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ARTICLE

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PALAEOBIOGEOGRAPHIC IMPLICATIONS OF TURRITELLID GASTROPODS FROM MIOCENE OF KUTCH, GUJARAT

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The intra-basinal correlation of turritellid species indicates size increment of T. narica and T. pseudobandongensis from older Bhadra dam to younger Chhasra section (Lower to Middle Miocene). The low Jaccardian correlation co-efficient suggests sub-basinal endemism. Among Turritellid, T. narica and Z. angulatahad inter provincial distribution, however T. narica was endemic to the Indian subcontinent. The high endemism of the early Palaeogene Turritella species of the Kutch Basin might have resulted from low dispersal potentials or due to restricted faunal mixing.

Introduction

The Tertiary deposit of the Kutch basin is rich in macro fauna such as mollusc (particularly pelecypods and gastropods), echinoids and cnidaria fossils. Primary work on fossils molluscs occurring in the Tertiary sediments of Kutch have been provided by Sowerby[1], way back in1840.The present work concerns systematic description of the species belonging to family Turritellidae, and the regional biogeographic correlation works extend to relate to different sections of Chhasra Formation (Table 1), namely Chhasra section and Bhadra dam section.The possible morphological variations or similarity have been enumerated between the Turritellidae species of the two sections. Both the sections belong to lower Miocene epoch (Burdigalian), The Chhasra section being relatively younger than the Bhadra dam section; morphological variations among different turritellid species as well as variation in faunal occurrences between the two sections have been studied. Similarity index among turritellid species from different basins of the world has been analysed as well as faunal correlation at the species level among different basins of the Indian peninsula to that of the Kutch basin (Figure 1) is also presented here.

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Table 1: Lithostratigraphic Classification of Miocene Rocks of Kutch.

Sandhan Formation (Pliocene)	
~~Unconformity~~~~~~~~~~~~~~~~~~	
	Siltstone member
Chhasra Formation (Burdigalian)	
	Claystone member
~~Unconformity~~~~~~~~~~~~~~~~~~	
Khari Nadi Formation (Aquitanian)	
~~Unconformity~~~~~~~~~~~~~~~~~~	
Maniyara Fort Formation (Oligocene)	

Discussion

Six species of the family Turritellidae namely *Turritella narica* Vredenburg, (1920), *Zaria angulata* (Sowerby, 1840), *Turritellapseudobandongensis* Vredenburg, (1928), *Turritella pseudotethis* Vredenburg, (1928), *Turritella assimilis* Sowerby (1940), *Turritella bhagothorensis* Vredenburg (1928) (Figure 2). Among these *Z. angulata* occur throughout the Chhasra section but not encountered in Bhadra dam section. Apart from this variation in faunal elements, Turritelline species namely *T. narica*, *T. pseudobandongensis* are showing variations in their size ratio (see Table 2). Both are wider at similar shell length in

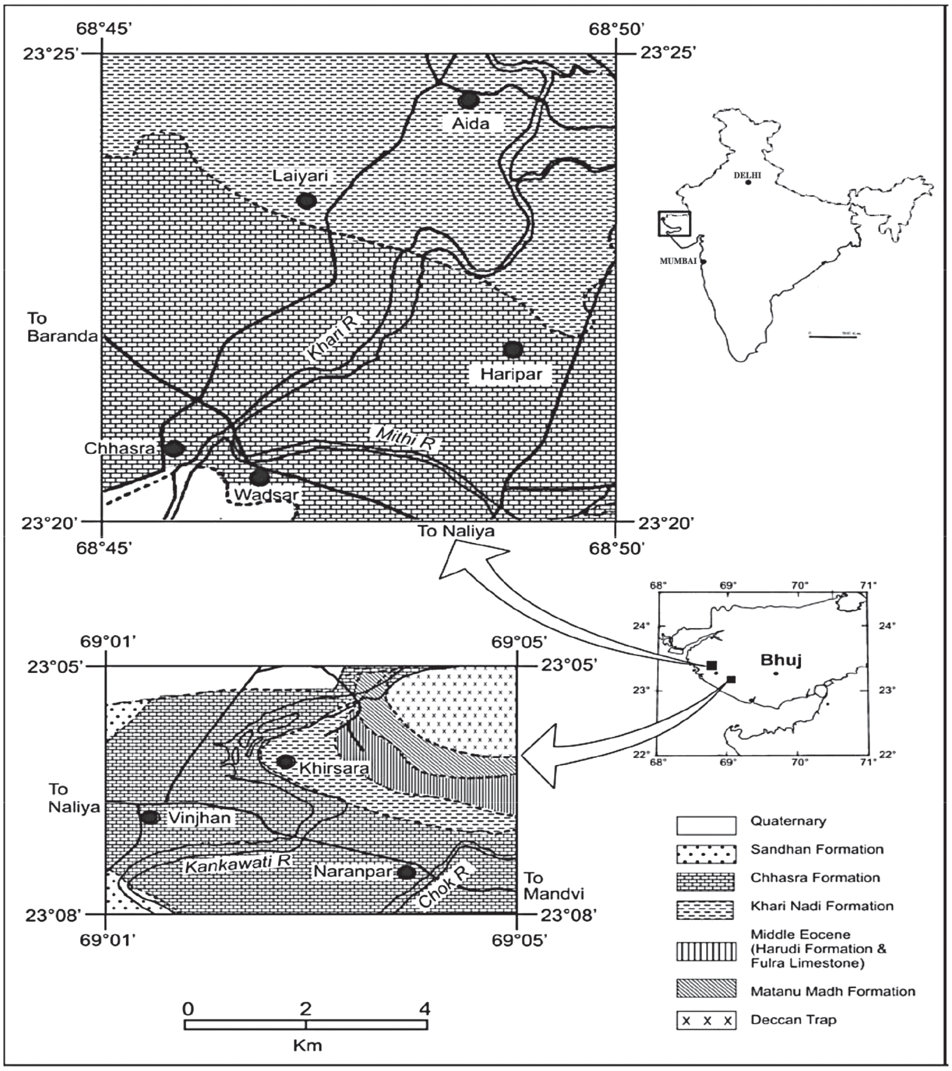

Fig. 1: Geologic Map of Parts of Kutch Region, Gujarat State, India. (Modified after Kulkarni et al., 2010).

case of Chhasra section as compared to Bhadra dam section. Besides both of these species from Chhasra section are having wider aperture than that of the Bhadra dam section (see Table 2).*Turritella narica* from Bhadra dam section shows a few variants having differences in their spacing of threads, convexity of whorls and apical angles. *T. narica* var. *baluchistanensis* Vredenburg, 1928 is a common variant. *Turritella assimilis* Sowerby, 1840 has a similar looking shell but *T. assimilis* has more threads in each whorl which can be used as a distinguishing element between these two species. *T. narica* and *T. assimilis* both are endemic to the Kutch – Pakistan province (see Table – 3 for references). *Zaria angulata* (Sowerby, 1840) has wider apical angle and has angular whorls. *Z. angulata* had wide biogeographic distribution which is present in Indo – Pakistani, East-African, central Iranian basins and in South – Asian countries of Myanmar and Indonesia (Table – 3 for references). Faunal correlation between turritellid species of Kutch with that of other basins of the world based on the data available from the work of different authors (Vredenburg[2-4], Cox[5], Mukherjee[6], Beets[7], Eames[8], King[9], Azzaroli[10], Crame[11], Kassab et al.[12], Lyngdoh et al.[13], Tiwari and Kachhara[14], Harzhauser et al.[15], Kulkarni et al.[16]) have been carried out and it depicts that there is very little variation in faunal elements between N-W Pakistan (Sindh and Baluchistan) and Kutch with respect to turritellid species. On the other hand, Indian fauna during Miocene show very little similarity with the other basins as depicted in Table 3. On the basis of data acquired from Table 2, an attempt has been made to establish faunal correlation at the species level among different region of the world by using Jaccard coefficient (Table 4). The low Jaccardian coefficient suggests the persistence of endemism among the region during early and middle Miocene.

Conclusion

The present author has undertaken a palaeobiogeographic analysis based on works of Sowerby[1] and Vredenburg[4]. In the papers of Biswas[17-19], the fossil content of Miocene strata of the Kutch basin were mentioned only at genus or family level. Nevertheless, the molluscan assemblages of the Kutch basin, together with coeval assemblages from Pakistan (d' Archiac and Haime[20]; Fedden[21]), were frequently used for biogeographic considerations concerning the closure of the Tethyan seaway (Vredenburg[3], Vlerk[22]; Sahni and Mitra[23]; Piccoli[24]; Piccoli et al.[25]; Harzhauser et al.[26,27]). Kulkarni et al.[16] provided a recent revision of the molluscan fauna from the Miocene sediments of Kutch. These considerations, however, suffered strongly from the mixing of faunas of

Table 2: Dimensions of Turritellid Species, LBH = Bhadra Dam Samples, CH = Chhasra Samples.

SAMPLE NO.	TOTAL LENGTH	TOTAL WIDTH	APERTURAL LENGTH	APERTURAL WIDTH
Turritella narica				
DGC/G/LBH/169	3.46	0.97	0.63	0.696
DGC/G/LBH/135	4.52	1.76	0.848	0.636
DGC/G/LBH/109	3.398	0.976	0.946	0.668
DGC/G/LBH/188	5.226	1.544	0.826	0.696
DGC/G/LBH/187	3.678	1.286	0.722	0.62
DGC/G/LBH/126	4.206	1.354	0.646	0.55
DGC/G/LBH/167	3.386	1.266	0.84	0.922
DGC/G/CH/315	3.208	1.118	0.538	0.478
DGC/G/CH/319	3.932	1.334	0.832	0.666
DGC/G/CH/280	3.462	1.052	0.588	0.576
DGC/G/CH/287	2.544	0.996	0.48	0.59
DGC/G/CH/266	2.85	0.954	0.562	0.542
DGC/G/CH/278	3.332	1.276	0.68	0.576
DGC/G/CH/286	3.024	1.098	1.196	0.496
DGC/G/CH/303	3.738	1.112	0.79	0.798
DGC/G/CH/268	4.394	1.55	0.83	0.83
DGC/G/CH/273	3.088	1.21	0.686	0.644
Zaria angulata				
DGC/G/CH/421	4.28	1.55	0.772	0.783
DGC/G/CH/425	4.43	1.17	0.712	0.792
DGC/G/CH/420	3.48	0.872	0.45	0.642
DGC/G/CH/400	2.62	0.762	0.342	0.308
DGC/G/CH/467	2.352	0.832	0.532	0.642
DGC/G/CH/423	3.18	1.24	0.444	0.718
DGC/G/CH/428	3.408	1.42	0.858	0.868
Turritella pseudobandongensis				
DGC/G/LBH/113	1.394	0.518	0.16	0.35
DGC/G/LBH/177	2.37	0.736	0.796	0.434
DGC/G/LBH/148	3.684	0.85	0.25	0.378
DGC/G/LBH/102	2.938	0.932	0.616	0.864
DGC/G/CH/267	3.348	1.04	0.662	0.678
DGC/G/CH/298	2.67	0.94	0.454	0.492
DGC/G/CH/299	5.17	1.438	0.84	0.88
DGC/G/CH/302	3.214	1.024	0.532	0.636
DGC/G/CH/283	3.614	1.22	0.686	0.708
DGC/G/CH/282	2.922	0.948	0.394	0.554
DGC/G/CH/440	6.432	1.462	1.82	1.274

Table 2: contd..

Turritella pseudotethis				
DGC/G/CH/445	2.856	1.032	0.54	0.702
DGC/G/CH/453	3.124	1.92	—	—
DGC/G/CH/446	3.08	1.08	—	—
DGC/G/CH/447	3.04	0.98	0.43	0.55
Turritella assimilis				
DGC/G/LBH/159	2.664	0.85	0.318	0.38
DGC/G/LBH/137	1.904	0.86	0.404	0.478
DGC/G/LBH/192	3.928	1.316	0.62	0.796
DGC/G/LBH/198	3.588	1.084	0.408	0.56
DGC/G/CH/321	3.104	1.056	1.196	0.77
DGC/G/CH/253	1.852	0.704	—	—
DGC/G/CH/256	2.06	0.844	—	—
Turritella bhagothorensis				
DGC/G/LBH/185	3.95	0.93	0.31	0.778
DGC/G/CH/341	2.41	0.882	0.444	0.51

Table 3: Paleobiographic distribution of Turritellidae species during Miocene (+ = Present, - = Absent)

Taxa Name	W. India	N.E India	Pakistan	Somalia	Myanmar	Indonesia	Egypt	Iran	S. Africa
T. narica	+	+	+	-	-	-	-	-	-
Z. angulata	+	+	+	-	+	+	+	+	+
T. pseudobandongensis	+	-	+	-	-	-	-	-	-
T. pseudotethis	+	-	+	+	-	-	-	-	-
T. assimalis	+	-	+	-	-	-	-	-	-
T.bhagothorensis	+	-	+	-	-	-	-	-	-

Table 4: Jaccard similarity coefficients of Miocene Turritellidae species between area pairs in different region of the world.

	India	Pakistan	Indonesia	Myanmar	Somalia	Egypt	S. Africa	Iran
India	-	1	0.125	0.125	0.125	0.125	0.125	0.125
Pakistan	1	-	0.125	0.125	0.125	0.125	0.125	0.125
Indonesia	0.125	0.125	-	0.33	0	0.33	0.33	0.33
Myanmar	0.125	0.125	0.33	-	0	0.33	0.33	0.33
Somalia	0.125	0.125	0	0	-	0	0	0
Egypt	0.125	0.125	0.33	0.33	0	-	0.33	0.33
S. Africa	0.125	0.125	0.33	0.33	0	0.33	-	0.33
Iran	0.125	0.125	0.33	0.33	0	0.33	0.33	-

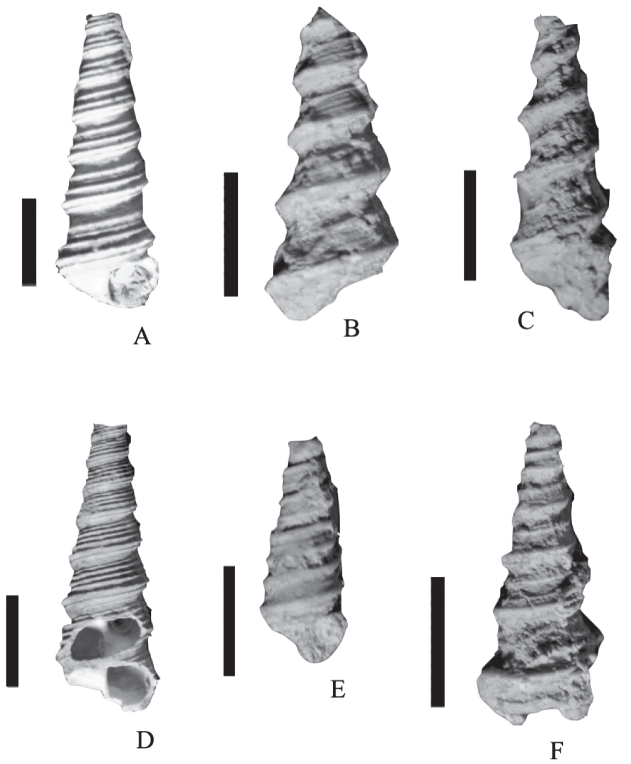

Figure 2. A. *Turritella narica*, B. *Zaria angulata*, C. *Turritella pseudobandongensis*, D. *Turritella assimilis*, E. *Turritella bhagothorensis*, F. *Turritella pseudotethis*

different stratigraphic levels.. The intra-basinal correlation based on Turritellid species described here clearly indicates increase in size of *T. narica* and *T. pseudobandongenasis* from older Bhadra dam section to younger Chhasra section (Lower to Middle Miocene).

The low Jaccardian correlation co-efficient suggests that each region has its own endemic species and relative endemism varies from place to place. Among the six Turritellid species; *T. narica* and *Z. angulata*had wider biogeographic distribution, however *T. narica* is strongly endemic to the Indian subcontinent. The high endemism of the early Palaeogene Turritella species of the Kutch basin in general might have resulted from low dispersal potentials of majority of the species. This may also happen due to restricted faunal mixing.

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