



# A note on the discovery of the suturocavate dinoflagellate cyst (*Limbodinium absidatum*) in the Middle East (Binalud Mountains, NE Iran)



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## ABSTRACT

*Limbodinium absidatum* is a suturocavate dinocyst that is being reported here from the Binalud Mountains, NE Iran, which is also the first record of this rare species from the Middle East. A few specimens of *L. absidatum* are recorded from samples taken from the Dalichai Formation at a section measured at Ghoroneh. The stratigraphic range of this species (Late Callovian–Early Oxfordian) is very important for Jurassic palynologists. Morphological characteristics of this Sexiform species are described in detail to support the identification.

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## 1. Introduction

From the Permian onwards, the Gondwana-derived Iran Plate drifted northward to collide with Eurasia in the late Triassic, thereby closing the Palaeotethys. This Eo-Cimmerian Orogeny formed the Cimmeride fold-and-thrust belt. The Upper Triassic–Middle Jurassic Shemshak Group of northern Iran is commonly regarded as the Cimmerian foreland molasse (Wilmsen et al., 2009). After the Mid-Cimmerian event, a renewed phase of rapid subsidence

occurred across all of Northern Iran from the late Bajocian onwards and deep marine sediments of the Dalichai Formation were deposited (Wilmsen et al., 2009).

The Binalud Mountains represents the eastern extension of the Alborz Range (Seyed-Emami et al., 2011; Wilmsen et al., 2009). Like several other sedimentary basins of Iran, the best succession of Jurassic strata is exposed in the Binalud Mountains. Systematic studies on the Jurassic succession of the Binalud Mountains that began in the 1990s as part of the ongoing Iranian–German collaboration resulted in a few papers (Seyed-Emami et al., 1998; Taheri et al., 2009; Wilmsen et al., 2009) on the lithology and stratigraphy of the Shemshak Group with an age range of Upper Triassic to

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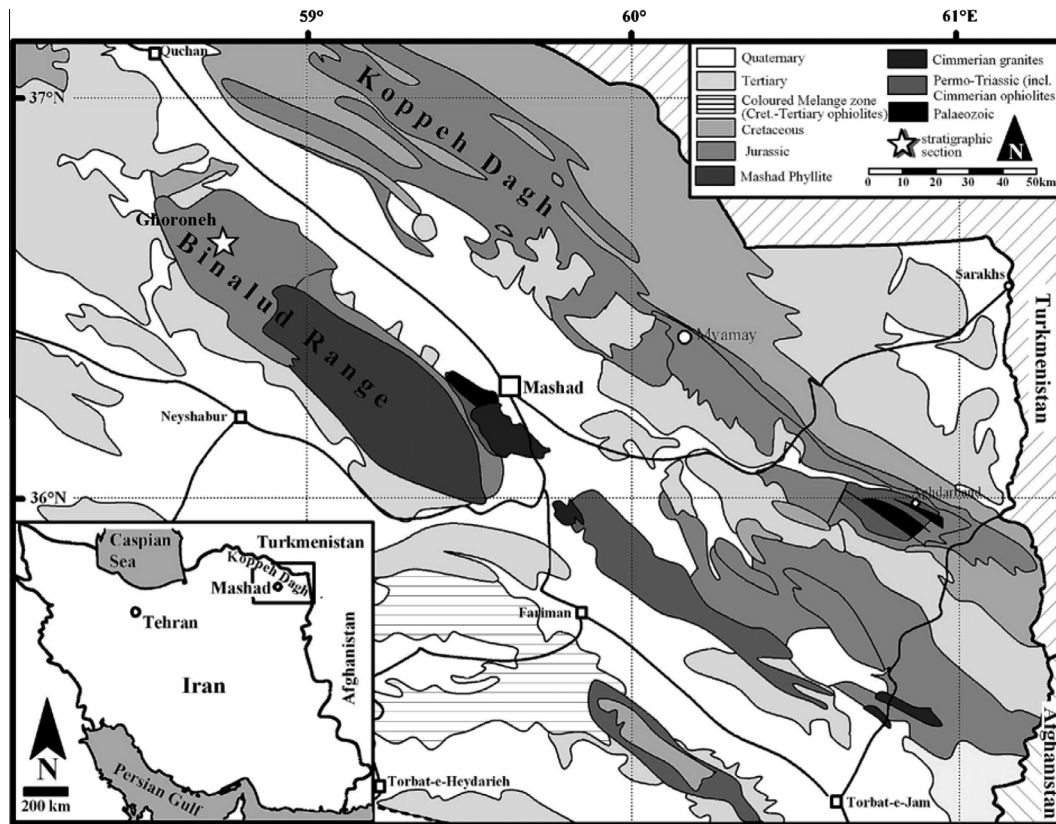


Fig. 1. Geographic overview showing the position of the studied area (adapted from Seyed-Emami et al., 2011).

Lower Middle Jurassic (Seyed-Emami et al., 2011). The first palaeontology publication on the Dalichai Formation in the Binalud Mountains was published by Seyed-Emami et al. (2011) based on ammonite faunas that were previously unknown from Iran.

The Middle–Upper Jurassic strata (the Dalichai Formation) are well developed at the Ghoroneh section, North of Neyshabour (Fig. 1). During our palynology studies from this section, we recorded a few individuals of a suturocavate dinoflagellate cyst that has not previously been reported from the Sub-Mediterranean province. This suturocavate dinocyst, *Limbodinium absidatum*, is very rare and prior to the present paper was only reported from Upper Callovian–Lower Oxfordian strata from a few localities in NW Europe and more recently in South America.

## 2. Geological setting

The studied section is located 42 km North of Neyshabour (coordinates: E58°41.31.6.53 and N36°34.49.3., Fig. 2). The Dalichai Formation is a unique lithostratigraphic unit in the Binalud Mountains. It overlies disconformably the Upper Triassic to Lower-Middle Jurassic Shemshak Group (Seyed-Emami et al., 2011) and is overlain by Upper Jurassic carbonates of the Lar Formation with a transitional boundary. The Dalichai Formation is approximately 710 m thick at this locality. The basal 130 m of the formation is composed of alternations of grey shale and marl with intercalations of very thin siltstone in the lower part and a lot of nodules. These layers are followed by 520 m of medium-thick bedded light grey limestone with intercalations of grey shale and shaly limestone rich in ammonites. The remaining 60 m of the upper part are composed of light grey-grey marl with intercalations of very thin bedded light grey limestone in the uppermost parts.

## 3. Material and methods

Forty-eight rock samples were collected systematically from the section and prepared in the palynology laboratory of the Geological Survey of Iran (Northeast Territory). The preparation method of Traverse (2007) was used. Cold hydrochloric (20%) and hydrofluoric (50%) acids were used to dissolve carbonates and silicates, respectively. The residue was then neutralized and centrifuged in  $ZnCl_2$  with specific gravity of  $1.9\text{ g/cm}^3$ . The materials were sieved thereafter using a  $15\text{ }\mu\text{m}$  nylon mesh, and mounted on microscope slides using liquid Canada balsam (Ghasemi-Nejad et al., 2012). Three slides were made from each sample and examined with a binocular microscope at 40X magnification.

## 4. Systematic palynology

In his taxonomic work, Drugg (1978) described *Dinopterygium absidatum* from the lower Oxfordian of England and the Upper Callovian of Germany. *D. absidatum* is a good marker for the Upper Callovian *Peltoceras athleta* Zone to the Middle Oxfordian *Cardioceras densiplicatum* Zone in Western Europe (Riley and Fenton, 1982; Woollam and Riding, 1983; Riding, 1984; Berger, 1986). Riding (1987), investigating the generic characteristics of *D. absidatum* noted that *D. absidatum* is sexiform and also differs from the genus in overall shape, wall relationships and ornamentation. He referred *D. absidatum* to the new genus *Limbodinium* and introduced *L. absidatum* as its type species. *Dinopterygium* is a quinqueform dinocyst and is confined to the late Early Cretaceous to Neogene (Riding, 1987).

The Sexiform species, *L. absidatum* is a very rare suturocavate dinoflagellate cyst and has only been reported from the United Kingdom (Riley and Fenton, 1982; Woollam and Riding, 1983;



Fig. 2. View of the Dalichai Formation at Ghoroneh, north of Neyshabour (A) and Upper Callovian–Lower Oxfordian strata seen from the NW (B).

Riding, 1984), Switzerland (Berger, 1986), Germany (Drugg, 1978) and Argentina (Riding et al., 2011). A few specimens of this species

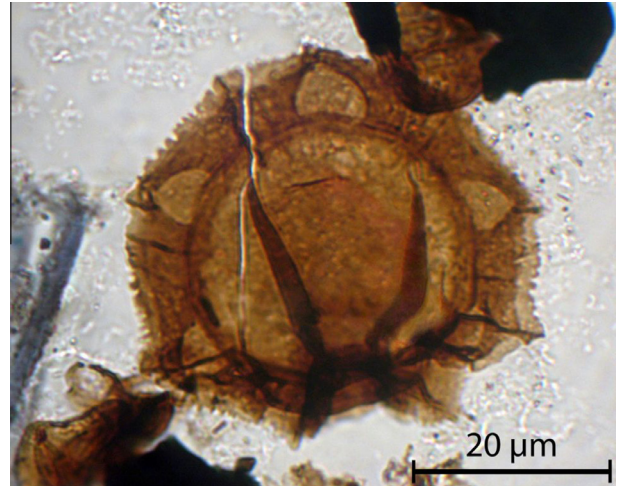


Fig. 4. *Limbodinium absidatum* (Drugg, 1978) Riding, 1987 comb.nov.emend., Sample No: 2010/Gho/68, Ghoroneh Section, NE Iran.

have been recorded from the section being reported here. The taxonomy of *L. absidatum* is as follows (Fig. 3).

- Division Pyrrhophyta Pascher (1914).
- Class Dinophyceae Fritsch (1929).
- Order Peridinales Haeckel (1894).
- Family Gonyaulacystaceae Sarjeant and Downie (1974).
- Genus *Limbodinium* Riding (1987).

4.1. Species *L. absidatum* (Drugg, 1978) Riding, 1987 comb.nov.emend

This species has been described by Riding (1987), and the main characteristics (which we also applied in our identification) are summarized here. *L. absidatum* (Fig. 3) is suturocavate at the antapical parasutures, both paracingular flanges and occasionally at the pre- and postcingular parasutures. Endophragm and periphragm are smooth to faintly ornamented. It is epicyst

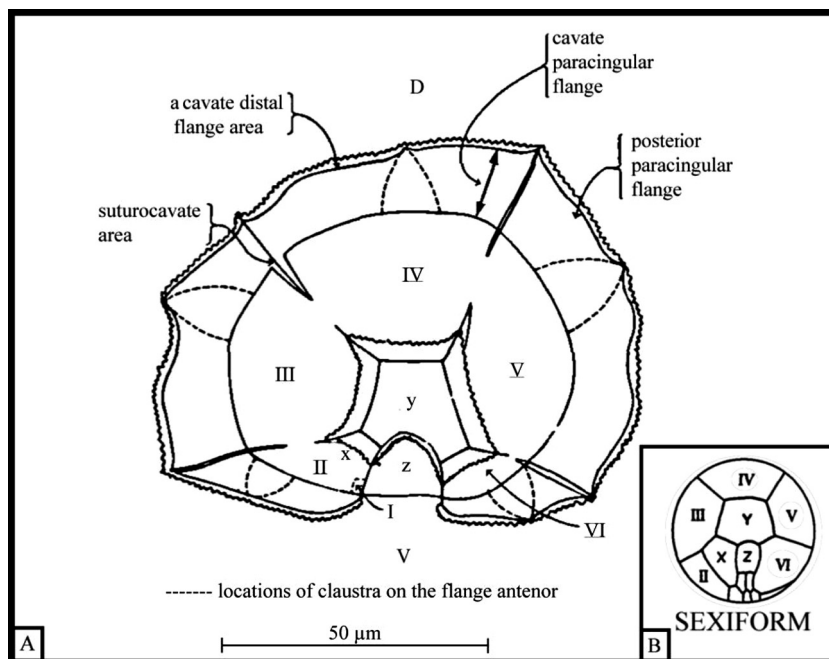


Fig. 3. A typical view of an isolated hypocyst (A). Abbreviation of orientation labels: V-ventral, D-dorsal. Configurations of Sexiform dinoflagellate thecae scheme (B), from Riding (1987).

non-paratabulate except for low, smooth precingular parasutural ridges, which are discontinuous towards the apex. These ridges extend for one-third at the margin of the anterior paracingular flange. The hypocyst is partially to fully paratabulate, and the postcingular paraplates are delineated by discontinuous to continuous paracingular ridges.

## 5. Remarks

The mean width of recorded cysts excluding the paracingulum and the maximum width of the posterior paracingular flange are, respectively, 30  $\mu\text{m}$  and 5  $\mu\text{m}$  (Fig. 4). In this recorded species the suturocavate area is slightly restricted at the paracingular flange. In the whole of the paracingular flange strong denticulations are seen. The Y portion of the recorded dinocysts is not clear, especially in the upper part.

## 6. Biostratigraphic implications and conclusions

*L. absidatum* (Fig. 4) is reported here for the first time from the Middle East (Binalud Mountains, NE Iran). The stratigraphic range of *L. absidatum* (Late Callovian–Early Oxfordian) is very important for palynologists that study the Middle to Upper Jurassic strata. This suturocavate species has previously been reported only from Northwest Europe, in the United Kingdom, Switzerland and Germany. The dinocyst assemblages recorded at the Ghoroneh section include such forms as *Adnatosphaeridium caulleryi*, *Chytroeisphaeridia chytrooides*, *Compositosphaeridium polonicum*, *Ctenidodinium combazii*, *Dichadogonyaulax sellwoodii*, *Gonyaulacysta jurassica*, *Rhynchodiniopsis cladophora*, *Rigaudella aemula*, *Sirmiodiniopsis orbis*, *Systematophora areolata* and *L. absidatum*. Their presence shows a close affinity and relationship with those of the northwestern Tethys and Northwest Europe, supporting the hypothesis of the existence of marine connections between Northern and NE Iran with Northwest Europe during the Middle Upper Jurassic, as also inferred by Seyed-Emami and Schairer (2011) and Ghasemi-Nejad et al. (2012).

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## Appendix A. Supplementary material

Supplementary data associated with this article can be found, in the online version, at <http://dx.doi.org/10.1016/j.jafrearsci.2013.12.012>. These data include Google maps of the most important areas described in this article.

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