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Middle Bathonian Foraminifers from the Patcham Formation, Jumara Dome, Kachchh, western India

S. Gupta and S.K. Singh
Department of Geology, University of Lucknow, Lucknow, U.P., India

ABSTRACT

The Patcham Shell Limestone and Coral Limestone of Jumara Dome have yielded a rich foraminiferal assemblage including species of *Garantella, Epistomina, Reinholdella, Pseudomarssonella,* and *Reyadhella.* On this basis middle Bathonian age is assigned to the fossil yielding basal part (Patcham Shell - Coral Limestone) of the Jumara Dome.

INTRODUCTION

In India, marine fossiliferous rocks of middle to late Jurassic age are developed in a series of domes in the mainland of Kachchh, western India. One of these domes, the Jumara Dome (Fig. 1), lying in the north of Village Jumara, has been studied in detail during the present course of study.

The sediments exposed there have yielded a fascinating suite of invertebrates including ostracods, holothurians, sclerities, ammonites, corals, echinoid fragments, bryozoans, foraminifers and micro gastropods. The foraminifers, which were studied in detail have proved to be an excellent tool for precise age determination.

In the present work an attempt has been made to precisely date the basal most sediments exposed in the centre of the dome on the basis of index foraminifers. These sediments were thought to be of considerable interest as various researchers gave different ages to the sequence on their observations on palaeontological and sedimentological aspects (Table 1).

A detailed study of foraminiferal assemblage, obtained from the above mentioned area has

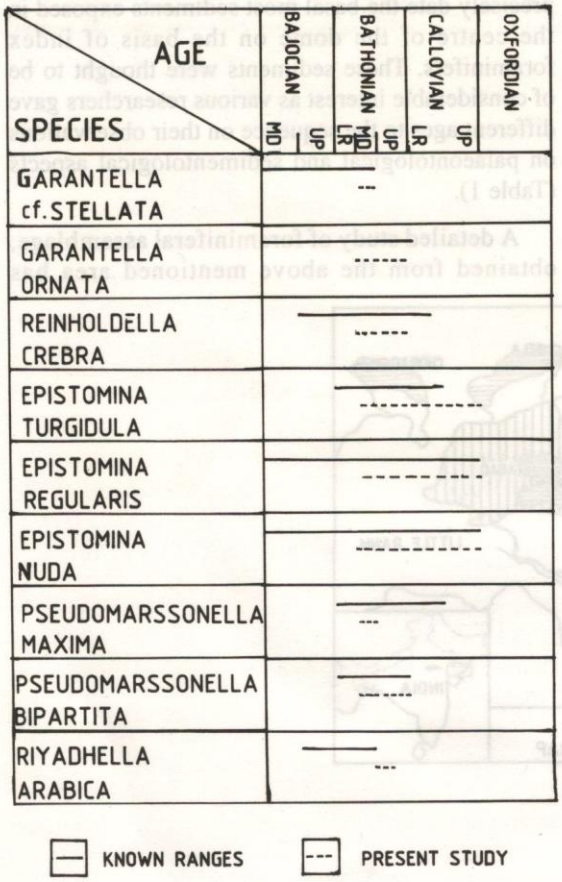
Fig 1: Location Map of Jumara Dome.

Table 1: Geological age of sediments exposed at Jumara Dome.

Researchers	Age	Bases
Gregory (1900)	Bathonian - Callovian	Corals
Spath (1927-33)	Lower Bathonian - Divesian	Lithology and Ammonites
Rajnath (1932)	Bathonian - Callovian	Lithology and Ammonites
Arkell (1956)	Lower Callovian	Ammonites
Pascoe (1959)	Upper Bathonian - Callovian	Invertebrates
Ghosh (1969)	(?) Middle Bathonian - Callovian	Invertebrates
Biswas (1971, 1977)	Bathonian - Callovian	Lithology
Guha (1973)	Bathonian - Callovian	Foraminifers and Ostrocodes
Soodan (1975)	Bathonian - Callovian	Holothuroids
Krishna et al. (1987)	Upper Bathonian - Callovian	Corals and Ammonites
Govindan et al. (1988)	Callovian - Oxfordian	Foraminifers

revealed the presence of eight characteristic foraminiferal species (Table 2) which belong to genera *Epistomina, Garantella, Reinholdella, Pseudomarssonella*, and *Riyadhella,* out of which three species have been recorded for the first time from the Jurassic rocks of Kachchh mainland. On the basis of the obtained assemblage, middle Bathonian age has been assigned to the basalmost sediments of Patcham Formation, exposed in the centre of the Jumara Dome, Kachchh.

Table 2: List of index forams.



Bhalla in collaboration with workers has done a detailed micropaleontological study of many parts of Kachchh based mainly on foraminifers. Bhalla and Abbas (1975, 1978) worked on Habo Hill, Bhalla and Talib (1978, 1980) near Badi village on Chari "series" and Bhalla and Lal (1985) on Chari series of Kalya Hill, but each time they claimed Callovian-Oxfordian age for the investigated sequences. Further, Mandwal and Singh (1989) assigned Bathonian age to the lower most sediments exposed at Jhurio Hill, which were previously considered as Callovian by Bhalla and Talib (1985).

STRATIGRAPHY

Stoliczka's unpublished four fold (Patcham, Chari, Katrol and Umia Groups) lithostratigraphic scheme (first used in Waagen, 1875) for Kachchh mainland has been adopted in the present work with minor modifications within its basic framework done by Krishna et al. (1983). The upper part of the Patcham Formation is present in the centre of the dome as an elliptical outcrop, represented by brownish-yellow shell coral limestone and a thick sequence of greyish white calcareous clay. Base is not exposed. The sequence has rich presentation of mega as well as microfossils (Fig. 2).

Systematic Descriptions

Superfamily CERATOBULIMINACEA Cushman, 1927

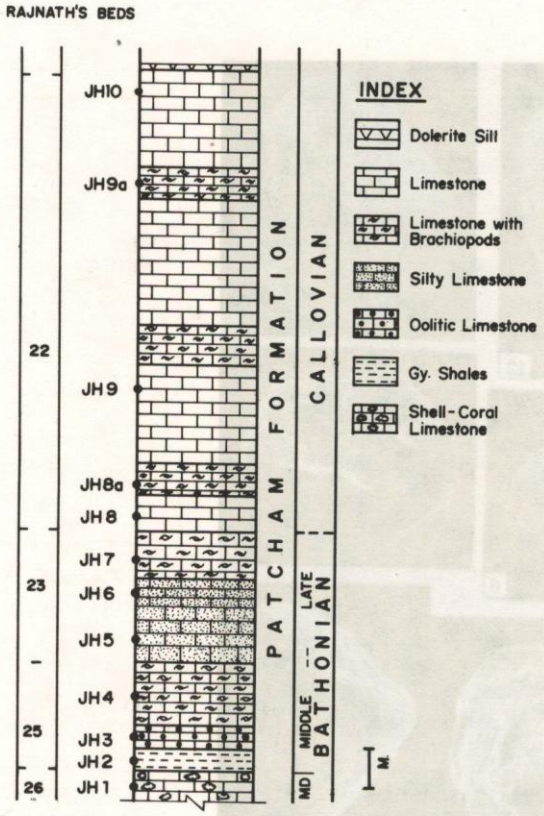


Fig 2: Lithology of Patcham Formation at Jumara Dome.

Family EPISTOMINIDAE Wedekind, 1937 Emend, Brotzen, 1942

Subfamily GARANTELLINAE Grigelis, 1977

Genus GARANTELLA Kaptarenko and Chernousova, 1956

Garantella cf. G. stellata: Kaptarenko and Chernousova, 1959, Pl. 1, Fig. 5-7

Garantella stellata Kaptarenko and Chernousova, 1959, P. 105-106, Pl. 13, Fig. 5a-c

Garantella cf. G. stellata Espitalie and Sigal, 1963, P. 115, Pl. 2, Fig. 7a-c, Mandwal and Singh, 1989, P. 46, Pl. 1, Fig. 4-7

Material: 8 specimens

Dimensions:

Diameter of test: 0.30 mm to 0.40 mm

Thickness of test: 0.15 mm to 0.25 mm

Remarks: The well preserved specimens are characterized by ridge like bordering of aperture. The Kachchh forms differ from the Madagascar forms in having slightly bigger test and more prominent ridge bordering the apertures.

Specimen Number: LUGD / 0098 - 000101

Occurrence and Age: Patcham Formation, Bathonian.

Garantella ornata Hofker, 1952, Pl. 1, Fig. 1-4, 14

Reinholdella ornata Hofker, 1952, P. 24, Fig. 12-16

Garantella floscula Kaptarenko and Chernousova, 1956, P. 104, Pl. 13, Fig. 4

Garantella ornata Hofker: Pazdro, 1969, P. 79-80, Pl. 10, Fig. 1-3, 6, Pl. 11, Fig. 2, Pl. 15, Fig. 3-4. Mandwal and Singh, 1989, P. 46, Pl. 1, Fig. 8-10

Material: 80 specimens

Dimensions:

Diameter of test: 8.35 mm to 0.50 mm

Thickness of test: 0.17 mm to 0.30 mm

Remarks: The present forms resemble with the forms described by Pazdro (1969) from Bajocian to lower Bathonian of Poland. In the present assemblage both sinistral and dextral forms are present. The dextral forms dominate over sinistral forms as out of 80 specimens, 50 are dextral. Pazdro (1969) described biconvex forms from Poland but during present investigation rare forms with compressed test are also encountered.

Specimen Number: LUGD / 00094 - 00097

Occurrence and Age: Patcham Formation, Bathonian

Genus REINHOLDELLA Brotzen, 1948

Reinholdella crebra Pazdro, 1969 Pl. 1, Fig. 8-11

Reinholdella crebra Pazdro, 1969, Pg. 69-70, Pl. VIII, Fig. 1-3, Pl. XII, Fig. 1-2, Pl. XIV, Fig. 7-8, Pl. XV, Fig. 1-2 Gradstein, 1978, Pg. 100, Pl. 2, Fig. 1a-c.

Material: 7 specimen

Dimension:

Diameter of test: 0.19 mm

Thickness of test: 0.11 mm

Remarks: Well preserved forms in the present assemblage resembles *R. crebra* Pazdro (1969) in overall morphology. Dorsal side is convex and ventral side is nearly flat. Altogether 16 chambers

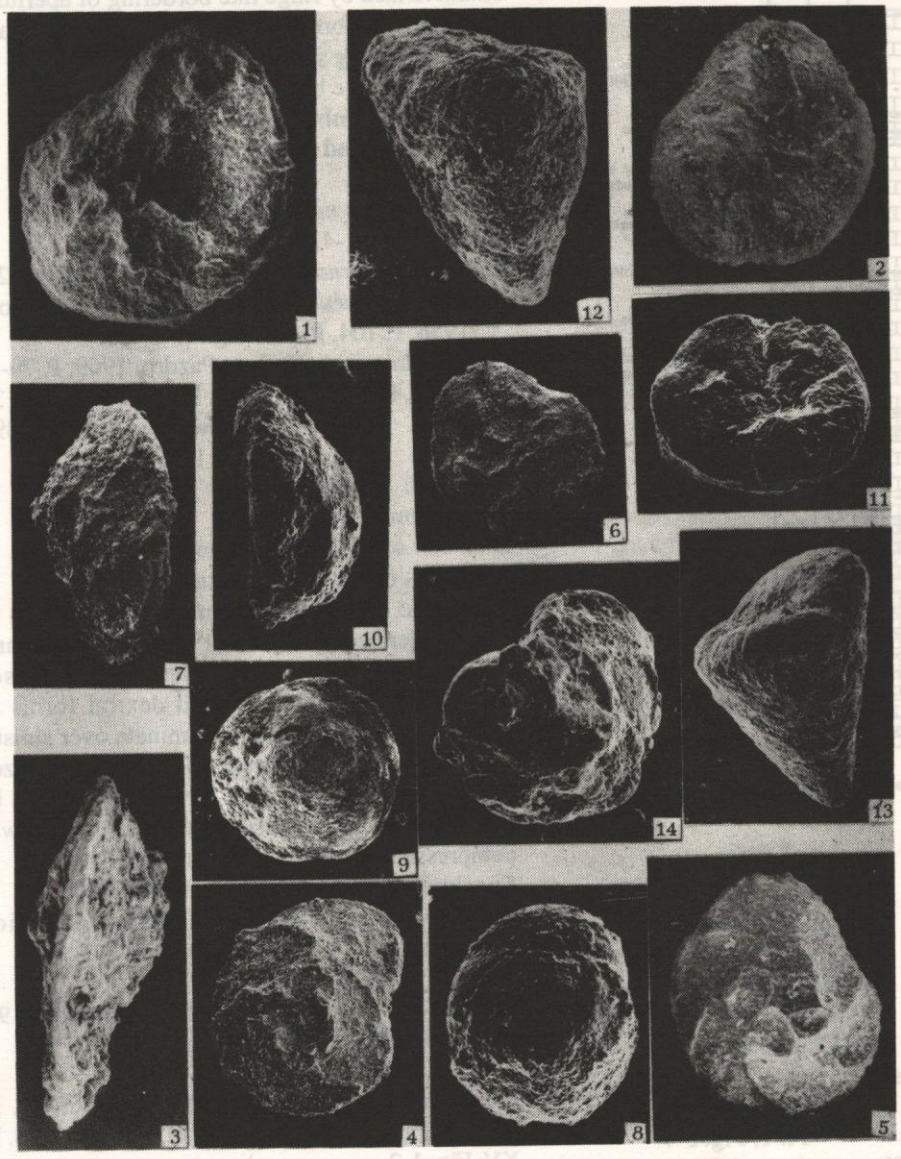


Plate 1

1-4 Garantella ornata
1. **Ventral view** x 150
2. **Ventral view** x 100
3. **Dorsal view** x 100
4. **Edge view** x 100

5-7 Garantella **cf.** G. stellata
5. **Ventral view** x 150
6. **Dorsal view** x 100
7. **Edge view** x 100

8-11 Reinholdella crebra
8. **Dorsal view** x 200
9. **Dorsal view** x 200
10. **Edge view** x 350
11. **Apertural view** x 350

12 Pseudomarssonella bipartita
12. **Side view** x 350

13. Pseudomarssonella maxima
13. **Side view** x 200

14. Garantella ornata
14. **Dorsal view** x 350

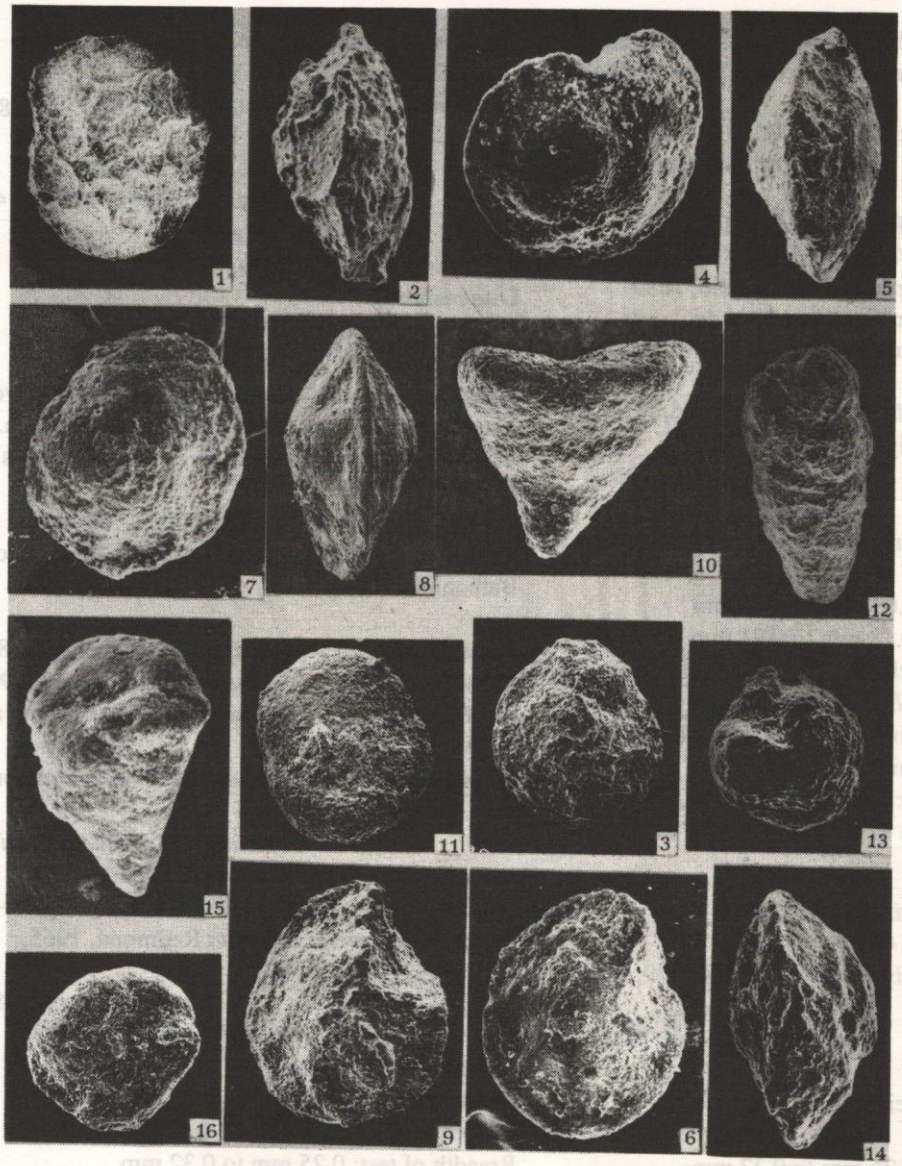


Plate 2

1-3 Epistomina regularis
1. Dorsal view x 200
2. Edge view x 100
3. Ventral view x 150

4-6 Epistomina turgidula
4. Dorsal view x 350
5. Edge view x 200
6. Ventral view x 150

7-9 Epistomina nuda
7. Dorsal view x 150
8. Edge view x 150
9. Ventral view x 200

10-11 Pseudomarssonella bipartita
10. Side view x 350
11. Apertural view x 500

12-13 Riyadhella arabica
12. Side view x 350
13. Apertural view x 500

14. Epistomina regularis
14. Edge view x 350

15-16 Pseudomarssonella maxima
15. Side view x 200
16. Apertural view x 350

in three complete whorls are present. This species is being described for the first time from Kachchh basin.

Specimen number: LUGD / 000101 - 000102

Occurrence and Age: Patcham Formation, Bathonian

Subfamily EPISTOMININAE Wedekind, 1937

Genus *Epistomina* Terquem, 1883

Epistomina turgidula Pazdro, 1969
Pl. 2, Fig. 4-6

Epistomina turgidula Pazdro, 1969, P. 66, Pl. 7, Fig. 1; Pl. 14, Fig. 3-4, text-fig. 12.
Mandwal and Singh, 1989, P. 46-47, Pl. 1, Fig. 1-3.

Material: 50 specimens

Dimensions:
Diameter of test: 0.03 mm to 0.36 mm
Thickness of test: 0.18 mm to 0.21 mm

Remarks: The Kachchh specimens fall within the variation range of *E. turgidula* Pazdro (1969) but forms are abundant in Kachchh material, though they were rare in Bathonian of Poland.

Specimen number: LUGD / 00081 - 00083

Occurrence and Age: Patcham Formation, Bathonian

Epistomina regularis Terquem, 1886
Pl. 2, Fig. 1-3, 14

Epistomina regularis Terquem, 1883, P. 379, Pl. 44, Fig. 1-2, monfig. 3
Mandwal and Singh, 1989, P. 47, Pl. 11, Fig. 1-3

Material: 200 specimens

Dimensions:
Diameter of test: 0.26 mm to 0.37 mm
Thickness of test: 0.20 mm to 0.25 mm

Remarks: The specimens of *E. regularis* Terquem (1883) from Kachchh correspond well with the specimens from the middle Jurassic of Poland (Pazdro, 1969). Specimens with feeble ornamentation on ventral side are also present which have resemblance with the specimens described by Garg (1983) from Bathonian of Jaisalmer.

Specimen number: LUGD / 00084 - 00086

Occurrence and Age: Patcham Formation, Bathonian

Epistomina nuda Terquem, 1883
Pl. 2, Fig. 7-9

Epistomina nuda Terquem, 1883, P.376, Pl.5, Fig. 1
Pazdro, 1969, P. 62-64, Pl. 6, Fig. 1-3, 6-8, Pl. 4, Fig. 6
Mandwal and Singh, 1989, P. 47, Pl. 1, Fig. 11-14

Material: 150 specimens

Dimensions:
Diameter of test: 0.20 mm to 0.39 mm
Thickness of test:0.08 mm to 0.17 mm

Remarks: *E. nuda* Terquem (1883) is a relatively long ranging species from Bajocian to Callovian. it was originally described from Parkinsonia beds of France.

Specimen number: LUGD / 00087 - 00089

Occurrence and Age: Patcham Formation, Bathonian

Superfamily *Textulariacea* Ehrenberg, 1838

Family *Chrysalidinidae* Neagu, 1968

Subfamily *Paravalvulininae* Bnner et al., 1991

Genus *Pseudomarssonella* Redmond, 1965

Pseudomarssonella bipartita Redmond, 1965
Pl. 1, Fig. 12, Pl. 2, Fig. 10-11

Pseudomarssonella bipartita Redmond, 1965, P. 134, Pl. 1, Fig. 2-3
Garg and Singh, 1983, P. 201, Pl. 1, Fig. 13-15

Material: 11 specimens

Dimensions:
Length of test: 0.03 mm to 0.20 mm
Breadth of test: 0.25 mm to 0.32 mm

Remarks: The Kachchh specimens attributed to *P. bipartita* Redmond (1965) commonly display four to four and a half chambers in the final whorl, initial portion of the test is narrow. Arabian specimens have five chambers in their final whorl and have stout initial portion of the test.

Specimen number: LUGD / 000106 - 000108

Occurrence and Age: Patcham Formation, Bathonian

Pseudomarssonella maxima Redmond, 1965
P. 11, Fig. 13, Pl. 2, Fig. 15-16

Pseudomarssonella maxima Redmond, 1965, P. 133, Pl. 1, Figs. 6-7

Banner et al., 1991, P. 137, Fig. 71-72

Material: 3 specimens
Dimensions:
Length of test: 0.28 mm to 0.30 mm
Breadth of test: 0.11 mm to 0.13 mm
Remarks: The specimens from Kachchh are referable to *P. maxima* due to their high trochospiral, conical test. They differ from the Arabian specimens in having smaller test and 3-4 whorls against 5 to 6 whorls. This species is being reported for the first time from the Kachchh region.
Specimen number: LUGD / 000109 - 000111
Occurrence and Age: Patcham Formation, Bathonian

Genus *Riyadhella*

Riyadhella arabica Redmond, 1965, Pl. 2, Figs. 12-13

Riyadhella arabica Redmond, 1965, P. 136, Pl. 1, Figs. 3-5,

Garg and Singh, 1983, P. 210, Pl. 8, Figs. 6-7

Banner et al., 1991, P.132, Fig. 66

Material: 1 (one) specimen
Dimensions:
Length of test: 0.4 mm
Breadth of test: 0.3 mm
Remarks: Solitary specimen of *Riyadhella arabica* Redmond found in Kachchh assemblage differs in having smaller test with slightly depressed and distinct sutures against flush sutures in holo-type described from Saudi Arabia (Redmond, 1965). This species is being recorded for the first time from the Kachchh mainland.
Specimen number: LUGD / 00093
Occurrence and Age: Patcham Formation - Bathonian.

DISCUSSION AND CONCLUSIONS

The ammonoid based stratigraphy in the Mesozoic basin of Kachchh has world wide acceptance and validity. However, foraminiferal species of *Epistomina* and *Garantella* are extensively used as zonal markers in global correlation of Jurassic sequences (Ascoli, 1976, Gradstein, 1976, 1978, and Williamson and Stam, 1988).

Gradstein (1976,1978), constructed "*Garantella* spp. zone" incorporating *Garantella stellata* and *G. ornata* with other species of *Garantella* and assigned Bajocian to early Bathonian age for the sediments encountered from Grand Banks. Ascoli (1976) recognized "*Garantella ornata* zone" from the sediments of Scotian Shelf and correlating it with Gradstein's "*Garantella* spp. zone" assigned an early Bathonian age. Occurrence of *Garantella stellata* (Middle Bajocian to Middle Bathonian) and *G. ornata* (Middle Bajocian to ?Callovian) from Shell - Coral Limestone sequence of Patcham Formation (JH1) of Jumara Dome favours Middle Bathonian age assignment.

Further, Redmond (1965), recorded several agglutinated foraminifers from the middle and upper Jurassic rocks of Saudi Arabia. According to him stratigraphic value of genus *Pseudomarssonella* and *Riyadhella* is well recognized in the middle Jurassic rocks of Saudi Arabia and they have been utilized for inter-regional zonation and correlation of the various lithostratigraphic units. The genera *Pseudomarssonella* and *Riyadhella* were recorded from the uppermost Bajocian to basal Callovian of Saudi Arabia, with maximum development during the Bathonian. Garg and Singh (1983), recorded several species of *Pseudomarssonella* and *Riyadhella* viz.: *Pseudomarssonella reflexa*, *P. biangulata*, *P. media*, *P. bipartita*, *P. inflata*, *P. primitiva*, *P. fenderina inflata*, *P. cf. P. gracilis*, *Riyadhella elongata*, *R. rotundata*, *R. arabica*, *R. intermedia*, *R. regularis*, *R. cf. R. nana* with *Epitomina turgidula* and *E. regularis* from middle to upper Bathonian rocks of Jaisalmer Formation, Rajasthan. Mandwal and Singh (1989) also recorded *Pseudomarssonella inflata*, *P. reflexa*, *P. primitiva*, *P. biangulata*, *Riyadhella elongata*, with species of *Epistominids*, *E. regularis*, *E. turgidula*, *E. nuda*, from the sediments exposed at lower part of Jhurio Hill, Kachchh and assigned a Bathonian age. Foraminiferal species of *Pseudomarssonella biparteta*, *P. maxima*, *Riyadhella arabica* along with index forms of Superfamily *Ceratobuliminacea* again provides a firm basis to assign Bathonian age to the studied succession.

The reliability of agglutinated genera *Pseudomarssonella* as a index form was questioned because the forms were known only from the Indian

sub-continent and Saudi Arabia. However, Delance and Ruget (1989) recorded the genera *Pseudomarssonella* from Bathonian of France, which proves its reliability in considering it as an index forms of Bathonian. As it is also evident from the assemblages of Jaisalmer and Jhurio Hill Kachchh and also in present assemblage that they occur in association with index species of *Garantella* so they can be considered as Bathonian forms.

However, Banner et al., (1991) reviewed the agglutinated forms reported by Redmond (1965) from Saudi Arabia and in their detailed study they found that the age assignment given to each species can be acceptable with a few minor changes. They also gave new classification based on the study of wall structure, is followed in the present work.

Thus, based on foraminiferal species *Garantella* cf. *G.stellata* (middle Bajocian to middle Bathonian); *Garantella ornata* (middle Bajocian to ?Callovian); *Pseudomarssonella bipartita* (Lower to Middle Bathonian); the basal most sediments of the Patcham Formation exposed at the Jumara Dome, can be dated as Middle Bathonian. However, earlier it was thought that lower and middle Bathonian rocks are missing at Jumara section, as workers (Krishna and Westermann, 1987; Bardhan et al., 1988) assigned upper Bathonian age based on *Macrociphalites triangularis* and *Bullatimorphites* sp., to the upper part of the Patcham Formation. Hence, the presence of foraminiferal species *Garantella* cf. *G. Stellata* along with other important species not only lends support to already assigned Bathonian age for the Patcham Formation but it also helps to put precisely the lower age limit of the Patcham Formation as Middle Bathonian.

Respositary

All the figured specimens are deposited in the museum, Department of Geology, University of Lucknow, Lucknow, India.

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