

## Alborziphyllinae, A New Late Devonian Rugose Corals Subfamily

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### Abstract

Members of the family Laccophyllidae are small, solitary rugose corals with stratigraphic ranges from Silurian to Permian. Among the laccophyllids, axial ends of major septa are united in an aulos and dissepiments may be absent or present. Minor septa can be contratingent and sometimes are small or in some genera are absent. Septa and aulos may be thick or thin. In this study, Famennian rugose corals of the Khoshyeilagh Formation in the north of Meyghan village (35 km NE Shahrood, Eastern Alborz) have been investigated for the first time. All the studied corals share their common characteristics with family Laccophyllidae. Convincingly, based on comparison of the presence of some key features among the collected samples with characteristics of existed subfamilies of laccophyllids, establishing a new subfamily can be essential. The Alborziphyllinae (new subfamily) encompasses a Late Devonian laccophyllid lineage. The new subfamily described here includes a new genus, *Alborziphyllum* and two new species, *Alborziphyllum ferdowsiense* and *Alborziphyllum lonsdaleiforme*.

**Keywords:** Eastern Alborz; Laccophyllidae; Late Devonian; Rugose corals; Khoshyeilagh Formation

### Introduction

The Khoshyeilagh Formation has an extensive exposure in the north of Semnan and Khorasan provinces (northeastern of Iran) and is one of the fossiliferous strata in the Eastern Alborz. Corals are one of the most frequent and important fauna that are presented in the formation. Unfortunately, only a few investigators have systematically worked on the corals of the mentioned formation. Ghods et al., [1] conducted some studies on Givetian and Frasnian coral fauna of

the mentioned formation at the type section, north of Dameghan and Semnan. One of the most complete sections of the Khoshyeilagh Formation is exposed in north of Meyghan village about 35 km northeast of Shahrood where its coral fauna has not been investigated so far. The studied section comprises of alternations of limestone and shale with abundant laccophyllid corals and other fauna.

Family Laccophyllidae [2] includes solitary and relatively small corals with their major septa meeting at early stages meeting at axis on metriophylloid plan and

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later withdrawing from the axis. Aulos is formed by ends thickening, conjunction or by deflection of axial ends of major septa or by conjunction of downturned edges of axial tabellae. At latest stages, aulos may be branched or vanished. Among the laccophyllids, minor septa may be long and contratingent or may be reduced to wall. Tabularium is biform when minor septa are contratingent. Dissepiments can be observed in some taxa. In the stratigraphic record, this family has occupied an interval ranging from Silurian to Permian period. According to Treatise on Invertebrate Paleontology [3] seven subfamilies have been described for laccophyllids, including Laccophyllinae, Guerichiphyllinae, Friedbergiinae, Neaxoninae, Amplexocarininae, Taralasmatinae and Uncertain. Here, laccophyllids with some characteristic features including presence of aulos, dissepiments, short minor septa and thin epitheca as well as other specifications have been classified within the subfamily Alborziphyllinae (new subfamily).

**Materials and Methods**

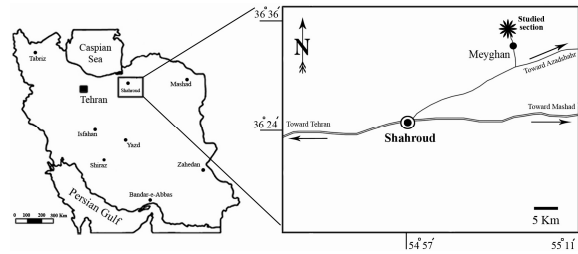
**Geographic Location**

The measured section is located at the coordination of 54° 57' 20" E and 36° 37' 14" N along a valley about 5 kilometers north of Meyghan village. A paved road connects the section to the village. The village is approximately situated 30 kilometers NE of Shahrood. The Shahrood-Azadshahr road is the best access to the village, so that after 25 kilometers from Shahrood, the village will be 5 Km on the west of the road (Fig. 1).

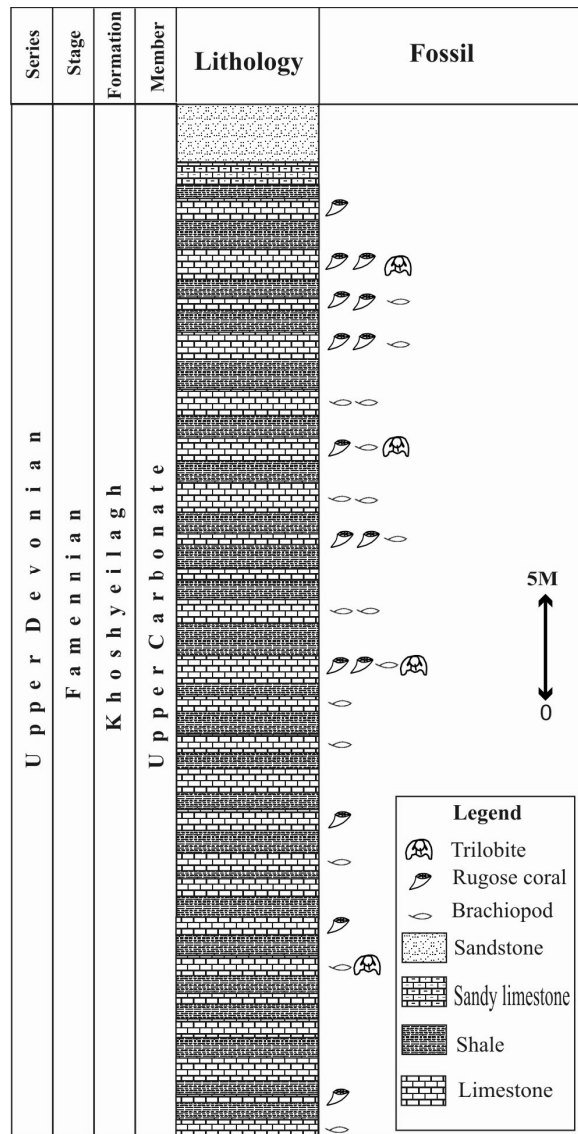
**Lithology of the Studied Section**

The studied section with general trend of N60E and dip of 45° consists of alternations of limestone and shale beds. Generally, thin-bedded and slightly weathered limestones with yellow, buff and gray color contain a great amount of different fauna including corals, brachiopods, and trilobites. Shale beds are mostly gray and in some parts of the section posses rare fauna consisting of brachiopods and corals. Lithologically, the complete section can be divided into two parts in ascending order (Fig. 2)

**Part 1:** This part has a thickness of 20 meters and consists of alternations of gray shale and yellow to buff limestone. Both shale and limestone beds are thin. No fossil has been found in the basal beds of this part. Gradually, toward the top, the fossils (mainly brachiopods) appear. Upward, the beds become thicker. Here, the fossil assemblages such as brachiopods, corals and trilobites with low abundances are found.



**Figure 1.** A simplified geographical location map of the studied area. The studied section has been shown by star.



**Figure 2.** Stratigraphic column of the studied section.

**Part 2:** This part shows the same lithology and bedding as observed in the first part but the difference is in diversity and fauna content which is higher than the first part, particularly in the upper beds. Brachiopods with high diversity and abundance are the prominent fauna. After brachiopods, rugose corals possess the most abundance. Besides these groups, trilobites, bryozoans, tentaculites and gastropods with relatively low occurrence are seen as well.

At the uppermost beds, limestones change to sandy limestones and sandstones in which no fossil was found. This part is about 30 meters thick.

#### **Sample Preparation**

During field trips, more than 150 samples were collected and transported to the laboratory. In order to remove the waste materials encompassing the samples, corals were soaked in the water for about 10 days. At the next step, the samples were cleaned by a fine brush and photographed. Before being sent to sectioning, some of the physical and external characteristics of the studied corals including diameter, length and features of calice were recorded. Samples were sectioned just beneath their calice. Besides transverse sections, longitudinal sections are helpful for better identification of corals. Binocular microscope was used for the study of specimens.

#### **Accompanied Fossils and Age Control**

As mentioned above, the studied section contains different faunal assemblages comprising rugose corals, brachiopods, trilobites, tentaculites, bryozoans, and gastropods. Brachiopods with good preservation are the most abundant fauna in the section. Families including Trigonirhynchiidae, Atrypidae, Cyrtospriferidae and Rhynchonidae show very high abundance and diversity. Genera comprising *Cyrtia*, *Culcathrys*, *Cyrthosprifer*, *Shiziphoria* and *Centrorhynchonous* with other known taxa indicate to the Late Devonian age for the section.

The species *Centrorhynchonous deltidialis* Geatani [4] is one of the Famennian index brachiopod in the Alborz Mountains. This species, as an index fossil for the Famennian age, has been reported from other localities in Iran. For example, in the Kerman Province (Bidu area) the forgoing species has been reported from other studied sections (for instance from Hutk and Madbun sections).

Trilobites have a great share as associated assemblage in the section. Commonly, this group has poor preservation. Except a few specimens, the rest of collected trilobites do not show complete morphology.

One of the specimens with remarked enrollment was named as *Phacops granulatus* by specialist Rymound Feist of Montpollier University. Undoubtedly, this species indicates the Middle through Late Famennian age for the worked section.

The rest of the accompanied fauna such as gastropods, tentaculites and bryozoans with lower degrees of abundance and preservation are of no precise value for biostratigraphic studies.

## **Discussion**

### **Systematic Paleontology Discussion**

The classification, which has been used for systematic description, is based on Hill [5].

Phylum Cnidaria Hatschek, 1888

Class Anthozoa Ehrenberg, 1834

Subclass Rugose Milne-Edwards & Haime, 1850

Order Stauriida Verrill, 1865

Suborder Metriophyllina Spasskiy, 1965

Family Laccophyllidae Grabau, 1928

Small, solitary rugose corals with axial ends of major septa united an aulos which divided horizontal inner tabellae from inclined outer tabellae, dissepiments may be absent or present, minor septa contratigent and sometimes small and in some genera absent, septa and aulos may be thick or thin in some genera.

Age: Silurian-Permian

Subfamily Alborziphyllinae, new subfamily

**Diagnosis:** Laccophyllidae with aulos, presence of dissepiment and short minor septa.

**Discussion:** The subfamily described here is similar to the subfamily Laccophyllinae but in the subfamily Alborziphyllinae, contratigent minor septa are short. Although the introduced subfamily shares many of its main characteristics with the subfamily Guerichiphyllinae Rozkowska [6] but in the former, aulos is seen at latest stages of ontogeny. Whereas, in the subfamily Guerichiphyllinae, this structure fails to continue into the latest stages of growth. In the subfamily Neaxoninae Hill [5] epitheca is thick but in the described subfamily, epitheca is thin. In the subfamily Taralasmatina Hill [5] the minor septa are long and contratigent but in the new subfamily as mentioned above, these septa are short but not contratigent.

*Alborziphyllum* gen. nov.

**Type Species:** *Alborziphyllum ferdowsiense* gen. et sp. nov., from section of Meyghan village.

**Derivation of Generic Name:** Dedicated to the Alborz Mountains where the samples were collected.

**Type Locality:** 35 Km northeast of Shahrood, 5 Km

north of Meyghan village, Eastern Alborz, northeast of Iran.

**Age:** Famennian

**Diagnosis:** Laccophyllidae with interseptal or both interseptal and lonsdaleoid dissepiments. The marked aulos is formed by conjunction of ends of major septa or ends of tabellae. Septa show bilateral symmetry and very short minor septa are in alternation with the long majors.

**Discussion:** Although dissepimentarium is only seen in some genera of the Family Laccophyllidae (for example *Guerichiphyllum* Rozkowska [6]), the presence of dissepiment is necessary for the introduced genus. In fact, among a range of characteristics of *Alborziphyllum*, the dissepiment is considered as a main feature. Dissepiments may be regular similar to *Amplexocarina* Soshkina [7] or lonsdaleoid such as *Guerichiphyllum*. The later, which described by Rozkowska [6], has only lonsdaleoid dissepimentarium, but *Alborziphyllum* can be observed by both interseptal and lonsdaleoid dissepiments. Presence of dissepimentarium belongs to latest stages of ontogeny. The two species assigned to *Alborziphyllum* show two different thickenings; one species with thick septa and aulos (similar to *Trochophyllum* M.Edw.H. [8]) and another with thin major septa and aulos (resemble to *Barrandeophyllum* Pocta [9]). Possessing short minor septa is a common characteristic in *Alborziphyllum*, even though in some genera of laccophyllids (for example *Trochophyllum* M.Edw.H.[8]) they are absent. Generally, this genus owns short cardinal septum whereas, in some taxa of the other subfamilies (for instance *Guerichiphyllinae* Rozkowska [6]) counter septum is short.

The genus described here, is similar to *Laccophyllum* Simpson [10] in dimensions and characteristics of aulos and tabellae but differs from *Laccophyllum* in short minor septa that are not contratingent. The new genus also resembles to *Guerichiphyllum* Rozkowska [6] in some characteristics so that in both genera, non-contratingent minor septa are short and reduced to wall. It is also noticeable that cardinal septum is shortened in two mentioned taxa. Lonsdaleoid dissepimentarium is the other common feature in both genera but the new genus differs from *Guerichiphyllum* in the presence of aulos in latest stages of ontogeny. The introduced genus differs from *Neaxon* Kullmann [11] in the presence of dissepiments.

*Alborziphyllum ferdowsiense* sp. nov.

(Plate 1, Figures 1-7)

**Holotype:** Me-6, from Meyghan section, Khoshyeilagh Formation.

**Material:** Ten specimens in total, thirteen thin

transverse sections and four thin longitudinal sections. All thin sections are hosted at the Geology Department of Ferdowsi University of Mashhad.

**Derivation of Specific Name:** Refers to Ferdowsi University of Mashhad where the corals have been studied.

**Type locality:** 35 Km northeast of Shahrood, 5 Km north of village of Meyghan. Eastern Alborz.

**Age:** Famennian.

#### Diagnosis

A species of *Alborziphyllum* with thick long major septa that become thinner at late stages of ontogeny and lacking of dissepiments at early stages of growth. Short minor septa of interseptal dissepiments are present.

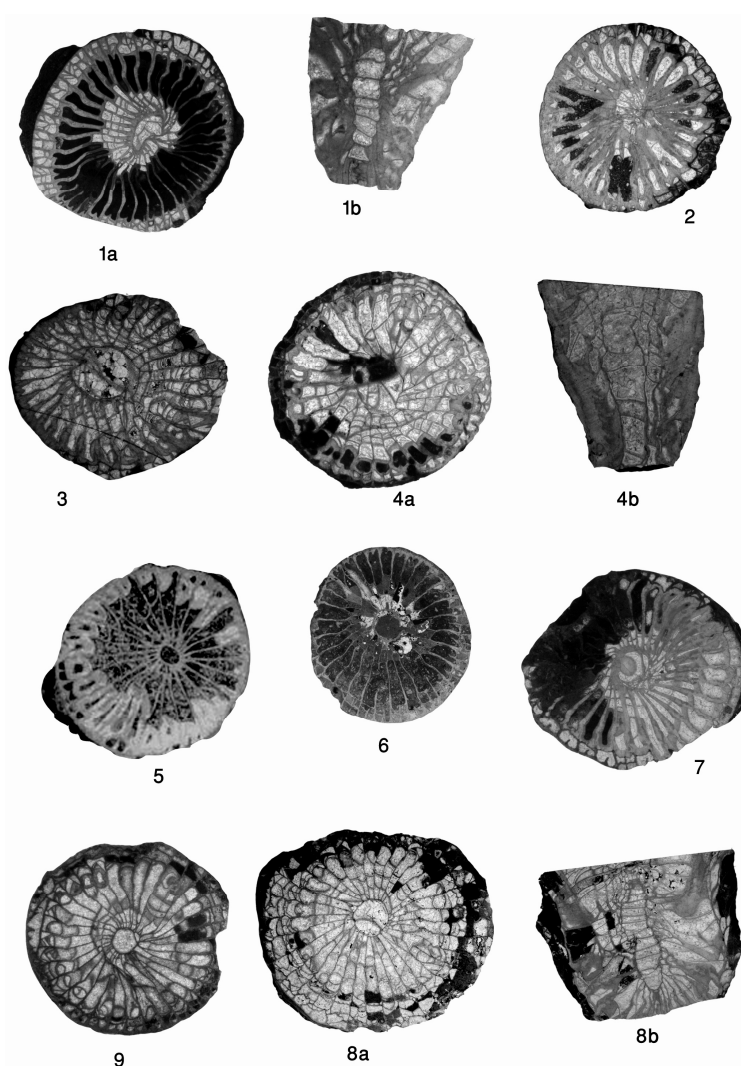
#### Description

**External characters:** Small solitary corals with aulos, ceratoid to trochoid in form, maximum diameter ranges between 9 to 18 mm, length varies from 12 to 25 mm. Marked longitudinal and transverse grooves on the external surface and also very prominent growth rings. Calice is shallow.

#### Internal characters

**Transverse sections:** The epitheca is thin and smooth. Diameter varies at the mature stages between 12 to 18 mm and septa are 25 to 37 in number. The major septa are long, slightly wavy form with caninoid thickening in outer part of tabularium and rhopaloid thickening in axial part of tabularium and reach to an aulos. They are thickened at early stages of ontogeny and become slightly thinner at adult stages. Major septa are slightly thin in dissepimentarium and thicker in cardinal quadrant and show bilateral symmetry. Minor septa are shortened, variable in length (between 1 to 2 mm) and sometimes withdrawn to the wall. Dissepimentarium is narrow (less than 3 mm) and consists of 1 to 3 rows of interseptal dissepiments. They are relatively small, inclined, rarely globular in the outer dissepimentarium and rarely angular in the inner dissepimentarium in some specimens. Presence of dissepiments belongs to late stages of growth. Cardinal septum is thickened and shortened, counter septum is long and relatively thin. There is a prominent large cardinal fossula in some specimens. An oval to circular aulos with diameter ranging between 0.6 and 3.1 mm can be seen in all samples.

**Longitudinal sections:** The epitheca observed in some of specimens is thin. Dissepimentarium is narrow and consists of 1 to 3 rows of small dissepiments. Tabularium is wide. Each tabulae consists of 3 to 6 tabellae. Tabellae are mostly convex in praxial parts of



**Plate 1.**

Figures 1-7. *Alborziphyllum ferdowsiense* sp. nov.

1a- Transverse section of the holotype (X3),

1b- Longitudinal section of the holotype (X3),

2- Transverse section of a specimen (X3),

3- Transverse section of a specimen (X3),

4a- Transverse section of a specimen (X3),

4b- Longitudinal section of above specimen (X3),

5- Transverse section of a specimen (X2.5),

6- Transverse section of a specimen (X3),

7- Transverse section of a specimen (X3).

Figures 8-9. *Alborziphyllum lonsdaleiforme* sp. Nov.

8a- Transverse section of the holotype (X3), 8b- Longitudinal

section of the holotype (X3), 9 - Transverse section of a

specimen (X3).

tabularium and concave in axial parts of tabularium where some of them form the wall of aulos. Tabellae are more condensed and smaller in axial parts of tabularium and larger in priaxial parts of tabularium. Septa are very thick at early stages of ontogeny and fill the tabularium partially and are thinner at adult stages of growth. Aular tabellae are flat and slightly inclined.

*Alborziphyllum lonsdaleiforme* sp. nov.

(Plate 1, Figures 8-9)

**Holotype:** Me-38, from section of Meyghan village, Khoshyeilagh Formation.

**Derivation of Specific Name:** The name of the specimen is dedicated to the presence of lonsdaleoid dissepiment.

**Material:** Three Specimens. Three transverse thin sections and two longitudinal thin sections. Samples are hosted at the Geology Department of Ferdowsi University of Mashhad.

**Type Locality:** 35 Km northeast of Shahrood, 5 Km north of village of Meyghan, northeast of Iran.

**Age:** Famennian.

**Diagnosis:** *Alborziphyllum* with thin aulos which is formed by conjunction of ends of thin and long major septa. The major septa show slightly bilateral symmetry. The presence of lonsdaleoid and interseptal dissepiments. Minor septa are very short.

### Description

**External characters:** Solitary corals, small to medium in size and ceratoid in form. Maximum diameter varies between 13 and 25mm and length ranges between 23 and 38mm. The external surface shows both longitudinal grooves and transverse furrows. Calice is shallow.

### Internal characters

**Transverse sections:** The epitheca is thin. The diameter is 25 mm at adult stages and number of major septa for this diameter is 30 to 33. Major septa are thin, smooth and without any ornamentation but they are slightly wavy form and show slightly bilateral symmetry. The length of major septa varies between 9 to 10 mm. Septa are terminated in a moderately large and marked aulos. Minor septa are very small and thin with length of 1 to 2 mm. Dissepimentarium is relatively wide and consists of both lonsdaleoid and interseptal dissepiments. There is at least one row of lonsdaleoid dissepiments which are different in shape and size. The rest part of dissepimentarium consists of 5 to 6 rows of dissepiments which are approximately large in the outer rows but angular and relatively small in the inner rows. Cardinal septum is relatively shortened and thin. Counter septum is long and reaches to aulos. There is a circular aulos with diameter of 2 to 3 mm.

**Longitudinal section:** The epitheca is thin. Dissepimentarium consists of 3 or 4 rows of dissepiments which are large and vertically elongated. Tabularium is relatively wide. Tabulae are incomplete and some of them compose the wall of aulos. They are concave in priaxial part of tabularium and with an upturn edge reach to the aulos. Tabellae are small, flat or convex and with a dip of 20 to 30 degrees have been inclined toward aulos and are flat in aulos. They are more condensed in axial parts of tabularium than priaxial parts of tabularium. Septa are thicker in early stages of growth.

### Results

Alborziphyllinae comprises a Late Devonian laccophyllid lineage. In fact, small and solitary laccophyllids with the presence of aulos, dissepiments and short minor septa are classified into the subfamily Alborziphyllinae. Among the members of the mentioned subfamily, thin or thick aulos which is formed by conjunction of ends of major septa or tabulae, can be seen during the whole stages of ontogeny, epitheca is thin, minor septa are not contrasting and lonsdaleoid dissepiment is present.

### Acknowledgment

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