Middle Eocene Planktonic Foraminifera *Inordinatosphaera* aff. *indica* from Jabal Hafit, Al Ain area, United Arab Emirates

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ABSTRACT

The Middle Eocene (Bartonian) planktic foraminiferal species *Inordinatosphaera* aff. *indica* Mohan and Soodan is recorded for the first time from the Middle Eocene *Orbulinoides beckmanni* Zone (E12) of Jabal Hafit, Al Ain area, United Arab Emirates (UAE), Northern Oman Mountains (NOM). Thirteen commonly occurring planktic foraminiferal species associate the new one in the biozone are also recorded. The record of *Inordinatosphaera* aff. *indica* in the UAE suggests that Arabia had marine link with India during Paleogene.

Keywords: *Inordinatosphaera* aff. *indica*, Middle Eocene, Jabal Hafit, United Arab Emirates, Northern Oman Mountains

INTRODUCTION

The current work records Middle Eocene (Bartonian) planktic foraminiferal species *Inordinatosphaera indica* Mohan and Soodan (1967) from Jabal Hafit, Al Ain area, UAE (Lat. 24° 06' and 24° 09' N, Long. 55° 46' and 55° 49' E). The Maastrichtian-Paleogene rocks of the United Arab Emirates (UAE) crop out as a discontinuous mountain belt (jabals) and hills (qarns) around the western front of the North Oman Mountains (NOM). Jabal Hafit is one of these mountains, and it is a NNW-SSE asymmetrical double plunging anticline. The study area is located at the eastern limb of J. Hafit (Fig. 1). The *Inordinatosphaera* aff. *indica* Mohan and Soodan is recorded and illustrated for the first time (Fig. 3b) from the *Orbulinoides beckmanni* Zone (P13 of Blow, 1969 = E12 of Berggren and Pearson, 2005) of Jabal Hafit, UAE. An assemblage of thirteen Bartonian planktic foraminiferal species is also recorded from the zone. These are: *Orbulinoides beckmanni* (Saito), *Turborotalia cerroazulensis* (Cole), *T. pomeroli* (Toumarkine and Bolli), *Acarinina bullbrookii* (Bolli), *Morozovella lehneri* (Cushman and Jarvis), *Truncorotaloides rohri* Brönnimann and Bermúdez, *T. topilensis* (Cushman), *Pseudohastigerina micra* (Cole), *Subbotina eoacaena* (Gümbel), *S. linaperta* (Finlay), *S. senni* (Beckmann), *Globigerinatheka subconglobata* (Shutskaya) and *Hantkenina alabamensis* Cushman.

GEOLOGICAL SETTING

The Maastrichtian-Oligocene sediments crop out around the western part of the UAE, NOM. Anan (2005) noted that the eastern limb of J. Hafit anticline exposes Middle-Upper Eocene succession along the Al Ain-Mazyad asphalted road. This succession is equivalent to

the mappable rock unit, coded Tle4 by Hunting Ltd. (1979, where T= Tertiary, l= lower, e= Eocene), or Ain Al Faydah Member (formal lithostratigraphic scheme of Hamdan and Bahr, 1992) of the Dammam Formation (Krumbein, 1942).

Fig. 1: Location map of the study area of Jabal Hafit, United Arab Emirates (UAE).

STRATIGRAPHY OF THE STUDY AREA

The eastern limb of J. Hafit anticline, east of Al Ain-Mazyad asphalted road, consists mainly of alternated marl, nummulitic marly limestone and hard limestone beds often with gypsiferous shale beds. One sample of gypsiferous shales (bed no. 4, about 15 m thick, Fig. 2) belongs to the late Middle Eocene *Orbulinoides beckmanni* Zone (about 40.5-40 Ma). This bed belongs to the upper part of Ain Al Faydah Member and is located about 50 m below the diagnostic intraformational conglomeratic bed (no. 13, Fig. 2), which separates Ain Al Faydah Member (Tle4) from Mazyad Member (Tle5) of the Dammam Formation.

Fig. 2: Simplified stratigraphic section of the Middle Eocene, eastern limb of Jabal Hafit, UAE, Tle4= Ain Al Faydah Member, and Tle5=Mazyad Member of the Damman Formation.

SYSTEMATIC PALEONTOLOGY

The classification of Loeblich and Tappan (1988) has been used in this study.

Order Foraminiferida Eichwald, 1830
 Suborder Globigerinina Delage and Hérouard, 1896
 Superfamily Globigerinacea Carpenter, Parker and Jones, 1862
 Family Globigerinidae Carpenter, Parker and Jones, 1862
 Subfamily Proticulasphaerinae Banner, 1982
 Genus *Inordinatosphaera* Mohan and Soodan, 1967
 Type species: *Inordinatosphaera indica* Mohan and Soodan, 1967
Inordinatosphaera aff. *indica* Mohan and Soodan, 1967

Fig.3b

Affinity: *Inordinatosphaera indica* Mohan and Soodan, 1967, p. 24, fig. 1. 1-7; 1970, p. 42, pl. 2, fig. 10; Loeblich and Tappan, 1988, p. 492, pl. 539, figs. 17-23.

Description: This Lutetian taxa was recorded from India by Mohan and Soodan (1967, 1970) and documented in Loeblich and Tappan (1988, p. 492). It has subglobular test, early ovoid chambers in a trochospiral coil, later chambers strongly enveloping, wall calcareous hyaline with poor pits, aperture interiomarginal and umbilical in early stage, later with multiple sutural supplementary apertures covered by elongate meandriform bullae with infralaminar accessory apertures.

Material and method: Only one specimen has been recorded and this view (Fig.3b) does not match very well with the illustration provided by Mohan and Soodan (Fig.3a). Therefore, *Inordinatosphaera* aff. *indica* Mohan and Soodan is recorded tentatively and illustrated for the first time in this study from the Bartonian *Orbulinoides beckmanni* Zone from sample 15 (P13 of Blow, 1969 = E12 of Berggren and Pearson, 2005) of Jabal Hafit, UAE with an assemblage of thirteen Bartonian planktic foraminiferal species from this biozone.

Frequency of occurrence of the studied forms: The *I. indica* is rare in the study section than the other recorded planktic species with a good preservation as well as the benthic assemblage.

Repository: Geology Department, UAE University, Anan collection.

Remarks: Mohan and Soodan (1967) noted that their Middle Eocene (Lutetian) genus *Inordinatosphaera* differs from the Miocene genus *Globigerinatella* Cushman and Stainforth (1945) and the Middle Miocene-Holocene genus *Orbulina* d'Orbigny (1839) in having different arrangement of bullae and lacks the areal apertures, but having profuse development of bullae with infralaminar accessory apertures. *I. Inordinatosphaera* aff. *indica* is recorded for the first time from outside India.

Fig. 3: a. *Inordinatosphaera indica* Mohan and Soodan x 60 (after Mohan and Soodan, 1970), Kutch area, India. b. *Inordinatosphaera* aff. *indica* Mohan and Soodan x 60, J. Hafit, UAE (this study).

Discussion: The Bartonian UAE specimen of *Inordinatosphaera* aff. *indica* seems to have more similar surfacial shape with the Indian figured specimen, which is characterized by its spherical-sub spherical test and irregular elongate meandriform bullae.

PALEOGEOGRAPHY

The Paleogene paleogeographic maps (partly or regionally), used by many authors, i.e. Berggren (1978), Moore *et al.* (1978), Adams *et al.* (1983) show that the Tethys had been connected with the Indo-Pacific Ocean in the east and with the Atlantic Ocean to the west. Anan (1995) concluded that the Tethyan Realm during the Middle-Late Eocene extends to the southeast and connected with the Indo-Pacific Realm via seaway. Haynes and Nwabufu-Ene (1998) suggested wider Tethyan connections, as far as the Carpathian and Pakistan. Anan (2015) recorded the *Acarinina berwaliana* Mohan and Soodan from the *H. nuttalli* Zone (P10) of the Kutch area (India) in the planktic assemblage from also the base of Middle Eocene (P10) of J. Hafit, UAE. The existence of Lutetian *A. berwaliana* and the Bartonian *Inordinatosphaera indica* (this study) strongly concluded that the Tethyan Realm during the Middle Eocene extends from Arabia to the southeast and connected with the Indo-Pacific Realm.

PALEOCLIMATOLOGY

Frerichs (1971) noted that the presence of keels, accessory apertures, and tubular spines of planktic foraminiferal species suggests a tropical sea. Anan (1994) noted that during Middle-Late Eocene time, the UAE and surrounding area had been located in the tropical and warm-temperate region. Accordingly, the Middle Eocene horizon at J. Hafit area seemed to have been located in the tropical and warm-temperate region, and this inference is based on many faunal environmental elements: presence of keel (*Morozovella lehneri*), accessory apertures (*Truncorotaloides rohri*, *T. topilensis*, *Globigerinatheka subconglobata*, *Orbulinoides beckmanni*, *Inordinatosphaera indica*), tubular spines (*Hantkenina alabamensis*) and rich Nummulitids in some horizons. This interpretation is in accordance with the environmental elements of the Middle-Late Eocene stratigraphic horizon in the UAE and surrounding area, as India.

EUSTATIC SEA LEVEL

Anan (2005, 2014) suggested that the unconformity at the boundary between the Ain Al Faydah and Mazyad Members in the eastern limb of J. Hafit (Fig. 2) at Al Ain Mazyad road is associated with the major sea-level lowering (about 41 Ma), within *Truncorotaloides rohri* Zone (P14). The global marked fall in the eustatic sea level (after Vail *et al.*, 1977, Haq *et al.*, 1987 and PHe of Keller *et al.*, 1987) took place at the end of the Middle Eocene (~ 40 Ma) and in Jabal Hafit as well.

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