



## The Heterobranchia gastropods from the Cabo Verde Islands (NE Atlantic): A hot-spot of endemism

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### ABSTRACT

The Archipelago of Cabo Verde is located in the northeastern Atlantic Ocean, off the coast of Senegal in West Africa. According to recent studies, it constitutes a distinct biogeographical subprovince with a subtropical affinity. The archipelago is well known for its high levels of marine endemism, likely due to the geological age and the isolation of the islands maintained by ocean currents and upwelling systems. In this paper, taxonomic findings from a field survey conducted on the islands of Sal, Boa Vista, and São Vicente are presented, accompanied by detailed geographical and ecological data to enhance the documentation of the distribution and habitat of species in the archipelago. Specimens were collected from tidal rock pools and subtidal zones down to 18 m depth through snorkeling and SCUBA diving. Sampling methods included direct hand collection, surface brushing, and gathering algae into sealed plastic bags for later examination. In the laboratory, specimens were sorted into morphospecies, photographed, cataloged, and preserved in 99 % ethanol following relaxation. A total of 27 species of Heterobranchia were identified, including one new record for the archipelago (*Caloria quatrefagesi*) and one species likely new to science (here identified as *Facelinidae* sp.). Notably, 44 % of the species collected are endemic to Cabo Verde, further highlighting the unique marine biodiversity of the region.

### 1. Introduction

Cabo Verde is well-known for its high levels of endemic marine species (reviewed in Freitas et al., 2019). Traditionally, the archipelago, with the Canaries, Selvagens, Madeira, and the Azorean islands, has been considered part of a biogeographical unit called Macaronesia (Sjögren, 2000). However, recent studies on marine organisms have found little evidence to support the affinity of Cabo Verde with these other archipelagos. Instead, these findings suggest its exclusion from Macaronesia and its reclassification as a distinct biogeographical subprovince (e.g., Freitas et al., 2019).

Cabo Verde lies within the West African Transition (WAT) biogeographical province, which includes the archipelago and the Sahelian upwelling zone between Mauritania and Guinea Bissau (Spalding et al., 2007). A taxonomic study on heterobranch philinid snails from West

Africa revealed a striking shift in species composition around this province, coinciding with the boundary between the cold-temperate fauna of the Lusitanian province (including the Canaries, Azores, and Madeira) and northern European seas provinces with the more tropical fauna of the Eastern Atlantic/Gulf of Guinea provinces (Malaquias et al., 2017).

The distinctiveness of Cabo Verde compared to other northeast Atlantic archipelagos is underscored by its high levels of endemism. For example, endemic species account for 7.3 % of coastal fishes, 44.1 % of gastropods, 8.5 % of brachyuran crustaceans, and 4.2 % of “polychaete” annelid worms (Freitas et al., 2019). Among gastropods, cones species exhibit an extraordinary endemism level of 94 % (Ávila et al., 2018; Tenorio et al., 2020), while endemism reaches 58 % in *Fissurella* keyhole limpets (Rolán, 2005), and 22 % in sea slugs (Freitas et al., 2019).

These high levels of endemism across various taxa likely result from

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the influence of the Northwest African Upwelling System (NAUS) and the Cape Verde Frontal Zone (CVFZ). The NAUS brings permanent cold waters to the surface (upwelling) along the coastline from Cape Ghir (Morocco) and Cape Blanc (Mauritania) north to Cape Verde, and seasonal cold waters between Cape Blanc and Guinea to the south (Matsuzaki et al., 2011; Valdés and Déniz-González, 2015). In addition, the CVFZ between the northern part of the archipelago and Cape Blanc, represents a transition zone between different water masses, with distinct temperature, salinity, and nutrient characteristics (Matsuzaki et al., 2011; Valdés and Déniz-González, 2015). The uniqueness of the marine biodiversity of Cabo Verde suggests that for many marine organisms, the western Africa upwelling systems and the Cape Verde Frontal Zone act as a biogeographical barrier, hindering larval dispersal between the Cabo Verde islands, the Canary Islands, and the African mainland (Freitas et al., 2019).

The earliest reports of sea slugs (Heterobranchia gastropods) from Cabo Verde date back to the 19th and early 20th centuries (Rang, 1828; Rochebrune, 1881; Eliot, 1906). However, significant advancements in documenting this fauna occurred much later during the 1980s and 1990s, marked by numerous publications and the description of many new species (reviewed by Ortea and Moro, 2019). Since that review, at least 15 additional studies have expanded our understanding of this fauna. Currently the marine heterobranch gastropods in Cabo Verde comprise approximately 259 species, including 96 shelled pyramidellids and lower heterobranchs, 24 shelled cephalaspids, and 139 slug species including nudibranchs, aglajiids, aplysiids, runcinids, pleurobranchids, and sacoglossans (Rolán, 2005; Ortea and Moro, 2019; Ortea, et al., 2019; Ortea and Moro, 2020a; b; c; d; e; Ortea et al., 2020; Ortea and Moro, 2021a; b; Ortea et al., 2021; Ortea and Moro, 2022a; b; c; d; Ortea et al., 2022).

The aim of this work is to provide new data on the diversity,

geography and ecology of the Heterobranchia marine gastropods of the Archipelago of Cabo Verde.

## 2. Material and methods

### 2.1. Taxon sampling, imaging, and fixation

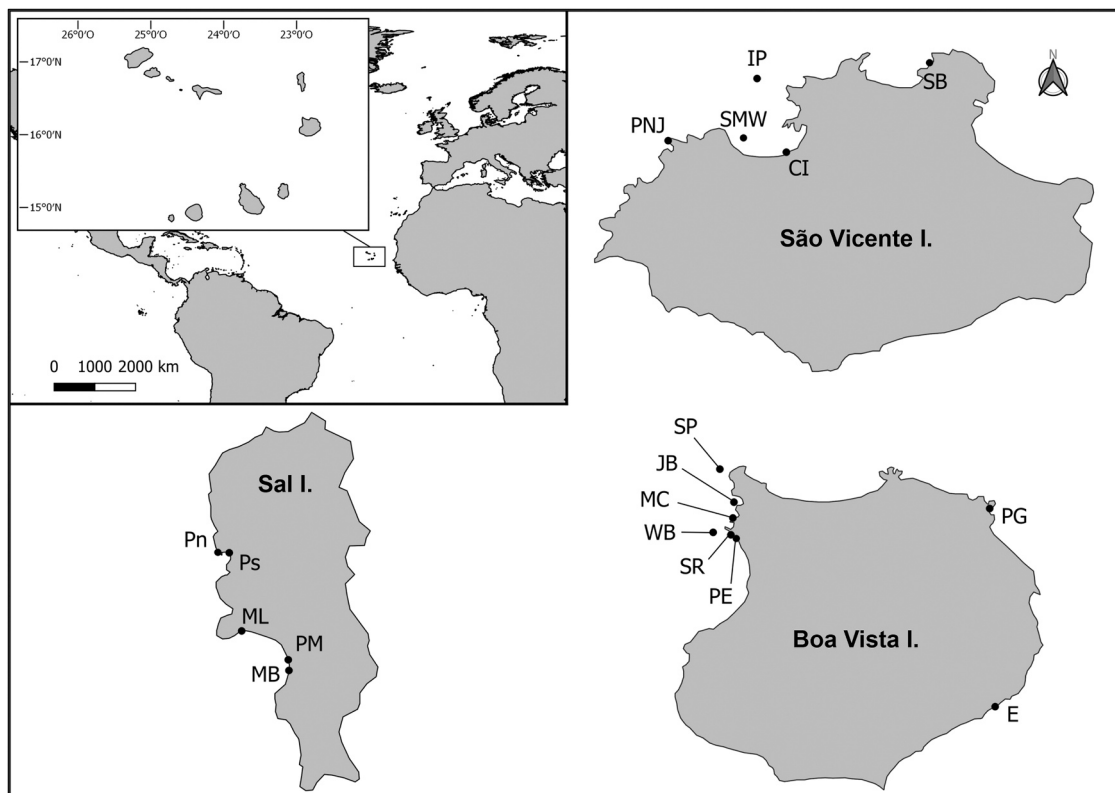
Sampling took place in the islands of Sal, Boa Vista, and São Vicente (Archipelago of Cabo Verde) between 3–18 September 2024 by tidal rock-pooling, snorkeling, and SCUBA diving down to 18 m depth on 18 sites (Fig. 1, Table 1). Animals were collected by hand after direct observation, and indirectly by brushing suitable surfaces or collecting algae into zip-lock plastic bags. In the laboratory the contents of the zip-lock bags were transferred to plastic trays with sea water and left to rest for ~ 1–2 h and then screened for specimens. Specimens were separated to morpho-species, photographed, measured, frozen overnight in sea water to allow animals to pass way in a natural position (this eases anatomical studies if necessary), defrosted the day after, and fixed in 99% ethanol.

## 3. Results

Twenty-seven species of Heterobranchia were collected. An annotated list of species is presented below, with the code of the sampling station in bold followed by a voucher number, date of collection, depth, habitat, number of specimens collected, and length of specimens (see Table 1 for acronyms, geographical coordinates, and description of sampling sites).

Remarks were added to the species with complex taxonomic status and to those endemic to the archipelago.

Abbreviations: L = animal length; ZMBN = Department of Natural



**Fig. 1.** Sampling sites in the Archipelago of Cabo Verde. **Sal I.:** MB, Murdeira Bay. ML, Monte Leão. PM, Praia da Murdeira. Pn, Palmeira (off desalination plant). Ps, Palmeira (off shell power plant inside harbor). **Boa Vista I.:** E, Ponta Cosme, Ervatão. JB, “Juan Bodega” diving reef. MC, “Marina Club” diving reef. PE, Praia do Estoril, Sal-Rei. PG, Praia das Gatas. SP, Shark Point. SR, Sal-Rei (north end of Diante Beach). WB, Wreck Boat, Sal-Rei. **São Vicente I.:** CI, Cova da Inglesa, Mindelo. IP, Ilhéu dos Pássaros. PNJ, Ponta de Nhó Djon. SB, NE of Salamansa Bay. SMW, São Macário Wreck, off Lazaretto, Mindelo (for details see Table 1).

**Table 1**  
Sampling stations with geographical coordinates, and biophysical descriptions.

Island	Sampling station	Code	Coordinates	Description
Sal	Praia de Murdeira	PM	16°40'43.57"N–22°56'11.79"W	Closed embayment with rocky outer margins and a sandy beach; rocky bottom with coral and algae (ca. 0.5–1 m)
Sal	Murdeira Bay	MB	16°40'16.01"N–22°56'10.05"W	Closed embayment with rocky outer margins and a sandy beach; sand and boulders at the bottom (ca. 0.5–3 m)
Sal	Monte Leão	ML	16°41'57.98"N–22°58'11.81"W	Shallow area (0–2 m) with boulders covered with algae are coral with white sand in between
Sal	Palmeira (off Shell power plant inside harbor)	Ps	16°45'19.67"N–22°58'43.80"W	Rocky tidal flat with pools with algae and silt
Sal	Palmeira (off desalination plant)	Pn	16°45'20.10"N–22°59'12.69"W	Subtidal rocky wall with caves near the bottom (ca. 14–16 m)
Boa Vista	Sal-Rei (north end of Diante Beach)	SR	16°10'32.10"N–22°55'14.50"W	Rocky tidal flat with pools and algae
Boa Vista	Praia das Gatas	PG	16°11'49.77"N–22°42'31.50"W	Shallow subtidal area (0.5–1 m) with coral boulders and algae dominated by <i>Caulerpa taxifolia</i>
Boa Vista	"Marina Club" diving reef	MC	16°11'21.811"N–22°55'8.598"W	Offshore rocky reef with coral, sponges, and other invertebrates (ca. 18 m)
Boa Vista	"Juan Bodega" diving reef	JB	16°12'8.51"N–22°55'5.47"W	Offshore rocky reef with coral, sponges, and other invertebrates (ca. 18 m)
Boa Vista	Praia do Estoril, Sal-Rei	PE	16°10'21.20"N–22°54'58.52"W	Subtidal rocky boulders with algae (0.5–2 m)
Boa Vista	Wreck Boat, Sal-Rei	WB	16°10'39.31"N–22°56'6.77"W	Boat wreck with surface covered by sponges and anthozoans.
Boa Vista	Shark Point	SP	16°13'46"N–22°55'47"W	Offshore rocky reef with coral, sponges, and other invertebrates (ca. 18 m)
Boa Vista	Ponta Cosme, Ervatão	E	16°24.57"N–22°42'15.34"W	Rocky tidal flat with pools covered by algae.
São Vicente	São Macário Wreck off Lazareto, Mindelo	SMW	16°52'59.8"N–25°01'05.7"W	Boat wreck with surface covered by algae, sponges and anthozoans (ca. 14 m).
São Vicente	Cova da Inglesa	CI	16°52'36.27"N–24°59'55.26"W	Rocky tidal flat with pools covered by brown and green algae
São Vicente	Ilhéu dos Pássaros, off Mindelo Bay	IP	16°54'37.5"N–25°00'43.4"W	Offshore islet with rocky bottoms with corals, sponges and anthozoans (14–18 m)
São Vicente	Ponta de Nhô Djon	PND	16°52'55.2"N–25°03'09.5"W	Subtidal rocky wall with boulders with coral and algae at the bottom (ca. 16–18 m)
São Vicente	NE end of Salamansa Bay	SB	16°55'3.47"N–24°55'59.96"W	Tidal bay with large pools with rocks, coral and algae

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#### Taxonomic list

##### Order Acteonimorpha

##### Family Aplustridae Gray, 1847

##### *Micromelo undatus* (Bruguère, 1792)

##### Fig. 2A, B

**Material collected:** ML, ZMBN 160867, 05–09–2024, 0.2 m depth, crawling on bear rock, 1 spc.; L = 10 mm. E, ZMBN 160900, 14–09–2024, intertidal zone, tidal pools covered with brown algae, 24 spcs, L = 4–15 mm. PND, ZMBN 160917, 17–09–2024, 8 m, crawling on reef, 1 spc., L = 12 mm.

**Remarks:** The systematics of the genus *Micromelo* was recently revised based on the combination of conchological and morphological features together with molecular phylogenetics (Feliciano et al., 2021). The authors confirmed the presence of only one species across the entire eastern and western circumtropical and sub-tropical Atlantic Ocean.

##### Order Cephalaspidea

##### Family Haminoeidae Pilsbry, 1895

##### *Haminoea orbignyana* (A. Férussac, 1822)

##### Fig. 2C, D

**Material collected:** Ps, ZMBN 160870, 05–09–2024, 0.2 m, on rocky flat with algae *Dictyota* sp. + silty bottom, 6 spcs, L = 4–7 mm, egg masses observed. Ps, ZMBN 160871, 05–09–2024, 0.2 m, on rocky flat with algae *Dictyota* sp. + silty bottom, 3 spcs, L = 5 mm, egg masses observed. Ps, ZMBN 160874, 06–09–2024, 0.2 m, on rocky flat with algae *Dictyota* sp. + silty bottom, 8 spcs, L = 7–8 mm, egg masses observed. SR, ZMBN 160884, 09–09–2024, tidal zone, on rocky flat with brown algae, 38 spcs, L = 4–8 mm. SR, ZMBN 160885, 09–09–2024, tidal zone, on rocky flat with brown algae, 1 spc., L = 7 mm. PE, ZMBN 160893, 12–09–2024, 0.5 m, rocky outcrop with small stones covered with green algae and sandy bottom, 4 spcs, L = 3–8 mm. PE, ZMBN 160895, 12–09–2024, 0.5 m, rocky outcrop with small stones covered with green algae and sandy bottom, 13 spcs, L = 3–7 mm. CI, ZMBN 160907, 16–09–2024, tidal zone, crawling on brown algae in rock pool, 4 spcs, L = 4–8 mm. CI, ZMBN 160924, 17–09–2024, tidal zone, crawling on brown algae in rock pool, 2 spcs, L = 8, 13 mm.

**Remarks:** The is a ubiquitous species distributed from the Atlantic

coast of France, southwards along the West African coast from Morocco to Nigeria and São Tomé. It is also present all over the Mediterranean Sea (Malaquias and Cervera, 2006; Zabby and Malaquias, 2013; Turani et al., 2024).

##### *Haminoea ortei* Talavera, Murillo & Templado, 1987

##### Fig. 2E–H

**Material collected:** ML, ZMBN 160868, 05–09–2024, 0.5 m depth, on reef with rocks and algae, 2 spcs, L = 3, 5 mm, egg masses observed. Ps, ZMBN 160873, 06–09–2024, 0.2 m depth, on rocky flat with algae *Dictyota* sp. + silty bottom, on reef with rocks and algae, 7 spcs; photographed; L = 4–7 mm, egg masses observed. ML, ZMBN 160875, 06–09–2024, 0.2 m depth, on reef with rocks and algae, 7 spcs, L = 5–14 mm, egg masses observed. SMW, ZMBN 160913, 17–09–2024, 8–10 m depth, on algae, 5 spcs, L = 4–10 mm. PND, ZMBN 160925, 17–09–2024, 10 m depth, on algae, 1 spc., L = 4 mm.

##### Order Aplysiida

##### Family Aplysiidae Lamarck, 1809

##### *Aplysia dactylomela* Rang, 1828

##### Fig. 3A

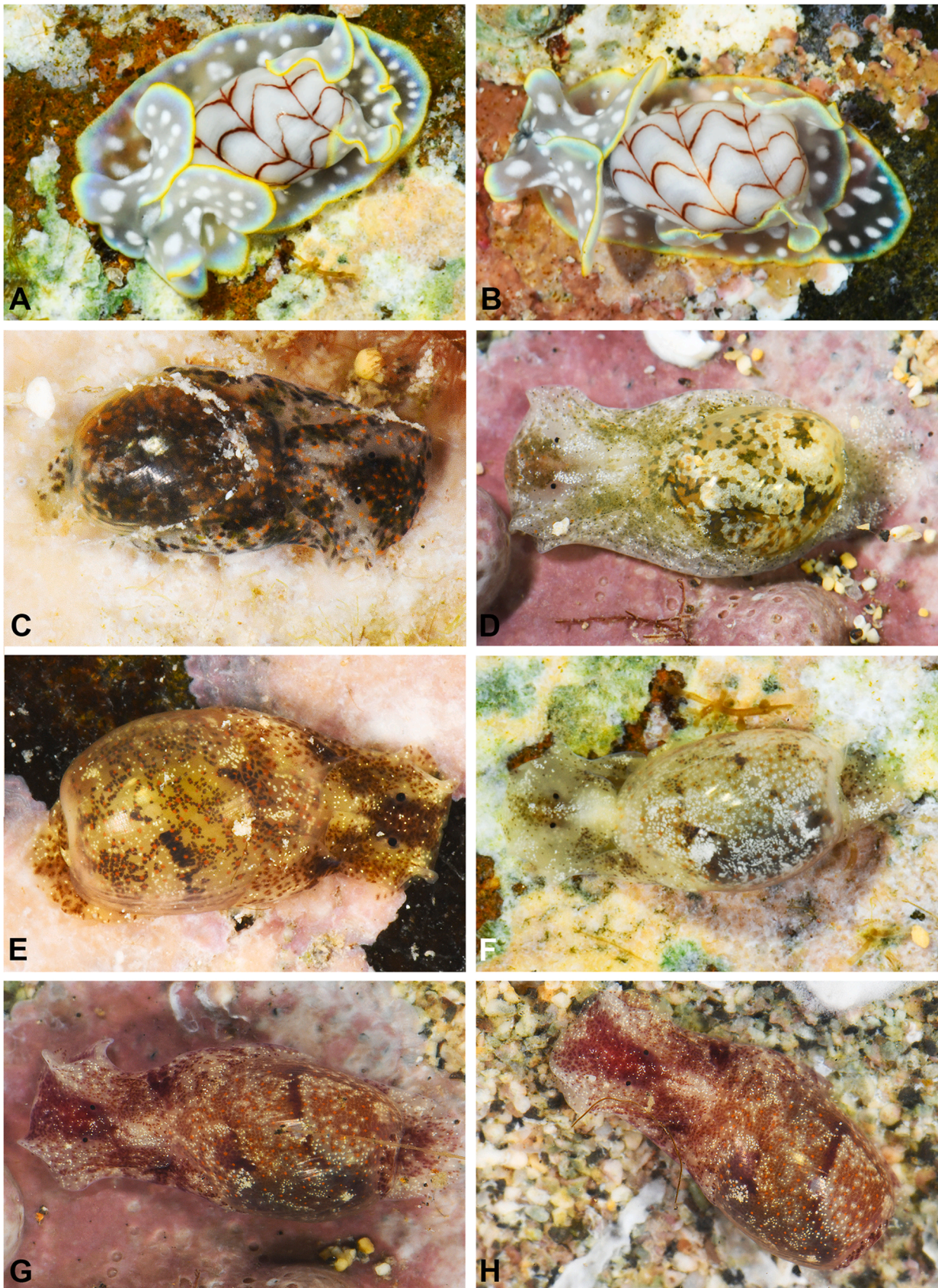
**Material collected:** PM, ZMBN 160861, 03–09–2024, 0.3 m depth, on algae, 2 spcs, L = 75, 50 mm. PM, ZMBN 160866, 04–09–2024, 0.5 m depth, on algae, 2 spcs, L = 30 mm. PE, ZMBN 160892, 12–09–2024, 0.5 m depth, rocky outcrop with small stones covered with green algae and sandy bottom, 4 spcs, L = 17–50 mm. E, ZMBN 160901, 14–09–2024, tidal zone, tidal pools covered with brown algae, 2 spcs, L = 50, 60 mm, released purple ink when disturbed. CI, ZMBN 160927, 17–09–2024, tidal zone, crawling on algae, 1 spc., L = 120 mm, released purple ink when disturbed.

*Dolabrifera edmundsi* Á. Valdés, Breslau, Padula, Schrödl, Camacho-García, Malaquias, Alexander, Bottomley, Vital, Hooker & Gosliner, 2017

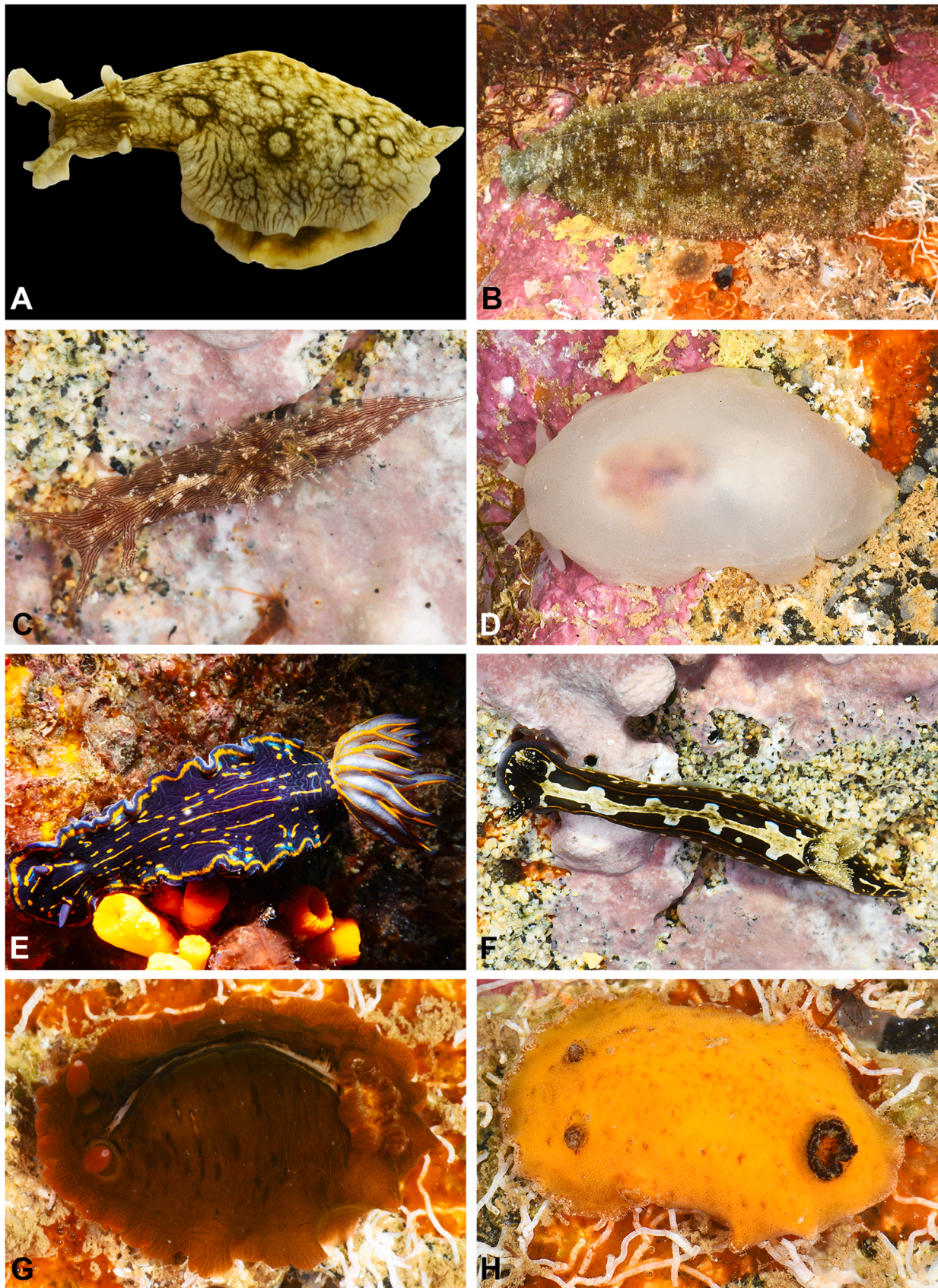
##### Fig. 3B

**Material collected:** SB, ZMBN 160930, 18–09–2024, tidal zone, hiding under rock, 1 spc., L = 53 mm.

**Remarks:** This is a recently described species with an amphi-Atlantic distribution known from the Canary Islands, Madeira, Cabo Verde, and São Tomé and Príncipe. It is also present in the island St. Helena in the



**Fig. 2.** (A) *Micromelo undatus*, ML (Sal I.), ZMBN 160867, L = 10 mm. (B) *Micromelo undatus*, E (Boa Vista I.), ZMBN 160900, L = 15 mm. (C) *Haminoea orbignyana*, Ps (Sal I.), ZMBN 160874, L = 8 mm. (D) *Haminoea orbignyana*, CI (São Vicente I.), ZMBN 160907, L = 8 mm. (E) *Haminoea ortei*, Ps (Sal I.), ZMBN 160873, L = 7 mm. (F) *Haminoea ortei*, ML (Sal I.), ZMBN 160868, L = 5 mm. (G, H) *Haminoea ortei*, SMW (São Vicente I.), ZMBN 160913, L = 10 mm.



**Fig. 3.** (A) *Aplysia dactylomela*, E (Boa Vista I.), ZMBN160091, L = 60 mm. (B) *Dolabrifera edmundsi*, SB (São Vicente I.), ZMBN160930, L = 53 mm. (C) *Stylocheilus polyomma*, SMW (São Vicente I.), ZMBN160914, L = 12 mm. (D) *Berthella spatula*, SB (São Vicente I.), ZMBN160933, L = 23 mm. (E) *Felimare tema*, SMW (São Vicente I.), ZMBN160902, L = 10 cm. (F) *Felimare pinna*, SMW (São Vicente I.), ZMBN160903, L = 20 mm. (G) *Dendrodoris senegalensis*, SB (São Vicente I.), ZMBN160934, L = 24 mm. (H) *Gargamella blokovertensis*, SB (São Vicente I.), ZMBN160935, L = 23 mm.

south Atlantic and in the Gulf of Mexico in the Western Atlantic (Valdés et al., 2018).

***Stylocheilus polyomma* (Mörch, 1863)**

**Fig. 3C**

**Material collected:** PM, ZMBN 160862, 03–09–2024, 0.3 m depth, on algae, 1 sp., L = 23 mm. ML, ZMBN 160869, 05–09–2024, 0.5 m depth, on rocks with algae, 1 sp., L = 15 mm. ML, ZMBN 160876, 05–09–2024, 0.5 m depth, on rocks with algae, 1 sp., L = 15 mm. SR, ZMBN 160883, 09–09–2024, tidal zone, on tidal rocky flat with brown algae, 19 spcs, L = 20–40 mm. JB, ZMBN 160891, 11–09–2024, 10 m depth, matting on reef flat with stones, 6 spcs, L = 7–35 mm, egg masses observed. SMW, ZMBN 160914, 17–09–2024, 8–10 m depth, on algae, 5 spcs, L = 7–12 mm. SB, ZMBN 160929, 18–09–2024, intertidal zone, on rocks with algae, 3 spcs, L = 40–50 mm.

**Remarks:** The taxonomy of the genus *Stylocheilus* has been through some uncertainties with animals being attributed more or less randomly to the names available. Four species are recognized worldwide (MolluscaBase eds, 2025) and in Cabo Verde two names have been used: *S. longicauda* (e.g., Ortea and Martínez, 1990) or *S. striatus* (e.g., Rolán, 2005). *Stylocheilus longicauda* is a Western Pacific lineage and Bazzicalupo et al. (2020) showed that *Stylocheilus striatus* is a complex of three species. According to the latter authors only one species seems to occur in the Atlantic, namely *S. polyomma*, but the authors only studied material from the Caribbean. Therefore, the identity of the eastern Atlantic specimens remains to be confirmed based on DNA studies. We provisionally ascribe our specimens to *S. polyomma*.

**Order Pleurobranchida**

**Family Pleurobranchidae Gray, 1827**

***Berthella spatula* Ortea, Moro and Caballer, 2014**

**Fig. 3D**

**Material collected:** SB, ZMBN 160933, 18–09–2024, intertidal zone, hiding under a rock, 1 sp., L = 23 mm.

**Remarks:** This species is only known from Cabo Verde where it was observed in the islands of Sal, Boa Vista (Ortea et al., 2014) and São Vicente (current study).

**Order Nudibranchia**

**Family Chromodorididae Bergh, 1891**

***Felimare tema* (Edmunds, 1981)**

**Fig. 3E**

**Material collected:** MC, ZMBN 160888, 11–09–2024, 10 m depth, crawling on reef, 1 sp. WB, ZMBN 160896, 13–09–2024, 12 m depth, crawling on wreck surface with sponges, 1 sp., L = 90 mm. SMW, ZMBN 160902, 16–09–2024, 12–14 m depth, crawling on sand and surface with sponges, 3 spcs, L = 90, 100, 130 mm. IP, ZMBN 160908, 16–09–2024, 14–18 m depth, crawling on reef under a boulder's roof, 1 sp., L = 80 mm. PND, ZMBN 160921, 17–09–2024, 10 m depth, crawling on reef wall, 1 sp., L = 90 mm.

**Remarks:** The taxonomic status of this large chromodorid nudibranch from Cabo Verde has been long debated. Initially, it was considered part of the *Hypselodoris picta* species complex and later assigned to a distinct subspecies – *Hypselodoris picta verdensis* – distributed in Cabo Verde, São Tomé and Príncipe, and southern Angola (Ortea et al., 1996). According to these authors, this subspecies is characterized by a dark green background color with abundant orange lines and dots. In the same work, they also reassigned *Hypselodoris tema* Edmunds, (1981) from Ghana to a local subspecies of *H. picta*, naming it *Hypselodoris picta tema*.

Later, the study by Johnson and Gosliner (2012) on chromodorid nudibranchs, led to the genus name *Hypselodoris* being replaced by *Felimare* Ev. Marcus and Er. Marcus, 1967 for the Mediterranean, Atlantic, and eastern Pacific species.

In January 2016 two studies about the *Felimare picta* complex were published with a difference of 10 days. Furfaro et al. (2016) suggested that *F. picta verdensis* from Senegal and São Tomé warranted species rank, based on 9–10 % genetic divergence (COI gene) from specimens from Italy. Almada et al. (2016) conducted the first comprehensive

study of the complex, examining specimens from Cabo Verde, São Tomé and Príncipe, Senegal, Selvagens, Canary Islands, the Azores, southern Spain, Gibraltar, Italy, Bermuda, Mexico, and Brazil. Their results identified three major groups compatible with species status: one Mediterranean and amphi-Atlantic group (*Felimare picta* proper), a western Atlantic group (with two species: *F. lajensis* and *F. zebra*), and a tropical eastern Atlantic group. The latter included specimens from Senegal, Cabo Verde, and São Tomé and Príncipe. Two nominal names were available for this species, namely *Hypselodoris tema* and *Hypselodoris picta verdensis*. As *H. tema* is an older name that has precedence, Almada et al. (2016) reinstated the name for the tropical eastern Atlantic species, ranging across Senegal, Ghana, southern Angola, and the archipelagos of Cabo Verde and São Tomé and Príncipe. This species is distinguished by longitudinal orange lines, an orange submarginal border, orange-lined gills, and a dark blue background with lighter blue patches along the submarginal mantle border (Edmunds, 1981; Ortea et al., 1996; Almada et al., 2016). These features match the specimens collected by us in Cabo Verde (Fig. 3E).

***Felimare pinna* (Ortea, 1988)**

**Fig. 3F**

**Material collected:** MC, ZMBN 160887, 11–09–2024, 10 m depth, crawling on open reef, 1 sp., L = 14 mm. SMW, ZMBN 160903, 16–09–2024, 12 m depth, crawling on boat wreck surface, 2 spcs, L = 14, 20 mm.

**Remarks:** This species is endemic from Cabo Verde and was described based on specimens collected from the islands of Maio, Boa Vista, São Vicente, and Sal (Ortea, 1988).

**Family Dendrodorididae O'Donoghue, 1924 (1864)**

***Dendrodoris senegalensis* Bouchet, 1975**

**Fig. 3G**

**Material collected:** SB, ZMBN 160934, 18–09–2024, intertidal zone, hiding under a rock, 1 sp., L = 25 mm.

**Family Discodorididae Bergh, 1891**

***Gargamella blokoverdensis* Moro and Ortea, 2015**

**Fig. 3H**

**Material collected:** SB, ZMBN 160935, 18–09–2024, intertidal zone, hiding under a rock, 1 sp., L = 23 mm.

**Remarks:** This endemic species from Cabo Verde was originally described based on specimens collected in the islands of Sal and São Vicente (Moro and Ortea, 2015).

**Family Discodorididae Bergh, 1891**

***Geitodoris bacalladoi* Ortea, 1990**

**Fig. 4A**

**Material collected:** SB, ZMBN 163493, 18–09–2024, intertidal zone, hiding under a rock, 1 sp., L = 26 mm.

**Family Polyceridae Alder and Hancock, 1845**

***Tambja fantasmalis* Ortea & García-Gómez, 1986**

**Fig. 4B**

**Material collected:** SB, ZMBN 160878, 7–09–2024, 12 m depth, on entrance of cave with sponges and other reef elements, 1 sp., L = 50 mm.

**Remarks:** This species is endemic from Cabo Verde and was first described from the islands of Sal and Boa Vista (Ortea and García-Gómez, 1986).

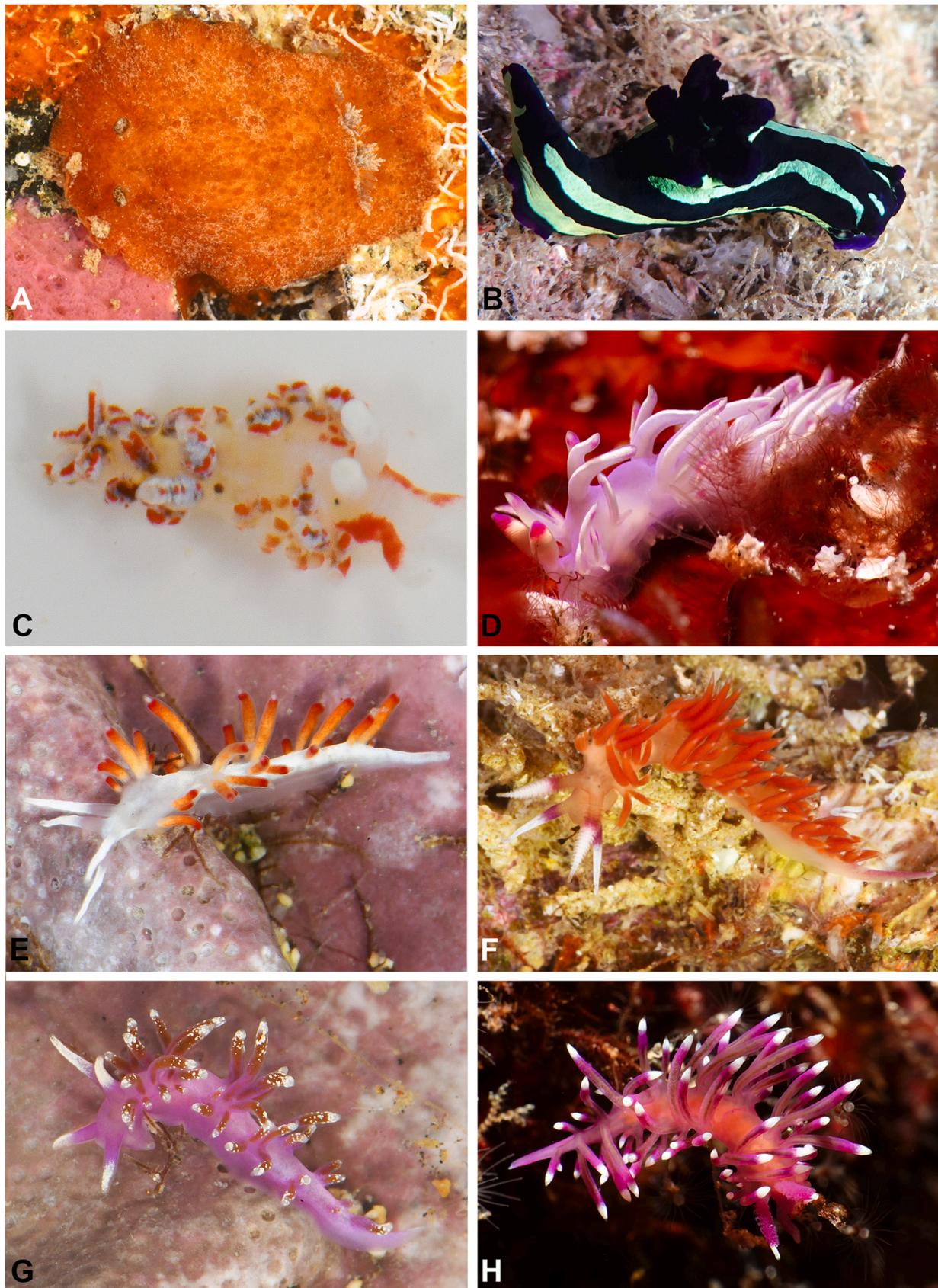
**Family Cuthonidae Odhner, 1934**

***Cuthona* cf. *mimar* Ortea and Moro, 2018**

**Fig. 4C**

**Material collected:** IP, ZMBN 160912, 16–09–2024, 14–18 m depth, crawling on reef near hydroids, 1 sp., L = 3 mm (deteriorated condition).

**Remarks:** *Cuthona mimar* is an endemic species from Cabo Verde, originally described from the island of São Vicente (Ortea and Moro, 2018). The single collected specimen also originates from São Vicente; however, its condition deteriorated before it could be thoroughly studied. Nonetheless, its visible morphological traits and colouration pattern conform to those of *Cuthona mimar*.



**Fig. 4.** (A) *Geitodoris bacalladoi*, SB (São Vicente I.), ZMBN163493, L = 26 mm. (B) *Tambja fantasmalis*, Pn (Sal I.), ZMBN160878, L = 50 mm. (C) *Cuthona* cf. *mimar*, IP (São Vicente I.), ZMBN160912, L = 3 mm. (D) *Flabellina llerae*, IP (São Vicente I.), ZMBN160911, L = 10 mm. (E) *Flabellina dushia*, SMW (São Vicente I.), ZMBN160906, L = 6 mm. (F) *Flabellina ilidioi*, Pn (Sal I.), ZMBN160881, L = 17 mm. (G) *Edmundsella albomaculata*, SMW (São Vicente I.), ZMBN160915, L = 7 mm. (H) *Coryphellina arveloi*, PND (São Vicente I.), ZMBN160918, L = 18 mm.

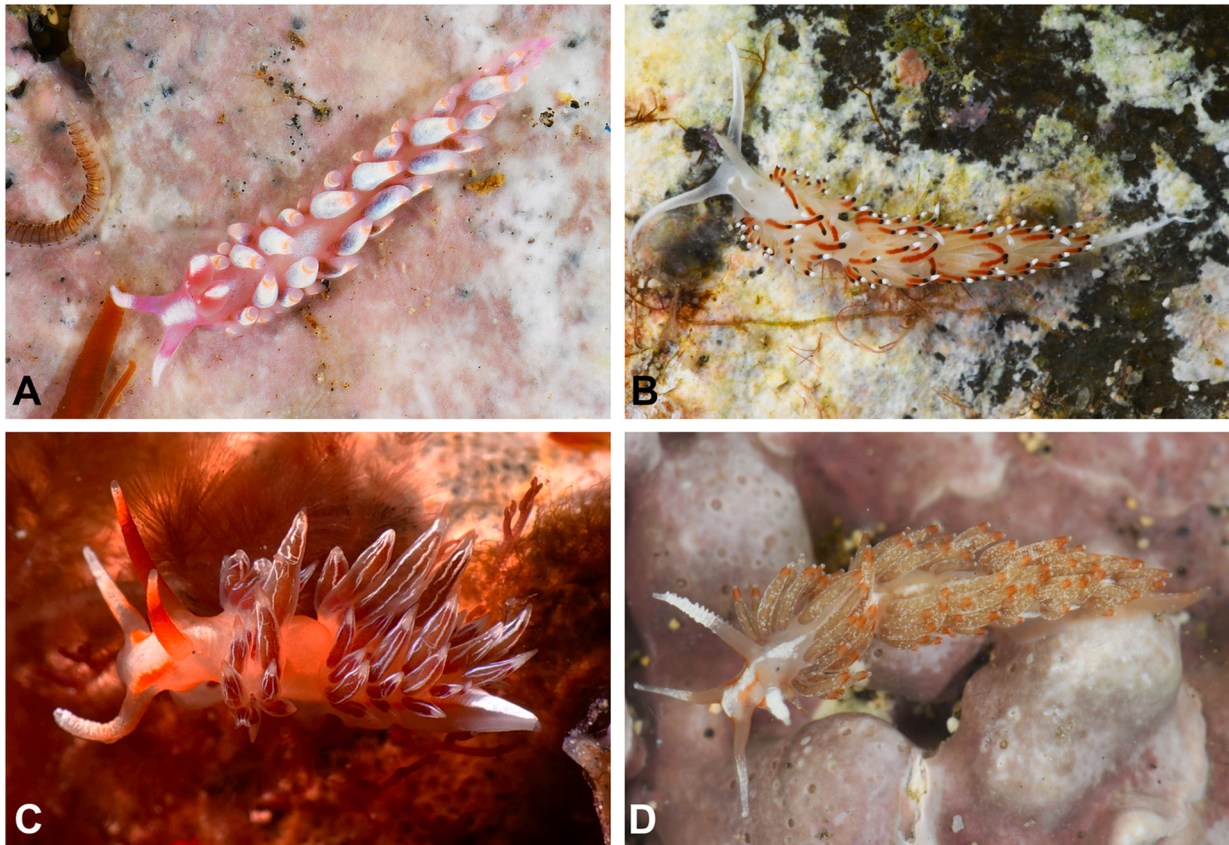


Fig. 5. (A) *Babakina anadoni*, PND (São Vicente I.), ZMBN160923, L = 7 mm. (B) *Caloria quatrefagesi*, WB (Boa Vista I.), ZMBN160898, L = 20 mm. (C) *Cratena scintilla*, IP (São Vicente I.), ZMBN160910, L = 9 mm. (D) Facelinidae sp., SMW (São Vicente I.), ZMBN160916, L = 13 mm.

#### Family Flabellinidae Bergh, 1889

##### *Flabellina llerae* Ortea, 1989

###### Fig. 4D

**Material collected:** Pn, ZMBN 160879, 7–09–2024, 6–14 m depth, on rocky wall, 10 spcs, L = 20–40 mm. IP, ZMBN 160911, 16–09–2024, 14–18 m depth, crawling on reef near hydroids, 2 spcs, L = 8, 10 mm.

**Remarks:** This is an endemic species from Cabo Verde described from the island of Sal (Ortea, 1989).

##### *Flabellina dushia* (Ev. Marcus & Er. Marcus, 1963)

###### Fig. 4E

**Material collected:** SMW, ZMBN 160906, 16–09–2024, 12–14 m depth, crawling on wreck surface with hydroids, 2 spcs, L = 6 mm.

**Remarks:** This species was described from the Caribbean Sea and has since its original description been found in Brazil (García et al., 2008), Cabo Verde, Canary Islands, and the Azores (Malaquias, 2024).

##### *Flabellina ilidioi* Calado, Ortea & Caballer, 2005

###### Fig. 4F

**Material collected:** Pn, ZMBN 160881, 7–09–2024, 8 m depth, on rocky wall, 2 spcs, L = 12, 17 mm.

**Remarks:** This endemic Cabo Verde species was originally described from the island of São Vicente.

*Edmundsella albomaculata* (Pola, Carmona, Calado & Cervera, 2014)

###### Fig. 4G

**Material collected:** SMW, ZMBN 160905, 16–09–2024, 12–14 m depth, crawling on boat wreck surface with hydroids, 1 spc., L = 6 mm. SMW, ZMBN 160915, 17–09–2024, 8–10 m depth, on algae with hydroids, 1 spc., L = 7 mm. PND, ZMBN 160922, 17–09–2024, 10–14 m depth, crawling on reef wall, 3 spcs, L = 5 mm.

**Remarks:** This species is endemic from Cabo Verde.

*Coryphellina arveloi* (Ortea & Espinosa, 1998)

###### Fig. 4H

**Material collected:** Pn, ZMBN 160880, 7–09–2024, 8 m depth, on rocky wall, 3 spcs, L = 5–14 mm. MC, ZMBN 160889, 11–09–2024, 10 m depth, crawling on reef with algae and hydroids, 7 spcs, L = 10–16 mm. JB, ZMBN 160890, 11–09–2024, 10 m depth, crawling on reef with algae and hydroids, 3 spcs, L = 15 mm. WB, ZMBN 160897, 13–09–2024, 12–14 m depth, on wreck surface with algae and hydroids, 2 spcs, L = 8, 16 mm. SP, ZMBN 160899, 13–09–2024, 12–14 m depth, on rocky walls with algae and hydroids, 3 spcs, L = 7–12 mm. SMW, ZMBN 160904, 16–09–2024, 12–14 m depth, crawling on boat wreck surface with hydroids, 4 spcs, L = 7–22 mm. PND, ZMBN 160918, 17–09–2024, 10–14 m depth, crawling on reef wall with hydroids, 7 spcs, L = 9–18 mm.

**Remarks:** This distinctive endemic species is probably the most common nudibranch in Cabo Verde occurring subtidally and feeding on hydroids. Nevertheless, a morphological and chromatic similar species was earlier described from Brazil and Pacific coast of Mexico, namely *Coryphellina marcusorum* (Gosliner and Kuzirian, 1990). The putative conspecificity of these two species cannot be discarded but this remains to be tested using DNA-based approaches.

#### Family Babakinidae Roller, 1973

##### *Babakina anadoni* (Ortea, 1979)

###### Fig. 5A

**Material collected:** PND, ZMBN 160923, 17–09–2024, 10–14 m depth, crawling on reef wall, 1 spc., L = 7 mm.

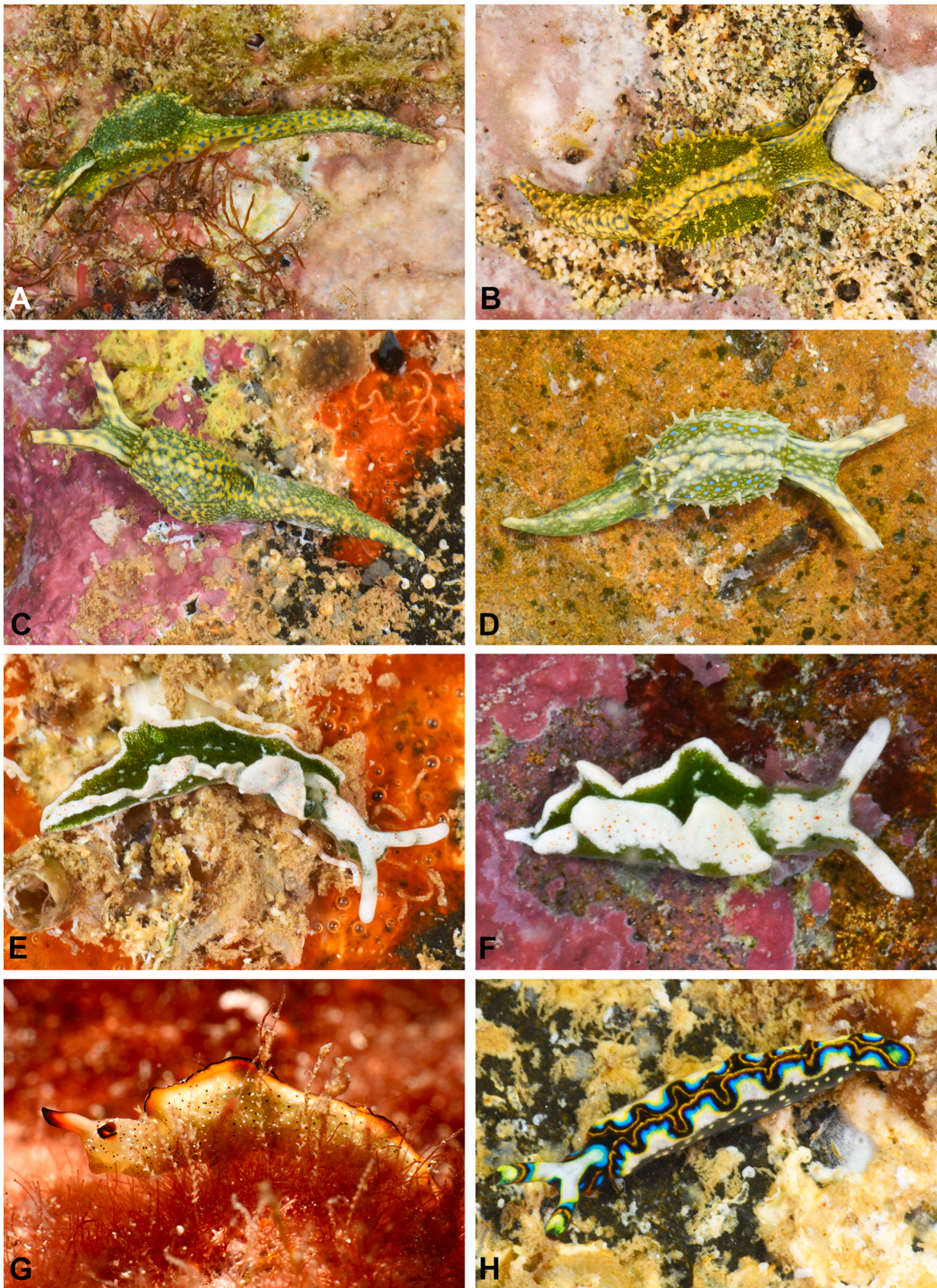
#### Family Facelinidae s. l. Bergh, 1889

##### *Caloria quatrefagesi* (Vayssièrre, 1888)

###### Fig. 5B

**Material collected:** WB, ZMBN 160898, 13–09–2024, 12–14 m depth, on wreck surface with algae and hydroids, 4 spcs, L = 7–20 mm.

**Remarks:** Picton (1979) suggested this species to be a synonym of



**Fig. 6.** (A–D) Variability in *Oxyne pakki*, (A), MB (Sal I.), ZMBN160865, L = 20 mm. (B) CI (São Vicente I.), ZMBN160926, L = 18 mm. (C) SB (São Vicente I.), ZMBN160928, L = 25 mm. (D) PG (Boa Vista I.), ZMBN160886, L = 10 mm. (E) *Elysia timida*, SB (São Vicente I.), ZMBN160932, L = 10 mm. (F) *Elysia timida*, PM (Sal I.), ZMBN160859, L = 8 mm. (G) *Elysia ornata*, PND (São Vicente I.), ZMBN160919, L = 18 mm. (H) *Thuridilla hopei*, SB (São Vicente I.), ZMBN160931, L = 9 mm.

*Caloria elegans* (Alder & Hancock, 1845) but later studies showed its validity based on morphological traits (Trainito and Doneddu, 2015) and molecular phylogenetics (Furfaro et al., 2016). This species is distributed along the central and western Mediterranean Sea from Italy to Spain and in the Atlantic is known from Portugal, Madeira and Canaries archipelagos (Furfaro et al., 2016; Ballesteros et al., 2025; <https://www.inaturalist.org/taxa/1255141-Caloria-quatrefagesi>).

This is the first record to Cabo Verde.

*Cratena scintilla* Ortea and Moro, 1998

Fig. 5C

**Material collected:** IP, ZMBN 160910, 16–09–2024, 14–18 m depth, crawling on reef near hydroids, 1 sp., L = 9 mm.

**Remarks:** This species is only known from Cabo Verde and was described from the islands of Fogo and São Tiago (Ortea and Moro, 1998). Debelius and Kuitert (2007) and Edmunds (2015) have erroneously cited this species in the Canary Islands (see Moro et al., 2016: 44 for a discussion).

Facelinidae sp.

Fig. 5D

**Material collected:** SMW, ZMBN 160916, 17–09–2024, 8–10 m depth, on algae with hydroids, 1 sp., L = 13 mm.

**Remarks:** This is likely an undescribed species that we ascribe to the family Facelinidae *sensu lato*. The taxonomic status of the family Facelinidae is currently elusive and controversial with a phylogeny that is poorly resolved and with a lack of sound synapomorphic traits (see phylogenetic hypotheses by Carmona et al., 2015; Martynov et al., 2019). For this reason and because of the external body appearance, rhinophoral ornamentation, and cerata shape and arrangement of our specimen, we provisionally assign our specimen to the traditional Facelinidae (*sensu* Thompson and Brown, 1984; Edmunds, 2015).

Order Sacoglossa

Family Oxynoidae Stoliczka, 1868 (1847)

*Oxynoe pakiki* Ortea and Moro, 2020

Fig. 6A–D

**Material collected:** PM, ZMBN 160863, 3–09–2024, 0.3 m depth, on *Caulerpa racemosa*, 6 spcs, L = 10–15 mm. PM, ZMBN 160865, 4–09–2024, 0.5 m depth, on algae, 1 sp., L = 20 mm. PG, ZMBN 160886, 10–09–2024, 0.5 m depth, on reef flat with *Caulerpa taxifolia*, 2 spcs, L = 7, 10 mm. CI, ZMBN 160926, 17–09–2024, intertidal zone, on algae, 1 sp., L = 18 mm. SB, ZMBN 160928, 18–09–2024, intertidal zone, on *Caulerpa taxifolia*, 3 spcs, L = 25 mm.

**Remarks:** This is an endemic species from Cabo Verde originally described from the island of Sal (Ortea and Moro, 2020b). The distribution of blue blotches, as well as the development of dorsal papillae can vary between specimens, with smaller specimens depicting conspicuous dorsolateral blue blotches which are not so apparent in larger ones (Fig. 6A–D).

Family Plakobranchidae Gray, 1840

*Elysia timida* (Risso, 1818)

Fig. 6E, F

**Material collected:** PM, ZMBN 160859, 3–09–2024, 0.3 m depth, on algae, 11 spcs, L = ca. 8 mm. SB, ZMBN 160932, 18–09–2024, tidal zone, on algae, 7 spcs, L = 10 mm.

**Remarks:** Ortea et al. (1997) synonymized *Elysia cornigera* Nuttall, 1989 (type locality: Florida Keys) with *Elysia timida* (type locality: Nice, Mediterranean Sea) based on a comparative analysis of specimens from the Mediterranean, Cabo Verde, and Cuba. The authors noted strong similarities in their locomotion mode ("jumping"), rhinophores, internal colouration of parapodial lobes, venation, and radula morphology. However, multiple molecular studies have since demonstrated that these two species are distinct and sister taxa (Carmona et al., 2011; Krug et al., 2011; Martín-Hervás et al., 2024). Furthermore, Krug et al. (2011) detailed morphological, developmental, and physiological differences between *E. cornigera* and *E. timida*, further supporting their status as separate species.

*Elysia timida* is primarily distributed across the Mediterranean Sea

but has also been recorded in Cabo Verde (Ortea et al., 1997) and São Tomé (Wirtz and Anker, 2009; Martín-Hervás et al., 2024).

*Elysia ornata* (Swainson, 1840)

Fig. 6G

**Material collected:** PM, ZMBN 160860, 3–09–2024, 0.3 m depth, on algae, 1 sp., L = 20 mm. IP, ZMBN 160909, 16–09–2024, 14–18 m depth, crawling on reef on top of green algae, 2 spcs, L = 17, 23 mm. PND, ZMBN 160919, 17–09–2024, 10–14 m depth, crawling on reef among algae, 3 spcs, L = 13–18 mm.

**Remarks:** We ascribe our specimens to this "circumtropical" species originally described from the Caribbean, but it is worth noting that Krug et al. (2013) have recognized a complex of at least five species (1 Caribbean + 4 Indo-Pacific). Unfortunately, samples from the eastern Atlantic were not included in their study and their identity remains to be confirmed.

*Thuridilla hopei* (Vérany, 1853)

Fig. 6H

**Material collected:** PM, ZMBN 160864, 4–09–2024, 0.5 m depth, on algae, 3 spcs, L = 5 mm. PE, ZMBN 160894, 12–09–2024, 0.5 m depth, rocky outcrop with small stones covered with green algae and sandy bottom, 1 sp., L = 6 mm. SB, ZMBN 160931, 18–09–2024, tidal zone, on algae, 1 sp., L = 9 mm.

#### 4. Discussion

One might expect speciation to be rare in the marine environment due to the apparent continuity of the ocean realm, yet this is clearly not the case. Certain groups of marine invertebrates exhibit remarkable diversity, driven by a combination of historical geotectonic events, oceanic currents, water temperature, geographical distance, ecological specialization, and limited or reduced dispersal capabilities (Palumbi, 1994; Bouchet et al., 2002; Williams and Reid, 2004; Martín-Hervás et al., 2021).

Islands and archipelagos are known to harbor high levels of endemism in both terrestrial and marine taxa (Roberts et al., 2002; Peters et al., 2016), and Cabo Verde is no exception. The archipelago is widely recognized for its endemic plants (Duarte et al., 2008; Romeiras et al., 2016), reptiles (Vasconcelos et al., 2013), and beetles (Triantis et al., 2010). In the marine realm, several cases of high endemism have already been highlighted in the Introduction, with cone snails reaching unparalleled levels of endemism, exceeding 90 % (Peters et al., 2013; Ávila et al., 2018; Tenorio et al., 2020).

Although Cabo Verde is relatively close to mainland West Africa (~570 km; Ramalho, 2011), oceanic currents and water masses surrounding the archipelago create significant barriers to gene flow, promoting isolation and favouring speciation (Matsuzaki et al., 2011; Valdés and Déniz-González, 2015; Freitas et al., 2029). Additionally, the geological history of the islands, dating back to the Oligocene and Miocene epochs—Brava:  $5.9 \pm 0.1$  million years (My), Santo Antão:  $7.56 \pm 0.56$  My, Sal:  $25.6 \pm 1$  My, Maio:  $21.1 \pm 6.3$  My, and Santiago:  $10.3 \pm 0.6$  My (Cunha et al., 2005)—provides the necessary conditions for the evolution of unique terrestrial and marine organisms in Cabo Verde.

The marine heterobranch fauna of Cabo Verde has been studied since the 19th century, with significant research efforts intensifying from the 1980s onward (see Introduction for details). Despite these efforts, the diversity of habitats across the archipelago and the number of islands suggest that much remains undiscovered.

The present study contributes to this growing body of knowledge by documenting 27 species including a new record for the archipelago (*Caloria quatrefagesi*; Fig. 5B) and a putative new species to science (Facelinidae sp.; Fig. 5D). Among the species collected, 37 % (= 10 species: *H. orbignyana*, *H. ortei*, *B. anadoni*, *C. quatrefagesi*, *E. timida*, *T. hopei*, *G. bacalladoi*, *D. senegalensis*, *F. tema*, *D. edmundsi*) have an eastern Atlantic affinity of which the latter four are restricted to tropical / subtropical waters, 19 % (= 10 species: *M. undatus*, *A. dactylomela*,

*S. polyomma*, *F. dushia*, *E. ornata*) have an ampho-Atlantic distribution, while notably 44 % (= 12 species; see Results, Taxonomic list) are endemic to the archipelago, underscoring the exceptional uniqueness of the marine biodiversity of Cabo Verde.

Most biodiversity surveys in Cabo Verde have focused on three islands, namely Sal, Boa Vista, and São Vicente, and primarily in tidal or relatively shallow subtidal areas. The islands of Maio and São Tiago have received only sporadic attention (e.g., Cunha et al., 2005; Ortea and Moro, 2019). In contrast, the more northern and southern islands of Santo Antão, Brava, and Fogo, have been scarcely sampled. These islands are more distant from mainland and, consequently, from potential sources of biological colonization, favouring isolation. Future research should prioritize these lesser-explored islands, which may harbor species and habitats yet to be discovered.

### CRedit authorship contribution statement

**Malaquias Manuel:** Writing – review & editing, Writing – original draft, Supervision, Project administration, Methodology, Investigation, Funding acquisition, Data curation, Conceptualization. **Lopes Evandro:** Writing – review & editing, Methodology. **Turani Martina:** Writing – review & editing, Investigation, Data curation. **Cervera Juan L.:** Writing – review & editing.

### Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Martina Turani and Manuel Malaquias reports financial support was provided by Research Council of Norway. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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### Data availability

Data will be made available on request.

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