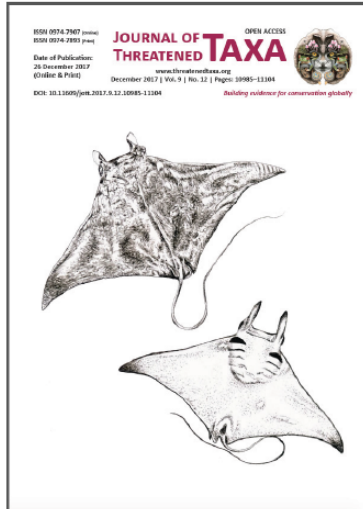


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## ADDITIONS TO THE SEA SNAIL FAUNA (MOLLUSCA: GASTROPODA: OPISTHOBANCHIA) OF LAKSHADWEEP ISLANDS, INDIA

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**Abstract:** Among the 373 species of opisthobranchs reported from India, 92 are from Lakshadweep. This paper documents 11 species of opisthobranch fauna from Lakshadweep Islands, classified under the families Haminoeidae, Colpodaspididae, Volvatellidae, Dendroborididae, Chromodorididae, Goniodorididae, Embletoniidae, and Tergipedidae, of which five are new records to India. *Goniobranchus rufomaculatus* and *Volvatella ventricosa* are reported for the first time from the western Indian Ocean.

**Keywords:** Coral islands, Indian Ocean, Lakshadweep, new records, opisthobranch, sea slug, union territory.

Opisthobranchs are a group of marine sea snails characterised by many unique features (Yonow 2008). They are diverse in morphological, dietary, and feeding aspects, and are ideal indicators of ecosystem health. They are characterised by unique behaviour such as kleptoplasty and maintenance of photosynthetically active chloroplasts in their body, acquisition of nematocysts from cnidarian prey, in situ synthesis of repugnatory fluids, and aposematic colouration (Wägele & Willan 2000). They have a strong chemical defence system by synthesising potent biochemicals as secondary metabolites (Beesoo et al. 2014) which possess pharmaceutical value. They are distributed in almost all marine habitats and are present in both temperate and tropical waters. Even though opisthobranchs were the least studied molluscan group in India, of late

there is renewed research interest in this fauna (Apte 2009, 2012; Apte et al. 2010, 2012; Raghunathan et al. 2010; Ramakrishna et al. 2010; Bhavé & Apte 2011, 2013; Sreeraj et al. 2012; Apte & Bhavé 2014; Carmona et al. 2014, 2016). Among the 373 species reported from India (Venkataraman et al. 2015), 92 are from the Lakshadweep group of Islands (Ravinesh & Bijukumar 2015). The earlier works on opisthobranchs of Lakshadweep Archipelago include those of Eliot (1903), Smith (1903), Hornell (1921), Nagabhushanam & Rao (1972), Rao et al. (1974), Sakthivel (1974), Namboodiri & Sivadas (1979), Appukuttan et al. (1989), Rao & Rao (1991) and Rao (2003). Subsequently, Apte (2009), Apte & Salahuddin (2011), Susan et al. (2012), Ravinesh et al. (2013), and Apte & Bhavé (2014) compiled information on opisthobranchs of these islands. Ravinesh & Bijukumar (2015) published a consolidated checklist of marine molluscs from Lakshadweep Islands. In the present study, 11 additional species of opisthobranchs are reported from various islands of Lakshadweep.

### MATERIALS AND METHODS

Live specimens were collected by snorkelling and handpicking from the intertidal areas, lagoons, and sea grass beds up to 4m depth. Specimens were photographed and documented alive, then preserved

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Competing interests: The authors declare no competing interests.

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in 90% ethyl alcohol for further taxonomic studies. All voucher specimens are deposited in the museum collections of the Department of Aquatic Biology and Fisheries, University of Kerala, India (accession numbers DABF/UOK/GAS 05-22).

Specimens were collected from Kavaratti (10.56500000N & 72.62611111E), Kadmat (11.17833333 N & 72.76027778 E), Kalpeni (10.06833333 N & 73.63361111 E), Minicoy (8.32305556 N & 73.07888889 E), Bitra (11.59916667 N & 72.18527778 E), and Chetlat (10.68111111 N & 72.70527778 E) islands of Lakshadweep Archipelago from December 2013 to June 2015.

## RESULTS

During the survey 11 species of opisthobranchs were recorded for the first time from Lakshadweep Islands; of these, five are new records to India.

Infra-class: Opisthobranchia Milne-Edwards, 1848

Order: Cephalaspidea P. Fischer, 1883

Superfamily: Haminoeidea Pilsbry, 1895

Family: Haminoeidae Pilsbry, 1895

Genus: *Atys* Montfort, 1810

### 1. *Atys semistriata* Pease, 1860 (Image 1 a–c)

Synonyms: *Atys semistriata fordinsulae* Pilsbry, 1921; *Atys semistriata mua* Pilsbry, 1921

Materials examined: 12; accession numbers: DABF/UOK/GAS 05-07

Size: Shell length 4.5–5.7 mm, width 2.8–3.1 mm.

Locality: Kadmat, Kavaratti, Agatti, and Minicoy islands

Description: Animal is translucent white in colour. The cephalic region and parapodia are characterised with numerous brown spots. The body is speckled with numerous small peach coloured spots visible through the shell on the dorsal surface of the body. Two anteriorly

placed black eye spots are visible. Foot elongate with small white blotches. Ovate, transparent barrel shaped shell light brown and wider at the middle, protruded at the anterior region and truncated, narrower at the posterior end. Conspicuous striations are seen at the shell base and apex, closer together at the ends. The central portion of the shell is without striations. There are approximately 10 anterior grooves and 12 posterior grooves in the shell. Spire sunken, shell aperture broader anteriorly and narrow posteriorly.

Size: Shell length 4.5–5.7 mm, width 2.8–3.1 mm

Remarks: Widely distributed in the Indo-Pacific, this species was first recorded from the Sandwich Islands (Pease 1860). This is a new record to India. Collected from intertidal areas and found among the seaweed *Halimeda* sp., at a depth of 1.5m.

Distribution: Madagascar, Indonesia, Malaysia, Japan, Philippines, Papua New Guinea, New Caledonia, Guam, Tahiti, Hawaii (Ingram 1939; Kuroda & Habe 1952; Gosliner et al. 2008; Too et al. 2014), North Tutuila Island, Samoa (Rudman 2000a), Red Sea (Yonow 2008).

Superfamily: Philinoidea Gray, 1850 (1815)

Family: Colpodaspididae Oskars, Bouchet & Malaquias, 2015

Genus: *Colpodaspis* M. Sars, 1870

### 2. *Colpodaspis thompsoni* G.H. Brown, 1979 (Image 2)

Material examined: 1; Accession number: DABF/UOK/GAS 08

Size: Length 2mm

Locality: Kavaratti Island

Description: Small, tiny black body with numerous large yellow pustules bordered by white rings; tail black. An exhalant siphon is present on the right, at the back of the body. Rhinophores rolled, with whitish tips. Thin coiled and delicate internal shell remains completely

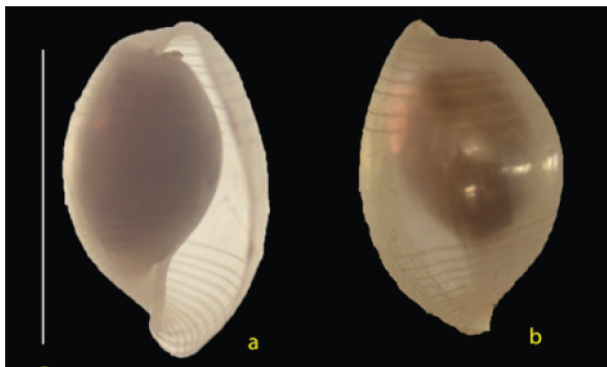


Image 1 a–c. *Atys semistriata* Pease, 1860. a - ventral view of shell; b - dorsal view of shell (scale = 5mm); c - live animal 5mm.



Image 2. *Colpodaspis thompsoni* G. H. Brown, 1979. Live animal, 2mm.

enveloped by the mantle. The foot is conspicuous, with a central groove and expanded to form a rounded lobe in the anterior region and is visible beneath the rhinophores. Large mucous gland is present in the foot which helps the animal to attach firmly to the substratum.

Remarks: First described from the Tanzanian coast (Brown 1979). A new record for India. Found crawling on the hard coral *Goniastrea pectinata* at a depth of 0.80m.

Distribution: Red Sea (Heller & Thompson 1983, Yonow 2008), Japan, Réunion, Queensland, Christmas Island (Rudman 2000b), Fiji (Brodie & Brodie 1990), Guam (Carlson & Hoff 2003), Hawaii Islands (Gosliner et al. 2008), Tanzania (Brown 1979), Madagascar (Gosliner et al. 2008), and Mozambique (Tibiriçá & Malaquias 2016).

Order: Sacoglossa Ihering, 1876

Superfamily: Oxynooidea Stoliczka, 1868

Family: Volvatellidae Pilsbry, 1895

Genus: *Volvatella* Pease, 1860

**3. *Volvatella ventricosa* Jensen & Wells, 1990 (Image 3a, b)**

Material examined: 1; accession number: DABF/UOK/GAS 09

Size: Length 7mm

Locality: Chetlat Island

Description: The animal is green in colour in live condition when viewed exteriorly through the shell, but appears straw coloured when preserved in ethanol. Rhinophores conical, small, conspicuous, and white. White oral tentacle is present in the anterior region. Eyes are located at the base of anterior tentacle. Cephalic shield is absent. White foot with rounded

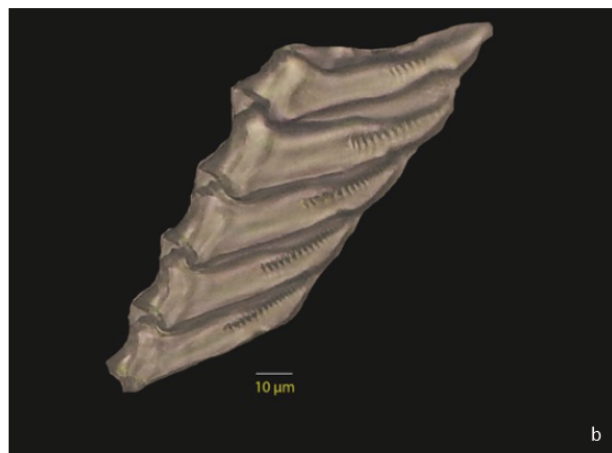
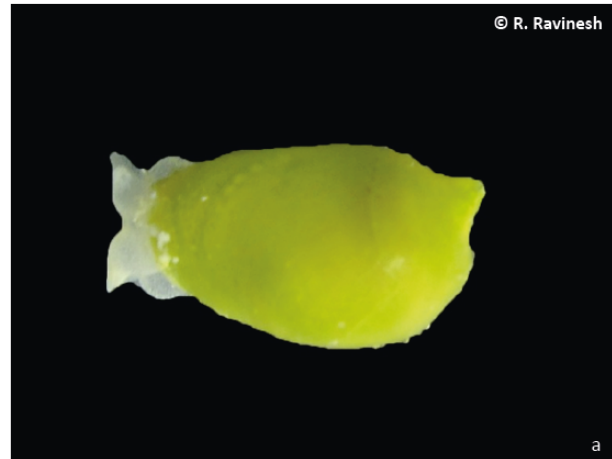


Image 3. *Volvatella ventricosa* Jensen & Wells, 1990. a - live animal, 7mm; b - Radular teeth.

anterior region. Calcareous, ovate, thin delicate shell with a conspicuous posterior spout skewed towards the right side of the shell (Image 3a). Radular teeth elongate with numerous fine denticles distally (Image 3b).

Remarks: The distribution records of *V. ventricosa* shows the presence of this species in the western and central Pacific. First record for the Indian coast and new distribution record for the western Indian Ocean. The species was collected from the intertidal area along with the sea weed *Caulerpa* sp. at a depth of 1m.

Distribution: Australia (Jensen & Wells 1990), Singapore (Jensen 2015).

Order: Nudibranchia Cuvier, 1817

Superfamily: Phyllidioidea Rafinesque, 1814

Family: Dendrodorididae O'Donoghue, 1924 (1864)

Genus: *Dendrodoris* Ehrenberg, 1831

**4. *Dendrodoris krusensternii* (Gray, 1850) (Image 4)**

Synonyms: *Actinodoris krusensternii* Gray, 1850; *Dendrodoris clavulata* (Alder & Hancock, 1864); *Dendrodoris denisoni* (Angas, 1864); *Dendrodoris*

*gemmacea* (Alder & Hancock, 1864); *Doridopsis clavulata* Alder & Hancock, 1864; *Doridopsis gemmacea* Alder & Hancock, 1864.

Material examined: 1; accession number: DABF/UOK/GAS 13

Size: Length 19mm

Locality: Bitra Island

Description: Body is ovate, convex and brown in colour; numerous yellowish fleshy tubercles with light purplish lines are found scattered on the dorsum; presence of three rows of isolated smooth brown patches with 3–5 electric blue spots is a feature of the species; two rows of these emerge laterally beyond the rhinophore clubs and one seen midline on the dorsum. The mantle edge is bordered with alternate white and purplish colour. Brown lamellate rhinophore clubs with light yellow tips. Light yellow large, feathery gills with brown rachis. Foot is light purplish in colour.

Remarks: *Dendrodoris krusensternii* is a widespread species in the Indo-Pacific (Valdés & Fahey 2006) and from Indian waters it is recorded from Andaman and Nicobar Islands (Ramakrishna et al. 2010; Venkataraman et al. 2015), Andhra Pradesh (Alder & Hancock 1864) as *Dendrodoris denisoni* (Angas, 1864) and from Goa (Apte & Desai 2017). The current record extends its distribution to the Lakshadweep coasts.

Distribution: Tropical and warm temperate Indo-West Pacific (Rudman 1998), Japan (Valdés & Fahey 2006), Red Sea (Yonow 2015), Andhra Pradesh (Alder & Hancock 1864), Andaman & Nicobar Islands (Ramakrishna et al. 2010; Venkataraman et al. 2015).

Superfamily: Doridoidea Rafinesque, 1815

Family: Chromodorididae Bergh, 1891

Genus: *Ardeadoris* Rudman, 1984

#### 5. *Ardeadoris angustolutea* (Rudman, 1990) (Image 5)

Synonym: *Noumea angustolutea* Rudman, 1990

Material examined: 1; accession number: DABF/UOK/GAS 14

Size: Length 5mm

Locality: Minicoy Island

Description: Body elongate, ovate, and translucent creamy white in colour. Mantle skirt broad, wavy and is bordered with an opaque white band. Presence of a median white patch extending from anterior to the rhinophore covering the gill arc posteriorly. Rhinophoral sheath is raised and translucent white in colour. The orange lamellate rhinophores are elongate, tapering, and the midlines marked by a white line posteriorly. Gills simple, upper half orange, lower half white; arranged posteriorly in a cirlet around the anus. White foot with



Image 4. *Dendrodoris krusensternii* (Gray, 1850). Live animal, 19mm.

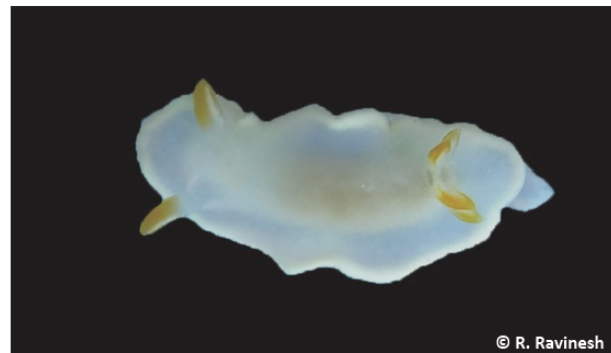


Image 5. *Ardeadoris angustolutea* (Rudman, 1990). Live animal, 5mm

opaque white margin extends beyond the mantle.

Remarks: From Indian waters, presence of this common Indo-Pacific species was reported from the Andaman and Nicobar Islands (Sreeraj et al. 2013; Venkataraman et al. 2015; Apte & Desai 2017). *Ardeadoris angustolutea* is reported for the first time from Lakshadweep.

Distribution: Indo-West Pacific (Rudman 1990), Marshall Island (Johnson & Gosliner 2012), Hawaii (Matsuda & Gosliner 2017).

Genus: *Goniobranchus* Pease, 1866

#### 6. *Goniobranchus conchyliaius* (Yonow, 1984) (Image 6)

Synonym: *Chromodoris conchyliaia* Yonow, 1984

Materials examined: 2; accession number: DABF/UOK/GAS15-16

Size: Length 7–9 mm

Locality: Kavaratti, Kadmat islands

Description: Body ovate, anterior portion slightly wider than the rest of the body. Mantle white, not smooth, with numerous yellow pustules and deep

violet markings; mantle edge wavy and white. One violet marking is present anterior to the rhinophores, one on the middle of the dorsum, which is X-shaped, and the last one is in the front of the gills. Rhinophores perfoliate with deep orange lamellae on translucent white stalks. Eight simple pinnate gills arranged in a circlet around the anus. A thin, continuous deep violet line runs laterally between the foot and the mantle. The underside of the anterior mantle flap is thickly bordered by deep orange and an inner dark violet line. Foot white extended beyond the mantle.

Remarks: *Goniobranchus conchylatus*, although found widespread on both east and west coasts of India, is recorded for the first time from the Lakshadweep. In the island it was found on rock along with hydroids and bryozoans, up to depth of 3m.

Distribution: Sri Lanka (Yonow 1984), Seychelle Islands (Yonow 2012), Thailand, Maldives, Myanmar (Rudman 2000c), Andaman & Nicobar Islands (Sreeraj et al. 2012; 2013; Shaktivel et al. 2014), Goa (Apte & Desai 2017).

#### 7. *Goniobranchus rufomaculatus* (Pease, 1871) (Image 7)

Synonyms: *Chromodoris histrio* Bergh, 1877; *Chromodoris rufomaculata* Pease, 1871; *Glossodoris rufomaculata* (Pease, 1871)

Material examined: 1; accession number: DABF/UOK/GAS16

Size: Length 3.31mm.

Locality: Kavaratti Island.

Description: Body elongate, mantle white, wavy with numerous small yellow spots except at the mantle edge; mantle edge is ornamented with dark violet spots in a

light violet band. A blurred creamy yellow submarginal band is present. Rhinophores perfoliate with brown lamellae on a translucent stalk. Rhinophore lamellae edged in a white line, on both anterior and posterior regions. Translucent white, simple, feathery gills on white rachis arranged in a cup-shaped cluster posteriorly around the anus. Foot white and extends beyond the mantle.

Remarks: Rudman (1987) recorded this species from Australia. This is a new record to both India and the western Indian Ocean. This species closely resembles *Goniobranchus alius* (Rudman 1987). *Goniobranchus rufomaculatus* differs from the other species in the genus by its narrow mantle overlap, erect cup-shaped gill cluster, and indistinct yellow submarginal band.

Distribution: Tahiti (Pease, 1871), Australia (Rudman 1987), Japan, Philippines (Debelius & Kuitert 2007).

Genus: *Mexichromis* Bertsch, 1977

#### 8. *Mexichromis pusilla* (Bergh, 1874) (Image 8)

Synonyms: *Chromodoris pusilla* Bergh, 1874; *Durvilledoris pusilla* (Bergh, 1874)

Material examined: 1; accession number: DABF/UOK/GAS 17

Size: Length 4mm.

Locality: Kalpeni Island.

Description: Elongate pink-bluish coloured body. Irregular light yellowish-cream band along the mantle edge, narrowing at three places: one behind the rhinophores, the other just in front of the gills, and at the posterior end after gills. Two prominent, discontinuous white streaks present on the dorsum, one between the rhinophore and the second just in front of the gills. The purple colour stains the creamy white band in front of the rhinophores, laterally on either side of the first



Image 6. *Goniobranchus conchylatus* (Yonow, 1984). Live animal, 7–9 mm.



Image 7. *Goniobranchus rufomaculatus* (Pease, 1871). Live animal, 3.31mm.

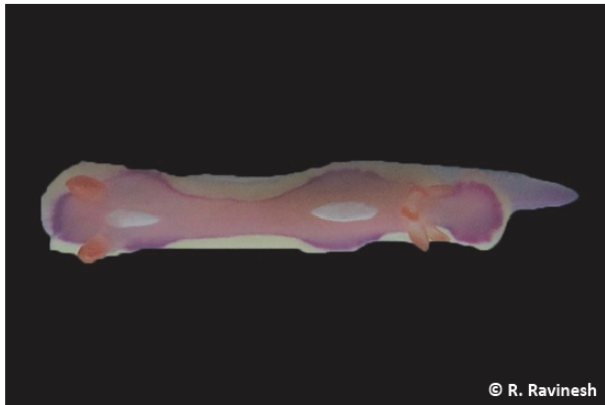


Image 8. *Mexichromis pusilla* (Bergh, 1874). Live animal, 4mm.



Image 9. *Trapania euryeia* Gosliner & Fahey, 2008. Live animal, 3–3.5 mm.

white streak, laterally on either side of the second white streak, and behind the gills. The orange rhinophoral club sits on a translucent white stalk. Eight simple gills have a white rachis and orange lamellae, and are arranged in a circlet. Foot elongate, purplish in colour dorsally, white ventrally, and extends beyond the mantle.

Remarks: This species is recorded for the first time from Lakshadweep.

Distribution: North western Australia, Enewetok Atoll (Rudman 1986), South Africa (Gosliner 1987), Maldive islands (Yonow 1994), Red Sea (Yonow 2008), Andaman (Sreeraj et al. 2013; Venkatraman et al. 2015; Apte & Desai 2017).

Superfamily: Onchidoridoidea Gray, 1827

Family: Goniodorididae H. Adams & A. Adams, 1854

Genus: *Trapania* Pruvot-Fol, 1931

#### 9. *Trapania euryeia* Gosliner & Fahey, 2008 (Image 9)

Materials examined: 2; accession number: DABF/UOK/GAS 19

Size: Length 3–3.5 mm.

Locality: Kavaratti Island.

Description: Body elongate, convex with a broad central region. Body dark brown with fine yellow speckling all over the body. The dorsum bears highly dispersed symmetrical yellow marking from anterior to posterior. A distinct yellow marking is present between the oral tentacles, which are short and rounded. Presence of a large, conspicuous yellow marking between the rhinophores and the branchial plume. There is also a long yellow marking extending behind the gill up to the posterior tip of the body. Small lamellate rhinophore clubs with elongate white tips, which bear seven lamellae with varying amounts of brown and yellow from the base to half way up. Two pairs of

recurved lateral processes, one with each rhinophoral club and the others placed on either side of the gills. Posteriorly placed bipinnate gills; predominance of yellow with brown tinges and spots throughout the gills. The anterior region of the foot is expanded laterally into foot corners.

Remarks: Originally described from Madang, Papua New Guinea by Gosliner & Fahey (2008). This is a new record to Lakshadweep islands. Seen crawling on rocks among hydrozoans and bryozoans at depths of 0.7–3 m.

Distribution: Réunion, Papua New Guinea, Indonesia: Sulawesi and Bali; Okinawa, Marshall Islands, Hawaii (Rudman 2008), Madang, Papua New Guinea (Gosliner & Fahey 2008), Red Sea (Yonow 2015), Andaman & Nicobar Islands, India (Apte & Desai 2017).

Family: Embletoniidae Pruvot-Fol, 1954

Genus: *Embletonia* Alder & Hancock, 1851

#### 10. *Embletonia gracilis* Risbec, 1928 (Image 10)

Synonyms: *Embletonia paucipapillata* Baba, 1967; *Embletonia gracilis paucipapillata* Baba & Hamatani, 1963

Materials examined: 8; accession numbers: DABF/UOK/GAS 20-21

Size: Length 12–16 mm.

Locality: Kavaratti Island.

Description: Body slender, elongate and translucent white. A single row of six pairs of peach-coloured cerata. Presence of bifid structures on the ceratal tips. Presence of numerous small opaque white spots are scattered throughout the dorsal side of the animal. Bilobed, rounded oral veil and is seen in front of the rhinophores. Rhinophores short, cylindrical, translucent, and distantly spaced; a clear white marking is present





Image 10. *Embletonia gracilis* Risbec, 1928. Live animal, 12–16 mm.

between the rhinophores. Each ceratal base emerging from the notum is characterised by an opaque white circular marking.

Remarks: The only earlier record of *Embletonia gracilis* from India was from Ratnagiri (Apte et al. 2012). This is a new record to Lakshadweep. The specimens were found crawling on hard coral *Porites solida* (Forskål, 1775) at a depth of 4m.

Distribution: New Caledonia, Christmas Island (Rudman 2002), South Africa, Japan, Red Sea (Yonow 2000; 2008), New Zealand (Miller & Willan 1991), Ratnagiri (Apte et al. 2012).

Superfamily: Fionoidea Gray, 1857

Family: Tergipedidae Bergh, 1889

Genus: *Phestilla* Bergh, 1874

**11. *Phestilla melanobranchia* Bergh, 1874 (Image 11)**

Material examined: 1; accession number: DABF/UOK/GAS 22

Size: Length 4mm.

Locality: Kavaratti Island.

Description: Body translucent white with numerous black cerata with opaque white tips. A central white area is present along the entire length of the body which is devoid of cerata. Arrangement of cerata is on an elevated cushion on either side of the body. Rounded oral veil with long oral tentacles arising from its edges. Rhinophores are long, slender, smooth, and white.

Remarks: Many colour morphs of this species were reported in the Indo-West Pacific, as colour variation occurs in accordance with diet (Yonow 2008). This is a new record to Lakshadweep islands.

Distribution: Queensland (Rudman 1981), Red Sea (Yonow 2000, 2008), Maldives (Yonow 1994), Thailand (Mehrotra & Scott 2016).

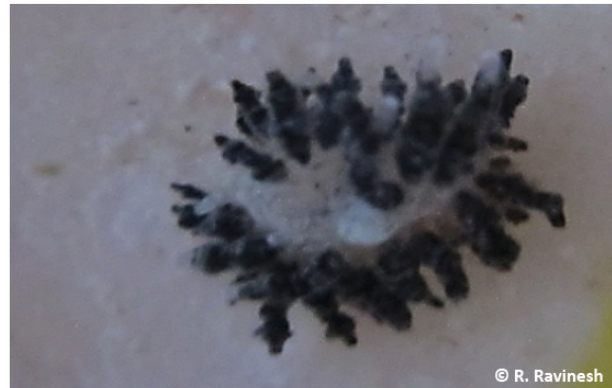


Image 11. *Phestilla melanobranchia* Bergh, 1874. Live animal, 4mm.

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