**Comment on: "Evolutionary trend of Cenomanian alveolinids from Zagros Basin, SW of Iran" by Dousti Mohajer et al. 2021 in Geological Journal.**

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## Abstract

The results achieved in "Evolutionary trend of Cenomanian alveolinids from Zagros Basin, SW of Iran" by Dousti Mohajer et al. (2021), Geological Journal, are here critically discussed. According to the data published in that study, the identification of alveolinoids in thin section and the relative evolutionary model given could be considered as not accurate or not well supported, weakening the potential of such a foraminiferal group for thorough consideration on its phylogeny and evolution.

## 1 INTRODUCTION

Dousti Mohajer et al. (2021) studied a Cenomanian shallow-water succession from the Sarvak Formation of the Interior Fars Zone (Iran, Zagros Zone) to identify the alveolinoid fauna and discuss their relative evolutionary relationships through time. The stratigraphic occurrences of such alveolinoids seem frequently hampered by incorrect identifications that are mostly based on a very flimsy taxonomic ground. This makes the dataset inconsistent for any subsequent phylogenetic or evolutionary study. Consequently, the evolutionary discussion given by the authors is impacted. It is assumed that it is arbitrary or not well constrained, probably rooted in the confusion of concepts between what authors refer to as an “evolutionary trend” and the use of architectural criteria merely for a taxonomic identification. Comparison with other regions are also impacted; they look inappropriate, particularly because they do not take into account the biogeographic gradients that permitted the alveolinoids to develop endemic assemblages through the Cenomanian Tethys.

## 2 IDENTIFICATION OF ALVEOLINOIDS IN THIN SECTION

Protocols for identification of alveolinoids studied in thin section are based on comparative anatomy and on the relationships among exo- and endoskeletal shell elements as proposed by Reichel (1933; 1937) and Hottinger (1960; 1978) (see also Wannier, 2021, on Reichel’s scientific approach). Identification of shell structures and their functional meanings should also be regarded with precision referring to a glossary of terms (e.g. Hottinger, 2006). Concerning the “middle” Cretaceous alveolinoids, several works have particularly highlighted the usefulness of a bulk of data including several oriented –centered axial and equatorial– as well as random sections, coupled with detailed biometrical and structural approaches, to recognize genera and species with little room for uncertainty (Calonge et al., 2002; Hottinger, 1960; Piuz et al., 2014; Vicedo et al., 2009; Vicedo & Piuz, 2016, among others). Such highly specialized taxonomic studies, which can be considered as basic for any further consideration on other type of general –evolutionary, biostratigraphic or paleobiogeographic– approaches, require of large number of tangential to centered sections to be accurately compared with the type material. Accordingly, Dousti Mohajer et al. (2021) claim to have analyzed 434 thin sections to study "significant biometric features and ratios, such as shell size, shape, number of chambers, and internal structures". However, the illustrated specimens are often of low quality of preservation, which raises a question on the usefulness of the remaining material, unfortunately not catalogued under any depository. The onward procedure adopted by Dousti Mohajer et al. (2021) seems lacking in some fundamental basis for alveolinoidean classification, and generally speaking for any study of larger Foraminifera in thin section, that leaves apart the critical significance of centered axial and equatorial sections for taxonomic discrimination. This is particularly noticeable if looking at Dousti Mohajer et al. (2021) photomicrographs in which most of the alveolinoids are figured under non-diagnostic oblique or non-centered view (e.g. fig. 8), with some very poorly preserved (e.g. figs. 4, 8b, 8g, 9a). In addition, Dousti Mohajer et al. (2021) do not provide any raw data on the biometric measurements obtained, nor any taxonomic and biometric comparison with the type material. Among the few barely diagnostic sections, their figures 9b and 9d are good examples of inaccurate identifications. Both display a shell architecture characterized by pillars. This would point to the occurrence of a species close to a distinctive, likely endemic, form identified as *Myriastyla grelaudae* Piuz et al., 2014 (Figure 1), instead of *Praealveolina debilis* claimed by Dousti Mohajer et al. (2021). Another error can be documented with their specific identification of scarcely recognizable *Cisalveolina* sections (figs. 8h, 9f) as *Cisalveolina fraasi* according to Dousti Mohajer et al. (2021). Whereas, in our point of view, they are closer to *Cisalveolina nakharensis* Piuz et al., 2014 (Figure 1).

## 3 ADVERSE CONSEQUENCES OF THE MISIDENTIFICATIONS

### 3.1 Recognizing evolutionary trends in alveolinoids

The stratigraphic record of larger Foraminifera in shallow-water carbonate rocks is i) often discontinuous due to several biotic and abiotic factors, and ii) strictly determined by biostratinomic processes that control fossilization among, but not limited to, shelf hydrodynamics, bioturbation, and erosion (Consorti & Schlagintweit, 2020; Hottinger, 2001; Martin, 1999). In view of these biases, evolutionary tendency through a determined time frame should also be further assessed considering the phyletic nature of a certain foraminiferal group (monophyletic vs. polyphyletic). Moreover, especially when working with fossils, evolutionary arguments could be based on a certain speciation model by considering a complex array of determining conditions (see e.g. Hohenneger, 2014, for a comprehensive discussion). Evolutionary models should be based on a solid, multidisciplinary-based, corollary such as the studies of Hottinger (2001) and Septfontaine (2020). The concept of "evolutionary trend" exposed by Dousti Mohajer et al. (2021) is, however, based on an unrelated corollary that merely concerns some arguments classically used in foraminiferal taxonomy as stated (page 11): "The following features are of significance in the evolutionary study of alveolinids: Shell size (axial length), shell shape, number of chambers in each whorl, the ratio of axial length to the equatorial radius or the index of elongation, the status of aperture and internal structures e.g. septa, septula, floor, shape, and number of chamberlites". Although such features could be considered as the basis to understand the evolutionary patterns of larger Foraminifera at a broader scale, the evolutionary model of Dousti Mohajer et al. (2021) is so far unrooted, lacking any type of explanation regarding their new(?) vision of the concept of "evolutionary trend", recurrently used throughout the text when speaking of local findings. It seems that the authors get confused among the notion of taxonomical discrimination and the concepts related to the evolutionary patterns at a broader scale. The authors also claim that every alveolinoid genus bears "its own given evolutionary trend", writing dedicated subchapters (in chapter 5) for each of them, but no new data are given, getting a discussion completely rooted on previous works. Through the text there are also some claims like "*C. fraasi* appears at the Cenomanian / Turonian boundary". However, it is largely demonstrated that the genus *Cisalveolina*, as well as most complex Cenomanian larger Foraminifera, disappeared at the Cenomanian-Turonian boundary (Arriaga et al., 2016; Consorti et al., 2015; Frijia et al., 2015; Hart et al., 2005, among others).

### 3.2 Endemism in the alveolinoids

Correlations with other regions such as Croatia (Husinec et al., 2000), Spain (Calonge et al., 2002) or Mexico (Omaña et al., 2019) would not be straightforward, since the Cretaceous and Paleogene platforms of the Middle East represent a biogeographic region characterized by endemism and high diversification rates (see e.g. Consorti & Rashidi, 2019; Consorti & Schlagitnweit, 2020; Piuz et al., 2014; Serra-Kiel et al., 2016, Vicedo & Piuz, 2016; Vicedo et al., 2021, among others). In our Figure 1 we have summarized the occurrences of the species here discussed, highlighting the absence of *Cisalveolina fraasi* in Spain (Schroeder & Neumann, 1985) and the limited spatial distribution of the endemic taxa *Cisalveolina nakharensis* and *Myriastyla grelaudae* through the Middle East (Piuz et al., 2014). According to Dousti Mohajer et al. (2021) "Endemism has led to the scarcity of some genera and species in some regions", i.e. a vision that, in our point of view, oversimplifies the complex issue of the foraminiferal provincialism for geological correlations.

## 4 CONCLUSIONS

Dousti Mohajer et al. (2021) leaves apart some basic principles in foraminiferal taxonomy and publish a contribution on the Cenomanian alveolinoids of Iran weakening the potential of larger Foraminifera to solve complex issues on evolution and paleobiogeography. This seem to result from a lack of expertise (or a limited experience) in recognizing the key diagnostic features for taxonomic identification. These issues are dramatically rising in recent times through the geological literature (e.g. Consorti & Schlagintweit, 2020; Granier, 2020a, b; Schlagintweit, 2021a, b) and maybe facilitated by a false sense of security some authors display on larger Foraminifera identification. Taxonomic identifications and any further evolutionary considerations should be based on a wide experience in taxonomy and supported by adequate material. We strongly recommend authors to re-assess the study on alveolinoids using appropriate sections along diagnostic views that, furthermore, should be selected (and figured) under the supervision of a specialist.

**Figures**

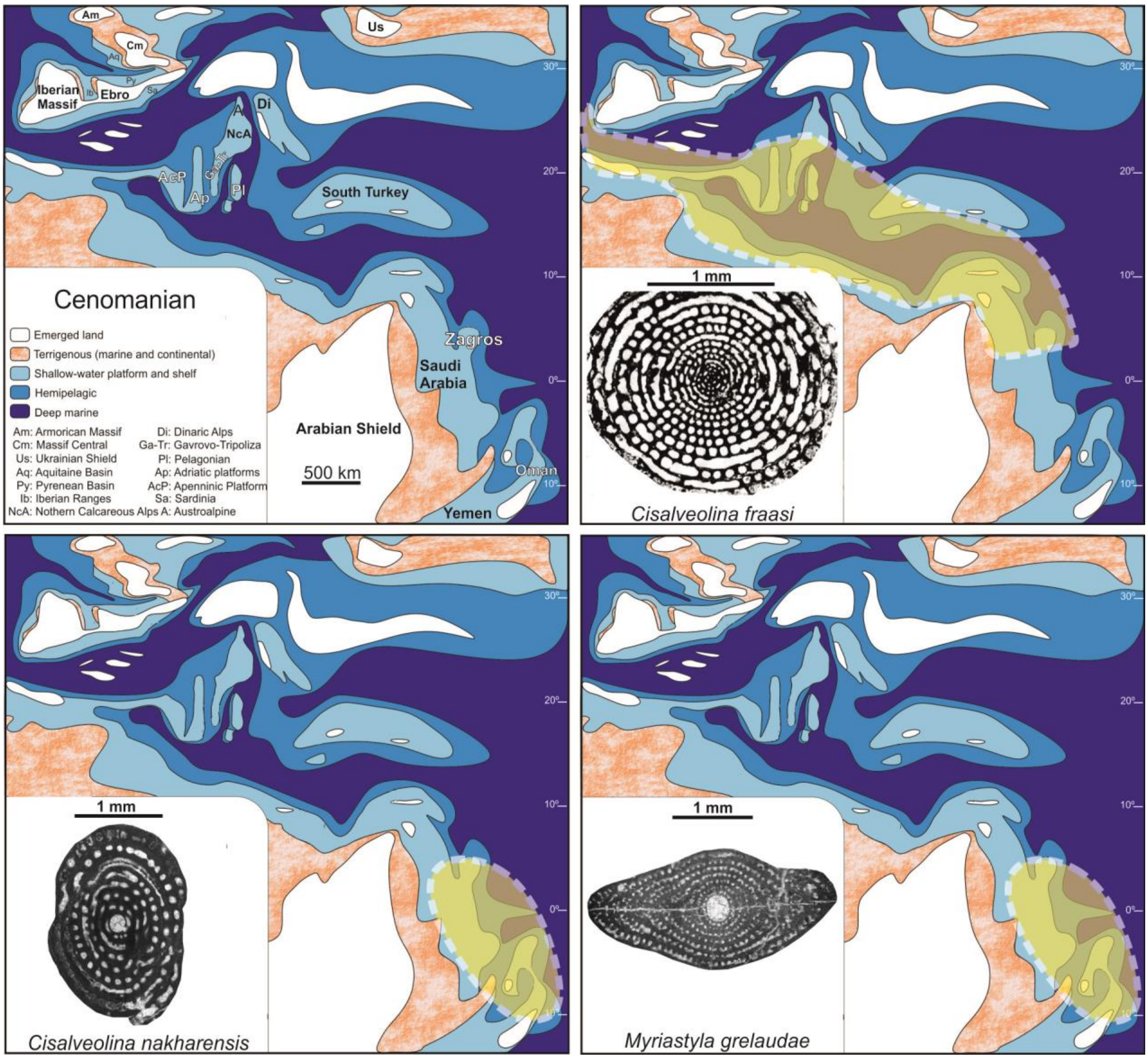

FIGURE 1 – Paleobiogeography of selected species discussed in the text. Base paleogeographic map for the Cenomanian taken from Consorti et al. (2016). Yellowish areas indicate the distribution for each taxon. Occurrences of Cisalveolina fraasi are taken from Schroeder and Neumann (1985); those of Myriastyla grelaudae and Cisalveolina nakharensis are from Piuz et al. (2014) and Dousti Mohajer et al. (2021).

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**Conflict of Interest statement**

The authors declare that they have no conflict of interest related to this manuscript

**Data Availability Statement**

The data that support the findings of this study are available from the corresponding author, [LC], upon reasonable request.

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