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A First Approach to the Marine Heterobranchia (Mollusca: Gastropoda) Fauna of Marettimo, Egadi Islands, MPA (Western Sicily, Mediterranean Sea)

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Abstract: For almost all the Sicilian islands, there are no faunistic data concerning marine Heterobranchia, which is one of the most sought-after groups of marine critters by photographers and diving enthusiasts all over the world. With the present study, carried out through underwater photography at various dive sites and stretches of coastline in the island of Marettimo, we made the first contribution to the knowledge of the marine Heterobranchia fauna present on this island of the Egadi archipelago. Through data collection, it was possible to document the presence of 43 species of marine Heterobranchia. Data analysis showed a remarkable homogeneity in the number of species between the examined sites. This is probably due to the peculiar environmental homogeneity present in the sites of this island, which are almost all rich in the presence of both benthic suspension feeders (the favorite prey of many groups of marine Heterobranchia) and environments full of crevices, grottos, and vertical walls, which are the preferred habitats of the majority of these mollusks. The higher number of marine heterobranch species found in Marettimo compared to the smaller number of species found on the other recently examined Sicilian islands (Pantelleria, Lipari, and Vulcano) is probably due to the massive presence of rich coralligenous biocoenoses and the particular hydrodynamic regime to which Marettimo is subject.

Keywords: faunistic list; Opisthobranchia; sea slug; visual census

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1. Introduction

The Aegades/Egadi (term derived from the Greek "Aigatai" meaning "islands of goats") are a group of three major islands (Favignana, Levanzo, and Marettimo) and some small islets and rocks located in front of the westernmost part of Sicily, between the Tyrrhenian Sea and the Sicily Channel [1] (Figure 1A–C). This archipelago, with a covered surface of 53,992 ha and 74 km of coast, is entirely enclosed by the perimeter of the Egadi Islands Marine Protected Area, which represents one of the largest MPA of Europe [2].

Of the three main islands that make up this archipelago, Marettimo can certainly be considered the most interesting, thanks to its historical, geological, and biological peculiarities [3–7].

Marettimo (formerly called by the Greek name "Hierà Nésos" which means "sacred island" [7]) is the westernmost and most distant island of the archipelago from the Sicilian coast (about 37 km) [8] (Figure 1D). This island has an almost rhomboid shape (it is 7–7.5 km long and 2–2.5 km wide) and a predominantly mountainous morphology with steep slopes [4,8]. The island of Marettimo is mainly formed by limestone rocks: the lower part of the island consists of dolomite, which outcrops along the western and part of the north-eastern coastline; while the upper part of the island, on the other hand, consists of liasic crystalline limestone [4,9]. The coasts of Marettimo are mainly characterized by dolomite cliffs and crags; however, some coastal stretches have small inlets with sand

and pebbles [8,10]. The western side of the island is characterized by the presence of large dolomitic cliffs, which are broken up for a large part of the coastline into blocks by steep valley incisions [10]. This island side is particularly subjected to the force of waves, which make this sector of the island rugged and almost inaccessible [11]. On the other hand, the eastern side presents for most of its extension a gentler morphology featuring outcrops of calcarenites and conglomerates ([10], personal observations). Finally, the northern side of the island is characterized by a rectilinear trend with sheer walls [10].

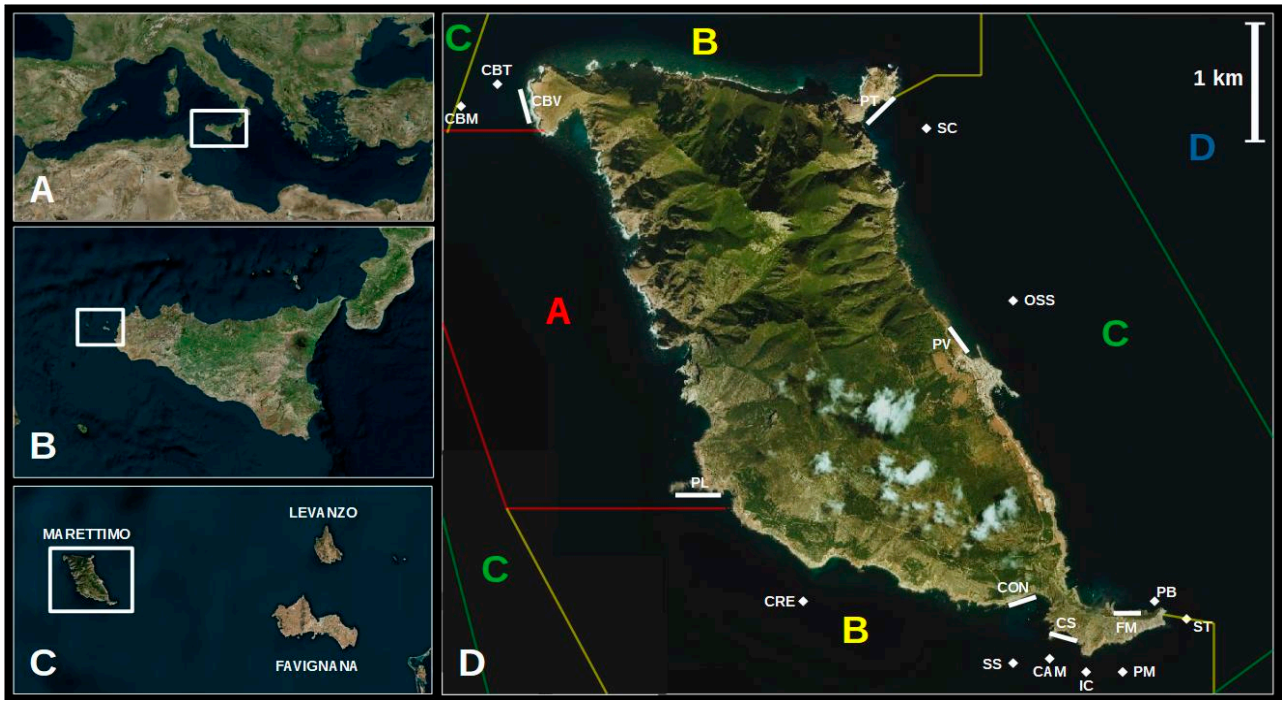

Figure 1. Study area (**A**) position of Sicily and its islands in the Mediterranean Sea. (**B**) Location of the Aegades/Egadi in Sicily. (**C**) The three Egadi islands. (**D**) Marettimo: the sites examined are indicated in white; specifically, the dive sites are represented by small rhombuses (abbreviations are reported in Table 1); the MPA areas and borders (blue: D zone; green: C zone; yellow: B zone; red: A zone) are also indicated in the images.

The bottoms of Marettimo are characterized by limestone rocky outcrops and sandy beds of the same composition, which come into contact at a depth of about 30–40 m. These underwater outcrops are very structured due to inclined slopes, vertical walls, and rifts [12]. Contrary to the remaining Egadi islands, an important feature of this island is that its submarine shelf is totally separated from Sicily's continental shelf by a deep submarine channel called the Marettimo Channel [13].

This underwater separation (which prevents the connection of this island with the Sicilian territory during past sea regressions [14]), as well as the geology of this island, which is totally different from that of the Sicilian territory (this island is geologically more akin to areas of North Africa and the Iberian Peninsula [15]), have made the terrestrial fauna of Marettimo rich in endemism and similar to those of the western areas of the Mediterranean [5].

However, as already seen in other Sicilian islands [16], almost all information concerning the fauna of this island relates to the terrestrial part, leaving out the marine environment. For the terrestrial part of the island, there are numerous and well-organized data on arthropods, vertebrates, and mollusks [5]. On the contrary, there are no lists on the marine fauna of Marettimo, and the very few published data are either not specific to a given taxonomic group (e.g., [10,12,17]), alien/cryptogenic species reports (e.g., [18,19]), or single-species

studies/observations (e.g., [20,21]). Consequently, to date, an organized knowledge base about the marine animal taxonomic groups of this island does not exist.

Even for one of the groups of marine critters most sought after by underwater photographers, the marine Heterobranchia, there are limited data.

Table 1. List of the dive sites examined in this study. The full names of the dive sites are reported with their abbreviation in brackets. Further details on the habitat characterization and collecting dates are given.

Dive Sites	Island Side	Characterization of the Habitat	MPA Zone	Coordinates	Date
Punta Bassana Lato Nord (PB)	eastern	Rocky wall on a sandy sandy-gravel seabed (30 m) with *Posidonia oceanica*	C	37°57′00.7″ N 12°05′27.2″ E	07-07-24
Orlata San Simone (OSS)	eastern	Rocky outcrops that drop down to 40–50 with coralligenous	C	37°58′29.7″ N 12°04′33.6″ E	08-07-24
Secca del Cammello (SC)	eastern	Rocky outcrops that drop down to 40 m	C	37°59′19.5″ N 12°03′57.2″ E	08-07-24
Scoglio Cavo e Scoglio di Tramontana (ST)	eastern	Two rocky outcrops with *Paramunicea clavata* on a sandy seabed (35–40 m)	B	37°56′54.0″ N 12°05′39.1″ E	09-07-24
Scoglio Spandillo (SS)	southern	Rocky outcrops covered with *Posidonia oceanica* on a sandy seabed (28–30 m)	B	37°56′38.9″ N 12°04′32.9″ E	09-07-24
Ingresso Cattedrale (IC)	southern	Rocky slope rich in crevices that drops down to 30 m	B	37°56′37.5″ N 12°05′00.7″ E	10-07-24
Cretazzo (CRE)	southern	Small rocky outcrops with *Posidonia oceanica* on a seabed of 20 m	B	37°57′00.7″ N 12°03′20.4″ E	10-07-24
Punta Martina (PM)	southern	Rocky slope which goes down to 40 m in depth on a horizontal seabed with coralligenous	B	37°56′35.5″ N 12°05′16.0″ E	11-07-24
Il Camino (CAM)	southern	Rocky slope with *Posidonia oceanica* that drops down to 30 m	B	37°56′42.7″ N 12°04′47.6″ E	11-07-24
Secca di Cala Bianca di fuori (CBM)	western	Rocky wall with *Eunicella singularis* that drops on a seabed of 45 m	B	37°59′19.0″ N 12°01′00.5″ E	12-07-24
Secca di Cala Bianca di terra (CBT)	western	Rocky plateau that leans gently toward a seabed of 30 m	B	37°59′30.6″ N 12°01′28.6″ E	12-07-24

This informal group of gastropod mollusks (popularly referred to as "sea slugs") contains within it all the groups once considered part of the no-longer-valid subclass Opisthobranchia of the class Gastropoda (i.e., Acteonoidea, Cephalaspidea, Runcinida, Aplysiida, Pteropoda, Umbraculida, Ringiculimorpha, Pleurobranchida, Nudibranchia, Acochlidiimorpha, Sacoglossa, and Rhodopoidea) [22–24]. These animals, considered as the most striking and diversified gastropods, are all characterized by a more or less strong evolutionary trend in the reduction of the shell, which has caused the astonishing diversification in body shapes that can be seen in the various groups of marine heterobranchs [22,25]. This impressive variety of shapes and colors is precisely what has made these animals so appealing to divers and enthusiasts all over the world [26].

To date, there is very little information concerning this group of marine invertebrates for the island of Marettimo, and they only concern the reporting of a few species. Indeed, at present, only four marine Heterobranchia species are documented at Marettimo. The first reported marine Heterobranchia species was the nudibranch *Phyllidia flava* Aradas, 1847, which was documented only once at a depth of 30 m by Giannuzzi Savelli [27], who did not specify the finding site [28]. The second report is that of three specimens of the aplysiids *Aplysia dactylomela* Rang, 1828 at Scalo Vecchio (5 m in depth) [18,19]. The last two records are those regarding the nudibranchs *Cratena peregrina* (Gmelin, 1791) and *Peltodoris atromaculata* Bergh, 1880. The former was found only at Scoglio del Cammello, and *P. atromaculata* was documented at four sites (Orlo paese, Il Camino, La Cattedrale, and

Scoglio Spandillo). These findings were reported by Cocito et al. [12], who only provided the location where the species were found without further information.

Given the above-mentioned peculiarities of this island, this very low number of marine Heterobranchia species is certainly due to the lack of specific studies on this group of gastropod mollusks. Consequently, the present work aims to provide the first preliminary faunistic list of marine Heterobranchia species for the island of Marettimo.

2. Materials and Methods

The present study was carried out from the 7 July 2024 to the 12 July 2024 in several dive sites and coastal stretches at Marettimo. Data collection was performed through both scuba diving and snorkeling activities.

The scuba dives were conducted during the morning and the early afternoon following the bottom morphology of each examined site for about 60 min. A total of 11 dive sites were examined during this study (Figure 1D). Further details for each dive site are reported in Table 1.

Punta Bassana Lato Nord (PB) is characterized by an inclined rocky wall that stands on a flat sandy-gravel seabed (30 m in depth) dominated by a *Posidonia oceanica* (Linnaeus) Delile meadow. Orlata San Simone (OSS) is a cluster of underwater rocky outcrops whose tops are about 14 m deep, and it extends on a sandy-gravel seabed of approximately 40–50 m. The tops of these outcrops are covered by *P. oceanica* meadows, while their walls are featured with coralligenous biocenosis dominated by the red gorgonia *Paramuricea clavata* (Risso, 1827). Secca del Cammello (SC) is a rocky outcrop from 16–20 m in depth to about 40 m. This rocky outcrop is connected to another one, which presents a tunnel within its base. The site of Scoglio Cavo e Scoglio di Tramontana (ST) is characterized by two huge underwater rocky outcrops covered by *P. clavata* resting on a sandy seabed at about 35–40 m in depth. Scoglio Spandillo (SS) is a cluster of low and wide submerged rocky outcrops covered by *P. oceanica* and rich in crevices that rest on a sandy seabed of about 28–30 m in depth. Ingresso Cattedrale (IC) is represented by the submerged rocky slope that makes the external part of an underwater cave called "La Cattedrale". This slope goes down to 30 m in depth and features walls and crevices. On the front of this slope, there is a sandy seabed with several rocks covered with the white gorgonia *Eunicella singularis* (Esper, 1791). Cretazzo (CRE) is an underwater cluster of small–medium rocky outcrops that stand on a sandy seabed (20 m in depth), covered by patches of *P. oceanica*. Punta Martina (PM) is characterized by a rocky slope which goes down to 40 m in depth on an almost horizontal sandy bottom that presents scattered rocky outcrops covered by *E. singularis* and the sponge *Axinella cannabina* (Esper, 1794). Il Camino (CAM) is characterized by a rocky slope covered by scattered patches of *P. oceanica*, which develops toward the sea in the form of a promontory, which goes down until it meets a horizontal sandy bottom at 30 m in depth. Secca di Cala Bianca di fuori (CBM) represents the outer rim of the Cala Bianca shoal, which is formed by the most seaward part of the shoal. This part sinks, forming a huge rocky wall (covered with *E. singularis*) falling on a mass of rocks and white sand at about 45 m. Secca di Cala Bianca di terra (CBT) is the part towards the coast of the Cala Bianca shoal. This site is characterized by a large and continuous rocky plateau starting at 10 m in depth that leans gently toward a bottom featured with large boulders/rocks (covered with *P. oceanica*) plunging down to about 30 m in depth.

The snorkeling activities were performed in the late morning following a given stretch of coastline for about 90 min. A total of seven coastal stretches were examined during this study (Figure 1D). Further details for each site are given in Table 2.

Tra Punta Bassana Nord e Finocchio marino (FM) is a coastal rocky wall on a bottom rich in boulders and small rocky outcrops/terraces that emerge from the water. Costa Porto Vecchio (PV) is a shallow area which deepens to 2–3 m, characterized by pebbles, rocks, and emerged rocky outcrops. Punta Troia Lato Sud (PT) features highly outcropping cliffs made up of large rocks and boulders. La Conca (CON) is a jagged rocky coast situated within a shallow bay featured with an almost continuous belt of emerged inclined (about 45°) rocky outcrops. Punta

Libeccio Sud-Ovest (PL) is similar to the previous one, but the emerged rocky outcrops are less inclined and are rich in crevices and inlets. Among the emerging rocky outcrops there are surface pools. Cala Sarde (CS) is a jagged rocky coast with boulders. Punta di Cala Bianca-Vermetid Reef (CBV) is a continuous rocky coastline characterized by vermetid trottoirs, which present some discontinuities due to the presence of inlets with rocks and pebbles.

Table 2. List of the snorkeling sites examined in this study. The full names of the snorkeling sites are reported, with their abbreviation in brackets. Further details on the habitat characterization and collecting dates are given.

Snorkeling Sites	Island Side	Characterization of the Habitat	MPA Zone	Coordinates	Date
Tra Punta Bassana Nord e Finocchio marino (FM)	eastern	Coastal rocky wall on a bottom rich in boulders	C	from 37°56′57.6″ N 12°05′20.2″ E to 37°56′58.4″ N 12°05′11.1″ E	07-07-24
Porto Vecchio (PV)	eastern	Shallow area with a seabed of 2–3 m with pebbles	C	from 37°58′11.0″ N 12°04′17.7″ E to 37°58′13.8″ N 12°04′15.9″ E	07-07-24
Punta Troia Lato Sud (PT)	eastern	Outcropping cliffs made up of large rocks and boulders	C	from 37°59′24.3″ N 12°03′50.5″ E to 37°59′17.4″ N 12°03′41.4″ E	08-07-24
La Conca (CON)	southern	Rocky coast within a shallow bay with a belt of inclined rocky outcrops	B	from 37°56′56.8″ N 12°04′30.2″ E to 37°57′01.1″ N 12°04′43.1″ E	09-07-24
Punta Libeccio Sud-Ovest (PL)	southern	Rocky coast with the emerged rocky outcrops	A	from 37°57′29.4″ N 12°02′50.8″ E to 37°57′30.1″ N 12°02′32.1″ E	10-07-24
Cala Sarde (CS)	southern	Jagged rocky coast with boulders	B	from 37°56′46.8″ N 12°04′57.8″ E to 37°56′47.5″ N 12°04′48.7″ E	11-07-24
Cala Bianca-Vermetid Reef (CBV)	western	Rocky coastline with vermetid trottoirs	B	from 37°59′19.3″ N 12°01′45.6″ E to 37°59′27.8″ N 12°01′42.4″ E	12-07-24

In both the scuba diving and snorkeling activities, data were gathered with the same photographic technique described by Lombardo and Marletta [29]: every marine Heterobranchia specimen and egg mass were photographed through an Olympus TG-6 underwater camera, and information about their depth was recorded. The photographs were subsequently examined on the computer to determine the various species encountered. In this regard, the marine Heterobranchia species identification was carried out mainly by consulting identification books [23,30–32] and specialized websites [33,34]. The marine Heterobranchia species nomenclature was checked through WoRMS [35].

A faunistic list (Table 3) with the encountered marine Heterobranchia species was elaborated using the computer program LibreOffice. In this list, for each species, the site/s where it was found was indicated, along with its bathymetric range, the number of specimens, and if present, the egg masses or documented mating activity. Each of the documented species was depicted in one or more photos (Figures 2–12).

Table 3. List of the marine Heterobranchia species found during this study.

	Dive Sites											Snorkeling Sites							
Island Side	**Eastern Side**				**Southern Side**					**Western Side**		**Eastern Side**			**Southern Side**			**Western Side**	
MPA Zone	**C Zone**				**B Zone**							**C Zone**			**B Zone**	**A Zone**		**B Zone**	
Taxa	**PB**	**OSS**	**SC**	**ST**	**SS**	**IC**	**CRE**	**PM**	**CAM**	**CBM**	**CBT**	**FM**	**PV**	**PT**	**CON**	**PL**	**CS**	**CBV**	**Depth Range (m)**
Order Pleurobranchida																			
Family Pleurobranchidae Gray, 1827																			
Berthellina edwardsii (Vayssière, 1897)							1												12.5
Pleurehdera stellata (Risso, 1826)																		1	1<
Order Nudibranchia																			
Suborder Cladobranchia																			
Family Aeolidiidae Gray, 1827																			
Spurilla neapolitana (Delle Chiaje, 1841)													2						1<
Family Facelinidae Bergh, 1889																			
Caloria elegans (Alder and Hancock, 1845)				3				2											30.4–41.8
Cratena peregrina (Gmelin, 1791)	12 *	1	*	12 *	3 *	3 *		16 *	7 *	8 *									11.2–33
Facelina rubrovittata (A. Costa, 1866)						1						1							1 < – 23.7
Facelinopsis marioni (Vayssière, 1888)												1							1<
Family Flabellinidae Bergh, 1889																			
Edmundsella pedata (Montagu, 1816)		3 *	2 *	1	5 *		2	1	3		1								10.3–41.5
Flabellina affinis (Gmelin, 1791)	5 *			7 *				1 *	3 *	10 *‡									12.8–42.1
Paraflabellina gabinierei (Vicente, 1975)					1 *	3			1										14.5–25.7
Paraflabellina ischitana (Y. Hirano and T. E. Thompson, 1990)		2	1	2	1		1												16.3–35.2
Family Myrrhinidae Bergh, 1905																			
Nemesignis banyulensis (Portmann and Sandmeier, 1960)				1															32.3
Family Trinchesiidae F. Nordsieck, 1972																			
Trinchesia caerulea (Montagu, 1804)	1			12 *		3		5											21.8–39.3
Trinchesia genovae (O'Donoghue, 1926)			3																4.5–5.5
Trinchesia morrowae Korshunova et al., 2019	2									4									4–42.2
Trinchesia ocellata Schmekel, 1966		1 *																	24.5
Family Dotidae Gray, 1853																			
Doto sp.				*															31.9

Table 3. *Cont.*

	Dive Sites											Snorkeling Sites							
Island Side	**Eastern Side**				**Southern Side**					**Western Side**		**Eastern Side**			**Southern Side**			**Western Side**	
MPA Zone	**C Zone**				**B Zone**							**C Zone**			**B Zone**	**A Zone**	**B Zone**		
Taxa	**PB**	**OSS**	**SC**	**ST**	**SS**	**IC**	**CRE**	**PM**	**CAM**	**CBM**	**CBT**	**FM**	**PV**	**PT**	**CON**	**PL**	**CS**	**CBV**	**Depth Range (m)**
Family Tritoniidae Lamarck, 1809																			
Candiella sp.								4											40
Candiella striata (Haefelfinger, 1963)																	1		1<
Family Janolidae Pruvot-Fol, 1933																			
Antiopella cristata (Delle Chiaje, 1841)			1																28.8
Suborder Doridina																			
Family Chromodorididae Bergh, 1891																			
Felimare fontandraui (Pruvot-Fol, 1951)	1	6 ‡	3	1	1	4		3	1	1	5								14.3–41.9
Felimare tricolor (Cantraine, 1835)		13 ‡		6	8	6 ‡	6	3		7	7								10.5–42.2
Felimare villafranca (Risso, 1818)				1		2		3 ‡		3									18.9–35.5
Felimida binza (Ev. Marcus and Er. Marcus, 1963)	1					1		3		3									12.8–28.2
Felimida krohni (Vérany, 1846)		1				1	1	1		1									12.7–41.5
Felimida luteorosea (Rapp, 1827)			1		1		1		2	1									16.3–42.2
Felimida purpurea (Risso, 1831)				1															35
Family Discodorididae Bergh, 1891																			
Peltodoris atromaculata Bergh, 1880	1	4	1 *		1	*		*		1									13–35.2
Platydoris argo (Linnaeus, 1767)														2 *					1<
Family Goniodorididae H. Adams and A. Adams, 1854																			
Goniodoridella picoensis (Paz-Sedano, Ortigosa and Pola, 2017)		14	4	2	15	4	1	1	3										14.6–34.3
Family Dendrodorididae O'Donoghue, 1924 (1864)																			
Dendrodoris sp.																	*		1<
Doriopsilla rarispinosa Pruvot-Fol, 1951																	1		1<
Family Phyllidiidae Rafinesque, 1814																			
Phyllidia flava Aradas, 1847		2	1		1		1 *												15.2–25
Order Cephalaspidea																			
Family Haminoeidae Pilsbry, 1895																			

Table 3. *Cont.*

	Dive Sites											Snorkeling Sites							
Island Side	**Eastern Side**				**Southern Side**					**Western Side**		**Eastern Side**			**Southern Side**			**Western Side**	
MPA Zone	**C Zone**				**B Zone**							**C Zone**			**B Zone**	**A Zone**	**B Zone**		
Taxa	**PB**	**OSS**	**SC**	**ST**	**SS**	**IC**	**CRE**	**PM**	**CAM**	**CBM**	**CBT**	**FM**	**PV**	**PT**	**CON**	**PL**	**CS**	**CBV**	**Depth Range (m)**
Haminoeidae sp.			*	*					*		*								10.2–33
Incertae sedis																			
Cephalaspidea sp.					1														22.1
Order Aplysiida																			
Family Aplysiidae Lamarck, 1809																			
Aplysia dactylomela Rang, 1828													5 ‡						1<
Aplysia punctata (Cuvier, 1803)															1	1	5 *‡		1<
Order Umbraculida																			
Family Tylodinidae Gray, 1847																			
Tylodina perversa (Gmelin, 1791)							1												14.8
Superorder Sacoglossa																			
Family Plakobranchidae Gray, 1840																			
Bosellia mimetica Trinchese, 1891	10	1	2		2	6 *	2		1		2	2		4 *‡	1	5	14 *	2	1 < – 31.7
Elysia flava A. E. Verrill, 1901																1			1<
Elysia gordanae T. E. Thompson and Jaklin, 1988			3			*	1 *				1							1	1 < – 19.5
Elysia timida (Risso, 1818)													1	1			8	3	1<
Thuridilla hopei (Vérany, 1853)			1				4	1	1	1	2	2	3	3	3	10	7	28	1 < – 41.9
Number of species per site	8	11	14	14	12	13	12	14	10	11	7	4	4	4	3	4	7	5	
Total number of species										43									
Number of families per site	6	8	10	8	8	7	7	7	6	6	4	2	3	2	2	2	4	2	
Total number of families										**19**									

The numbers in the table indicate the number of specimens for each species in the studied sites. The symbol * indicates the presence of one or more egg mass in the site. The symbol ‡ indicates documented mating activity in the site.

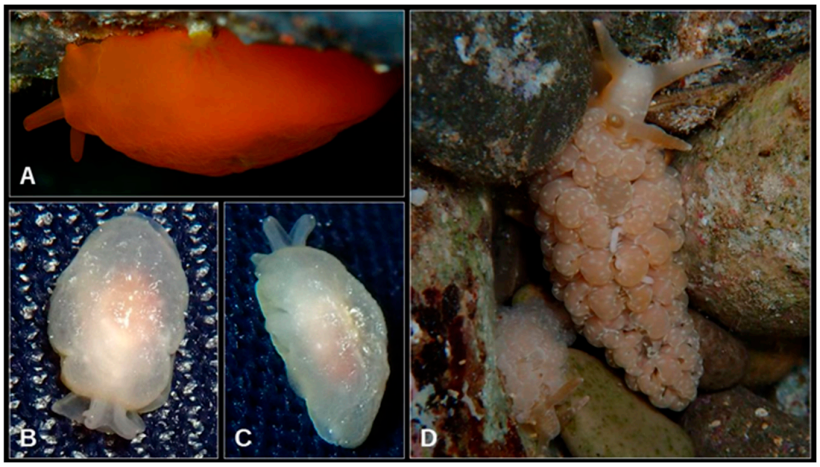

Figure 2. *Berthellina edwardsii*, (**A**) right-lateral view. *Pleurehdera stellata*, (**B**) dorsal view; (**C**) left dorso-lateral view. *Spurilla neapolitana* (**D**), two specimens.

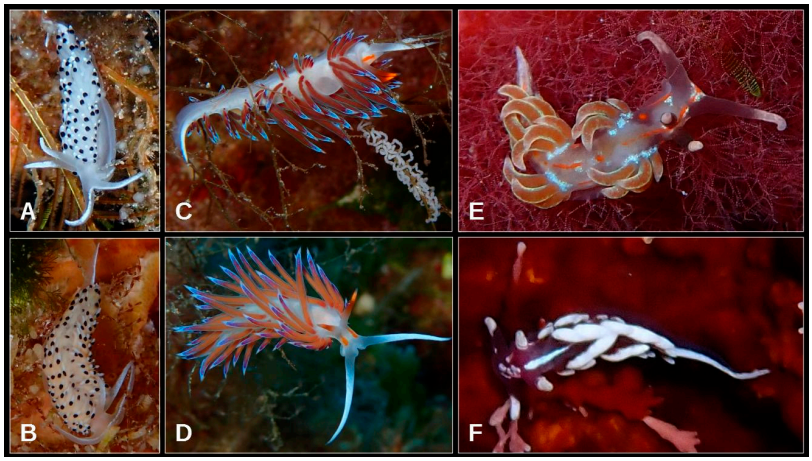

Figure 3. *Caloria elegans*, (**A**) left antero-dorsal view; (**B**) right antero-dorsal view. *Cratena peregrina*, (**C**) a specimen with an egg mass; (**D**) left antero-dorsal view. *Facelina rubrovittata*, (**E**) dorsal view. *Facelinopsis marioni* (**F**), dorsal view.

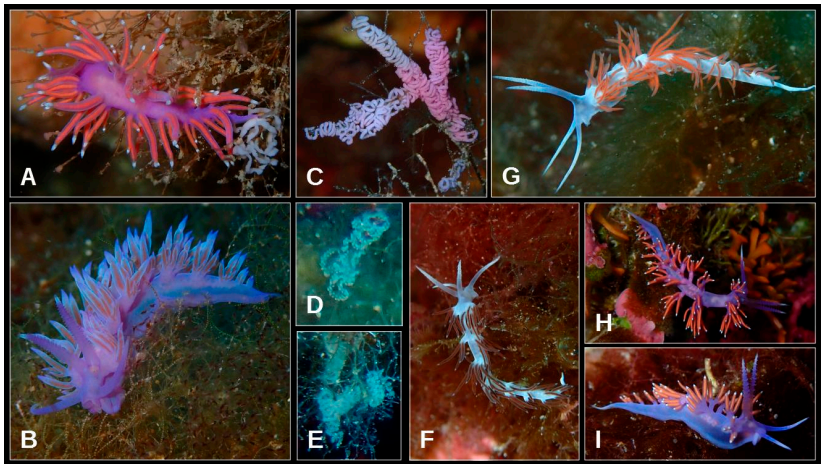

Figure 4. *Edmundsella pedata*, (**A**) a specimen with an egg mass. *Flabellina affinis*, (**B**) left antero-lateral view; (**C**) an egg mass. *Paraflabellina gabinierei*, (**D**) a small egg mass; (**E**) a larger egg mass; (**F**) right dorso-lateral view; (**G**) left lateral view. *Paraflabellina ischitana*, (**H**) dorsal view; (**I**) right antero-lateral view.

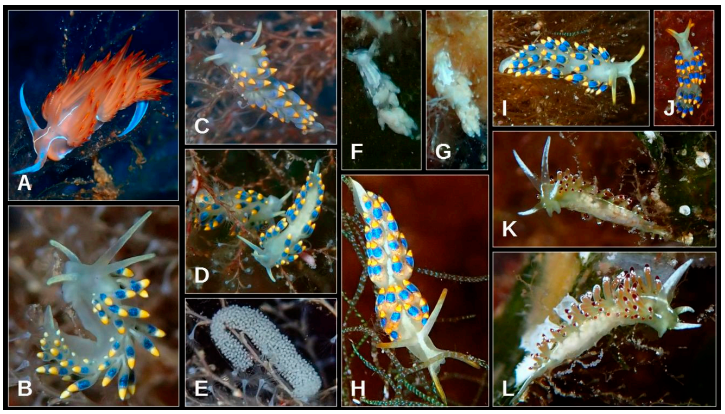

Figure 5. *Nemesignis banyulensis*, (**A**) left antero-dorsal view. *Trinchesia caerulea*, (**B**) left later view; (**C**) left latero-dorsal view; (**D**) two specimens; (**E**) an egg mass. *Trinchesia genovae*, (**F**) dorsal view; (**G**) another specimen in dorsal view. *Trinchesia morrowae*, (**H**) antero-dorsal view; (**I**) dorsal view; (**J**) another individual in dorsal view. *Trinchesia ocellata*, (**K**) left lateral view; (**L**) right lateral view.

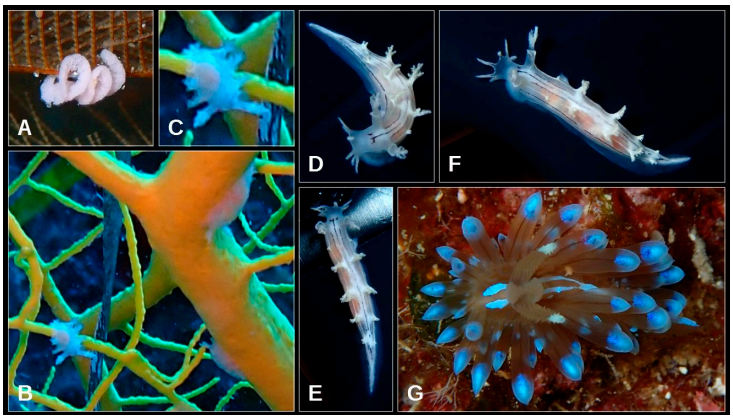

Figure 6. *Doto* sp., (**A**) an egg mass. *Candiella* sp. (**B**) Three specimens of *Leptogorgia sarmentosa* (Esper, 1791); (**C**) detail of one of the individuals. *Candiella striata*, (**D**) antero-dorsal view; (**E**) dorsal view; (**F**) left latero-dorsal view. *Antiopella cristata*, (**G**) dorsal view.

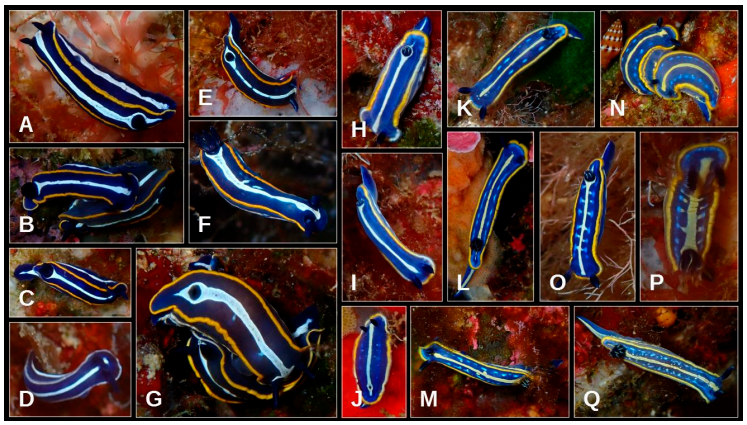

Figure 7. *Felimare fontandraui*, (**A**) right dorso-lateral view; (**B**) two specimens; (**C**) postero-dorsal view; (**D**) antero-dorsal view; (**E**) dorsal view; (**F**) right dorso-lateral view; (**G**) two specimens during mating. *Felimare tricolor*, (**H**) dorsal view; (**I**) antero-dorsal view; (**J**) dorsal view; (**K**) dorsal view; (**L**) dorsal view; (**M**) dorsal view; (**N**) two individuals during mating; (**O**) left dorso-lateral view; (**P**) dorsal view; (**Q**) dorsal view.

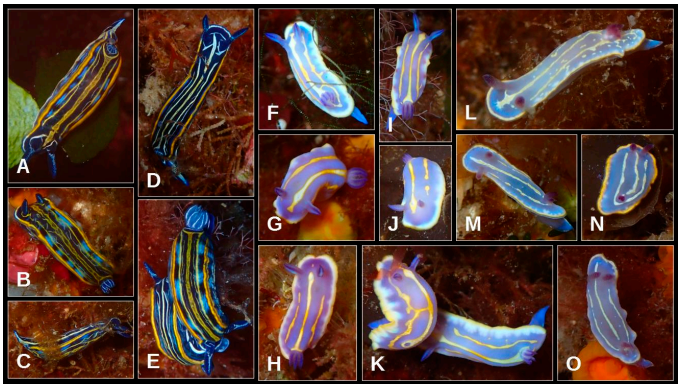

Figure 8. *Felimare villafranca,* (**A**) right latero-dorsal view; (**B**) dorsal view; (**C**) left latero-dorsal view; (**D**) dorsal view; (**E**) two individuals during mating. *Felimida binza*, (**F**) right latero-dorsal view; (**G**) antero-dorsal view; (**H**) dorsal view; (**I**) another specimen in dorsal view; (**J**) left antero-dorsal view; (**K**) two individuals. *Felimida krohni*, (**L**) left latero-dorsal view; (**M**) dorsal view; (**N**) a contracted specimen; (**O**) dorsal view.

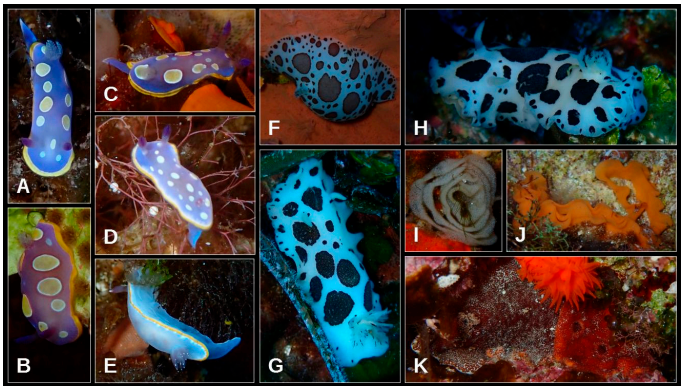

Figure 9. *Felimida luteorosea*, (**A**) dorsal view; (**B**) left latero-dorsal view; (**C**) right latero-dorsal view; (**D**) left postero-dorsal view. *Felimida purpurea*, (**E**) right lateral view. *Peltodoris atromaculata*, (**F**) a specimen on the sponge *Crambe crambe* (Schmidt, 1862); (**G**) dorsal view; (**H**) left latero-dorsal view; (**I**) an egg mass. *Platydoris argo*, (**J**) an egg mass; (**K**) two concealed specimens.

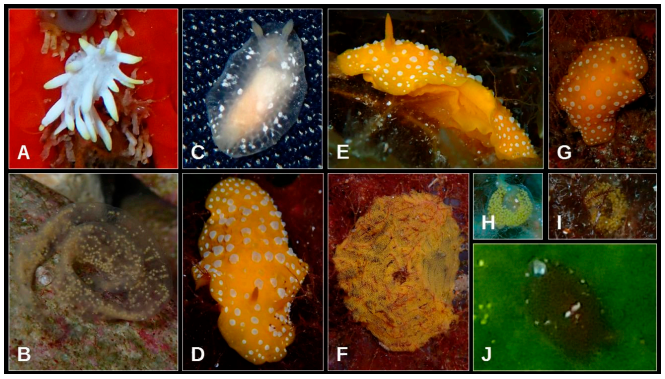

Figure 10. *Goniodoridella picoensis*, (**A**) a specimen on the bryozoan *Nolella* sp. *Dendrodoris* sp., (**B**) an egg mass. *Doriopsilla rarispinosa*, (**C**) dorsal view. *Phyllidia flava*, (**D**) antero-dorsal view; (**E**) left lateral view of an individual with a lacking part of the mantle, which shows some of the ventrally located secondary gills of this species; (**F**) an egg mass; (**G**) dorsal view. *Haminoeidae* sp., (**H**) an egg mass; (**I**) another example of an egg mass. *Cephalaspidea* sp. (**J**) a contracted individual on the green algae *Halimeda tuna* (J. Ellis and Solander) J. V. Lamouroux.

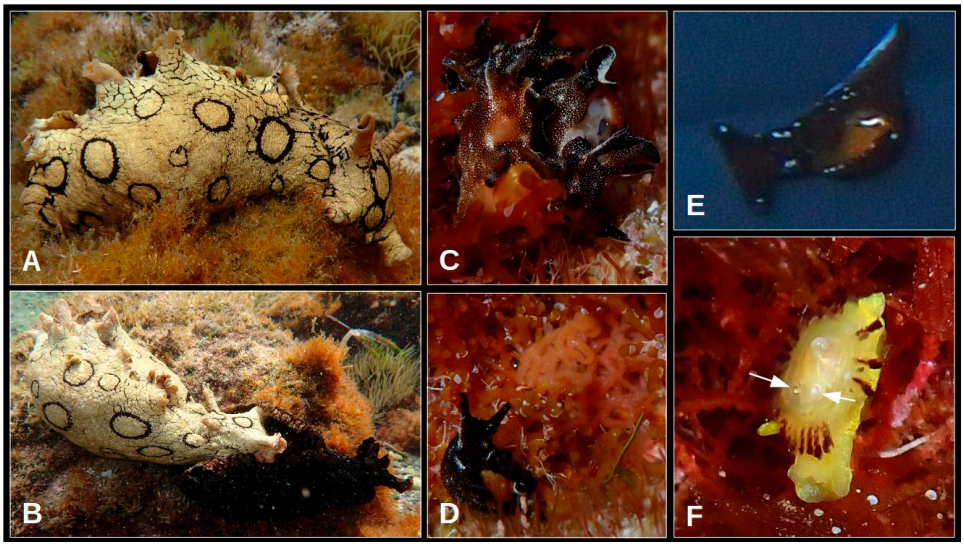

Figure 11. *Aplysia dactylomela*, (**A**) right lateral view; (**B**) a normal cream-colored individual which follows a black one. *Aplysia punctata*, (**C**) a group of specimens on the red algae *Laurencia* sp.; (**D**) an individual with an egg mass; (**E**) a very small specimen. *Tylodina perversa*, (**F**) an individual with two strange and small objects (indicated by the two white arrows) which exit the shell (maybe parasites?).

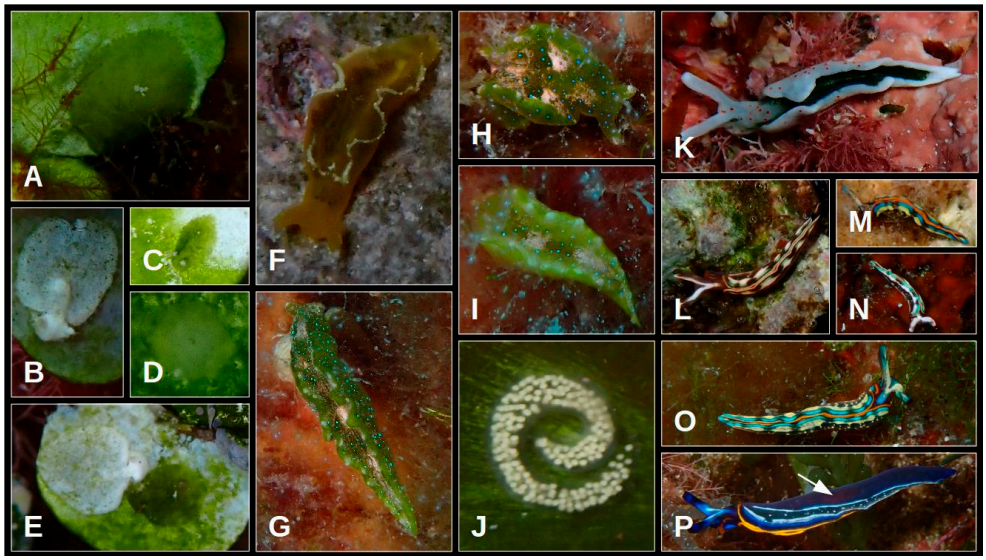

Figure 12. *Bosellia mimetica*, (**A**) dorsal view of a green specimen; (**B**) a white individual; (**C**) a small specimen; (**D**) an egg mass; (**E**) a white individual and a green one during mating. *Elysia flava*, (**F**) dorsal view. *Elysia gordanae*, (**G**) dorsal view; (**H**) antero-dorsal view; (**I**) postero-dorsal view; (**J**) an egg mass on *Flabellia petiolata* (Turra) Nizamuddin. *Elysia timida*, (**K**) dorsal view. *Thuridilla hopei*, (**L**) dorsal view; (**M**) left lateral view; (**N**) right latero-dorsal view; (**O**) dorsal view; (**P**) a large specimen with many red dots (indicated by the white arrow), which shows the areas in which the penis of the partner entered the body cavity.

Data on the number of species were elaborated with Excel, and bar charts were constructed for both dive and snorkeling sites, sides of the island, and MPA protection zones.

Data on the abundance were analyzed through multivariate analysis on the software Jamovi, version 2.3. The pattern of variance in species composition among the sides of the island was shown with principal component analysis (PCA).

3. Results

Through the present study, a total of 43 marine Heterobranchia species were found, subdivided into six taxonomic groups. The most species-rich group was the order Nudibranchia (31 species, 13 families) followed by Sacoglossa (5, 1), Pleurobranchida (2, 1), Cephalaspidea (2, 2), Aplysiida (2, 1), and Umbraculida (1, 1).

3.1. Dive Sites

Concerning the dive sites, those which presented the highest number of species were Secca del Cammello (SC), Scoglio Cavo e Scoglio di Tramontana (ST), and Punta Martina (PM), with 14 species, followed by Ingresso Cattedrale (IC) (13 species), Scoglio Spandillo (SS) (12), Cretazzo (CRE) (12), Orlata San Simone (OSS) (11), Secca di Cala Bianca di fuori (CBM) (11), and Il Camino (CAM) (10). Those with the lowest number of species were Punta Bassana Lato Nord (PB) (8) and Secca di Cala Bianca di terra (CBT) (7) (Figure 13).

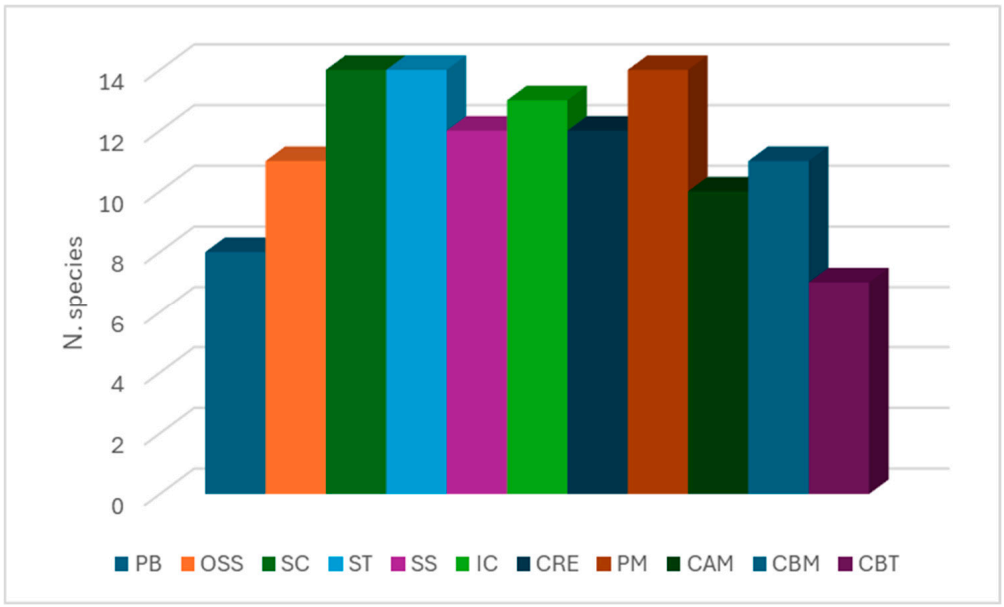

Figure 13. Number of species found in the dive sites (the abbreviations are reported in Table 1).

The marine Heterobranchia species that were found in all or almost all the examined dive sites were *Felimare fontandraui* (10 dive sites), *Cratena peregrina* (9), *Edmundsella pedata* (8), *Felimare tricolor* (8), *Goniodoridella picoensis* (8), *Bosellia mimetica* (8), *Peltodoris atromaculata* (7), and *Thuridilla hopei* (6). The species encountered in at least half the sites were *Flabellina affinis* (5 dive sites), *Paraflabellina ischitana* (5), *Felimida krohni* (5), *Felimida luteorosea* (5), and *Trinchesia caerulea* (4). Those that were found in less than half of the sites were *Felimare villafranca* (4 dive sites), *Felimida binza* (4), *Phyllidia flava* (4), *Haminoeidae* sp. (only the egg masses) (4), *Elysia gordanae* (4), *Paraflabellina gabinierei* (3), *Caloria elegans* (2), and *Trinchesia morrowae* (2). The other species [*Berthellina edwardsii*, *Facelina rubrovittata*, *Nemesignis banyulensis*, *Trinchesia genovae*, *T. ocellata*, *Doto* sp. (only one egg mass), *Candiella* sp., *Antiopella cristata*, *Felimida purpurea*, *Cephalaspidea* sp., and *Tylodina perversa*] were found only in a single dive site (Table 3).

The side of the island where the highest number of species was found was the eastern one (25 species), followed by the southern one (24), and finally the western one (15) (Figure 14).

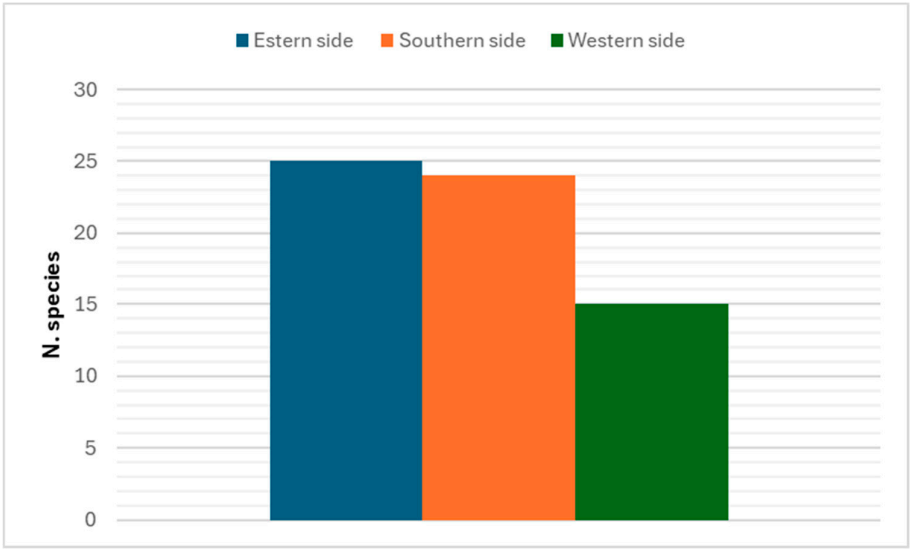

Figure 14. Number of species found along the sides of the islands during scuba dives.

The multivariate analysis PCA highlighted that even the faunistic composition of the eastern side was similar to the southern one but separated from the western side (Figure 15).

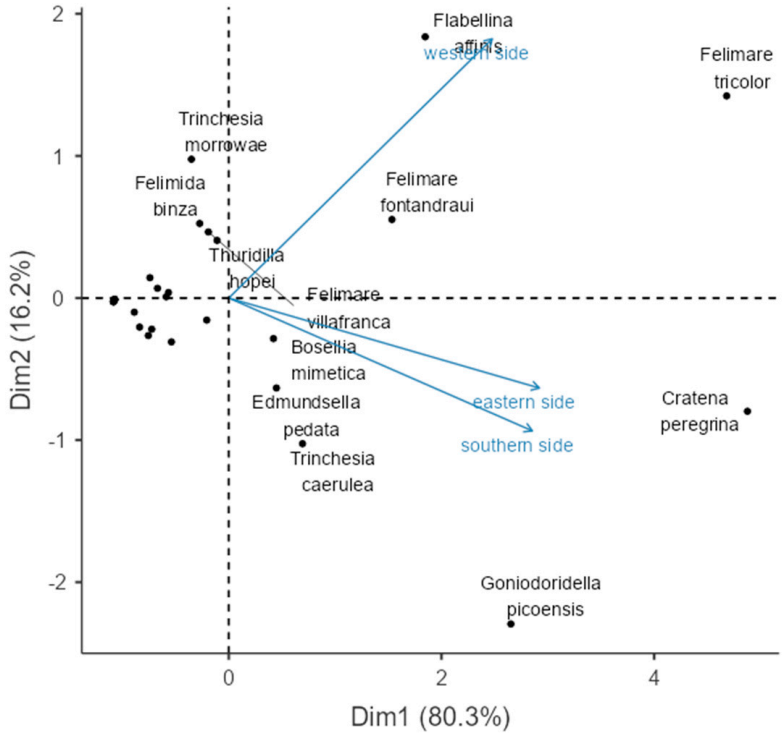

Figure 15. Principal component analysis (PCA) on the abundance data collected along the sides of the island during the scuba dives.

3.2. Snorkeling Sites

Considering the coastal stretches examined through snorkeling activities, those that presented the highest number of species were Cala Sarde (CS) (seven species) and Cala Bianca-Vermetid Reef (CBV) (five). In the coastal tracts of Tra Punta Bassana Nord e Finocchio marino (FM), Costa Porto Vecchio (PV), Punta Troia Lato Sud (PT), and Punta Libeccio Sud-Ovest (PL), four species were found. The coastal stretch with the lowest number of species was La Conca (CON) (three) (Figure 16).

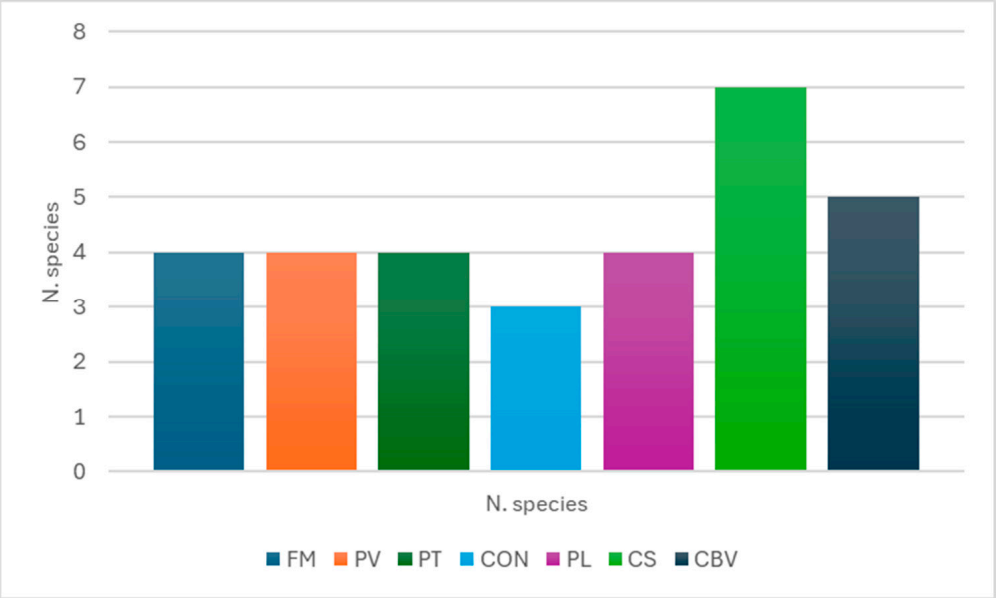

Figure 16. Number of species found in the snorkeling sites (the abbreviations are reported in Table 2).

The species found in all or almost all the investigated coastal stretches were *T. hopei* (seven coastal stretches) and *B. mimetica* (six). Those documented in less than half of the coastal tracts were *Elysia timida* (four coastal stretches) and *Aplysia punctata* (three). The remaining species [*Pleurehdera stellata*, *Spurilla neapolitana*, *F. rubrovittata*, *Facelinopsis marioni*, *Candiella striata*, *Platydoris argo*, *Dendrodoris limbata* (only one egg mass), *Doriopsilla rarispinosa*, *Aplysia dactylomela*, *Elysia flava* and *E. gordanae*] were found only in a single coastal tract (Table 3).

The sides of the island with the highest number of species were the eastern and southern ones (eight species), while along the western side, only five species were detected (Figure 17).

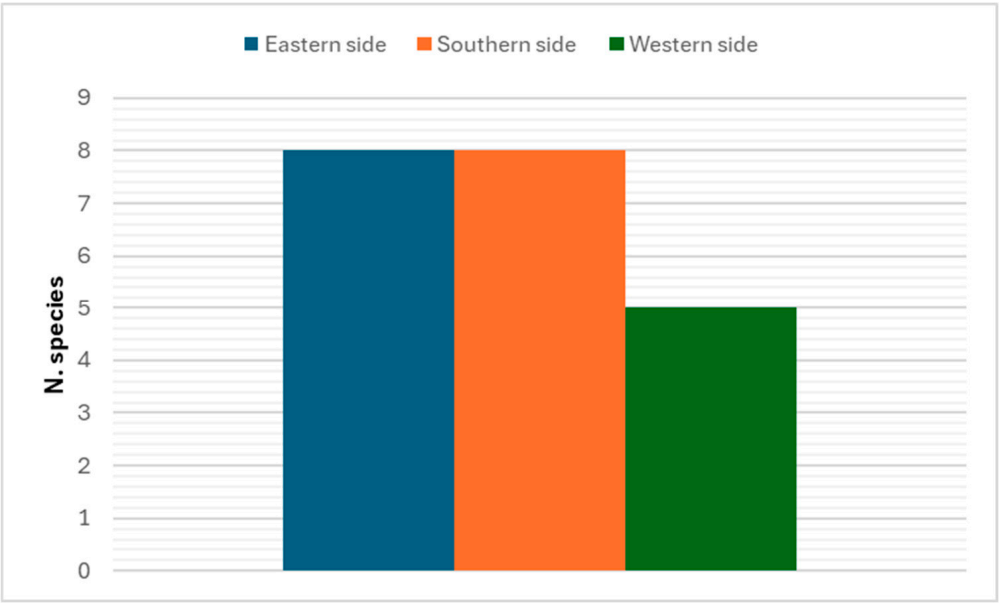

Figure 17. Number of species found along the sides of the islands during the snorkeling activities.

Even in this case, the PCA underlined that the eastern and southern sides had a similar faunistic composition, while the western side was separated (Figure 18).

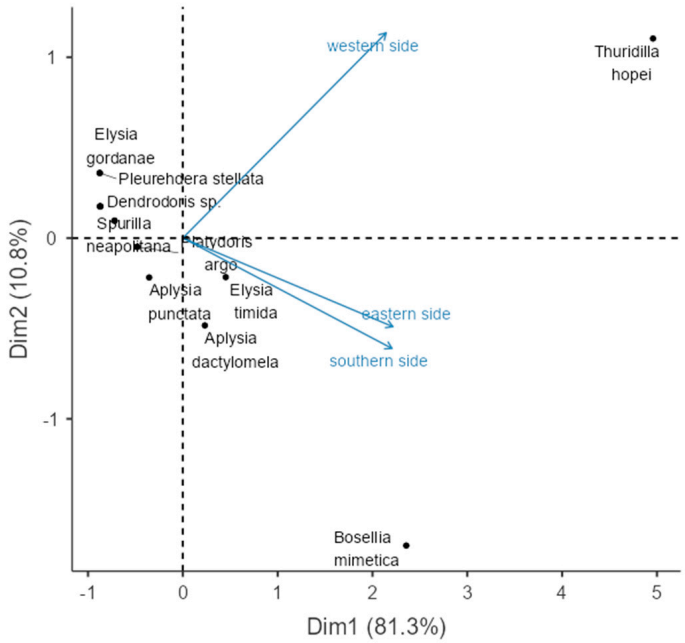

Figure 18. Principal component analysis (PCA) on the abundance data collected along the sides of the island during the snorkeling activities.

3.3. MPA Zonation

Considering the data collected during both the scuba dives and the snorkeling activities, it was observed that the highest number of species was found in the zone B of the MPA (37 species); 29 species were documented in the zone C; while only 4 species were detected in the zone A (Figure 19).

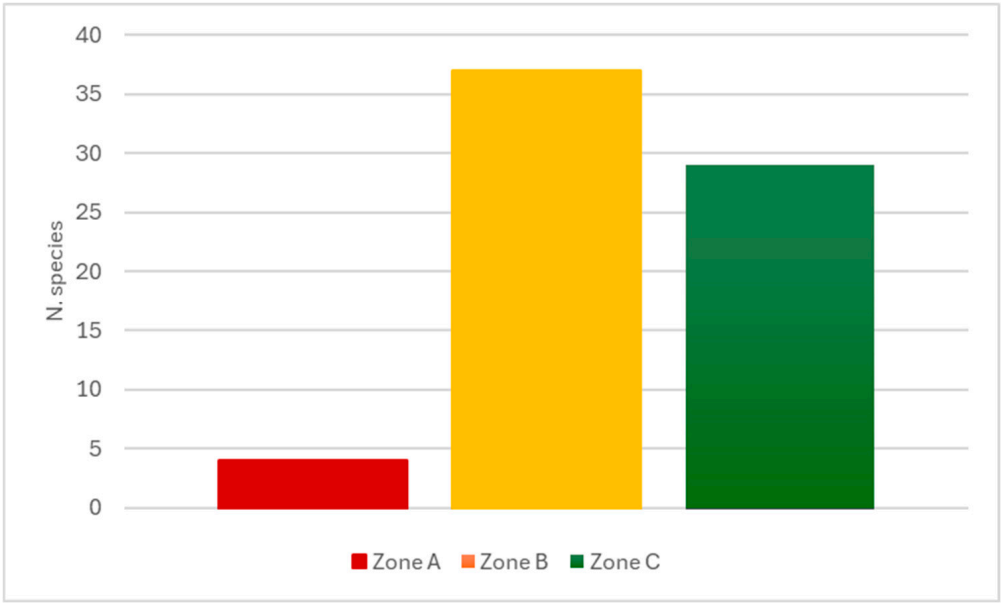

Figure 19. Number of species found in the different MPA protection zones during both scuba dives and snorkeling activities.

4. Discussion

This study provided the first preliminary data on the marine Heterobranchia fauna of the Marettimo island. A total of 43 species, divided into 6 taxonomic groups, were found during both the scuba dives and snorkeling activities.

By analyzing the differences in the number of species between the investigated sites, a rather homogeneous trend was observed. Indeed, the various dive sites and coastal stretches examined here presented a similar number of species (Figures 13 and 16). This numerical similarity was even noted when considering the island sides. Excluding the western side of the island (for which it was not possible to study more than three sites), a numerical similarity in the number of species between the eastern and southern sides of Marettimo was observed. This was observed both for the data collected during scuba dives (25 species in the eastern side and 24 in the southern side) or during snorkeling (8 species in both eastern and southern sides). This numerical similarity could be due to the considerable environmental homogeneity of the dive sites and coastal stretches examined. Indeed, although the dive sites of the eastern and southern sides of the island have a different general sea bottom organization (the eastern sites generally have a seabed characterized by a sandy base with scattered large shoals and rocky outcrops, while the southern ones are characterized by a large coastal rock escarpment descending to a sandy bed), they show rich and healthy coralligenous biocoenoses thanks to the presence of numerous crevices, tunnels, caves, and vertical walls ([12] and authors personal observations). These types of environments are those where there is the highest probability of encountering such animals since they are rich in sessile benthic suspension feeders, such as sponges, cnidarians, bryozoans, and ascidians, which are the main prey of most groups of marine Heterobranchia [32]. In this respect, it is noteworthy that the only dive site surveyed among those on the eastern and southern sides of the island where these types of environments are absent or greatly reduced was the one with the lowest diversity [Punta Bassana Lato Nord (PB) (eight species)]. This state of affairs can be detected also by comparing the only two western side dive sites examined: Secca di Cala Bianca di fuori (CBM) and Secca di Cala Bianca di terra (CBT). The former site, characterized by a rich coralligenous biocoenosis, crevices, and vertical walls, presented a higher number of species (11) than the nearby dive site of Secca di Cala Bianca di terra (CBT), characterized by a homogeneous rocky slope with few crevices and few vertical walls, presenting a lower number of species (seven).

Similar environmental homogeneity can also be seen in the stretches of coastline examined through snorkeling. Indeed, apart from the snorkeling site, tra Punta Bassana Nord e Finocchio marino (FM), which presents mainly a wall morphology, the other examined coastal stretches are characterized by more or less jagged and shallow/very shallow cliffs, rich in inlets and crevices, and with a moderate or high presence of pebbles of various sizes. These environments, being featured with both large areas rich in algae and shadowy ravines and pebbles, presented a mixture of preferential habitats for both photophilous and sciaphilous marine Heterobranchia species [32].

Despite the above-mentioned numerical and environmental similarities, there are some differences in the faunistic composition between the sides of the island. Indeed, apart from the most common marine Heterobranchia species of the island [*Cratena peregrina*, *Edmundsella pedata*, *Flabellina affinis*, *Felimare fontandraui*, *F. tricolor*, *F. villafranca*, *Felimida binza*, *F. krohni*, *F. luteorosea*, *Peltodoris atromaculata*, *Haminoidae* sp. (only egg masses), *Bosellia mimetica*, *Elysia gordanae*, *E. timida*, and *Thuridilla hopei*], which were found in almost all the examined island sides, there were species exclusive to one or two sides. For example, *Caloria elegans*, *Facelina rubrovittata*, *Paraflabellina ischitana*, *Trinchesia caerulea*, *Goniodoridella picoensis*, and *Phyllidia flava* were found in both the eastern and southern sides of the island. Moreover, only one species, *Trinchesia morrowae*, was found in both the western and eastern sides of the island. The remaining species were documented exclusively for one side of the island; specifically, *Spurilla neapolitana*, *Nemesignis banyulensis*, *Trinchesia genovae*, *T. ocellata*, *Doto* sp. (only an egg mass), *Antiopella cristata*, *Felimida purpurea*, *Platydoris argo*, and *Aplysia dactylomela* were found only on the eastern side; while *Berthellina edwardsii*, *Paraflabellina gabinierei*, *Candiella* sp., *C. striata*, *Dendrodoris* sp. (only one egg mass), *Doriopsilla rarispinosa*, *Cephalaspidaea* sp., *Aplysia punctata*, *Tylodina perversa*, and *Elysia flava* were documented only on the southern side; finally, *Pleurehdera stellata* was found only on the western side of the island. These diversities of species composition for the three island sides are probably the

result of differences in microhabitats and the different courses of currents on the sides of the island.

Concerning the differences in diversity between the three MPA zones examined during this study (A, B, C), a real comparison cannot be made. In fact, unlike the island sides, where almost the same number of sites were surveyed (apart from the western side, where only three sites were visited), the three MPA zones surveyed had a different number of sites (zone C: 6 sites; zone B: 10 sites; and zone A: 1 site). Consequently, considering the above, it is not possible to state with certainty which zone is richer in marine Heterobranchia species compared to the others. In general, and for information purposes only, from the data gathered through this study, it was noted that zone B has a higher number of species (37 species) compared to zone C (29 species). The scanty data from zone A (four species) are clearly due to the insufficient number of samplings in that area.

Comparing the total number of species and families found at Marettimo during this study (43 species) with that documented (with the same techniques displayed here) in the other recently examined Sicilian islands, namely, Pantelleria (southwestern Sicily) and Lipari and Vulcano (northeastern Sicily), it seems that Marettimo is the one with the highest diversity concerning this group of mollusks. Indeed, comparing the marine Heterobranchia diversity found in Pantelleria (33 species) [36], Lipari (26 species), and Vulcano (18 species) [16], the island of Marettimo appears to be the richest in marine Heterobranchia species. This higher diversity in marine Heterobranchia could be the direct consequence of two different factors: (1) the ubiquitous presence of rich, well-structured coralligenous biocoenoses; and (2) the regime of currents.

Marettimo is the only island among the cited ones that presents, in almost all the examined dive sites, well-structured coralligenous biocoenoses, with many shady rocky crevices, tunnel, and vertical walls between 20 and 40 m in depth. These environments are the preferred ones by the majority of marine Heterobranchia species, which feed on sessile benthic suspension feeders. The other islands mentioned do not have such an abundance of these specific habitats, and, where they do exist, they are either not as structured, or they start much deeper than at Marettimo. For example, at Pantelleria, this type of environment was encountered only at the site of Punta Spadillo and only lower than 45 m in depth. At Lipari, it was only found in two sites (Parete dei Gabbiani and Punta Castagna) and was less structured than that of Marettimo. Finally, Vulcano does not, from authors' personal observations, seem to present this type of environment.

Regarding the regime currents, Marettimo is the only one of the islands mentioned here that is simultaneously reached by two different important surface currents: the Atlantic Ionian Stream (AIS) and Tyrrhenian Sicilian Current (TSC). The first, originating from the Algerian current, branches out from this latter in the seawaters off Marettimo, approaching the island and then crossing the entire channel of Sicily. The second, starting from the west coast of Calabria and moving towards the west along the entire northern coast of Sicily, reaches the island of Marettimo from the north [37]. Since the main component in the recruitment of marine heterobranchs is given by allochthonous-produced larvae [38], and since the majority of these animals present planktotrophic larvae (i.e., the veliger larvae are obliged to live and feed on the plankton for a variable quantity of time) [39], Marettimo might be reached by more larvae than the other islands mentioned.

5. Conclusions

The island of Marettimo can represent a potential biodiversity hotspot for the marine Heterobranchia fauna. This, considering the high marine biodiversity richness of this island [12], highlights the importance of building a solid knowledge base of the different groups of marine animals found on this Mediterranean island, which, due to its natural peculiarities, presents itself as a perfect semi-virgin terrain to study.

In conclusion, in the present study, it was possible to lay the foundations of our knowledge of one of the most peculiar and sought-after groups of gastropod mollusks.

This knowledge is only preliminary and will have to be supplemented by new information in the years to come.

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