mm. The inside of the wall is covered with sub-triangular septal projections.

Tabulae mostly complete. In the central part of the tabularium they are flat, sub-horizontal, near dissepimentarium abruptly bent down. In 1 cm length of the coral placed 5-6 tabulae, but there are also areas where the number of tabulae may increase to 12.

Remarks. The new specimens are similar to the holotype of *Siphonophyllia cylindrica* Scouler in McCoy, 1844, both by lacking of interspectral subzones of dissepiments. Narrow dissepimentarium and thickened septa do not allow attribution of the specimens studied here to this species. Absence of interspectral dissepiments differentiates the present specimens from similar *S. rivagensis* Poty & Boland, 1994 and *S. cylindrica hasteriensis* (Salee, 1913) (Poty & Boland, 1994; Boland, 1997). Studied specimens probably should be attributed to a new species, but available material is not enough for more detailed study.

Occurrence. Visean, Northern Iran, Kiyasar area.

**Bifossularia** Dobroljubova, 1966

**Type species.** *Caninia ussowi* Gabunia, 1919.

**Diagnosis.** See Hill (1981).

*Bifossularia aghanabatiei* sp. nov.

(Figures 6D,E)

**Etymology.** The species is named in honor of Seyed Ali Aghanabati, who published a book on Iranian Geology.

**Holotype.** Specimen TSNUK 3P267/KC29.3.

**Type locality.** North Iran, Kiyasar section.

**Type horizon.** Visean, Mobarak Formation.

**Material.** Five fragments of corals without calices and proximal ends (TSNUK 3P267/KC29.3; DUI KC29.4, KC29.7, KC29.10, KC29.11, KC29.21). Dissepimentarium commonly destroyed. Eight thin sections.

**Diagnosis.** *Bifossularia* with thick major septa in tabularium and very short minor septa with n:d value 55-73:35-44 mm. Dissepimentarium consist of interspectral inner and lonsdaleoid external subzones.

**Description.** Conic-cylindrical fragments. Major septa do not reach the axis leaving a free space, about one-quarter to one-third of the diameter of corallites. Major septa thickened, but not invariably, this thickening is characteristic only of the cardinal quadrants. Major septa often have sharp ends. Cardinal and counter septa shortened and located in clear fossula. Two septa adjacent to the cardinal septum also shortened.

Minor septa are very short, but commonly cross dissepimentarium and penetrate tabularium as short thickened spikes. All septa are interrupted in the dissepimentarium area without reaching the external wall. This wall is thin (0.25-0.3 mm) and, in most specimens, destroyed. In early mature morphology n:d value 44:22 mm; in fully mature morphology n:d value 55-73:35-44 mm.

Dissepimentarium narrow and commonly consists of two subzones (Figure 6D). Internal subzone is not uniform and partially developed, composed of concentric interspectral dissepiments. The external subzone contains large lonsdaleoid dissepiments that interrupt septa, but short septal spines on dissepiments are common. The inner subzone has a diameter of 0.2 mm at 36 mm and external subzone is 4 mm. In the longitudinal section is observed 3-4 rows of almost vertical large elongated dissepiments.

Tabulae are complete, horizontal in the central part, sharply bent down near dissepimentarium. They are on average 1.2 mm apart.

Remarks. Despite the lack of young growth stages in the present specimens, the present authors believe it is possible to define a new species, because, as shown by the detailed study of the material from the Kuznetsk Basin (Dobrolyubova & Kabakovich, 1966), features of the main species *Bifossularia* are represented in the adult stages. *Bifossularia aghanabatiei* sp. nov. is similar to *B. ussowi* (Gabunia) from the lowermost part of the Visean of the Kuznetsk Basin (Fomichev, 1931; Dobrolyubova & Kabakovich, 1966), but easily distinguished by short minor septa, which in *B. ussowi* reach from one-half to two-third of the length of the major septa, much longer than in the described species. Even more significant differences, particularly in the structure of the dissepimentarium and length of septa are observed when compared to *B. tictensis* (Tolmatchov, 1931), from the Kuznetsk Basin. In addition to the minor septa, *B. tictensis* has a short major septa and only lonsdaleoid dissepiments on the periphery. There is a great similarity with the *B. aff. B. tictensis* (Tolmatchov, 1931) from Yvoir Formation (RC3a) of Belgium (Denayer et al., 2011, p. 158, pl. 2, fig. I), which however, in contrast to the described species has no visible minor septa.

Occurrence. Visean, Northern Iran, Kiyasar area.

Suborder AULOPHYLLINA Hill, 1981

Family CLISIOPHYLLIDAE Nicholson, 1889

Subfamily CLISIOPHYLLINAE Nicholson, 1889

*Clisiophyllum* Dana, 1846
Figure 6. A, Siphonophyllia hettonensis (Wilmore, 1910), specimen DUI KC29.15, transverse section. B-C, Siphonophyllia sp.: B, specimen TSNUK 3P267/KC29.6, B1 transverse section, B2 longitudinal section. C, specimen DUI KC 29.1, transverse section. Cardinal (lower) septum marked by black trigon. D-E, Bifossularia aghanabatiae sp. nov. D, specimen TSNUK 3P267/KC29.3, holotype, D1-D2 transverse sections, D3 longitudinal section; E, specimen DUI KC29.4, transverse section. Cardinal (lower) and counter (upper) septa marked by black trigons. Scale bar = 10 mm.
Type species. *Clisiophyllum keyserlingi* McCoy, 1849.


*Clisiophyllum garwoodi* (Salée, 1913)  
(Figures 7A-D)

1913 *Carruthersella garwoodi* Salée, p. 274, pl. XI, figs. 4 a-c, 5, 6.  
2001 *Clisiophyllum garwoodi* (Salée 1913). Rodríguez et al., p. 59-62, pl. 2, figs. 5-11, pl. 4, figs. 5-6.

**Material.** Seven corallites (TSNUK 3P267 KC29.13; KC30A, KC30B; KC37A; DUI KC29.19, KC33, KC38) without proximal ends, one of them with partly preserved calice. Seventeen thin sections.

**Description.** Ceratoid corals up to 48 mm in length. The theca is covered with the growth striae and without longitudinal septal furrows (Figures 7A-D). Central part of the calice occupied by wide axial boss (Figure 7D). It is composed of median lamella and spirally coiled counterclockwise septal lamellae.

Major septa are straight or slightly bent in one direction, thickened in the cardinal quadrants and thin in counter quadrants as in dissepimentarium. Some septa are connected to the septal lamellae, and others do not penetrate the axial structure. Minor septa appear before dissepiments, reaching one-half lengths of major septa, cross the dissepimentarium and penetrate far into tabularium. In early growth stages cardinal septum connected with median lamella but in the later growth stages it is short, located in fossula. In studied sections n:d value varies from 29:10 mm to 46:21 mm.

Dissepimentarium is concentric; appears with a diameter of 8 mm; in the adult growth stages, it consists of 4-6 steeply sloping rows of small homogeneous dissepiments. Tabularium bizonal. Tabellae in the periaxial zone horizontal, slightly convex or mildly ascending to axial zone. In the axial zone they are tent like, sharply raised up to median lamella.

Axial column wide elongated in transverse sections; its width increases with the diameter of the corallites, occupying from one-third to one-half of the diameter of mature corallites. It is composed of the thickened straight median lamella, septal lamellae straight or spirally coiled and intersections of tabellae. In the longitudinal sections, axial structure has clear boundaries without stereoplasmatic swelling on its margin.

**Remarks.** Iranian specimens are slightly larger in size (length of Belgian specimens does not exceed 45 mm) and have thickened septa in cardinal quadrants, which are not observed in specimens from Belgium (Poty, 1981) and Spain (Rodríguez et al., 2001). The present authors consider these features as result of intraspecific variability because the present samples demonstrate both thin (Figures 7A, C) and thickened major septa (Figure 7B).

**Occurrence.** Visean (Livian), RC5γ-RC6 of Belgium; Upper Visean, Spain; Visean, Northern Iran, Kiyasar area.

*Clisiophyllum kiyasarensis* sp. nov.  
(Figures 7E-H)

**Holotype.** Specimen TSNUK 3P267KC38.  
**Type locality.** North Iran, Kiyasar section.  
**Type horizon.** Visean, Mobarak Formation.

**Etymology.** The species is named from the studied section.

**Material.** Holotype and ten corallites (TSNUK 3P267/KC28.3, KC29.14, KC30.1, KC33, KC35/D, KC37.2, KC38.2, KC38.3; DUI KC 29.16, KC 37). The holotype with inner morphology well preserved, but with the calice missing. Twenty-four thin sections and three peels were studied.

**Diagnosis.** A *Clisiophyllum* with 39-2 septa at a diameter of 16 mm. Axial structure occupying one-third- one-half of the diameter of corallites; major septa thickened in cardinal quadrants; minor septa long and well-developed, their length reach one-half-two-third of the length of major septa; dissepimentarium narrow consists of 1-2 rows of dissepiments.

**Description.** Ceratoid, rarely trochoid (TSNUK KC30.1) medium-sized corals, up to 50 mm in length. External surface with the growth striae and without septal ribbing. Fragments of calice observed in two specimens (TSNUK KC28.3, KC30.1). Central part of specimen KC30.3 with maximum diameter of 37 mm located calice with istaboss, having a width of 20 mm and are lief (distance between the highest and lowest parts) 6 mm.

Major septa thicken in tabularium in the early growth stages, especially in the cardinal quadrants. In mature stages thickening of the septa are only saved in the cardinal quadrants, their inner ends pointed. Minor septa since 8.2 mm in diameter of corallites form of the tubercles. At the same diameter appear dissepiments. Major and minor septa in the early growth stages fused their bases, forming a thick (0.5-1.0 mm) septotheca. Length of minor septum increases with increasing of diameter of the corals and can be one-half or even two-third of the major ones. They completely cross the dissepimentarium. All septa are thin in dissepimentarium.

Cardinal septum shortened in fossula, located on the convex side of corals. In the transverse section of 17 mm in diameter, cardinal septa disconnects from the thickened median lamella. For the holotype n:d values are -27-29:11 mm; 29-32: 14-16 mm. In other specimens n:d values are -38-42:18-23 mm; and 51:25-35 mm. At the maximum diameter of 36 mm number of septa is about 64×2.

Narrow dissepimentarium consists of 1-2 rows of small homogeneous dissepiments steeply located parallel to the wall. They are regular in transverse sections.

The longitudinal sections show bizonal tabularium, which consists of an axial zone, tent like arranged axial tabellae and periaxial zone of horizontal, or convex periaxial tabellae. At a diameter of corals from 17 to 23 mm, a 5 mm length of corallites contains up to 6 axial and 5 periaxial tabellae.

Median lamella, 8-14 of septal lamellae and few intersections of axial tabellae form axial column. It takes one-third to one-half of the diameter of corallites, increases with increasing diameter. The axial column is clearly separated from the periaxial zone. In the holotype d:s:d value (mm) -3.5:8; 4:11; 7:17. In other specimens, with larger size, this value following -12:26; 16:34; 19:36.
Figure 7. A-D. Clisiophyllum garwoodi (Salée, 1913): A, specimen TSNUK 3P267/KC30A, A$_1$, external view, A$_2$-A$_6$, transverse sections, A$_4$, longitudinal section; B, specimen TSNUK 3P267/KC37A, B$_1$, transverse section, B$_2$, longitudinal section; C, specimen TSNUK 3P267/29.13, C$_1$, transverse section, C$_2$, longitudinal section; D, specimen TSNUK 3P267/KC30B, D$_1$, external view, D$_2$, transverse section, D$_4$, longitudinal section. E-H, Clisiophyllum kiyasarensis sp. nov. E, holotype TSNUK 3P267/KC38, E$_1$-E$_4$, transverse sections, E$_4$, longitudinal section; F, specimen TSNUK 3P267/KC29.14, F$_1$, transverse section, F$_2$, longitudinal section; G, specimen TSNUK 3P267/KC33, transverse section; H, specimen TSNUK KC30.1, transverse section. Scale bars = 10 mm.
**Remarks.** The septa are thickened at all growth stages, wide axial column and narrow dissepimentarium are the main features that allow to distinguish the new species from all other known species of *Clisiophyllum* Dana, 1846.

**Occurrence.** Visean, Northern Iran, Kiyasar area.

Subfamily HETEROCANINIINAE Hill, 1981

*Kueichouphyllum* Yü, 1931

**Type species.** *Kueichouphyllum sinense* Yü, 1931.


*Kueichouphyllum* cf. *K. laosense* Fontaine, 1961 (Figure 8A)

**Material.** One fragment (TSNUK 3P267/KC32) of coral without calices and proximal end. Three thin sections.

**Description.** Fragment of coral cylindrical-conical, up to 47 cm in length and a maximum diameter of 40 mm. Major septa thin and long, but do not reach axis, leaving in the central part a space of about one-third of the diameter of the coral. Only some bent major septa reach the axis. Cardinal septum shortened, placed in an open narrow fossula. Minor septa thinner than major, their length increases from two-thirds to four-fifth of the major septa with increasing diameter. In studied sections n:d value following -66×2.32 mm, and 68×2.40 mm.

Dissepimentarium wide range from one-half to one-third of the diameter of the coral. It consists of 1-20 steeply sloping rows of small round rather homogeneous dissepiments having a regular shape in transverse section. Tabulae incomplete, convex.

**Remarks.** The n:d value of the present specimen is similar to the holotype *Kueichouphyllum laosense* Fontaine, 1961 from the Upper Visean of Laos (Fontaine, 1961) and Elburz (Flügel, 1963). Thickened septa in the cardinal quadrants are presence in some sections of *K. laosense* and absent in others (Flügel, 1963, text-figs. 1C,D). Considering the variation in this feature, limitation of material and great length of minor septa, the specimens here described cannot be attributed to *K. laosense*.

The fragment described here is similar to the species *Kueichouphyllum sinense* Yü, 1931 from China in having large thin septa in the cardinal quadrants (Wu, 1964, pl. XV, figs. 1,2; Liao & Rodriguez, 1999, p. 550, fig. 1). However, the significantly smaller number of septa in the present specimen does not allow assignation to this species.

Species and subspecies of *Kueichouphyllum* described by Khaksar (1996) from the Tournaisian of Iran have shorter minor septa.

**Occurrence.** Visean, Northern Iran, Kiyasar area.

*Kueichouphyllum* sp. (Figure 8B)

**Material.** Two fragments of corals (DUI KC25, KC39.2), without calices and proximal ends. Two transverse thin sections.

**Description.** Major septa long, but only few of them reach the axis, forming the web-like unstable axial structure. Other major septa joined in tabularium to the most elongated ones. The exact number of septa by a fragment cannot be established, but is probably more than 100 (47 mm in diameter). In the cardinal quadrants septa slightly thickened. Cardinal septum short somewhat thickened, and located in a narrow open fossula. The side of fossula walls slightly thickened by stereoplasm. It juts into the dissepimentarium. Minor, thin septa cross dissepimentarium but only in cardinal quadrants. Judging by a fragment of DUI KC25, length of minor septa variable, they can essentially jut out into tabularium. Dissepimentarium wide, about one-third of the diameter of coral, thinned in the cardinal quadrants. It consists of 16-18 concentric rows of dissepiments. Tabulae are not studied.

**Remarks.** Described specimens are characterized by axial structure, very similar to the Iranian subspecies *Kueichouphyllum alborense* major Khaksar, 1996 from the Tournaisian and Visean of North Iran (Khaksar, 1996), but it has thicker septa in cardinal quadrants and, judging by the number of intersections, less elevated tabulae. These features of the genus *Kueichouphyllum* are very volatile. Closely related species were described in China as *Kueichouphyllum sinense* var. *gracile* (Yü, 1933). Papojan (1969) viewed it as a separate species *Kueichouphyllum gracile*. In contrast to the described specimens except for thickening of septa in the cardinal quadrants, it has minor septa that are two-thirds the length of the radius. Dissepimentarium width is more than one-half of the radius, i.e., it is much thicker than that of the specimens here studied. Lack of material prevents more precise definition of the species.

**Occurrence.** Visean, Northern Iran, Kiyasar area.

Subfamily AMYGDALOPHYLLINAE

Grabau in Chi, 1935

*Spirophyllum* Fedorowski, 1970

**Type species.** *Spirophyllum sanctae-crucensis* Fedorowski, 1970.

**Diagnosis.** See Fedorowski (1970, p. 571).

**Remarks.** Corals, which the present authors referred to the *Spirophyllum* are similar to some species of the genus *Amygdalophyllum* (amygdalophylloid trend after Fedorowski, 1970, p. 571-572). Two essential characteristics suggest proximity of the studied samples of the genus *Spirophyllum*: (i) presence of pseudocolumella with a tendency towards disintegration, and (ii) the tendency to spiral twisting of the inner ends of the septa in the central zone. Some of the studied corals also have the complicated structure of the axial zone that Volkova (1941) attributed to the genus *Arachnolasma*. One of these species (*Arachnolasma? clisaxophyloides* Volkova) was included into the genus *Spirophyllum* Fedorowski, 1970. Other species with complicated axial structure and interrupted septum in the dissepimentarium described by M. Volkova are close to the studied specimens but require a revision of the original material. At the same time, the Iranian specimens are different from...
Figure 8. A, Kueichouphyllum cf. K. laosense Fontaine, 1961: specimen TSNUK 3P267/KC32, A₁, transverse sections, A₄ longitudinal section. B, Kueichouphyllum sp.: specimen DUI KC39.2, transverse section. C, Hexaphyllia cf. H. mirabilis (Duncan, 1867), transverse section. Scale bars: A₁₋₃ = 10 mm; B = 5 mm; C = 0.5 mm.
Amygdalophyllum by lacking the amygdalophyllloid columella and from Arachnolasma by lacking a pseudocolumella. The genus Tehranclamis Khaksar (1996) described on the Iranian samples is similar to the specimens studied here, but it has much longer major septa reaching axial structure. It also has regular dissepimentarium formed by vertical rows of dissepiments. In contrast, the samples here studied have major septa that on mature grows stages do not reach the axial structure. They have also interruptions of the septa by dissepiments and the flat sloping rows of dissepiments.

Spirophyllum iranicum sp. nov.  
(Figures 9A-F)

Etymology. From Iran where the studied samples were found.  
Holotype. Specimen TSNUK 3P267/KC35A.  
Diagnosis. A Spirophyllum to 20 mm in diameter with 50×2 septa and with amygdalophyllloid trend. Major septa long, reach axis and in early morphology their ends spirally twisted. In mature growth, major septa do not reach median lamella. Minor septa long, in narrow dissepimentarium interrupted, penetrate tabularium, thinner than major. Axial structure is variable swollen in early morphology, connected to the cardinal septum. It consists of the median lamella, a few short improperly bent septal lamellae and several intersections of tabulae.  
Description. Narrowly conical and cylindrical coral fragments, up to 35 mm in length and a maximum diameter of 20 mm.  
Major septa long, in the young growth stages to reach axis, in later growth stage disconnected from it. They are slightly thickened in tabularium, and their inner ends tend to twist into a spiral. Minor septa noticeably thinner, large, intersect dissepimentarium and have variable length, but with a tendency to lengthen with increasing diameter, and reach a length of one-half of major septa. Major and minor septa in the dissepimentarium are thinned and commonly discontinued by large dissepiments (Figure 9C.). For studied section n:d value following: 24-32:6-10 mm, 34-42:10-17 mm, 50:19 mm. Dissepimentarium separated from tabularium by noticeable inner wall, from which depart thick parts of septa.  
Axial structure is variable. It is commonly irregular thickened by stereoplasm and in the early growth stages consists of lenticular median plate, connecting with the cardinal and counter septa and joining to the median plate spirally twisted axial endings of major septa (Figures 9A, A.). In the later growth stages, axial structure consists of thin median plate, a small number of short septal and free lamellae and a small number of intersections of tabulae (Figures 9A, C.). It is commonly cuspidate towards the shortened cardinal septum.  
In the longitudinal sections, the dissepimentarium consists of 1-2 rows of rather large dissepiments, located very gently, at an angle of about 45° to the external wall. This wall is very thin and mostly destroyed. Tabularium consists of two parts. Tabulae of the peripheral part are horizontal; they abruptly raised up in the axial part (Figure 9F.).  
Remarks. New species is similar to Spirophyllum clisaxophylloides (Volkova) but can be easily distinguished by much less number of septa, less complex axial structure and general amygdalophyllloid trends of their development.  
Occurrence. Visean, Northern Iran, Kiyasar area.  

Kiyasarophyllum gen. nov.  

Type species. Kiyasarophyllum fluegeli gen. et sp. nov.  
Etymology. For occurrence in the Kiyasar area, Northern Iran.  
Species assigned. ?Arachnolasma (?) clisiophylloides Volkova, 1941; K. fluegeli gen. et sp. nov.  
Diagnosis. Solitary corals with complex pseudocolumella composed of the thickened median lamella, septal lamellae incorporated and axial tabellae. Major septa in mature growth stage do not reach the axial structure. Minor septa short do not leave dissepimentarium. Dissepimentarium consists only of interseptal dissepiments. Tabulae incomplete, convex and vesicular in periphery.  
Remarks. Although the diagnosis of Amygdalophyllum made by Dun & Benson, 1920 is much expanded by Poty (2007) the new taxon differs from this genus by absence of axial structure formed of fused thick median lamella and axial lamellae. It seems commonly that longer and thinner minor septe in comparison with major ones are important feature of the Amygdalophyllum. The axial structure of Spirophyllum Fedorowski, 1970 is more complex and more variable septe has a tendency to disintegrate in the periphery. The genus Guadiatia Gómez-Herguedas & Rodriguez, 2005 has similar morphology, but it is pseudocolonial or protocolonial unlike the new genus. Tehranophyllum Khaksar (Khaksar, 1996) is different from Kiyasarophyllum by simple axial structure formed of thick median lamella and some radial lamellae. In addition, Tehranophyllum has a long major septa connecting to the axial structure of very long minor septa (from one-half to two-thirds of the major septa). Khaksar (1996) considers the length of the minor septe as an important feature of the genus Tehranophyllum.  

Kiyasarophyllum fluegeli gen. et sp. nov.  
(Figures 10; 11A,B; 12A,B)  
Holotype. Specimen TSNUK 3P267/KC33C.  
Type locality. Northern Iran, Kiyasar section.  
Type horizon. Visean, Mobarak Formation.  
Etymology. In honor of Austrian paleontologist Prof. Dr. Helmut W. Flügel, who studied Carboniferous and Permian corals of Iran.  
Material. Six corallites (TSNUK 3P267/KC33C, KC35B, KC35E, KC38B, KC40.2; DUI KC29.8) without proximal ends; in one specimen calices partially preserved. Eighteen thin sections and six peels.  
Diagnosis. As for genus.
Figure 9. A-F, Spirophyllum iranicum sp. nov. A, holotype TSNUK 3P267/KC35A, A1-2, transverse sections; A3, longitudinal section, A4-5, fragments of axial structure; B, specimen TSNUK 3P267/KC35, B1-2, transverse sections; C, specimen TSNUK 3P267/KC44A, C, transverse section, C2, fragment of axial structure, C3, fragment of transverse thin section showing the thickened inner wall and interruption of the minor septum; D, specimen DUI KC32.2, transverse section; E, specimen DUI KC29.27, transverse section; F, TSNUK 3P267/KC31, F1, transverse section, F2, longitudinal section. Scale bars: A1-3, B1-2, C1, D-F1-2 = 10 mm; A4-5, C2-3 = 1 mm.
Description. Ceratoid and subcylindrical fragments of medium size (length > 4 cm) with signs of rejuvenation. The external surface covered by growth striae and weak of ribbing. Specimen KC38B is a fragment of calice (Figure 12B.). In the central part, it has a major depression, 7 mm in diameter with steep walls and elongated low elevation in the center. Significant variability in the structure of the transverse and longitudinal sections could be a result of the presence of alien organisms that distort the internal structure of corals (Figures 12A1,2).

Major septa complete, slightly thickened in the tabularium and thinning in dissepimentarium; only some of them reach axial structure. In fully mature morphology, cardinal septa shortened and not connected to the axial structure. Minor septa variable in length, short and wavy; do not leave dissepimentarium, accounting for no more than one-half of its thickness. N:d value of the holotype sections -33:11 mm; 37:14,5 mm and 48:50:19-22 mm; 52:54:29-31 mm of another specimens. Strong growth lines and probably rudiments of trabecula are observed in longitudinal section (Figure 10A.).

Dissepimentarium concentric, approximately one-third of the corallites radius and about one-half of major septa length. The inner wall is not developed. In transverse sections, dissepiments irregular near the thin external wall. In the longitudinal section, it consists of four rows steeply inclined to the axis homogeneous medium sized dissepiments.

Tabularium bizonal. Axial tabellae abruptly inclined to median lamella; periaxial tabellae incomplete convex and vesicular.

Axial structure complex; consisting of median lamella, septal lamellae and intersections of axial tabellae. Median lamella long, thickened. Septal lamellae different in lengths, in general correspond to major (septal lamellae) and minor (extra septal lamellae) septa; in fully mature growth stages they commonly take the form of short spines attached to the median lamella and axial tabellae. Structure of the pseudocolumella complicated with increase of corallite diameter (Figures 10A1,3, B,C). In a diameter of corallite 14.5 mm are observed axial structure width of 4-5 mm, number of septal lamellae 25-30 and 3-8 intersections of axial tabellae.

Remarks. The new described species is morphologically similar to Arachnolasma (?) cistophyloides Volkova, 1941 (Volkova, 1941, p. 62-63, pl. XIV, fig. 8) from the Upper Visean of Kazakhstan. The holotype of this species is characterized by the presence of oval axial structure, attached to it 30 axial lamellae and 5-6 intersection of axial tabellae. However, this species is inadequately known as it was illustrated by a single thin section.

Occurrence. Visean, Northern Iran, Kiyasar area.

Subclass DIVIDOCORALLIA Fedorowski, 1991
Order HETEROCORALLIA Schindewolf, 1941
Suborder HETEROCORALLIA Schindewolf, 1941
Family HETEROPHYLLIDAE Dybowski, 1873

Hexaphyllia Stuckenbery, 1904

Type species. Hexaphyllia prismatica Stuckenberg, 1904.

Diagnosis. See Poty (2007, p. 73).

Remarks. Despite a long period of study, independence of this genus is debated (Fedorowski, 1991; Aretz & Nudds, 2005).

Hexaphyllia cf. H. mirabilis (Duncan, 1867) (Figure 8C)

Material. One specimen (DUE KC29.2) in thin section. In oblique section corallite is round-hexagonal prismatic, elongated. Visible dimensions 0.8×1.4 mm. The wall poorly preserved.

Figure 10. A-C, Kiyasarophyllum fluegeli gen. et sp. nov. A, holotype TSNUK 3P267/KC33C, A1-3 transverse sections of axial structure, A4 growth lines and possible rudiments of trabeculae in longitudinal section of septum; B, specimen TSNUK 3P267/KC35E; C, specimen TSNUK 3P267/KC40/2, transverse sections of axial structure. Scale bars: A1-3 B-C = 1 mm; A4 = 0.5 mm.
Figure 11. A-B. Kiyasarophyllum fluegeli gen. et sp. nov. A, holotype TSNUK 3P267/KC33C, A₁–3, transverse sections, A₄, longitudinal section; B specimen TSNUK 3P267/KC35E, B₁,₂, transverse sections, B₃, longitudinal section. Scale bars = 10 mm.
Remarks. Dimensions of Iranian specimen slightly larger than in other occurrences of Hexaphyllia mirabilis. Usually, the diameter indicates for this species not exceeding 1.1 mm.

Occurrence. Visean, Northern Iran, Kiyasar section.

THE COMPOSITION AND STRATIGRAPHIC DISTRIBUTION OF CORALS

Most of the studied specimens belong to solitary rugose corals (Figure 13). The dominant genera them are Siphonophyllia, Bifossularia, Kueichouphyllum, Clisiophyllum, Alborzia gen. nov. and two genera of the subfamily Amygdalophyllinae Grabau in Chi, 1935 also were identified Rotiphyllum, the tabulate corals Michelinia and Turnacipora? and the Heterocorallia Hexaphyllia cf. H. mirabilis (Duncan, 1967). Fourteen taxa of corals are described, many of them identified for the first time in the Carboniferous of Iran. Seven species were left in open nomenclature, whereas two genera and five species were described for the first time. A salient feature of the coral complex is the abundance of specimens of the subfamily Amygdalophyllinae.

Corals are distributed unevenly and two stratigraphic coral assemblages are recognized in the Kiyasar area. In the first (the lower part of the section) Siphonophyllia is dominant. The the second assemblage (upper part of the section) consists of Clisiophyllum, Spirophyllum, Kiyasarophyllum gen. nov. and Alborzia gen. nov. The largest numbers of specimens were collected from the middle part of the section (Bed 29), where there is a higher diversity of species and mixed composition of corals.

Only some of the described species are known in other regions, and therefore suitable for determining the age of deposits in which they were enclosed. Clisiophyllum garwoodi is known from the Middle Visean (Livian) of Belgium and from the Upper Visean of Spain. Siphonophyllia hettonensis is characteristic of the Lower Visean of France, UK (Yorkshire), and Central Kazakhstan.

Species that are left in open nomenclature can only partly be used to determine the age of sediments. Similar to described Rotiphyllum omaliusi (Milne-Edwards & Haime, 1851) has a wide stratigraphic interval, in the Upper Tourneian and Lower Visean of Western and Eastern Europe, Urals and Kuznetsk Basin. Hexaphyllia mirabilis is found mainly from Visean sediments in many regions of the world (Perret & Semenoff-Tian-Chansky, 1971; Khoa, 1977; Poty, 1981; Poty & Hannay, 1994). Similarly Michelinia tenuisepta (Phillips, 1836) and Tournacipora megastoma (Phillips, 1836) have been recovered mostly from the Visean deposits of Western Europe (Tourneur et al., 1989; Somerville et al., 1986).

Thus, the studied corals confirm early-middle Visean age of Units 3 and 4 previously determined by foraminifers (Falahatgar et al., 2012).

Composition and geographical distribution of Carboniferous corals, including early-middle Visean ones, have been generalized by Fedorowski (1981). However, after this, only few published results on investigation of corals of this age might be used as additional information to the data of J. Fedorowski’s studies.

According to numerous paleogeographic reconstructions, Kiyasar area was a part of Iranian block that was situated at the northern margin of Gondwana (e.g. Fedorowski, 1981; Webb, 2001; Brenckle et al., 2009). Lower Visean corals from this margin, including deposits from Sinai Peninsula (NE Egypt) (Kora, 1992, 1995), Turkey (Denayer & Høgsør, 2014), and only partially from North Iran Block (Khaksar, 1996) are known.

Corals from the Sinai Peninsula are represented mainly by non-dissepimented rugose corals, which are not found in the sections studied. Only Clisiophyllum garwoodi(?) shows features similar to the corals association described by us. Tabulate corals and Hexaphyllia are also found in the Sinai Peninsula (Sobhy & Ezaki, 2006).

Non-dissepimented rugose corals are also predominant in Turkey and they are similar to coeval faunal associations found in Sinai Peninsula. According to Denayer & Høgsør (2014), corals from Turkey and Sinai should be related to a salient feature of the Lower Visean corals of many regions of Eurasia, with exception of the Donets Basin.

Common feature of the Lower Visean corals of many regions of the paleoequatorial zone are presence of syringoporid and colonial rugose corals. They are found in many regions of Eurasia: Kuznetz Basin (Sayutina, 1966), Tien-Shan, Donets Basin (Ogar, 2006, 2010), China (e.g. Xu & Poty, 1997) and other regions. Their absence in the studied area is unusual, especially for syringoporid corals. In spite of their cosmopolitan nature, they are little dependent on facies and are found in the majority of regions where early-middle Visean corals have been studied in detail. These absences do not find any reasonable explanation. Suggestion of more cold-water in comparison to warm-water of paleoequatorial zone does not agree with other data obtained on carbonate rocks. These rocks are interpreted to be deposited in shallow basin of the carbonate ramp platform. The platform was situated on the passive margin of the Southern Palaeo-Tethys Ocean at the lower subtropic region (Sobhy & Ezaki, 2005; Falahatgar & Mosaddegh, 2012).

Even if to make suggestion about possible location of the Iranian block in higher latitude regions during early Visean, than warm-water character of sea basin can be explained by warm current flow that bring waters from near-equator area to the northern coast of Gondwana (Brenckle et al., 2009).
Early publications also suggest possible existence of such currents that stimulate corals colonization (Fedorowski, 1981; Webb, 2001).

More detailed researches are necessary to explain compositional features of the coral associations here studied and that eventually allow the finding of syringoporid corals in the Early-Middle Visean of Kiyasar area.

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REFERENCES


DeKoninck, L.G. 1841. Description des animaux fossiles qui se trouvent dans le terrain carbonifère de Belgique (Division 1, Zoophytes). Liège, H. Dessain, p. 1-32.


