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Some Cyclostome (Bryozoa) from Maastrichtian Kallankurichchi Formation, Ariyalur Group, South India

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Abstract

Systematic study of nine species of cyclostome bryozoan has been done from the Maastrichtian sediments of Kallankurichi Formation, Ariyalur Group, Cauvery Basin, South India. Among these *Idmidronea sastreii n. sp.* is new to science. Four species namely, *Ybselosoecia* sp., *Spiropora* sp., *Tayloripora* sp. and *Exidmonea* sp. are kept in open nomenclature and rests are already described from these deposits. These species are belonging to families Diaperoeciidae, Entalophoridae, Plagiociidae, Spiroridae, Stomatopridae and Tubuliporidae. These species are, *Mecynoecia cf. virgula*, *Mesenteripora cf. corrugata*, *Proboscinopora cf. bassleri*, and *Exidmonea robusta*.

Keywords: Bryozoa, Carbonate sediments, Cyclostome, Kallankurichi, Maastrichtian, South India.

Introduction

The Kallankurichchi Formation belongs to the Ariyalur Group, South of Maastrichtian age India (Fig. 1; Guha and Nathan, 1996) containing rich and diverse mega and micro invertebrate fossil record (Sastry *et al*., 1972; Ayyasami, 2006). The beds of fossiliferous limestone exposed as detached outcrops (Guha and Nathan, 1990; Ramkumar, 2004) with a general N-S trend, gently dipping towards east, about 25-35 km long and 500 and 3500 m. thick. The occurrence of fossil bryozoans in the carbonate sediments of Ariyalur Group was first reported by Stoliczka (1873). Guha and Nathan (1990; 1996) have further studied fossil Bryozoa from these sediments.

The present paper describes eleven species of Cyclostomatid Bryozoa belonging to families Diaperoeciidae Canu, 1918; Entalophoridae Reuss, 1869; Plagiociidae Canu, 1918; Spiroridae Voigt, 1968; Stomatopridae Pergens and Meunier, 1886 and Tubuliporidae Johnston, 1838 from the Kallankurichi Formation. These species are *Ybselosoecia* sp., *Spiropora* sp., *Tayloripora* sp. and *Exidmonea* sp., *Mecynoecia cf. virgula* (Hagenow), *Mesenteripora cf. corrugata* Guha and Nathan, *Proboscinopora cf. bassleri* Guha and Nathan, *Idmidronea sastreii n. sp.* and *Exidmonea robusta* (Brood).

Material and Methods

The centre of attention of this study is the abundant bryozoan component (Table 1). For this study fragments of limestone (*c*. 1 Kg) were separated and collected from the different sites of Kallankurichchi Formation (Fig. 2). Approximately, 300 grams of each sample was soaked with 50% concentrated H_2O_2 for 48-72 hours followed by sieve analysis using the standard mesh sizes of 1.68–0.25 mm. Colonies and internodes of bryozoans were picked up for the identification. The colonies were cleaned with Na_2SO_4 solution in an ultrasonic bath for 4 to 5 cycles. Uncoated specimens were photographed with the help of ZEISS evo ma15 SEM at the Agharkar Research Institute, Pune. Measurements were taken from SEM photographs with the help of ImageJ software. Cyclostome bryozoan classification used in the systematic part of this paper follows the World Register of Marine Species (WoRMS, 2023) and bryozoa.net.

Table 1: Lithostratigraphy of the Campanian–Maastrichtian strata, Cauvery Basin, southern India (*modified after* Sonar *et al.*, 2022)

	Age	Formation	Member	Thickness (m)
Ariyalur Group	KTB	~~~~~~~~~~ Unconformity ~~~~~~~~~~		100
		Kallamedu		
		~~ Unconformity ~~~~~~~~~~		40
		Ottakovil		
	Maastrichtian	~~~~~~~~~~ Unconformity ~~~~~~~~~~		
		Kallankurichchi	Srinivaspuram gryphean limestone member	18
			Tancem biostromal member	08
			Kattupiringiyam inoceramus limestone member	08
			Kallar Arenaceous member	06
		~~ Unconformity ~~~~~~~~~~		
	Campanian	Sillakudi		400

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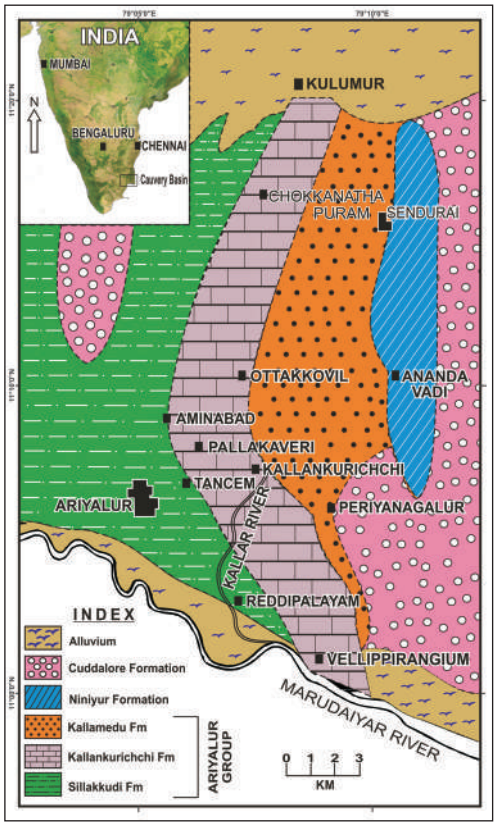

Fig.1. Generalized location map of the study area (*modified after* Sonar *et al*., 2022).

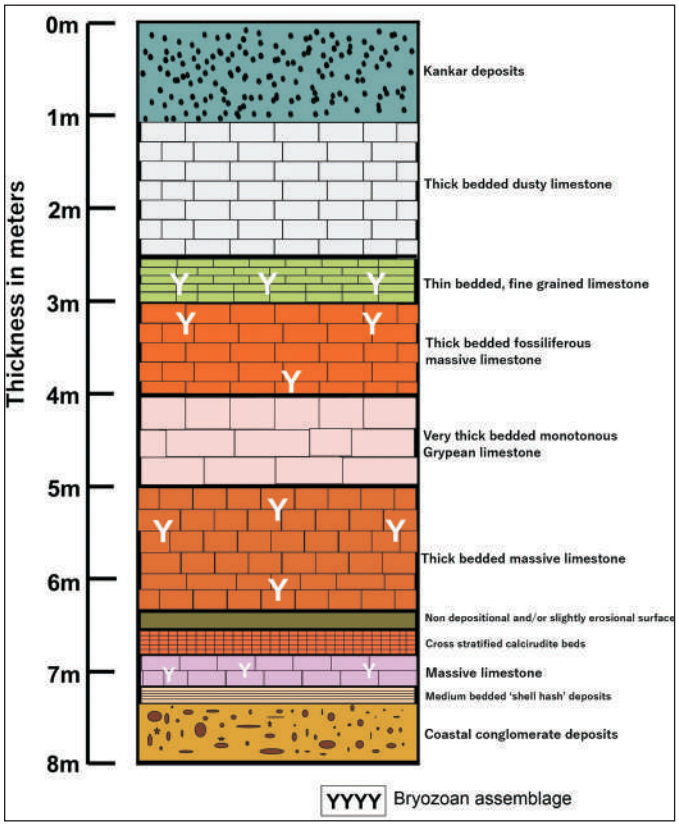

Fig.2. Lithosection of the study area (*modified after* Sonar *et al*., 2022).

Measurements in Text

Mean in mm (Range in mm, SD, No. of specimen observed)

Repository

GIS/CS, Post Graduate Department of Geology, Government Institute of Science, Aurangabad, Maharashtra, India - 431004.

Results

Systematic Palaeontology

Order **Cyclostomatida** Busk, 1852
Family Diaperoeciidae Canu, 1918
Genus *Ybselosoecia* Canu and Lecointre, 1933
Ybselosoecia sp.
(Fig. 3a, b)

Material: GIS/CS: 001–005

Description

Colony erect, with flattened, dichotomously branching. Autozooidal tubes with circular apertures having 0.127 mm (0.082–0.214 mm, 0.006, 10) diameter, grown in fascicles, frontal wall lightly perforated, each adjacent autozooids separated laterally by indistinct, thread-like, ridges. Peristomes 0.141 mm (0.107–.0181 mm, 0.006, 06) long projecting slightly obliquely from the autozooidal front, commonly three to four autozooidal peristomes in each row, slightly curved distally, proximal surface almost flat. Dorsal surface smooth, almost flat or fairly convex. Gonozooid and kenozooids not observed.

Remarks

This species closely resembles *Nevianipora stoliczkai* Guha and Nathan (1996) in autozooidal, characters and shape of peristomes, but differs in having fascicles.

Distribution

Kallankurichchi Formation, Ariyalur group, Cretaceous, South India.

Family **Entalophoridae** Reuss, 1869
Genus ***Mecynoecia*** Canu, 1918
Mecynoecia cf. virgula (Hagenow, 1840)
(Fig. 3c, d)

Mecynoecia proboscidea (Milne-Edwards), Canu and Bassler, 1920, p. 726, pl. 108, figs. 1–15.
Entalophora proboscidea (Milne-Edwards), Voigt, 1964, p. 421, pl. I, figs. 8 and 9.
Pustulopora virgula (Hagenow), Brood, 1972, p. 283, pl. 37, figs. 10, 11.
Mecynoecia cf. *proboscidea* (Milne–Edwards), Voigt, 1973, p. 116, pl. 7, fig. 6.
Pustulopora virgula (Hagenow), Brood, 1977, p. 76, figs. 14 C, D.
Mecynoecia virgula (Hagenow), Guha and Nathan, 1996, p. 62, pl. 6, figs. 6 and 7.

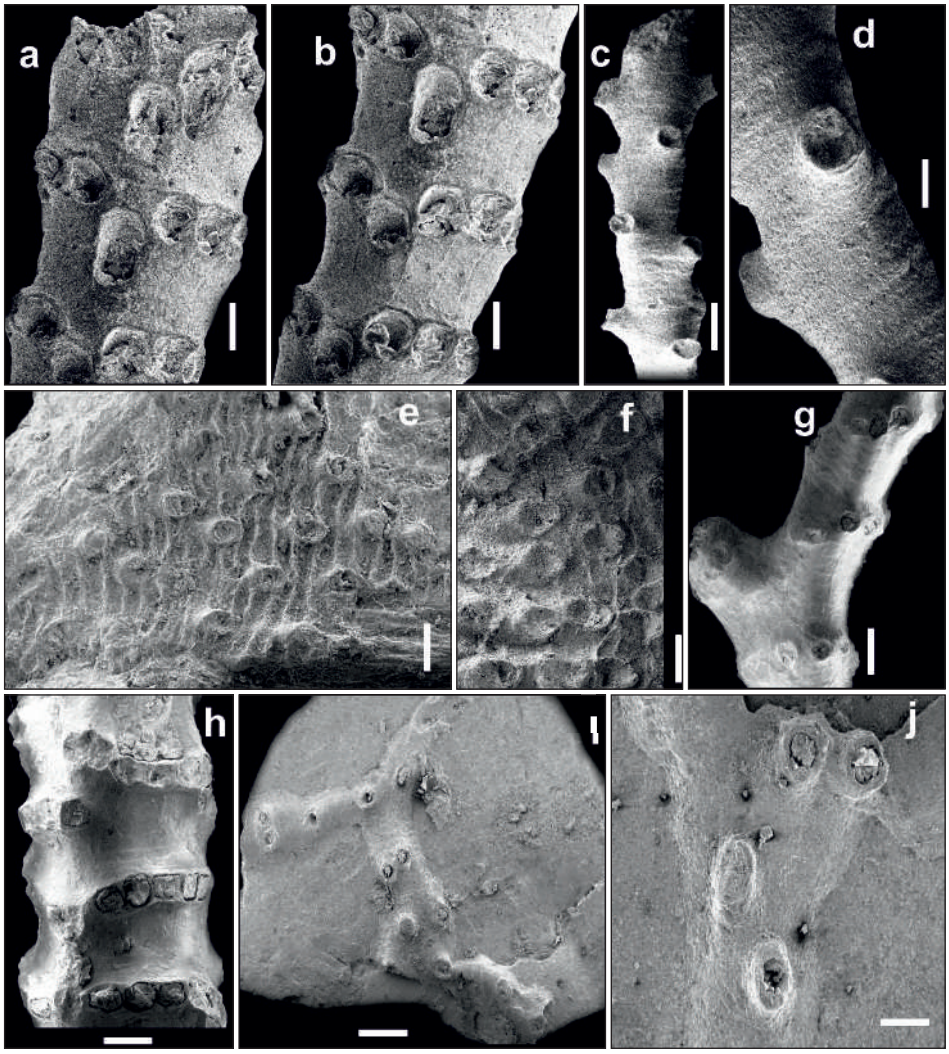

Fig.3. a-b, GIS/CS: 001–005, *Ybselosoecia sp.*; **a**. Colony showing autozooids and peristomes. **b.** Close–up of top of the colony (Scale: a–100 µm, b–50 µm). **c-d:** GIS/CS: 006–012, *Mecynoecia cf. virgula* (Hagenow), 1840; **c**. Colony showing autozooids. **d.** Close–up of peristome showing aperture (Scale: c–100 µm, d–50 µm). **e-f,** GIS/CS: 013–015, *Mesenteripora cf. corrugata* Guha and Nathan, 1996; **e**. Colony showing autozooids and transverse wrinkles. **f.** Close–up of autozooids, apertures and peristomes. (Scale: e–100 µm, f–50 µm). **g-h;** GIS/CS: 022–027, *Spiropora sp.*; **g**. Colony showing bifurcating branch. **h.** Close-up of top view (Scale: g–1 mm, h–200 µm). **i-j,** GIS/CS: 037–042**,** *Proboscinopora cf. bassleri* Guha and Nathan, 1996; **i**. Colony showing autozooids, apertures and peristomes. **j.** Close-up of encrusting biserial colony (Scale: i–500 µm, j–100 µm).

Material: GIS/CS: 006–012

Description

Colony erect, cylindrical to sub-cylindrical branches. Autozooidal tubes long steadily tapering proximally. Apertures having 0.108 mm (0.061–0.122 mm, 0.007, 08) diameter, all around the branch, autozooidal boundaries indistinct marked by thin line of impression, frontal surface somewhat convex distally, flat proximally with numerous small pores. Peristomes having 0.093 mm (0.071–0.116 mm, 0.004, 06) diameter, projecting perpendicular or slightly oblique to the autozooidal surface, thin, circular. Gonozooid not observed.

Remarks

This species agrees with *Mecynoecia* cf. *virgula* (Hagenow, 1840), Guha and Nathan (1996) in all essential characters however, in the present material gonozooecium is not observed.

Distribution

Kallankurichchi Formation, Ariyalur group, Cretaceous, South India.

Family **Plagiociidae** Canu, 1918
Genus ***Mesenteripora*** de Blainville, 1830
Mesenteripora cf. corrugata (Guha and Nathan, 1996)
(Fig. 3e, f)

'Bidiastopora' corrugata Guha and Nathan, 1996, p. 36, pl. 1, Figs. 9 and 10.

Material: GIS/CS: 013–015

Description

Colony erect, bilaminar. Ancestrula and early astogenic autozooids not observed. Autozooids arranged parallel rows with

more or less variable spacing, peristomes having 0.144 mm (0.129–0.156 mm, 0.002, 10) diameter, projecting right angles to the surface, longitudinally elliptical, thin. Zooidal frontal surface marked with transverse, somewhat uniformly spaced wrinkles. Autozooidal boundaries unclear. Gonozooid not observed.

Remarks

This species agrees with *'Bidiastopora' corrugata* Guha and Nathan (1996) in all essential characters however, in the present material gonozooecium is not observed.

Distribution

Kallankurichchi Formation, Ariyalur group, Cretaceous, South India.

Family **Spiroporidae** Voigt 1968
Genus ***Spiropora*** Lamouroux, 1821
Spiropora *sp.*
(Fig. 3g, h)

Spiropora irregularis Brood, 1977, p. 78, pl. 18D–F and 19.
Spiropora irregularis Brood, Guha and Nathan, 1996, p. 63, pl. 6, figs. 8–11.

Material: GIS/CS: 016–020

Description

Colony erect, with cylindrical, dichotomously branching, Autozooidal tubes with circular apertures having 0.156 mm (0.142–0.175 mm, 0.004, 10) diameter, encircling repeatedly spaced ring-like bands around the branch. Generally, 10-14 autozooidal peristomes per complete band. Peristome long 0.153 mm (0.138–0.174 mm, 0.003, 10) and having diameter 0.148 mm (0.135–0.160 mm, 0.004, 10). Frontal wall of the autozooid, slightly curved distally, proximal surface almost flat, perforated by numerous pseudopores, separated from lateral autozooids by thin, furrows; peristomes broken or abraded. Gonozooid and kenozooids not observed.

Remarks

This species resembles *Spiropora irregularis (*Brood) Guha and Nathan (1996) in all essential characters however, in the present material gonozooecium is not observed. So, the present material is left in open nomenclature until colonies with gonozooid available.

Distribution

Kallankurichchi Formation, Ariyalur group, Cretaceous, South India.

Family **Stomatoporidae** Pergens and Meunier, 1886
Genus ***Proboscinopora*** Pitt and Taylor, 1990
Proboscinopora cf. bassleri Guha and Nathan, 1996
(Fig. 3i, j)

Proboscinopora bassleri Guha and Nathan, 1996, p. 42–44, pl. 2, Figs. 8–10

Material: GIS/CS: 021–029

Description

Colony encrusting on Pycnodonte shell, narrow, biserial branches, relatively uniform thickness, dividing dichotomously at different angles. Laterally budded branches narrowing at point of origin. Ancestrula and initial autozooids are not observed. Autozooids distinct, short to moderate in length with fine subrounded pseudopores on the frontal surface, peristomes having length 0.144 mm (0.093–0.226 mm, 0.017, 10) and diameter 0.125 mm (0.067–0.162 mm, 0.015, 10) projecting right angles to branch surfaces and ending in thin, circular apertures normally in transverse group of two. Gonozooids not observed.

Remarks

This species agrees with *Proboscinopora bassleri* Guha and Nathan (1996) in all essential characters. But, the gonozooid is not observed in present material.

Distribution

Kallankurichchi Formation, Ariyalur group, Cretaceous, South India.

Family **Tubuliporidae** Johnston, 1838
Genus ***Tayloripora*** Zágoršek, 2003
Tayloripora sp.
(Fig. 4a–c)

Material: GIS/CS: 030–033

Description

Colony erect, dichotomously branching, subcircular in cross-section. Autozooidal tubes long or medium sized separated by distinct, thin, autozooidal boundaries, frontal surface curved distally becoming flat proximally, finely porous. Peristomes short 0.108 mm (0.074–0.140 mm, 0.008, 07) and having diameter 0.131 mm (0.105–0.203 mm, 0.011, 07), longitudinally oval, projecting obliquely upward and turned in alternating fascicles. Dorsal surface convex with longitudinal slender kenozooids. Gonozooid not observed.

Remarks

In the present material the gonozooecium is unclear. So the presently this material provisionally assigned to genus *Tayloripora* on the basis of its appearance of autozooids, peristome and kenozooids on dorsal surface of colony.

Distribution

Kallankurichchi Formation, Ariyalur group, Cretaceous, South India.

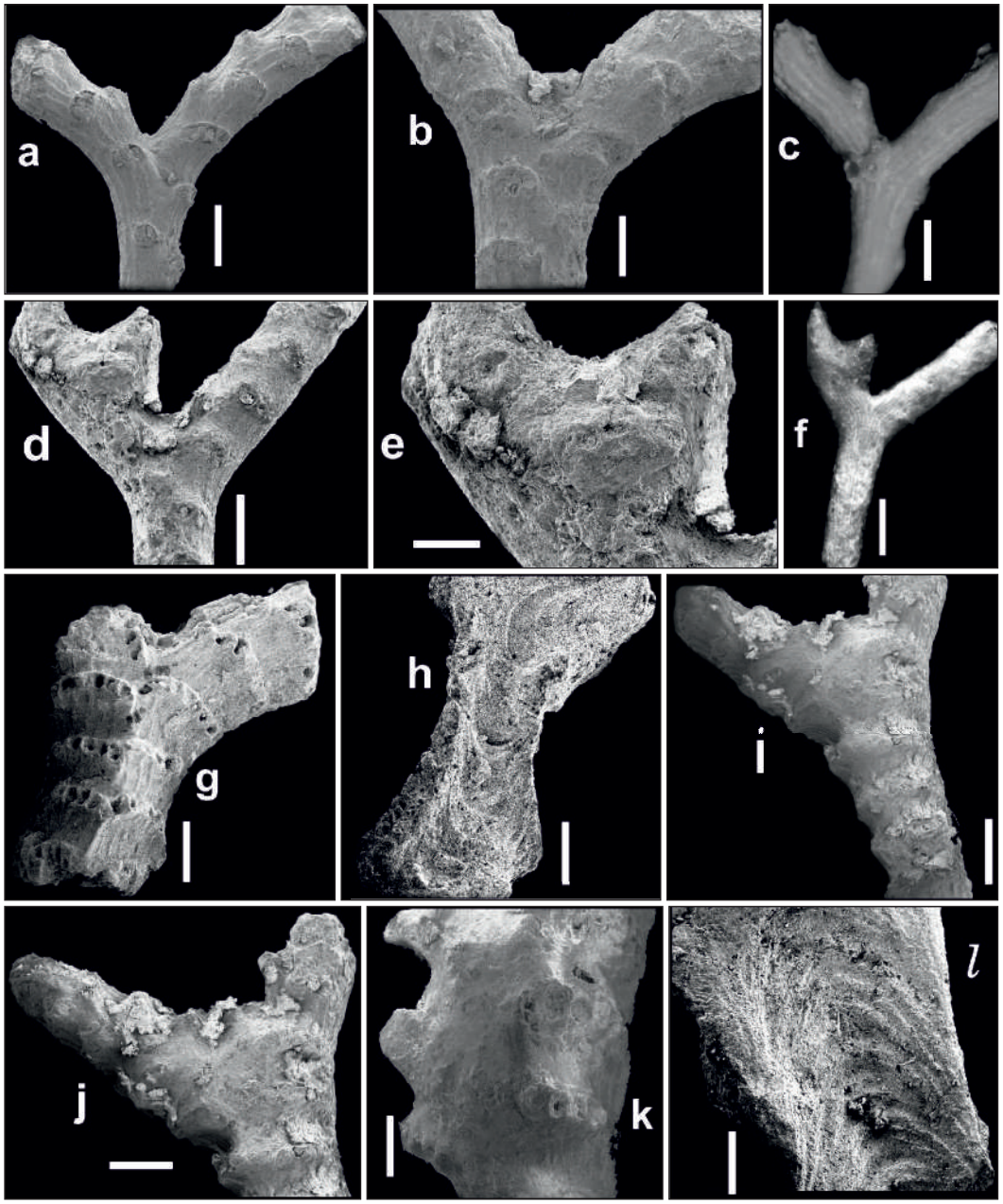

Fig.4. a-c, GIS/CS: 043–055, *Tayloripora* sp. **a**. Colony showing bifurcation, autozooids and peristome. **b.** Enlargement of the colony. **c.** Dorsal surface of the colony showing striations (Scale: a–500 µm, b–200 µm, c–100 px). **d-f,** GIS/CS: 056–065, *Idmidronea sastreii* n. sp.; **d.** General view of the colony showing gonozooecium. **e.** Enlargement of the gonozooecium. **f.** Micrograph of the dorsal surface of the colony showing longitudinal striations. (Scale: d–200 µm, e–100 µm, f–300 px). **g-h,** GIS/CS: 081–089, *Exidmonea robusta* (Brood), 1977; **g**. General view of the colony showing finely perforated autozooids. **h.** Dorsal surface of the colony showing concave striations. (Scale: g–500 µm, h– 200 µm). **i-l,** GIS/CS: 066–080, *Exidmonea* sp.; **i**. General view of the colony. **j.** Enlargement of the colony at bifurcation. **k.** Enlargement of autozooecia. **l.** Enlargement of the dorsal surface of the colony showing striations (Scale: i–500 µm, j–200 µm, k–100 µm, l– 100 µm).

Genus '***Idmidronea'*** Canu and Bassler, 1920
Idmidronea sastreii n. sp.
(Fig. 4d–f)

Material: GIS/CS: 034–043

Diagnosis

Autozooidal tubes moderate thick, frontal wall finely perforated, aperture curved with frontal surface, peristomes squarish and oblique, dorsal surface slightly convex with longitudinal striations. Kenozooids on dorsal side. Gonozooecium at one side of bifurcation. Ooeciopore circular.

Etymology

The species named after Dr. M. V. A. Sastry in recognition of his contribution to the Cretaceous fauna of the South India.

Description

Colony erect, made up of dichotomously branching stems

with triangular cross-section. Autozooidal tubes moderate and thick, arranged in alternating, transverse rows of three to four in each zooid. Autozooidal front finely perforated; indistinct due to secondary calcification. Apertures 0.166 mm (0.144–0.252 mm, 0.006, 09) long, projecting obliquely and slightly curved with frontal surface, separated by median ridge, peristomes squarish, thin and oblique, adjacent autozooids laterally separated by distinct thick ridges. Dorsal surface almost flat or slightly convex, decorated with longitudinal striations. Few kenozooids on dorsal surface. Gonozooecium 0.109 mm (0.105–0.115 mm, 0.001, 03) long and 0.113 mm (0.097–0.133 mm, 0.006, 03) wide, small, little lobated or globular, with minutely perforated surface, situated away from the bifurcation of the branch, ooeciopore subcircular.

Remarks

Idmidronea bombetokensis Brood, 1976 is similar with this new species in the autozooidal characters, kenozooids; however, differs in elongated gonozooecium and appearance of ooeciopore. In the description of *Exidmonea filiformis* Guha and Nathan 1996, observed minutely pitted striations on concave dorsal surface and gonozooecium placed on the median crest of the branch near bifurcation. However, in present specimens we observed longitudinal striations, few kenozooids on slightly convex dorsal surface and gonozooecium is placed on one side of bifurcation of branch and subcircular ooeciopore.

Distribution

Kallankurichchi Formation, Ariyalur group, Cretaceous, South India.

Genus ***Exidmonea*** David, Mongereau and Pouyet, 1972
Exidmonea robusta Brood, 1977
(Fig. 4g, h)

Idmidronea robusta Brood, 1977, p. 73, figs. 11A and 13A.

Material: GIS/CS: 044–048

Description

Colony erect, ramous, made up of dichotomously branching stems with triangular cross-section. Autozooidal tubes long and thick, arranged in alternating, transverse rows of seven to nine in each zooid. Autozooidal front finely perforated; indistinct due to secondary calcification. Apertures projecting obliquely and slightly curved with frontal surface, separated by median ridge, peristomes sub-circular 0.138 mm (0.111–0.161 mm, 0.007, 10) in diameter, thin and oblique, adjacent autozooids laterally separated by distinct thick ridges. Dorsal surface concave with smooth, thick edges, decorated with concave growth striations. Gonozooecium 0.129 mm (0.11–0.145 mm, 0.008, 02) long and 0.103 mm (0.097–0.113 mm, 0.005, 02) wide, elongate, placed on the median ridge of the autozooidal front. Ooeciopore not observed due to secondary deposition.

Remarks

This material agrees well with *Idmidronea robusta* Brood, 1977 in all essential characters; however, the ooeciopore is obscured due to secondary deposits in present specimen.

Distribution

Kallankurichchi Formation, Ariyalur group, Cretaceous, South India.

Exidmonea sp.
(Fig. 4i–l)

Material: GIS/CS: 049-052

Description

Colony erect, ramose, made up of dichotomously branching stems with triangular cross-section. Autozooidal tubes medium sized, arranged in alternating, transverse rows of three to seven in each zooid. Autozooidal front finely perforated; indistinct due to secondary calcification. Apertures projecting obliquely and slightly curved with frontal surface, separated by median ridge, peristomes more or less circular having 0.128 mm (0.114–0.146 mm, 0.003, 12) diameter, thin and oblique. Dorsal surface concave with smooth, thick edges, decorated with concave growth striations. Gonozooecium and Ooeciopore obscured due to secondary deposit.

Remarks

In this species the gonozooecium has lobate appearance at the bifurcation of the branch, however; it is long narrow in Brood's specimens of *Idmidronea africana* from the Upper Cretaceous of Need's Camp, South Africa (p. 74, fig. 10 A).

Distribution

Kallankurichchi Formation, Ariyalur group, Cretaceous, South India.

Discussion

Kallankurichi formation constitutes four members such as Kallar arenaceous member, Inoceramus limestone member, Tancem biostromal member and Srinvasapuram gryphean member (Ramkumar *et al*., 2020). This formation is marked by transgressional episodes (Hart *et al*., 2000). Occurrence of Inoceramus, Gryphea, Bryozoa and foraminifers suggests rise in sea level (Nagendra *et al*., 2011; Ramkumar *et al*., 2020). Neritic environment representing existence of benthic foraminifers *Gavelinella, Cibicides, Orbitoids, Siderolite* etc and palaeobathimetry below 50 m (Nagendra *et al.,* op.cit). There was deposition of biostromal limestone which was immensely bioturbated attributing transgressional event (Ramkumar and Satish, 2009). Bryozoa are dominantly occurring in three members except Kallar arenaceous member. Erect rigid delicate branching, erect flexible articulated branching and erect folios branching morphotypes are commonly observed in the three members. Stomatoporid morphotypes occurring in small percentage indicating *Proboscinopora cf. bassleri* found encrusting on *Inoceramus* and Gryphean shells. Further, Erect rigid folios and erect rigid delicate forms are abundant showing low to moderate energy and low rate of sedimentation (Amini *et al*., 2004; Nelson *et*

al., 1988; Smith, 1995). According to Amini *et al*., (2004) erect rigid and folios forms are found in middle shelf areas and erect delicate branching forms are found in moderate to shallow waters. Nagendra *et al*., (2010) reported mudstone and wackstone facies indicating a low energy environment in the Kallankurichi Formation. The associated mega fossils such as, *Pycnodonte, Pholodomya, Trigonia, Exxogyra, Lopha* suggests shallow water, tropical-subtropical, euhaline to stenohaline conditions in the Kallankurichi Formation (Tapaswi, 1978; Ayyasami, 2006).

Conclusions

The present study indicates the Kallankurichchi formation experienced transgrassive events. Bryozoan fauna of this area is suggestive of moderate energy, low rate of sedimentation deposited in the middle shelf environment. Along with bryozoa, the associated fauna indicates shallow water, tropical-subtropical, euhaline to stenohaline conditions in the studied region.

Authors' Contributions

MS: Conceptualization, Methodology, Supervision, Funding acquisition, Writing- Original Draft Preparation, Project Administration. **GK:** Software, Data Curation, Formal Analysis, Investigation. **DW:** Software, Data Curation, Methodology, Visualization, Resources, Writing- Review and Editing.

Conflict of Interest

No potential conflict of interest.

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