

The biodiversity of the marine Heterobranchia fauna along the central-eastern coast of Sicily, Ionian Sea

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ABSTRACT

The first updated list of the marine Heterobranchia for the central-eastern coast of Sicily (Italy) is here reported. This study was carried out, through a total of 271 scuba dives, from 2017 to the beginning of 2020 in four sites located along the Ionian coasts of Sicily: Catania, Aci Trezza, Santa Maria La Scala and Santa Tecla. Through a photographic data collection, 95 taxa, representing 17.27% of all Mediterranean marine Heterobranchia, were reported. The order with the highest number of found species was that of Nudibranchia. Among the study areas, Catania, Santa Maria La Scala and Santa Tecla had not a remarkable difference in the number of species, while Aci Trezza had the lowest number of species. Moreover, among the 95 taxa, four species considered rare and six non-indigenous species have been recorded. Since the presence of a high diversity of sea slugs in a relatively small area, the central-eastern coast of Sicily could be considered a zone of high biodiversity for the marine Heterobranchia fauna.

KEY WORDS

diversity; marine Heterobranchia; Mediterranean Sea; sea slugs; species list.

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INTRODUCTION

Malacological studies and researches on marine Heterobranchia in Sicily (Italy) have always been scarce and fragmentary. Indeed, the last study on Sicilian marine Heterobranchia dates back to 1987 (Cattaneo Vietti & Chemello, 1987). Cattaneo and Barletta (1984) argued that taxa collected and reported in Sicily represent about 30% of all Mediterranean species. This last date may not reflect a low level of biodiversity in marine Heterobranchia, but a lack of data on this group (Cattaneo Vietti & Chemello, 1987). Moreover, studies on sea slugs in Sicily show a difference. Indeed, the eastern sector was less explored than the western sector, where

more researches were carried out (Cattaneo Vietti & Chemello, 1987).

In this work the marine Heterobranchia fauna of the central-eastern sector of Sicily (Ionian Sea) has been studied. This area, represented by Etna's eastern slopes, is geologically constituted by a complex of subvolcanic rocks, mainly consisting of columnar basalts deposited within the "pre-Etnean Gulf", and effusive marine products forming fields of pillow lavas (Cristofolini, 1975; Corsaro & Cristofolini, 1997; Sciuto et al., 2017). Accumulated along the coast and at the base of shallow cliffs, there is a belt of blocks up to a few meters in size, caused by rocky outcrops dissected by fault systems and partially dismantled (Sciuto et al.,

2017). From the coastline to down to 10-15 m depth, the bottom has a sloping topography and consists of the basaltic bedrock covered with large volcanic blocks (Sciuto et al., 2017). Offshore, the bottom of sediments becomes progressively muddier at major depths with rocky outcrops locally exposed (Rosso, 2001). The study area hosts several benthic habitats, some of which are protected by the EU Habitat Directive (92/43/EEC): pre-coraligenous and coralligenous assemblages, soft-bottom substrates, *Posidonia oceanica* (Linnaeus) Delile, 1813 meadows, and algal biocoenosis on rocky substrates.

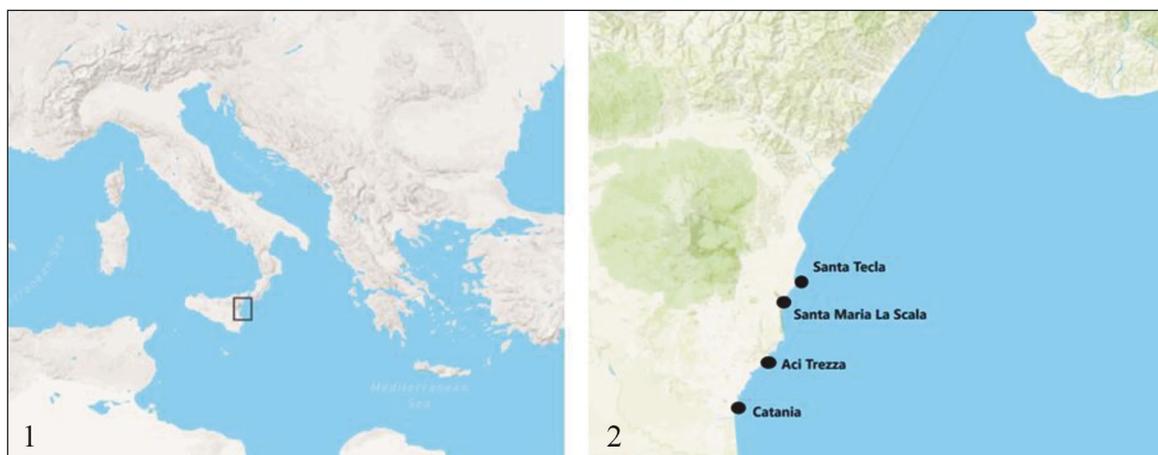
To carry out this study six stations along the central-eastern coast of Sicily were selected, two of which are in Protected Areas. Indeed, in the site of Aci Trezza (37.561389 N; 15.157492 E) there are a Marine Protected Area (MPA) named “Ciclops Islands”, an Integral Nature Reserve called “Lachea Island and Cyclops stacks” and two Sites of Community Importance (SCIs) (“Bottoms of Acicastello” and “Cyclops Islands”), according to the Natura 2000 network. Furthermore, in the site of Santa Maria La Scala (37.617222 N; 15.172222 E) there are an Oriented Natural Reserve called “La Timpa” and a Site of Community Importance named “Timpa of Acireale” (Catra et al., 2006). Therefore, especially in these areas, knowing and preserving the biodiversity of sea slugs is extremely important and necessary. Indeed, the changes in marine Heterobranchia fauna composition may reveal environmental modifications (Furfaro et al., 2020),

caused by natural or anthropogenic factors. Moreover, a knowledge on the diversity of the marine Heterobranchia fauna can disclose the presence of any non-indigenous species. Consequently, studies focused on the production of species lists allow the hidden diversity to be revealed (Furfaro et al., 2020) and allow comparisons with different geographical areas to be made.

To date, there is not an updated list on the sea slugs of the central-eastern sector of Sicily. Indeed, data on the marine Heterobranchia fauna of the central-eastern sector of Sicily, referred to as Gulf of Catania and provinces, are ancient and reported only 5 species (Philippi, 1836-1844; Aradas, 1847; Cattaneo Vietti & Chemello, 1987). For this reason, the aim of this work was to contribute to the knowledge of the marine Heterobranchia present in this area, which has always been poorly explored, and to document the presence of rare and non-indigenous species.

MATERIAL AND METHODS

This study was carried out from January 2017 to March 2020, in 6 stations located along the central-eastern sector of Sicily (Figs. 1, 2). These sites were selected based on different environmental conditions. Two stations, “Ognina” (37.530528 N; 15.120028 E) and “Bellatrix” (37.533917 N; 15.126778 E), are situated close to each other in the municipality of Catania. These sites are sub-



Figures 1, 2. Geographical area in the Ionian Sea (Mediterranean Sea) where this study was carried out: central-eastern sector of Sicily, where are located the study areas (Fig. 1); detail of the study areas (Fig. 2).

jected to a strong anthropization, due to the proximity of a harbour and the exploitation of the coast. Since these sites have similar ecological conditions, they were considered as a single site, listed from now on as “Catania”. Another station called “Padre Pio” (37.566083 N; 15.166361 E) is located in the zone “B”, the general reserve zone, of the MPA of “Ciclopi Islands”, in the hamlet of Aci Trezza, within the municipality of Acicastello. This site, especially during summer, has a strong anthropic pressure. From now on, for simplification this area will be referred as “Aci Trezza”. A station named “Testa dell’acqua” (37.6125 N; 15.175389 E) is located in the hamlet of Santa Maria La Scala and, thus, it will be simply listed as “Santa Maria La Scala”. Finally, two sites, “Scalo Pennisi” (37.639778 N; 15.184722 E) and “Acque Fredde” (37.637583 N; 15.181167 E), are situated in the hamlet of Santa Tecla. These three stations are all located in the municipality of Acireale. Moreover, in these three sites there are several springs due to the flow of freshwater from the Etna to the sea (Ferrara, 1977; Catra et al., 2006). Since the stations of “Scalo Pennisi” and “Acque Fredde” are situated close to each other and are the least affected by anthropogenic factors, they considered as a single site, listed from now on as “Santa Tecla”. Instead, the site of “Santa Maria La Scala” was considered individually because it has intermediate conditions between those of Catania and Santa Tecla.

Throughout the years of study, a total of 271 scuba dives was carried out: 92 in “Catania”, 81 in “Santa Maria La Scala”, 74 in “Santa Tecla”, 24 in “Aci Trezza”. The scuba dives (0 - 45 m) were conducted all year round (marine-weather conditions permitting), twice a week, during daylight, between 9-11:30 am. Occasionally, some dives were carried out at night in the site of Aci Trezza. In each site, the same pathway has always been followed. Data on marine Heterobranchia fauna were collected with the “photographic capture” technique: during each scuba dive all sea slugs were photographed with an Olympus TG-4 Underwater Camera, were counted and the depth, where they were encountered, was annotated. Subsequently, the photographs with the specimens were used for the identification of the species, by consulting Schmekel & Portmann (1982), Thomson & Brown (1984), Betti (2011), Trainito & Doneddu

(2014) and Sea Slug Forum (Rudman, 1999). The validity of the species names has been checked by consulting the World Register of Marine Species (Horton et al., 2020). Finally, the collected data were processed in Excel to create a table and graphs.

RESULTS

Through data collection, a total of 95 taxa of marine Heterobranchia (Table 1) were found, consisting of: 1 Rhodopoidea, 4 Pleurobranchida, 61 Nudibranchia, 2 Umbraculida, 7 Aplysiida, 5 Cephalaspidea, 1 Runcinida, 14 Sacoglossa. Their percentages are shown in figure 3. Among these 95 taxa, 75 were found in Catania, 43 in Aci Trezza, 74 in Santa Maria La Scala, 71 in Santa Tecla (Fig. 4).

Since the highest percentage of species belongs to the order Nudibranchia (64%), the differences within this order have been highlighted and it has been seen that 56% of them are represented by the suborder Cladobranchia and 44% by the suborder Doridina. Within the suborder Cladobranchia (Fig. 5), a total of 34 species was found, consisting of 12 families. Instead, within the suborder Doridina (Fig. 6) a total of 27 species was found, consisting of 9 families.

In Table 1 all sea slug species, which were found throughout this study, are reported. The asterisks present in the table represent the finding of only the eggs of a species in an area.

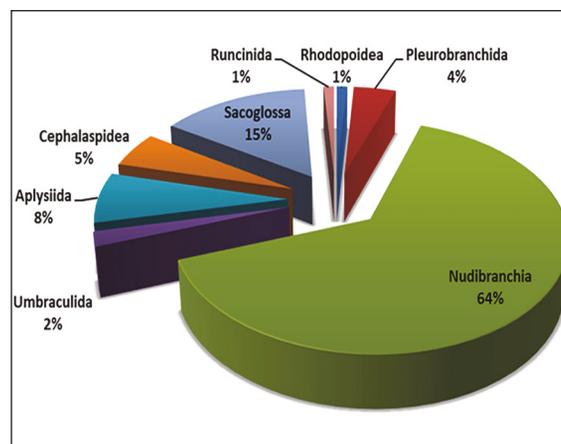


Figure 3. Percentages of the marine Heterobranchia groups found throughout the study.

Taxa	Catania	Acitrezza	Santa Maria La Scala	Santa Tecla	Depth
"Lower Heterobranchia"					
Superfamily Rhodopoidea Ihering, 1876					
Family Rhodopidae Ihering, 1876					
<i>Rhodope</i> sp.	X		X	X	6.8-28 m
Euthyneura					
Order Pleurobranchida					
Family Pleurobranchidae Gray, 1827					
<i>Berthella</i> cf. <i>aurantiaca</i> (Risso, 1818)	X				6 m
<i>Berthella ocellata</i> (Delle Chiaje, 1830)	X	X		X	15-34.2 m
<i>Pleurobranchus testudinarius</i> Cantraine, 1835	X	X	*	*	5-45 m
<i>Pleurobranchus wirtzi</i> Ortea, Moro & Caballer, 2014	X				6.6 m
Order Nudibranchia					
Suborder Doridina					
Family Calycidorididae Roginskaya, 1972					
<i>Diaphorodoris alba</i> Portmann & Sandmeier, 1960	X	X	X	X	12-37 m
<i>Diaphorodoris papillata</i> Portmann & Sandmeier, 1960	X	X	X	X	7-37 m
Family Goniadorididae H. Adams & A. Adams, 1854					
<i>Okenia problematica</i> Pola, Paz-Sedano, Macali et al., 2019	X				14.5-17.4 m
<i>Trapania lineata</i> Haefelfinger, 1960	X		X	X	5.3-35 m
Family Polyceridae Alder & Hancock, 1845					
<i>Kaloplocamus ramosus</i> (Cantraine, 1835)		X			15 m
<i>Polycera quadrilineata</i> (O.F. Müller, 1776)	X	X	X	X	6-37 m
Family Aegiridae P. Fischer, 1883					
<i>Aegires leuckartii</i> Vérany, 1853	X			X	6-17.1 m
<i>Aegires sublaevis</i> Odhner, 1932	X				5,7 m
Family Chromodorididae Bergh, 1891					
<i>Felimare fontandraui</i> (Pruvot-Fol, 1951)	X	X	X	X	9-37 m
<i>Felimare gasconi</i> (Ortea, 1996)	X		X		6.1-19.2 m
<i>Felimare orsinii</i> (Vérany, 1846)			X		25,6 m
<i>Felimare picta</i> (Philippi, 1836)	X	X	X	X	4-36.6 m
<i>Felimare tricolor</i> (Cantraine, 1835)	X	X	X	X	7-37.2 m
<i>Felimare villafranca</i> (Risso, 1818)	X		X	X	8-30 m
<i>Felimida binza</i> (Ev. Marcus & Er. Marcus, 1963)	X	X	X	X	6-34 m
<i>Felimida krohni</i> (Vérany, 1846)	X	X	X	X	6-36 m
<i>Felimida luteorosea</i> (Rapp, 1827)	X		X	X	10-35 m
<i>Felimida purpurea</i> (Risso, 1831)	X		X	X	8-35.5 m

Taxa	Catania	Acitrezza	Santa Maria La Scala	Santa Tecla	Depth
Family Dorididae Rafinesque, 1815					
<i>Doris verrucosa</i> Linnaeus, 1758		X			< 1 m
Family Discodorididae Bergh, 1891					
<i>Baptodoris</i> cf. <i>cinnabarina</i> Bergh, 1884	X				5,7 m
<i>Jorunna tomentosa</i> (Cuvier, 1804)		X			< 1 m
<i>Peltodoris atromaculata</i> Bergh, 1880	X	X	X	X	10-37 m
<i>Platydoris argo</i> (Linnaeus, 1767)	X		X	X	< 1-34 m
<i>Taringa tritorquis</i> Ortea, Perez & Llera, 1982	X		X		6.9-9.5 m
Family Phyllidiidae Rafinesque, 1814					
<i>Phyllidia flava</i> Aradas, 1847	X	X	X		12-37 m
Family Dendrodorididae O'Donoghue, 1924 (1864)					
<i>Dendrodoris limbata</i> (Cuvier, 1804)	X	X		X	3.7-28.4 m
<i>Doriopsilla areolata</i> Bergh, 1880			X	X	5-8.7 m
Suborder Cladobranchia					
Family Tritoniidae Lamarck, 1809					
<i>Tritonia manicata</i> Deshayes, 1853			X		34 m
<i>Tritonia striata</i> Haefelfinger, 1963		X			17 m
Family Dotidae Gray, 1853					
<i>Doto acuta</i> Schmekel & Kress, 1977	X		X	X	6-34 m
<i>Doto cervicenigra</i> Ortea & Bouchet, 1989	X			X	15-20 m
<i>Doto floridicola</i> Simroth, 1888			X	X	17.5-32.5 m
Family Janolidae Pruvot-Fol, 1933					
<i>Antiopella cristata</i> (Delle Chiaje, 1841)	X	X	X	X	11-36 m
Family Flabellinidae Bergh, 1889					
<i>Calmella cavolini</i> (Vérany, 1846)	X	X	X	X	4-37 m
<i>Edmundsella pedata</i> (Montagu, 1816)	X	X	X	X	3-37 m
<i>Flabellina affinis</i> (Gmelin, 1791)	X	X	X	X	8-38 m
<i>Paraflabellina ischitana</i> (Hirano & T. E. Thompson, 1990)	X		X	X	5-37 m
Family Coryphellidae Bergh, 1889					
<i>Fjordia lineata</i> (Lovén, 1846)	X		X	X	8,5-34 m
Family Samliidae Korshunova, Martynov et al., 2017					
<i>Luisella babai</i> (Schmekel, 1972)	X	X	X	X	20-37 m
Family Eubbranchidae Odhner, 1934					
<i>Amphorina farrani</i> (Alder & Hancock, 1844)	X		X	X	5-16 m
<i>Capellinia doriae</i> Trinchese, 1874			X		9.1 m
<i>Eubbranchus tricolor</i> Forbes, 1838				X	9 m
Family Trinchesiidae F. Nordsieck, 1972					
<i>Trinchesia caerulea</i> (Montagu, 1804)	X		X	X	6.5-37 m

Taxa	Catania	Acitrezza	Santa Maria La Scala	Santa Tecla	Depth
<i>Trinchesia foliata</i> (Forbes & Goodsir, 1839)	X	X	X	X	6-27 m
<i>Trinchesia genovae</i> (O'Donoghue, 1926)	X	X	X	X	5-35 m
<i>Trinchesia ocellata</i> Schmekel, 1966	X		X	X	17-36 m
Family Embletoniidae Pruvot-Fol, 1954					
<i>Embletonia pulchra</i> (Alder & Hancock, 1844)	X		X	X	10-6 m
Family Facelinidae Bergh, 1889					
<i>Caloria elegans</i> (Alder & Hancock, 1845)	X		X		21.3-27.8 m
<i>Cratena peregrina</i> (Gmelin, 1791)	X	X	X	X	4-37 m
<i>Dicata odhneri</i> Schmekel, 1967	X	X	X	X	4.5-32 m
<i>Facelina annulicornis</i> (Chamisso & Eysenhardt, 1821)	X		X	X	7-10 m
<i>Facelina rubrovittata</i> (Costa A., 1866)	X	X	X	X	5-32 m
<i>Facelinopsis marioni</i> (Vayssière, 1888)	X	X	X	X	3-22 m
<i>Favorinus branchialis</i> (Rathke, 1806)	X	X	X	X	5-37 m
Family Myrrhinidae Bergh, 1905					
<i>Dondice banyulensis</i> Portmann & Sandmeier, 1960	X		X	X	8-38 m
<i>Dondice trainitoi</i> Furfaro & Mariottini, 2020			X		20 m
<i>Godiva quadricolor</i> (Barnard, 1927)			X		7 m
Family Aeolidiidae Gray, 1827					
<i>Berghia coerulescens</i> (Laurillard, 1832)	X		X	X	8-36 m
<i>Berghia verrucicornis</i> (A. Costa, 1867)	X				4,8 m
<i>Limenandra nodosa</i> Haefelfinger & Stamm, 1958			X	X	5-17 m
<i>Spurilla neapolitana</i> (Delle Chiaje, 1841)	X	X	X	X	5-20 m
Order Umbraculida					
Family Umbraculidae Dall, 1889 (1827)					
<i>Umbraculum umbraculum</i> (Lightfoot, 1786)		X	X	X	5.1-36 m
Family Tylodiniidae Gray, 1847					
<i>Tylodina perversa</i> (Gmelin, 1791)	X		X	X	12-31 m
Order Aplysiida					
Family Aplysiidae Lamarck, 1809					
<i>Aplysia dactylomela</i> Rang, 1828	X	X	X	X	< 1-19 m
<i>Aplysia depilans</i> Gmelin, 1791	X		X	X	2.9-23 m
<i>Aplysia fasciata</i> Poiret, 1789	X		X	X	2-25.3 m
<i>Aplysia parvula</i> Mörch, 1863	X	X	X	X	2.9-17 m
<i>Aplysia punctata</i> (Cuvier, 1803)	X	X	X	X	1.4-21.7 m
<i>Notarchus punctatus</i> Philippi, 1836	X	X	X	X	6-21,5 m
<i>Phyllaplysia</i> cf. <i>lafonti</i> (P. Fischer, 1870)	X		X	X	5-18 m
Order Cephalaspidea					
Family Aglajidae Pilsbry, 1895 (1847)					

Taxa	Catania	Acitrezza	Santa Maria La Scala	Santa Tecla	Depth
<i>Aglaja tricolorata</i> Renier, 1807			X	X	11.2-15 m
<i>Biuve fulvipunctata</i> (Baba, 1938)				X	4.4 m
<i>Camachoaglaja africana</i> (Pruvot-Fol, 1953)	X	X		X	< 1 - 7 m
Family Haminoeidae Pilsbry, 1895					
<i>Haloa</i> sp.	*	X	*	X	3-33 m
<i>Lamprohaminoea cyanomarginata</i> (Heller & T.E. Thompson, 1983)	X	X	X	X	5-25 m
Order Runcinida					
Family Runcinidae H. Adams & A. Adams, 1854					
<i>Runcina</i> sp.	X		X		6-7.2 m
Superorder Sacoglossa					
Family Oxynoidae Stoliczka, 1868 (1847)					
<i>Lobiger serradifalci</i> (Calcara, 1840)			X	X	5-10 m
<i>Oxynoe olivacea</i> Rafinesque, 1814				X	6-7.6 m
Family Plakobranchidae Gray, 1840					
<i>Bosellia mimetica</i> Trinchese, 1891	X	X	X	X	1 -38 m
<i>Elysia hetta</i> Perrone, 1990	X		X		21-30 m
<i>Elysia margaritae</i> Fez, 1962	X	X	X		5-30 m
<i>Elysia rubeni</i> Martín-Hervás, Carmona et al., 2019	X	X	X	X	7-21 m
<i>Elysia timida</i> (Risso, 1818)	X	X	X	X	1-18 m
<i>Elysia translucens</i> Pruvot-Fol, 1957			X	X	6.8-7.5 m
<i>Elysia viridis</i> (Montagu, 1804)	X		X	X	7-22 m
<i>Thuridilla hopei</i> (Vérany, 1853)	X	X	X	X	1 - 36 m
Family Limapontiidae Gray, 1847					
<i>Placida cremoniana</i> (Trinchese, 1892)	X				1.4 m
<i>Placida viridis</i> (Trinchese, 1874)				X	7.2 m
Family Hermaeidae H. Adams & A. Adams, 1854					
<i>Hermaea bifida</i> (Montagu, 1816)	X			X	6-19 m
<i>Hermaea variopicta</i> (A. Costa, 1869)	X		X		7 m

Table 1. List of marine Heterobranchia found in four areas along the central-eastern sector of Sicily (Ionian Sea). Abbreviation cf. is from the Latin confer/conferatur, both meaning compare.

DISCUSSION

The present study, which was carried out from 2017 to the beginning of 2020 in four areas located along the central-eastern sector of Sicily, reports the presence of 95 taxa of marine Heterobranchia (Table 1). Through data collection, it was observed that the highest number of

the found species belongs to the order Nudibranchia, with a percentage of 64% (Fig. 3). Moreover, within this order the majority of the species belongs to the suborder Cladobranchia (56%), in which the family with the highest number of species was that of Facelinidae Bergh, 1889 (Fig. 5). Instead, the suborder Doridina represented 44% of the Nudibranchia. In this suborder,

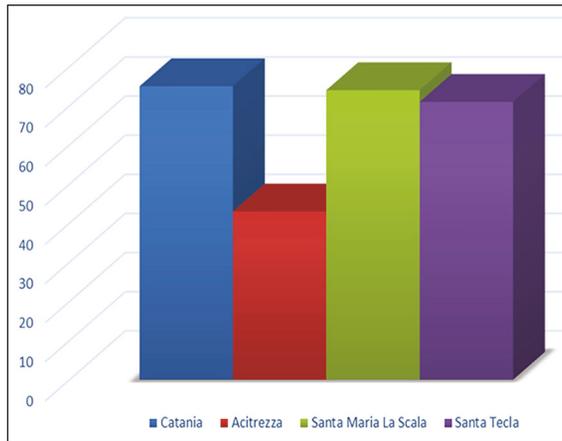


Figure 4. Number of taxa found in the different study areas.

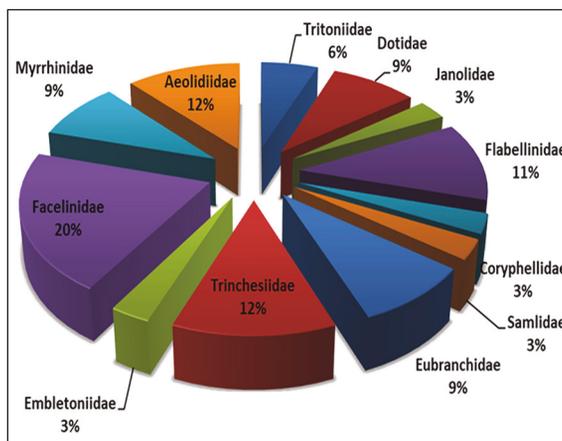


Figure 5. Percentages of the families of the suborder Cladobranchia (Nudibranchia) seen during this study.

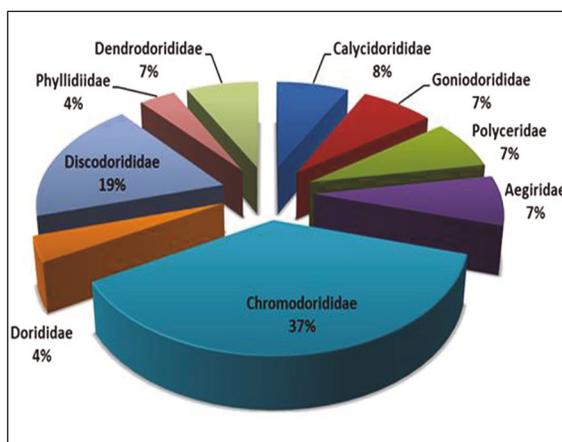


Figure 6. Percentages of the families of the suborder Doridina (Nudibranchia) seen during this study.

the family with most species was that of Chromodorididae Bergh, 1891 (Fig. 6).

Regarding the distribution of the sea slug taxa in the different study areas (Fig. 4), it was not observed a remarkable difference in the number of the found species in the sites of Catania, Santa Maria La Scala and Santa Tecla. Instead, in the site of Acitrezza the lowest number of species has been found. Although in this area fewer scuba dives were conducted than the other sites, the authors have extended knowledge of this area before the present study and believe that the lower number of species is related to other factors. Indeed, the site of Acitrezza presents a homogeneous topography and is characterized by shallower sea bottoms, while the remaining study areas have a sloping topography and deeper sea bottoms. Therefore, this last type of topography allows the presence of a higher number of microhabitats and more variable environmental conditions.

Through data collection, for the first time it has been realized a list of the marine Heterobranchia present in the central-eastern coast of Sicily. Among the 95 taxa here reported, four species considered rare and five non-indigenous species have been found. Among the rare species, the following are reported: *Elysia rubeni* Martín-Hervás, Carmona, K. R. Jensen, Licchelli, Vitale & Cervera, 2019 (Gerovasileiou et al., 2020), *Okenia problematica* Pola, Paz-Sedano, Macali, Minchin, Marchini, Vitale, Licchelli et Crocetta, 2019 (Lombardo & Marletta, 2020a), *Taringa tritorquis* Ortea, Perez & Llera, 1982 (Gerovasileiou et al., 2020; Lombardo & Marletta, 2020b) and *Dondice trainitoi* Furfaro & Mariottini, 2020 (Gerovasileiou et al., 2020). Instead, regarding non-indigenous species, the following taxa are here reported: *Aplysia dactylomela* Rang, 1828 (Valdés et al., 2013), *Lamprohaminoea cyanomarginata* (Heller & T. E. Thompson, 1983) (Crocetta & Vazzana, 2009), *Godiva quadricolor* (Barnard, 1927) (Lombardo & Marletta, 2019a), *Biuve fulvipunctata* (Baba, 1938) (Lombardo & Marletta, 2020b), and *Pleurobranchus wirtzi* Ortea, Moro & Caballer, 2014 (Lombardo & Marletta, 2019b). Moreover, six species, whose identification is doubtful, are reported in Table 1 and in figures 7–12: *Rhodope* sp., *Berthella* cf. *aurantiaca* (Risso, 1818), *Baptodoris* cf. *cinnabarina* Bergh, 1884, *Phyllaplysia* cf. *lafonti* (P. Fischer, 1870), *Runcina* sp., *Halooa* sp.

In conclusion, the present study on the marine



Figures 7–12. Species whose identification is doubtful: Fig. 7) *Rhodope* sp.; Fig. 8) *Berthella* cf. *aurantiaca*; Fig. 9) *Baptodoris* cf. *cinnabarina*; Fig. 10) *Phyllaplysia* cf. *lafonti*; Fig. 11) *Runcina* sp.; Fig. 12) *Haloa* sp. (photos A. Lombardo).

Heterobranchia of the central-eastern coast of Sicily, represents the first contribution to the knowledge of this group in this area, that has always been poorly studied. Moreover, this study revealed high biodiversity in the marine Heterobranchia present in this area. Indeed, the found taxa represent 17.27% of all Mediterranean sea slugs, which in total are about 550 (Trainito & Doneddu, 2014; Furfaro et al., 2020). Therefore, although the small examined area, the central-eastern coast of Sicily could be considered a zone of high biodiversity for the marine Heterobranchia fauna. Future studies will be focused on the frequency, abundance and seasonality of the species distributed in the examined areas.

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