11. NEW RECORDS OF FIVE SPECIES OF COLONIAL ASCIDIANS OF THE GENUS *ECTEINASCIDIA* HERDMAN, 1880, FROM THE GULF OF MANNAR, INDIA

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Introduction

So far, only six species of colonial ascidians of the genus *Ecteinascidia* – *E. bombayensis* Das, 1938; *E. garstangi* Sluiter, 1898; *E. imperfecta* Tokioka, 1950; *E. krishnani* Renganathan & Krishnaswamy, 1985; *E. venui* Meenakshi, 2000; *E. sluiteri* Herdman, 1906, have been reported from India by earlier workers (Das 1938; Renganathan 1984, 1986; Renganathan and Krishnaswamy 1985; Meenakshi 2000; Meenakshi and Venugopal 2000). The present paper reports five more species, *E. diaphanis* Sluiter, 1885; *E. diligens* Sluiter, 1900; *E. koumaci* Monniot, 1987; *E. nexa* Sluiter, 1904 and *E. styeloids* Traustedt, 1882, for the first time from the Gulf of Mannar.

Ecteinascidia diaphanis Sluiter, 1885

Occurrence and distribution: The colony was collected from the intertidal rocky shore of Ervadi, (9° 11' N; 78° 43' E) Tamil Nadu, south-east coast of India, seen attached to the undersurface of rocks. Only a few zooids were intact. This species has been previously reported from Australia, Palau Islands and Indonesia.

Synonymy: *Ecteinascidia diaphanis* Sluiter, 1885, p. 168. Beneden, 1887, p. 28. Sluiter, 1904, p. 10. Tokioka, 1950, p. 127. Kott, 1964, p. 145. Kott, 1966, p. 292. Kott, 1985, p. 90.

External appearance: Individuals are small – 0.75-1 cm, upright, cylindrical tapering to a stalk posteriorly. There is a common basal stolon mass attached to the substratum to which the short posterior stalk is connected. The test is thin and transparent. The apertures are on short conical projections on opposite sides of the upper surface. Both the apertures have six lobes. The main test vessel leaves the body from the posterior end of the endostyle. Vascularisation of the test inconspicuous. Living specimens are light pinkish orange with a reddish orange band around the rim of apertures and base of siphons; the colour fades on preservation.

Internal appearance: Body wall thin and transparent with a fine network of muscles in the anterior half. Circular and longitudinal muscles are present in the siphons. Transverse muscles are not present between siphons, but posterior to the atrial siphon, a wide band of 35-40 fine parallel

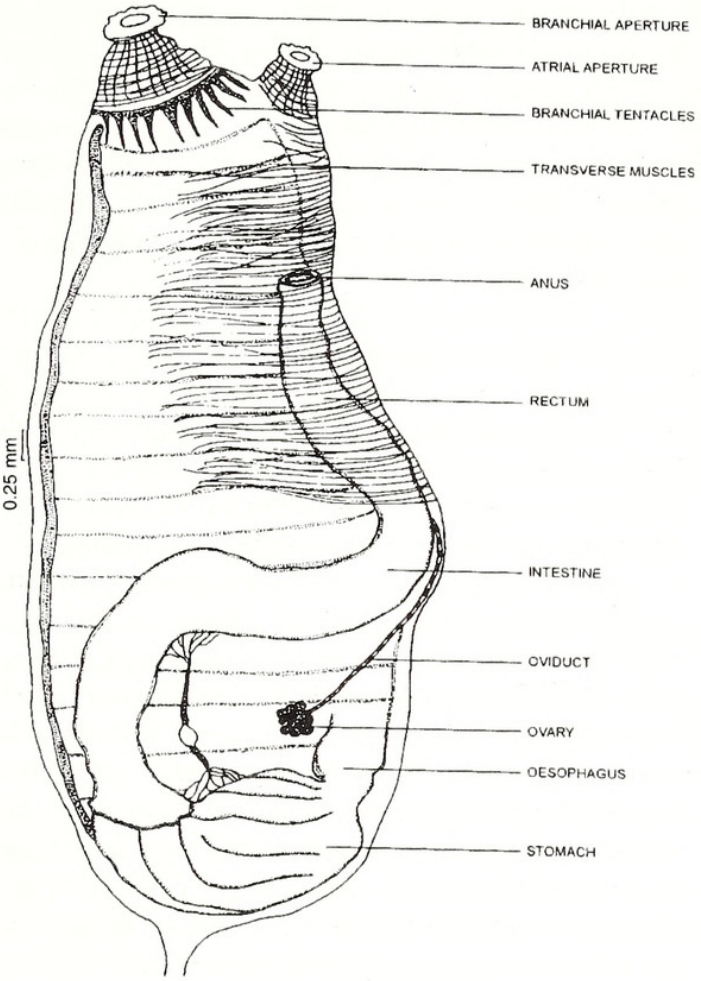

Fig. 1: *Ecteinascidia diaphanis*: Zooid from left side showing gut loop, ovary and muscles

muscles are present, which extends only three-fourths of the body on the right and half of the body on the left. Transverse muscles absent from the ventral half of the body (Fig. 1). The dorsal tubercle has a two-lipped opening. The dorsal lamina has long pointed transversely flattened languets without an upright membrane between them. The branchial sac has 16 rows, each row with about 45-50 stigmata. About 15 internal longitudinal vessels are present on each side with small rounded papillae at their junction with the transverse vessels. There are 3-4 stigmata per mesh. Oesophageal opening at the posterior end of the branchial sac. Oesophagus short, stomach large, rectangular with 5 spiral ridges. The mid-intestine

curves anteriorly and the intestine forms a wide curve towards the mid-dorsal border. Rectum extends anteriorly. There is a gastro-intestinal connective from the distal end of the stomach, which breaks up into many branches along the inner curve of the intestine. Gonads situated in the gut loop. Only ovary was found in the zooids examined. Larvae were not observed.

Remarks: This species is being reported for the first time in Indian waters. The present species can be identified by their transparent test, posterior position of stalk, wide band of transverse muscles behind the atrial siphon, absence of transverse muscles from the ventral half of the body, apertures on the upper surface on short conical projections, and transversely flattened languets. The present specimens have 16 rows of stigmata resembling Tokioka's specimens from Palau Islands, but differ from Kott's specimen from New South Wales which has 18-19 rows.

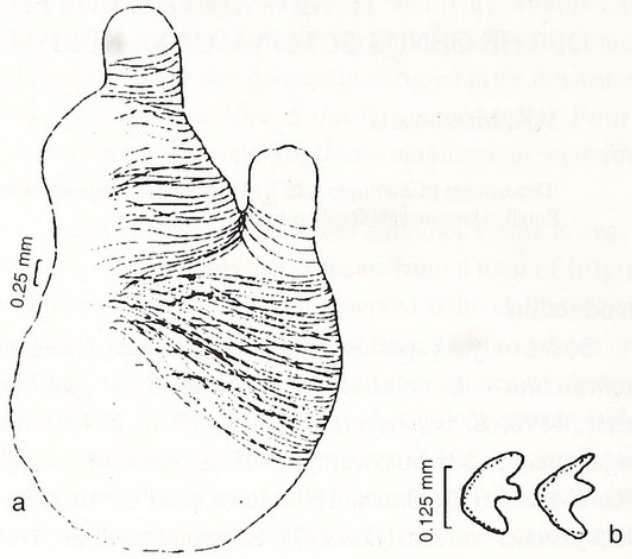

Fig. 2 (a-b): *Ecteinascidia diligens*:
a. Zooid from left side showing musculature;
b: branchial papillae

Ecteinascidia diligens Sluiter, 1900

Occurrence and distribution: Many colonies were collected from the littoral zone of Mandapam (9° 16' N; 79° 8' E), attached to the undersurface of calcrete rocks. This species has been previously reported from Philippines.

Synonymy: *Ecteinascidia diligens* Sluiter, 1900, p. 110.

External appearance: The colony consists of a crowded mass of zooids, a few of them fused along their sides to the adjacent zooid. A short stalk from the posterior ventral end of the body connects the zooids to a basal mass of stolon network. Largest zooid 9 mm high and 6 mm broad and the smallest one 6 mm x 4 mm. Posterior end of the body rounded. The test is thin, glassy and vascularised. Mud, sand, shell pieces and other epibionts were attached to it. In life, the zooids are reddish brown, but the colour was lost on preservation. The apertures are sessile in individuals with test, but when the test is removed siphons are visible as short cylindrical structures. Branchial aperture terminal with 7-9 small broad lobes, atrial aperture one-third of the distance along the dorsal surface with 6-9 small lobes.

Internal structure: Body wall thin, transparent with conspicuous network of blood vessels and yellowish brown pigments in life. Circular and longitudinal muscles are present in the siphons. Transverse muscles are present between the siphons and below the atrial aperture as parallel bands extending only three-fourths on the right side and halfway on the left side (Fig. 2a). About 40 branchial tentacles of two orders – long and medium – alternate with each other. Prebranchial area wide. Dorsal tubercle an oval cushion with a narrow inconspicuous slit. The dorsal lamina is inconspicuous and languets were not observed. The branchial sac has 11 rows, each with 35-40 stigmata. 8-12 internal longitudinal vessels are present on each side which are interrupted in many regions where the papillae are bifid (Fig. 2b). At other regions, the papillae are large and rounded. There are 3-4 stigmata between two papillae. Oesophagus at the posterior end of the branchial sac. The stomach is slightly elongate, smooth. Posterior stomach, mid-intestine not distinct (Fig. 2c). The anterior margin of the primary gut loop is in level with the anus present at the level of the 7th transverse vessel. The primary gut loop is deep with an open pole. The secondary gut loop is also deep and the axis passes through the oesophagus. Rectum fairly long on the mid-dorsal line.

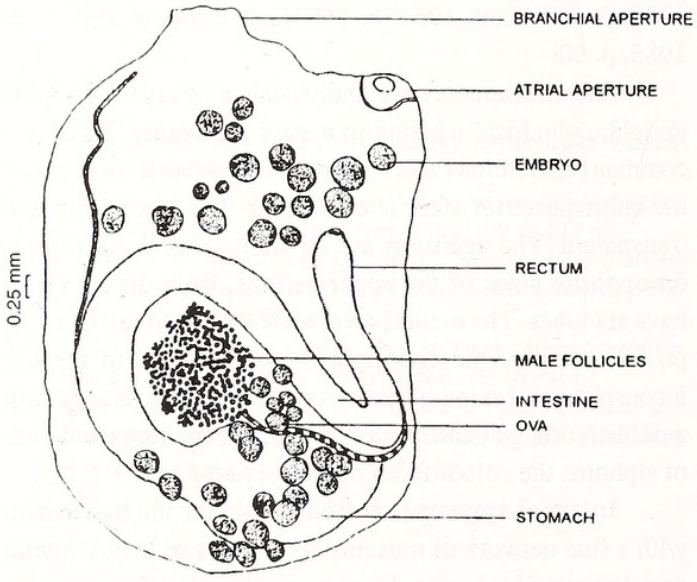

Fig. 2c: *Ecteinascidia diligens*: Zooid from left side showing gut loop, gonads and embryos packed in the peribranchial cavity

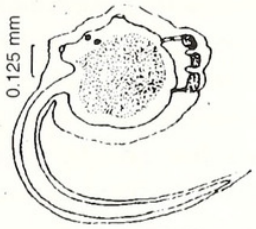

Fig. 2d: *Ecteinascidia diligens*: Larva

Anus with smooth border. Gastro-intestinal duct was not observed. The gonads consist of the testis follicles in the form of a bunch, occupying a major portion of the primary gut loop with a distinct vas deferens. 3-10 large ova situated in front of the testis follicles. About 54 embryos in various stages of development were present in the right peribranchial cavity. The larval trunk measures 0.5 to 0.6 mm with an otolith and ocellus. The adhesive organs are unstalked, present in the median vertical line. The tail extends more than halfway (Fig. 2d).

Remarks: The characters distinguishing the species are their colour (reddish brown in living colonies), parallel transverse muscles, between the siphons and posterior to the atrial siphon, primitive nature of the dorsal lamina, interrupted internal longitudinal vessels with bifid papilla, smooth stomach, anus, testis follicles behind the ovary, right peribranchial cavity packed with developing embryos and the larval trunk measuring only 0.5 to 0.6 mm.

The specimen studied has been deposited in the National Collections of the Zoological Survey of India, Chennai (Reg. No. AS. 18).

Ecteinascidia koumaci Monniot, 1987

Occurrence and distribution: Many colonies were seen attached to the undersurface of rocks in the littoral zone of Mandapam. This species has been previously reported from New Caledonia.

Synonymy: *Ecteinascidia koumaci* Monniot, 1987, p. 28.

External appearance: The colonies consist of large individuals, upright and cylindrical, 1 cm x 0.5 cm and smaller ones measuring 6 mm x 3 mm, attached to a basal mat of stolon by a short stalk from the postero-ventral corner of the zooid. The basal stolon has many small buds. The test is transparent, glassy and the mustard coloured gut and gonads can be clearly seen through the test in live specimens. Epibionts, sand and algal filaments were found attached to the test in a few zooids. The apertures are on conspicuous cylindrical siphons, the branchial aperture terminal with 6 lobes and the atrial aperture antero-dorsal with 6 lobes. The posterior end of the zooid may be rounded or tapering to

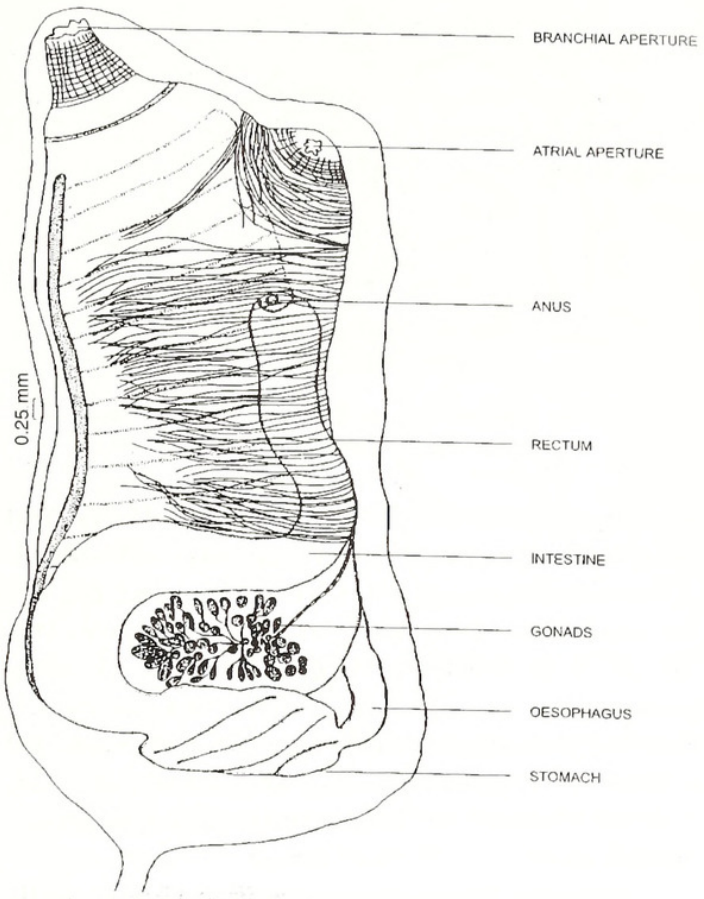

Fig. 3: *Ecteinascidia koumaci*: Zooid from left side showing gut loop, gonads and muscles

a stalk in a few zooids. The test is vascularised.

Internal structure: The body wall is thin and transparent. Circular muscles and short longitudinal muscles are present only in the siphons (Fig. 3). There are around 40-45 transverse muscles running parallel to each other extending only three-fourth of the sides of the body. There are 3-4 transverse muscles between the siphons. These muscles proceed towards the transverse muscles situated posterior to the atrial siphon and usually merge with them. More than 40 tentacles of two different sizes – medium and long. The dorsal tubercle is an elongated cushion with a simple opening. The dorsal lamina has large triangular languets laterally flattened, situated at places where the transverse vessel crosses the branchial sac with a membrane connecting them. The free ends of the languets are curved to the right. The pre-pharyngeal groove has no outgrowth. Branchial sac has 15 rows with 30 elongate stigmata in each half. 2-3 stigmata in a mesh. 13 internal longitudinal vessels, not interrupted. On either sides of the dorsal lamina internal longitudinal vessels are absent but are represented by small papillae. Branchial papillae inconspicuous. Primary gut loop wide. The axis of the secondary loop passes in front of the

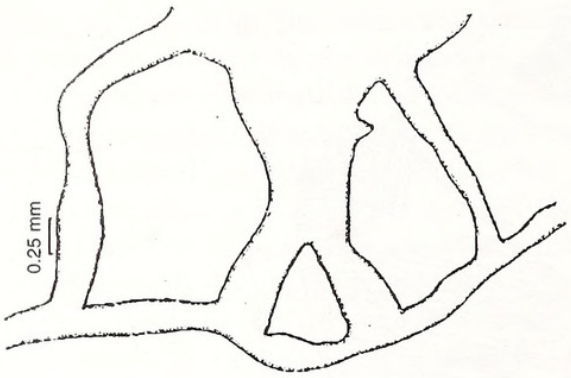

Fig. 4a: *Ecteinascidia nexa*: Accessory connectives from the posterior end of zooid

oesophagus, which is at the posterior end of the branchial sac. Stomach more or less rectangular and ridged. A constriction is present between the mid-gut and intestine. No intestinal pouches. Rectum is short. Anterior pole of the gut loop at the level of the 11th transverse vessel. A gastro-intestinal duct is present. Gonads consist of a central ovary with 10-12 ova and numerous elongate testis follicles arranged in a semicircle around the ovary. No larva was observed. A brood pouch with eggs observed on the posterior right side of the body.

Remarks: The characters used to distinguish the species are the open gut loop, the presence of 3-5 transverse muscles in the inter-siphonal area, membrane between the languets and ridges on the stomach. Most of the characters observed in the present species agree with the description of *Ecteinascidia koumaci* Monniot, 1987. But a few differences, such as size of the zooid, less number of rows of stigmata, less number of internal longitudinal vessels, were observed in the present specimen.

The specimen studied has been deposited in the National Collections of the Zoological Survey of India, Chennai (Reg. No. AS. 15).

Ecteinascidia nexa Sluiter, 1904

Occurrence and distribution: Many colonies were seen attached to the undersurface of calcrete stones in the littoral zone of Ervadi. This species has been previously reported from Australia, Indonesia, Fiji, Sri Lanka and Japan.

Synonymy: *Ecteinascidia nexa* Sluiter, 1904, p. 11. Herdman, 1906, p. 298. Tokioka, 1954, p. 255. Kott, 1966, p. 292. Kott, 1981, p. 196. Kott, 1985, p. 94.

External appearance: Colonies consist of crowded zooids forming extensive mats on the undersurface of stones, rocks, etc. The zooids are transparent or with a light greenish yellow colour. The alimentary canal and gonads are mustard yellow. Zooids are prostrate or upright, 4-5 mm long and 2-3 mm wide, attached by a short horny stalk from the posterior end of the ventral surface to a basal mass of stolons. In a few zooids, the stalk was found to arise from about the middle of the ventral surface. Accessory test connectives were observed only in a few zooids (Fig. 4a). The test is vascularised, thin, transparent, delicate and naked. The apertures are on short conical siphons, branchial aperture terminal with 8 lobes and atrial aperture 6-lobed halfway along the dorsal surface. The posterior end of the zooid is rounded and the zooid as a whole is egg-shaped.

Internal structure: Body wall is thin, delicate, vascularised and reddish brown after preservation. Circular muscles are present around the siphons, longitudinal muscles do not extend beyond the siphons, transverse muscles about 12-15 present between siphons and 16-20 posterior to the atrial siphon (Fig. 4b). These muscles extend almost the whole of the right side of the body, but only three-fourths on the left side. The dorsal tubercle is an oval cushion with a simple opening. The dorsal lamina has transversely flattened languets with a low basal membrane between them. The main test vessel originates from the body wall one-third to one-half the distance from the posterior end of the body. There are 12-15 rows of stigmata with 40-45 stigmata on each side. About 13 internal longitudinal vessels are present with 2-3 stigmata in each mesh. A few internal longitudinal vessels near the dorsal lamina are interrupted. Short rounded branchial papillae are present. There are about 30-45 branchial tentacles of two sizes – medium and long. The gut loop occupies the posterior half of the body. The primary gut loop is deep,

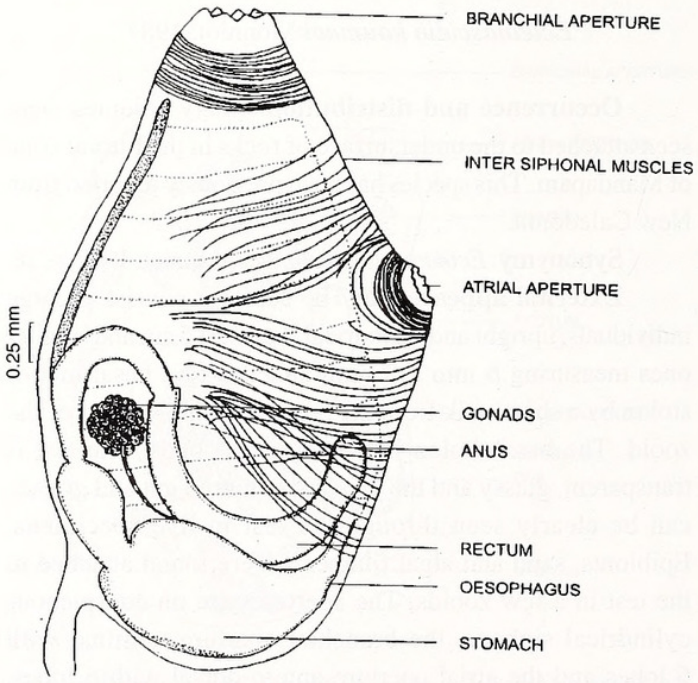

Fig. 4b: *Ecteinascidia nexa*: Zooid from left side

slightly open at the pole. The rectum forms a deep secondary loop with the descending limb of the intestine. The axis of the secondary gut loop passes through the middle of the stomach. Oesophagus is curved, situated at the posterior end of the branchial sac. The stomach is slightly elongate, horizontal without any ridges. A small posterior stomach is present. The mid-intestine is wide and there is a constriction between the mid-intestine and the narrow duodenal area. The rectum is short. The anterior pole of the gut loop is at the level of the 5th transverse vessel and the anus is smooth and situated at the level of the 8th transverse vessel. A gastro-intestinal duct is present. Gonads enclosed in the gut loop. The ovary is very small, situated in the centre of a circle of male follicles. Larvae were not observed.

Remarks: The characters mentioned by earlier workers were also observable in this Indian specimen. The important characters are the large carpet-like colonies, small prostrate zooids, position of atrial aperture, cloudy body wall, deep secondary gut loop and large smooth stomach.

The specimen studied has been deposited in the National Collections of the Zoological Survey of India, Chennai (Reg. No. AS. 14).

Ecteinascidia styeloids Traustedt, 1882

Occurrence and distribution: A few zooids were collected in June, 1993 from the intertidal rocky shores of Ervadi. This species has been previously reported from France.

Synonymy: *Ecteinascidia styeloids* Traustedt, 1882, p. 277. Van Name, 1921, p. 391. Van Name, 1930, p. 470. Monniot, 1983, p. 59.

External appearance: Zooids upright and sub-cylindrical, measuring 5-7 mm high. The test is delicate and transparent, with a network of blood vessels. The apertures are on long cylindrical siphons. The branchial aperture is terminal with 6 small inconspicuous lobes. Atrial aperture at the level of 4-5th row of gill slit and with 6 broad lobes. Body is rounded posteriorly and a stalk is present at the postero-ventral side attached to a sponge. The test is naked and the living colony has a slight red colour. The main test vessel arises from the posterior ventral end of endostyle.

Internal structure: Body wall is thin, transparent, circular and longitudinal muscles are present in the siphons. The transverse muscles include 25 intersiphonal muscles and 40-45 transverse muscles below the atrial siphon, which extend to about three-fourths of the body on both sides (Fig. 5). The dorsal tubercle is small, oval with a slit-like opening. The dorsal lamina has tongue-shaped transversely flattened languets. The branchial tentacles are of two sizes, very long and medium, about 50-60. The branchial sac has

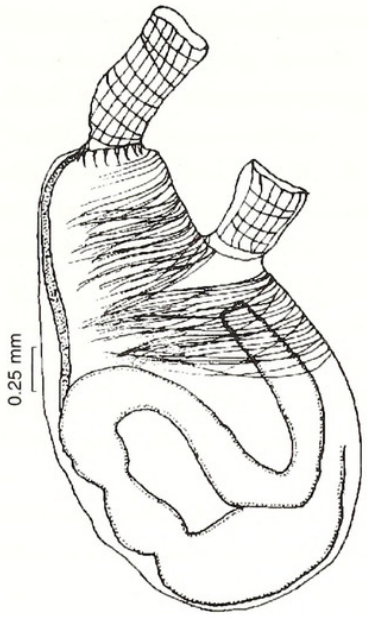

Fig. 5: *Ecteinascidia styeloids*: Zooid from left side showing gut loop and musculature

13 rows of about 20 stigmata in each row. There are 14 internal longitudinal vessels and 1-1½ stigmata per mesh. Branchial papillae are present at the junction of the internal longitudinal vessels. Transverse vessels are small and rounded. The gut forms a deep primary and secondary loop. Oesophagus is at the posterior end of the branchial sac. Stomach is smooth, rounded, lying horizontally. There is a constriction between the posterior stomach, mid-intestine and intestine. The axis of the primary gut loop is at the level of the 5th transverse vessel. The axis of the secondary gut loop passes through the posterior end of the stomach. The rectum is long and the smooth anus lies very near to the 4th transverse vessel. Gastro-intestinal duct not observed. Gonads were not present in the few zooids studied.

Remarks: This species is being reported for the first time from Indian waters. The characters by which this species can be identified are the long cylindrical siphons, inter siphonal muscles, deep primary and secondary gut loop and rounded smooth stomach.

The specimen studied has been deposited in the National Collections of the Zoological Survey of India, Chennai (Reg. No. AS. 17).

KEY TO THE SPECIES OF *ECTEINASCIDIA* RECORDED FROM INDIA

1. Both apertures on or near the anterior end of the body, no transverse muscles between apertures 2
— Atrial aperture dorsal, branchial aperture terminal, transverse muscles between atrial and branchial apertures 4
2. Transverse muscles in 3 longitudinal bands ..... *E. sluiteri*
— Transverse muscles not in 3 longitudinal bands 3

3. Almost sessile apertures, transversely flattened languets ..... *E. diaphanis*
— Short cylindrical siphons, laterally flattened languets with a membrane between them ..... *E. venui*
4. Only 3-5 transverse muscles between siphons .. *E. koumaci*
— More than 3-5 transverse muscles between siphons 5
5. Meshwork of muscles on the right side of the body .... *E. imperfecta*
— No meshwork of muscles on the right side of the body 6
6. 11 rows of stigmata ..... *E. diligens*
— More than 11 rows of stigmata 7
7. Anterior border of gut loop level with the anus ..... *E. krishnani*
— Anterior border of gut loop not level with the anus 8
8. Stomach with longitudinal folds ..... *E. bombayensis*
— Stomach without longitudinal folds 9
9. With conspicuous siphons ..... *E. styeloids*
— Without conspicuous siphons 10
10. Large carpet-like colonies with prostrate zooids, cloudy body wall, large spherical smooth stomach ..... *E. nexa*
— Colonies not crowded, erect zooids, body wall not cloudy, small oval smooth stomach ..... *E. garstangi*

ACKNOWLEDGEMENTS

The author expresses her deep sense of gratitude to Dr. T.K. Renganathan, former Professor, Department of Zoology, V.O. Chidambaram College, Tuticorin, for his kind help in the identification of specimens and to the U.G.C., New Delhi, for financial assistance.

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12. BIODIVERSITY OF WILD SILK MOTHS IN NAGALAND

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Introduction

Wild silk moths are a relatively well-known group of insect fauna of Family Saturniidae. They are admired by people throughout the world (Peigler 1996). A good number of references are available on seribiodiversity and its potential as the source of natural silk in the Indian subcontinent,