JOURNAL GEOLOGICAL SOCIETY OF INDIA
Vol.80, November 2012, pp.667-675

Foraminifera from Jurassic Sediments of Keera Dome, Kutch

A. Talib[1], K.N. Gaur[2], A.K. Sisodia[3], Bilal A. Bhat[4] and Roohi Irshad[1]
[1]Department of Geology, Aligarh Muslim University, Aligarh - 202 002
[2]K-69, Gyansarover, Aligarh - 202002
[3]Phase-2, Kavery Apartments, Swarnjayanti Nagar, Aligarh - 202 002
[4]Department of Geology, Kashmir University, Srinagar - 190 006
Email: talib04@gmail.com

Abstract: A foraminiferal assemblage comprising 30 species dominated by the family Vaginulinidae is recovered from the Chari Formation exposed at Keera Dome, Kutch. The paper presents a systematic account of eight species, reported for the first time form the Indian region. Preliminary interpretations regarding age and palaeoenvironment are drawn on the basis of the recovered foraminiferal assemblage. The assemblage supports a Callovian to Oxfordian age for the studied sequence. A near shore, open marine environment ranging from mid to outer shelf is interpreted on the basis of the foraminiferal assemblage.

Keywords: Jurassic sediments, Foraminifera, Systematics, Age, Palaeoenvironment, Keera Dome, Kutch, Gujarat.

INTRODUCTION

Marine Jurassic rocks are well developed in the Kutch region of Gujarat and have been subject of extensive geological and palaeontological studies. Although megafossils of these sediments are well studied, little attention has been paid to their microfossils including foraminifera. There are a few detailed investigations on the microfossils of these rocks (Bhalla and Abbas, 1978; Bhalla and Talib, 1991; Khosla et al., 1997, 2004, 2005; Pandey and Dave, 1993; Gaur and Talib, 2009). Furthermore, most of the micropalaeontological studies on the Jurassic rocks of Kutch are devoted to taxonomy and systematics with little emphasis on their applications. This prompted us to carry out a detailed study of the Jurassic microfossils of Kutch, especially foraminifera which are varied, abundant, and well preserved in these rocks with a view to apply them for various interpretations, viz., palaeoecology, biostratigraphy, and palaeogeography. Such studies assume importance in view of the Kutch basin being categorized as the potential hydrocarbon producing basin of the country. The present study forms a part of a comprehensive investigation of the foraminifera from Jurassic rocks of Kutch and presents the preliminary results obtained during the foraminiferal investigation of a well exposed sequence of Middle to Late Jurassic rocks exposed at Keera Dome, near Keera village (69°14'30" E : 23°36'00" N), about 50 km northwest of Bhuj, the district headquarter of Kutch region (Fig. 1).

GEOLOGY AND STRATIGRAPHY

Jurassic rocks in the Kutch region are exposed in three parallel east-west trending anticlinal ridges and an isolated rock mass in the east near Wagad. Of these, the middle ridge is the most conspicuous and is broken up into several domal outcrops. Most well exposed sequences of Jurassic rocks are situated in this ridge in the form of structural domes and the Keera Dome is one of the well exposed domes of this ridge. Following a widely used classification originally proposed by Waagen (1873-75) and later modified by Sastry and Mamgain (1971) and Kumar (1985), the Jurassic rocks of Kutch are grouped into four formations, viz., Patcham, Chari, Katrol and Umia in ascending order, ranging in age from Bajocian to Tithonian. Only Chari and Katrol formations are exposed in the Keera Dome, the latter is devoid of foraminifera and hence excluded from the present study. In the present investigation, the Chari Formation of Keera Dome is grouped into four informal members designated as A, B, C, and D and subdivided into seven lithounits from bottom to top, viz., Kr-1 to Kr-7 (Fig. 2).

MATERIALS AND METHODS

Twenty-one samples were collected from the selected section of the Chari Formation exposed at Keera Dome, mainly on the basis of lithological variation. About 500gm of dried rock sample was crushed and boiled with sodium

0016-7622/2012-80-5-667/$ 1.00

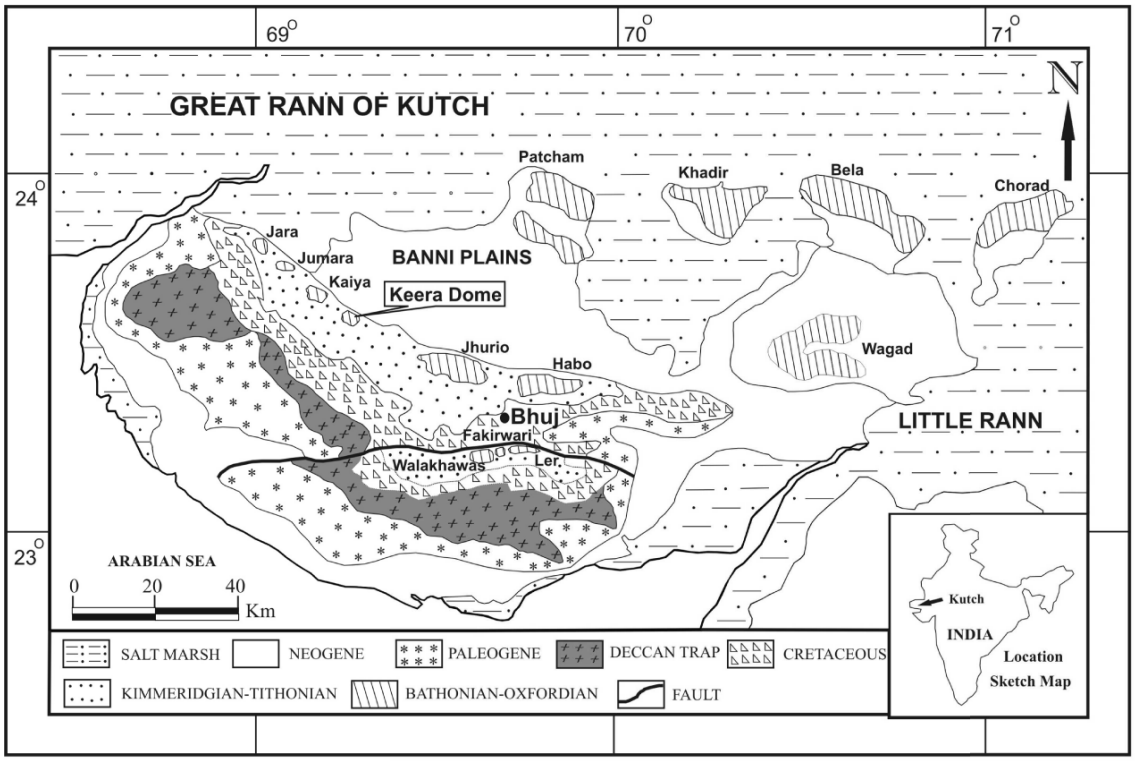

Fig. 1. Location map of Kutch showing the study area (*after* Biswas, 1977).

carbonate and the disintegrated material was washed and screened through a set of standard sieves of 30, 60 and 120 mesh and dried in oven. 10 gm material from 60 and 120 mesh fractions were examined under a stereozoom binocular microscope to pick foraminiferal tests. Some specimens were further cleaned in an ultrasonic cleaner. One well preserved specimen of each species was photographed with the help of SEM make Zeiss model EVO-40 at Wadia Institute of Himalayan Geology, Dehradun.

FORAMINIFERAL COMPOSITION

A foraminiferal assemblage comprising thirty species belonging to nine families is recovered from the Chari Formation exposed at Keera Dome. A check list of species is given in Table 1. The assemblage is characterized by both calcareous and agglutinated species, the calcareous component constituting 70% of the total foraminiferal species and, except for a single porcelaneous species, contains only hyaline forms. The ratio of agglutinated to calcareous species is 1: 2.3.

Figure 3 displays the composition of the foraminiferal assemblage recovered from Keera Dome. The Keera Dome foraminiferal assemblage is dominated by the species belonging to family Vaginulinidae constituting 40% of the total species and represented by 12 species belonging to seven genera. Of the remaining, six species belong to Lituolidae (20%), four to Nodosariidae (13.3%), three to Epistominidae (10%), and one each to families Saccamminidae, Hormosinidae, Haplophragmiidae, Spirillinidae, and Nubeculariidae (3.3% each). Eight species are being reported for the first time from the Indian region. The systematics of these species is given below:

SYSTEMATICS

For the sake of brevity, a systematic account of only the foraminiferal species recovered for the first time from the Indian subcontinent is presented here and the rest have only been illustrated in the plates. Generic classification of Foraminiferida proposed by Loeblich and Tappan (1988) is followed and different species within a genus are arranged in alphabetical order. References concerning important shifts in generic names or species closely resembling ours have only been cited. In order to avoid repetition, suffix *et syn.* has been added to the references which contain satisfactory synonymies.

All the described and photographed specimens have been deposited in the micropalaeontological collection of the Department of Geology, Aligarh Muslim University, Aligarh.

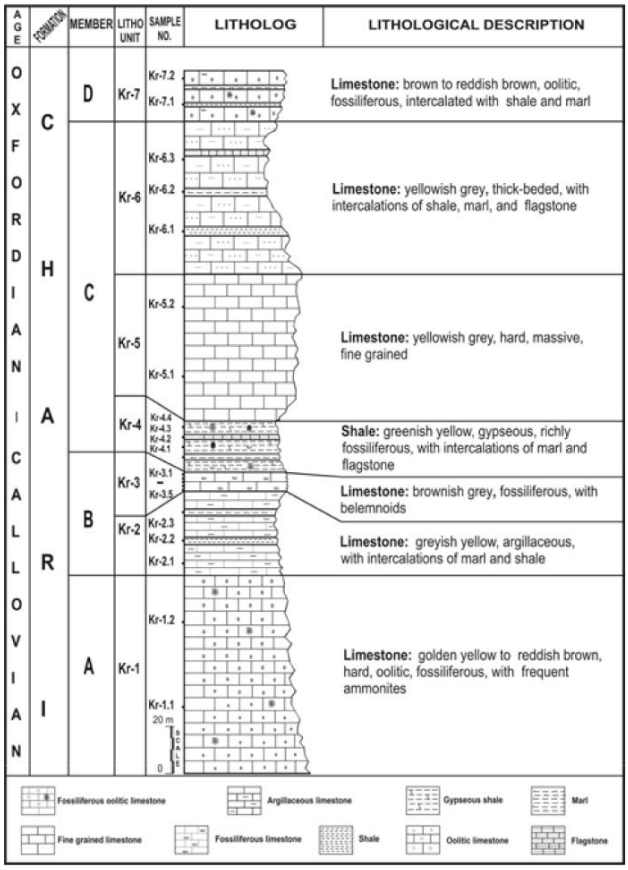

Fig.2. Litholog of Middle-Late Jurassic sequence, Keera Dome, Kutch.

Order: FORAMINIFERIDA Eichwald, 1830
Suborder: TEXTULARIINA Delage & Hérouard, 1896
Superfamily: ASTRORHIZACEA Brady, 1881
Family: SACCAMMINIDAE Brady, 1884
Subfamily: SACCAMMININAE Cushman, 1910

Genus: *LAGENAMMINA* Rhumbler, 1911

Lagenammina pseudodifflugiformis Nogan, 1964
(Plate 1, fig. 1)

Lagenammina pseudodifflugiformis Nogan, 1964, pp.19, 20; pl.1, fig.1.

Remarks: Two specimens are present in our material which show close resemblance to the original form of this species described by Nogan (1964). However, in the Indian specimens the neck is shorter and the base is somewhat pointed. This species is very coarsely agglutinated and differs from *Lagenammina difflugiformis* in lacking a long tubular neck.

Superfamily: HORMOSINACEA Haeckel, 1894
Family: HORMOSINIDAE Haeckel, 1894
Subfamily: REOPHACINAE Cushman, 1910
Genus: *REOPHAX* de Montfort, 1808

Reophax sterkii Haeusler, 1890
(Plate 1, fig. 2)

Reophax sterkii Haeusler, 1890, p.29, pl.3, fig.23.
Reophax sterkii Haeusler - Gordon, 1967, p.449, pl.1, figs.16,17, *et syn.*

Remarks: Two specimens closely resembling those described by Gordon (1967) and having four chambers like most of his specimens, were recovered from the present material, though the number of chambers in this species ranges from three to six. This is a large species of *Reophax* with a large final chamber occupying nearly half of the test.

Superfamily: LITUOLACEA de Blainville, 1827
Family: LITUOLIDAE de Blainville, 1827
Subfamily: AMMOMARGINULININAE Podobina, 1978
Genus: *AMMOBACULITES* Cushman, 1910

Ammobaculites alaskensis Tappan, 1955
(Plate 1, fig. 3)

Ammobaculites alaskensis Tappan, 1955, p.43, pl.12, figs.1-10.
Ammobaculites alaskensis Tappan - Souaya, 1976, p.268, pl.5, fig.3.

Remarks: Several specimens of this extremely variable species are found in the present material which come well within the variation range of this species as shown in the original description by Tappan (1955).

Subfamily: FLABELLAMMININAE Podobina, 1978
Genus: *TRIPLASIA* Reuss, 1854

Triplasia althofi jurassica (Myatliuk, 1939)
(Plate 1, fig. 8)

Flabellammina (*Frankeina*?) *jurassica* Myatliuk, 1939, p.47, pl.2, fig.22.
Triplasia althofi jurassica (Myatliuk, 1939) – Bielecka, 1975, p.310, pl.2, figs.6-8; pl.3, fig.1, *et syn.*

Remarks: A number of specimens of this subspecies of

Table 1. List of foraminiferal species recovered from Keera Dome, Kutch

1. *Lagenammina pseudodifflugiformis* Nogan, 1964
2. *Reophax sterkii* Haeusler, 1890
3. *Ammobaculites alaskensis* Tappan, 1955
4. *A. coprolithiformis* (Schwager, 1867)
5. *Ammobaculites* aff. *A. hagni* Bhalla and Abbas, 1978
6. *Ammobaculites* sp.
7. *Triplasia emslandensis* Bartenstein and Brand, 1951
8. *T. althofi jurassica* (Myatliuk, 1939)
9. *Haplophragmium aequale* (Roemer), emend. Bartenstein, 1952
10. *Spirillina polygyrata* Gümbel, 1862
11. *Vinelloidea* aff. *V. bigoti* (Cushman, 1930)
12. *Laevidentalina gümbeli* (Schwager, 1865)
13. *Nodosaria* aff. *N. biloculina* Franke, 1936
14. *N. simplex* (Terquem, 1858)
15. *Pseudonodosaria sowerbyi* (Schwager, 1867)
16. *Lenticulina nodosa* (Reuss, 1863)
17. *L. quenstedti* (Gümbel, 1862)
18. *L. subalata* (Reuss, 1854)
19. *L. varians* (Bornemann, 1854)
20. *Astacolus anceps* (Terquem, 1870)
21. *A. pauperatus* (Jones ad Parker, 1860)
22. *Vaginulinopsis* aff. *V. enodis* Loeblich and Tappan, 1950
23. *Citharina entypomatus* Loeblich and Tappan, 1950
24. *C. zaglobensis* (Bielecka and Pozaryski, 1954)
25. *Citharinella rhomboidea* Loeblich and Tappan, 1950
26. *Planularia tricarinella* (Reuss, 1863)
27. *Vaginulina inspissata* Loeblich and Tappan, 1950
28. *Epistomina alveolata* Myatliuk, 1954
29. *E. mosquensis* Uhlig, 1883
30. *E. stellicostata* Bielecka and Pozaryski, 1954

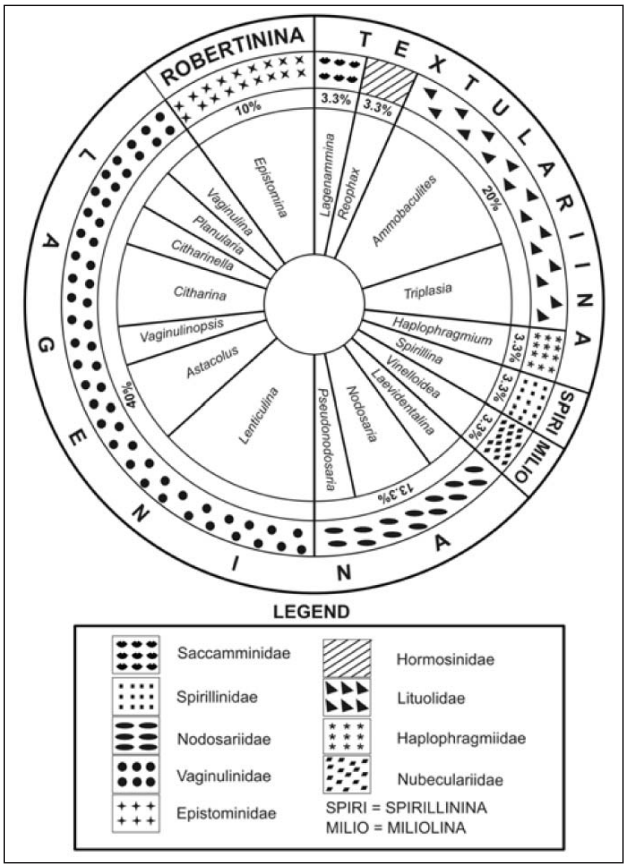

Fig. 3. Composition of the foraminiferal assemblage, Keera Dome, Kutch.

Triplasia are found in our material which closely resemble the original form described by Myatliuk (1939).

Superfamily: HAPLOPHRAGMIACEA Eimer and Fickert, 1899
Family: HAPLOPHRAGMIIDAE Eimer and Fickert, 1899
Genus: *HAPLOPHRAGMIUM* Reuss, 1860

Haplophragmium aequale (Roemer), emend. Bartenstein, 1952
(Plate 1, fig. 9)

Haplophragmium aequale (Roemer), emend. Bartenstein, 1952, p.325, pl.1, figs. 2,11; pl 2, figs.17-26; pl.3, figs.1-6; pl.6, figs.6-8; pl.7, figs.1-2.
Haplophragmium aequale (Roemer), emend. Bartenstein – Neagu, 1965, p.4, pl. 2, fig.1, *et syn.*

Remarks: This species is represented by two specimens in the present assemblage which come well within its variation range as illustrated in the original description by Bartenstein (1952).

Suborder: MILIOLINA Delage and Hérouard, 1896
Superfamily: CORNUSPIRACEA Schultze, 1854
Family: NUBECULARIIDAE Jones, 1875
Subfamily: NUBECULINELLINAE Avnimelech and Reiss, 1954
Genus: *VINELLOIDEA* Canu, 1913

Vinelloidea aff. *V. bigoti* (Cushman, 1930)
(Plate 1, fig. 11)

aff. *Nubeculinella bigoti* Cushman, 1930, p.34; pl.4, figs.2, 3.
aff. *Nubeculinella bigoti* Cushman – Gordon, 1965, p.338, text-fig.11, figs.16-19, *et syn.*
aff. *Nubeculinella bigoti* Cushman - Barnard et al., 1981, p.395, fig.20, text-fig.7, *et syn.*

Remarks: A single broken specimen having affinity with *Vinelloidea bigoti* and having only two chambers was found in our material which shows close resemblance to fig. 14 of Gordon (1965). This is an attached form but Gordon (1965) recovered a number of specimens having

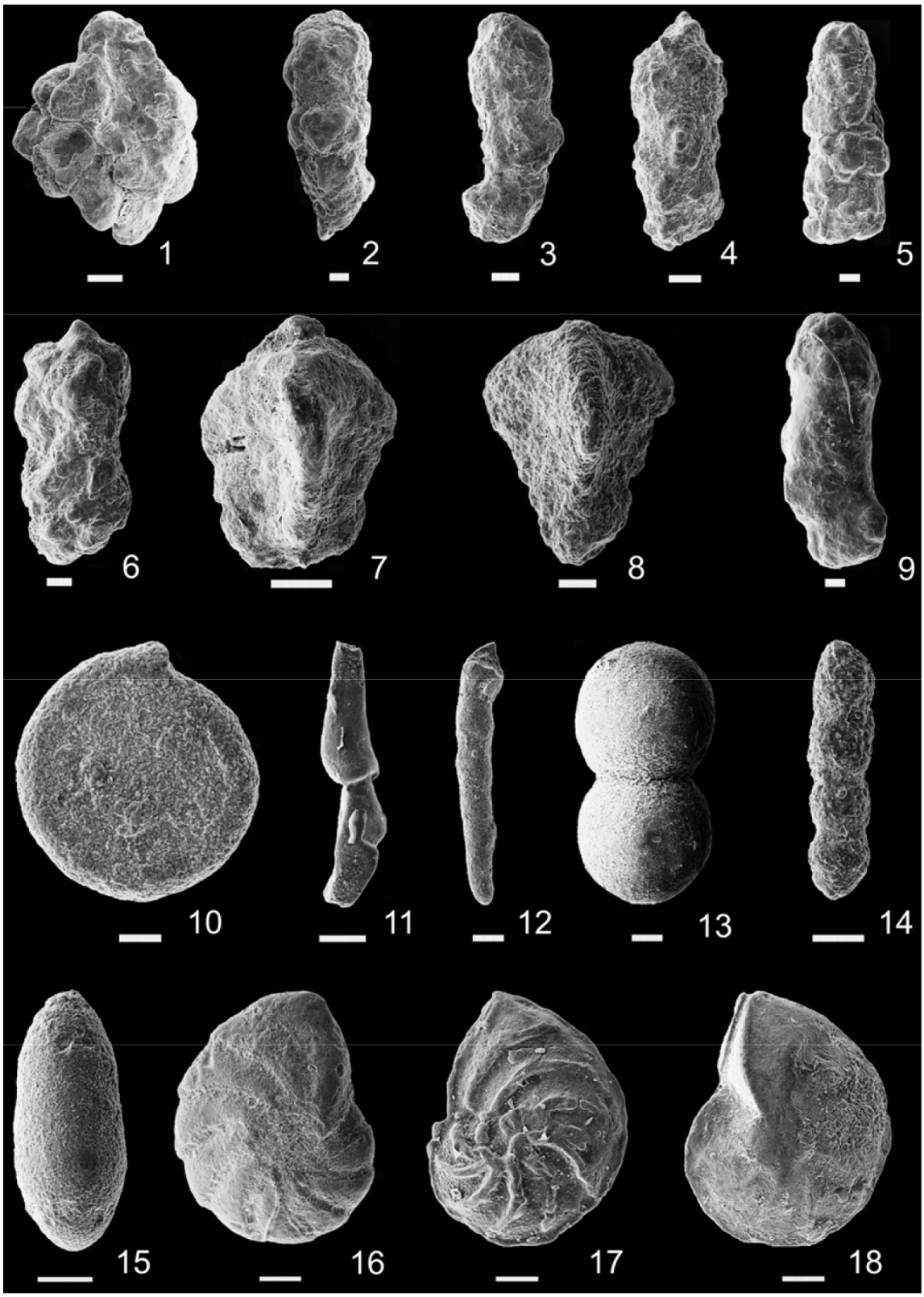

Plate 1. 1. *Lagenammina pseudodifflugiformis,* **2.** *Reophax sterkii,* **3.** *Ammobaculites alaskensis,* **4.** *A. coprolithiformis,* **5.** *A.* aff. *A. hagni,* **6.** *Ammobaculites* sp., **7.** *Triplasia emslandensis,* **8.** *T. althofi jurassica,* **9.** *Haplophragmium aequale,* **10.** *Spirillina polygyrata,* **11.** *Vinelloidea* aff. *V. bigoti,* **12.** *Laevidentalina gümbeli,* **13.** *Nodosaria* aff. *N. biloculina,* **14.** *N. simplex,* **15.** *Pseudonodosaria sowerbyi*, **16.** *Lenticulina nodosa,* **17.** *L. qünstedti,* **18.** *L. subalata*. (Bar scale = 100 µm)

chambers with circular cross-section and remarked that this suggests non-adherent nature of the adult test. Our specimen appears to be part of an adult test as the chambers show circular cross-section. The original species was reported by Cushman (1930) from Oxfordian but Adams (1962) gave its range from ?lower Lias, upper Lias to Kimmeridgin. However, Loeblich and Tappan (1988) considered genus *Vinelloidea,* a senior synonym of *Nubeculinella*, restricted to Oxfordian. This genus is being reported for the first time from the Indian region.

Suborder: LAGENINA Delage and Hérouard, 1896
Superfamily: NODOSARIACEA Ehrenberg, 1838
Family: VAGINULINIDAE Reuss, 1860
Subfamily: VAGINULININAE Reuss, 1860
Genus: *CITHARINA* d'Orbigny, 1839

Citharina entypomatus Loeblich and Tappan, 1950
(Plate 2, fig. 5)

Citharina entypomatus Loeblich and Tappan, 1950, p.57, pl.15, figs.1-12.
Vaginulina entypomatus (Loeblich and Tappan) - Espitalie and Sigal, 1963, pl. 20, fig.11.
Citharina entypomatus Loeblich and Tappan - Kottachchi et al., 2002, p.118, fig. 22 (5).

Remarks: Two specimens of this species originally described from the Oxfordian of South Dakota by Loeblich and Tappan (1950) were recovered from the Keera Dome. Our forms are closer to the one figured by Kottachchi et al. (2002).

Citharina zaglobensis (Bielecka and Pozaryski, 1954)
(Plate 2, fig. 6)

Vaginulina zaglobensis Bielecka and Pozaryski, 1954, p.42, pl.6, fig.23a, b.
Citharina zaglobensis (Bielecka and Pozaryski) - Bielecka, 1975, p.329, pl.5, figs.13, 14, *et syn.*

Remarks: Several specimens showing close resemblance to the original form as well as those described by Bielecka (1975) are found in our material. This species differs from *Citharina parallela* in having a thinner test, more number of chambers and ribs, and presence of intercalary ribs.

FORAMINIFERAL DATING

Jurassic foraminifera of the Indian region are rather long ranging and unreliable for biostratigraphic analysis (Bhalla and Abbas, 1976; Kalia and Chowdhury, 1983; Bhalla and Talib, 1991; Talib et al., 2007; Talib and Gaur, 2008; Gaur and Talib, 2009). Ammonites have proved to be more useful for Jurassic biostratigraphy in India, although Jurassic foraminifers have proved their biostratigraphic worth in other parts of the world, especially in lower Jurassic where they sometimes even compete with ammonites in biostratigraphic utility (Herrero et al., 1996). However, the present foraminiferal assemblage contains some fairly short ranging species either restricted to or frequently reported from Callovian to Oxfordian strata. These include *Ammobaculites* aff. *A. hagni, Spirillina polygyrata, Laevidentalina gümbeli, Lenticulina varians,* and *Citharina rhomboidea.*

Ammobaculites hagni has been reported from the Callovian-Oxfordian sediments exposed in various domes of the Kutch region (Bhalla and Abbas, 1978; Talib and Faisal, 2006, 2007). *Spirillina polygyrata* though long ranging has been recorded from Callovian-Oxfordian of Kutch (Bhalla and Abbas, 1978; Bhalla and Talib, 1991; Pandey and Dave, 1993; Talib and Faisal, 2006, 2007; Gaur and Talib, 2009). *Lenticulina varians* is also reported from Callovian-Oxfordian of Kutch (Bhalla and Abbas, 1978; Bhalla and Talib, 1991; Gaur and Talib, 2009). *Citharina rhomboidea* has a restricted vertical range from Callovian to Oxfordian in different parts of the world (Talib and Gaur, 2008) Therefore, in view of the occurrence of these species in the present foraminiferal assemblage a Callovian to Oxfordian age is assigned to the Chari Formation exposed at Keera Dome, Kutch.

PALAEOENVIRONMENT

Foraminifera are extremely sensitive to environmental fluctuations and are used worldwide as reliable palaeoecological indicators. The Keera Dome foraminiferal assemblage is dominated by the family Vaginulinidae and includes mostly calcareous hyaline and agglutinated forms, the former overwhelmingly dominating (70%), while porcelaneous form is represented by a single species. The dominance of Vaginulinids indicates shallow water, open marine shelf environment (Barnard, 1948; Coleman, 1981; Bhalla and Abbas, 1984; Bhalla and Talib, 1991; Talib and Gaur, 2005; Gaur and Talib, 2009). Near absence of porcelaneous forms excludes proximity to inner shelf as porcelaneous tests, as a rule, are typical for inner shelf except for genera *Pyrgo* and *Biloculinella* which are reported from abyssal depths (Valchev, 2003). The present assemblage, therefore, appears to belong to mid to outer shelf

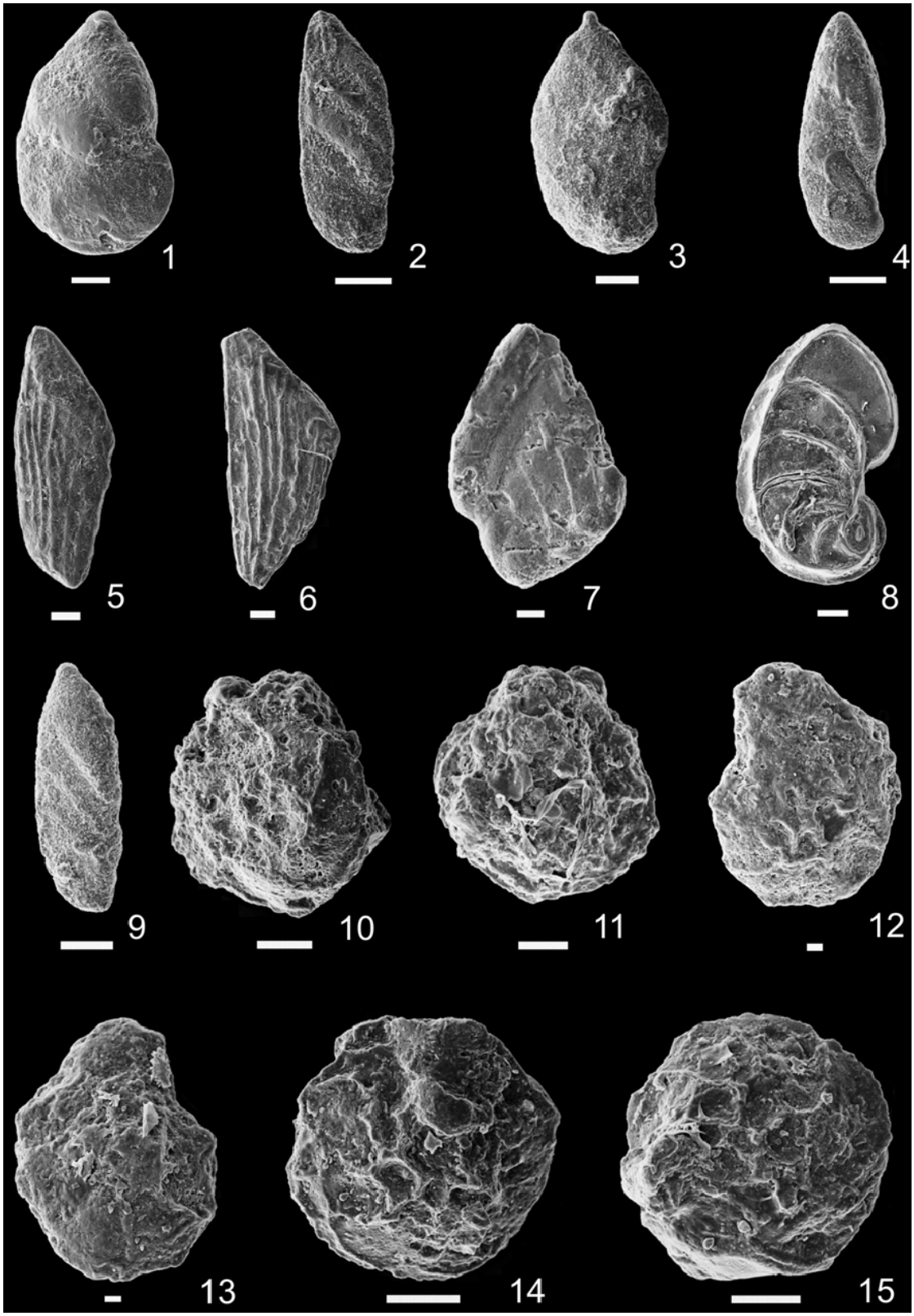

Plate 2. **1.** *Lenticulina varians,* **2.** *Astacolus anceps,* **3.** *A. pauperatus,* **4.** *Vaginulinopsis* aff. *V. enodis,* **5.** *Citharina entypomatus*, **6.** *C. zaglobensis*, **7.** *Citharinella rhomboidea*, **8.** *Planularia tricarinella*, **9.** *Vaginulina inspissata,* **10-11.** *Epistomina alveolata*, **10,** dorsal view; **11,** ventral view; **12-13.** *E. mosquensis*, **12,** dorsal view; **13,** ventral view; **14-15.** *E. stellicostata,* **14,** dorsal view; **15,** ventral view. (Bar scale = 100 μm).

Table 2. Distribution of dominant morphogroups (*after* Reolid et al., 2008) in the Chari sequence, Keera Dome, Kutch

Sample No.	Dominant Morphogroup	Sample No.	Dominant Morphogroup
Kr-7.2	J2	Kr-3.5	Nil
Kr-7.1	J2	Kr-3.4	J1
Kr-6.3	Nil	Kr-3.3	J2
Kr-6.2	G	Kr-3.2	J1
Kr-6.1	G	Kr-3.1	J2
Kr-5.2	C2	Kr-2.3	Nil
Kr-5.1	C2, C3	Kr-2.2	Nil
Kr-4.4	C3, K	Kr-2.1	Nil
Kr-4.3	C3	Kr-1.2	Foraminifera
Kr-4.2	C2, K		absent
Kr-4.1	Nil	Kr-1.1	Foraminifera absent

environment. Dominance of hyaline species further supports normal salinity. Dominance of infaunal genera such as *Lenticulina, Reophax, Vaginulinopsis* and *Vaginulina* supports well-oxygenated waters. *Lenticulina* followed by *Ammobaculites* is the most abundant genus in the present assemblage (Table 1). The Keera Dome foraminiferal assemblage commonly contains morphogroup J2 of Reolid et al. (2008) (Table 2) which includes flattened forms with shallow infaunal microhabitat and active deposit feeder and grazing omnivore trophic behaviour. Presence of unornamented species of the genera belonging to this morphogroup indicates normal dissolved oxygen for the present foraminiferal assemblage (Bernhard, 1986). The foraminiferal assemblage, therefore, suggests that the Chari sequence exposed at Keera Dome, Kutch accumulated in an open marine environment of mid to outer shelf having normal salinity and well oxygenated water.

Acknowledgement: We are grateful to Chairman, Department of Geology, A.M.U., Aligarh, for providing various facilities. Thanks are also due to Director, WIHG, Dehradun for permission to work in SEM Laboratory of the Institute. Logistic support during the field work provided by the district authorities of Kutch is gratefully acknowledged.

References

Adams, C.G. (1962) Calcareous adherent foraminifera from the British Jurassic and Cretaceous and the French Eocene. Palaeontology, v. 5, pp.149-170.

Barnard, T. (1948) The uses of foraminifera in Lower Jurassic stratigraphy. Rept. Int. Geol. Cong., 18th Sess., v.15, pp.3-10.

Bartenstein, H. (1952) Taxonomische Bemerkungen zu den *Ammobaculites, Haplophragmium, Lituola* und verwandten Gattungen (For.). Senckenbergiana, v.33(4/6), pp.313-342.

Bernhard, J.M. (1986) Characteristic assemblages and morphologies of benthic foraminifera from anoxic, organic-rich deposits: Jurassic through Holocene. Jour. Foram. Res., v.16(3), pp.207-215.

Bhalla, S.N. and Abbas, S.M. (1976) The age and paleogeographical significance of Jurassic Foraminifera from Kutch: *In:* 1st Int. Symp. Benthonic Foraminifera of Continental Margins. Maritime Sediments, Spec. Publ., v.1(B), pp.537-544.

Bhalla, S.N. and Abbas, S.M. (1978) Jurassic foraminifera from Kutch, India. Micropaleontology, v.24(2), pp.160-209.

Bhalla, S.N. and Abbas, S.M. (1984) Depositional environment of the Jurassic rocks of Habo hill, Kutch, India. *In:* Benthos'83: Proc. 2nd Int. Symp. Benthic Foram., pp.55-60.

Bhalla, S.N. and Talib, A. (1991) Callovian-Oxfordian foraminifera from Jhurio hill, Kutch, Western India. Rev. Palèobiol., v.10(1), pp.85-114.

Bielecka, W. (1975) Foraminifera and brackish ostracoda from the Portlandian of Polish lowlands. Acta Palaeontol. Polonica, v.20(3), pp.296-393.

Biswas, S.K. (1977) Mesozoic Rock-Stratigraphy of Kutch, Gujarat. Bull. Geol. Min. Met. Soc. India, v.49, pp.1-52.

Coleman, B. (1981) The Bajocian to Callovian. *In:* D.G. Jenkins and J.W. Murray (Eds.), Stratigraphic Atlas of Fossil Foraminifera. Ellis-Horwood Ltd., Chichester, pp.106-124.

Cushman, J.A. (1930) Note sur quelques foraminifers Jurassiques d'Auberville (Calvados). Bull. Soc. Linn. Normandie, v.2, pp.132-135.

Gaur, K.N. and Talib, A. (2009) Middle-Upper Jurassic foraminifera from Jumara Hills, Kutch, India. Rev. Micropalaeontol., v.52, pp.227-248.

Gordon, W.A. (1965) Foraminifera from the Corallian Beds, Upper Jurassic of Dorset, England. Jour. Paleontol., v.39(5), pp.828-863.

Gordon, W.A. (1967) Foraminifera from the Callovian (Middle Jurassic) of Barora, Scotland. Micropaleontology, v.13, pp.445-464.

Herrero, C., Copestake, P. and Johnson, B. (1996) *Saracenella mochrasensis* sp. nov. (Foraminiferida), a regional biostratigraphic marker species for Upper Toarcian (Jurassic) of Europe. J. Foraminifer. Res., v.26 (3), pp.187-192.

Kalia, P. and Chowdhury, S. (1983) Foraminiferal biostratigraphy, biogeography, and environment of Callovian sequence, Rajasthan, northwestern India. Micropaleontology, v.29 (3), pp.223-253.

Khosla, S.C., Jakhar, S.R. and Mohammed, M.H. (1997) Ostracodes from the Jurassic rocks of Habo hill, Kachchh, Gujarat. Micropaleontology, v.43 (1), pp.1-39.

Khosla, S.C., Jakhar, S.R. and Mohammed, M.H. (2004) Ostracodes from the Jurassic beds of Jhura hill, Kachchh,

Gujarat. Jour. Geol. Soc. India, v.63, pp.15-28.

KHOSLA, S.C., KUMARI, M., FLEX, A.D., JAKHAR, S.R. and NAGORI, M.L. (2005) Middle Jurassic ostracodes from the northern Island belt, Rann of Kachchh, Gujarat, India. Jour. Palaeontol. Soc. India, v.50 (1), pp.7-64.

KOTTACHCHI, N., SCHRÖDER-ADAMS, C.J., HAGGART, J.W. and TIPPER, H.W. (2002) Jurassic foraminifera from the Queen Charlotte Islands, British Columbia, Canada: biostratigraphy, paleoenvironments and paleogeographic implications. Palaeogeogr., Palaeoclimatol., Palaeoecol., v.180, pp.93-127.

KUMAR, R. (1985) Fundamentals of Historical Geology and Stratigraphy of India. Wiley Eastern Limited, 1st Edn., 254p.

LOEBLICH, A.R. JR. and TAPPAN, H. (1950) North American Jurassic foraminifera: 1. The type Red Water Shale (Oxfordian) of South Dakota. Jour. Paleontol., v.24(1), pp.39-60.

LOEBLICH, A.R. JR. and TAPPAN, H. (1988) Foraminiferal genera and their classification. Van Nostrand Reinhold Company, 970p.

MYATLIUK, E.V. (1939) Foraminifera from the Upper Jurassic and Lower Cretaceous deposits of the Middle Volga region and Obshchyi Syrt. Trans. Oil Geol. Inst., Leningrad, A(120), pp.3-76.

NOGAN, D.S. (1964) Foraminifera, stratigraphy, and paleoecology of the Aquia Formation of Maryland and Virginia. Cushman Found. Foraminifer. Res., Spec. Publ., v.7, pp.19-20.

PANDEY, J. and DAVE, A. (1993) Studies in Mesozoic foraminifera and chronostratigraphy of Western Kutch, Gujarat. Paleontographica Indica, v.1, pp.1-221.

REOLID, M., RODRÍGUEZ-TOVAR, F.J., NAGY, J. and OLÓRIZ, F. (2008) Benthic foraminiferal morphogroups of mid to outer shelf environments of the Late Jurassic (Prebetic Zone, southern Spain): Characterization of biofacies and environmental significance. Palaeogeogr., Palaeoclimatol., Palaeoecol., v.261, pp.280-299.

SASTRY, M.V.A. and MAMGAIN, V.D. (1971) The marine Mesozoic formations of India. Rec. Geol. Surv. India, v.101(2), pp.62-177.

TALIB, A. and FAISAL, S.M.S. (2006) A preliminary note on the occurrence of foraminifera in the Middle to Upper Jurassic sediments of Fakirwari, Kutch Mainland, Gujarat. Jour. Geol. Soc. India, v.68, pp.963-966.

TALIB, A. and FAISAL, S.M.S. (2007) On the occurrence of microfossils (Foraminiferida) in the Jurassic rocks of Ler Dome, Kutch Mainland, Gujarat. Curr. Sci., v.92(5), pp.595-596.

TALIB, A. and GAUR, K.N. (2005) Foraminiferal palaeoecology, microfacies and palaeoenvironment of the Middle-Upper Jurassic sequence, Jumara hills, western Kutch. Indian Jour. Pet. Geol., v.14(2), pp.9-21.

TALIB, A. and GAUR, K.N. (2008) Foraminiferal composition and age of the Chari Formation, Jumara Dome, Kutch. Curr. Sci., v.95(3), pp.367-373.

TALIB, A., GAUR, K.N. and BHALLA, S.N. (2007) Callovian-Oxfordian boundary in Kutch Mainland, India - A foraminiferal approach. Rev. Palèobiol., v.26 (2), pp.625-630.

TAPPAN, H. (1955) Foraminifera from the Arctic slope of Alaska: Part 2, Jurassic foraminifera. U.S. Geol. Survey, Prof. Paper, v.236 (B), pp.21-90.

VALCHEV, B. (2003) On the potential of small benthic foraminifera as paleoecological indicators: Recent advances. 50 years University of Mining and Geology "St. Ivan Rilski" Ann., Geol. Geophys., v.46, pp.189-194.

WAAGEN, W. (1873-75) Jurassic fauna of Kutch. The Cephalopoda. Pal. Ind., Geol. Surv. India, Ser.9, v.i.

(Received: 16 February 2012; Revised form accepted: 9 May 2012)