






Aggregations of a Sessile Ctenophore, *Coeloplana* sp., on Indo-West Pacific Gorgonians

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Abstract: We document the benthic ctenophores *Coeloplana* sp. and *Vallicula multiformis* from Oman, extending their geographic range. A new *Coeloplana* species was found forming aggregations on gorgonians of two octocoral host genera, *Melithaea* and *Euplexaura*, representing associations previously unknown to occur in the Indo-West Pacific region. Our findings also illustrate the concurrent presence of the ectocommensal ophiuroid *Ophiothela mirabilis*, which adversely affects other *Coeloplana* species in the tropical West Atlantic, where it is considered invasive. This exploration contributes to our understanding of the biogeography, species distribution, and ectosymbiotic associations of these genera, setting the stage for a comprehensive species description and in-depth analysis of host relationships in future studies.



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The realization that ctenophores are the sister group to all other Metazoa [1,2] and that many aspects of their biology are likely convergent with other phyla, is attracting attention to this small phylum. Ctenophores, commonly known as comb jellies, are most diverse, and thought to have originated in the plankton, but three lineages have taken up a benthic existence [1–4].

The order Platyctenida is the main group of benthic ctenophores, characterized by an expanded oral region that forms a creeping sole, loss of ctenes in the adults of most species, and extensive tentacles extended by flow for prey capture [5–7]. They predominantly exhibit two distinct body types: the “lyre-shaped” form, which has two large aboral projections to extend tentacles into the water column, and the “flat” form with oral-aboral compression.

Most platyctenes are ectosymbiont commensals that live in close association with cnidarians, echinoderms, and algae [6–10]. The number of individuals per host depends on the species, host, and environmental conditions and can vary from one to hundreds [7,8,11]. Brooding, paedogenesis, and fragmentation are the main modes of propagation. Hermaphroditism, larval dispersal, and rapid development are likely traits that promote colonization, sustain high population densities, and provide resilience [12].

They are consumed by various predators, including sea anemones, molluscs, brachyuran crabs, and fishes [8,13,14].

The order Platyctenida is currently divided into five families, with Coeloplanidae being the most diverse [15]. Coeloplanidae includes two genera, *Coeloplana* Kowlevsky, 1880, with about 35 species [15], one species in the West Atlantic, and the rest in the Indo-West Pacific region; and the monotypic *Vallicula* Rankin, 1956, recorded across all warm oceans (Figure 1). Recent molecular studies suggest that the genus *Vallicula* belongs to a different family (Bezio and Collins, pers. comm.). *Coeloplana* is differentiated by its flask-shaped tentacle sheaths from *Vallicula*, which has anchor-shaped (or H-shaped) sheaths with a prominent cross-piece [5]. Six species of *Coeloplana* have been reported from the northwestern Indian Ocean, one from the Persian Gulf [16] and Somalia [17], and five from the Red Sea [6,18] (Figure 1A,B). No coeloplanids have been previously recorded from Oman.

Identification of Coeloplanidae is based on colour pattern, patterns of aboral papillae, development of oral groove and oral lappets, and host [5–7,19]. Additionally, recent studies have utilized *Cytochrome c Oxidase Subunit I* (COI) sequences for species differentiation [10,18]. *Vallicula multiformis* is a habitat generalist with low host specificity, whereas most *Coeloplana* species are habitat specialists with high host specificity and are restricted to a specific host or a group of morphologically similar hosts [6–8,19].

This ectosymbiont/host association in coeloplanids can provide insights into species distributions and biogeography. Cnidarians are the most common hosts, with at least 19 described (and numerous undescribed) species of *Coeloplana* recorded from them, 17 obligately so. One species (*C. loyai*) lives on mushroom corals (Fungiidae), while the rest occur on octocorals, all but three on soft corals (Table 1). The only exceptions are the Atlantic *C. waltoni* and the Indo-West Pacific *C. sophiae* both known only from gorgonians, and the generalist *C. duboscqui* recorded from sea pens [6,7,12,20–22]. This suggests that soft-coral morphology is better suited for *Coeloplana*, and the low diversity of *Coeloplana* in the Atlantic compared to Indo-West Pacific reefs may be due to the practical absence of soft corals from Atlantic reefs [23]. *Coeloplana* species on gorgonians are generally also smaller than those on soft corals.

During a large-scale survey of the marine biodiversity of Oman (2019–2023) that aimed to characterize macroinvertebrate fauna, we encountered aggregations of an undescribed *Coeloplana* species on two gorgonian hosts, *Melithaea* Milne Edwards, 1857 (Melithaeidae) and *Euplexaura* Verrill, 1869 (Euplexauridae), around Masirah Island (Figures 1–3, Videos S1 and S2). The animals were a few millimetres long and appeared to occupy the hosts without particular preference for location or orientation on the colony (Figures 2 and 3). Approximately 15–30 individuals were found on *Melithaea* sp. colonies (Figure 2C,D), and over 60 individuals on *Euplexaura* sp. colonies (Figure 2A,B). They were noted in situ on *Euplexaura* colonies, but were cryptic on the orange-yellow *Melithaea* colonies and only noticed in the lab, when they crawled off the colony as water quality in their tank declined. Two colour forms, pink and yellow, cooccurred on both hosts and likely represent morphotypes of the same species. The yellow form is effectively invisible on the similar-coloured *Melithaea* (Figure 3). We reviewed all known species of *Coeloplana* and these specimens do not match any described species. In addition, we encountered *Vallicula multiformis* on a green alga host (Figure 4, Video S3).

The ctenophores co-occurred with the ectocommensal ophiuroid *Ophiothela mirabilis* (Verrill, 1867) (Figure 2B,C). This ophiuroid is invasive in the tropical West Atlantic and appears to negatively impact *Coeloplana waltoni* in south Florida [24].

Our observations constitute the first report of such aggregations on gorgonians in the Indo-West Pacific, as well as the first record of *Coeloplana* sp. and *Vallicula multiformis* in Oman. This discovery contributes to our understanding of ectosymbiont-host associations, biogeography, and species distribution of *Coeloplana* and *Vallicula*. Future research will focus on formally describing the species and its gorgonian hosts.

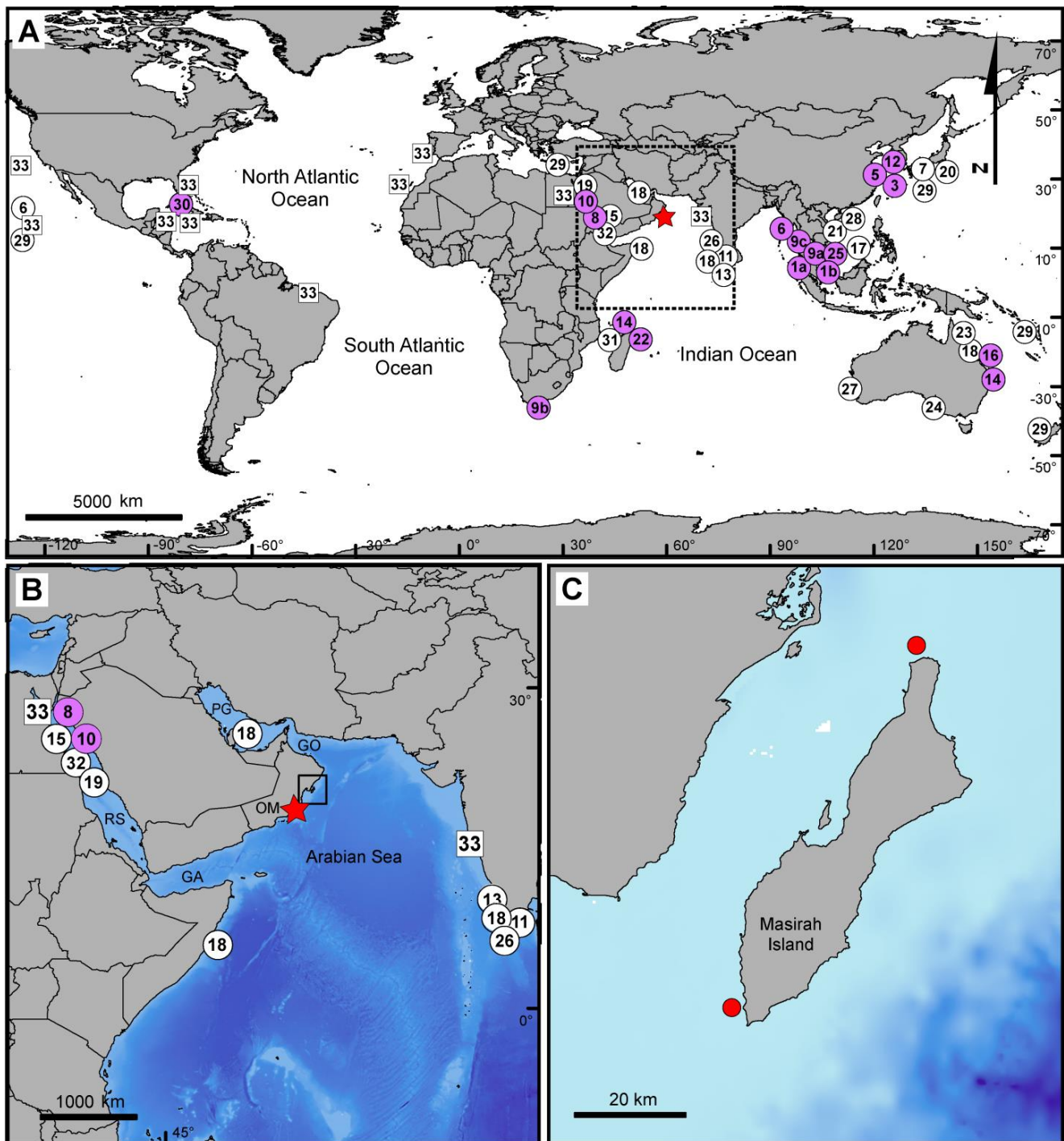


Figure 1. (A,B) Global distribution of *Coeloplana* (circles) and *Vallicula* (squares). *Coeloplana* records from octocoral hosts are purple in colour. The star represents the first record of the *Coeloplana* and *Vallicula* from Oman. (C) Locations of the observations and collections of *Coeloplana* sp. on gorgonian hosts in Masirah Island. Numbers indicate different species (Table 1, localities extracted from [6], and other publications). OM = Oman, PG = Persian Gulf, GO = Gulf of Oman, GA = Gulf of Aden, and RS = Red Sea. Blue shading in (B,C) represents depth.

Table 1. List of valid species of Coeloplanidae and their host based on [6,15]. Please note that the octocoral taxonomy has been updated in the table as accurately as possible. The *Coeloplana* records from octocoral host have been shaded purple (corresponding to Figure 1).

Record No.	Species	Host
1a	<i>C. agniae</i> Dawydoff, 1930	<i>Sclerophytum polydactylum</i> (Octocorallia)
1b	<i>C. agniae</i> var. <i>striata</i> Dawydoff, 1938	<i>Sclerophytum polydactylum</i> (Octocorallia)
2	<i>C. anthostella</i> Song & Hwang, 2010	<i>Dendronephthya spinulosa</i> and other <i>Dendronephthya</i> spp. (Octocorallia)
3	<i>C. astericola</i> Mortensen, 1927	<i>Echinaster luzonicus</i> (Asteroidea)
4	<i>C. bannwarthi</i> Krambach, 1933	<i>Diadema</i> spp. (Echinoidea)
5	<i>C. bocki</i> Komai, 1920	<i>Stereonephthya japonica</i> , <i>Dendronephthya spinulosa</i> , <i>D. dendricata</i> (Octocorallia), Hydrozoa, algae, Echinodermata
6	<i>C. duboscqui</i> Dawydoff, 1930	<i>Pteroides</i> (Octocorallia), <i>Hypnea</i> (red algae)
7	<i>C. echinicola</i> Tanaka, 1932	<i>Toxopneustes pileolus</i> (Echinoidea)
8	<i>C. fishelsoni</i> Alamaru, Brokovich & Loya, 2015	<i>Xenia umbellata</i> , <i>Paralemnalia</i> (Octocorallia)
9a	<i>C. gonoctena</i> Krempf, 1920	<i>Cladiella krempfi</i> , <i>Cladiella pachyclados</i> (Octocorallia)
9b	<i>C. gonoctena</i> var. <i>natalensis</i> Pople, 1960	<i>Cladiella krempfi</i> (Octocorallia)
9c	<i>C. gonoctena</i> var. <i>rosea</i> Dawydoff, 1938	<i>Klyxum</i> (Octocorallia)
10	<i>C. huchonae</i> Alamaru, Brokovich & Loya, 2015	<i>Dendronephthya hemprichi</i> (Octocorallia)
11	<i>C. indica</i> Davansan & Varadarajan, 1942	NA
12	<i>C. komaii</i> Utinomi, 1963	<i>Cladiella digitulata</i> (Octocorallia)
13	<i>C. krusadiensis</i> Devanesen & Varadarajan, 1942	<i>Pentaceros hedemanni</i> (Asteroidea)
14	<i>C. lineolata</i> Fricke, 1970	<i>Sarcophyton</i> (Octocorallia)
15	<i>C. loyai</i> Alamaru & Brokovich, 2015	<i>Herpolitha limax</i> , <i>Ctenactis echinata</i> (Scleractinia)
16	<i>C. mellosa</i> Gershwin, Zeidler & Davie, 2010	<i>Sarcophyton</i> (Octocorallia)
17	<i>C. mesnili</i> Dawydoff, 1938	Planktonic/free living
18	<i>C. meteoris</i> Thiel, 1968	Free living on soft sediments
19	<i>C. metschnikowii</i> Kowalevsky, 1880	<i>Zostera</i> (seagrass)
20	<i>C. mitsukurii</i> Abbott, 1902	<i>Melobesia</i> (red algae) and <i>Sargassum</i> (brown algae)
21	<i>C. perrieri</i> Dawydoff, 1930	<i>Posidonia</i> (seagrass) or free living on rocks
22	<i>C. punctata</i> Fricke, 1970	<i>Sarcophyton</i> (Octocorallia)
23	<i>C. reichelti</i> Gershwin, Zeidler & Davie, 2010	Variety of red and green algae and seagrasses
24	<i>C. scaberiae</i> Matsumoto & Gowlett-Holmes, 1996	<i>Scaberia agardhii</i> (algae)
25	<i>C. sophiae</i> Dawydoff, 1938	<i>Solenocaulon jedanensis</i> (Octocorallia)
26	<i>C. tattersalli</i> Devanesen & Varadarajan, 1942	Planktonic/free living
27	<i>C. thomsoni</i> Matsumoto, 1999	<i>Jania</i> (coralline algae)
28	<i>C. weilli</i> Dawydoff, 1938	<i>Heterocentrotus mamillatus</i> (Echinoidea)
29	<i>C. willeyi</i> Abbott, 1902	<i>Zostera</i> , <i>Caulerpa</i> , <i>Sargassum</i> (seagrass and algae) and <i>Echinothrix diadema</i> , <i>Echinothrix calamaris</i> , <i>Heterocentrotus mamillatus</i> (Echinoidea)
30	<i>C. waltoni</i> Glynn, Bayer & Renegar, 2014	Various species of shallow-water gorgonians from the genera <i>Eunicea</i> , <i>Plexaurella</i> , <i>Muricea</i> , <i>Gorgonia</i> , <i>Pseudoplexaura</i> , <i>Antillologorgia</i> , <i>Plexaura</i> , <i>Muriceopsis</i> (Octocorallia)
31	<i>C. wuennenbergi</i> Fricke, 1970	<i>Sarcophyton</i> (Octocorallia)
32	<i>C. yulianicorum</i> Alamaru, Brokovich & Loya, 2015	<i>Sarcophyton</i> (Octocorallia)
33	<i>Vallicula multiformis</i> Rankin, 1956	Various algae and invertebrates, such as seagrasses, algae, <i>Pearsonothuria graeffei</i> (Holothuroidea)

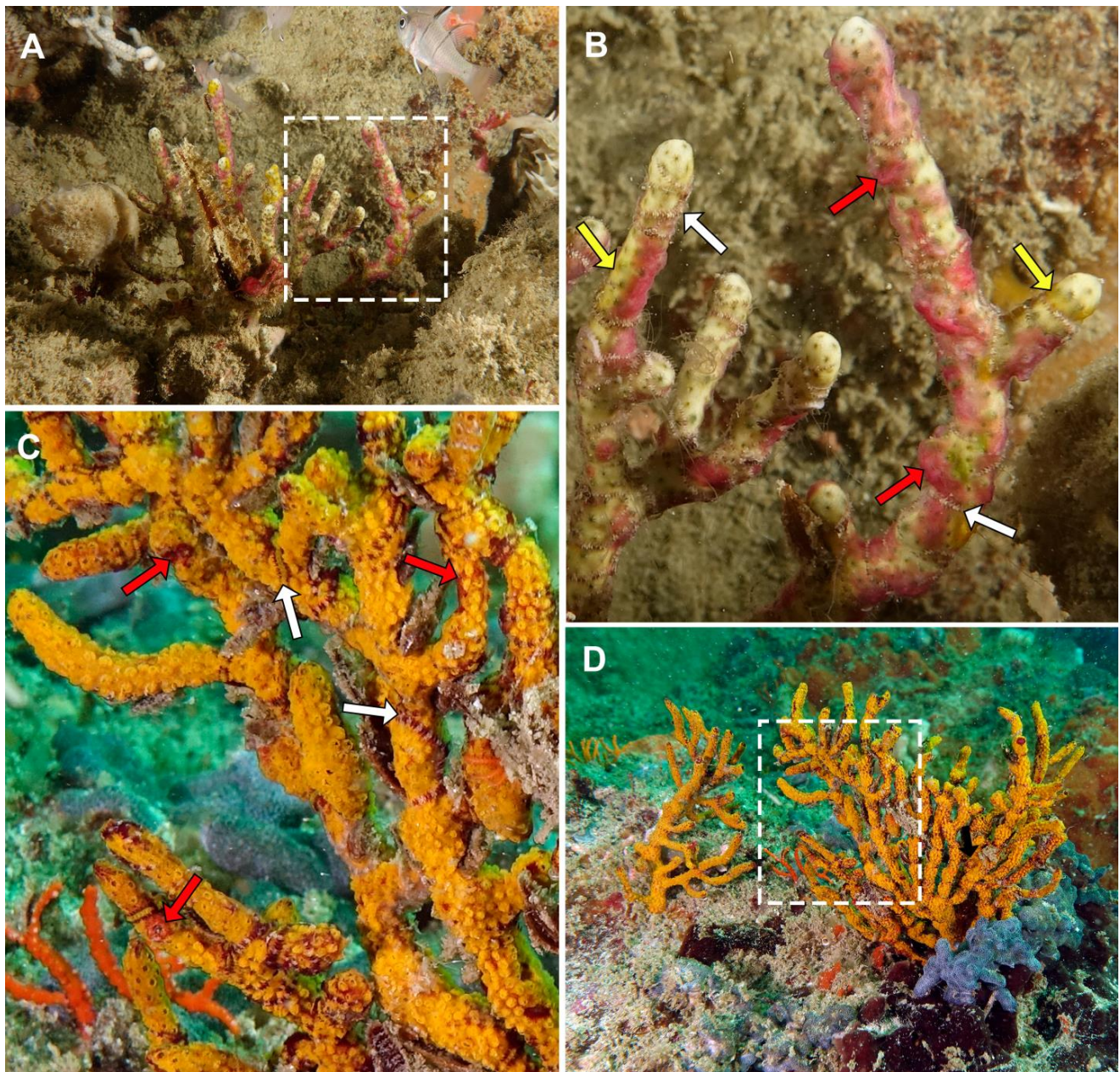


Figure 2. Aggregations of *Coeloplana* sp. on gorgonians around Masirah Island, Oman. (A,B) Colony of *Euplexaura* sp. at 18 m depth (BOMAN-13166) covered with both colour morphotypes of *Coeloplana* (red and yellow arrows), some with extended tentacles. (C,D) Colony of *Melithaea* sp. (BOMAN-13152) at 7 m depth. *Coeloplana* individuals occur in both colours in this species; however, it is very difficult to see them underwater. Note the concurrent presence of the ophiuroid *O. mirabilis* in both gorgonians (white arrows). All observations were made during the day (Photo credit: K. Samimi-Namin).

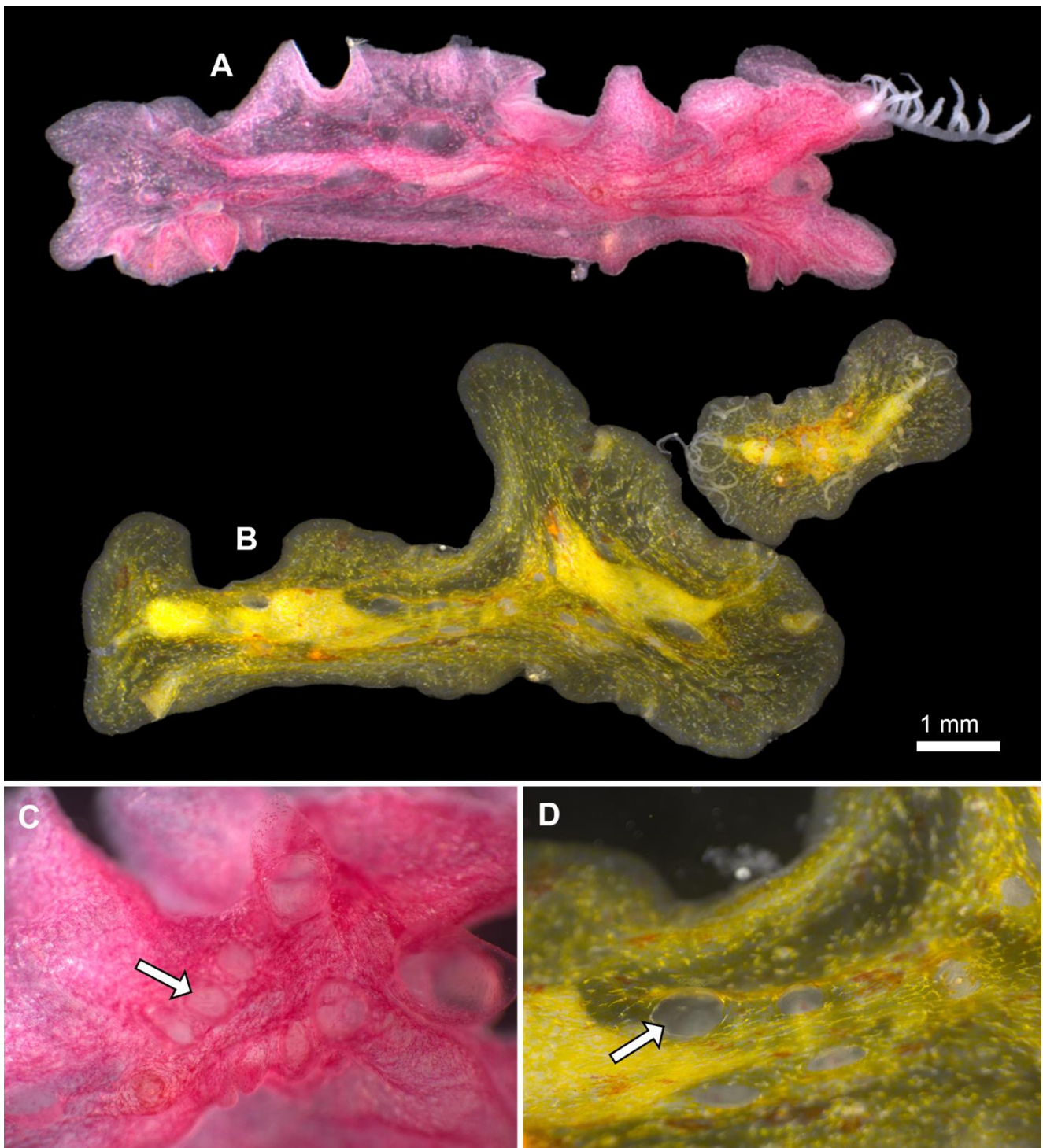


Figure 3. (A,B) Photographs of the two colour morphs of *Coeloplana* sp. (C,D) Close-ups of the aboral papillae (white arrow) (Photo credit: G. Paulay).

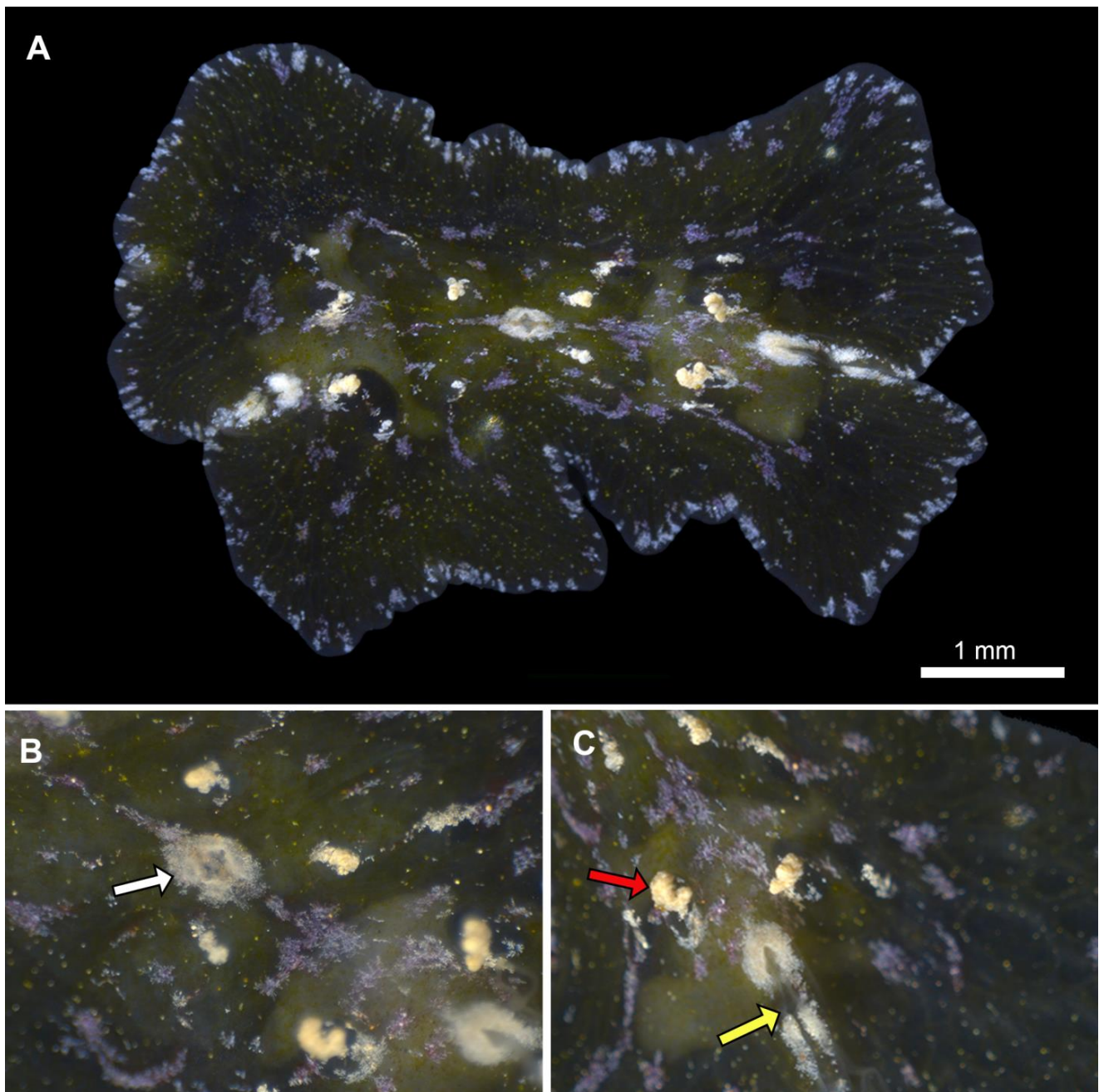


Figure 4. (A–C) Photographs of *Vallicula multiformis* from Oman (BOMAN-10006). (B,C) Close-ups of the same specimen showing the aboral sense organ (white arrow), papillae (red arrow), and the extension of the oral groove to the tentacle sheath (yellow arrow) (Photo credit: G. Paulay).

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/d15101060/s1>, Video S1. *Coeloplana* sp. yellow colour morph from Oman, Video S2. *Coeloplana* sp. red colour morph from Oman. Video S3. *Vallicula multiformis* from Oman.

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N.B. and G.P.; visualization, K.S.-N. and G.P. All authors have read and agreed to the published version of the manuscript.

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