

SUBLITTORAL NUDIBRANCH MOLLUSCA (SEA SLUGS) IN PEMBROKESHIRE WATERS

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INTRODUCTION

FOR more than twenty-five years the marine biological work from Dale Fort, Pembrokeshire, at the south-western tip of Wales, has concentrated on the intertidal plants and animals and has been summarized in the fauna list published by Crothers (1966), the algal list of Jones & Williams (1966) and by Nelson-Smith (1967).

Until recently sublittoral organisms were accessible only through rather crude sampling by dredge and net. Increased use of aqualungs has facilitated direct sublittoral observation, measurement and collection and has produced many additions to the marine fauna and flora lists.

Particular attention has been paid to the nudibranch sea-slugs, and this paper lists and provides descriptions of those species found on rock bottoms around the Dale peninsula and Skomer.

The molluscan order Nudibranchia includes animals capable of graceful swimming, passive floating in the plankton layers, creeping over hard rock surfaces or along delicate hydroid stems, and burrowing into sand or mud. The colour patterns of many are more vivid and varied than any coral fish and their forms are marvelously diverse. Those nudibranchs which thrive in the harsh, changing environment of the shore tend to be tough, unspectacular species. The most striking species are by no means limited to tropical waters; more than ninety species live around Britain, of which almost half have been found around Dale and Skomer. Several included in this paper have never before been recorded from Wales, including *Discodoris planata*, *Doris maculata*, *Crimora papillata*, *Grailada elegans*, *Polycera faeroensis*, *Okenia elegans*, *Facelina annulicornis* and one, *Favorinus brianus*, was new to science (Lemche & Thompson, 1974).

The diversity of form, colour and ecology in the Nudibranchia provides interesting study. The original, secretive, burrowing, strong-shelled species (for example, *Acteon*) have at several points in their evolutionary history, reduced or completely lost the shell to become active, naked, brightly-coloured sea-slugs. Whilst many of the typical marine snails (prosobranchs) have remained virtually unchanged for millions of years, (the most primitive of the existing gastropods, the slit-shells (the zeugobranchia), appeared in the late Upper Cambrian (Yonge, 1973)), the loss of the restrictive shell has enabled the plasticity of the molluscan body to be exploited and many more ecological niches to be occupied.

Within the Nudibranchia two body forms have proved particularly successful. The dorids (Fig. 1) are broad-footed and low-profiled, with delicate organs of smell (rhinophores) and gills retractable beneath a tough mantle. The eolid form (Fig. 2)

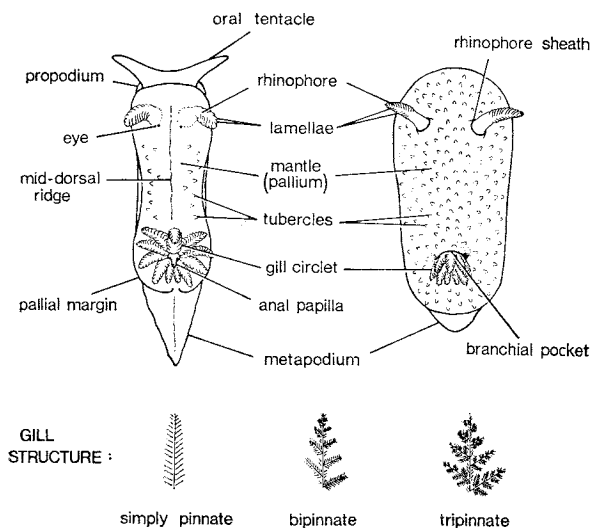


FIG. 1.

is narrow-footed with numerous dorsal projections (cerata), which are also found in unrelated sea-slugs and even some dorids.

Defence is of paramount importance for a shell-less soft-bodied mollusc moving over the sessile organisms of the sea bed. The colours of many sea-slugs, particularly the dorids, seem to be advertising their existence. Some bear what can only be understood as warning colours which are associated with glands producing distasteful, sometimes strongly acidic secretions (Thompson, 1969). Others may be mimicking species more distasteful than themselves. In many species the delicate, unprotected projections, i.e. rhinophores, oral tentacles and the posterior tip of the foot, are the same colour as, in colids, the cerata which contain stinging cells (nematocysts) derived from their hydroid prey, and as the finger-like dorsal projections containing glands in some dorids. Presumably the vulnerable projections cannot be distinguished by a predator; cerata or protective projections can soon be regenerated and so their

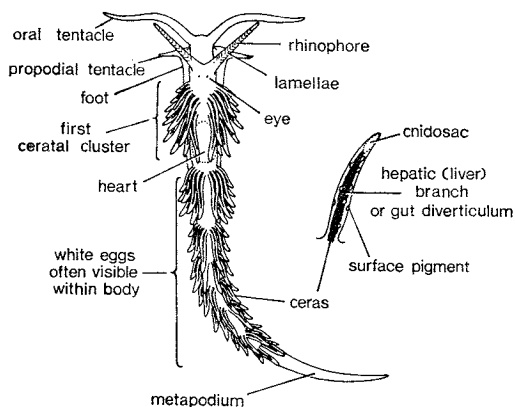


FIG. 2.

loss is no real threat to the continued life of the animal. Many species are cryptically coloured, their bodies matching the colour of their habitat or the prey upon which they live and feed. For example, the bright red *Rostanga rubra* feeds on an equally bright red sponge; *Tritonia hombergi* feeds on *Alcyonium digitatum* (Dead-man's fingers); *Glaucus atlanticus* is counter-shaded, blue ventrally, white dorsally, and lives upside down at the ocean surface.

All nudibranchs are carnivorous, some voraciously so, such as *Facelina annulicornis* which is said to approach its prey with a clicking of the jaws (Alder & Hancock, 1845–55). Others graze sedately over sponges or sea-mats (Polyzoa).

ACCOUNT OF THE AREA

The survey area extends south-eastwards from Skomer and Martins Haven to the mouth of Milford Haven (Fig. 3).

Edwards (1963) includes a geological map of Pembrokeshire. Oliver (1959) describes the local climate. Tidal data, the effects of wind and wave action, and information on salinity, turbidity and water temperature are summarized and discussed for Milford Haven by Nelson-Smith (1965). Full bibliographies are cited by Crothers (1966).

THE SAMPLES

The present account is based on forty-one underwater searches specifically for sublittoral molluscs during 1972 (July to September) and 1973 (May to September). Other specimens were collected incidentally during marine biology field courses.

The majority of samples were obtained by two divers working for twenty to thirty minutes along arbitrary transects of the sea bed, searching carefully amongst the sessile organisms which cover the rock surfaces—notably sponges, cnidarians, polyzoans, barnacles and ascidians—and in the brown and red algae in shallower water. Specimens, together with samples of the cover organisms, were removed by hand into a collecting jar or polythene bag. In the laboratory the cover organisms were examined for further specimens and all molluscs identified and counted.

The forty-one samples were from twelve distinct areas, for which the location, depth of substrate and current rate and direction are shown on the map (Fig. 3). The species are listed in Table 1, and for each species an indication of the number of specimens recorded in each area is given.

DESCRIPTIONS

Descriptions are given of the total nudibranch fauna known from the Dale peninsula and associated islands. The drawings used in conjunction with the colour, size and diet notes will enable accurate identification of the specimens. Where applicable, the pseudonyms used by Alder & Hancock (1845–55) are given. The scale in each case represents the true size of the individual drawn, whilst the shaded area on each adjacent map shows the known distribution around Great Britain and Ireland. Although careful research into records compiled by the Conchological Society of Great Britain, together with personal finds and personally communicated records, are responsible for the maps as they stand, we recognize that they are undoubtedly incomplete. So we hope that divers and shore collectors will continue to provide information about collections in areas outside those shown for each species.

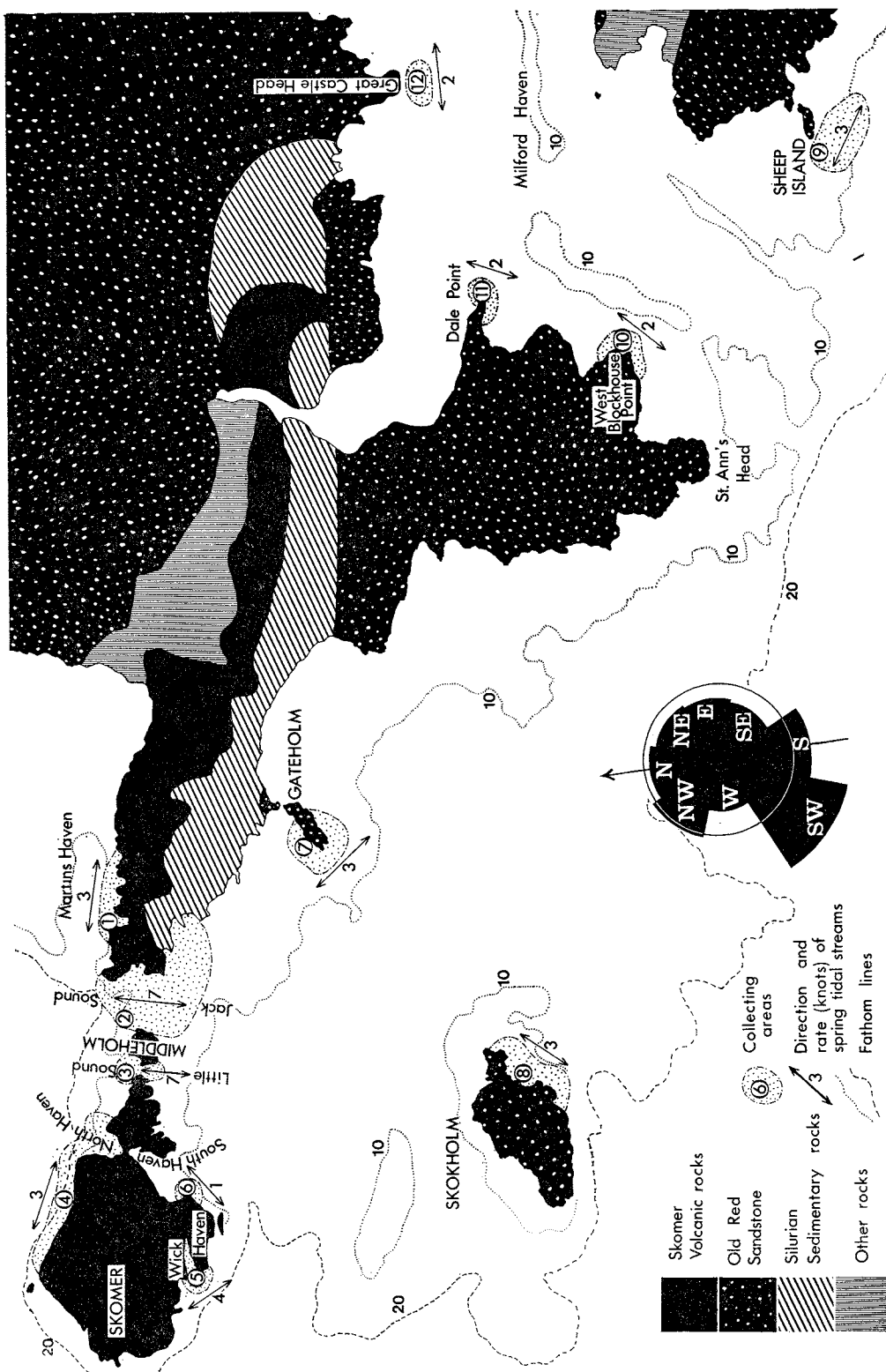


Table 1. *Nudibranch species found sublittorally on rocky substrates around Skomer and the Dale peninsula*

Collecting Areas

Species	1	2	3	4	5	6	7	8	9	10	11	12
<i>Tritonia hombergi</i>	++	++		++		++	++		+	+	+	
<i>Tritonia lineata</i>	++	++		++								
<i>Tritonia plebeia</i>	++	++	+	++					+	++		+
<i>Doto coronata</i>	++	++	++	++					++			
<i>Doto fragilis</i>	++	++	++	++					+			
<i>Doto pinnatifida</i>	++	++		++								
<i>Rostanga rubra</i>	++	++		++								
<i>Cadlina laevis</i>	++	++		++								
<i>Discodoris planata</i>	++	++		++								
<i>Archidoris pseudoargus</i>	++	++		++								
<i>Jorunna tomentosa</i>	++	++		++								
<i>Doris maculata</i>	++	++		++								
<i>Limacia clavigera</i>	++	++		++								
<i>Aegires punctilucens</i>	++	++		++								
<i>Crimora papillata</i>	++	++	+	++								
<i>Acanthodoris pilosa</i>	++	++	++	++					++			
<i>Goniiodoris nodosa</i>	++	++	++	++					++			
<i>Goniiodoris castanea</i>	++	++	++	++					++			
<i>Palio dubia</i>	++	++		++					++			
<i>Greilada elegans</i>	++	++		++					++			
<i>Polycera faeroensis</i>	++	++		++					++			
<i>Polycera quadrilineata</i>	++	++	++	++					++			
<i>Onchidoris bilamellata</i>	++	++	++	++					++			
<i>Onchidoris luteocincta</i>	++	++	++	++					++			
<i>Okenia elegans</i>	++	++		++					++			
<i>Ancula cristata</i>	++	++		++					++			
<i>Antipella cristata</i>	++	++		++					++			
<i>Favorinus bianus</i>	++	++		++					++			
<i>Facelina annulicornis</i>	++	++	++	++					++			
<i>Facelina coronata</i>	++	++	++	++					++			
<i>Facelina curta</i>	++	++	++	++					++			
<i>Coryphella pedata</i>	++	++	++	++					++			
<i>Eubranchius exiguus</i>	++	++	++	++					++			
<i>Eubranchius farrani</i>	++	++	++	++					++			
<i>Eubranchius tricolor</i>	++	++	++	++					++			
<i>Tergipes tergipes</i>	++	++	++	++					++			
<i>Carriona aurantia</i>	++	++	++	++					++			
<i>Aeolidia glauca</i>	++	++	++	++					++			
<i>Aeolidia papillosa</i>	++	++	++	++					++			

+ = fewer than 5 specimens found altogether

++ = 5 to 10 specimens found in most samples

+++ = over 10 specimens found in most samples

n/r = no location recorded although found sublittorally during the survey

DENDRONOTACEA (Figs. 4 and 5)

This sub-order is characterized by large trumpet-shaped rhinophore sheaths. The Dotoidae have paired branchiae along the pallial margin which are bulbous and easily lost due to the narrow, weak bases. They can be readily distinguished from the feathery gills of the Tritoniidae. The number of gills or branchiae varies with size in both families.

Tritonia hombergi Cuvier, 1803

The juveniles are translucent white with opaque white pigment on the dorsum but this dorsal colour changes to a dark purple-brown with age. The oral veil is large, white and bilobed with a papillate margin, and merges with the mantle which is rather bumpy. The rhinophores consist of a thick finger-like core from which numerous feathery branches originate. The gills are translucent white and found along the whole length of the mantle edge. Large "primary" gills with up to six branches reflex over the mantle in pairs, leaving the less branched "secondaries" to project laterally. This is the largest British nudibranch and can attain lengths of 20 cm. Diet: the soft coral, *Alcyonium digitatum*.

Distribution: western Europe from Norway to the Mediterranean.

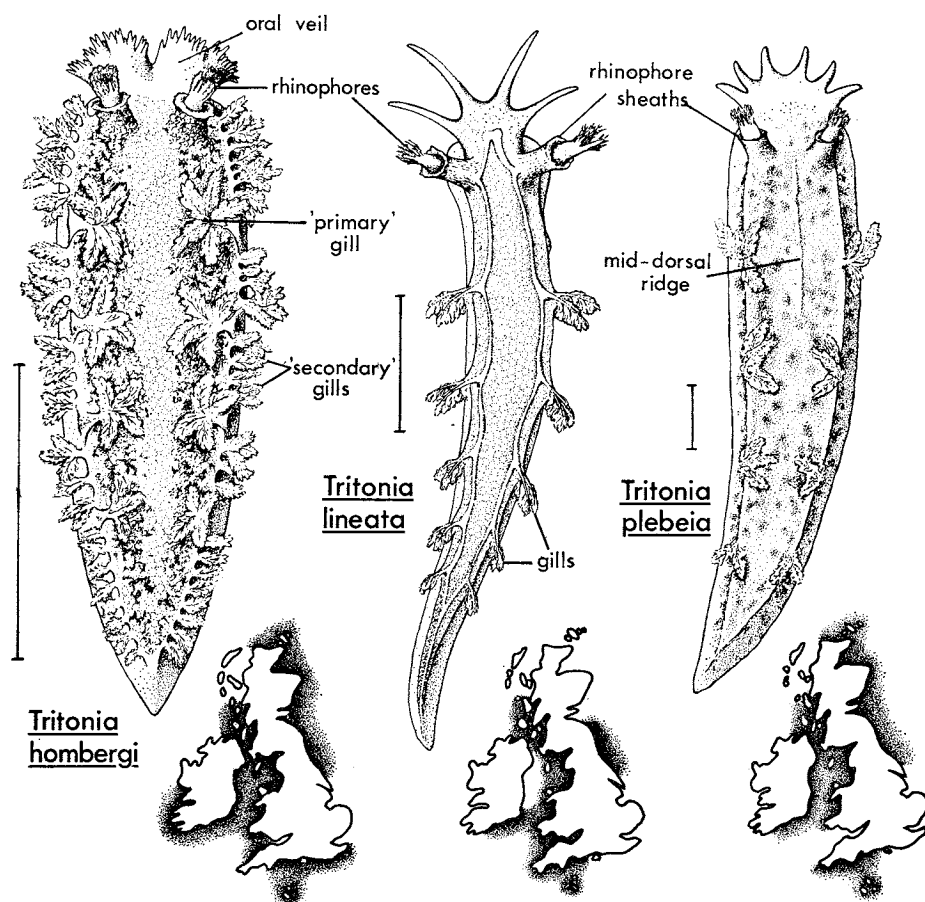


FIG. 4.

Tritonia lineata Alder & Hancock, 1848

This is a slender animal, basically white, with often a pink tinge from the internal organs. A brilliant opaque white line runs down either side of the dorsum, linking the rhinophores and the gills as shown, and penetrating the bases to some extent. The oral veil is produced into four tentacles, each one ending in white. The rhinophores are usually white but sometimes the branches from the finger-like core are tinged brown. Each of the paired white gills increases in size towards the head and consists of two main, branching stems. The translucent, slender foot is rounded anteriorly but terminates in a sharp point. Individuals up to 34 mm were found in Jack Sound in August, 1973, twice the length of any previous record.

Diet: uncertain. Has been found on the hydroid, *Kirchenpauria pinnata* and on gorgonians (sea fans).

Distribution: to 36 metres depth; western Europe as far south as Roscoff in France.

Tritonia plebeia Johnston, 1828

The body is white with light brown mottling over the dorsum and sides. The translucent, white oral veil is produced into six small tentacles and from this the head slopes steeply up to the sheathed and branched rhinophores. The mantle is slightly narrower than the foot, bearing an unobtrusive mid-dorsal ridge which tapers out before the second gill pair. These gills are translucent white and relatively more branched than is found in *T. lineata*. 16 mm is the largest recorded from around the British Isles but 30 mm specimens have been found around France.

Diet: soft corals, *Alcyonium digitatum*, *Paramuricea placomus* and the gorgonian *Eunicella verrucosa*.

Distribution: from Scandinavia along western Europe to the Mediterranean and Aegean.

Doto coronata (Gmelin, 1791)

The body is a translucent white with patches of crimson or maroon of varying size and density scattered over the body. It is clear of pigment around and between the bases of the branchiae although there is often a dark maroon streak in the centre of each branchial stem. The oral veil is expanded into distinct lateral lobes. The rhinophore sheaths have smooth, clear, expanded rims which slant upwards from the side nearest the mid-line. The rhinophores themselves are translucent white with streaks of white pigment. The smoothly rounded, fat papillae on the branchiae nearly always contain a maroon spot and similar maroon bodies are intermingled with opaque white bodies in the core. The largest recorded specimen was 15 mm from the Isle of Man (Miller, 1958).

Diet: a wide variety of hydroids.

Distribution: to 180 metres depth; N.E. America, Iceland, northern and western Europe and the Mediterranean.

Doto fragilis (Forbes, 1838)

The body varies from light to dark brown, larger specimens being darkest. Glistening white patches occur on the body, particularly on the dorsum and margins of the oral veil, which is expanded into lobes but less so than in *D. coronata*. The head region in front of the rhinophores is concave due to prominent white ridges on either side.

The rhinophore sheaths have smooth white expanded rims but otherwise are a darker brown than the smooth finger-like rhinophores themselves. The branchiae are reminiscent of fir-cones and appear dark brown in the crevices between the fleshy lobes, fading to light brown centrally. The lobes are either tight together as shown or more or less "opened out". The largest recorded specimen is 30 mm from County Dublin (Colgan, 1914).

Diet: hydroids, *Nemertesia antenna*, *N. ramosa*, *Halecium halecium*.

Distribution: to 200 metres depth; from Iceland and Norway down western Europe to the Mediterranean.

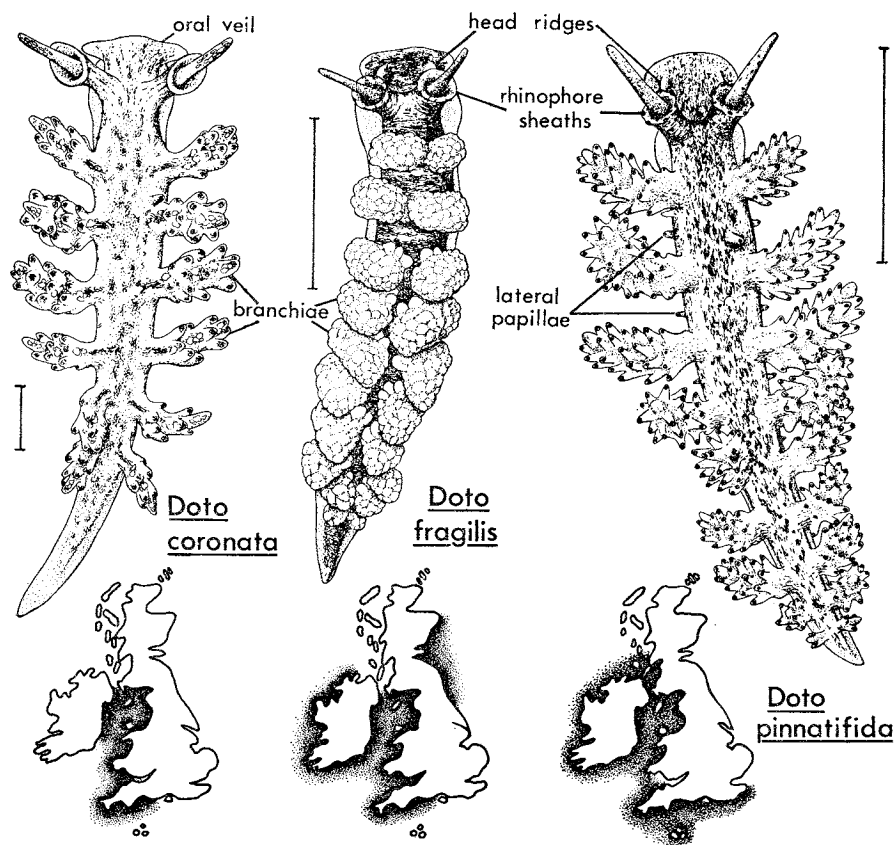


FIG. 5.

Doto pinnatifida (Montagu, 1804)

The body is pellucid white with pink viscera usually showing through. Black mottling to a greater or lesser extent covers the dorsum and sides but two clear strips are left around and between the branchial bases. The oral veil is smoothly rounded, not expanded into distinct lobes. The head region is concave due to the lateral ridges which are clear of pigment. Characteristically, a row of minute papillae is present along both lateral body surfaces beneath the branchial processes. The expanded rims of the rhinophore sheaths are bumpy, each undulation containing a black spot, whilst the rhinophores are pellucid white with a few white dots. The branchiae have

narrow bases but become much broader due to the delicate papillae arranged roughly in circlets around the central core. Nearly all the papillae have a black terminal spot. The largest specimen that has been recorded is 29 mm from Jack Sound in August, 1973.

Diet: the hydroid, *Nemertesia antennina*.

Distribution: to 65 metres depth; recorded only from New Hampshire and the Atlantic coast of France outside the British Isles.

DORIDACEA (Fig. 1)

In British forms a gill circlet is always present mid-dorsally towards the rear of the pallium (or mantle) which may be smooth, papillose, tuberculose, tentacular or covered by a variety of excrescences. The genital papilla is always found to the right, whilst the anal papilla is always near the centre of the gill circlet, i.e. mid-dorsal. Dorids are either cryptobranchiate (gills retractile; withdrawn into a common pocket beneath the mantle) or phanerobranchiate (gills contractile; withdrawn into separate pockets or merely capable of contraction but not into the body). This latter difference represents the distinction between two individual lines of evolution although convergence to the doridiform shape, i.e. wide mantle and foot, contractile rhinophores and gills, has resulted in some phanerobranches appearing very similar to cryptobranchiate forms, e.g. *Onchidoris*, *Acanthodoris*. Other phanerobranchiate dorids have forsaken these successful adaptations to become colourful, delicate animals with glandular protective processes.

Rostanga rubra (Risso, 1818)

Doris coccinea Forbes, 1848

The body colour is orange to scarlet with less obvious scattered black specks lying beneath the mass of microscopic caryophyllidia covering the mantle. Each of these structures consists of a blunt core within a sheath which expands terminally into several points; a few of them are yellow and these are found around and between the rhinophores. This cryptobranchiate dorid extends about 12 white, simply pinnate gills in an almost vertical circlet around the anal papilla. The short lamellate rhinophores are indented posteriorly and basically yellow with some red mottling. The foot is white. The largest was a 15 mm specimen from Bergen, Norway, recorded by Loyning in 1927.

Diet: sponges, *Microciona atrasanguinea* and probably *Ophilitaspongia seriata* (Thompson, 1964).

Distribution: Norway, the Atlantic coast of France, Portugal and possibly the Mediterranean.

Cadlina laevis (L. 1767)

Doris repanda Alder & Hancock, 1842

Both the body and foot are translucent white. The mantle surface is bumpy, each undulation having a more opaque white (rarely yellow) core, while towards the margin lie several larger yellowish glistening bodies which are in fact glands on the underside showing through. Very occasionally the margin to the mantle and foot is yellow. The lamellate rhinophores are translucent white as is the small circlet of bi- or tripinnate gills, sometimes bearing yellow tips. Up to six branchiae have been

counted in large specimens of this cryptobranchiate nudibranch. It is the only nudibranch which avoids any larval stage by direct development, perhaps facilitating its ability to live constantly in sub-zero temperatures around eastern Greenland. The largest recorded was a 32 mm specimen from St. Mary's I, Northumberland in September, 1973. Diet: a white sponge, *Stylotella columella*.

Distribution: to 810 metres depth; Greenland and Iceland, western Europe and the Mediterranean. Also reported from the Gulf of Mexico and the Pacific coasts of Central America.

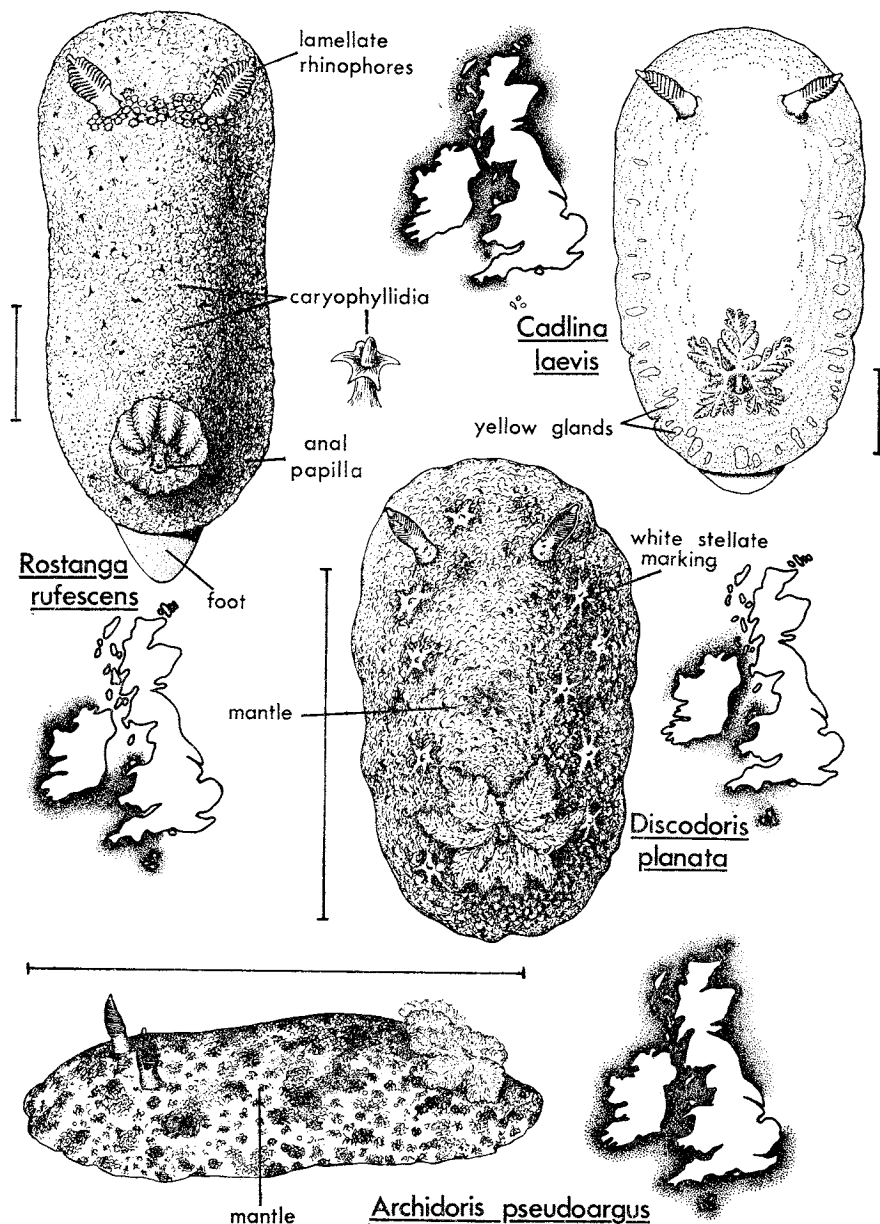


FIG. 6.

Discodoris planata (Alder & Hancock, 1846)

Doris planata Alder & Hancock, 1846

This rare dorid is like darker specimens of *Archidoris pseudoargus*. However, close scrutiny reveals distinguishing white stellate markings on the dorsum and small oral tentacles visible ventrally. Also there is a greater predominance of reddish-brown pigment in the mottling of the mantle, which is a mass of minute tubercles, a slightly larger one being situated in the centre of each stellate marking. Strong acid is secreted all over the mantle surface. The lamellate rhinophores are mottled with dark brown pigment. The white, tripinnate gills, up to 10 in number, are relatively less expansive than those in *Archidoris pseudoargus* although it is similarly cryptobranchiate. Specimens have been found up to 65 mm long.

Diet: sponge, *Hemimycale columella* (Thompson, 1964).

Distribution: to 80 metres depth; along the western coasts of Europe to the Mediterranean.

Archidoris pseudoargus (Rapp, 1827)

Doris tuberculata Müller, 1778

This commonest of shore nudibranchs around Britain is tough and hardy, able to withstand low salinities down to 22–20 per cent (Swennen, 1961). The finely tuberculate mantle is usually a mottled pattern of yellows, browns and reds with yellow often predominating. Smaller specimens tend to be paler, even white. The broad foot is yellow, as are the lamellate rhinophores. Large, white, tripinnate gills overlap the mantle margin when fully extended. The 8 or 9 gills are hard to separate visually in this cryptobranchiate dorid. It is not unusual to find specimens up to 12 cm in length.

Diet: sponges, *Grantia compressa*, *Halichondria panicea*, *Hymeniacidon perleve*, (juveniles feed on *Myxilla incrustans*, *Esperella aegagropila*, *Tethya aurantia*) (Thompson, 1964).

Distribution: shore and shallow waters from Iceland, western Europe and the Mediterranean. Also the Gulf of Mexico.

Jorunna tomentosa (Cuvier, 1804)

Doris johnstoni Alder & Hancock, 1845

The mantle colour is variable but larger specimens are usually an uneven yellowish brown, the smaller being whiter. Characteristically, always about 8 dark brown spots are widely spaced on the dorsum. The mantle surface is composed of countless minute caryophyllidia (see *Rostanga rubra*). The short, finely lamellate, white rhinophores are speckled with brown becoming denser towards the blunt tips. This cryptobranchiate dorid has about 11 tripinnate, white gills. Specimens have been found up to 55 mm long.

Diet: the sponge, *Halichondria panicea*.

Distribution: to 420 metres depth; the Faeroes, Scandinavia, Atlantic and Mediterranean coasts of France, Senegal and possibly Hawaii.

Doris maculata Garstang, 1896

Both mantle and foot of this very rare dorid are yellow. Numerous stumpy papillae with purple crests, connected by ridges, are scattered over the dorsum, the larger

being situated near the mid-line. Always a ring of small papillae (with purple crests) surround the gill pocket and there are usually two large papillae lateral to each pocket containing a short, finely lamellate, yellow rhinophore. It is a crypto-branchiate dorid with 5 bi- or tripinnate, white gills. The largest recorded was 45 mm from Martins Haven in June, 1973.

Diet: unknown.

Distribution: outside Britain it is known only from Guernsey and the Mediterranean.

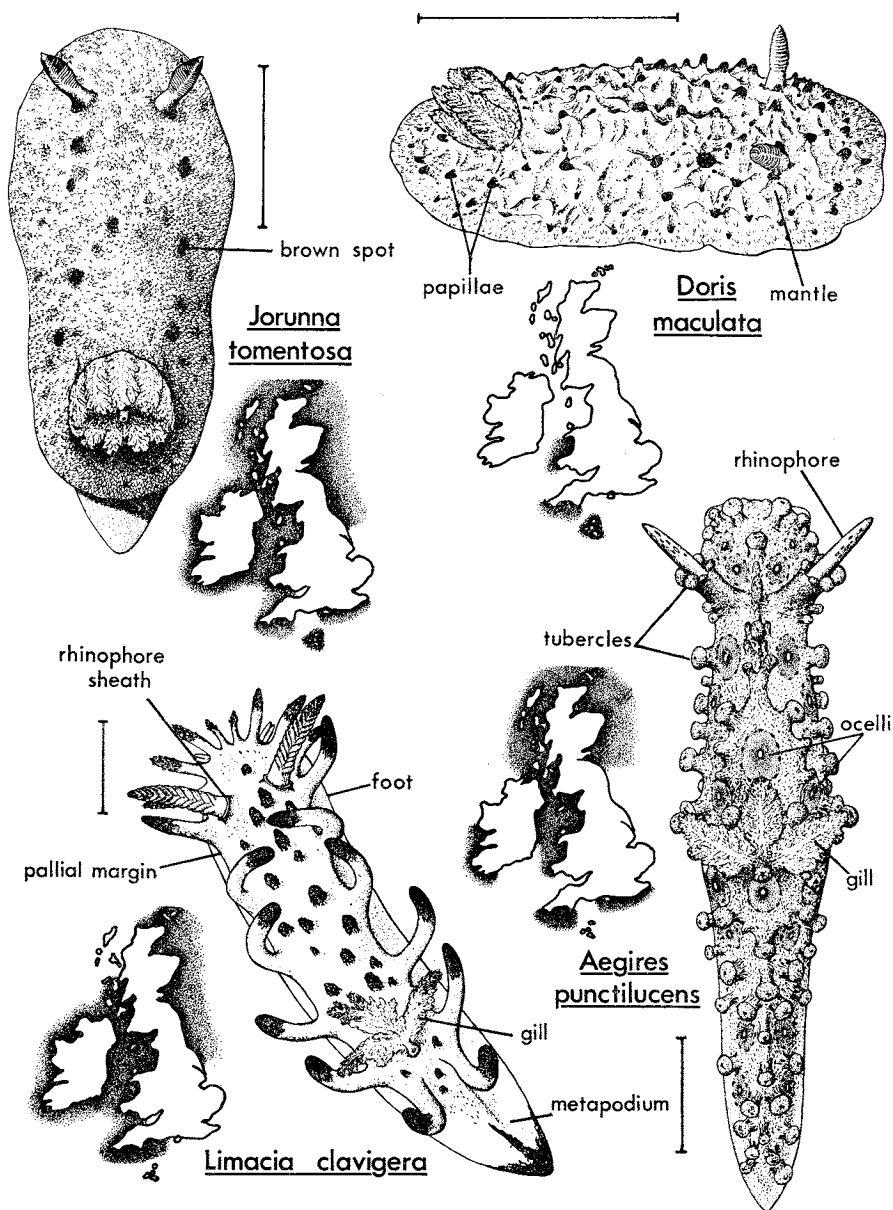


FIG. 7.

Limacia clavigera (Müller, 1776)

Triopa clavigera (Müller, 1776)

Possibly this species mimics eolids such as *Eubranchus farrani* (Hecht, 1895). Specimens from the west and south-west are noticeably sleeker and paler than those from the north-east. The white body has paired finger-like processes projecting from the pallial margin, the ones anterior to the rhinophores having feathery endings, those posterior being larger and smoother. All have yellow tips as do the gills and rhinophores. Scattered on the dorsum are a variable number of orange/yellow papillae. The foot is white except for yellow pigment in the metapodium. The lamellate rhinophores emerge from short sheaths with thickened rims. This phanerobranch has 3–5 small tripinnate gills. The largest recorded specimen is 40 mm from S. Africa (Marcus, 1957) but 18 mm is the maximum known from European waters.

Diet: polyzoans, *Callopora dumerili*, *Cryptosula pallasiana*, *Electra pilosa*, *Membranipora membranacea*, *Porella concinna*, *Schizoporella unicornis*, *Umbonula littoralis* (Thompson, 1964).

Distribution: to 60 metres depth; the Faeroes, western Europe and the Mediterranean.

Aegires punctilucens (Orbigny, 1837)

The ground colour is light fawn with delicate white flecking and fewer dark brown spots. Numerous pedunculate tubercles are found all over the body, apparently always in the arrangement shown in the diagram. Each tubercle has a light brown, spiculate terminal swelling with a darker centre. Similar processes are found around the lips of the rhinophore sheaths and on the three protective arms in front of the gills. Between these tubercles are ocelli; each is a light brown disc darkening towards an iridescent turquoise centre and bordered peripherally by a ring of about nine dark brown spots. The smooth and finger-like rhinophores are light brown with white flecks. The three, white, tripinnate gills are retractable but there is some doubt as to whether the species is truly cryptobranchiate. This nudibranch can reach a length of 20 mm.

Diet: thought to feed on encrusting polyzoans.

Distribution: to 100 metres depth; Scandinavia, Atlantic and Mediterranean coasts of France, and New Caledonia in the Pacific.

Crimora papillata Alder & Hancock, 1862

The body is translucent white, the skin often appearing wrinkled. The pallial margin is delineated by numerous, small, branched, yellow papillae, being greatly branched around the frontal veil. Less densely scattered papillae are found on the dorsum and sides, mostly simple points but also bifurcate and trifurcate. The rhinophores have a white basal region and protrude from short sheaths with thickened rims. This phanerobranch has 3–5 tripinnate gills around the anal papilla. All are white with yellow tips. The largest recorded specimen was 35 mm from Tusker rock in June, 1973.

The diet and life cycle are unknown.

Distribution: only four specimens previously recorded, two dredged in shallow waters around Guernsey, one from Morocco and one from the Mediterranean coast of France. In June, 1974, populations were discovered on the south coast and off North Devon.

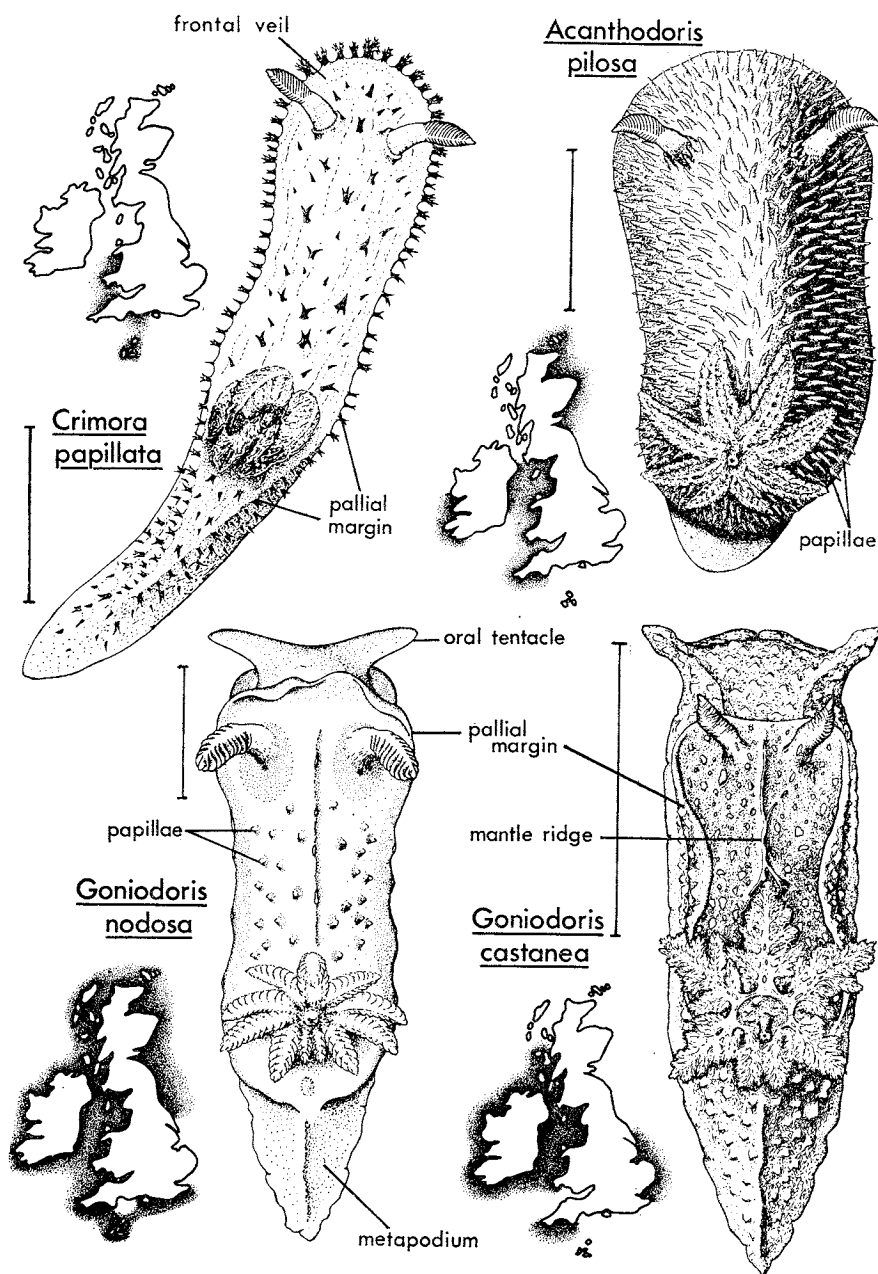


FIG. 8.

Acanthodoris pilosa (Müller, 1789)

Doris pilosa Müller, 1789

Acanthodoris subquadrata (Alder & Hancock, 1845)

The body varies from black to white. The ample mantle is covered by minute, soft, pointed papillae, sometimes large enough to give the animal a "shaggy" appearance. The lamellate rhinophores can be retracted into the short papillate

sheaths, but when extended, the tips characteristically curve over backwards. This phanerobranchiate dorid has up to 9 large tripinnate gills. They have been found up to 50 mm long, in the North Sea (Walton, 1908). This is a common host for *Splanchnotrophus*, an internal copepod parasite which extrudes two white egg sacs.

Diet: polyzoans *Alcyonidium gelatinosum*, *A. hirsutum*, *A. polyoum*, *Callopora dumerili*, *Flustrella hispida* (Thompson, 1964).

Distribution: to 270 metres depth and from Eastern America, northern and western Europe and the Mediterranean.

Goniodoris nodosa (Montagu, 1808)

This nudibranch is very common even on silty substrates and is white with the pink liver usually showing through from beneath the gills. Salmon-coloured specimens are rare. Two stout tentacles, flattened dorso-ventrally, project laterally from the head. The pallial margin is produced and curves back over the mantle which is covered by opaque white pigment except for an area around the base of each rhinophore. Small papillae are scattered as shown, but sometimes found concentrated towards the sides of the mantle. A mid-dorsal ridge always connects a row of papillae. The broadly-lamellate rhinophores and simply pinnate gills are white. This phanerobranch usually possesses about 11 branchiae. Specimens up to 27 mm have been recorded.

Diet: the young feed on the polyzoan, *Alcyonidium polyoum*; adults eat the ascidians, *Dendrodoa grossularia*, *Botryllus schlosseri* and *Diplosoma listerianum* as well as the polyzoans, *Callopora dumerili* and *Flustrella hispida* (Thompson, 1964).

Distribution: to 117 metres depth along the coasts of western Europe as far south as Croisic in France.

Goniodoris castanea Alder & Hancock, 1845

The body is a light fawn, the mantle being slightly darker or even a deep reddish brown. Scattered all over the dorsal surface are small creamy-white raised spots. A mid-dorsal branching ridge runs from between the rhinophores to the gill circlet, while the mantle margin is produced and curves up and inwards. The rhinophores are unevenly lamellate with some darker mottling towards the white tip. 7 fawn-coloured gills surround a prominent anal papilla although the branchial stems of this phanerobranch are speckled with a little white pigment. The largest recorded, 38 mm long, was found in Jack Sound in August, 1973.

Diet: compound ascidians, *Botrylloides leachii*, *Botryllus schlosseri* (Thompson, 1964).

Distribution: to 80 metres depth along western European coasts, the Mediterranean, New Zealand and Japan.

Palio dubia (M. Sars, 1829)

Polycera ocellata Alder & Hancock, 1842

Polycera nothus (Johnston, 1838)

This hardy species can withstand low salinity down to 14 per cent (Swennen, 1961). The body is a dark greenish brown, with fawn raised patches. The undulating pallial expansion is also fawn as is the foot which bears two short propodial tentacles.

The lamellate rhinophores are light fawn but the 5 bi- and simply pinnate gills are white in this phanerobranch. Specimens up to 29 mm occur around Iceland (Colgan, 1914).

Diet: polyzoans, *Cryptosula pallasiana*, *Escharella immersa*, *Microporella ciliata*, *Schizoporella unicornis*, *Smittina reticulata* (Thompson, 1964).

Distribution: to 100 metres depth; widely distributed around North Atlantic coasts, the White Sea, the Mediterranean, and New Caledonia in the Pacific.

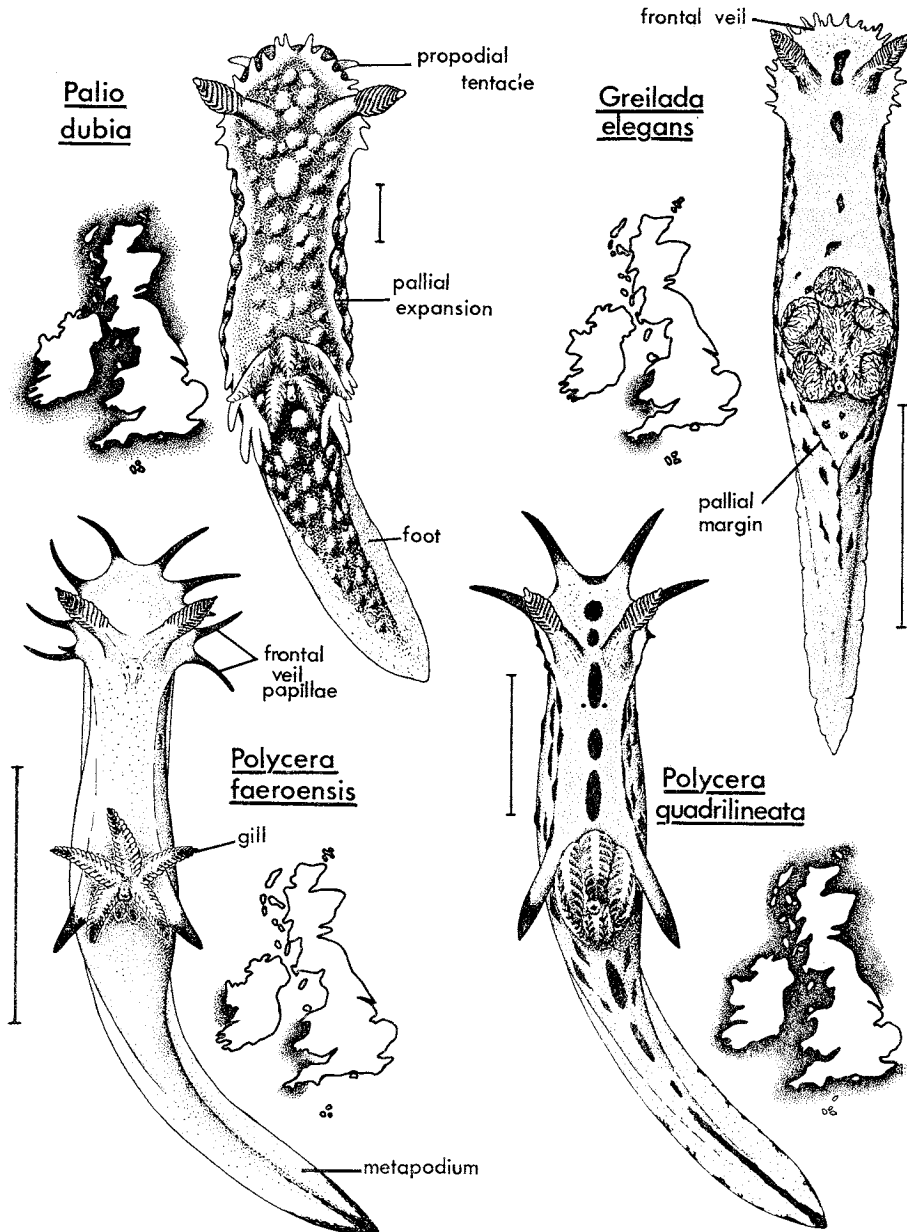


FIG. 9.

Greilada elegans (Bergh, 1894)

The body is orange as are the small papillae of the frontal veil. The pallial margin is delineated by two lateral rows of blue/black bumps uniting behind the gills. Other similarly pigmented swellings are found on the sides and the dorsum. The lamellate rhinophores and 5 tripinnate gills are all orange in this phanerobranchiate dorid. Blue dots are found on the inner branchial stem surfaces, while white pigment highlights the outer ridges. Specimens have been found up to 43 mm long (Edmunds, 1961).

Diet: simple ascidians

Distribution: only three previous British records, all from the Plymouth area. Rare finds off Atlantic France and the Mediterranean.

Polycera faeroensis Lemche, 1929

The translucent white body bears a variable number of frontal veil papillae, of which usually 8 are well developed. The pallial margin is often hard to discern but leads into flap-like projections lateral to the gills; rarely these are compound having two or three points. These, the frontal veil papillae and the tips of the gills and metapodium are all yellow. Specimens have been found with yellow patches on the body and pigment along the pallial margins forming ridges, i.e. reminiscent of *P. quadrilineata*. However no confusion need arise as *P. quadrilineata* never has more than 6 frontal veil tentacles (usually 4) and the colour is a darker orange/yellow than the pure light yellow of *P. faeroensis*. This is a phanerobranch with usually 7 simply pinnate gills around the anal papilla. The largest recorded was a 40 mm specimen from North Haven in June 1973.

Diet: found on upright and encrusting polyzoans.

Distribution: despite its abundance around Dale, it has only rarely been found in Galway Bay and around the Faeroes and Sweden.

Polycera quadrilineata (Müller, 1776)

The body is translucent white with gentle mounds of orange/yellow pigment usually arranged in the mid-dorsal line, along the pallial margins and on the body sides and tail. There are usually four frontal veil tentacles and two finger-like papillae lateral to the gills, all with orange/yellow ends. Rarely, the body is grey with black speckles predominating in the tips of the rhinophores and gills. The lamellate rhinophores have yellow apices as do the 7, simply pinnate gills of this phanerobranchiate dorid. The largest recorded was 39 mm long from Tusker rock in August, 1973.

Diet: polyzoans, *Callopora dumerili*, *Schizoporella unicornis*, *Electra pilosa*, *Membranipora membranacea* (Thompson, 1964). We found many around Skomer on *Membranipora*.

Distribution: to a depth of 265 metres; Greenland, western Europe and the Mediterranean.

Onchidoris luteocincta (M. Sars, 1870)

The body is white but the wide mantle is vividly pigmented. A yellow ring marks the rim, whilst the central area of the dorsum is a deep brick-red, densest near the mid-line. This pigment is punctuated by numerous stumpy, colourless papillae. Individuals vary considerably in the width of the yellow band, the amount of red

pigment and the size and number of the papillae. The metapodium has a mid-dorsal ridge, a yellow tip and a crenulated edge. The rhinophores are long and white with very slanted lamellae. This phanerobranchiate dorid has 5, white, simply pinnate gills surrounding the anal papilla, each contractable into a separate pocket beneath the mantle. The largest was 10 mm, recorded from the Dale area in June, 1972.

Diet: the polyzoan, *Smittina reticulata*.

Distribution: to 60 metres depth; known only from Skagerrak, the British Isles and the Mediterranean coast of France.

Onchidoris sparsa (Alder & Hancock, 1846)

Doris sparsa Alder & Hancock, 1846

Typically, the mantle outline is broadly oval, yellowish white overlain by brown patches. The broadly lamellate rhinophores also bear brown spots and emerge from sheaths bordered by three or four large tubercles. The mantle itself is covered by smaller, widely spaced tubercles. Nine, very small, simply pinnate gills make up the white circlet in this phanerobranch.

Specimens are known up to 8 mm in length.

Diet: the polyzoan, *Cellepora pumicosa*.

Distribution: very rare and unknown outside the British Isles.

Onchidoris inconspicua (Alder & Hancock, 1851)

Doris inconspicua Alder & Hancock, 1851

The mantle is white with some purple and sprinkled with tiny brown spots between the small blunt tubercles. The lamellate rhinophores tend to be yellow. The simply pinnate gills are small, white and number up to ten arranged in an incomplete circle around the anal papillus. Specimens can grow to at least 10 mm but records are few. It probably prefers deepish water although the only specimen found around Dale was on the shore.

Diet: the polyzoans, *Cellaria sinuosa* and *Cellepora pumicosa*.

Distribution: Outside the British Isles, known only from Arcachon (Atlantic coast of France).

Onchidoris muricata (Müller, 1776)

Doris aspera Alder & Hancock, 1842

The pale yellow or white mantle is noticeably spiculose as are the numerous, stout, flattened tubercles. The lamellate rhinophores are colourless, as are the simply pinnate gills which number up to 11 and are arranged in a horseshoe in this phanerobranch. Specimens may reach 14 mm in length.

Diet: a wide variety of polyzoans.

Distribution: to 70 metres depth along the coasts of western Europe, Nova Scotia and Alaska.

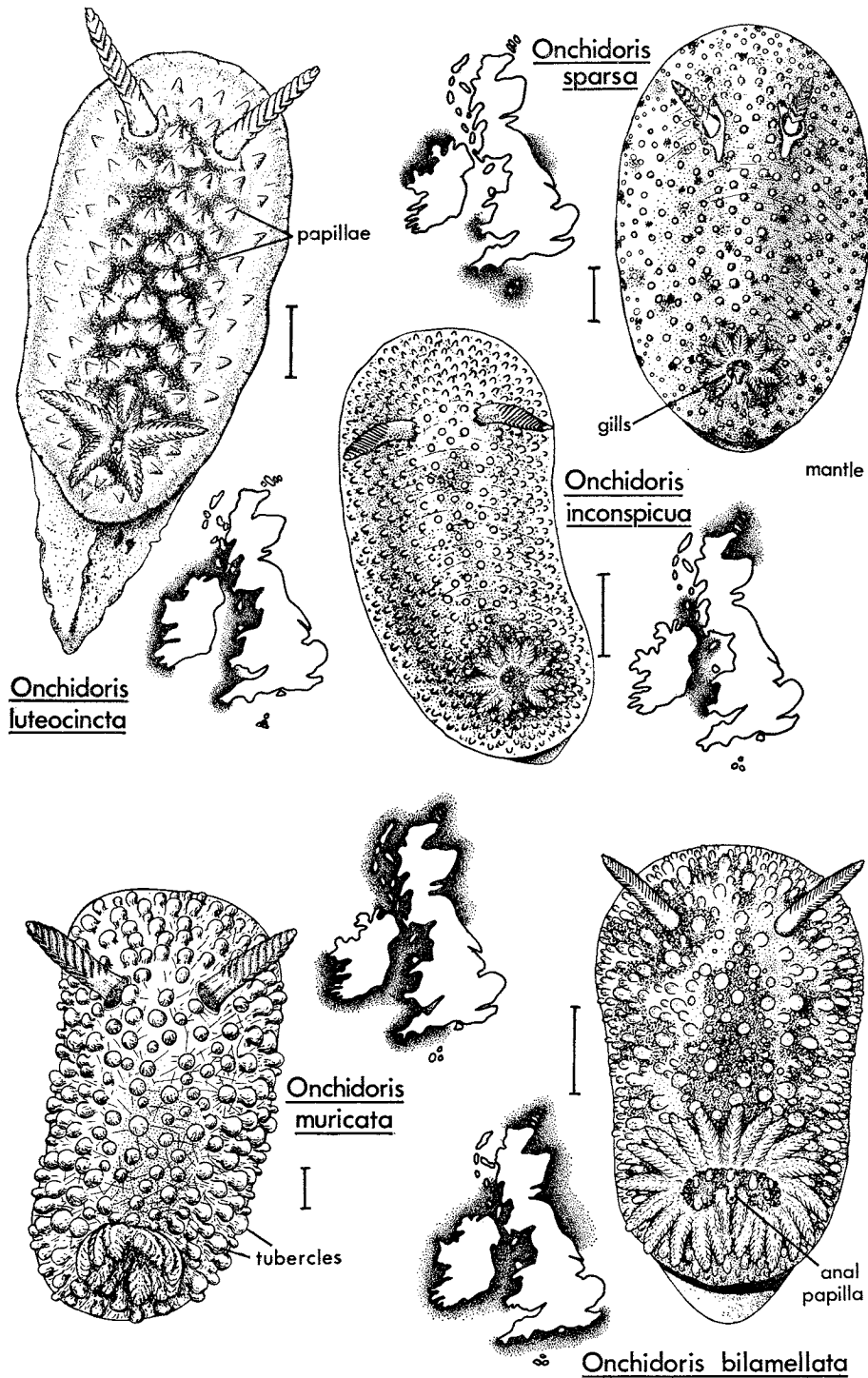


FIG. 10.

Onchidoris bilamellata (L., 1767)

Doris bilamellata L., 1767

The body is a mottled mixture of brown and creamy white. The pallium is covered by white, pustulose tubercles, larger but less densely spaced towards the centre. Long, narrow, finely lamellate, white rhinophores protrude from sockets without raised sheaths. Up to 26 simply pinnate gills are arranged in a horseshoe around the anal papilla. The gills are completely contractable into separate pockets beneath the mantle. Tubercles occur within the gill circlet. Specimens recorded up to 40 mm long (Swennen, 1961). Acid is secreted through the mantle.

Diet: barnacles, *Balanus balanoides*, *B. crenatus*, *B. porcatus*, *Elminius modestus*.

Distribution: to 250 metres depth; western Europe, Greenland N.E. America, Bering Sea, Alaska, Vancouver I., Pacific central America, and northern Japan.

Okenia elegans (Leuckart, 1828)

Idalia elegans Leuckart, 1828

The body is red or pink, darkest on the mantle, but with a white oral veil. The mantle margin is drawn out into flaps, often alternating large and small on both sides, whilst anteriorly are two long slender tentacles and a mid-dorsal row of flap-like papillae with a pair offset just prior to the gills. All these projections are yellow with white tips. The size of the papillae and all colour densities vary greatly in different individuals. The foot is broad with a yellow margin, the ventral surface being a speckled pale pink. The rhinophores are streaked red at the base, paling at the start of the very fine lamellae, whilst the distal portion reverts to a dark red leaving a yellow knob terminally. It is a phanerobranch with about 21 simply pinnate gills which unite basally to form a kidney-shaped funnel around the anal papilla, and they grade from pink at the base to yellow at the tips. When harrassed the gills are pulled down, the pallial flaps are held over the mantle completely obscuring it from view, and the two frontal tentacles curve back over the body with the rhinophores. Specimens have been recorded up to 80 mm long.

Diet: simple ascidians, *Ciona*, *Molgula*, *Cynthia tuberosa* (Thompson, 1964).

Distribution: only known from the Mediterranean coast of France outside Britain and Ireland.

Ancula cristata (Alder, 1841)

The translucent white body bears two short oral tentacles. From the base of each rhinophore two digitiform processes project anteriorly whilst somewhat blunter papillae of varying lengths are in a line on either side of the gills. All projections, including the broadly-lamellate rhinophores and the 3 tripinnate gills, have yellow distal portions. The metapodium has a yellow tip and often dots of similar pigment lie along the foot margin. The largest recorded was 33 mm long (Swennen, 1961).

Diet: compound ascidians, *Botrylloides leachii*, *Botryllus schlosseri*, *Diplosoma listerianum*.

Distribution: to 95 metres depth; eastern Canada, Greenland, and western Europe as far south as Brest.

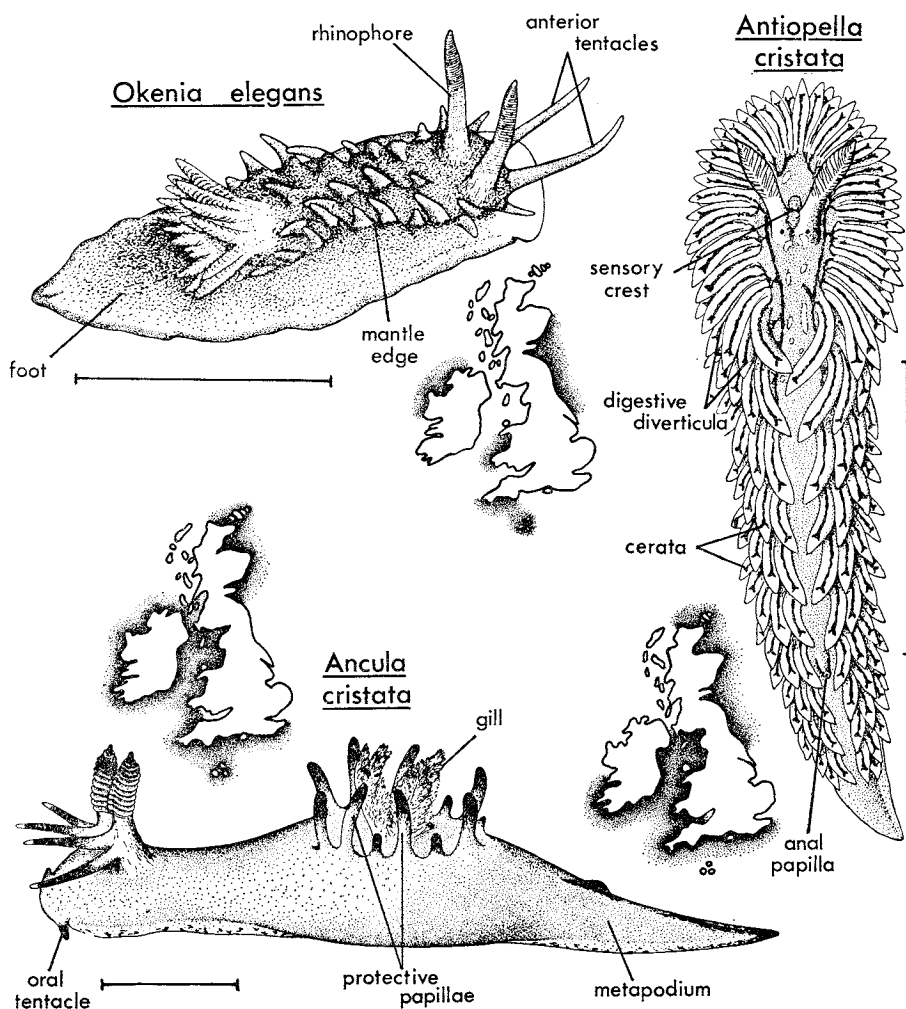


FIG. 11.

ARMINACEA

This sub-order contains animals very heterogenous in form, some mimicking the dorids and others, such as *Antiopella*, reminiscent of eolids.

Antiopella cristata (Chiaje, 1841)

Antiopa cristata (Chiaje, 1841)

This animal is seen at once not to be an eolid because the cerata are continous all around the head and the anal papillus is mid-dorsal posteriorly. A sensory crest is between the light brown, lamellate rhinophores. The body has no pigment except for a few scattered patches of white, allowing the digestive diverticula to be seen leading into each ceras. The cerata are clear except for white pigment at the tip (which often appears somewhat blue) and the dark brown digestive branch in the centre of each. Specimens found in Jack Sound up to 39 mm long.

Diet: the polyzoans, *Bugula* and *Cellaria*.

Distribution: Great Britain and Ireland, Atlantic coast of France and the Mediterranean.

AEOLIDACEA (Fig. 2)

This group is characterized by the dorsal projections (cerata) containing the diverticula of the gut as a central channel. It is via these diverticula, often described as liver or hepatic branches, that the undischarged nematocysts (sting cells) of the cnidarian prey reach the apical cnidosacs of each ceras, and can then be used by the sea slug in its own defence. The often rather sparse surface pigment of these animals is more important for identification than the more noticeable colour of the gut contents which can be very variable.

Favorinus blianus (Lemche & Thompson, 1974)

The distinctive appearance of the rhinophores enables easy identification of this species. Each has three bulbous rings near the base and a dark brown line down the posterior surface which widens on each swelling. The body is pale yellow while the ceratal liver branches are brownish-yellow. Glistening white pigment on each oral tentacle continues as a thin band onto the head and between the rhinophores. Similar pigment is found covering the tip of each ceras and as spots and patches further down. A white streak runs mid-dorsally in the metapodium. The foot is constricted just behind the large propodial tentacles. The largest found measured 35 mm alive (Lemche & Thompson, 1974).

Diet: probably nudibranch eggs.

Distribution: to 35 metres depth; Scandinavia, western Ireland and Pembrokeshire.

Facelina annulicornis (Chamisso & Eysenhardt, 1810)*Eolis punctata* Alder & Hancock, 1845

Characteristically, iridescent white spots are scattered over the body, foot and cerata (where they coalesce at the tips to cover the cnidosacs completely). The head and anterior section of the body are a rosy pink which fades behind the first ceratal cluster. The rhinophores are obliquely lamellate and brown, darkening distally but leaving white tips. The liver branch in each ceras varies in colour from dark brown or green to pink. The oral tentacles are long and highly mobile as is the whole animal, hunting down prey with noticeable voracity. A 43 mm specimen was recorded from Martins Haven in May, 1973.

Diet: the natural diet is undetermined. In the laboratory it will take a wide variety of hydroids and eat other nudibranchs, including its own species, if hungry.

Distribution: only a few records from Great Britain and Atlantic and Mediterranean coasts of France.

Facelina coronata (Forbes & Goodsir, 1839)*Eolis coronata* (Forbes & Goodsir, 1839)

Easily distinguished from *F. annulicornis* by the absence of white spots on the body, although small patches are found on the cerata which merge to form a shield-shaped band over the cnidosac. The body is pink, with a blue sheen on the head and cerata, sometimes apparent only under the microscope. The red oesophagus shows through the skin just behind the bases of the lamellate, light-brown rhinophores which have

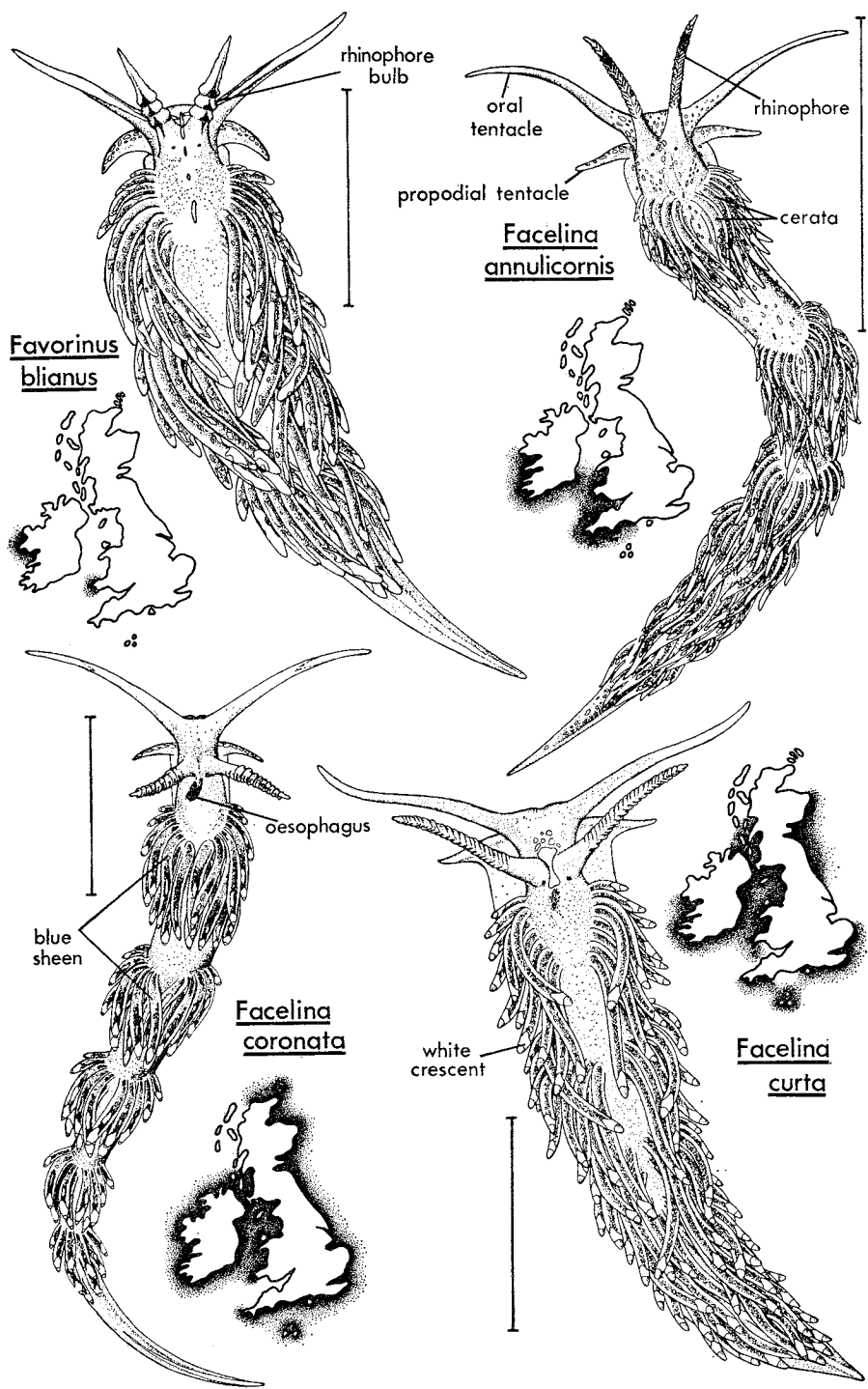


FIG. 12.

white tips. The liver branches in the cerata can be light brown or a deep red/brown. Specimens are recorded up to 37 mm long.

Diet: hydroids.

Distribution: Britain, Scandinavia and one specimen from the Mediterranean coast of France.

Facelina curta (Alder & Hancock, 1843)

Eolis drummondi Thompson, 1844

Many authors have combined *F. curta* and *F. coronata* under *F. auriculata* because of their similar colour. External features that differ consistently are the broader foot and relatively longer cerata of *F. curta*, in which cerata from the first cluster sometimes reach half the length of the body. Any trace of the blue sheen over the body and cerata, so apparent in *F. coronata*, is rare in *F. curta*, in which the "shield" of white pigment overlying the cnidosac tends to be distinct, not fragmenting into spots lying further down the ceras and the white pigment shown between the rhinophores is nearly always present. Specimens measuring 30 mm are recorded.

Diet: hydroids, including *Dynamena*, *Obelia*, *Clava*, *Lucernaria*, *Tubularia*.

Distribution: North Atlantic and Mediterranean.

Coryphella pedata (Montagu, 1815)

Eolis landsburgii Alder & Hancock, 1846

The body varies between a delicate translucent violet and a dark impenetrable mauve. Long mobile tentacles project from the narrow head and are tipped with white as are the rhinophores which often contract and wrinkle but lack lamellae. The clusters of cerata are situated rather laterally and closely grouped at the bases, appearing almost to unite. Each ceras has an orange or pink core terminating beneath an iridescent white band of surface pigment at the tip. The paler mauve foot is very narrow, produced into propodial tentacles, and terminating in a fine point. 40 mm specimens were collected in the Mediterranean (Ischia) in April, 1974.

Diet: hydroids, *Abietinaria abietina*, *Hydrallmania falcata*, *Tubularia indivisa*, *T. larynx*. Also found on polyzoans, *Flustra foliacea* and *Garveia nutans* (Thompson, 1964).

Distribution: to 27 metres depth; western Europe and the Mediterranean.

Eubranchus exiguus (Alder & Hancock, 1848)

Eolis exigua Alder & Hancock, 1848

The body is translucent white but mottled with brown pigment, often with a greenish tinge. Some white is frequently found on the head. The rhinophores are smooth with white tips above a dark brown band. The few cerata, in clusters of up to three, are fat and bulbous, even when relaxed, terminating in a clear point above a dark brown band. Greenish brown mottling is on all the cerata and may be in two or more bands. This species is often found with *Tergipes tergipes* amongst hydroids and the cerata are said to resemble the gonophores on *Obelia inflata* (Hecht, 1895). Specimens have been found measuring 21 mm but usually it does not exceed 5 mm and is mature when only 2.5 mm long.

Diet: hydroids, *Obelia* spp., *Laomeda flexuosa*, *Plumularia catharina*, *Hydrallmania falcata*, *Kirchenpauria pinnata*.

Distribution: to 150 metres depth; N.E. America, the White Sea, western Europe, and the Mediterranean.

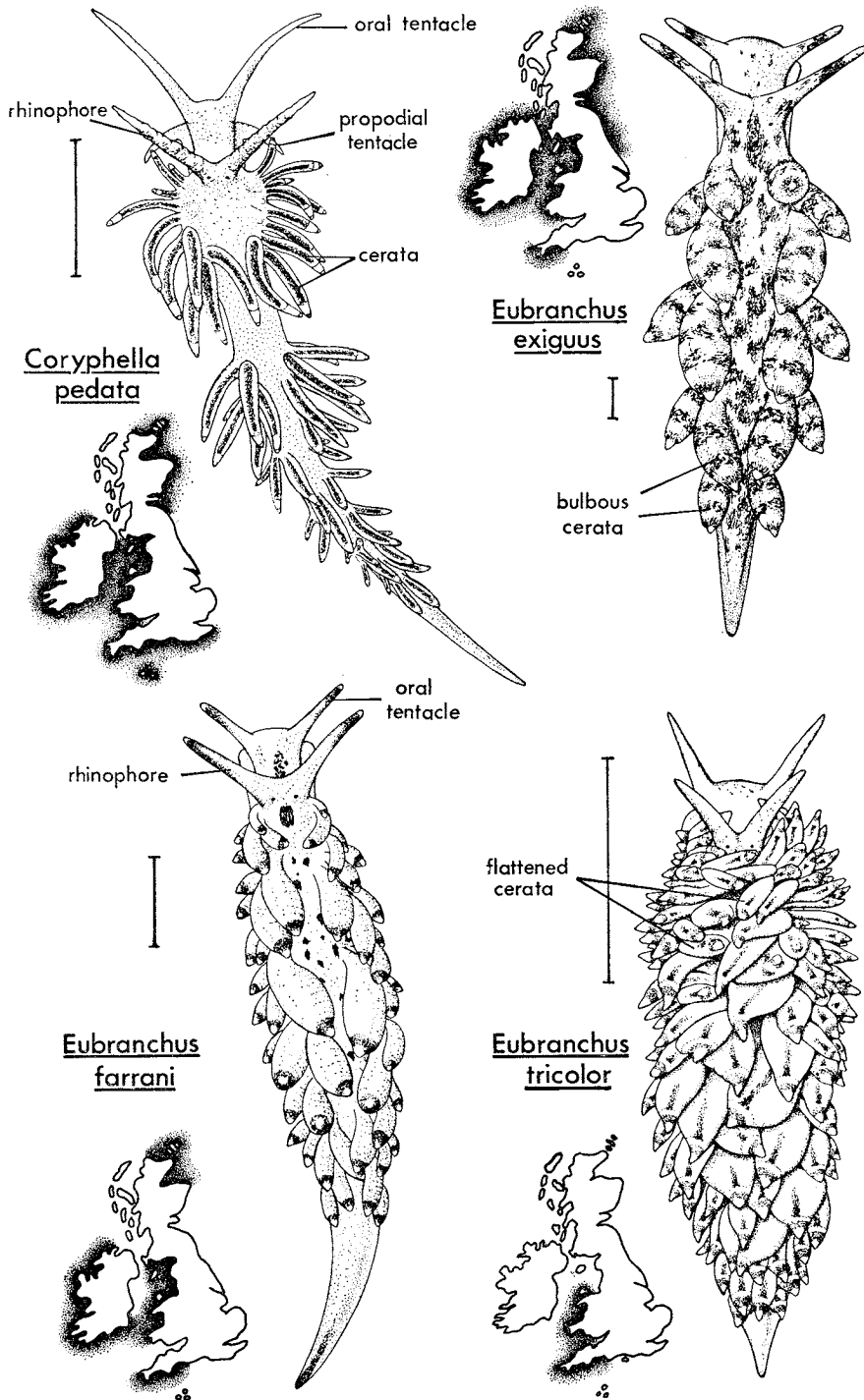


FIG. 13.

Eubranchus farrani (Alder & Hancock, 1844)

Eolis farrani Alder & Hancock, 1844

Although some have the body totally orange, or black with a few orange spots, usually it is white or smokey grey with several orange/yellow spots scattered over the dorsum and head. The bulbous cerata end in a ring of yellow, the same pigmentation being found on the short oral tentacles, the smooth rhinophores and the tip of the metapodium. The foot is smoothly rounded anteriorly. Specimens up to 18 mm have been found around Skomer.

Diet: calyptoblastic hydroids.

Distribution: common along the coasts of western Europe and the Mediterranean.

Eubranchus tricolor (Forbes, 1838)

Eolis tricolor Forbes, 1838

Although variable in colour, this species usually has a greyish white body with some faint brown pigment concentrated on the rhinophores and cerata. The cerata appear very swollen and flattened antero-posteriorly, especially the larger ones which completely obscure the body in adult specimens. The cnidosac region is white but may be overlain by a band of yellow. The hepatic core is brown, darkening or turning to violet just beneath the cnidosac. The foot is smoothly rounded anteriorly. This species can reach lengths of 30 mm.

Diet: undoubtedly hydroids although specific records are uncertain due to historical confusion with *E. farrani*.

Distribution: Greenland, Scandinavia, British Isles and Atlantic coasts of France.

Tergipes tergipes Forskall, 1775

Eolis despecta (Johnston, 1835)

The short oral tentacles are translucent as are the long, smooth and mobile rhinophores except for a dark red/brown streak originating in each near the base, and extending to a paler lateral streak running from head to tail on either side of the body, which is pale brown with patches of black dots near the ceratal bases. The cerata are few and arranged as shown. The liver branches can often be seen as light green channels running down the cerata to unite with the gut branch zig-zagging between the bases. A brown band encircles the cerata terminally. The largest recorded is an 8 mm specimen from the Isle of Man (Miller, 1958).

Diet: many small hydroids, most commonly *Obelia* spp.

Distribution: to 45 metres depth; N. America, Iceland, western Europe and the Mediterranean coast of France. Also reported from Brazil and New Caledonia.

Catriona aurantia (Alder & Hancock, 1842)

Eolis aurantiaca Alder & Hancock, 1851

The body and oral tentacles are translucent white or pale pink. The smooth rhinophores are pale orange as is the band of pigment on each cerata just below the tip. The cerata are arranged in 5–7 clusters. The hepatic duct is granular, pale brown or red. The smoothly rounded foot is thickened along the leading edge. Specimens measuring 22 mm have been found around Skomer.

Diet: hydroids, *Bougainvillia ramosa*, *Sarsia eximia*, *Tubularia indivisa*, *T. larynx*, *Garveia nutans* (Thompson, 1964).

Distribution: coasts of western Europe and Mediterranean France. Possibly Friday Harbour (Pacific coast of U.S.A.).

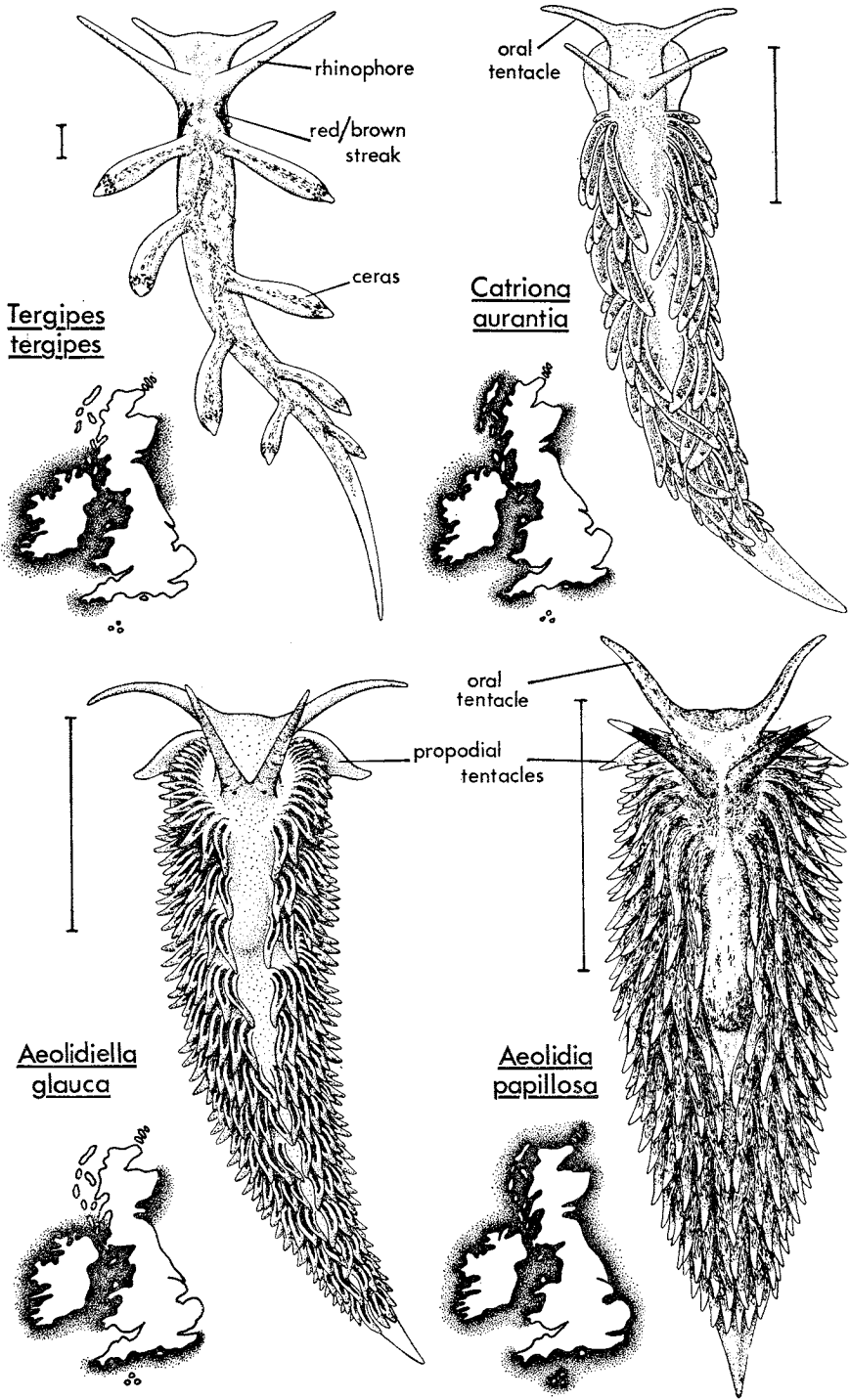


FIG. 14.

Aeolidiella glauca (Alder & Hancock, 1845)

Eolis glauca Alder & Hancock, 1845

This animal has a broad body and foot with prominent propodial tentacles. The cerata are short but numerous, arranged in distinct rows beginning in front of the rhinophores which are smooth and pale orange/pink. The body ranges from translucent white to orange/pink. The hepatic branches in the cerata are brown while the tips are grey/white. This species can grow to 40 mm.

Diet: anemones, *Sagartia elegans* and *Heliactis bellis*.

Distribution: to 80 metres depth; western Europe, Mediterranean and Caribbean.

Aeolidia papillosa (L., 1758)

Eolis papillosa L., 1758

This is a broad, rather flat animal with many cerata in numerous rows extending in front of the rhinophores. The body and cerata are mottled from grey to brown, leaving only white ceratal tips and a white band mid-dorsally which branches over the head to give a white line running up each oral tentacle to the tip. The smooth rhinophores become dark brown distally but the very end is white. This is perhaps the commonest and largest eolid found intertidally and can be 12 cm long.

Diet: some hydroids, e.g. *Tubularia indivisa*, but mainly sea anemones such as *Actinia*, *Anemonia*, *Metridium*, *Tealia* (Thompson, 1964).

Distribution: to 800 metres depth; western Europe, California, Alaska, Falkland Isles, Chile and Japan.

SUMMARY AND ACKNOWLEDGEMENTS

This is an up to date list of the nudibranch fauna found in the Dale area. Experience in other coastal waters around Britain shows that prolonged recording is still needed. Two *Trinchesia* species have recently been collected from Martin's Haven, which cannot be identified with any previously known in Britain, while *Trapezia maculata* (a Mediterranean species closely related to *Ancula*) was found for the first time in Britain only in June, 1974, on the south coast. More specimens are urgently needed, and we hope divers and shore collectors throughout the country will help us. Descriptions of all known British opisthobranchs are given in a Linnean Society synopsis to be published shortly (Thompson & Brown, in press).

We are more than grateful to Dr. T. E. Thompson for help at all stages of this work and to D. C. Emerson, warden of Dale Fort Field Centre, for the assistance and facilities needed in the field work.

REFERENCES

- ALDER, J. and HANCOCK, A. (1845-55). *A Monograph of the British Nudibranchiate Mollusca*. Ray Society, London.
- COLGAN, N. (1914). The opisthobranch fauna of the shores and shallow waters of County Dublin. *Ir Nat. J.*, **73**, 161-204.
- CROTHERS, J. H. (1966). Dale Fort Marine Fauna (2nd Ed.). *Field Studies*, **2**, Supplement 169 pp.
- EDMUNDS, M. (1961). *Polycera elegans* Bergh: a new species to Britain and discussion on its taxonomy. *Proc. malac. Soc. Lond.*, **34**, (6), 316-321.
- EDWARDS, G. (1963). The coal industry in Pembrokeshire. *Field Studies*, **1** (5), 33-64.
- HECHT, E. (1895). Contribution a l'étude des nudibranches. *Mém. Soc. zool. France*, **8**, 539-711.
- JONES W. E. and WILLIAMS, R. (1966). The seaweeds of Dale. *Field Studies*, **2** (3), 303-330.

- LEMICHE, H. and THOMPSON, T. E. (1974). Three opisthobranch gastropods new to the British fauna. *Proc. malac. Soc. Lond.*
- LOYNING, P. (1927). Nudibranchs from Bergen, collected in the neighbourhood of the biological station at Herdla. *Nyt Mag. Naturvid.*, **65**, 243–264.
- MARCUS, E. (1957). On Opisthobranchia from Brazil. 2. *J. Linn. Soc.*, **43**, 390–486.
- MILLER, M. (1958). Studies on the nudibranchiate mollusca of the Isle of Man. Ph.D. Thesis University of Liverpool.
- NELSON-SMITH, A. (1965). Marine biology of Milford Haven—the physical environment. *Field Studies*, **2** (2), 155–188.
- NELSON-SMITH, A. (1967). Marine biology of Milford Haven—the distribution of littoral plants and animals. *Field Studies*, **2** (4), 435–477.
- OLIVER, J. (1959). The climate of the Dale peninsula. *Field Studies*, **1** (1), 40–56.
- SWENNEN, C. (1961). Data on distribution, reproduction and ecology of the nudibranchiate molluscs occurring in the Netherlands. *Netherlands J. Sea Res.*, **1**, 191–240.
- THOMPSON, T. E. (1964). Grazing and the life cycles of British nudibranchs. (in) *Grazing in terrestrial and marine environments. Brit. Ecol. Soc. Symp.* No. 4, 275–297.
- THOMPSON, T. E. (1969). Acid secretion in Pacific Ocean gastropods. *Aust. J. Zool.*, **12**, 755–764.
- THOMPSON, T.E. and Brown, G. (in press): *British Opisthobranchs*. Linnean Soc. Synop. (New Series) No.6 Academic Press.
- WALTON, C. L. (1908). Nudibranchiata collected in the North Sea by the S.S. “Huxley” during July and August, 1907. *J. mar. biol. Ass. U.K.*, **8**, 227–240.
- YONGE, C. M. (1973). Observations on the Pleurotomarid *Entemnotrochus adansoniana* in its natural habitat. *Nature*, **241**, 66–68.