



## Jurassic Foraminiferal Palaeobiogeography of Kutch – A Review

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### Abstract

Jurassic foraminiferal biogeography of western India is hitherto unsettled. Only few studies on this topic exist which assign them either a Tethyan or an Antiboreal affinity along with other neighbouring regions of Malagasy, Somalia, Ethiopia, Egypt, Jordan, Saudi Arabia, Qatar, Iran and Afghanistan. The present study attempts to settle this controversy by analyzing the prolific foraminiferal assemblages recovered from different Jurassic exposures of Kutch and adjoining regions of the world and comparing them with some well-known Boreal assemblages of Europe and North America. The study reveals that the Jurassic foraminiferal assemblages of Kutch are closer to Boreal ones having only rare Tethyan elements. On this basis, the Jurassic foraminiferal assemblages are assigned to a distinct province of Antiboreal Realm, the Indo-East African Province, located at the southern margin of the Tethys Realm at about the same but opposite latitudes of Boreal Realm in the southern hemisphere. The proposed Indo-East African Province represents a transitional zone between the Tethyan and Antiboreal realms, as indicated by the presence of rare occurrence of a few typical Tethyan genera in the Jurassic assemblages of Kutch.

*Keywords:* Jurassic Foraminifera, Kutch, Palaeobiogeography, Indo-East African Province, Antiboreal Realm

### Introduction

Jurassic rocks of Kutch are famous all over the world for their excellently preserved megafossils, particularly ammonites which have been studied in considerable detail. Mostly, Jurassic rocks in Kutch are exposed in three east-west trending ridges, broken into numerous domes. The middle ridge is most prominent, called Kutch Mainland and includes most of the exposures of the Jurassic rocks. Microfossil, especially foraminifera of the Jurassic rocks of Kutch are mainly studied by the researchers of the micropaleontology group of the Department of Geology, Aligarh Muslim University, Aligarh who have recovered foraminiferal assemblages from all the major Jurassic exposures of Kutch including Jara (Wasim *et al.*, 2018) Jumara (Gaur and Talib, 2009; Wasim *et al.*, 2021) Kaiya (Talib *et al.*, 2012a), Keera (Talib *et al.*, 2012b), Jhurio (Bhalla and Talib, 1991) and Habo domes (Bhalla and Abbas, 1978; Talib *et al.*, 2017; Fig. 1). The present study deals with the foraminiferal assemblages recovered from different Jurassic outcrops of the Kutch region of Gujarat State and their application in establishing the palaeobiogeographic affinity of the Jurassic foraminifera of Kutch as well as reconstructing the palaeogeography of the Kutch region during Jurassic.

### Global Jurassic Foraminiferal Biogeography

Gordon (1970) identified two foraminiferal assemblages during the Jurassic Period, *viz.*, Shelf assemblage and Tethyan assemblage. The former is dominated by nodosariids, vaginulinids, and agglutinated species with simple interior and shelf calcareous species and the latter mainly composed of planktonic and arenaceous species with complex interior. 'Shelf region' was an extension of Tethys in the northern and southern continental shelves whereas the 'Tethyan zone' was the deep geosynclinal area ranging from the Mediterranean Sea to the Himalayas and extended to Indonesia. However, Kalia and Chowdhury (1983) considered the Tethyan assemblage of Gordon (1970) as belonging to shallow water areas on the margin of the tropical Tethys Sea and as such, did not accept the Gordon's (1970) definition for the 'Shelf' and the 'Tethys zone'. Kalia and Chowdhury (1983) further commented that the 'shelf' and 'Tethyan' zone of Gordon (1970) are unclear as both the zones lie on the shelf areas north and south of Tethys with opposite latitudes.

Gordon (1970) proposed the concept of latitudinal bipolarity, following Strakhov (1962) who suggested this concept for Late Jurassic belemnoids, by coining the terms 'Antiboreal' or 'Austral' Realm, an equivalent of the Boreal

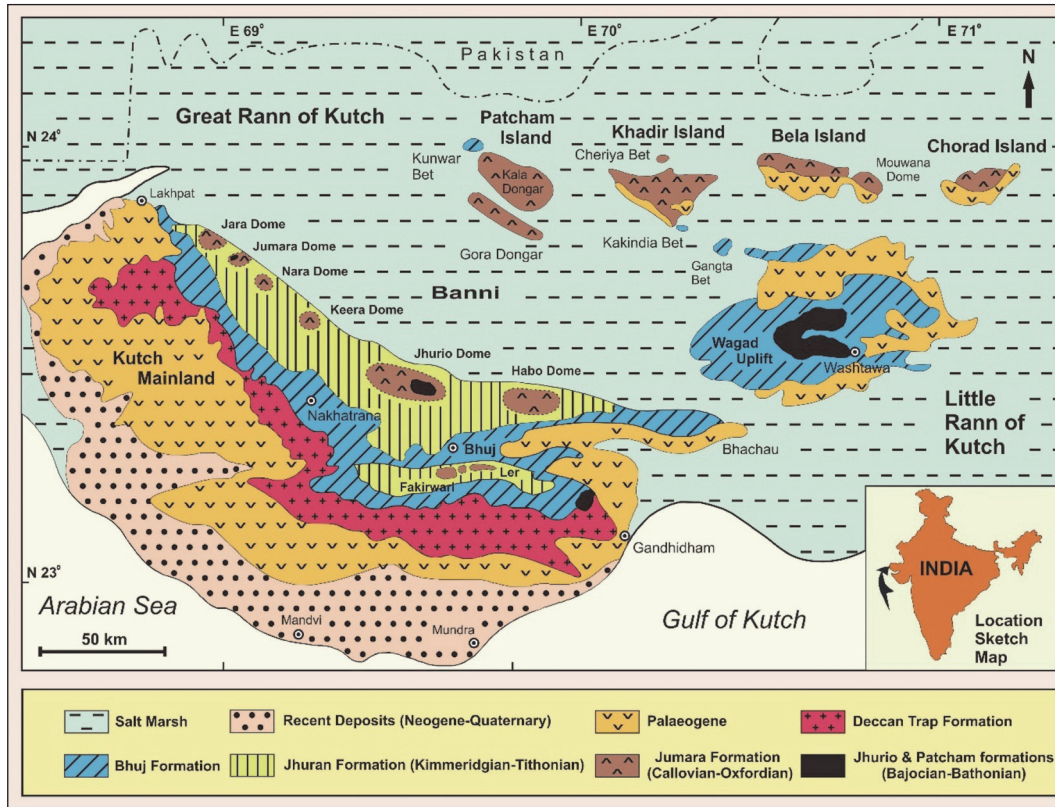


Fig. 1: Geological map of the Kutch showing various Jurassic outcrops in the form of domes (after Patel *et al.*, 2012).

Realm in the southern hemisphere. Scheibnerová (1972) proposed three foraminiferal biogeoprovinces during the Mesozoic, *viz.*, Boreal/Austral, Tethyan, and transitional biogeoprovince. Based on the relative abundance of epistominids and lenticulinids in the foraminiferal assemblages from the East European Platform and the scarcity of nodosariids. Grigelis and Ascoli (1995) observed that this kind of assemblage is neither typically Boreal nor Tethyan and may be termed as 'Sub-Boreal-Atlantic'. Both the Boreal-Atlantic and Sub-Boreal-Atlantic kind of microfauna show great taxonomic diversity, heterogeneity and rapid evolutionary rate of lenticulinids and epistominids.

**Jurassic Foraminiferal Biogeography of Kutch and Palaeogeographic Reconstruction**

There are few studies on Jurassic foraminiferal biogeography of the Kutch region (Table 1). The first study dealing with the foraminiferal palaeobiogeography of the Kutch region was published by Bhalla and Abbas (1976) which suggested that Jurassic foraminiferal assemblages recovered from Habo hills, Kutch are endemic and as such contribute very little in making interregional correlations. They, however, assigned a Tethyan affinity to this fauna. Various workers have discussed the Jurassic foraminiferal biogeography at some length and assigned the Jurassic foraminiferal assemblages of Kutch a Tethyan affinity (Talib and Bhalla, 2006; Talib and

Gaur, 2008). Talib *et al.* (2016, 2017), Bhat *et al.*(2017), and Wasim *et al.* (2021) briefly commented on the biogeographic affinity of the Jurassic foraminifera of Kutch but assigned them to Antiboreal Realm. However, as observed in the present study, various foraminiferal assemblages of Kutch do not compare favourably with the Tethyan assemblages.

A large number of Jurassic foraminiferal species from Kutch are also found in various Jurassic assemblages of Europe and North America (Kalia and Chowdhury, 1983). Following the Gordon's (1970) concept, Kalia and Chowdhury (1983) assigned an Antiboreal affinity to the Jurassic foraminiferal assemblages of Rajasthan which also contain a small proportion of Tethyan element. However, no solid argument was put forward by these authors for this assignment. Kalia and Chowdhury (1983) further commented that the Callovian

**Table 1:** Palaeobiogeographic affinity of Jurassic foraminifera of Kutch assigned by various authors.

Author	Palaeobiogeographic Affinity
Bhalla and Abbas (1978)	Tethyan
Talib and Bhalla (2006)	Tethyan
Talib and Gaur (2008)	Tethyan
Talib <i>et al.</i> (2016)	Antiboreal
Talib <i>et al.</i> (2017)	Antiboreal
Wasim <i>et al.</i> (2021)	Antiboreal
Present Study	Antiboreal

assemblages of Rajasthan described by these authors and the Callovian-Oxfordian assemblages of Kutch reported by Bhalla and Abbas (1978) appear to have Boreal affinity because almost 80% of the foraminiferal species of these regions closely resemble with the European and North American species. Talib and Gaur (2008), however, suggested that biogeographical affinity of foraminiferal assemblages should not be decided only on the basis of number of common species and other evidences like morphology and frequency of species should also be considered.

From this discussion, it is evident that the researchers are unable to unequivocally decide the biogeographic affinity of the Jurassic foraminifera of Kutch. This problem is probably due to the limited number of studies on Jurassic foraminifera in India and neighbouring regions. However, the Jurassic foraminiferal assemblages of Kutch are very close not only to those of adjoining Tethyan regions of Saudi-Arabia, Jordan, Egypt, Iran, Afghanistan, Ethiopia and Eastern Mediterranean but also to those of Europe and North America. In view of the above, it is endeavoured here to solve the problem of biogeographic affinity of the Jurassic foraminifera of Kutch and reconstruct the palaeogeography of the Kutch region during Jurassic.

### **A Re-analysis of Foraminiferal Morphology and Assemblages of Kutch**

Here we compare the foraminiferal assemblages of Kutch with various Boreal and Tethyan assemblages of neighbouring regions. Number of common species, percentage of agglutinated versus calcareous species, percentage of ornamented species as well as intensity of ornamentation in some selected species was considered for this purpose. The comparison shows that most of the Jurassic foraminiferal assemblages of the Indian and neighbouring regions are characterized by the dominance of European and North American species assigned to Boreal Realm and majority of assemblages of both the regions are dominated by calcareous forms. Said and Barakat (1958) commented that the lagenids in the Egyptian Jurassic foraminiferal assemblages having Tethyan affinity are less ornamented than the European ones showing Boreal affinity. However, percentages of ornamented species in different assemblages of Boreal and Tethyan realms were observed in this study but no significant difference was found between the two. Furthermore, intensity of ornamentation in some species, belonging to Boreal and Tethyan was compared but not much difference was revealed between the two.

### **Discussion**

Talib and Bhalla (2006) and Talib and Gaur (2008) commented that minor differences exist in species frequency and some morphological features particularly size, number of

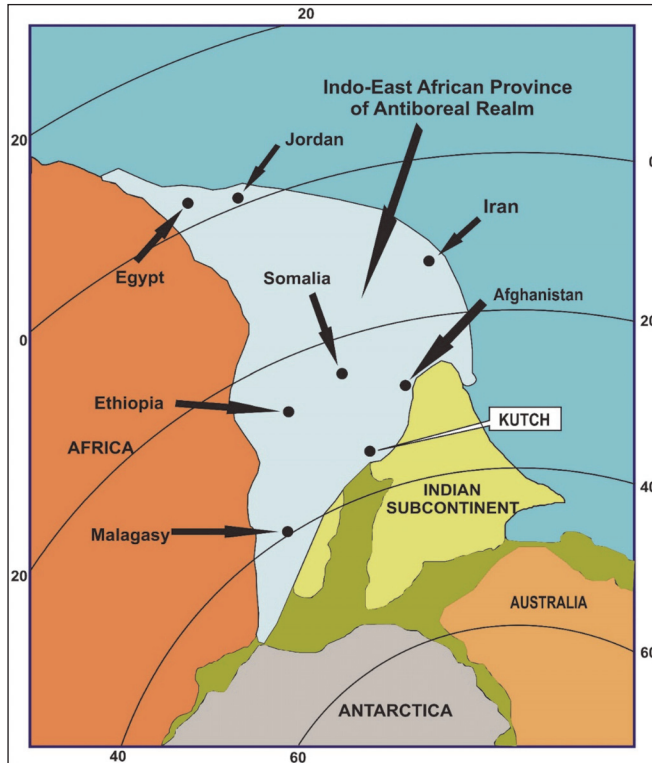
chambers, and ornamentation in some species of European and North American assemblages and the assemblages of the Indian and neighbouring regions. These differences may be due to local ecological conditions and may not be taken as a basis for placing them into different foramgeographic provinces. The present analysis, therefore, revealed that contemporaneous Jurassic Tethyan and Boreal foraminiferal faunas are not much different and support the bipolarity concept of Strakhov (1962) proposed for Late Jurassic belemnoids and followed by Gordon (1970) and Kalia and Chowdhury (1983) for Jurassic foraminifera. In view of the above discussions, it is reasonable to infer that the Jurassic foraminiferal assemblages of Kutch may be assigned to 'Antiboreal Realm' of the southern hemisphere, opposite to the Boreal Realm in the northern hemisphere. Indian subcontinent was located near the same but opposite latitude in the southern hemisphere, to that of the Boreal Realm in the northern hemisphere. Consequently, similar foraminiferal assemblages flourished in the two regions during Jurassic.

On the basis of the above discussions, it can be inferred that no appreciable difference exists between the Boreal and the Tethyan foraminiferal assemblages of Jurassic. The Jurassic foraminiferal assemblages of Kutch and adjoining regions of Afghanistan, Iran, Middle East, and Eastern Africa do not belong to the Indo-East African Province of the Tethyan Realm as suggested by some researchers (Bhalla and Abbas, 1976; Talib and Bhalla, 2006; Talib and Gaur, 2008). The Kutch Jurassic foraminiferal assemblages should be assigned to a distinct province of the Antiboreal Realm, the Indo-East African Province (Fig.2). This province is located at the southern extremity of the Tethyan Realm and occupied a mixed zone near the junction of the Tethyan and Antiboreal realms. The presence of some typical Tethyan elements in the Jurassic foraminiferal assemblages of Kutch and Rajasthan, viz., *Gubkinella*, *Kurnubia*, *Pfenderina*, *Pseudolamarckina*, *Pseudomarssonella*, and *Ryadhella* in a small proportions are reported by various authors (Garg and Singh, 1983; Kalia and Chowdhury, 1983; Mandwal and Singh, 1994; Garg and Jain, 2012; Jain and Garg, 2014; Talib *et al.*, 2016, 2017; Bhat *et al.*, 2017; Wasim *et al.*, 2021). However, as these Tethyan species occur in very small percentage (below 13% of the total species) it is not proper to assign the Kutch foraminiferal assemblages to the Tethyan Realm on this basis as the occurrence of small number of Tethyan elements as mixed fauna is normally found at the border zone between the two biogeographic provinces or realms. In this regard the views of Talib *et al.* (2016, 2017), Bhat *et al.* (2017), and Wasim *et al.* (2021) in assigning the Kutch foraminiferal fauna to the Antiboreal Realm appear to be more valid.

### **Conclusions**

A survey of literature on Jurassic foraminiferal biogeography reveals that most of the researches assign them





**Fig. 2:** Palaeogeography of Kutch and adjoining regions during Jurassic showing Indo-East African Province of Antiboreal Realm (continental assembly after Enay and Cariou, 1997).

to Tethyan affinity. However, a comparison of the foraminiferal assemblage of Kutch with the Tethyan assemblages of the neighbouring regions and the Boreal assemblages of Europe and North America, suggests that the Kutch foraminiferal assemblages are very close to several Boreal assemblages of Europe and North America rather than

Tethyan ones. This may be explained by the concept of bipolarity. This study supports the presence of a distinct foraminiferal realm, called the Antiboreal Realm, located in the southern hemisphere, opposite to the Boreal Realm at about the same latitudes which was occupied by a foraminiferal fauna very close to those of Boreal realms. The Jurassic foraminiferal fauna of Kutch flourished in a shallow sea along with other neighbouring regions of Malagasy, Somalia, Ethiopia, Egypt, Jordan, Saudi Arabia, Qatar, Iran and Afghanistan in a distinct province of the Antiboreal Realm, the Indo-East African Province, a constituent of the Antiboreal Realm on the southern border of the Tethyan Realm and transitional between the Tethyan and the Antiboreal realms as suggested by the presence of some Tethyan foraminiferal taxa in the Jurassic foraminiferal assemblages of Rajasthan.

#### Authors' Contributions

**Avneet Kumar:** Conceptualization, Data Collection and Analysis, Interpretation, Writing Original Draft. **Abu Talib:** Supervision, Reviewing, Editing. **Ainul Hasan Ansari:** Collection and Review of Literature, Preparation of Figures.

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