

Check-list of the Nudibranchs (Mollusca Gastropoda) from the biodiversity hot spot “Scoglio del Corallo” (Argentario promontory, Tuscany)

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ABSTRACT

The Mediterranean nudibranch (Mollusca Gastropoda) fauna is part of complex communities belonging to the Mediterranean endemic “Coralligenous”. This important ecosystem shows a high species richness and functional diversity with assemblages of species tied together by major trophic and ecological relationships. A first check-list for the biodiversity hot spot “Scoglio del Corallo”, located along the coast of the Argentario promontory (Tuscany, Tyrrhenian Sea) is here reported.

KEY WORDS

Nudibranchs; biodiversity; check-list; Tyrrhenian Sea.

Received 28.01.2016; accepted 27.02.2016; printed 30.03.2016

Proceedings of the Ninth Malacological Pontine Meeting, October 3rd-4th, 2015 - San Felice Circeo, Italy

INTRODUCTION

Nudibranchs are molluscs brightly coloured and frequently photographed by Scuba diver amateurs, since these sea slugs can be found in most coastal areas of the world, from polar to tropical waters. The most Nudibranchia diversity is known for shallow waters, ranging 0–30 m depth, but deep-sea research is unravelling high levels of previously unknown diversity of these molluscs at high depths too (Valdés, 2008; Oskars et al., 2015). The Mediterranean nudibranch diversity to date is of about 270 species, according to more recent checklists (Öztürk et al., 2014; Trainito & Doneddu, 2014), regional faunal catalogues and Internet forum (WoRMS, Sea-slug forum). Although Mediterranean nudibranch species richness is smaller than that of the Indo-Pacific biogeographic region or the Caribbean Sea (Atlantic Ocean), the Mediterranean fauna has a high level of endemic diversity. Their scarce

mobility in some cases leads them to live their entire life cycle associated to their trophic source and this is the reason why they are deeply related to the most important endemic habitats of the semi-closed Mediterranean Sea. In fact, they are common inhabitants of the Mediterranean benthic ecosystem defined as “Coralligenous” (Ballesteros, 2006), where they livefeeding on a broad range of different substrates (Sponges, Cnidarians, Bryozoans, Tunicates and other sessile animals) (Gutiérrez, 2015). These complex communities are composed of a wide variety of suspension feeders, exhibiting high species richness and functional diversity (Gili & Coma, 1998). Recent molecular studies (e.g., Schrödl et al., 2011; Zapata et al., 2014) have proposed a new classification on the base of the polyphyly showed by this group that nowadays is split into 3 different Suborders (WoRMS: Gofas, 2015). This work aims to produce the first comprehensive catalogue of the nudibranchs for the Biodiversity Journal.

iversity hot spot “Scoglio del Corallo”, located along the coast of the Argentario Promontory (Tuscany, Tyrrhenian Sea) (Figs. 1–3), based on a fieldwork carried out by the authors in the last two years. An annotated Nudibranch checklist is produced discussing taxonomic problems and new ecological data (association with other organisms, parasitism, cryptic species and geographical distribution) whenever relevant. Each species observed has been photographed in field and ecological and distribution data are provided for all species recorded.

MATERIAL AND METHODS

Sampling area

“Scoglio del Corallo” is an underwater rocky habitat located in the in National Park of “Arcipelago Toscano” (42°23’60.00”N, 11°5’30.00”E, Central Tyrrhenian Sea). This submarine formation outcrops just for a few centimetres (depending on the marine tide) from the surface and slopes down vertically to a depth of 35 meters (Figs. 3, 4). The most relevant inhabitant of this area is the Octocoral *Corallium rubrum* (Linnaeus, 1758) (Cnidarian), a Mediterranean endemic species included in several European and International protocols for conservation, like the FAO General Fisheries Commission for the Mediterranean (GFCM) and the Convention on International Trade in Endangered Species (CITES). The presence of *C. rubrum* seems to be closely related to the high level of biodiversity characteristic of this area (Gili & Coma, 1998) (Figs. 5–9). This site is very small in extent (about 500 m²), but nevertheless characterized by a set of rocks and walls forming canyons, caves and platforms placed on a muddy substrate creating a lot of microhabitats where a conspicuous number of species live and reproduce (Fig. 5).

Protocol Sampling

Sampling took place between the years 2013 to 2015 as a part of a broader research project (“Project Baseline *Corallium rubrum*”, directed by the “Global Underwater Explorer” No-Profit Organization) aiming to produce the first characterization of this biota and of its associated biocoenoses. The produced preliminary data will become the starting



Figures 1–3. Study area. Location of the “Scoglio del Corallo” (“Arcipelago Toscano”, 42°23’60.00”N, 11°5’30.00”E, Central Tyrrhenian Sea) in the Mediterranean Sea.

point for monitoring future environmental changes and to evaluate possible conservation strategies. Materials were sampled using SCUBA diving techniques. Specimens were obtained by manual collecting, photographed and fixed for future DNA extraction and anatomical studies in 96 % ethanol. Some species were observed and photographed on their natural habitat during field campaigns, but not captured.

RESULTS AND DISCUSSION

For the first time a Nudibranchs catalogue from a Tyrrhenian Sea submarine hot spot of biodiversity is here provided. A total of 23 species of nudibranchs belonging to 9 different families were collected during the project. Among these, 4 are endemics of the Mediterranean Sea showing the importance of this Mediterranean coralligenous assemblage. All collected species coexist in this small area according to the high biodiversity showed by this hot spot marine site. The list of the sampled species is here reported, with notes on their ecology and distribution according to OPK-Opisthobranchis (Available from <http://opisthobranchis.info/en/>), Sea Slug Forum (Australian Museum, Sydney, Available from <http://www.seaslugforum.net/>), World Register of Marine Species (WoRMS, Available from <http://www.marinespecies.org> at VLIZ), “*Sea slug of the Algarve*” (Calado & Silva, 2012), “*Nudibranchi del Mediterraneo*” (Trainito & Doneddu, 2014) and personal underwater observations.

Phylum MOLLUSCA
Classis GASTROPODA
Subclass HETEROBRANCHIA
Infraclass OPISTHOBRANCHIA
Order NUDIBRANCHIA
Suborder DEXIARCHIA
Infraorder CLADOBRANCHIA
Parvorder AEOLIDIDA

Familia FACELINIDAE Bergh, 1889
Genus *Cratena* Bergh, 1864

1. *Cratena peregrina* (Gmelin, 1791) (Fig. 10)

ECOLOGY. This species commonly feeds on hydroids of the genus *Eudendrium* Ehrenberg, 1834

on which it usually lays eggs. *Cratena peregrina* lives between a few meters from the surface till about 50 meters depth.

DISTRIBUTION. It has been found from Western to Eastern basin of the Mediterranean Sea, in the Portuguese and Andalusian Atlantic coasts and in the Canary Islands. It was also informally recorded from Senegal, South Africa, India and in Western Atlantic.

Genus *Facelina* Alder et Hancock, 1855

2. *Facelina annulicornis* (Chamisso et Eysenhardt, 1821) (Fig. 11)

ECOLOGY. This species has a varied diet consisting on different genera of Hydrozoans: *Eudendrium* Ehrenberg, 1834, *Obelia* Péron et Lesueur, 1810, *Pennaria* Goldfuss, 1820 and *Tubularia* Linnaeus, 1758.

DISTRIBUTION. WoRMS (2015) recorded it from Mediterranean Sea and Atlantic Ocean (Ireland, United Kingdom, Azores, Portugal). The recent work of Öztürk et al. (2014) expands its distribution range to the Turkish coasts of Aegean Sea.

3. *Facelina rubrovittata* (Costa A., 1866) (Fig. 12)

ECOLOGY. The few pictures of this rare nudibranch often show it staying on algae substratum. On the diet of *F. rubrovittata* little is known but it seems to feed on hydrozoans as well as most of the aeolids do.

DISTRIBUTION. It is distributed from the whole Mediterranean Sea till the Atlantic coasts of Spain.

Familia FLABELLINIDAE Bergh, 1889
Genus *Calmella* Eliot, 1910

4. *Calmella cavolini* (Vérany, 1846) (Figs. 13, 14)

ECOLOGY. This aeolid species usually feeds on *Halecium pusillum* Sars, 1856 and *Eudendrium racemosum* (Cavolini, 1785) but can be found on different substrates. This small nudibranch can be easily misidentified with the sibling species *Piseinotecus gaditanus* Cervera, García-Gómez et García, 1987 from which it can be recognized by the absence, on its cerata, of the little white spots typical of *P. gaditanus*. Interestingly we could observe some individuals (Fig. 14) with very few

white dots, whose identification needs possibly a DNA barcoding approach.

DISTRIBUTION. This endemic species originally was found only in the western coast of Mediterranean Sea but on the base of recent records its distribution range now includes also the Turkish coasts and the Atlantic coast of the Iberian Peninsula.

Genus *Flabellina* Gray, 1833

5. *Flabellina affinis* (Gmelin, 1791) (Fig. 15)

ECOLOGY. *Flabellina affinis* is a very common species present all year long often feeding on colonies of *Eudendrium* spp. and belongs to the complex of the ‘pink Flabellinidae species’, see below *F. ischitana* and *F. pedata*. This species usually coexists in the same arborescent hydrozoan colony with *C. peregrina* and can be parasitized by Copepods of the family Splanchnotrophidae, whose eggs often can be seen extruding from the notum of the host.

DISTRIBUTION. This is one of the most common European species ranging it from the eastern coast of Mediterranean Sea to the Atlantic basin of Spain and Portugal and in the Canarias islands.

6 *Flabellina babai* Schmekel, 1972 (Fig. 16)

ECOLOGY. This species shows a large body size atypical for a common ‘Flabellinid’. It can be found easily on different substrates mostly on hydroids of the genus *Campanularia* Lamarck, 1816, *Eudendrium* Ehrenberg, 1834 and *Bougainvillea* Lesson, 1830, but is still unclear if it feeds on them.

DISTRIBUTION. This species has been recorded throughout the Mediterranean Sea and also in Senegal.

7. *Flabellina ischitana* Hirano et Thompson, 1990 (Fig. 17)

ECOLOGY. This species feeds on two different species of athecate hydrozoans of the genus *Eudendrium*, i.e. *E. racemosum* (Cavolini, 1785) and *E. glomeratum* Picard, 1952 often coexisting with *F. affinis*. They are morphologically very similar and easily confused with each other and, as mentioned above, both belong to the complex of the ‘pink Flabellinidae species’.

DISTRIBUTION. Its distribution overlap with the geographical range of *F. affinis* going from eastern basin of Mediterranean sea to the Atlantic coast of Iberian peninsula.

8. *Flabellina lineata* (Lovén, 1846) (Fig. 18)

ECOLOGY. Mediterranean specimens of this ‘Flabellinid’ usually feed on *Eudendrium* spp. while the extra-Mediterranean individuals were observed on different species of hydroids like *Tubularia indivisa* Linnaeus, 1758, *Coryne eximia* Allman, 1859, *Hydrallmania falcata* (Linnaeus, 1758) and *Sertularia argentea* Linnaeus, 1758.

DISTRIBUTION. This species is distributed in the Atlantic Ocean, from the Arctic Circle to the French Atlantic coast, and in the European waters.

9. *Flabellina pedata* (Montagu, 1816) (Fig. 19)

ECOLOGY. *Flabellina pedata* also belongs to the complex of the ‘pink Flabellinidae species’, see above, being very similar to *F. affinis* and *F. ischitana* from which differs on the base of possessing single cerata, not clustered together on a single peduncles, and by a smoothed rhinophores. It feeds on athecate hydrozoans of genus *Eudendrium* (especially in the Mediterranean Sea), but also on sertularids of genus *Abietinaria* Kirchenpauer, 1884 and on the plumularid genus *Aglaophenia* Lamouroux, 1812. Recently was discover a new species of Flabellinid, *Flabellina albomaculata* Pola, Carmona, Calado et Cervera, 2014, very similar to *F. pedata* and easily confused with it.

DISTRIBUTION. This common Flabellinid is distributed from eastern basin of the Mediterranean Sea to the Strait of Gibraltar and in the Atlantic Ocean from the Azores to the North Atlantic Coast of Norway.

Parvorder CLADOBRANCHIA

Familia PROCTONOTIDAE Gray, 1853

Genus *Janolus* Bergh, 1884

10. *Janulus cristatus* (Delle Chiaje, 1841) (Fig. 20)

ECOLOGY. This species lives between 10 and 40 m deep on a rocky substrate. Usually it was associated to different Bryozoans on which *J. cristatus* seemed to feed on. *Alcyonidium gelatinosum* (Hud-

son) J.V. Lamouroux, *Bicellariella ciliata* (Linnaeus, 1758), *Bugulina avicularia* (Linnaeus, 1758), *B. flabellata* (Thompson in Gray, 1848), *B. turbinata* (Alder, 1857), *Bugula neritina* (Linnaeus, 1758) and species of genus *Cellaria* Ellis et Solander, 1786 were cited as a presumed preys.

DISTRIBUTION. It is commonly found throughout the Mediterranean Sea and in the North-eastern Atlantic Ocean from Norway to Morocco coasts.

Parvorder DENDRONOTIDA

Familia TRITONIIDAE Lamarck, 1809

Genus *Marionia* Vayssière, 1877

11. *Marionia blainvillea* (Risso, 1818) (Fig. 21)

ECOLOGY. It is recorded to feed on different preys like *Alcyonium acaule* Marion, 1878, *A. palmatum* Pallas, 1766, *Eunicella cavolinii* (Koch, 1887), *E. singularis* (Esper, 1791), *Eunicella* sp., *Leptogorgia sarmentosa* (Esper, 1789), *Paramuricea clavata* (Risso, 1826). The juveniles have different body colours; in particular they are completely white while the adults range in colour from a pale translucent orange to a deeper reddish brown with irregular white patches. They can be parasitized by Copepods like the ectoparasitic *Doridicola comai* Conradi, Megina et López-González, 2004 and the endoparasitic *Linaresia bouligandi* Stock, 1979 and *L. mammillifera* Zulueta, 1908.

DISTRIBUTION. Its geographical range goes from the whole Mediterranean Sea to the North-eastern and South-eastern Atlantic Ocean (Angola).

Genus *Tritonia* Cuvier, 1798

12. *Tritonia manicata* Deshayes, 1853 (Fig. 22)

ECOLOGY. This species lives in shallow and very bright waters between the rhizomes of *Posidonia oceanica* (Linnaeus) Delile, 1813 or on a rocky substrates where it can find a lot of Anthozoan (Cnidaria) species. The *Stoloniferous* group is the one on which *T. manicata* seems to feed on, in particular on genus *Cornularia* Lamarck, 1816 and *Clavularia* Greville, 1865.

DISTRIBUTION. Present along the coasts of the Mediterranean Sea and also recorded from coast of Morocco and North-Atlantic British islands.

13. *Tritonia striata* Haefelfinger, 1963 (Fig. 23)

ECOLOGY. This species lives in shallow waters on rocky substrates full of algae, sponges and cnidarians. It has been recorded to feed on the soft coral *Paralcyoniums pinulosum* Delle Chiaje, 1822.

DISTRIBUTION. *Tritonia striata* is known to be endemic of the Mediterranean Sea but recently it has been also recorded from the Gulf of Biscay in North Atlantic Ocean.

Suborder EUCTENIDIACEA

Infraorder DORIDACEA

Familia ONCHIDORIDIDAE Gray, 1827

Genus *Diaphorodoris* Iredale et O'Donoghue, 1923

14. *Diaphorodoris papillata* Portmann et Sandmeier, 1960 (Fig. 24)

ECOLOGY. It feeds on Bryozoans so it is often observed in habitats rich in algae and sessile invertebrate fauna.

DISTRIBUTION. This species is endemic of the Mediterranean Sea but recorded also from coasts of Portugal and Strait of Gibraltar.

15. *Diaphorodoris luteocincta* var. *alba* (M. Sars, 1870) (Fig. 25)

ECOLOGY. It is reported to feed on different bryozoans genus *Smittina* Norman, 1903, *Cellepora* Linnaeus, 1767 and *Crisia* Lamouroux, 1812. It can be found in a rock walls hosting bryozoans, scyaphilic algae, hydroids and sponges.

DISTRIBUTION. There are two different morphotypes referring to *D. luteocincta* var. *alba* and *D. luteocincta* var. *reticulata* on the base of a dorsal notum completely white (var. *alba*) or red coloured (var. *reticulata*). These two morpho variants share the same wide distribution inhabiting the Mediterranean Sea and North-Eastern Atlantic Ocean (Trainito & Doneddu, 2014).

Familia POLYCERIDAE Alder et Hancock, 1845

Genus *Polycera* Cuvier, 1816

16. *Polycera quadrilineata* (O. F. Müller, 1776) (Fig. 26)

ECOLOGY. Different species of Bryozoans were reported to be the substrate (possibly food) of the

P. quadrilineata. This species lives in a rocky habitats where is relatively common. This species is often parasitized by Copepod Crustaceans belonging to the genus *Splanchnotrophus* Hancock et Norman, 1863 with the injection of its eggs into the body tissues of its host.

DISTRIBUTION. This species is distributed in Western Europe from Iceland and Greenland to the entire Mediterranean Sea.

Familia CHROMODORIDIDAE Bergh, 1891
Genus *Felimare* Ev. Marcus et Er. Marcus, 1967

17. *Felimare fontandraui* (Pruvot-Fol, 1951) (Fig. 27)

ECOLOGY. *Felimare fontandraui* feeds on Sponges belonging to the genus *Dysidea* Johnston, 1842. This species can be found during all the year from the intertidal zone to about forty meters deep. It is very variable in colour morphs and some specimens can be misidentified with the sister species *Felimare tricolor* (Cantraine, 1835) from which can be recognized by the presents of a white basal spots on the rhinophores and other diagnostic characters.

DISTRIBUTION. Its distribution ranges from both the eastern and western Mediterranean basins to the North-eastern Atlantic coasts.

18. *Felimare picta* (Schultz in Philippi, 1836) (Fig. 28)

ECOLOGY. This species feeds on different sponges like species belonging to genus *Ircinia* Nardo, 1833, *Crella* Gray, 1867 and *Dysidea* Johnston, 1842. This common species lives on rocky substrate and shows different colour morphotypes described in the past like different subspecies.

DISTRIBUTION. *Felimare picta* has a wide spread distribution. It lives from the western coast of the Atlantic Ocean, Brazil and Florida, to the eastern Atlantic, Spanish and African coast as well and in the entire Mediterranean Sea.

19. *Felimare tricolor* (Cantraine, 1835) (Fig. 29)

ECOLOGY. *Felimare tricolor* lives in rocky substrates from intertidal zone to about hundred meters deep. It feeds on different genera of sponges; *Dysidea* Johnston, 1842, *Scalarispongia* Cook et Bergquist, 2000 and *Spongia* Linnaeus, 1759.

DISTRIBUTION. This common species is distributed in the Mediterranean Sea and in the North-eastern Atlantic Ocean.

Genus *Felimida* Ev. Marcus, 1971

20 *Felimida krohni* (Vérany, 1846) (Fig. 30)

ECOLOGY. This species has a morphology similar to the sister species *Felimida britoi* (Ortea & Pérez, 1983), from which can be recognized by differences in the shape of the rhinophores and the mantle colour pattern. Its bathymetric range goes from subtidal zone down to 50 meters depth where it lives on different sponges like *Hymeniacidon perlevis* (Montagu, 1814) and species of genus *Ircinia* Nardo, 1833. Its diet is still not clear.

DISTRIBUTION. The distribution of this species goes from the eastern basin of the Mediterranean Sea to the Strait of Gibraltar. It lives also in the North eastern Atlantic Ocean from Canary Islands and north coasts of Africa to the Atlantic coasts of Spain and France.

21. *Felimida luteorosea* (Rapp, 1827) (Fig. 31)

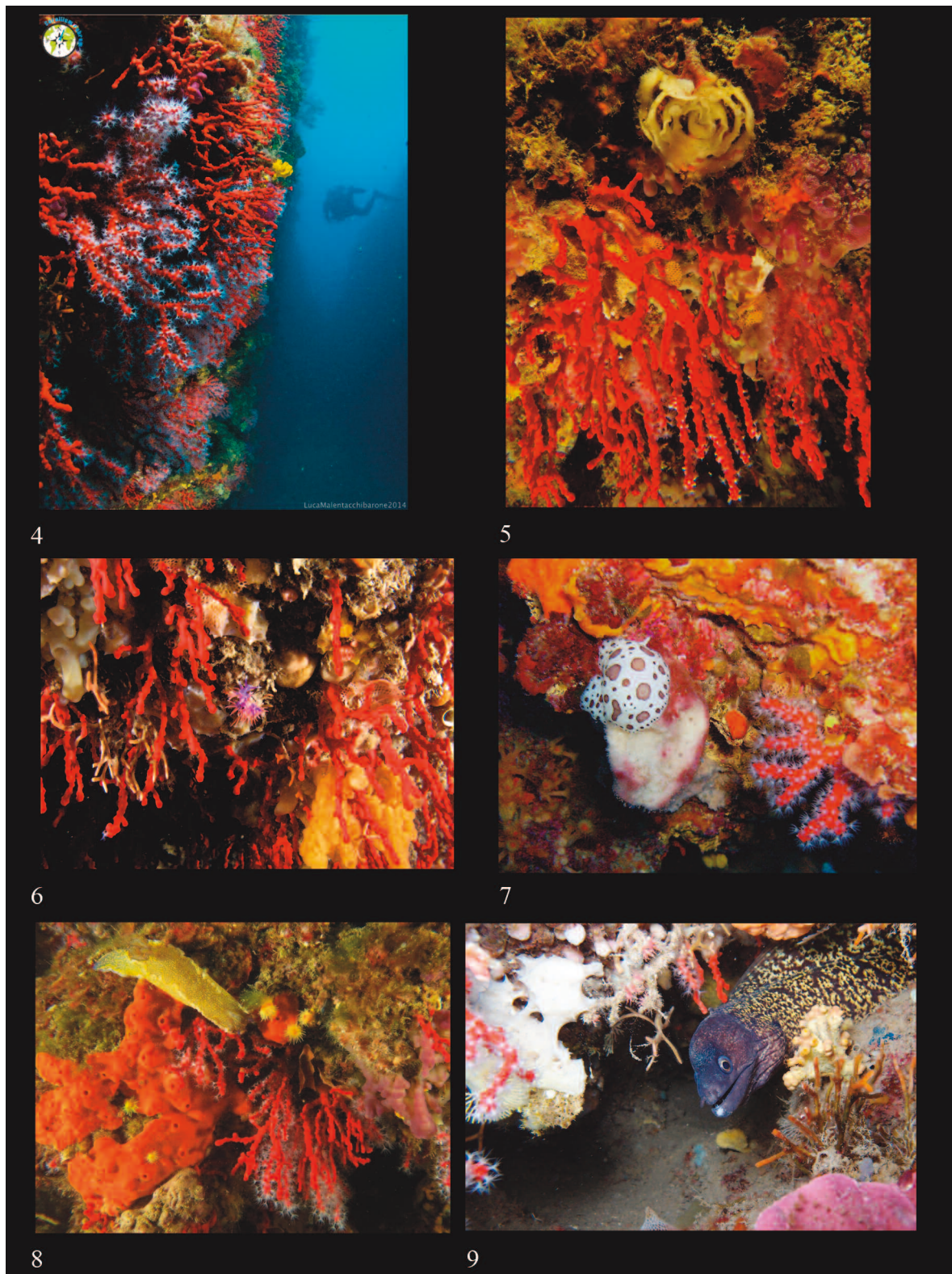
ECOLOGY. It lives under stones and on illuminated precoralligenous walls from 10 to 50 meters deep. It is reported to feeds on sponges like *Aplysilla rosea* (Barrois, 1876) and *Spongionella pulchella* (Sowerby, 1804).

DISTRIBUTION. It is distributed in the Mediterranean Sea and in the North Atlantic Ocean from the north coast of France and Spain to Angola and Canary islands.

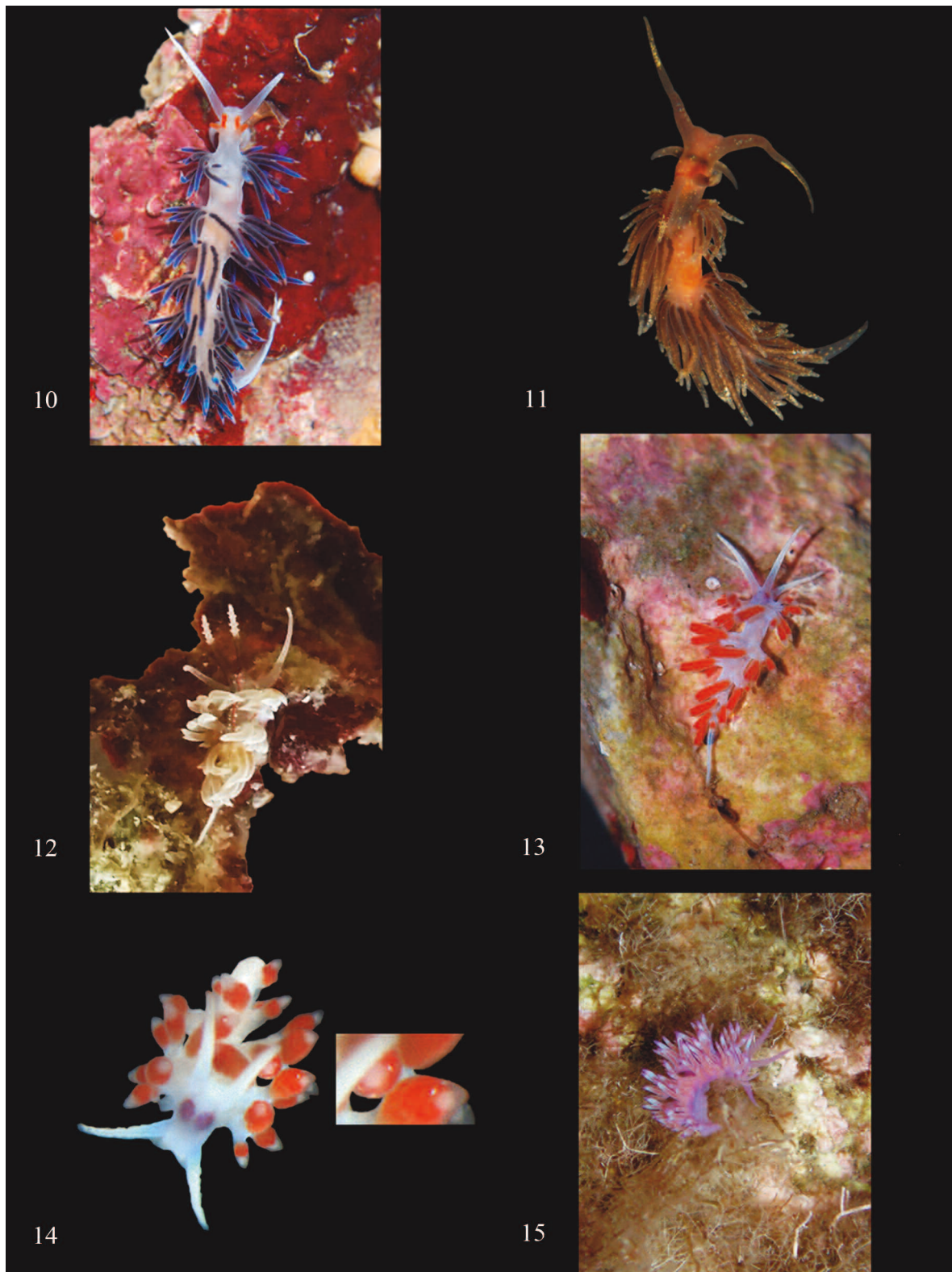
Familia DISCODORIDAE Bergh, 1891
Genus *Peltodoris* Bergh, 1880

22. *Peltodoris atromaculata* Bergh, 1880 (Fig. 32)

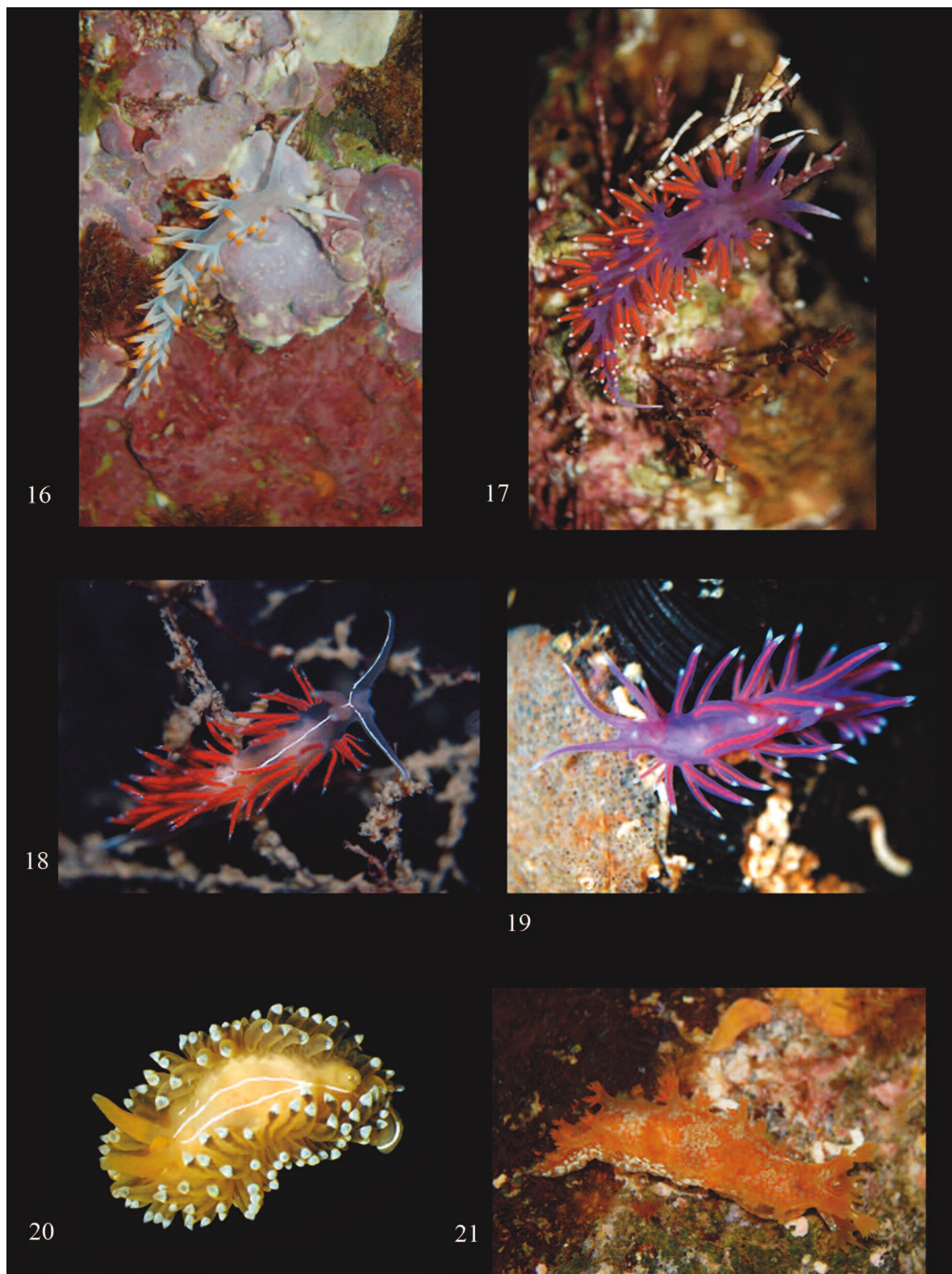
ECOLOGY. This common nudibranch lives on rocky bottoms usually associated to its prey, the sponge *Petrosia* (*Petrosia*) *ficiformis* (Poirlet, 1789). It is extremely abundant in the coralligenous where it lives searching for its food or staying on it. This sea slug is very sedentary so it can be found on the same sponge for different days.



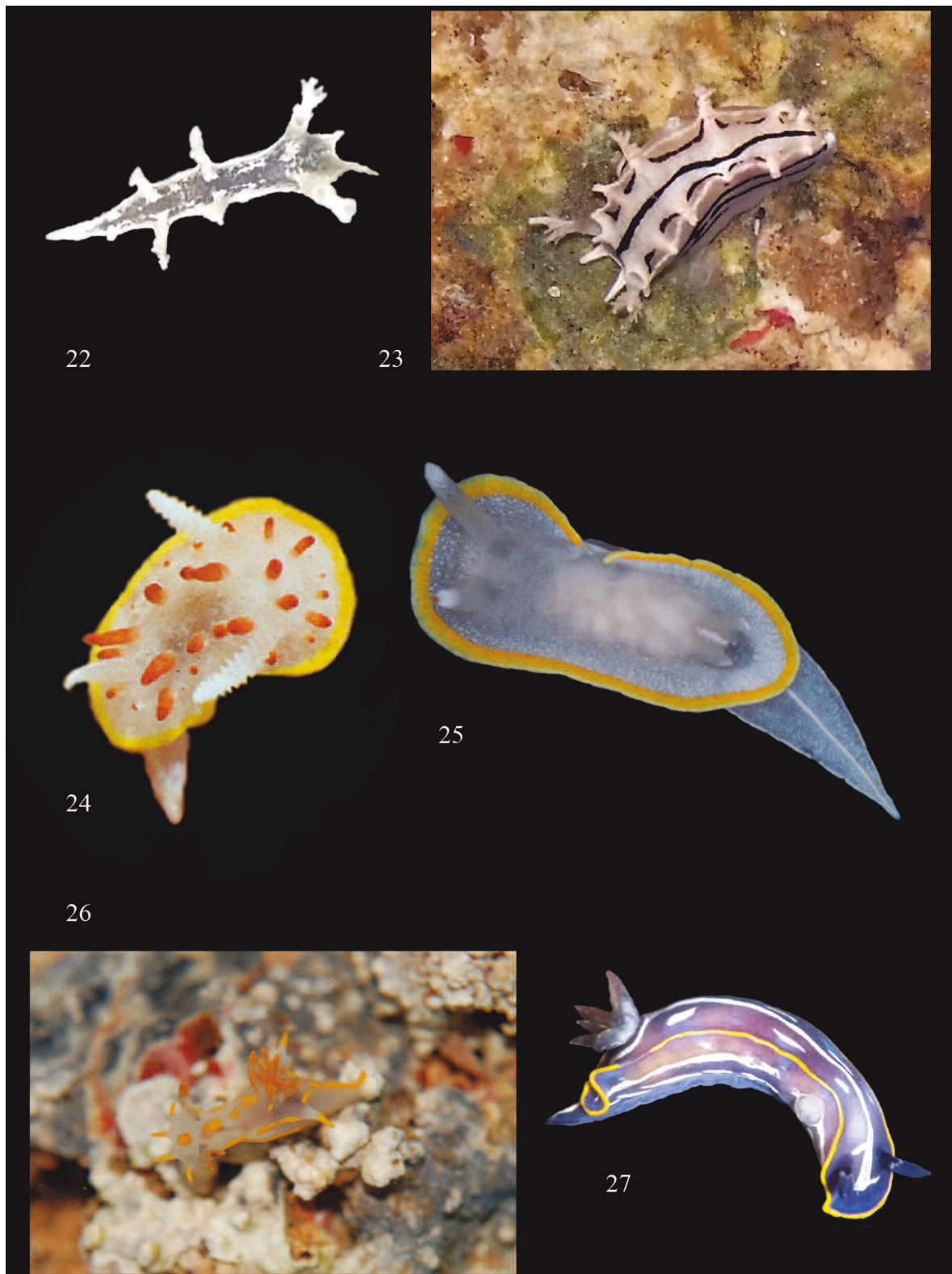
Figures 4–9. Underwater photographs of the “Scoglio del Corallo”, showing the *Corallium rubrum* assemblages.



Figures 10–15. Fig. 10: *Cratena peregrina* (Gmelin, 1791). Fig. 11: *Facelina annulicornis* (Chamisso et Eysenhardt, 1821). Fig. 12: *Facelina rubrovittata* (Costa A., 1866). Figs. 13,14: *Calmella cavolini* (Vérany, 1846). Fig. 15: *Flabellina affinis* (Gmelin, 1791).



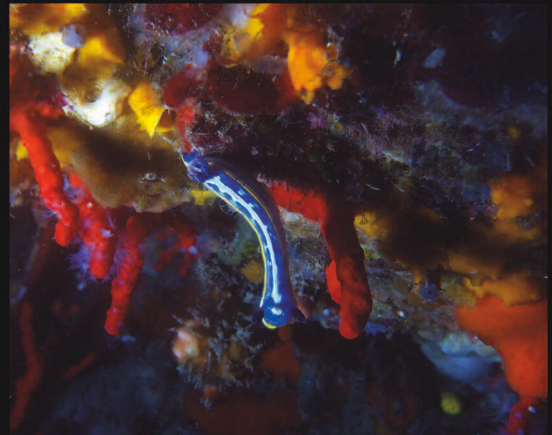
Figures 16–21. Fig. 16: *Flabellina babai* Schmekel, 1972. Fig. 17. *Flabellina ischitana* Hirano et Thompson, 1990. Fig. 18. *Flabellina lineata* (Lovén, 1846). Fig. 19: *Flabellina pedata* (Montagu, 1816). Fig. 20: *Janulus cristatus* (Delle Chiaje, 1841). Fig. 21: *Marionia blainvillea* (Risso, 1818).



Figures 22–27. Fig. 22: *Tritonia manicata* Deshayes, 1853. Fig. 23: *Tritonia striata* Haefelfinger, 1963. Fig. 24: *Diaphorodoris papillata* Portmann et Sandmeier, 1960. Fig. 25: *Diaphorodoris luteocincta* var. *alba* (M. Sars, 1870). Fig. 26: *Polycera quadrilineata* (O. F. Müller, 1776). Fig. 27: *Felimare fontandraui* (Pruvot-Fol, 1951).



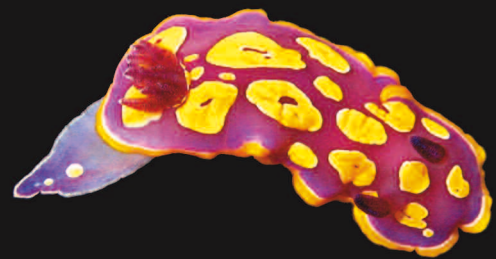
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Figures 28–33. Fig. 28: *Felimare picta* (Schultz in Philippi, 1836). Fig. 29: *Felimare tricolor* (Cantraine, 1835). Fig. 30: *Felimida krohni* (Vérany, 1846). Fig. 31: *Felimida luteorosea* (Rapp, 1827). Fig. 32: *Peltodoris atromaculata* Bergh, 1880. Fig. 33: *Phyllidia flava* Aradas, 1847.

DISTRIBUTION. This is one of the most common species of the Mediterranean Sea. It is also recorded from Western Atlantic Ocean from Portuguese coasts to Canary Islands.

Familia PHYLLIDIIDAE Rafinesque, 1814
Genus *Phyllidia* Cuvier, 1797

23. *Phyllidia flava* Aradas, 1847 (Fig. 33)

ECOLOGY. This interesting sea slug has a characteristic body colour that can camouflage it when it is associated to sponges like *Axinella cannabina* (Esper, 1794), *A. polypoides* Schmidt, 1862 and *Acanthella acuta* Schmidt, 1862. It has been known to feed on the latter sponge.

DISTRIBUTION. This species is rare and distributed throughout the Mediterranean Sea, it has been also recorded from the Canary Islands.

ACKNOWLEDGEMENT

The authors gratefully acknowledge the GUE instructor Luca Malentacchi (Arezzo, Italy), the “Project Baseline *Corallium rubrum*” manager, for its help during sampling and monitoring and for providing underwater photographs and videos. Thanks to the big community of volunteers that work for “Project Baseline *Corallium rubrum*”. We are indebted to Monica Valdambrini (Arezzo, Italy), Massimiliano Falleri, Massimiliano Orsi and Gianluca Cireddu (Rome, Italy, Italy) for providing underwater photographs. We thank people from “Gruppo Malacologico Mediterraneo” (Rome, Italy) for their assistance during samplings. GF and PM wish to thank the University of Roma Tre for financial funding.

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