

# New records and updated checklist of heterobranch sea slug (Gastropoda: Heterobranchia) from South Malang, Indonesia

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**Abstract.** *Andrimida A, Hakim L, Retnaningdyah C. 2025. New records and updated checklist of heterobranch sea slug (Gastropoda: Heterobranchia) from South Malang, Indonesia. Biodiversitas 26: 3674-3693.* This article presents an integrated and updated checklist of heterobranch sea slug species from South Malang, East Java, Indonesia, based on additional records from recent surveys, published records and citizen scientist findings since 2019. A different approach to survey method was conducted during this study, where surveys were done by exploring shallow tidepools in contrast to previous studies in South Malang that followed SCUBA diving-based survey. Twelve surveys have been conducted at three new localities in South Malang from September 2024 to March 2025. A total of 14 new species has been successfully documented as new locality records from three main sites, which are Banyu Towo, Tanjung Penyu, and Gatra. These 14 species assigned to the Aplysiida order (two species), Sacoglossa superorder (three species), Pleurobranchida order (three species) and Nudibranchia order (six species). With this finding, combined with previous studies, a total of 79 heterobranch sea slug species has been recorded from South Malang, which 57 species belong to the Nudibranchia order, nine species belong to the Aplysiid order, eight species belong to the Sacoglossa superorder, three species belong to the Pleurobranchida order, and two species belong to the Cephalaspidea order were found. This study also provides nine species corrections from past studies following taxonomical update or possible misidentification in the past. Compared to other records, it is revealed that heterobranch sea slug species diversity in South Malang is higher than the average heterobranch sea slug species diversity in Java Region. Higher heterobranch sea slug diversity indicates diverse habitat structure and higher overall diversity in coral reef ecosystem. This study provides baseline data for future monitoring programs, as there is a rising anthropogenic pressures from the nearby fishing port activities and forest conversion that causes sedimentation and threatens the coral reef health in Sempu Island, East Java. Furthermore, this extended checklist significantly enhances marine biodiversity records by filling knowledge gaps from understudied area in South Malang, thereby strengthening the data basis that is necessary for future coastal ecosystem monitoring and conservation in South Java Region.

**Keywords:** Eastern Indian Ocean, marine biodiversity, Nudibranch, Opisthobranch

## INTRODUCTION

Heterobranchia is a subclass of Gastropoda that includes epibenthic sea slugs formerly assigned to Opisthobranchia (Parera et al. 2020). This group encompasses Nudibranchia, Pleurobranchida, Aplysiida, Cephalaspidea, and Sacoglossa (Nimbs et al. 2020). They are distinguished by reduced or absent shells and high morphological variation in body form, size, and coloration (Gosliner et al. 2019; Cruz-Francisco 2023). Heterobranchs inhabit a wide array of benthic habitats, with substrate diversity shaping community structure (Nimbs et al. 2020; Ah-Shee-Tee et al. 2022; Riccardi et al. 2022). Their diversity is linked to overall benthic biodiversity, reflecting their specialized feeding and habitat niches (Rosyid et al. 2022).

In tropical coral reefs, heterobranchs play key ecological roles through strong habitat associations and specialized diets (Ampou et al. 2023). Most Nudibranchia feed on sponges, coral polyps, hydroids, tunicates, bryozoans, or other sea slugs, acting as regulators of benthic invertebrate populations (Yiu and Qiu 2022; Garner and Oosthuizen 2023; Molina et al. 2024; Ohashi et al. 2025). Sacoglossa consume green algae and can retain

functional chloroplasts, influencing algal dynamics and primary productivity (Nakpan et al. 2023). Heterobranchs are also used as bioindicators, since their persistence depends on intact reef habitats (Adiwijaya et al. 2021; Garner and Oosthuizen 2023). Their sensitivity to environmental stress makes them effective indicators of reef health under anthropogenic and climate change pressures (Ah-Shee-Tee et al. 2022; Garner and Oosthuizen 2023).

Although Indonesia lies within the Coral Triangle, a global biodiversity hotspot, knowledge of its heterobranch fauna remains limited (Eisenbarth et al. 2018; Rosyid et al. 2022; Aulia et al. 2024). This information is crucial for understanding biodiversity, bioprospecting, ecotourism, and environmental indicators (Andrimida and Hermawan 2020; Izzati et al. 2021; Aulia et al. 2024). Fieldwork, however, is difficult because heterobranchs are small, cryptic, and time-consuming to survey, so most studies cover small areas (Ah-Shee-Tee et al. 2022). Nonetheless, collaborations with volunteers and citizen scientists have expanded (Smith and Davis 2019; Parera et al. 2020), while taxonomic research has grown steadily, with new species continually described (Yonow 2015; Kristiana et al. 2024).

Globally, about 6,000 heterobranch species are known, at least 3,400 from the Indo-Pacific, with ~1,000 still undescribed (Auld and Jarne 2016; Gosliner et al. 2019). In Indonesia, records began with 78 species from North Sulawesi (Burghardt et al. 2006), later increasing to 135 (Kaligis et al. 2018). From 2015 to 2020, attention focused on Sulawesi, stimulated by muck diving (de Brauwer et al. 2017; Undap et al. 2019; Papu et al. 2020). After 2020, studies shifted west, particularly Bali and East Java, documenting 42 species in Penimbangan, 144 in Tulamben (Amelia et al. 2022; Kristiana et al. 2024), and 85 in Bangsring, Banyuwangi (Rosyid et al. 2022). In contrast, surveys outside tourism centers, such as Jepara and Gunungkidul, found only five or six species (Sabdono et al. 2021; Kumarahaqi et al. 2022). These differences suggest significant undiscovered richness in less explored areas (Kristiana et al. 2024).

South Malang's coastal waters comprise less than 2% of Java's reefs, most in degraded condition (Isdianto et al. 2024a, b, c). Decline is driven mainly by fisheries and deforestation that reduce water quality (Isdianto et al. 2023). Despite this, Sempu Strait remains an ecological refuge, with reef fish abundant (Bintoro et al. 2023) and macroinvertebrate diversity beginning to be documented (Aulia et al. 2024). The first heterobranch survey there in 2018 was followed by sporadic studies recording 60 species across Aplysiida, Nudibranchia, Sacoglossa, and Cephalaspidea (Andrimida and Hermawan 2019, 2020; Andrimida 2021, 2022, 2023).

Documenting marine biodiversity, particularly macroinvertebrates, is essential for understanding ecosystem function, especially in degraded reefs (Isdianto et al. 2023). Yet data on macro-zoobenthos in South Malang are scarce (Andrimida and Hermawan 2020; Aulia

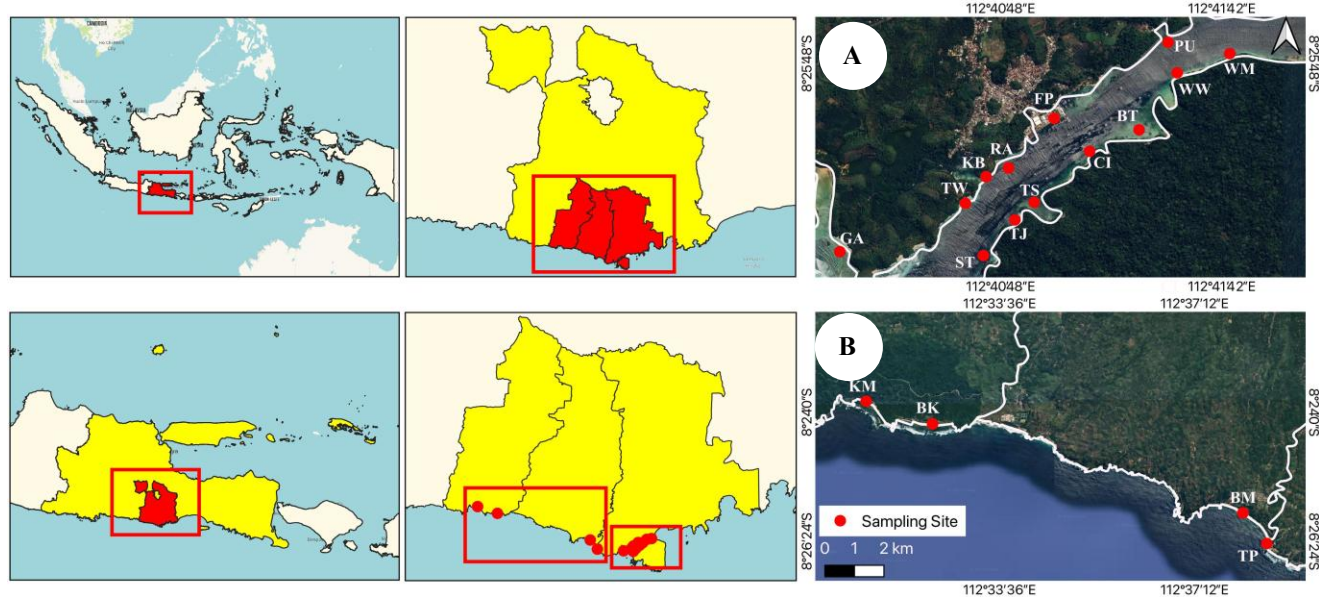
et al. 2024), preventing accurate assessment of anthropogenic impacts. Integrative studies providing baseline records are urgently needed for long-term monitoring. This research combines new field surveys with historical data and, for the first time, incorporates citizen scientists in documenting sea slugs—an approach proven effective elsewhere (Chow et al. 2022).

The objective of this study is to provide comprehensive baseline data on heterobranch sea slug diversity in South Malang, an underrepresented and environmentally threatened region, while also contributing to taxonomy by reporting new records, verifying earlier data, and updating identifications according to recent taxonomic revisions or corrections of past misidentifications.

## MATERIALS AND METHODS

### Study area

Surveys took place at three sites, two sites in Sempu Strait and one in Tanjung Penyu Beach in South Malang, East Java, Indonesia (Figures 1.A-B). The surveys are conducted during September 2024 to February 2025. The surveys conducted on each site during low tide during the daytime. The tidal pattern on the coast of South Malang is mixed semi-diurnal tide, which it experiences two high tides and two low tides which differ in size every lunar day. The overall benthic cover of Sempu Strait is dominated with abiotic cover, such as sand, rubble and rock. Recent studies in Sempu Strait reveals that the living coral covers in Sempu Strait are varied between 12.57 to 14.28%, on which it is classified as 'degraded reef' (Isdianto et al. 2024a, b, c).



**Figure 1.** Sampling locations from South Malang, East Java, Indonesia. A. Sempu Strait, B. The sites outside Sempu Strait in South Malang. Sampling sites abbreviations follows Table 1

**Table 1.** Sampling sites from South Malang, East Java, Indonesia, with detailed habitat type. Sites with asterisks (\*) are the sites surveyed during this study, while the rests are sampling sites from previous studies. Sites abbreviations are used in Figure 1.A

Sampling sites	Abbrev.	Habitat type	Coordinate	Years of records
Watu Meja	WM	Hard-bottomed substrate, coral reef.	8°25'46.65"S, 112°41'52.74"E	2019-2021
Waru-Waru	WW	Sand-bottomed substrate, coral reef, seagrass beds (low cover).	8°25'49.74"S, 112°41'34.78"E	2019-2021
Banyu Towo*	BT	Sand-bottomed substrate, coral reef, seagrass beds (moderate cover) exposed during low tide.	8°26'2.58"S, 112°41'19.38"E	2024-2025
Calo Ilang	CI	Soft-bottomed substrate, coral reef (mostly damaged).	8°26'11.80"S, 112°41'8.30"E	2019-2021
Teluk Semut	TS	Hard bottomed substrate on shallows, Soft bottomed substrate on deeper water, coral reef.	8°26'22.21"S, 112°40'55.88"E	2019-2022
Tanjung	TJ	Hard bottomed substrate on shallows, Soft bottomed substrate on deeper water, coral reef.	8°26'26.11"S, 112°40'51.16"E	2019-2021
Stumbut	ST	Hard bottomed substrate, rich with biotic covers (sponge, hydroids, soft coral), coral reef (moderate cover).	8°26'34.23"S, 112°40'45.13"E	2019-2022
Gatra*	GA	Rocky shallows mostly covered with algae, exposed during low tide, seagrass beds (very low cover).	8°26'32.29"S, 112°40'9.01"E	2024
Tiga Warna	TW	Sand-bottomed substrate, coral reef (moderate cover), also artificial reefs are present.	8°26'22.17"S, 112°40'39.95"E	2019-2022
Kondang Buntung	KB	Rocky ledge with moderate coral cover.	8°26'16.54"S, 112°40'43.94"E	2019-2021
Rumah Apung	RA	Soft-bottomed substrate with very low coral cover, artificial reefs are present.	8°26'14.32"S, 112°40'47.95"E	2019-2022
Fishingport	FP	Rocky shallows with coral reef (very low cover).	8°26'1.59"S, 112°41'3.15"E	2019-2021
Pondok Urang	PU	Sand-bottomed substrate, coral reef (low cover).	8°26'14.15"S, 112°40'46.47"E	2019-2021
Tanjung Penyu*	TP	Rock and Rubble bottomed substrate, rock covered with algae in the nearshore, moderate coral covers that exposed during low tide.	8°26'26.21"S, 112°38'32.12"E	2024-2025
Bajul Mati	BM	Rocky reef that exposed during low tide.	8°25'52.06"S, 112°38'5.62"E	2019
Balekambang	BK	Sand and rock-bottomed substrate, exposed during low tide	8°24'12.69"S, 112°32'21.89"E	2023
Kondang Merak	KM	Rocky reef that exposed during low tide.	8°23'47.40"S, 112°31'8.43"E	2020

Banyu Towo (BT) station situated in the middle of Sempu Strait, on which it has calmer waters as it is protected by external disturbance by the Sempu Island. It is characterized by vast sand-bottomed shallows with seagrass cover. The reefs are situated at the crest of the shallows where the bottom cover starts to mixed with rubbles and rocks. This reef crest is also exposed during low tide, allowing the surveyors to conduct the survey without using scuba diving gears. Meanwhile, Gatra (GA) station situated in a more exposed area, means it is only could be surveyed during the lowest tide. Generally, GA station has rougher waters as it has no natural barriers, the bottom covers are dominated by rubble and rocks with some living hard coral cover near the eastern part of the survey area. Tanjung Penyu station situated outside Sempu Strait (Figure 2.B), this site is characterized by vast rocky intertidal with moderate coral reef cover. The main abiotic substrates are composed of rock and rubbles. Historic sites containing records from previous studies and personal communications also shown in map.

## Procedures

### Survey procedure

A total of twelve surveys has been conducted with six surveys done in Sempu Strait (1 in GA, 5 in BT), and six surveys done in Tanjung Penyu from 1 September 2024 to 31 March 2025. The survey procedure follows a modified Roving Diver's Technique (RDT) method (Rassweiler et al. 2020), where two observers actively exploring the exposed reefs at low tide in a fixed time. The tidal regime

in South Malang Coast follows the mixed semi-diurnal tides where the later low tide is lower than the early low tide in one tidal day. Thus, the surveys are mostly done in the afternoon around 02:00 PM to 05:00 PM (UTC+07:00) approximately around the lowest tide condition. This particular time is chosen because some sites such as Tanjung Penyu and Gatra are too exposed to the open ocean, and thus SCUBA-based sampling are not recommended. This exploration-based method gives the surveyors the freedom of movement and it has been proven successful in revealing the hidden diversity of reef fishes and benthos, especially rare and cryptic species (Rassweiler et al. 2020; Bravo et al. 2023). Surveys are conducted by exploring 10 meters radius area by snorkeling around in surface depth or by foot if the water level drops to the lowest level. At least two or three areas are explored on each survey, depending on the tidal level and the expanse of the tidepool shallows. Each survey site situated approximately 25 meters from coastline, where the rocky coral reef habitat usually found. Each survey usually lasted for 60 to 120 minutes, depending on the tide level during the survey. However, this sampling protocol mostly done in daylight or late afternoon, it suggests that a lot of nocturnal marine heterobranch are still yet to be revealed due to the sampling limitation.

Each sea slugs encountered during this study were photographed in-situ using Canon G7X of Olympus TG5 digital camera that capable to shoot in macro mode. Sea slugs encountered during the surveys in the intertidal area were carefully placed on a petri dish and photographed

under artificial light. No specimens were collected as the slugs are carefully released back to their respective habitats. The photographs taken during the survey were post-processed in Adobe Lightroom and Adobe Photoshop software to isolate the sea slug image and enhance the image clarity. Sea slug photographs were archived in personal database that has been built since the first publication in 2019, so that new records and findings could be easily tracked.

#### Sea slug identification

Sea slugs encountered during this study were photographed in-situ using macrophotography camera. The photographs taken during the survey were post-processed in Adobe Lightroom and Adobe Photoshop software to isolate the sea slug image and enhance the image clarity. Sea slug photographs were identified visually by comparing their external morphology, such as the profile, shape, pattern and coloration of its notum; shape, arrangement, and coloration of rhinopores and gills; and other specific morphological characteristics such as cerata or tubercle arrangement, the absence and presence of oral tentacle. The examined characteristics on external morphology were compared with the identification books “Nudibranch and Sea Slug Identification: Indo-Pacific” (Gosliner et al. 2019). However, Gosliner et al. (2019) still possess many undescribed species, so we used species number for internal identifier for a specimen photograph that match those undescribed species (sp.1, sp.2. etc.). Scientific publications (Papu et al. 2020; Mehrotra et al. 2021; Tibirićá et al. 2023) also utilized as a comparison to verify identity or updates. Each sea slug species that has been identified has its species validity verified with the World Register of Marine Species database (WoRMS 2024). Previous records regarding sea slug in South Malang area were also taken from previous studies from 2018 to 2024. Any taxonomical updates or possibly misidentifications from previous studies are stated in a short note on the species description.

#### Data analysis

Spatial analysis used to map the heterobranch sea slug distribution data both from this study and record from literature. Each record was georeferenced using GIS Software and mapped to obtain heterobranch sea slug order distribution and species distribution map. Heterobranch sea slug order distribution was mapped using a straight forward color scale, with each color scale represents the number of the heterobranch sea slug order recorded. Heterobranch sea slug species distributions were weighted and analyzed using Inverse Distance Weight (IDW) Spatial Interpolation to obtain the heatmap of species distribution in study area.

## RESULTS AND DISCUSSION

The present study records a total of fourteen new species of heterobranch sea slugs from South Malang. These fourteen species of sea slugs consist of two Aplysiid sea hare species, three sacoglossan species, three

pleurobranch species, and six nudibranch species (Table 2). These species belong to seven families, which are Aplysiidae (2 species), Dorididae (1 species), Dendrodorididae (2 species), Facelinidae (1 species), Hexabanchidae (1 species), Plakobanchidae (3 species), Pleurobranchidae (3 species), and Polyceridae (1 species). All species documented during this study provided in Figure 2.

This study also provides an integrative record of heterobranch sea slug in South Malang from previous studies, dated from 2018 to 2024. It is revealed that there are 79 species of heterobranch sea slug are present in South Malang through this integrative documentation. From the 79 species of heterobranch sea slug, 57 species could be assigned to the Nudibranchia order, which holds the most percentage (72.15%) of heterobranch sea slug diversity in South Malang. 9 species (11.39%) assigned to the Aplysiid order, 8 species (10.13%) assigned to the Sacoglossa superorder, 3 species (3.80%) assigned to the Pleurobranchida order, and 2 species (2.53%) assigned to the Cephalaspidea order. Based on species richness, the family Chromodorididae has the highest number of recorded species (24 species), where half of them (12 species) belong to a single genera *Hypselodoris* (Table S1).

Each species encountered during this study, along with any preciously recorded species were presented below, along with the explanation on their previous records, global distribution, remarks and morphological description of newly recorded species, as well as notes on species that underwent taxonomical updates or possible misidentification on previous studies.

#### Checklist of heterobranch sea slug from South Malang

New species recorded during this study are indicated with asterisk sign (\*), while species with distribution extension recorded during this study are indicated with circumflex accent sign (^).

*Class Gastropoda* Cuvier, 1795

*Subclass Heterobranchia* Burmeister, 1837.

*Order Pleurobranchida*

*Superfamily Pleurobranchioidea* Gray, 1827.

*Family Pleurobranchidae* Gray, 1827

***Pleurobranchus peronii* Cuvier, 1804\*** (Figure 2).

**Remarks:** New record in South Malang from Tanjung Peny, Gatra Beach, and Banyu Towo. Some individuals found on coral crevices and under coral rubble at rocky shallows during low tide.

**Morphological description:** Notum covered with polygonal tubercles, body covered in orange or dark red color. Tubercles have darker shade coloration, which give its notum a reticulated look. The tip of rhinopores also darker, with horizontal striation along the rhinopores. The gills are hidden beneath the mantle and tuberculate at its base (Goodheart et al. 2015).

**Ecology:** Found crawling in open spaces between rocks and rubbles, some found inside the rock crevices during the survey. Mostly nocturnal species that active during the night, but stay hidden under coral crevices during daytime (Eisenbarth et al. 2018; Papu et al. 2020). **Global**

**distribution:** Indo-Pacific, from the coast of South Africa, the Island of Madagascar to Western Pacific, Australia, South East Asia to Hawai'i (Goodheart et al. 2015).

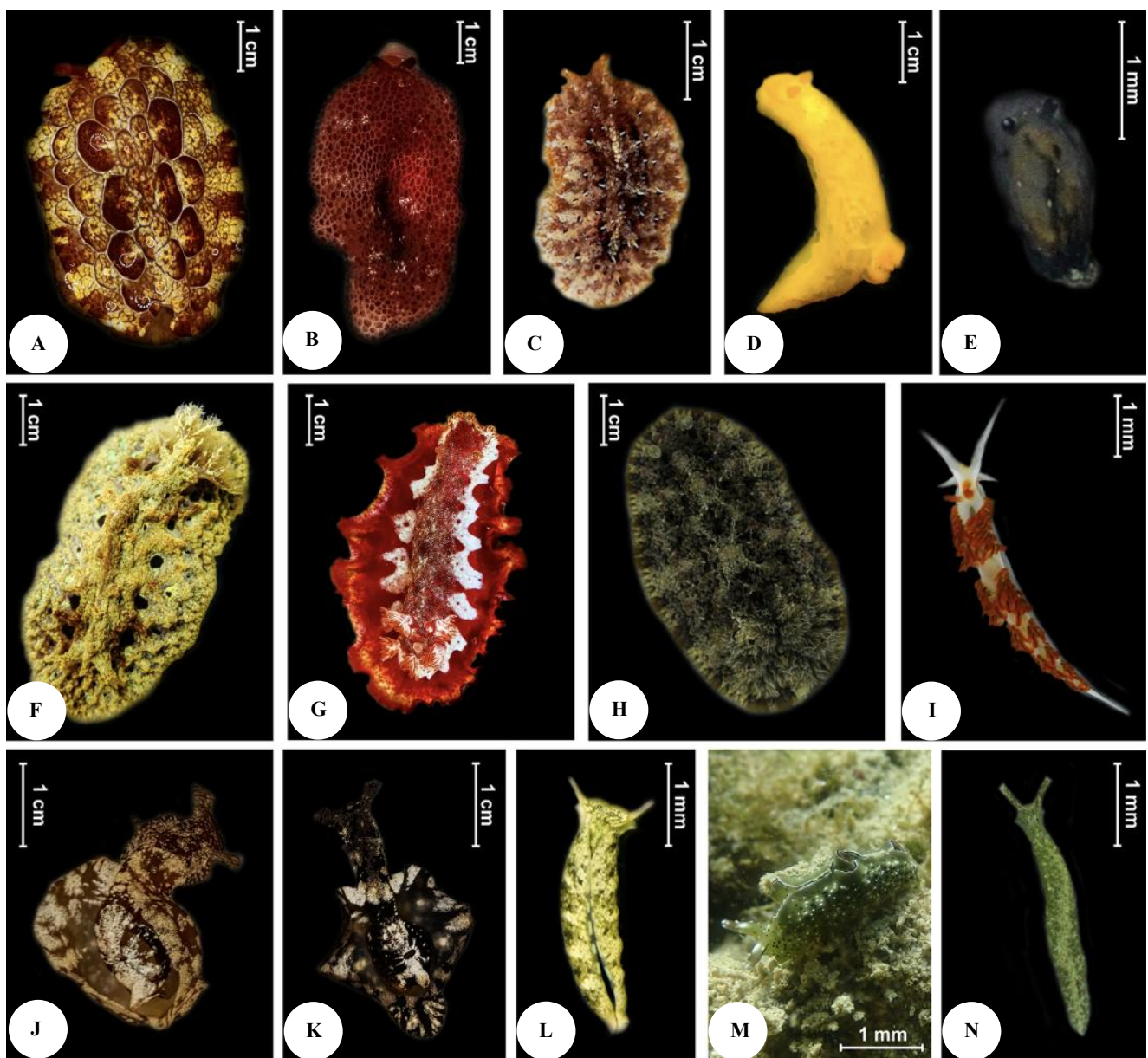
***Pleurobranchus forskalii* Rüppell and Leuckart, 1828\*** (Figure 2). **Remarks:** New record in South Malang from Tanjung Penyau and Gatra Beach. Some individuals found on coral crevices and under coral rubble at rocky shallows during low tide.

**Morphological description:** Notum covered in broad tubercles that arranged in compound. The outer edge of the tubercle lined with different shade of color, giving its notum a scaled look. Colors are varied, from mottled brown with dark brown band on outer tubercle edge to dark

red with white band on outer tubercle edge (Goodheart et al. 2015).

**Ecology:** Found on soft sediment habitats (sand) in the vicinity of coral reef area (Mehrotra et al. 2021). A nocturnal pleurobranch species that active during the night (Papu et al. 2020). **Global distribution:** Indo-Pacific, from Tanzania to the Red Sea, South East Asia, Australia and Southern Japan (Goodheart et al. 2015).

***Pleurobranchus albiguttatus* (Bergh, 1905)\*** (Figure 2). **Remarks:** First record in South Malang from Gatra Beach. One individual found on coral crevices at rocky shallows during low tide.



**Figure 2.** New sea slugs species encountered during this study. A. *Pleurobranchus forskalii*, B. *Pleurobranchus peronii*, C. *Pleurobranchus albiguttatus*, D. *Gymnodoris inornate*, E. *Doris* sp., F. *Atagema spongiosa*, G. *Hexabranhus lacer*, H. *Discodoris tuberculosa*, I. *Moridilla brockii*, J. *Aplysia extraordinaria*, K. *Aplysia reticulata*, L. *Plakobranhus ocellatus*, M. *Elysia rufescens*, N. *Elysia* sp.

**Morphological description:** Notum covered with short, conical tubercles. Tubercles sizes are smaller than those in *P. peronii*. Body orange to brown with mottled pattern, sometimes with white color on the tip of the tubercle. Rhinopores have the same color as its notum (Goodheart et al. 2015).

**Ecology:** Found in the vicinity of coral reef area at shallow depth less than 9 meter (Kristiana et al. 2024). **Global distribution:** Indo-Pacific, from the Coast of Tanzania, Red Sea, Australia, South East Asia, Southern Japan, as well as small Islands in Indian and Central Pacific Ocean (Goodheart et al. 2015).

*Order Nudibranchia Cuvier, 1817*

*Family Hexabranthidae Bergh, 1891*

***Hexabranthus lacer Cuvier, 1804\**** (Figure 2).

**Remarks:** First record in South Malang from Tanjung Peny. One individual found at rocky shallows during low tide.

**Morphological description:** It has flexible mantle that irregularly pustulate when resting, pear-shaped when the mantle is rolled, and nearly oval-shaped when the mantle is fully extended. The rhinopores are short and smooth with stocky peduncle. The gill is branched and complex, circling the anus. Colors are highly variable, but mainly described as “mottled”. Notum mainly covered with red color with red and white marginal band. The inner mantle bordering the notum decorated with broad white pigment (Tibirićá et al. 2023).

**Ecology:** Found on hard-bottomed tide pool at during low tide. This species tends to inhabit shallow water, juveniles are commonly seen in tide pools area, while larger specimens are commonly seen in shallow water less than 5 meters in depth (Tibirićá et al. 2023).

**Note:** Previously, *Hexabranthus sanguineus* Rüppell and Leuckart, 1830 was accepted as a single species throughout Indo-Pacific. Recent study based on molecular evidence proved that this species is a species complex that comprises of five species (Tibirićá et al. 2023). This record provides information on its distribution extension to Western Indonesia, as past records are mainly from Central to Eastern Indonesia region (GBIF 2025a).

**Global distribution:** Broadly distributed throughout Indo-Pacific, from the Coast of East Africa to the Central Pacific (Tibirićá et al. 2023).

*Family Polyceridae Alder and Hancock, 1845*

***Plocamopherus imperialis Angas, 1864.*** **Previous record:** RA in Sempu Strait (Andrimida 2022). **Note:** Record in 2022 signifies a distribution extension near tropical area in Indonesia as previous records are mainly from Sub-tropical Australia and Japan (GBIF 2025b).

**Global distribution:** Northern New Zealand to Eastern Australia, Christmas Islands to Southern Japan (Gosliner et al. 2019), New Caledonia (Raubold et al. 2024), possible first record in Java (Andrimida 2022).

***Gymnodoris inornata Bergh, 1880\**** (Figure 2).

**Remarks:** First record in South Malang from BT, Sempu Strait. Two individuals found under coral rubbles at rocky shallows during low tide.

**Morphological description:** Notum lack of mantle skirt, uniform orange in color with 10 to 14 gills circling the anus. Rhinopores with darker shade of orange in color and could not be retracted inside the mantle (Jensen 2000).

**Ecology:** Usually found among coral or rubble in shallow water to subtidal depth up to 12 meters (Mehrotra et al. 2021). **Global distribution:** Indo-Pacific, from East Coast of Africa to the Red Sea, South East Asia, China, Japan, and Hawai’i (Mehrotra et al. 2021).

*Family Dorididae Rafinesque, 1815*

***Doris sp. 1 (Figure 2)\*.*** **Remarks:** First record in South Malang from Banyu Towo. One individual found at crevice of a massive coral rubble in rocky shallows during low tide.

**Morphological description:** Body oval, small and smooth. Notum profile convex with prominent mid dorsal ridge between the rhinopores and the gill. Rhinopores and gills are retractable. Notum covered with grayish black background, mid dorsal ridge has darker coloration, with yellowish-brown shade around it. Rhinophores and gill black with white tip.

*Family Discodorididae Bergh, 1891*

***Discodoris boholiensis Bergh, 1877.*** **Previous record:** Sempu Strait (Andrimida 2021). **Global distribution:** Indo-West Pacific (Gosliner et al. 2019).

***Halgerda elegans Bergh, 1905.*** **Previous record:** Stumbut, Sempu Strait (Andrimida 2022). **Global distribution:** Western Pacific (Gosliner et al. 2019).

***Halgerda wasinensis Eliot, 1904.*** **Previous record:** Stumbut, Sempu Strait (Andrimida 2022). **Global distribution:** Indian Ocean, from East Africa to Christmas Island (Gosliner et al. 2019).

***Atagema spongiosa Kelaart, 1858\**** (Figure 2). **Remarks:** First record in South Malang from BT, Sempu Strait. Two individuals found under a massive coral rubble at rocky shallows during low tide.

**Ecology:** Found in intertidal area in Sempu Strait, hid among massive coral rubble. This species prefers soft sediment habitat when in deeper water (Mehrotra et al. 2021).

**Morphological description:** Body oval and flat, with central ridge that runs between the gills and rhinopores. Notum covered in tubercles, irregular in size and generally smaller near the central ridge. Large rounded depressions are present near the central ridge. Gills are branched, with five branchial leaves, each with tripinnate branches. Body brownish with dark brown or black in the depression area (Innabi et al. 2023). **Global distribution:** Indo-West Pacific (Innabi et al. 2023).

*Family Chromodorididae Bergh, 1891*

*Subfamily Chromodoridinae Bergh, 1891*

***Chromodoris magnifica Quoy and Gaimard, 1832.*** **Previous record:** Tiga Warna, Sempu Strait (Andrimida 2022). **Global distribution:** Western Pacific (Gosliner et al. 2019).

***Chromodoris aspersa Gould, 1852.*** **Previous record:** ST in Sempu Strait (Andrimida and Hermawan 2020). **Global distribution:** Indo-Pacific (Gosliner et al. 2019).

**Chromodoris sp. 1.** Note: Listed as *Chromodoris* sp. in Andrimida (2021), revised as *Chromodoris* sp. 1 in Andrimida (2023). **Previous record:** RA in Sempu Strait (Andrimida 2021).

**Chromodoris sp. 2.** Note: Listed as *Chromodoris* sp. 1 in Andrimida (2022), revised as *Chromodoris* sp. 2 in Andrimida (2023). **Previous record:** ST in Sempu Strait (Andrimida 2022).

**Goniobranchus reticulatus** Quoy and Gaimard, 1832. **Previous record:** KB in Sempu Strait (Andrimida and Hermawan 2020; Andrimida 2021). **Note:** Misidentified as *G. tinctorius* Rüppell and Leuckart, 1830 in Andrimida (2020), revised as *G. reticulatus* as it lacks yellow marginal band. **Global distribution:** Indo-West Pacific (Gosliner et al. 2019).

**Goniobranchus geometricus** Risbec, 1928. **Previous record:** ST in Sempu Strait (Andrimida 2021), also WW (Ditha R 2022, pers. comm). **Global distribution:** Indo-Pacific (Gosliner et al. 2019).

**Goniobranchus verrieri** Crosse, 1875. **Previous record:** ST in Sempu Strait (Andrimida and Hermawan 2020). **Global distribution:** Indo-Pacific (Gosliner et al. 2019).

**Goniobranchus sp. 1.** Note: Listed as *Goniobranchus* sp. in Andrimida (2021), revised as *Goniobranchus* sp. 1 in Andrimida (2023).

**Doriprismatica atromarginata** Cuvier, 1804. **Previous record:** KB and ST in Sempu Strait (Andrimida and Hermawan 2020), Bajul Mati (Pratomo 2019, pers. comm). **Global distribution:** Indo-Pacific (Gosliner et al. 2019).

**Vercornia simplex** Pease, 1871. **Previous record:** TW, Sempu Strait (Andrimida 2022). **Global distribution:** Indo-Pacific (Gosliner et al. 2019).

#### Subfamily Miamirinae Bergh, 1891

**Mexichromis aurora** Johnson and Gosliner, 1998. **Previous record:** ST, Sempu Strait (Andrimida 2022). **Global distribution:** Western Pacific (Gosliner et al. 2019).

**Thorunna daniellae** Kay and Young, 1969. **Previous record:** RA, ST, TJ in Sempu Strait (Andrimida and Hermawan 2020). **Note:** *Thorunna florens* Baba, 1949 listed in Andrimida (2020), are proven to be a variation of *T. daniellae* with incomplete purple marginal band. **Global distribution:** Indo-Pacific (Gosliner et al. 2019).

**Hypselodoris emma** Rudman, 1977. **Previous record:** KB in Sempu Strait (Andrimida and Hermawan 2020). **Global distribution:** Indo-West Pacific (Gosliner et al. 2019).

**Hypselodoris maculosa** Pease, 1871. **Previous record:** RA and TJ in Sempu Strait (Andrimida and Hermawan 2020). **Global distribution:** Indo-Pacific (Gosliner et al. 2019).

**Hypselodoris decorata** Risbec, 1928. **Previous record:** TS, Sempu Strait (Andrimida 2022). **Global distribution:** Western Pacific (Gosliner et al. 2019).

**Hypselodoris infucata** Rüppell and Leuckart, 1831. **Previous record:** KB, ST, and TW in Sempu Strait (Andrimida 2021). **Global distribution:** Indo-Pacific (Gosliner et al. 2019).

**Hypselodoris confetti** Gosliner and Johnson, 2018. **Previous record:** ST in Sempu Strait (Andrimida 2022). **Global distribution:** Western Pacific (Gosliner et al. 2019).

**Hypselodoris roo** Gosliner and R. Johnson, 2018. **Previous record:** TW in Sempu Strait (Andrimida 2022). **Global distribution:** Western Pacific (Gosliner et al. 2019).

**Hypselodoris kanga** Rudman, 1977. **Previous record:** ST and WW in Sempu Strait (Andrimida and Hermawan 2020; Andrimida 2022). **Global distribution:** Indian Ocean (Gosliner et al. 2019).

**Hypselodoris dollfusi** Pruvot-Fol, 1933. **Previous record:** KB in Sempu Strait (Andrimida and Hermawan 2020). **Note:** Misidentified as *G. tumuliferus* (Collingwood, 1881) in Andrimida and Hermawan (2020), revised as *H. dollfusi* as it has light pink dot with dark purple *ocelli* which unique to the *H. dollfusi*. **Global distribution:** Indian Ocean (Gosliner et al. 2019).

**Hypselodoris apolegma** Yonow, 2001. **Previous record:** KB and ST in Sempu Strait (Andrimida and Hermawan 2020). **Global distribution:** Western Pacific (Gosliner et al. 2019).

**Hypselodoris bullocki** Collingwood, 1881. **Previous record:** Kondang Merak (Arifin et al. 2020). **Global distribution:** Western Pacific (Gosliner et al. 2019).

**Hypselodoris tryoni** Garrett, 1873<sup>^</sup>. **Previous record:** KB, TS, TJ, TW, WW and ST in Sempu Strait (Andrimida and Hermawan 2020, 2021), new record from BT (this study). **Global distribution:** Western to Central Pacific (Gosliner et al. 2019).

**Hypselodoris pulchella** Rüppell and Leuckart, 1828<sup>^</sup>. **Previous record:** TW, PU, and TJ in Sempu Strait (Andrimida and Hermawan 2020), new record from BT (this study). **Remarks:** An individual with unusual red spots, rather than yellow spots observed in TW (Andrimida 2023). **Global distribution:** Indian Ocean (Gosliner et al. 2019).

#### Family Dendrodorididae O'Donoghue, 1924

**Dendrodoris tuberculosa** Quoy and Gaimard, 1832\* (Figure 2), **Remarks:** First record in South Malang from Tanjung Penyu. One individual found at rocky shallows during low tide.

**Morphological description:** Notum covered with large and complex tubercles, color very variable from yellowish to greenish brown. Tubercles arranged in compounds, some tubercles are larger and more prominent. Rhinopore thick with pale-white or creamy tips (Gosliner et al. 2019).

**Ecology:** Found in hard-bottomed rocky shallows in intertidal area. Known to inhabit intertidal area with rocky reef or sandy substrates (Nimbs et al. 2020). **Global distribution:** Indo-Pacific (Gosliner et al. 2019).

**Dendrodoris krusensternii** J. E. Gray, 1850. **Note:** Listed as *Dendrodoris denisoni* (Angas, 1864) in Andrimida (2021), revised following taxonomical update (Nimbs and Smith 2021). **Previous record:** RA and TW in Sempu Strait (Andrimida and Hermawan 2020; Andrimida 2022). **Global distribution:** Indo-Pacific (Gosliner et al. 2019).

***Dendrodoris nigra* Angas, 1864.** Previous record: RA in Sempu Strait (Andrimida and Hermawan 2020). **Global distribution:** Indo-Pacific (Gosliner et al. 2019).

Family Phyllidiidae Rafinesque, 1814

***Phyllidia varicosa* Lamarck, 1801.** Previous record: Widespread in Sempu Strait (Andrimida 2021, 2022), Kondang Merak (Arifin et al. 2020). **Global distribution:** Indo-Pacific (Gosliner et al. 2019).

***Phyllidia ocellata* Cuvier, 1804.** Previous record: ST in Sempu Strait (Andrimida 2021). **Global distribution:** Indo-Pacific (Gosliner et al. 2019).

***Phyllidiella annulata* Gray, 1853.** Previous record: Sempu Strait (Andrimida 2023). **Global distribution:** Western to Central Pacific (Gosliner et al. 2019).

***Phyllidiella pustulosa* Cuvier, 1804.** Previous record: Widespread in Sempu Strait (Andrimida 2021, 2022). **Global distribution:** Indo-Pacific (Gosliner et al. 2019).

***Phyllidiella granulata* Brunckhorst, 1993.** Previous record: Kondang Merak (Arifin et al. 2020). **Note:** Listed as *Phyllidia granulata* in (Arifin et al. 2020), revised following proper taxonomical name. **Global distribution:** East Indo-West Pacific (Gosliner et al. 2019).

***Phyllidiopsis fissurata* Brunckhorst, 1993.** Previous record: CI, WM and TS in Sempu Strait (Andrimida and Hermawan 2020). **Global distribution:** Indo-West Pacific (Gosliner et al. 2019).

Family Arminidae Iredale and O'Donoghue, 1923

***Dermatobranchus albus* Quoy and Gaimard, 1825.** Previous record: RA in Sempu Strait (Andrimida and Hermawan 2020). **Global distribution:** Indo-West Pacific (Gosliner et al. 2019).

Family Bornellidae Bergh, 1874

***Bornella anguilla* S. Johnson, 1984.** Previous record: RA in Sempu Strait (Andrimida and Hermawan 2020). **Global distribution:** Indo-Pacific (Gosliner et al. 2019).

Family Scyllaeidae Alder and Hancock, 1855

***Scyllaea fulva* Quoy and Gaimard, 1824.** Previous record: RA in Sempu Strait (Andrimida and Hermawan 2020). **Global distribution:** Indo-West Pacific (Gosliner et al. 2019).

Family Tethyidae Rafinesque, 1815

***Melibe viridis* Kelaart, 1858.** Previous record: RA in Sempu Strait (Andrimida and Hermawan 2020). **Global distribution:** Indo-Pacific (Gosliner et al. 2019).

Family Tritoniidae Lamarck, 1809

***Tritoniopsis elegans* Audouin, 1826.** Previous record: Kondang Merak (Arifin et al. 2020). **Global distribution:** Indo-West Pacific (Gosliner et al. 2019).

Family Flabellinidae Bergh, 1889

***Coryphellina rubrolineata* O'Donoghue, 1929.** Previous record: TW and ST in Sempu Strait (Andrimida

and Hermawan 2020). **Global distribution:** Indo-Pacific (Gosliner et al. 2019), spread to the Eastern Mediterranean and Adriatic Sea (Türker et al. 2020).

***Coryphellina lotos* Korshunova et al. 2017.** Previous record: Tiga Warna, Sempu Strait (Andrimida 2022). **Global distribution:** Western Pacific (Gosliner et al. 2019).

Family Samlidae Korshunova et al. 2017

***Samla bicolor* Kelaart, 1858.** Previous record: WM and TW in Sempu Strait (Andrimida and Hermawan 2020; Andrimida 2022). **Global distribution:** Indo-Pacific (Gosliner et al. 2019).

Family Eubranchidae Odhner, 1934

***Eubranchus mandapamensis* K. P. Rao, 1968.** Previous record: RA in Sempu Strait (Andrimida and Hermawan 2020). **Global distribution:** Indo-Pacific (Gosliner et al. 2019).

***Eubranchus* sp. 1.** **Note:** Listed as *Eubranchus* sp. 1, recorded from RA in Sempu Strait (Andrimida 2022). Identical to *Eubranchus* sp. 2 Gosliner et al. 2019 by possessing similar structured rhinopores, such finding only recorded in Indonesia (Gosliner et al. 2019) signifying a possible endemism.

Family Facelinidae Bergh, 1889

***Facelina bouraili* Risbec, 1928.** Previous record: RA and PU Sempu Strait (Andrimida 2022). **Note:** Listed as *Phidiana bouraili* Risbec, 1928 in Andrimida (2022), revised following taxonomical update (Gosliner et al. 2023). *Cratena simba* Edmunds, 1970 listed in Andrimida (2021) also revised to *Facelina bouraili* Risbec, 1928 as the specimen observed proved to possess annulated rhinopores, where *C. simba* has smooth rhinopores. **Global distribution:** Indo-Western Pacific (Gosliner et al. 2019).

***Caloria indica* Bergh, 1896.** Previous record: ST in Sempu Strait (Andrimida 2021). **Note:** *Coryphellina exoptata* (Gosliner and Willan, 1991) listed in Andrimida (2020), are proven to be *Caloria indica* as it has smooth rhinopores. **Global distribution:** Indo-Pacific (Gosliner et al. 2019).

***Caloria militaris* Alder and Hancock, 1864.** Previous record: RA in Sempu Strait (Andrimida and Hermawan 2020). **Note:** Listed as *Phidiana militaris* Alder and Hancock, 1864 in Andrimida (2021), revised following taxonomical update (Gosliner et al. 2023). **Global distribution:** Indo-Western Pacific, spread to the Eastern Mediterranean Sea. **Global distribution:** Indo-West Pacific (Gosliner et al. 2019).

***Phidiana anulifera* Baba, 1949.** Previous record: Rumah Apung, Sempu Strait (Andrimida 2023). **Note:** Mislabeled as *Phidiana anulifera* Baba, 1949 in Andrimida (2023), revised following proper taxonomical name. **Global distribution:** Western to Central Pacific (Gosliner et al. 2019).

**Table 2.** List of newly recorded heterobranch sea slug species in this study, along with their respective habitat type and abundance

Order, Family	Species	Habitat type	Abundance	IUCN
<b>Pleurobranchida</b>				
Pleurobranchidae	<i>Pleurobranchus peronii</i>	Rocky reefs with coral rubble	Abundant in all three study sites (Gatra, Tanjung Penyu, and Banyu Towo)	NE
	<i>Pleurobranchus forskalii</i>	Rocky reefs with coral rubble	Found in low number in Gatra and Tanjung Penyu	NE
	<i>Pleurobranchus albiguttatus</i>	Rocky reefs with coral rubble	Only found once in Gatra	NE
<b>Nudibranchia</b>				
Hexabranchidae	<i>Hexabranchus lacer</i>	Rocky reef	Only found once in Tanjung Penyu	NE
Polyceridae	<i>Gymnodoris inornata</i>	Sandy reefs with coral rubble	Two individuals found in Banyu Towo	NE
Dorididae	<i>Doris</i> sp. 1	Sandy reefs with coral rubble	Only found once in Banyu Towo	NE
Discodorididae	<i>Atagema spongiosa</i>	Sandy reefs with coral rubble	Two individuals found in Banyu Towo	NE
Dendrodorididae	<i>Dendrodoris tuberculosa</i>	Rocky reefs with coral rubble	Found twice in Tanjung Penyu	NE
Facelinidae	<i>Moridilla brockii</i>	Hydroid-covered dead coral	Only found once in Tanjung Penyu	NE
<b>Aplysiida</b>				
Aplysiidae	<i>Aplysia extraordinaria</i>	Algae-covered rock and dead corals	Very abundant in Tanjung Penyu	NE
	<i>Aplysia reticulata</i>	Algae-covered rock and dead corals	Very abundant in Tanjung Penyu	NE
<b>Sacoglossa</b>				
Plakobranchidae	<i>Elysia rufescens</i>	Sandy reefs with coral rubble	Commonly found in Banyu Towo and found once near Teluk Semut	NE
	<i>Elysia</i> sp. 1	Sandy reefs with coral rubble	Only found once in Banyu Towo	NE
	<i>Plakobranchus ocellatus</i>	Sandy reefs with coral rubble	Only found once in Banyu Towo	NE

Note: NE: Not Evaluated

***Moridilla brockii* Bergh, 1888\*** (Figure 2). **Remarks:** First record in South Malang from Tanjung Penyu. One individual found crawling on hydroid-covered rock at rocky shallows during low tide.

**Morphological description:** Body elongated and slender, with slightly flattened at the posterior end. Foot narrow and elongated with acute end. Rhinopores papillated, tentacles smooth and elongated. Dorsal notum covered with elongated cerata in a cluster, arranged in the outer end of the notum. Body milky white, with red rhinopores and cerata (Gosliner et al. 2019; Schillo et al. 2019).

**Ecology:** Found in hydroid covered rock substrate in intertidal area. *Moridilla* is a nocturnal species that often found under coral rubble (Cunha et al. 2023). **Note:** This record provides information on distribution extension in Western Indonesia, as previous records are mainly from Central Indonesian Region (GBIF 2025c). **Global distribution:** Indo-Pacific (Gosliner et al. 2019).

***Pteraeolidia semperi* Bergh, 1870. Previous record:** KB, TS, TW, and FP in Sempu Strait (Andrimida and Hermawan 2020; Andrimida 2022). **Note:** Listed as *Pteraeolidia ianthina* Angas, 1864 in Andrimida (2021), revised following recent study that proved *P. ianthina* only referred to the species with a limited distribution in the Australian Sub-tropical Sea (Wilson and Burghardt 2015). **Global distribution:** Indo-Pacific (Gosliner et al. 2019)

Family Myrrhinidae Bergh, 1905

***Phylloidesmium poindimiei* Risbec, 1928. Previous record:** RA in Sempu Strait (Andrimida and Hermawan 2020). **Global distribution:** Indo-Pacific (Gosliner et al. 2019)

Order Cephalaspidea Fischer, 1883

Family Bullidae J.E. Gray, 1827

***Bulla ampulla* Linnaeus, 1758. Previous record:** Sempu Strait (Andrimida 2021), Gatra Beach (Widiandyah

et al. 2016). **Global distribution:** Indo-Western Pacific (Gosliner et al. 2019), also present in the Gulf of Antalya, Turkiye (Gökoglu et al. 2018).

Family Aglajidae Pilsbry, 1895

***Tubulophilinopsis pilsbryi* Eliot, 1900<sup>^</sup>. Previous record:** KB in Sempu Strait (Andrimida 2021), new record from BT (this study). **Ecology:** Previously found in silt dominated substrate in KB in 2021, in this study it found in sandy substrate in BT. It is commonly found in abundance in soft sediment substrate away from coral reef area (Mehrotra et al. 2021). **Global distribution:** Tropical Indo-Pacific (Gosliner et al. 2019).

Order Aplysiida Pelseneer, 1906

Family Aplysiidae Lamarck, 1809

***Aplysia oculifera* A. Adams and Reeve, 1850<sup>^</sup>. Previous record:** RA in Sempu Strait (Andrimida 2021), Kondang Merak (Arifin et al. 2020), new record in Tanjung Penyu (this study). **Global distribution:** Tropical Indo-Pacific, Western Australia, Queensland, New South Wales, and Victoria (Nimbs et al. 2017a).

***Aplysia extraordinaria* J. K. Allan, 1932\*** (Figure 2). **Remarks:** First record in South Malang from Tanjung Penyu. Found in abundance on turf algae-covered rock at rocky shallows during low tide.

**Morphological description:** Larger in size than most of *Aplysia*, body is smooth and covered in a pair of parapodial flaps on its dorsal side. The parapodial flaps are thin and broad and could assist the sea hare in swimming. Body colored dark brown or yellowish brown with series of whitish pattern with irregular sizes. It also has black patten on the outside of the head and parapodial flaps but absent in the inner side of parapodial flaps (Hamatani and Baba 2004).

**Ecology:** Abundant in algae-covered rock at intertidal depth. Observed in rocky reefs at intertidal to shallow subtidal in Australia, also found among flotsams in Singapore (Nimbs et al. 2020; Lin et al. 2024). **Global distribution:** New Zealand to Eastern Australia (Gosliner et al. 2019), Australia: Western Australia, Queensland, New South Wales, and Norfolk Island (Nimbs et al. 2017a), also Japan (Hamatani and Baba 2004).

***Aplysia reticulata* Eales, 1960\*** (Figure 2). **Remarks:** First record in South Malang from Tanjung Penyau. Found in abundance on turf algae-covered rock at rocky shallows during low tide.

**Morphological description:** Body covered with black and white pigments in reticulated pattern. It has small and contractible head and neck. Foot is narrow and tail is short and pointed. Pair of large and thin parapodial flaps with undulated margin covering dorsal side of notum (Bebbington 1977).

**Ecology:** Found in algae-covered rock at intertidal depth. Sea hare from the *Aplysia* genus known to inhabit shallow intertidal rocky reef, their abundance is associated with the availability of green algae (Nimbs et al. 2020). **Global distribution:** Pacific Ocean (Bebbington 1977), Australia (Nimbs et al. 2017b).

***Dolabella auricularia* Lightfoot, 1786<sup>^</sup>.** **Previous record:** FP in Sempu Strait (Andrimida 2021), new record from BT and GA (this study). **Global distribution:** Indo-Pacific and East Pacific (Gosliner et al. 2019), Australia: Western Australia, Northern Territory, Queensland, New South Wales (Nimbs et al. 2017a).

***Stylocheilus striatus* Quoy and Gaimard, 1832<sup>^</sup>.** **Previous record:** RA in Sempu Strait (Andrimida 2021), new record from BT (this study). **Global distribution:** Circumtropical (Gosliner et al. 2019), Australia: Queensland, New South Wales (Nimbs et al. 2017a).

***Stylocheilus longicauda* Quoy and Gaimard, 1825.** **Previous record:** RA in Sempu Strait (Andrimida 2021). **Global distribution:** Circumtropical (Gosliner et al. 2019).

***Bursatella leachii* Blainville, 1817.** **Previous record:** RA in Sempu Strait (Andrimida 2021). **Global distribution:** Indo-Pacific (Gosliner et al. 2019).

***Notarchus indicus* Schweigger, 1820.** **Previous record:** RA in Sempu Strait (Andrimida 2021). **Global distribution:** Indo-Pacific and East Pacific (Gosliner et al. 2019), Australia: Western Australia, Queensland, New South Wales, and South Australia (Nimbs et al. 2017a).

***Dolabrifera dolabrifera* Rang, 1828.** **Previous record:** Tanjung Penyau (Tamam MB 2024, pers. comm.). **Global distribution:** Indo-Pacific (Gosliner et al. 2019), Australia: Western Australia, Queensland, New South Wales, and Victoria (Nimbs et al. 2017a).

*Superorder Sacoglossa von Ihering, 1876*

*Family Plakobranchidae Gray, 1840*

***Elysia rufescens* Pease, 1871\*** (Figure 2). **Remarks:** First record in South Malang from Sempu Strait. Found in pair hiding on coral crevice at 2 meters depth.

**Morphological description:** Body elongated with high and ruffled parapodial flaps. Body olive green with black

and white spots. Parapodia with bluish black margin and thin orange sub-marginal band (Gosliner et al. 2019).

**Ecology:** Found under coral crevices at intertidal area. Sap-sucking slug from the *Elysia* genus known to inhabit intertidal to shallow subtidal reef, it preys on green algae (Nimbs et al. 2020). **Global distribution:** Indian and Pacific Oceans (Gosliner et al. 2019).

***Elysia marginata* Pease, 1871<sup>^</sup>.** **Previous record:** RA in Sempu Strait (Andrimida and Hermawan 2020), new record from Tanjung Penyau and Banyu Towo (this study). **Global distribution:** Indo-Pacific (Gosliner et al. 2019).

***Elysia ornata* Swainson, 1840.** **Previous record:** Kondang Merak (Arifin et al. 2020). **Global distribution:** Indo-Pacific (Gosliner et al. 2019), Lizard Island, Australia (Donà et al. 2022).

***Elysia* sp. 1.** **Remarks:** First record in South Malang from Sempu Strait. Found hiding on coral crevice during low tide. **Morphological description:** Similar to *Elysia* sp. 27 in Gosliner et al. (2019). **Global distribution:** Philippines (Gosliner et al. 2019).

***Thuridilla lineolata* Bergh, 1905.** **Previous record:** ST in Sempu Strait (Andrimida and Hermawan 2020). **Global distribution:** Indonesia and the Philippines (Gosliner et al. 2019).

***Thuridilla gracilis* Risbec, 1928.** **Previous record:** ST in Sempu Strait (Andrimida 2022), Kondang Merak (Arifin et al. 2020). **Global distribution:** Indo-Western Pacific (Gosliner et al. 2019), Lizard Island, Australia (Donà et al. 2022).

***Thuridilla undula* Gosliner, 1995.** **Previous record:** Kondang Merak (Arifin et al. 2020). **Global distribution:** Western Pacific (Gosliner et al. 2019).

***Plakobranchus ocellatus* van Hasselt, 1824<sup>^</sup>** (Figure 2). **Remarks:** New record in South Malang from Sempu Strait. An individual found hiding in coral rubble at sand-bottomed shallows during low tide. Previously reported from Balekambang (Rini DS 2023, pers. comm.).

**Morphological description:** Notum is typically flat, parapodial flaps are broad and folded on its dorsal side. Body color is greenish gray or pale green, covered with bluish ocelli. The ventral side is peppered with black spots. Head is broad and flattened, rhinopores are smooth and short (Mehrotra et al. 2020).

**Ecology:** Prefer sandy substrate in shallow intertidal waters. This species inhabits soft sediment habitats up to 25 meters depth (Mehrotra et al. 2020). **Global distribution:** Indo-Pacific (Gosliner et al. 2019), Southwestern Japan (Chihara et al. 2020), Lizard Island, Australia (Donà et al. 2022).

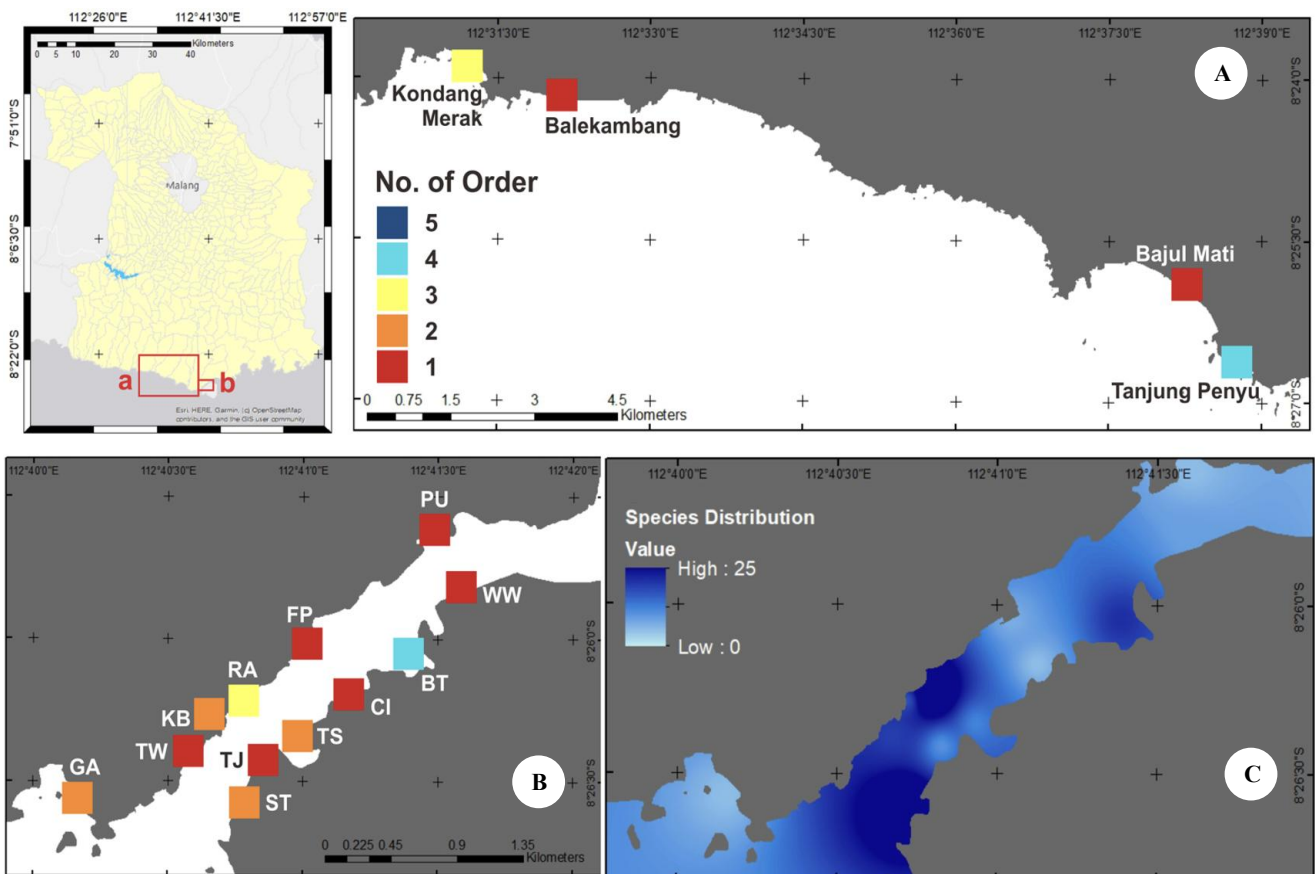
## Discussion

Most of the heterobranch sea slug species are recorded in South Malang comes from the Sempu Strait area, as it is the safest place to conduct SCUBA diving-based surveys year-round. The difference in survey method conducted during this study has been successfully reveals novel potential habitat for heterobranch sea slug in the Tanjung Penyau Beach. Tanjung Penyau Beach has an extensive intertidal area that exposed during the low tide, making it suitable to conduct surveys targeted at intertidal sea slug's

diversity. Most of the new heterobranch sea slugs record during this study are found in Tanjung Penyu and Sempu Strait Area, with additional record found outside study area both from past literatures not written by the author or from personal communications. Tanjung Penyu and Banyu Towo in Sempu Strait has an extensive intertidal area that provide a suitable habitat for marine heterobranch that could tolerate a wide range of temperature shifts, such as pleurobranchs that found in both study area as new records (Goodheart et al. 2015; Broms 2024).

GIS analysis results shows that majority of the study site only have one order of heterobranch sea slug (Figures 3.A-B). Even though the southern part of Sempu Strait has a higher sea slug diversity, most of the species are from Nudibranchia order, with some records of sacoglossan and cephalaspidean. The dive site with most sea slug order in Sempu Strait was Banyu Towo (BT) with 4 orders, namely sacoglossan, cephalaspidean, pleurobranch and nudibranch. The dive site with most sea slug order outside Sempu Strait was Tanjung Penyu, also with 4 orders, namely the sacoglossan, anaspidean, pleurobranch, and nudibranch.

Interpolated species abundance within Sempu Strait shows that Southern Part of Sempu Strait and area around Banyu Towo have a proportionally higher species abundance, while the area near fishing port has lower species abundance. Areas around Banyu Towo is characterized by moderate coral cover with more complex ecosystem containing seagrass beds and sand-bottomed shallows, while area around Stumbut in the southern part of Sempu Strait is characterized by moderate coral cover, rich biotic covers (sponges, hydroids, etc.) and hard bottomed substrate (rubble and rock). Heterobranch sea slug diversity is largely affected by the substrate composition the percentage of dead corals and sponge are shown proportional to nudibranch diversity. Dead corals (rubbles) provide shelters for nudibranchs to withstand underwater current, as well as providing safe shelter to ensure free movement for the nudibranch (Adiwijaya et al. 2021). Biotic covers such as sponges and hydroids are also important as it is the main food source for a large group of heterobranch sea slug that lives within the vicinity of coral reef ecosystem (Gosliner et al. 2019).



**Figure 3.** Heterobranch sea slug order distribution in South Malang, East Java, Indonesia. A. Stations outside Sempu Strait, B. Stations inside Sempu Strait, South Malang. Interpolated heterobranch sea slug species abundance distribution within Sempu Strait showed in blue shade, dark blue signfic high species abundance, C. Pale blue signfic low species abundance. Sampling sites abbreviation WW: Waru-Waru, PU: Pondok Urang, BT: Banyu Towo, CI: Calo Ilang, FP: Fishing Port, TS: Teluk Semut, RA: Rumah Apung, TJ: Tanjung, KB: Kondang Buntung, ST: Stumbut, TW: Tiga Warna, GA: Gatra

Past studies in Sempu Strait reveals that no pleurobranch species were recorded in this area (Andrimida and Hermawan 2019, 2020; Andrimida 2021, 2022). The record of three pleurobranch species in this study provides the first pleurobranch record from Sempu Strait. The absence of pleurobranch in the past study is a result of a different approach on the survey method. While past surveys are focused on exploring sea slug species on the subtidal depth, mostly during the daytime, current survey focused on exploring the intertidal area during low tide, mostly on the late afternoon. This different approach successfully recorded pleurobranchid sea slugs as pleurobranches are mainly inhabit shallow intertidal area that exposed during low tide and mostly nocturnal (Goodheart et al. 2015).

This study combines recent findings with past studies, which successfully record for a combined 76 species of heterobranch sea slug. The dominant family of sea slug found in South Malang is Chromodoridiidae with 24 species, on which 10 species belong to the Chromodorinae subfamily and 14 species belong to the Miamirinae subfamily. Similar studies also bear the same results as species belong to the Chromodoridiidae family are mostly found in daylight at the vicinity of coral reef area (Amelia et al. 2022; Rosyid et al. 2022). The second family with the highest species number is Aplysiidae, or commonly referred as “sea hare”. Sea hares are commonly found in the intertidal and subtidal zones, where it is seasonally abundant with the blooming of green algae (Plaut et al. 1998). The third sea slug family with the most species that contribute to the sea slug diversity in South Malang is Plakobrachidae. This family of sap-sucking slug prefers soft-bottomed substrates near coral reef area (Mehrotra et al. 2020). Past studies on the nearby area in East Java and Bali also provide similar number of Plakobrachidae species (Rosyid et al. 2022; Kristiana et al. 2024).

Several species of particular interest, such as cryptic and underreported species such as *P. albiguttatus*, *G. inornata* and *A. spongiosa* which previously never been documented from this area. The record of these species signifies that alternative survey method done during this study covers a range of complex microhabitat which never surveyed before, thus resulted in uncovering overlooked diversity that often missed by traditional survey method. Another rarely documented species such as *M. brockii* that has a specific association with hydroids signify that some sites in South Malang have a suitable habitat for heterobranch sea slug with very specific niche specialization and a potential for habitat fidelity. Additionally, the record of Aplysiid species such as *A. extraordinaria* and the sacoglossan *P. ocellatus* might signifies their distribution extension southward to Southern Java Coastline.

Habitat condition also acts as the main driver of heterobranch sea slug richness. Sites such as Banyu Towo features a mixed substrate of sand, rubble, seagrass, and moderate coral covers or Tanjung Penyu that features a mixed substrates of rock, algae, rubble, and moderate coral covers support more heterobranch sea slug diversity compared to other sites that has less habitat variation (Table 1). This supports previous findings that substrate heterogeneity and availability of prey items, mostly

consists of sessile benthic invertebrates like sponges and hydroids, as well as turf algae are critical for sustaining heterobranch sea slug richness and diversity in a given area (Eisenbarth et al. 2018; Kristiana et al. 2024). The record of side-gilled slugs (Pleurobranchida) in intertidal habitats that are absent in previous SCUBA-based surveys, demonstrates the importance of the temporal aspect and tidal height condition in marine biodiversity surveys, as these species are known to be active near the dusk and cryptic by nature, as well as preferring shallow, sheltered reef crevices (Goodheart et al. 2015).

Comparing to other surveys in Western Indonesia (Java and Bali) and Eastern Indonesia (Ambon and Sulawesi), the heterobranch sea slug species richness recorded in this study is notably high (Table 3). With a total of 79 species, South Malang surpasses other sites in Java, such as Jepara (6 species; Sabdono et al. 2021), Gunungkidul (5 species; Kumarahaqi et al. 2022), Karimunjawa (5 species; Kusuma 2013) and also surpasses Sumberkima (15 species; Ampou et al. 2023) and Penimbangan in Bali (42 species; Amelia et al. 2022). Even though, this number doesn't exceed the heterobranch species richness of Tulamben Bali (144 species; Kristiana et al. 2024), Ambon (138 species; Yonow and Jensen 2018), and Bangka Archipelago in Sulawesi (149 species; Papu et al. 2020). The highest number of heterobranch sea slug is still held by Bunaken National Park, with 215 species recorded from 2003 to 2017 (Eisenbarth et al. 2018). The small number of species found in Western Indonesia is a result of a combined factor, such as limited survey time and survey effort that only concentrated in a small area (Sabdono et al. 2021; Kristiana et al. 2024). The Eastern Indonesian Region still holds the most abundant heterobranch sea slug species, with more than 100 species are recorded from each site. In contrast with the Western Indonesian counterpart, heterobranch sea slug surveys in Eastern Indonesia are mainly done regularly over a broad time scale (Kaligis et al. 2018; Papu et al. 2020).

The high diversity of heterobranch sea slugs recorded in South Malang in this study emphasize the ecological value of South Malang in broader region and highlights its significance for marine conservation. The dominant heterobranchia family such as Chromodorididae and Plakobrachidae are highly dependent on specific prey such as sponges, hydroids and algae, as well as inhabiting specific microhabitats in benthic environments (Eisenbarth et al. 2018; Gosliner et al. 2019; Mehrotra et al. 2020). This indicate that the presence of these certain taxa could be utilized as indicator of coral reef health and benthic environment composition. The discovery of 14 new locality records on South Malang further reveals on how many biodiversity remain unknown and undocumented, particularly in area that understudied and underexplored, such as intertidal zone that rarely observed in past SCUBA-based surveys. This finding also aligns with the trend on a global scale that start to utilize marine heterobranch as bioindicator of to understand underwater ecosystem complexity, both in tropical reef or in the higher altitude waters (Nimbs et al. 2020; Garner and Oosthuizen 2023; Ballesteros et al. 2025).

**Table 3.** Comparison of heterobranch sea slug species in South Malang with other areas in Indonesia

Sites	Year	Cephalaspidea	Aplysiida	Sacoglossa	Pleurobranchida	Nudibranchia	Total	Source
South Malang	2018-2025	2	9	8	3	57	79	Current observation by authors
Tulamben, Bali	2021-2022	4	1	16	2	121	144	Kristiana et al. 2024
North East Banyuwangi	2022	5	0	9	0	71	85	Rosyid et al. 2022
Penimbangan, Bali	2020-2021	1	0	3	1	37	42	Amelia et al. 2022
Sabang Island	2013-2019	0	0	0	0	21	21	Kurnianda et al. 2020
Sumberkima, Bali	2021	0	0	0	0	15	15	Ampou et al. 2023
Jejara, Central Java	2020	0	0	0	0	6	6	Sabdono et al. 2021
Gunungkidul, Yogyakarta	2021	0	1	0	0	4	5	Kumarahaqi et al. 2022
Karimunjawa, Central Java	2013	0	0	0	0	5	5	Kusuma 2013
Bangka Archipelago	2017-2018	5	2	15	2	125	149	Papu et al. 2020
Ambon	2018	11	6	12	4	105	138	Yonow and Jensen 2018
Bunaken National Park	2003 and 2015	26	4	15	4	85	135	Kaligis et al. 2018

On larger scale, these new regional records provide an important biogeographical insight for marine heterobranchia species distribution in Indonesian Waters. The record of *H. lacer* and *M. brockii* from South Malang extend their distribution westward into the Western Indonesia Region, where these species were previously observed in Central and Eastern Indonesia (GBIF 2025b, c). This finding highlights their new potential habitat and locality in Western Indonesia from previously undocumented populations. Heterobranch sea slug range extension might related to their life history, marine heterobranch typically have planktonic larvae that dispersed by oceanic currents (Montana et al. 2024) thus this might indicate their potential dispersal or signifying poorly surveyed habitats in this region. The records of heterobranch species in this study emphasize the importance of South Malang Coastal Area and in larger scale, South Java Coastal Area in understanding connectivity and species dispersal of marine heterobranch in Indonesian Waters. However, to assess the connectivity thoroughly, advanced method such as genetic studies considered important to support the existence of biogeographical connection between distinct marine heterobranch populations (Ekimova et al. 2021).

The high diversity of coloration, shape and size of nudibranchs and other heterobranch sea slug could become a potential to develop special interest marine ecotourism activity, such as underwater macrophotography or better known as ‘muck diving’ (Andrimida and Hermawan 2020). Muck diving is a niche diving activity that target cryptic marine species, including nudibranch as their main attraction. This type of diving has been conducted in some parts of Indonesia and mostly done in sandy or rubble-dominated habitats (De Brauwer et al. 2017). Some locations in Sempu Strait such as Banyu Towo, were novel species found and Stumbut have the ideal condition to be developed into muck diving area. But still further suitability study is needed to assess the feasibility of those

sites with high heterobranchia diversity. Proposing appropriate guidelines in community-based marine ecotourism also could help to actualize the potential to enhance local livelihood while supporting environment conservation (Kurnia et al. 2024).

However, most of the study areas in South Malang are facing habitat degradation, as coral covers are declining as low as 12.57% to 14.28% (Isdianto et al. 2024a, b, c). This phenomenon possesses a serious threat to the heterobranch sea slug diversity as this group of animals is vulnerable to environmental changes. Increased sedimentation changes water quality that leads to compromised coral health, competition with macroalgae, also pollution and marine debris could rapidly deteriorate the coral reef integrity and destroy microhabitat that these species needed to live (Isdianto et al. 2023b; 2024b, c). The presence of certain taxa in degraded coral reef area indicates their survivability and resilience, but the broader assemblages are remained vulnerable (Isdianto et al. 2023a). By integrating heterobranch sea slug diversity into future monitoring programs, it could contribute to determining the proper action to protect these fragile habitat and ecosystem (Sabdono et al. 2021). Adaptive conservation strategies, along with public education and citizen scientist participation in monitoring activities could become important on maintaining the specific biodiversity that could be actualized into special interest ecotourism activity that benefit the locals (Hermoso et al. 2021).

The implementation of non-traditional survey method that includes intertidal exploration and collaboration with citizen science are proven to be effective in detecting underreported and cryptic marine heterobranch species in South Malang. This study provides an updated checklist of heterobranch sea slug from South Malang, Indonesia, recording a total of 79 species of marine heterobranch across five orders, which are Nudibranchia (57 species), Aplysiida (nine species), Sacoglossa (eight species), Pleurobranchida (three species), and Cephalaspidea (two

species). Notably, this research also recorded 14 new heterobranch sea slug in South Malang, which comprise of two Aplysiid sea hare species, three sacoglossan species, three pleurobranch species, and six nudibranch species. This finding is helpful in enriching current knowledge and understanding of marine heterobranch diversity in this understudied region. This finding also suggest that South Malang area could become a biodiversity hotspot for heterobranch sea slug in West Indonesia Region. Given the importance of heterobranch sea slugs' role in coral reef health and their specific microhabitats requirements, long term monitoring particularly considering the change in habitat as a response for anthropogenic effect in South Malang is recommended to be conducted. Conservation strategies should prioritize on the protection of benthic habitat diversity, mainly in the particular area with high species abundance such as Stumbut, Tiga Warna and Banyu Towo in Sempu Strait. This could be achieved by promoting the participation of citizen scientist in building a comprehensive database, especially for marine macrozoobenthos and integrating the data into a broader marine biodiversity for reef resilience assessment. Also, with all of its limitations, this study is heavily relied on photographic-guided identification, future studies might incorporate advanced methods such as Environmental DNA to reveal the hidden marine heterobranch diversity that has yet to be revealed (Grimm et al. 2022). In conclusion, this comprehensive data on heterobranch sea slug's diversity in South Malang could be utilized as a baseline for future monitoring programs for marine biodiversity assessments, as well as a valuable input to be implemented on future conservation management in area disturbed by environmental pressure in South Java Region.

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**Table S1.** List of heterobranch sea slug species compiled from this study, past studies, and citizen scientists report (labeled as pers. comm.) in South Malang, East Java, Indonesia

Family	Species	Recorded site(s)	Record basis	Habitat	Novelty status	Note
<b>Pleurobranchida (3 species)</b>						
Pleurobranchidae Gray, 1827	<i>Pleurobranchus peronii</i> Cuvier, 1804	GA, TP, BT	This study	Rocky reefs	New record in South Malang	
	<i>Pleurobranchus forskalii</i> Rüppell and Leuckart, 1828	GA, TP	This study	Rocky reefs	New record in South Malang	
	<i>Pleurobranchus albiguttatus</i> Bergh, 1905	GA	This study	Rocky reefs	New record in South Malang	
<b>Nudibranchia (57 species)</b>						
Hexabanchidae Bergh, 1891	<i>Hexabanchus lacer</i> Cuvier, 1804	TP	This study	Rocky reef	New record in South Malang	
Polyceridae Alder & Hancock, 1845	<i>Plocamopherus imperialis</i> Angas, 1864	RA	Andrimida 2022	Rocky reef		
Dorididae Rafinesque, 1815	<i>Gymnodoris inornata</i> Bergh, 1880	BT	This study	Sandy coral reef	New record in South Malang	
	<i>Doris</i> sp.1	BT	This study	Sandy coral reef	New record in South Malang	
Discodorididae Bergh, 1891	<i>Discodoris boholiensis</i> Bergh, 1877	ST	Andrimida 2021	Sandy coral reef		
	<i>Halgerda elegans</i> Bergh, 1905	ST	Andrimida 2022	Algae and sponge covered rock		
	<i>Halgerda wasinensis</i> Eliot, 1904	ST	Andrimida 2022	Dead coral rubble		
	<i>Atagema spongiosa</i> Kelaart, 1858	BT	This study	Sandy coral reef	New record in South Malang	
Chromodorididae Bergh, 1891	<i>Chromodoris magnifica</i> Quoy & Gaimard, 1832	TW	Andrimida 2022	Dead coral rubble		
	<i>Chromodoris aspersa</i> Gould, 1852	ST	Andrimida 2021	Dead coral rubble		
	<i>Chromodoris</i> sp. 1	RA	Andrimida 2021	Rocky reef		Chromodoris sp. 13 in Gosliner et al. (2019)
	<i>Chromodoris</i> sp. 2	ST	Andrimida 2022	Algae-covered coral		
	<i>Goniobranchus reticulatus</i> Quoy & Gaimard, 1832	KB	Andrimida 2021	Rocky reef		Misidentified as <i>G.</i> <i>tinctorius</i> in Andrimida (2021), revised as <i>G.</i> <i>reticulatus</i>
	<i>Goniobranchus geometricus</i> Risbec, 1928	WW, ST	Andrimida 2021; Ditha R 2022, pers. comm	Dead coral rubble		
	<i>Goniobranchus verrieri</i> Crosse, 1875	ST	Andrimida 2021	Dead coral rubble		
	<i>Goniobranchus</i> sp. 1	ST	Andrimida 2021	Algae and hydroid covered rock		<i>Goniobranchus</i> sp. 39 in Gosliner et al. (2019)
	<i>Doriprismatica atromarginata</i> Cuvier, 1804	KB, ST, BM	Pratomo W 2019, pers. comm; Andrimida 2021	Sandy and rocky coral reef		
	<i>Vercornia simplex</i> Pease, 1871	TW	Andrimida 2022	Dead coral rubble		
	<i>Mexichromis aurora</i> Johnson & Gosliner, 1998	ST	Andrimida 2022	Sponge-covered coral rubble		

	<i>Thorunna daniellae</i> Kay & Young, 1969	RA, TJ, ST	Andrimida 2021	Rocky reef		<i>Thorunna florens</i> (Baba, 1949) in Andrimida (2021), revised as <i>T. daniellae</i>
	<i>Hypselodoris emma</i> Rudman, 1977	KB, ST	Andrimida 2021	Rocky reef, coral rubble		
	<i>Hypselodoris maculosa</i> Pease, 1871	RA, TJ	Andrimida 2021			
	<i>Hypselodoris decorata</i> Risbec, 1928	TS	Andrimida 2022	Crevice of algae-covered rock		
	<i>Hypselodoris infucata</i> Rüppell & Leuckart, 1831	KB, TW, ST	Andrimida 2021	Coral rubble		
	<i>Hypselodoris confetti</i> Gosliner & Johnson, 2018	ST	Andrimida 2022	Coral rubble		
	<i>Hypselodoris roo</i> Gosliner & R. Johnson, 2018	TW	Andrimida 2022	Rock crevice		
	<i>Hypselodoris kanga</i> Rudman, 1977	WW, ST	Andrimida 2021	Rocky reef		
	<i>Hypselodoris dollfusi</i> Pruvot-Fol, 1933	KB	Andrimida 2021	Sponge covered substrare		Misidentified as <i>G. tumuliferus</i> in Andrimida (2021), revised as <i>H. dollfusi</i>
	<i>Hypselodoris apolegma</i> Yonow, 2001	KB, ST	Andrimida 2021	Rocky reef		
	<i>Hypselodoris bullocki</i> Collingwood, 1881	KM	Arifin et al. 2020	Rocky reef		
	<i>Hypselodoris tryoni</i> Garrett, 1873	WW, BT, TS, KB, TJ, TW, ST	Andrimida 2021	Sandy and rocky reef		Also recorded during 2024 survey
	<i>Hypselodoris pulchella</i> Rüppell & Leuckart, 1828	PU, BT, TW, ST	Andrimida 2021	Sandy and rocky reef		Also recorded during 2024 survey
Dendrodorididae O'Donoghue, 1924	<i>Dendrodoris tuberculosa</i> Quoy & Gaimard, 1832	TP	This study	Rocky reef	New record for South Malang	
	<i>Dendrodoris krusensternii</i> J. E. Gray, 1850	RA, TW	Andrimida 2021	Coral reef		<i>Dendrodoris denisoni</i> in Andrimida (2021) revised as <i>D. krusensternii</i>
Phyllidiidae Rafinesque, 1814	<i>Dendrodoris nigra</i> Angas, 1864	RA	Andrimida 2021	Rocky reef		
	<i>Phyllidia varicosa</i> Lamarck, 1801	WW, CI, FP, TS, RA, TJ, ST, KM	Arifin et al. 2020; Andrimida 2021, 2022	Rocky and sandy reef, coral rubble		
	<i>Phyllidia ocellata</i> Cuvier, 1804	ST	Andrimida 2021	Rocky reef		
	<i>Phyllidiella annulata</i> Gray, 1853	WM	Andrimida 2023	Rocky reef, coral rubble		
	<i>Phyllidiella pustulosa</i> Cuvier, 1804	WM, WW, PU, CI, FP, TS, RA, KB, TJ, ST	Andrimida 2021, 2022	Rocky reef, coral rubble		
	<i>Phyllidiella granulata</i> Brunckhorst, 1993	KM	Arifin et al. 2020	Rocky reef		
	<i>Phyllidiopsis fissurata</i> Brunckhorst, 1993	WM, CI, TS	Andrimida 2021	Rocky reef		
Arminidae Iredale &	<i>Dermatobranchus albus</i> Quoy & Gaimard,	RA	Andrimida 2021	Algae and hydroid		

O'Donoghue, 1923	1825				covered rock	
Bornellidae Bergh, 1874	<i>Bornella anguilla</i> S. Johnson, 1984	RA	Andrimida 2021		Hydroid covered rock	
Scyllaeidae Alder & Hancock, 1855	<i>Scyllaea fulva</i> Quoy & Gaimard, 1824	RA	Andrimida 2021		Algae covered rock	
Tethyidae Rafinesque, 1815	<i>Melibe viridis</i> Kelaart, 1858	RA	Andrimida 2021		Algae covered rock	
Tritoniidae Lamarck, 1809	<i>Tritoniopsis elegans</i> Audouin, 1826	KM	Arifin et al. 2020		Rocky reef	
Flabellinidae Bergh, 1889	<i>Coryphellina rubrolineata</i> O'Donoghue, 1929	TW, ST	Andrimida 2021		Rocky and sandy reef	
	<i>Coryphellina lotos</i> Korshunova et al. 2017	TW	Andrimida 2022		Sandy reef	
Samliidae Korshunova et al. 2017	<i>Samla bicolor</i> Kelaart, 1858	WM, TW	Andrimida 2021, 2022		Coral rubble	
Eubranchidae Odhner, 1934	<i>Eubranchus mandapamensis</i> K. P. Rao, 1968	RA	Andrimida 2021		Hydroid covered rock	
	<i>Eubranchus</i> sp. 1	RA	Andrimida 2022		Hydroid covered rock	<i>Eubranchus</i> sp. 1 in Gosliner et al. (2019)
Facelinidae Bergh, 1889	<i>Facelina bouraili</i> Risbec, 1928	PU, RA	Andrimida 2022		Hydroid and algae covered flotsams	<i>Cratena simba</i> in Andrimida (2021) and <i>Phidiana bouraili</i> in Andrimida (2022) revised as <i>F. bouraili</i>
	<i>Caloria indica</i> Bergh, 1896	ST	Andrimida 2021		Hydroid covered rock	<i>Coryphellina exoptata</i> in Andrimida (2021) revised as <i>Caloria indica</i>
	<i>Caloria militaris</i> Alder & Hancock, 1864	RA	Andrimida 2021		Hydroid covered rock	<i>Phidiana militaris</i> in Andrimida (2021) revised as <i>Caloria militaris</i>
	<i>Phidiana anulifera</i> Baba, 1949	RA	Andrimida 2023		Hydroid covered rock	Mislabeled as <i>Phidiana anulifera</i> in Andrimida (2023)
	<i>Moridilla brockii</i> Bergh, 1888	TP	This study		Hydroid covered dead coral	New record in South Malang
	<i>Pteraeolidia semperi</i> Bergh, 1870	FP, TS, KB, TW	Andrimida 2021, 2022		Sandy and rocky reef	<i>P. ianthina</i> in Andrimida (2021) revised as <i>P. semperi</i>
Myrrhinidae Bergh, 1905	<i>Phylloidesmium poindimiei</i> Risbec, 1928	RA	Andrimida 2021		Hydroid and algae covered substrate	
<b>Cephalaspidea (2 species)</b>						
Bullidae J.E. Gray, 1827	<i>Bulla ampulla</i> Linnaeus, 1758	RA, GA	Widiansyah et al. 2016; Andrimida 2021		Algae covered rock	
Aglajidae Pilsbry, 1895	<i>Tubulophilinopsis pilsbryi</i> Eliot, 1900	BT, KB	Andrimida 2021		Sandy and rocky reef	Also recorded during 2024 survey
<b>Aplysiida (9 species)</b>						
Aplysiidae Lamarck, 1809	<i>Aplysia oculifera</i> A. Adams & Reeve, 1850	RA, TP, KM	Arifin et al. 2020;		Algae covered rock	Also recorded during 2024

	<i>Aplysia extraordinaria</i> J. K. Allan, 1932	TP	Andrimida 2021	Algae covered rock	New record in South Malang	survey
	<i>Aplysia reticulata</i> Eales, 1960	TP	This study	Algae covered rock	New record in South Malang	
	<i>Dolabella auricularia</i> Lightfoot, 1786	BT, FP, GA	Andrimida 2021	Algae covered rock		Also recorded during 2024 survey
	<i>Stylocheilus striatus</i> Quoy & Gaimard, 1832	BT, RA	Andrimida 2021	Algae covered rock		Also recorded during 2024 survey
	<i>Stylocheilus longicauda</i> Quoy & Gaimard, 1825	RA	Andrimida 2021	Algae covered rock		
	<i>Bursatella leachii</i> Blainville, 1817	RA	Andrimida 2021	Algae covered rock		
	<i>Notarchus indicus</i> Schweigger, 1820	RA	Andrimida 2021	Algae covered rock		
	<i>Dolabrifera dolabrifera</i> Rang, 1828	TP	Tamam MB 2024, pers. comm.	Algae covered rock		Recorded outside study timeline
<b>Sacoglossa (8 species)</b>						
Plakobranchidae Gray, 1840	<i>Elysia rufescens</i> Pease, 1871	BT, TS	This study	Sandy reef with coral rubble	New record in South Malang	
	<i>Elysia marginata</i> Pease, 1871	BT, RA, TP	Andrimida 2021	Rocky reef with coral rubble		Also recorded during 2024 survey
	<i>Elysia ornata</i> Swainson, 1840	KM	Arifin et al. 2020	Rocky reef		
	<i>Elysia</i> sp. 1	BT	This study	Sandy reef with coral rubble		New record in South Malang, <i>Elysia</i> sp. 27 in Gosliner et al. (2019)
	<i>Thuridilla lineolata</i> Bergh, 1905	ST	Andrimida 2021	Rocky reef with coral rubble		
	<i>Thuridilla gracilis</i> Risbec, 1928	ST	Arifin et al. 2020; Andrimida 2021	Rocky reef with coral rubble		
	<i>Thuridilla undula</i> Gosliner, 1995	KM	Arifin et al. 2020	Rocky reef		
	<i>Plakobranchus ocellatus</i> van Hasselt, 1824	BT, BK	Rini DS 2023, pers. comm.; This study	Sandy reef with coral rubble	New record in South Malang	

Note: WM: Watu Meja, WW: Waru-Waru, PU: Pondok Urang, BT: Banyu Towo, CI: Calo Ilang, FP: Fishing Port, TS: Teluk Semut, RA: Rumah Apung, TJ: Tanjung, KB: Kondang Buntung, ST: Stumbut, TW: Tiga Warna, GA: Gatra, BM: Bajul Mati, BK: Balekambang, KM: Kondang Merak, TP: Tanjung Penyu