



## SOME FOSSIL SPECIES OF CATENICELLID AND SCHIZOPORELLOID BRYOZOANS FROM THE CENOZOIC SEDIMENTS OF WESTERN KACHCHH, GUJARAT, INDIA

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### ABSTRACT

Four species of catenicellid and schizoporelloid Bryozoa are described from the Cenozoic rocks of western Kachchh, Gujarat, India. *Ditaxipora lakriensis* n. sp. and 'Catenicellid gen. et sp. indet.' are new to science and *Tetraplaria tuberculata* Canu & Bassler, 1920 and ?*Malakosaria* sp. are reported for the first time in these rocks. As regards provincial relations, *Ditaxipora lakriensis*, 'Catenicellid gen. et sp. indet.' have Indo-Pacific affinities, while *Tetraplaria tuberculata* is an Atlantic element.

**Key words:** Kachchh, Catenicellid, Schizoporelloid, Cenozoic, Bryozoans, Gujarat

### INTRODUCTION:

Sonar and Gaikwad (2013a,b and c) have described poricellariid, steginoporellid and cyclostome bryozoans from the Cenozoic rocks exposed along the shelf zone adjoining Mesozoic sequences in western Kachchh, Gujarat (Fig.1). The entire succession from Paleocene to Holocene occurs in this region (Table 1). Fossil bryozoan faunas have been collected from the rocks belonging to the Harudi (Middle Eocene, Lutetian), Fulra (Middle Eocene, Bartonian), Maniyara Fort (Rupelian-Chatian) to Kharinadi (Early Miocene, Aquitanian-Burdigalian) formations.

An enormous quantity and diversity of cheilostome bryozoans has been found in the Cenozoic sequences of western Kachchh. The occurrence of fossil Bryozoa from these rocks was first reported by Tewari *et al.* (1958) and Tewari and Srivastava (1967). Subsequently, Guha and Gopikrishna (2004a, b, 2005 b-f, 2007 a-d and) and Guha (2013) described rich and varied bryozoan faunas from this region. Considering their diversity in these rocks, there is a need to update their systematic through a bed-by-bed study. As an outcome of our research, the present communication describes two catenicellid and two schizoporelloid species belonging to the families Catenicellidae, Busk, 1852, Tetraplariidae Harmer, 1957 and Calwellidae MacGillivray, 1887.

### MATERIAL AND METHODS

Encrusters on bivalve and gastropod shells were collected in the field. About 250 grams of weathered, gently crushed limestone, mudstone and shell were treated with 50% concentrated H<sub>2</sub>O<sub>2</sub> for 48-72 hours. Samples were gently washed over a set of standard sieves with mesh size (10f-60f), conventionally used in foraminiferal extraction. Colonies and internodes of bryozoans were picked from different fractions for identification. Before identification, specimens were cleaned by soaking in dilute acetic (5%) acid solution as described by Zágorský and Vávra (2000). The orifices of autozooids and

avicularium were cleaned with a very thin metallic needle. Colony surfaces were scrubbed in sodium nitrate solution and under tap water with hard 0.2mm brush. The specimens were identified and photographed with the help of JEOL/EO, Version-0.1SEM. Measurements were taken with 15X ocular micrometer in a Nikon, SMZ-800 stereoscopic zoom microscope following standard measuring techniques.

All dimensions cited in this paper are in millimeters, the observed range expressed to the nearest 0.01mm, and the mean and standard deviation calculated following the procedure described by Cheetham (1966). For conciseness, the following scheme of parameters is applied throughout the systematic part of this paper:

Lz= Length of Zooid, Wz= width of zooid, Lop= length of opesia, Wop= width of opesia, N= Number of zooids, Mean, Standard deviation (SD), Coefficient of variation (CV) and observed range.

The systematic part of this paper follows, except otherwise indicated, the bryozoan "Treatise on Invertebrate Palaeontology" Bassler (1953) along with the working list for "Treatise" recommended by Gordon (2014). The described types are housed in the Museum of Geology, P.G. Department of Geology, Government Institute of Science, Aurangabad-431004 under catalogue numbers as indicated in the text.

### SYSTEMATIC PALAEOLOGY

- Order **Cheilostomata** Busk, 1852
- Suborder **Neocheilostomina** d'Hondt, 1985
- Infraorder **Ascophora** Levinsen, 1909
- Superfamily **Catenicelloidea** Busk, 1852
- Family **Catenicellidae**, Busk, 1852
- Genus ***Ditaxipora*** MacGillivray, 1885

*Ditaxipora lakriensis* n. sp.  
(Pl.I, figs. 1-2.)

*Material:* Holotype: GIS/B: 0678; Paratypes: GIS/B: 0679-0690.

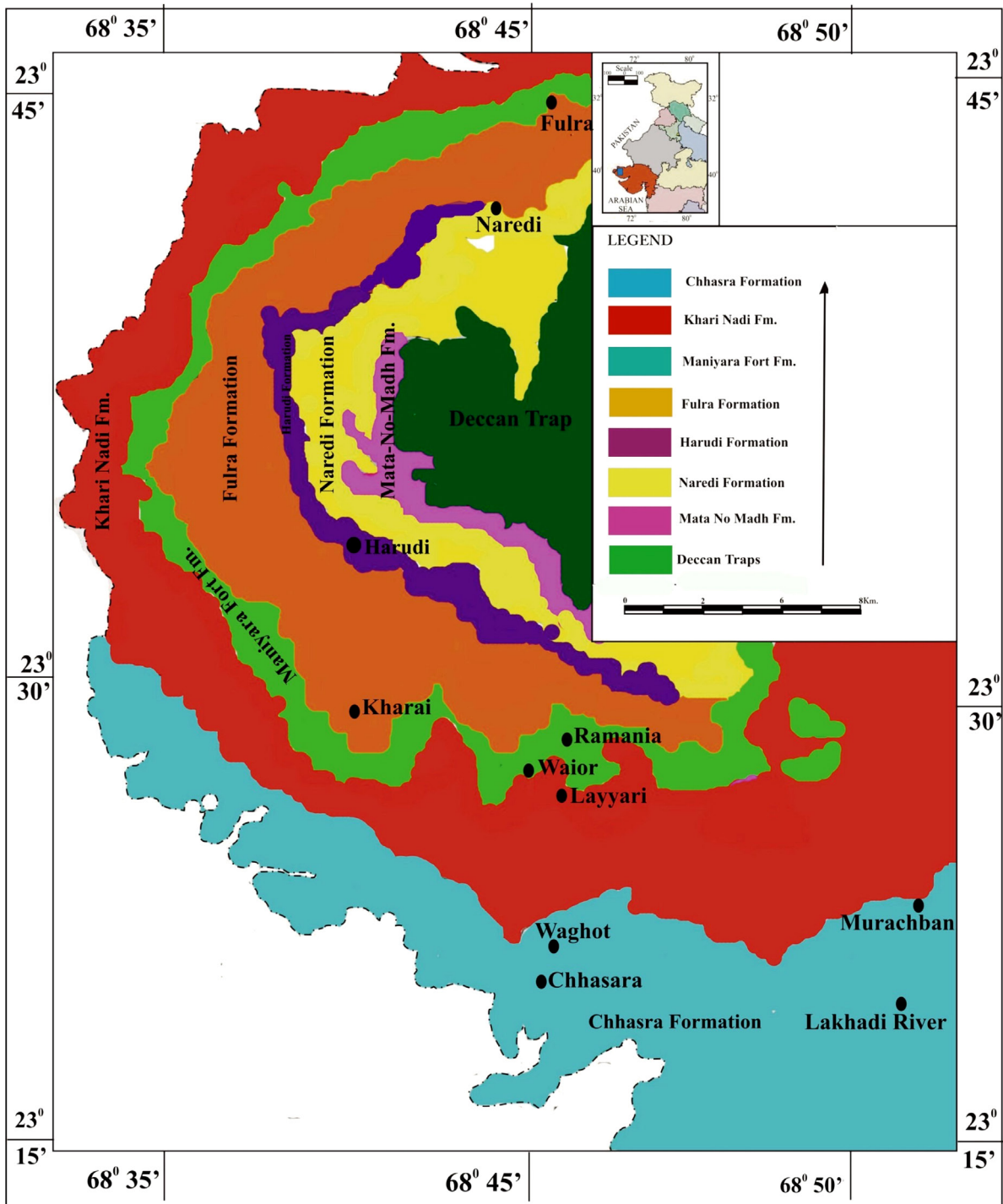


Fig.1 Generalized geological map of Kachchh (modified after Biswas,1992)

#### EXPLANATION OF PLATE I

1, 2. *Ditaxipora lakriensis* n.sp.; 1. Close-up view of a segment showing alternating pairs of autozooids, avicularia, orifices and frontal shield. 2. Close-up view of a single autozooids showing Triangular median gymnocrystal ridge on the frontal shield, orifice and an avicularium; 3, 4. *Catenicellid* gen. et sp. indet; 3. Close-up view of a complete segment showing zigzag ridge in the middle of the branch and details of autozooids; 4. Close-up view of single autozooid showing gymnocrystal ribs pores and pair avicularia adjacent to orifice; 5, 6 & 9. *Malakosaria gordonii* n.sp.; 5. Close-up view of a complete segment showing back to back arrangement of autozooids. 6. Close-up view of pair of autozooids showing T-shaped gymnocrystal rib on the frontal and lateral surface. 9. Close-up view of T-shaped gymnocrystal rib on the frontal and lateral surface. 7, 8, 10 & 11. *Tetraplaria tuberculata* Canu & Bassler, 1920. 7. Close-up view of a complete segment alternate arrangement of autozooids and one ovicelled autozooid. 8. Close-up view of part of segment showing two lateral small tubercles on the autozooid. 10. Close-up view of ovicell showing frontal shield of the ovicell. 11. Close-up view of pair of basal autozooids tapering at the base and showing basis-rami.

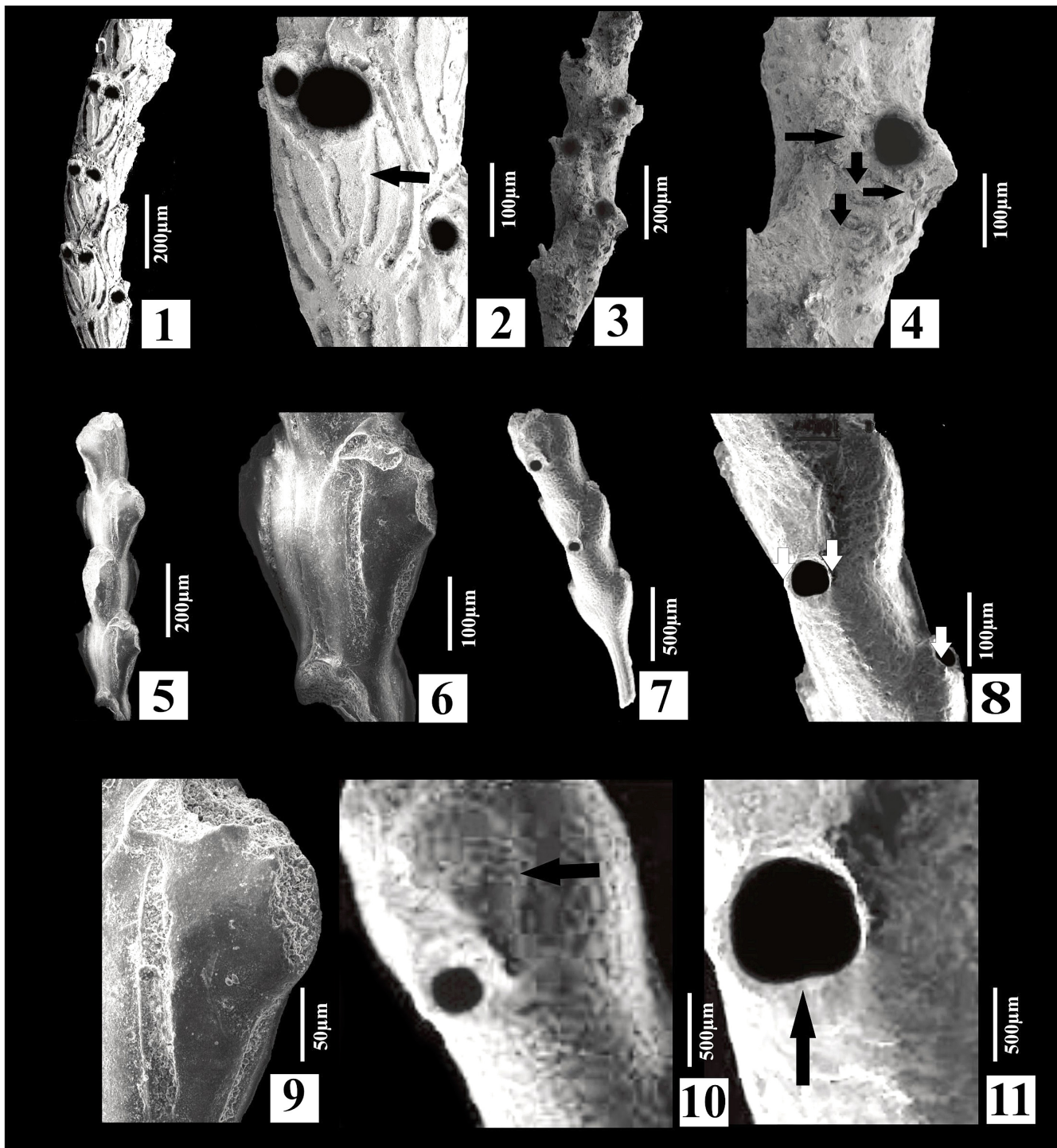


Table 1: Tertiary Stratigraphy of Kachchh (after Biswas, 1992)

TIME IN M.Y.	SERIES		STAGES	LITHOSTRATIGRAPHY FORMATIONS	LITHOLOGY
	UPPER	LOWER			
10	MIOCENE	UPPER	MESSINIAN	SANDHAN	Sandstones, minor limestones and shales.
		UPPER	TORTONIAN		
		MIDDLE	SERRAVALLIAN		
		MIDDLE	LANGHIAN		
	20	LOWER	BURDIGALIAN	CHASRA	Silty shales and impure limestones
			AQUITANIAN	KHARI NADI	Variegated siltsstones and sandstones.
30	OLIGOCENE	UPPER	CHATTIAN	MANIYARA FORT	Foraminiferal limestone, shales and coral bichams, lumpy claystones.
		LOWER	RUPELIAN		
40	EOCENE	UPPER	PRIABONIAN		
		MIDDLE	BARTONIAN	FULRA	Dense foraminiferal limestones.
		MIDDLE	LUTETIAN	HARUDI	Claystones/ limestones, coquina, etc.
		LOWER	YPRESIAN		
		60	PALAEOCENE	UPPER	THANETIAN
LOWER	DANIAN			M ATANOMADH	Volcanoclastics, shales and sand-
				DECCAN TRAP	Basalt

## Measurements:

	Range (mm)	Mean(mm)	N
Lz	0.41-0.49	0.421	10
Wz	0.19-0.25	0.209	10
Lop	0.08-0.10	0.087	10
Wop	0.08-0.09	0.085	10

**Diagnosis:** Segments delicate. Autozooids arranged in alternating pattern. Orifices transversely oval. T-shaped, triangular gymnocrystal ridge and two lateral ridges branching from it proximally on the frontal shield. Avicularium somewhat rounded located distolateral corner of autozooid. Ovicells not observed.

**Description:** Segments delicate, erect. Autozooids arranged in alternate fashion; vase shaped with sides tapering towards proximal end. Orifices wider than long, arched distally, proximal edge concave. Frontal shield with two long ridges tapering proximally, separated by T-shaped, triangular median gymnocrystal ridge. A single avicularium per zooid, always on the outer (marginal) side of the orifice, with a rounded opesia, without cross bar and acute rostrum. Ovicells not observed.

**Remarks:** Presence of T-shaped, triangular gymnocrystal ridge and lateral ridges is a characteristic feature to differentiate this species from the other species described elsewhere from the world. The present species exhibits a close resemblance to

*Ditaxipora pannonensis* Braga in Antolini *et al.*, 1980 (p.60, figs. 63-64) from the Priabonian (Upper Eocene) of northern Italy (see Gordon & Braga, 1994, p.68, fig.6a-c) in the shape of colony and autozooids, but, differs in having a transversely oval orifice, T- shaped gymnocrystal ridge. The present species differs from *Ditaxipora internodia* (Waters (see Gordon & Braga, 1994, p.66, fig.5a-c) from the Miocene of Victoria in the alternating pattern of the autozooids, shape of autozooids and gymnocrystal ridge.

**Occurrence:** 13 zoarial fragments from Chhasra Formation (yellow limestone of Lakdi River).

**Type Horizon and locality:** Fossiliferous yellowish limestone of the Chhasra Formation exposed on the left bank of Lakdi River, 6 km from Tera.

**Age:** Lower Miocene (Burdigalian).

**Derivation of name:** The species is named after type locality Lakdi Nadi.

Catenicellid gen. et sp. indet.

(Pl.I, figs. 3-4, 12.)

**Material:** GIS/B: 0691-0695.

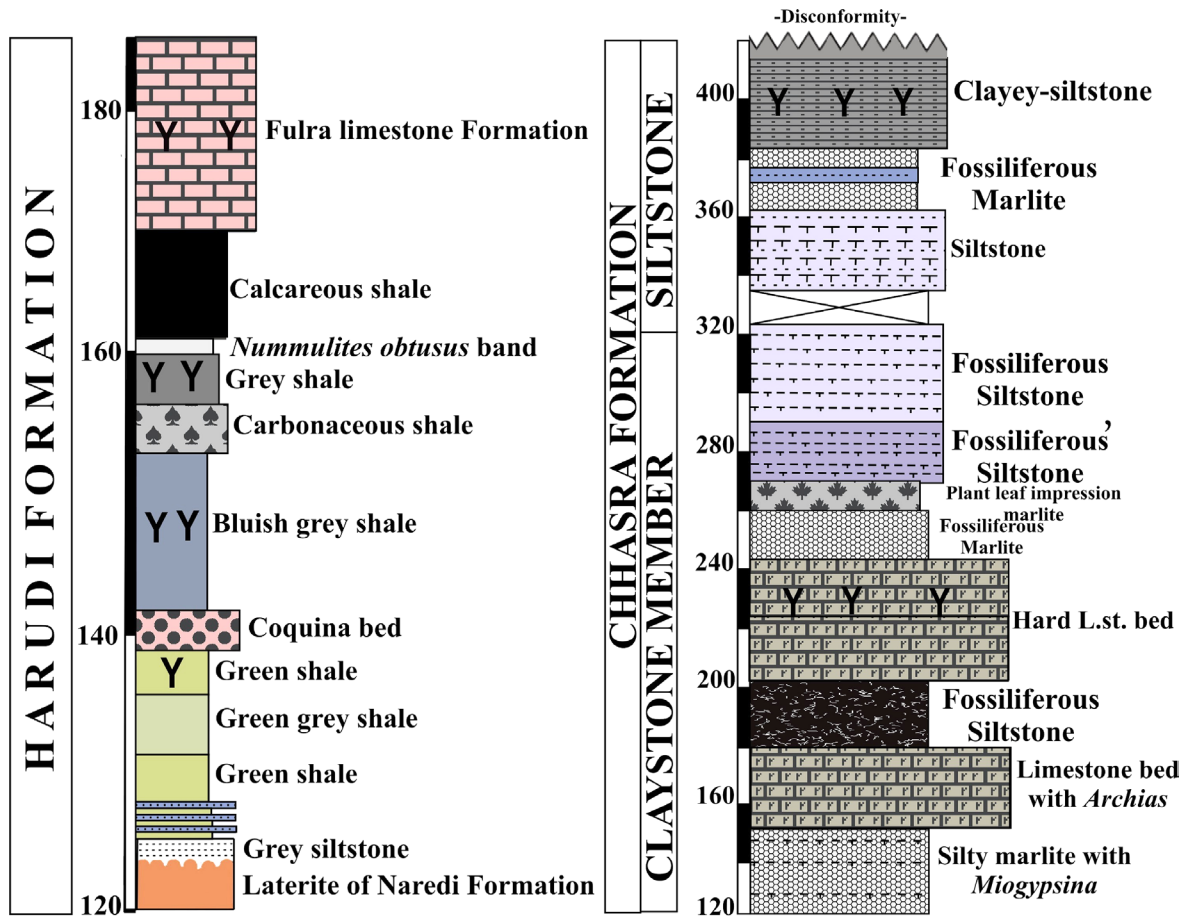
**Measurements:**

	Range (mm)	Mean (mm)	N
Lz	0.40-0.51	0.782	6
Wz	0.20-0.27	0.373	6
Lop	0.18-0.21	0.32	6
Wop	0.10-0.11	0.172	6

**Description:** Segments 3.85 mm long and 0.47-0.54 mm wide, with up to 6 or 7 autozooids per segment. Autozooids arranged in alternating fashion, rather slender and small, the most proximal autozooid roughly club-shaped, tapering proximally. Gymnocrystal or frontal shield evenly perforated by numerous pores and a significant costal field in the distal half of the frontal shield giving impression of costal ribs. Orifice wider than long with shallow broad sinus along proximal edge, the primal border slightly raised. Adjacent to the orifice is a pair of avicularia, the axial one occasionally absent, if not facing frontally, the marginal one facing laterally, each slightly projecting. Each with a hemispherical opesia, without cross-bar, with small triangular rostrum. A small pore chamber frequently observed below avicularia. Ovicells not observed.

**Remarks:** Kachchh specimens closely resemble genus *Ditaxiporina* in having alternate arrangement of autozooids. This material differs from *Vasignyella* in which only fertile internodes are biserial like *Vasignyella ovicellata* Vieira *et al.*, 2007 (p.52, figs.2-14). The autozooids in present specimens appear to have a significant costal field in the distal half of the frontal shield. These give the impression of both gymnocrystal pores and ribbing. That combination, in addition to multizooidal segments, indicates that the present form is a new genus and species.

According to D.P. Gordon (pers. commun. 2013), the photographs of the specimens resemble *Ditaxiporina* - gymnocrystal pores are well developed. However, the autozooids in the present specimens appear to have a significant costal field in the distal half of the frontal shield. The upper left autozooid in the photo and the lower right autozooid also seem to have ribs (more evident on the left-hand side). If this is indeed a costal field, then it seems to be a new genus. *Ditaxiporina* conceptually



Y-Bryozoan Colony

Fig. 2. Generalized Lithosections of the Harudi and Chhasra formations (modified after Biswas, 1992).

could be derived from such a form by reduction of the costal field to a vestigial suboral pair of costae. The gymnocystal pores are indicative of this relationship. However, only a few poorly preserved specimens at hand hence, it is not possible now to erect new genus and species. Instead, it is better to leave them in open nomenclature, until better preserved material will be obtained.

**Occurrence:** 6 zoarial fragments from the Chhasra Formation (yellow limestone of Lakdi Nadi)

- Grade** Lepraliomorpha Gordon, 1989
- Superfamily** Schizoporelloidea Jullien, 1883
- Family** Tetraplariidae Harmer, 1957
- Genus** Tetraplaria Tenison-Woods, 1878

*Tetraplaria tuberculata* Canu and Bassler, 1920 (Pl.I, figs. 7-8, 11)

*Tetraplaria tuberculata* Canu & Bassler, 1920 p. 368, pl.48, figs.7-10; Tewari & Srivastava, 1967, p.26, fig.2, nos.4 and 4a.

**Material:** Plesiotypes: GIS/B: 0696-0717.

**Measurements:**

	Range (mm)	Mean (mm)	N
Lz	0.60-0.68	0.634	8
Wz	0.34-0.36	0.346	8
Lop	0.19	0.19	8
Wop	0.13-0.14	0.135	8

**Description:** Internodes erect, articulated, 4-serial. Autozooids arranged in pairs, facing alternately at right angles to one another; convex, with distinct sutures between autozooids; pyriform, tapering proximally; frontal shield with elongated pits, each with a pore. Orifices semicircular, proximal edge somewhat concave or straight, with two small tubercles on either side of the orifice. Ovicells large, globular, hyperstomial, resting on the distal autozooid, frontal surface with numerous small pores.

**Remarks:** The present species agrees in all essential characters with *Tetraplaria tuberculata* Canu & Bassler, 1920 (p.368, pl.48, figs.7-10) described from the Upper Eocene of Florida. *Tetraplaria turgida* described by Tewari & Srivastava from the Lutetian of Sche also agrees in all essential characters with the present species except they have not mentioned about tubercles on proximolateral sides of the orifice. *T. orospinea* Gordon & d'Hondt, 1997 (p.27, figs. 49-52) widely differs from the Kachchh species in having inconspicuous flattened condyles and six oral spines. *T. ventricosa* (Haswell) (see Gordon and d'Hondt, 1997, p.27-28, figs. 53-54) also differs from the present species in having a comparatively deep, U-shaped sinus at proximal edge of the orifice and stout condyles. The *Tetraplaria* sp. Gordon & d'Hondt, 1997 (p. 28, figs. 55-56) differs greatly from the present species in having a v-shaped rounded sinus with 2-4, tiny ephemeral spines. *T. immersa* (Haswell) (see Harmer, 1957, p.1055, Pl. 69, figs.5-7) also differs from the

present species in having a broad rounded orificial sinus.

**Occurrence:** Out of a total of 22 zoarial fragments in the present collection, 8 from the Fulra Formation (buff colour limestone of Fulra type section) and 14 from the Harudi Formation (claystone member of Harudi type section).

**Distribution:** Upper Eocene (Priabonian): Florida USA.

**Family** Calwellidae MacGillivray, 1887

**Genus** Malakosaria Goldstein, 1882

?*Malakosaria* sp.

(Pl. I, fig.5, 6, 9-10)

**Material:** Holotype: GIS/B: 0718; Paratypes: GIS/B: 0719-0732.

Measurements:

	Range (mm)	Mean (mm)	N
Lz	0.50-0.60	0.56	4
Wz	0.24-0.38	0.32	4

**Description:** Colony erect, dichotomously branching. Autozooids biserial arranged in back-back, alternating series; distally broad, tapering proximally, frontal shield smooth, with single, long, narrow T-shaped rib. Scapular region of autozooids exhibits hook-like avicularian process, curved proximally. Orifices oval, higher than wide. No oral spines, avicularia. Ovicells not present in the available material.

**Remarks:** The illustrated specimens are tentatively included into the ?*Malakosaria* genus, due to worn condition most of the characters are obscured and they lack ascopore. However, they resemble to this genus in a few morphological characters. The present species differs from *Malakosaria sinclairii* (Busk, 1857), (p.172, XV, figs.1, 2, and 3) in these characters. *Malakosaria atlantica* Vieira et al., 2010 (p.27-28, figs.64-66) widely differs from the present species in having elongate autozooids, a crescentic ascopore and six oval excavations around the orifice.

**Occurrence:** 15 zoarial fragments from the Harudi Formation (gypseous shale member of Harudi type section).

**Discussion:** *Ditaxiporina lakriensis* and Catenicellid gen. et sp. indet. are confined to lower Miocene rocks of the Chhasara Formation of Western Kachchh, Gujarat. However, ?*Malakosaria* sp. is common in middle Eocene rocks of the Harudi Formation of the Western Kachchh, Gujarat. *Tetraplaria tuberculata* is distributed in tropical to warm temperate waters. It is known to occur from the middle Eocene to the upper Eocene, being distributed in Florida, USA and Kachchh, Gujarat.

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## REFERENCES

Antolini, P., Braga, G. and Finotti, F. 1980. I Briozoi dei dintorni di Rovereto. Monte Baldo settentrionale e Valle di Gresta. *Pubblicazione della Società Museo Civico di Rovereto*, **82**: 1-104.

- Bassler, R. S. 1953. Bryozoa In: *Treatise on Invertebrate Paleontology* (Part G) (Ed. Moore, R.C.), Geological Society of America & University of Kansas Press, New York.253p.
- Biswas, S. K. 1992. Tertiary Stratigraphy of Kachchh; *Journal of the Palaeontological Society of India*, **37**:1-29.
- Braga, G. 1963. I Briozoi del Terziario veneta. *Bolletino Societe Paléontologie Ital.*, **2**: 16 -55, pls 2-5.
- Canu, F. and Bassler, R. S. 1920. North American Early Tertiary Bryozoa. *Bulletin of the United States National Museum*, No.106, 879p, 162 pls.
- Cheetham, A. H. 1963. The polyzoan genus *Ditaxiporina* Stach. *Annals & Magazine of Natural History*, ser.13, **5**: 485-490.
- Gordon, D. P. 2014. Interim Classification of genera and subgenera of Cheilostomata (working list for Treatise). 10 January 2005 version 5, [http://www.bryozoa.net/treat\\_genera\\_2014.pdf](http://www.bryozoa.net/treat_genera_2014.pdf)
- Gordon, D. P. and Braga, G. 1994. Bryozoa: Living and fossil species of the catenicellid subfamilies Ditaxiporinae Stach and Vasignyellinae nov. In: A. Crosnier (ed.), Résultats des Campagnes MUSORSTOM, Volume 12. *Mémoires du Muséum National d'Histoire Naturelle*, **161**:55-85.
- Gordon, D. P. and d'Hondt, J. L. 1997. Bryozoa: Lepraliomorpha and other Ascophorina, mainly from New Caledonian waters. In A. Crosnier (ed.) Résultats des Campagnes MUSORSTOM, Volume 18. *Mémoires du Muséum National d'Histoire Naturelle*, **176**:9-124
- Guha, A. K. and Gopikrishna, K. 2004a. Fossil *Thalamoporella* (Bryozoa) from the Tertiary Sequences of Kachchh, Gujarat, India. *Irene Marine McCulloch Foundation Monograph Series*, Hancock Institute of Marine Studies, University of Southern California, Los Angeles, California,7: 1-50.
- Guha, A. K. and Gopikrishna, K. 2004b. *Reniporella gordonii*, a new genus and species of Bryozoa (Cheilostomata: Steginoporellidae) from the Middle Eocene of Western Kachchh, Gujarat, India with a note on its significance. *Neues Jahrbuch für Geologie and Paläontologie Monatshefte*, **2004** (11): 681-693.
- Guha, A. K. and Gopikrishna, K. 2005a. Diversity, evolution and paleoecology of the Tertiary bryozoan assemblages of western Kachchh, Gujarat, India. P. 107-118. In *Bryozoan Studies 2004*: (Eds. Moyono G., H. I., Cancino, J.M. & Wyse Jackson, P.N.) A.A. Balkema Publishers: Leiden.
- Guha, A. K. and Gopikrishna, K. 2005b. *Archoporella* –a new hippopodid genus (Bryozoa: Cheilostomata) from the Palaeogene of Western Kachchh, Gujarat, India. *Neues Jahrbuch für Geologie and Paläontologie, Monatshefte*. **2005** (7): 415-30.
- Guha A. K. and Gopikrishna, K. 2005c. New petraliid cheilostome bryozoan taxa from Aquitanian of western Kachchh, Gujarat, India. *Neues Jahrbuch für Geologie and Paläontologie Monatshefte*, **2005** (11): 694-704.
- Guha, A. K. and Gopikrishna, K. 2005d. New Smittinid (Bryozoa, Cheilostomata) species from Tertiary Sequences of Western Kachchh, Gujarat, India. *Freiberger Forschungshefte C 507: Paläontologie, Stratigraphie, Fazies Freiberg*, **13**: 11-25.
- Guha, A. K. and Gopikrishna, K. 2005e. Lunulitiform cheilostome bryozoans from the Miocene sequences of western Kachchh, Gujarat, India *Journal of the Palaeontological Society of India*, **50**(2): 13-24
- Guha, A. K. and Gopikrishna, K. 2005f. Some fossil anascan bryozoan taxa from the Tertiary sequences of Western Kachchh, Gujarat. *Journal the Palaeontological Society of India*, **50**(2): 135-151.
- Guha, A. K. and Gopikrishna, K. 2007a. New celleporid (Bryozoa Cheilostomata) species from the Tertiary deposits of western Kachchh, Gujarat, India. *Paläontologische Zeitschrift*, **81**(1): 83-92.
- Guha, A. K. and Gopikrishna, K. 2007b. New fossil steginoporellid and schizoporellid species (Bryozoa, Cheilostomata) from the Tertiary sequence of western Kachchh, Gujarat, India. *Journal of the Geological Society India*, **69** (4): 801 -812.
- Guha, A. K. and Gopikrishna, K. 2007c. Cyclostome Bryozoa from the (Eocene) Lutetian of western Kachchh, Gujarat, India. *Journal of the Geological Society of India*, **69** (6) 1271-1278.
- Guha, A. K. and Gopikrishna, K. 2007d. New Calloporid (Bryozoa, cheilostomata) species from Tertiary sequences of western Kachchh, Gujarat, India. *Journal of the Palaeontological Society of India*, **70** (1): 121-130.

- Guha, A. K.** 2013. Tertiary Bryozoa from Western Kachchh, Gujarat – A Review. *Journal of the Palaeontological Society of India* 58: 3-15.
- Harmer, S. F.** 1957. The Polyzoa of the Siboga Expedition, Part 4. Cheilostomata Ascophora II. *Siboga Expedition Reports*, **28d**: 641-1147.
- Sonar, M. A. and Badve, R. M.** 2010. Fossil catenicellid bryozoans from the Holocene of the West coast of Maharashtra. *Journal of the Geological Society of India*, **76**: 283-288.
- Sonar, M. A. and Gaikwad, S.** 2013a. Fossil steginoporellid (Cheilostomata: Neocheilostomina), Bryozoa from the Tertiary Sediments of Western Kachchh, Gujarat, India. *Journal of Earth System Science*, **122**(1): 149-161.
- Sonar, M. A. and Gaikwad, S.** 2013b. Fossil neocheilostomine Bryozoa from the Tertiary Sediments of Western Kachchh, Gujarat, India. *Journal of the Geological Society of India*, **81**: 665-676.
- Tewari, B. S. and Srivastav, I. P.** 1967. On Some Fossil Bryozoa from India. *Journal of the Geological Society of India*, **3**:18-28.
- Vieira, M. L., Gordon, D. P. and Correia, M. D.** 2007. First record of a living ditaxiporine catenicellid in the Atlantic, with a description of *Vasignyella ovicellata* n. sp. (Bryozoa). *Zootaxa*, **152**: 49-58.
- Vieira, M. L., Gordon, D. P., Facelucia, B. C. and Haddad, M. A.** 2010. New and little-known cheilostomatous Bryozoa from the south and southeastern Brazilian continental shelf and slope. *Zootaxa*, 2722, 1-53.

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