

TAXONOMY AND ECOLOGY OF THE NUDIBRANCHIATE  
MOLLUSCA OF THE COOS BAY, OREGON, REGION

by

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## TABLE OF CONTENTS

Introduction	1
Materials and Methods	4
Taxonomy of the Nudibranchiata	6
Synopsis of the Species	8
Discussion and Summary	41
Bibliography	53



# TAXONOMY AND ECOLOGY OF THE NUDIBRANCHIATE

## MOLLUSCA OF THE COOS BAY, OREGON, REGION

### INTRODUCTION

Nudibranchiata is one of the three suborders of opisthobranchiate gastropod Mollusca. This group includes forms which exercise a noticeable influence upon associated species of the habitat in which they occur and forms which are relatively slow moving ecologically. They occur as bottom-dwellers in the littoral and abyssal regions and to some extent neritically and pelagically. Species are generally limited in habitat to one ecological region of the ocean, but the degree of such limitation varies with the species.

#### Types of habitat

The types of coastal habitat which are included in a marine environment are largely determined by the degree of wave action. Secondarily, they are delimited by kind of bottom and tidal exposure. The habitats resulting from the degree of wave shock include exposed outer coast, protected outer coast, and bays and estuaries.

Exposed outer coast is naturally subdivided into exposed outer rocky coast and exposed sandy beaches. Protected outer coast is subdivided into protected rocky outer coast (subsequently referred to as PROC - a habitat description borrowed from Dr. I. Pratt) and protected sandy beaches. Bays and estuaries are subdivided by the types of bottom which include sand, muddy sand, sandy mud, and mud. Another habitat included in bays and estuaries is wharf piling.

The food of the nudibranchs includes a wide variety of organisms. Some species are herbivorous, and some forms may be limited in diet to

a given genus of marine algae. Carnivorous or predaceous species exhibit degrees of food preference ranging from a single species or relatively small group of zoophytes to species which feed voraciously on numerous animals including small crustacea, sponges, coelenterates, bryozoa, and other available organisms. Some members of the group are known to feed on both plants and animals.

As would be expected, the forms with comparatively little diet specificity often have a more extensive ecological and geographical distribution than those which possess dietary habits of relatively high specificity. As usual, exceptions to this tendency are to be found, but the exceptions are forms whose food is widely distributed. A species is rarely found in areas lacking its preferred food organisms. Other factors which presumably limit distribution of nudibranchs include temperature, salinity, duration of exposure in intertidal zones, pollution, and protection from possible predators and wave action.

The absence of the typical molluscan shell on adult nudibranchs results in a fragility which makes it necessary to study them at a marine laboratory or directly on the beach. For this reason, extensive collections are lacking in the museums. Consequently, distribution records are centered around established marine stations. Only two records for Oregon were found in the literature.

There have been three areas on the West Coast of North America in which comparatively extensive collection and study of nudibranchs has been conducted. Bergh (1879) and (1880) received material collected by Dall and others in Alaskan waters between 1865 and 1876, and on those collections based a number of new specific descriptions.



O'Donoghue in 1920 conducted the most comprehensive study of Nudibranchiata of a given region of the West Coast of North America - the Vancouver Island and Puget Sound regions. This work was supplemented by Kerschow-Agersborg in the early 1920's. The nudibranchs of the coast of California have been studied by MacFarland and Stearns in Monterey Bay, and the La Jolla-Laguna area by Cockerell, Eliot, Cooper, and Guernsey. The two records from Oregon are forms which were sent to Bergh for identification. These centers of study correspond to the established marine stations with the exception of collections from Alaska.

The purpose of the work undertaken in this thesis was to discover what species of nudibranchs inhabit the Oregon Coast, particularly the Coos Bay region; to ascertain relative abundance and ecological distribution; and, to supplement the recorded distribution of East Pacific Nudibranchiata.



## MATERIALS AND METHODS

The procedures followed in making this study include collection, preservation, fixation and preparations for histological study and dissection for the purpose of identification. Ecological observations were for the most part made in the field.

Several types of collecting were employed; the most common of which was on the shore in intertidal zones. Dredge samples from inside Coos Bay over several types of bottom at depths ranging from two to six fathoms were examined. Other subtidal collecting was limited to the examination of a number of crab pots in water of approximately six fathoms about one and one-half miles off shore.

Several preservatives were used in preparation of specimens for both dissection and permanent storage. Among those used were various concentrations of formaldehyde, fixation in formaldehyde and subsequent transfer to 70% ethanol, storage in a dilution of acetic acid-ethanol-formaldehyde, 70% ethanol alone, 70% ethanol containing 1:10 parts glycerol (with and without previous fixation) and fixation in Bouin's solution and subsequent washing with lithium carbonate-treated 50% ethanol and storage in both formalin and 70% ethanol. None of these procedures showed marked advantages over any other method. No satisfactory means of preserving color of specimens was found; and none of these kept the tissues in a good state of preservation for more than about one year.

Small specimens were usually fixed in toto. Larger specimens were also placed in fixative after injection of fixative into the body cavity or after incisions had been made between the mantle and the

foot. Tissues thus prepared include radulae, genital organs, and excised unbranched digestive tracts.

Infiltration of paraffin into the gut of algae-feeding forms such as Hermisenda crassicornis and even Archidoris montereyensis and Rostanga pulchra proved difficult to obtain. Reduced pressure did not improve the extent of paraffin infiltration.

Fixatives which were used for histological material include Bouin's, Zenker's, and alcohol-formol-acetic mixture. The stains used in preparing slides for histological study were iron hematoxylin and Harris' hematoxylin-eosin.

Various narcotizing agents were tried when killing the animals for preservation. Magnesium sulfate, cocaine hydrochloride and chlorobutanol - all in various concentrations in sea water, fresh water, and sea water in which the oxygen content had been reduced by boiling - were used. The object of the use of narcotizing agents was to kill the animals with branchial plumes and rhinophoria extended. This was rarely achieved. The most effective agent employed was sea water half-saturated with magnesium sulfate for two hours followed by complete saturation of the solution with magnesium sulfate until the death of the animal occurred.



## TAXONOMY OF THE NUDIBRANCHIATA

Taxonomic subdivision of the Nudibranchiata has assumed two distinct aspects, excluding the proposed union of the nudibranchs with uniseriate radulae in which the teeth have a special form and are not lost when worn out but are preserved in a sac at the base of the buccal apparatus, the proposed section Ascoglossa. One criterion chosen for the proper subdivision has been the disposition of the digestive gland - whether compact or ramified - on the basis of which the group has been divided into two tribes: (1) the Holohepatica - nudibranchs with a compact "liver", and, (2) Cladohepatica - forms which have a highly branched hepatic organ.

The subdivision of tribes occurs on the family level. Family characteristics have come to include characteristics of morphologically heterogenous levels to which as a whole, few will ascribe phylogenetic significance.

The second criterion (or group of criteria) used in major subdivision of the suborder Nudibranchiata splits the group into four tribes on the basis of a combination of characteristics which include internal diffuse extension of the "liver" presence or absence of blood gland, number of vesiculae seminales, type of rhinophores, and position of anus. This system excludes consideration of the ascoglossate forms. The only ascoglossate form included in this thesis is Hermaea vancouverensis. This latter group, the Elysioidea, must by definition include a number of forms which have previously been considered as tectibranchs. The Elysioidea differs from the forms strictly termed nudibranchs in several respects other than radula; shape of the



rhinophores, the genital organs and the nervous system.

The divisions of Nudibranchiata appear here as presented by Odhner (1934, p. 231).

- I. Holohepatic nudibranchs with right liver absent or reduced to a caecal appendix ("gall-bladder"). Blood-gland and (as a rule) two vesiculae seminales present.....Doridacea
- II. Holohepatic or cladohepatic nudibranchs with right liver smaller than but of similar structure to the left. No blood-gland. Only one vesicula seminalis.
  - A. Rhinophores simple, without sheaths, generally not retractile.
    1. Eyes stalked. Mouth with velum, generally without tentacles, anus lateral (dorsal in Antiope only) .....Arminacea
    2. Eyes sessile (or with very short stalks). Mouth with tentacles, without velum (except in Embletonia). Anus lateral or laterodorsal, in or behind the interhepatic space.....Eolidacea
  - B. Rhinophores retractile within sheaths. Anus lateral or laterodorsal in the interhepatic space.....Dendronotacea

The species collected in the Coos Bay region appear systematically arranged according to division into Holohepatica and Cladohepatica.

#### Section Sacoglossa

##### Tribe Holohepatica

##### Superfamily Zonobranchiatae

##### Sphaerostoma festiva

##### Superfamily Cryptobranchiatae

##### Archidoris montereyensis

##### Anisodoris nobilis

##### Aldisa sanguinea

##### Cadlina marginata

##### Cadlina pacifica

##### Cadlina flavomaculata

Rostanga pulchra

Diaulula sandiegensis

Discordis heathi

Superfamily Phanerobranchiatae

Triopha carpenteri

Laila cockerelli

Onchidorus fusca

Tribe Cladohepatica

Dendronotus frondosus

Dirona albolineata

Hermisenda crassicornis

Aeolidia papillosa

Section Ascoglossa

Hermaea vancouverensis

### Synopsis of the Species

An artificial key to the nudibranchs of the Coos Bay region is included in this report. A taxonomic key would necessarily be based on internal anatomy and on external features, but as such would be of little value to anyone unequipped for, or lacking time for careful dissection. The key included herein utilizes external characters to facilitate identification. A sufficient number of characters are listed for each species to make even a superficial identification to species fairly positive.

The species of nudibranchs identified in the Coos Bay region are considered from the standpoint of ecological distribution,

geographical distribution, variations and biological notes in the order in which they appear in the key. Following the list of species are three tables which summarize occurrence (Table I) and bathymetric distribution (Table II) in the Coos Bay region, and recorded geographical distribution on the West Coast of North America (Table III).



## Key to the suborders of Opisthobranchiata

1. Shell usually present; gill in the mantle cavity...Tectibranchiata  
(No members of this suborder have been collected locally)
1. Pelagic forms with lateral portions of foot modified to form fins  
.....Pteropoda  
(No members of this suborder have been collected locally)
1. Shell and true mantle absent; secondary gills on dorsum.....  
.....Nudibranchiata

Artificial Key to the Nudibranchiata  
of the Coos Bay Region

2. Dorsum with a median posterior circlet of branchial plumes;  
with or without dorsal papillae (cerata).....3
2. Dorsum without a circlet of branchial plumes.....16
3. Branchial plumes retractile into cavity.....4
3. Branchial plumes non-retractile.....12
4. Dorsum distinctly tuberculate or granulose.....5
4. Dorsum minutely tuberculate or villous.....9
5. Foot light yellow to orange in color.....6
5. Foot red, white or off-white.....7
6. Species rarely exceeding 5-6 cm total length; light yellow to  
orange with scattered dark spots varying in size on and  
between tubercles, or greenish yellow with larger black splotches  
sometimes almost covering dorsum; tubercles conical; dorsum  
somewhat arched; seven 3- to 4-pinnate branchial plumes;  
tentacles short, blunt, to 3mm long. Found at low tide.....  
.....Archidoris montereyensis
6. Species to 20cm total length; orange to yellow with relatively  
few small black spots between tubercles; large tubercles  
slightly enlarged at distal end, surrounded by smaller  
tubercles; dorsum not arched; six 3- to 4-pinnate branchial  
plumes joined at the base by a membrane; conical tentacles,  
5 to 5mm long. Found at low tide.....Anisodoris nobilis
7. Ground color white.....8
7. Anterior margin of foot bilabiate, the upper lip of margin  
thin and un-notched medianly; rhinophores stout, perfoliate  
with 12-15 leaves; 8-10 simply pinnate or irregularly bi-  
pinnate branchial plumes. Found in rocky tide pools.....  
.....Aldisa sanguinea
8. Ground color white with no colored external structures;  
dorsum covered with large, low, rounded tubercle; rhino-  
phores large, perfoliate with 20-30 leaves; the margin of the

- rhinophore sheaths markedly elevated; seven 3- to 4-pinnate branchial plumes; large head with long, thick tentacles ...  
.....Cadlina pacifica
8. Ground color white, with low tubercles tipped with lemon yellow; a lemon yellow line around edge of "mantle" and foot; 6 bipinnate branchial plumes; rhinophores small perfoliate with 16-18 leaves. Found in protected crevices on rocky substrate at low tide.....Cadlina marginata
8. Ground color white to cream; a row of 7-10 yellow spots borne on low tubercles on each side of dorsum; 10-11 simple pinnate or bipinnate branchial plumes; rhinophores brownish-black or reddish brown, large, perfoliate with 10-12 leaves..  
.....Cadlina flavomaculata
9. Ground color red; margin of rhinophore sheath not appreciably elevated, papillose but not crenulate; branchial plumes separate at base.....10
9. Margin of rhinophore sheath elevated and crenulate.....11
10. Branchiae of 10-12 separate, erect plumes; rhinophores short, stout, translucent pink, the stalk stout and conical, prolonged above the clavus. Small, red, found feeding on red encrusted sponge in rocky pools at low tide....Rostanga pulchra
11. Ground color pale yellowish to gray, with dark brown or black rings of varying size, number and position; dorsum minutely villous; 6 tripinnate branchial plumes; rhinophores perfoliate with 20-30 leaves.....Diaulula sandiegensis
11. Dorsum minutely tuberculate to almost smooth; general color light yellow, darker toward the median line, with variable number of irregularly scattered black to brownish flecks; 8-10 small, tripinnate branchial plumes; rhinophores perfoliate with 10-15 leaves, darker than the "mantle". Habitat: rocky tide pools.....Discodoris heathi
12. No papillae on dorsum.....13
12. Papillae present.....14
13. 5-7 tripinnate branchial plumes arranged in a circle, tubercles conical; rhinophores elongate; general color brown with lighter areas, especially between and at the base of the tubercles. Low tide to subtidal.....genus Acanthodoris\*
13. 15-25 simply pinnate branchial plumes arranged in the shape of a horseshoe; dorsum covered with rounded tubercles through which spicules are visible; ground color brown with areas of white to cream, especially along each side of the midline. Found at low tide, usually in association with hydroids.....Onchidorus fusca
14. Papillae long, occasionally forked; long non-retractile rhinophores; branchial plumes separate, simple pinnate; ground color red to pink. Found between shelving stones at



- low tide.....Hopkinsia rosacea\*
14. Papillae short; rhinophores retractile; branchial plumes  
tripinnate, not markedly separate at base.....15
15. Body depressed; ground color white; narrow frontal  
margin and lateral margins, set with red-tipped club-shaped  
papillae; no colored papillae along mid-dorsal region;  
branchiae white, tripinnate, joined at base.....Lialia cockerelli
15. Body limaciform; ground color white; branchial plumes  
not distinctly joined at base; lateral margins with orange  
or red compound tubercles elevated by a ridge; anterior  
margin and mid-dorsal region bearing similar processes;  
branchial plumes orange or red-tipped.....Triopha carpenteri
16. Arborescent papillae (Branchial plumes, in this case)  
in a single row along each lateral margin.....17
16. Papillae not arborescent, not in single row along each  
lateral margin.....18
17. White, with anterior margin flattened, bearing row of  
white digitiform projections; rhinophores arising from  
sheaths formed by markedly proliferated "mantle", the  
lower portion of the rhinophores perfoliate with clavus  
extended to form tentacle-like elongations with slightly  
bulbous distal portions.....Sphaerostoma festiva
17. Ground color white to off-white, mottled with greenish-  
brown or thickly mottled with purple to reddish-brown  
flecks; dendritic branchial plumes; rhinophores perfoliate,  
not completely retractile into sheaths which are greatly  
elevated from the dorsum and have the appearance of a pair  
of branchial plumes; anterior margin of "mantle" set with  
a row of branched projections. Found feeding on hydroids  
on wharfs and to depths of at least 6 fathoms.....Dendronotus frondosus
18. Rhinophores perfoliate; tentacles long or short; papillae  
round.....19
18. Rhinophores simple; tentacles short; papillae flattened  
to ovoid.....21
19. Papillae easily lost, elongate, transparent with liver  
diverticula appearing light brown to reddish brown; anterior  
margin of foot not angular.....20
19. Papillae not easily lost, not greatly elongate, not trans-  
parent; anterior margin of foot with produced angle.....genus Flabellina
20. Dorsum with a median opal blue line which bifurcates anteriorly;  
a blue line on each red-tipped papilla; if papilla not red  
at extreme distal end, a red or orange band of color just  
below a terminal area which may vary to pale yellow.....Hermisenda crassicornis



20. No blue line on dorsum or papillae; dorsum almost completely covered with pale transparent papillae revealing light brown to brown liver diverticula, light orange to almost white tips on papillae, with reddish band below and adjacent to each tip.....Hermisenda sp.
21. Papillae numerous, set in oblique rows; anterior margin of foot straight with rounded lateral edges; pharynx not bulbous.....genus Aeolidia papillosa
21. Anterior margin of foot with median portion produced at an angle; pharynx bulbous; papillae not easily lost and not markedly flattened.....genus Coryphella\*
- \* Probably present, but not herein described.

Archidoris montereyensis (Cooper) 1862

Doris montereyensis, Cooper, 1862. (p. 204)

Archidoris montereyensis, Bergh, 1879. (p. 107 with synonymy)

Archidoris montereyensis, MacFarland, 1906. (p. 124 with  
synonymy and colored lithograph fig. 4)

Ecological Distribution

Archidoris montereyensis is one of the most commonly occurring nudibranchs of the Coos Bay area. Its vertical range extends from slightly below the furoid zone to extreme low tide, and perhaps subtidally in PROC habitat, and from approximately plus two foot tide level to subtidally inside Coos Bay. This species is usually associated with the yellow sponges on which it feeds, although it occurs in areas lacking significant sponge and even algae growth. The contents of the digestive tract of specimens in such areas have been found to include chiefly fragments of non-encrusting algae. As evidence by the greater numbers of Archidoris found feeding on Halichondria and Ficulina, these sponges are the preferred item of diet, but not the only food source for Archidoris. Associated species include, in different parts of the vertical range, Fucus, Zostera, Strongylocentrotus purpuratus, Tegula funebralis, Balanus glandula, Bugula, Membranipora membranacea, Tubularia and the intertidal encrusting sponges.

Geographical Distribution

This species is recorded as occurring from Sitka (Bergh, 1878) to La Jolla (Cockerell and Eliot, 1905).



### Variations

The only observed variation from the descriptions in the literature of Archidoris montereyensis was that of color. O'Donoghue (1922) states that some individual specimens possess more black markings than others and that some are covered with minute black pigment deposits which give the animal a greenish cast. In the Coos Bay region, individuals with only one or two small irregular black spots about 2mm in diameter have been observed, as well as greenish-black animals in which the color was a result of solid black spots covering most of the surface of the nudibranch including the branchial plumes. The ground color varies from light yellow to orange. The foot is consistently light yellow in color.

### Notes on Biology

The color variations appear to correspond roughly to habitat variations. The color of specimens found inside Coos Bay at Fossil Point, South Slough and Fisherman's Wharf was consistently a lighter ground color coupled with an increased proportional amount of black markings. The reason for this was not ascertained.

Although the over-all population does not seem to vary seasonally, there is a noticeable difference between the abundance of Archidoris montereyensis in PROC habitat and in protected bay waters. The relative abundance decreases progressively from PROC to inside Coos Bay in the direction of South Slough. This population differential is probably effected by environmental changes occurring inside the bay, such as decreased salinity, increased temperature and an approximately equivalent decrease in number of sponges and algae.

The spawn of this species has been observed from April to August. It does not differ from the description by O'Donoghue and O'Donoghue (1922).

Anisodoris nobilis (MacFarland) 1905

(Plate III, fig. 1)

Montereina nobilis, MacFarland, 1905. (p. 38)

Anisodoris nobilis, MacFarland, 1906. (pp. 116-118 with synonymy and colored lithograph)

Geographical Distribution

The recorded range of Anisodoris nobilis extends from Monterey (MacFarland, 1905) to the Vancouver Island region (O'Donoghue, 1921). These extremes probably do not mark the northern and southern limits of the range accurately, since extensive collecting has not progressed from either point.

Variations

Little if any marked morphological variation is exhibited by Anisodoris nobilis. All specimens collected were essentially morphologically identical. The only variation observed was that of color which ranged from orange with jet black spots situated mainly between the tubercles to a buff with grey spots between the tubercles which characterize most of the larger individuals observed. The extent of black markings varied somewhat from one individual to another.

Ecological Distribution

The recorded vertical distribution extends from twenty-five fathoms (O'Donoghue, 1921) in the Vancouver Island region to the tide



pools of unspecified tide level (MacFarland, 1905) in the Monterey Bay region. Faunal associations of Anisodoris nobilis are not designated in the literature. This species has been collected from about minus two feet to as high as between zero and one foot tide levels. Although the food habits of this species are similar to those of Archidoris montereyensis, the vertical range appears to be more restricted in the upper limits than that of Archidoris montereyensis in the Coos Bay region. Associated species at the same tide levels are the same as those listed for Archidoris montereyensis, although the food source of Anisodoris nobilis appears not to be sponges to the same degree as for Archidoris montereyensis. Examination of stomach contents usually revealed a predominance of plant material.

The habitat requirements are seemingly more specific than that of Archidoris montereyensis, as indicated by the absence of Anisodoris nobilis inside Coos Bay and its restriction to relatively exposed PROC areas (Table I) and its vertical distribution (Table II).

#### Notes on Biology

Anisodoris nobilis occurs less abundantly in the Coos Bay region than has been reported for the Monterey area. MacFarland has reported it as being as numerous as Archidoris montereyensis in that area. Usually only a single specimen or perhaps two individuals are found in an area collected during a low tide in PROC habitat in the Coos Bay region.

Egg ribbons of this species are rarely seen and in only one instance has it spawned in laboratory aquaria. No positively identified specimen of a size smaller than what appears to be adult has been taken

from the area during the summers of 1947 and 1948. This has been taken as an indication that most spawning and early development of Anisodoris takes place subtidally (Costello, 1937). Color variations appear to be related to size. The lighter color was found in large individuals. MacFarland (1906) mentions the lighter color phases, but does not make any statement regarding its being limited to larger specimens.

Aldisa sanguinea, (Cooper) 1862

Doris (Asteronotus) sanguinea, Cooper, 1862. (p. 204)

Aldisa sanguinea, MacFarland, 1905. (p. 42)

Aldisa sanguinea, MacFarland, 1906. (p. 123, with colored lithograph and synonymy).

Ecological Distribution

The extent of the habitat of Aldisa sanguinea in the Coos Bay region was not definitely observed, since for some time the species was overlooked in the area. The color phase of Aldisa sanguinea present in the Coos Bay area bears a close resemblance to Rostanga pulchra, and it is probable that many individuals of this species were mistaken for Rostanga pulchra in the field. It has been collected in the same habitat as that of Rostanga pulchra. At Middle Bay and South Bay it was found in association with the red encrusting sponges and Rostanga pulchra. At Squaw Island, it was found on brown algae.

Geographical Distribution

This species has been previously recorded from San Diego (Cooper, 1862), Santa Barbara, (Orcutt, 1885), Monterey, (MacFarland, 1906) and Point Lobos (MacFarland, 1906) all in California.



### Variations

The two black spots described by MacFarland (1905 and 1906) were not present on the specimens collected in the Coos Bay region. The color of the specimens collected was lighter than that described for Aldisa sanguinea from the Coast of California. The armature of the penis, the branchial plumes and the rhinophorial characteristics served to distinguish it from Rostanga pulchra and place it in the genus. The radula was not examined.

Cadlina flavomaculata, (MacFarland) 1905

Cadlina flavomaculata, MacFarland, 1905. (p. 43)

Cadlina flavomaculata, MacFarland, 1906. (p. 126 with colored lithograph)

### Ecological Distribution

MacFarland (1905 and 1906) reported that Cadlina flavomaculata inhabits rocky tide pools, and does not further describe its typical habitat. O'Donoghue (1922) found it at low tide and under rocks in the Vancouver Island region. It is probably of little ecological significance in the Coos Bay region, since it is rare. Only four or five specimens were collected during the summer of 1948. One was taken at Lighthouse Reef, associated with Diaulula sandiegensis, and the remainder of those collected during the period were taken from under rocks at Fossil Point in Ulva beds.

### Geographical Distribution

This species is recorded from the Vancouver Island region, O'Donoghue (1922), Monterey, MacFarland, (1905) and La Jolla, (1905).

### Variations

The rhinophores are described by MacFarland (1905) as being black, brown or brownish yellow. They also may have a reddish brown or brick red color. The yellow spots on the dorsum are not always arranged in two regular rows, but may be arranged as two irregular rows of six to eight brownish yellow or yellow spots borne upon low compound tubercles which are broader than the other tubercles on the dorsum.

### Notes on Biology

The relatively low incidence of Cadlina flavomaculata in the Coos Bay region is not in agreement with its abundance in Monterey Bay where it is "not rare". "Found at all times of the year in small numbers" according to MacFarland (1906). The spawn was not identified, and there was no opportunity for observation in the field or in the laboratory.

### Cadlina marginata, MacFarland, 1905

Cadlina marginata, MacFarland, 1905. (p. 43)

Cadlina marginata, MacFarland, 1906. (p. 125 with colored lithograph)

Cadlina marginata has been found only outside Coos Bay. Its habitat is restricted to PROC. It is usually associated with Zostera, but not invariably since it occurs above the eel grass zone at times. Normally, it seeks protection on the underside of rocks in association with sponges, hydroids and encrusted algae on which it feeds. Its vertical distribution ranges from about two and one-half feet above mean low tide level to extreme low tide in the Coos Bay region.



It probably occurs subtidally in the area, and has been dredged at twenty five fathoms by O'Donoghue (1921) in the Vancouver Island region.

#### Geographical Distribution

The southernmost point of collection reported is La Jolla, California, O'Donoghue's (1921) report of its occurrence in the Vancouver Island region marks the most northern point recorded.

#### Variations.

The color is relatively constant, with only the yellow markings of the margin of the mantle and foot being less marked in some individuals than in others.

#### Notes on Biology

Although Cadlina marginata is not an abundant form, two or three individuals are usually found in rather close proximity. The spawn is rarely found; however, it has appeared frequently in the laboratory aquaria. The length usually falls between 3.5 and 4.5 cm. None less than three centimeters were collected, and MacFarland (1906) lists 4.5 cm as the length of a large individual.

Cadlina pacifica, Bergh, 1879

Cadlina pacifica, Bergh, 1879. (p. 120)

Cadlina pacifica, MacFarland, 1906

#### Ecological Distribution

Cadlina pacifica has been collected in PROC habitat in the Coos Bay region at tide levels ranging from extreme low to about plus two feet. Its ecological distribution closely coincides with that of Anisodoris nobilis. Specimens were collected at North Bay and Lighthouse Reef.

### Geographical Distribution

The recorded distribution of this species is limited to Bergh's (1879) record and description of specimens collected at Captain's Bay, Unalaska, Coal Harbour and the Shumagin Islands, all in Alaskan water.

### Variations

No morphological or color variations were observed in the specimens collected in the Coos Bay region. Bergh (1879) mentions that the color of the specimens which he received preserved in alcohol was cream or bluish white. The color of the living animals is always white about the same as the ground color of Cadlina marginata.

### Notes on Biology

This form is relatively rare in the Coos Bay region. It occurs more abundantly than Cadlina flavomaculata and is found less frequently than Cadlina marginata. Its food has not been determined; but, feces were found to contain remains of algae and a few nematocysts. It is thought that the nematocysts present were incidental on the algae since other members of the genus are not coelenterate feeders. Its spawn was not identified. Specimens did not spawn in the laboratory.

### Rostanga pulchra, MacFarland, 1905

Rostanga pulchra, MacFarland, 1905. (p. 40)

Rostanga pulchra, MacFarland, 1906. (p. 119 with colored lithograph)

### Ecological Distribution

Rostanga pulchra has an ecological distribution which corresponds to that of Ophlitaspongia and Esperiopsis, red sponges which serve as its principal item of diet. Other associated species include Strongylocentrotus purpuratus and Acmea mitra. Although the remarkable



color adaptation of Rostanga pulchra suggests that its diet might be exclusively limited to the red sponges, it has been found feeding on Laminaria and other brown algae. However, it has not been found to frequent areas devoid of the red sponges. Its vertical range is more limited than that of associated species Archidoris montereyensis and Diaulula sandiegensis (cf. Table II).

#### Geographical Distribution

Rostanga pulchra has a recorded distribution which extends from Point Lobos, California, (MacFarland, 1905) to Vancouver Island, (O'Donoghue, 1922). It occurs intertidally at both reported extremes of its range.

#### Variations

The ground color varies from pink to red, with or without the black flecks mentioned by MacFarland in the original description of the animal.

#### Notes on Biology

Rostanga pulchra is usually more numerous than Archidoris montereyensis in areas abounding in Ophlitaspongia and Esperiopsis. Its incidence is relatively constant from early spring through late summer. Its spawn has not been found after early July. The egg ribbon, which is pink, is not as obvious as those of Archidoris montereyensis and Diaulula sandiegensis, and consequently is not observed frequently.

Diaulula sandiegensis (Cooper) 1862

(Plate II, fig. 2)

Doris (Actinocyclus) sandiegensis, Cooper, 1862. (p. 204)

Diaulula sandiegensis, Bergh, 1880. (p. 40)

Doris (Diaulula) sandiegensis, Orcutt, 1885. (p. 598)

Diaulula sandiegensis, MacFarland, 1906. (pp. 122-123

with synonymy and colored lithograph)

#### Ecological Distribution

Diaulula sandiegensis lives within approximately the same wide ecological range as that of Archidoris montereyensis. Bergh (1880) lists its presence at six fathoms at Sitka and Unalaska. MacFarland, (1905), Cooper (1862), and Orcutt (1885), have found it in tide pools as far south as San Diego. This form usually stays in protected crevices in the rocks, but is capable of adhering quite strongly to the rock substrate and has been found in places exposed to direct surf action. Its food preference has not been determined. Its occurrence in a variety of ecological habitats indicates a low diet specificity. Inter-relationships with other species are evident to a lesser extent than those of Archidoris montereyensis, Rostanga pulchra and other similarly occurring nudibranchs which are more consistently associated with one or two animal or plant forms upon which they largely depend for food.

#### Geographical Distribution

Records of collections of Diaulula sandiegensis include many points on the West Coast of North America and South America from Sitka to the coast of Patagonia on the Atlantic Coast. However, it has not been reported from Oregon in the literature.

#### Variations

The color varies from a sepia ground color with spots or rings of darker brown to a white ground color with black rings or spots. Several specimens which appear to fit Bergh's (1880) description of the variety Diaulula sandiegensis var. pallida from the coast of



Patagonia have been collected in the Coos Bay region at widely separated points not within a single type habitat. It seems doubtful that Bergh's variety is of an ecotypical nature.

#### Notes of Biology

No relationships between size, color and ecological niche have been observed from Diaulula sandiegensis. The constant number of 6 branchial plumes and 20-30 rhinophorial leaves of individuals found in various marine communities leaves little superficial variation for ecotypes or varieties.

Diaulula sandiegensis usually occurs less abundantly than Archidoris montereyensis or Rostanga pulchra, but is usually more numerous than Anisodoris nobilis.

MacFarland (1906) reported observation of egg masses in December and January in Monterey Bay. The spawn has been observed in the Coos Bay region from March to September, and spawning may continue throughout the year here also. Similar to the observations on the California coast, the egg ribbons appear in greatest numbers during June and July. In the laboratory it spawns more freely than any other member of the family.

#### Discodoris heathi, MacFarland, 1905

Discodoris heathi, MacFarland, 1906. (colored lithograph)

One specimen of this species was collected at Middle Bay in April, 1949. It was found on almost bare rocks at about three feet above zero tide level. The single specimen differed from the description given by MacFarland (1905 and 1906) in two respects. The branchial plumes were twelve in number, and the brown flecks were more

concentrated at the margin of the "mantle". MacFarland described the branchial plumes as being eight to ten in number and did not mention the color at the margin of the "mantle".

This one record constitutes the extent of the information about the species in the Coos Bay region. It has been reported as an intertidal form in the Vancouver Island area (O'Donoghue, 1921) and at Monterey (MacFarland).

Sphaerostoma festiva, (Stearns), 1873

(Plate IV, fig. 2)

Lateribranchiaea festiva, Stearns, 1873

Tritonia festiva, Johnson and Snook, 1935. (p. 491,

Pl. VII)

Genus Sphaerostoma (validity discussed by Iredale, 1918)

This species is evidently the Lateribranchiaea festiva of Stearns which was so treated by O'Donoghue (1926); but, it appears to belong to the genus Tritonia of Cuvier (1803) and Alder and Hancock (1845), and therefore to the genus Sphaerostoma in which it is here placed.

#### Ecological Distribution

This small nudibranch was collected only in PROC habitat. It was almost invariably on or near an alcyonarian of the genus Alcyonium, which has the same white or salmon pink color. On one occasion it was found on the under side of shelving rock in the upper limits of the Strongylocentrotus purpuratus zone. It was surrounded by small solitary tunicates. It is usually found lower down in the intertidal zone.



### Geographical Distribution

In the literature, the species is reported from Point Pinos, California at low tide by Stearns (1873).

### Variations

The color varies from white to salmon pink. The branchial plumes are usually darker than the ground color when the color varies from white. They appeared light orange on one specimen.

### Notes on Biology

A European species of this genus reportedly feeds upon a species of Alcyonium, and it is possible that Sphaerostoma festiva feeds upon the soft coral mentioned as a closely associated species. This is a relatively uncommon form in the Coos Bay region. Only three individuals were collected during the summer session at the Oregon Institute of Marine Biology in 1948, and approximately the same numbers were collected during the summer of 1947. Two specimens were collected during a low tide series in April, 1949. The spawn was not identified.

Triopha carpenteri, (Stearns), 1873

(Plate III, fig. 2)

Triopha carpenteri, Stearns, 1873. (p. 78)

Triopha carpenteri, Bergh, 1880. (p. 112)

Triopha carpenteri, MacFarland, 1906. (Colored lithograph)

### Ecological Distribution

The ecological distribution of Triopha carpenteri appears to be more restricted in the Coos Bay region than in Monterey Bay where it is reported by MacFarland (1906) to include the fucoid zone and under

overhanging rocks of rocky tide pools. It is almost invariably found adhering to Zostera or Laminaria in tide pools below the fucoid zone. It was found to occupy the same situation in all three places where it was collected more than one time (cf. Table I).

#### Geographical Distribution

As far as can be determined at present, there is no record in the literature of the occurrence of Triopha carpenteri north of Monterey Bay. The first record of its collection in the Coos Bay region is not definitely known, but its presence in the area has been known for several years.

#### Variations

The ground color varies from white to pale yellow, and the color of the branchial plumes and rhinophoria varies from pale orange to vermillion.

#### Notes on Biology

Triopha carpenteri is a relatively rare nudibranch in the Coos Bay region as compared to its abundance in the Monterey Bay region where it was observed by MacFarland to be the most common nudibranch in that area. It is possible that Coos Bay is near the northern limit of the range, which may account for its occurrence in fewer numbers. The spawn has not been identified in the area; therefore, no statement regarding its breeding habits in the region can be made.

Fluctuation in the occurrence of Triopha carpenteri has been observed. During the summer of 1947, only a few individuals were collected, and of those, not one was of a length greater than 7 cm. During the summer of 1948, the number observed was even less than the previous summer. In April, 1949, Triopha carpenteri was present in



about twice the previous numbers, and up to 13 cm in length.

Lialia cockerelli, MacFarland, 1905

Lialia cockerelli, MacFarland, 1905. (p. 47)

Lialia cockerelli, MacFarland, 1906. (p. 135 with colored lithograph)

#### Ecological Distribution

Since only one specimen definitely identified as Lialia cockerelli was collected in the Coos Bay region during the summers of 1947 and 1948, practically nothing is known about the ecology of the species in the area. MacFarland (1906) describes the habitat as "under shelving rocks in tide pools along the coast, especially near Point Aulon and Point Pinos." O'Donoghue (1926) lists its habitat as being above the Zostera zone in the Vancouver Island region. At Coos Bay it was collected at about zero tide level on a rock along the Lighthouse Beach Channel.

#### Geographical Distribution

Lialia has been collected from the Vancouver Island region by O'Donoghue (1921); at Monterey Bay by MacFarland (1905); near Laguna by Guernsey (1912) and at San Pedro and La Jolla by Cockerell (1905).

Onchidorus fusca, (Muller), 1776

(Plate V, fig. 2)

Doris fusca, Muller, 1776

Lamellidoris bilamellata, Alder and Hancock, 1855.

(Colored plate and synonymy)

Onchidorus fusca, O'Donoghue, 1926. (Synonymy)

Ecological Distribution

This nudibranch has been observed on Fisherman's Wharf along with Hermisenda crassicornis, Archidoris montereyensis, Mytilus edulis, Mitella polymera, Ulva, Obelia and other wharf inhabitants, at Squaw Island under rocks on a coarse sand beach, in dredge hauls from two to five fathoms inside Coos Bay and on rocks at Old Jetty in the same habitat as Hermisenda sp.

Geographical Distribution

This boreoarctic species has been recorded from the East Coast of North America south to Cape Cod, from the West Coast to Europe south to France, from Greenland and Iceland, and from the West Coast of North America from the Bering Sea to Puget Sound. This record presumably extends the southern limit of the recorded range on the West Coast of North America.

Variations

The highly variable combinations of brown, cream and tan coloration on Onchidorus fusca described by O'Donoghue (1922) was observed in specimens from the Coos Bay region. Morphological variations were not detected.

Notes on Biology

This nudibranch is extremely variable in numbers locally. In March, 1948, numerous individuals were seen at about zero tide level at Squaw Island. In the summer of 1947, it appeared in comparatively large numbers on Fisherman's Wharf where it was responsible for the high concentration of egg ribbons present; but, was almost lacking



during the summer of 1948. In March, 1948, it was present in about the same numbers as were observed in July, 1947. In April, 1949, not a single individual of the species could be found on the wharf.

Dendronotus frondosus (Ascanius, 1774)

Amphitrite frondosa, Ascanius, 1774. (p. 155)

Dendronotus arborescens, Alder and Hancock, 1845. (Fam. 3,  
Plate 3)

Dendronotus frondosus, O'Donoghue, 1926. (Synonymy)

Ecological Distribution

Dendronotus frondosus has been found in subtidal association with hydroids and in no other habitat in the Coos Bay region. It presumably feeds exclusively on hydroids.

Geographical Distribution

This is a circumboreal form which has been reported from the Bering Sea (Krause, 1885), Bristol Bay, Alaska, and Vancouver Island region (O'Donoghue, 1921) on the West Coast of North America.

Variations

This species has two phases: one purple with five pairs of branchial plumes; the other, white with six pairs of branchial plumes. These combinations appear to be almost invariable. Alder and Hancock (1845) described white and red color phases, but did not mention variations in the number of branchial plumes. This species may deserve further study to determine the taxonomic significance of these variable characteristics.

Notes on Biology

Dendronotus frondosus has been collected on Obelia colonies on

Fisherman's Wharf, from hydroid colonies on crab pots in six fathoms of water and from crab pots buoys, the latter two outside the bay. Alder and Hancock list its habitat as including intertidal zones in Northern Europe and on the East Coast of North America. They stated that Dendronotus is found "crawling on seaweeds and corallines", but it has always been found on hydroids in the Coos Bay region.

Spawns were present, attached to the hydroids on all occasions when collections were made during June and July.

As many as five or six individuals have been found on a single Obelia colony of approximately 10 cm in length. No specimens were found on examination of the Obelia colonies on Fisherman's Wharf in April, 1949.

Dirona albolineata, MacFarland, 1912

Dirona albolineata, MacFarland, 1912

Dirona albolineata, O'Donoghue, 1922. (Color variations)

Ecological Distribution

Dirona albolineata appears to have a very limited intertidal distribution in the Coos Bay region. The only recorded collections in the area have been at North Bay between zero and plus 2 feet mean low tide level in quiet, rocky tide pools inhabited by Triopha carpen-terii, Hermisenda species, Zostera and Costeria and other brown algae. O'Donoghue (1921) collected it at a depth of 20 fathoms.

Geographical Distribution

Dirona albolineata has been identified in the Vancouver Island region, (O'Donoghue, 1921) at Pacific Grove, (MacFarland, 1912) and at Corona del Mar.



### Variations

No variation other than size were observed in this species.

### Notes on Biology

Dirona albolineata is one of the rare nudibranchs of the Coos Bay region. During the summers of 1947 and 1948, less than twenty specimens were brought in from the collecting trips at the Oregon Institute of Marine Biology. The food habits of this species were not observed.

Hermisenda crassicornis, (Eschscholtz), 1931

(Plate VI, fig. 1)

Cavolina crassicornis, Eschscholtz, 1931

Aeolis (Flabellina) opalescens, Cooper, 1862

Hermisenda crassicornis, O'Donoghue, 1922. (Synonymy)

### Ecological Distribution

Hermisenda crassicornis has been found feeding on Ulva, Laminaria and Halicystis, in bay and PROC habitats. It is reportedly herbivorous and capable of feeding on brown and green algae. However, it has been observed on Obelia on Fisherman's Wharf. Its known vertical distribution in the Coos Bay region extends from extreme low tide to approximately 2.0' above mean low tide level. It has been dredged from six to ten fathoms in Alaskan waters and occurs intertidally in the Vancouver Island region, and along the coast of California.

### Geographical Distribution

Sitka, (Eschscholtz), Vancouver Island, (O'Donoghue), Monterey Bay, (Costello) and San Pedro, (Cockerell) have been recorded as points of collection of Hermisenda crassicornis. It probably occurs more extensively along the California coast than the records indicate.

### Variations

The color variations of Hermisenda crassicornis described by O'Donoghue have been found on specimens in the Coos Bay region. One phase which is superficially distinguished from Hermisenda crassicornis (or its other color phases) by its larger size, larger egg string which has not the pink color typical of that of the Hermisenda crassicornis, proportionately shorter tentacles and more numerous papillae has been collected in considerable numbers at Old Jetty, Fossil Point, and North Bay among Laminaria and Costaria and in association with Triopha carpenteri and Dirona albolineata. This form appears to be specifically distinct from Hermisenda crassicornis, but has not been definitely determined. It possesses the characteristics of the genus.

### Notes on Biology

This is another species which varies considerably in its population in a given area. From the summer of 1947 to the summer of 1948, the number of individuals on Fisherman's Wharf fluctuated from abundance, about equal to that of Dendronotus frondosus, to scarce or completely lacking. In June, 1948, individuals of this species were readily observed on the wharf, but by the end of July none could be found there. It could not be determined whether or not the relative abundance was related to the breeding season of the animal as suggested by Costello(1937). Its spawn has been observed in the area only during the early summer months.



Aeolidia papillosa, (Linne), 1761

(Plate VII, fig. 1)

Limax papillosus, Linne, 1761. (p. 508)

Aeolidia papillosa, Gould, 1870. (p. 240 pt. XVIII)

Eolis papillosa, Alder and Hancock, 1848. (Fam. 3, plate 9  
with synonymy)

Aeolidia papillosa, O'Donoghue, 1926. (Synonymy)

#### Ecological Distribution

Aeolidia papillosa has a wide ecological distribution in the Coos Bay region. It has been found as high as four feet above mean low tide and at extreme low tide (Table II). It has been taken in depths as great as 400 fathoms off Santa Barbara Island. Principally it feeds on coelenterates, and shows little specificity with regard to diet within that group. It has been observed feeding on anemones and hydroids in PROC, protected coarse sandy beach, mud flats, and protected muddy bay habitats. It has been found in association with and feeding upon Bunodactis, Aiptasiomorpha, Metridium, Obelia, Tubularia, Plumularia and other coelenterates in a corresponding variety of habitats.

#### Geographical Distribution

According to Alder and Hancock, Aeolidia papillosa is widely distributed throughout Northern European Seas. It is recorded as an intertidal form in Alaska Waters, as a low tide form in the Vancouver Island region, and as a subtidal form off the coast of California. Presumably this record is an extension of its range of intertidal occurrence.

### Variations

Several variations in the color have been observed, but none of these could accurately be called a color phase, since color in this species is to some extent influenced by the immediate diet of the individual and has been observed to change from light brown to gray in aquaria in the absence of food.

### Notes on Biology

This nudibranch has received considerable notoriety as one of the nudibranchs which contains nematocysts in the terminal portions of the liver diverticulae of the papillae, taken from its coelenterate victims.

It is not abundant form in the Coos Bay region. During the summer of 1948, about a dozen specimens were collected by the students and staff at the Oregon Institute of Marine Biology. Its spawn has not been observed in the area.

Hermaea vancouverensis, (O'Donoghue), 1924

### Ecological Distribution

The only record of this form for the area is its collection on Bryopsis corticulans at Squaw Island at about two feet above mean low water level in July, 1948. In April, 1949, Bryopsis from the same area was examined but no nudibranchs were found on it. O'Donoghue (1924) collected and described the species from Vancouver Island. Other members of the genus have been found on Codium, another green alga.

### Geographical Distribution

The only record was O'Donoghue's from Vancouver Island, B.C.



## Notes on Biology

Like Rostanga pulchra, Hermaea is a form whose color is almost the same as the animal or plant upon which it depends for food. The green and yellow coloration of the animal makes it difficult to see in its natural habitat. Several individuals were found on a small amount of the algae. The other members of the genus are described as "gregarious". Eggs of the animal were not found on the Bryopsis.

Table I

## Species

## Occurrence in the Coos Bay Region

	South Bay	Middle Bay	North Bay	Tegula Bay	Sunset Bay	Squaw Island	Lighthouse Reef	Lighthouse Beach	Coos Head	Old Jetty	Fisherman's Wharf	South Slough	Fossil Point
<i>Archidoris montereyensis</i>	X	X	X	X	X	X	X	X		X	X	X	X
<i>Anisodoris nobilis</i>	X	X	X			X	X						
<i>Diaulula sandiegensis</i>	X	X	X	X	X	X	X	X		X	X	X	X
<i>Rostanga pulchra</i>	X	X	X	X	X	X	X	X					X
<i>Cadlina marginata</i>	X	X	X		X	X	X						
<i>Cadlina flavomaculata</i>							X*						X
<i>Cadlina pacifica</i>			X				X						
<i>Discoderis heathi</i>		X*											
<i>Onchidorus fusca</i>						X*				X	X	X	X
<i>Triopha carpenteri</i>	X		X			X							
<i>Liali cockerelli</i>													
<i>Lateribranchiaea festiva</i>		X			X*		X	X					
<i>Hermisenda crassicornis</i>	X		X							X	X		X
<i>Hermisenda</i> sp.			X				X	X		X	X		X
<i>Dendornotus frondosus</i>											X		
<i>Aeolidia papillosa</i>	X			X			X	X			X	X	X
<i>Dirona albolineata</i>		X	X										
<i>Aldinsa sanguinea</i>	X	X	X			X							
<i>Hermaea vancouverensis</i>						X*							

\* Found one time only at this site.



Table II

Species	Bathymetric Distribution					
	Sub- Tidal	-1.0'	0.0'	-1.0'	-2.0'	-4.0' -8.0'
Archidoris	_____					
Anisodoris nobilis	_____					
Diaulula sandiegensis	_____					
Rostanga pulchra	_____					
Cadlina marginata	_____					
Cadlina flavomaculata			?			?
Onchidorus fusca	_____					
Triopha carpenteri	_____					?
Lateribranchiaea festiva						
Hermisenda crassicornis	_____					
Aeolidia papillosa	_____					
Hermaea vancouverensis				?		?
Dendronotus frondosus	_____					
Hermisenda sp.						
Dirona albolineata						
Cadlina pacifica		?				
Aldisa sanguinea						
Lialia cockerelli				?		

\_\_\_\_\_ Collection range in the Coos Bay region

\_\_\_\_ Bathymetric range according to literature

? Limit not described in literature

Table III

Recorded distribution on West Coast  
of North America

Species	Alaska		British Columbia		California	
	Inter Tidal	Sub Tidal	Inter Tidal	Sub Tidal	Inter Tidal	Sub Tidal
<i>Archidoris montereyensis</i>	X		X		X	
<i>Anisodoris nobilis</i>			X		X	
<i>Diaulula sandiegensis</i>		X	X		X	
<i>Cadlina marginata</i>			X	X	X	
<i>Cadlina flavomaculata</i>			X		X	
<i>Cadlina pacifica</i>	X					
<i>Rostange Pulchra</i>					X	
<i>Discodoris heathi</i>			X		X	
<i>Triopha carpenteri</i>					X	
<i>Lialia cockerelli</i>			X		X	
* <i>Onchidorus fusca</i>	X		X			
* <i>Lateribranchiaea festiva</i>					X	
<i>Hermisenda crassicornis</i>	X		X		X	
<i>Aeolidia papillosa</i>	X		X			X
* <i>Hermaea vancouverensis</i>			X			
* <i>Dendronotus frondosus</i>		X		X		
<i>Dirona albolineata</i>			X	X	X	
<i>Aldisa sanguinea</i>					X	



### Discussion and Summary

According to distribution records for the Pacific Coast of North America, thirty to thirty-five species of nudibranchs should occur in the Coos Bay region. This report includes 20, or perhaps 21 species. The difference between the number of species collected and number of species which is probably present in the region is likely a result of the type of collecting which was done. It was for the most part limited to intertidal zones. Dredge samples from depths ranging from two to nine fathoms inside the bay and examination of crab pots from six fathoms in offshore waters constitute the extent of subtidal collecting. It seems reasonable to assume that subtidal collecting up and down the coast from Coos Bay would yield forms not included in this report.

Thus far, distribution records for the Coos Bay region indicate a predominance of species of *Holohepatica* over species of *Cladohepatica* in a ratio of about 2:1. Eliot (1910) stated that in northern waters the *Cladohepatica* tend to outnumber the *Holohepatica* in number of species and that a striking preponderance of *Cladohepatica* has been noted in Arctic waters. On the other hand, the species of *Holohepatica* outnumber the *Cladohepatica* in tropical waters. O'Donoghue confirms the statement, although he reported the ratio of *Holohepatica* to *Cladohepatica* as being about 1:1 in the Vancouver Island region. The failure of collecting in the Coos Bay region to substantiate this observation may indicate that the small *Cladohepatica* have been neglected, and that more extensive collecting might produce records of a greater number of species of *Cladohepatic* nudibranchs. However,

the waters of the Coos Bay region are by no means arctic, and it is possible that the ratio of species of Holohepatic forms to species of Cladohepatica might be somewhat greater than that which O'Donoghue lists for the Vancouver Island region. That being correct, the total number of species of nudibranchs in the Coos Bay region might be somewhat less than what is expected as based on distribution records for the entire Pacific Coast, since some species of Cladohepatica may not occur much farther south than the Vancouver Island region. Intense collecting at several points on the coast between Coos Bay and Puget Sound should determine whether or not this speculation is correct. The absence of records from that strip of coast makes estimation of the accuracy of the proportional representation of Cladohepatica and Holohepatica established by collections in either the Vancouver Island region or the Coos Bay region difficult.

The following tabulation (Table IV) shows the proportional representation of species of Cladohepatica and Holohepatica in the Vancouver Island region, in the Coos Bay area and on the coast of California. It can be seen from the table that the ratio of the number of species of Holohepatica to that of Cladohepatica is greater for the Coos Bay region than that in the Vancouver Island region, and greater than that for California. The ratio in the Coos Bay region more nearly agrees with that on the coast of California than with that of the Vancouver Island region. As mentioned previously, the difference between the Coos Bay figures and those in California is probably the result of failure to find the smaller Cladohepatic forms.



Table IV  
Proportional Representation of Species  
Cladohepatica and Holohepatica

	Cladohepatica		Holohepatica	
	Total	% Total	Total	% Total
Vancouver Island	20	45.5	24	54.5
Coos Bay	5	25	15	75
California	17	30.4	39	69.6

O'Donoghue (1926) called attention to the difficulty of interpreting the terms of distributional relationships records of nudibranch collections from widely separated points. He writes that "...while the regions of Alaska and Vancouver Island practically touch one another, there is a very large gap between the latter and the Californian region. Over this part of the coast there are no records (with the two isolated exceptions mentioned above)\* from Cape Flattery, at the entrance to the Strait of Juan de Fuca, down to near San Francisco: - this stretch includes the ocean seaboard of the states of Washington and Oregon, and a considerable part of Northern California. It is to be hoped that this gap will be filled, for, until it is, it will not be possible to appreciate the relationships between these two regions."

Forms collected which are recorded from the coasts of California,

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\*The two exceptions mentioned by O'Donoghue were one record from Washington and one record from Oregon.

British Columbia and Alaska include Archidoris montereyensis, Diaulula sandiegensis, Aeolidia papillosa and Hermisenda crassicornis. Those collected which have been reported from both Alaska and British Columbia include Onchidorus fusca and Dendronotus frondosus. Anisodoris nobilis, Cadlina marginata, Cadlina flavomaculata, Dirona albolineata, and Rostanga pulchra have been reported from California and as far as Vancouver Island. Species previously reported in California but not farther north include Triopha carpenteri, Sphaerostoma festiva and Aldisa sanguinea. Cadlina pacifica has not been reported previously south of Alaskan waters. Records of Hermisenda vancouverensis previously have been limited to Vancouver Island area. Sphaerostoma diomedea and Chlorodora leonina are nudibranchs recorded from Alaska, British Columbia and California which were not found in the Coos Bay region. Fiona pinnata, which has been found in Alaska and California regions but not in the Vancouver Island region, was not collected in the Coos Bay region.

This thesis presumably extends the recorded range of Onchidorus fusca, Dendronotus frondosus, Cadlina pacifica and Hermisenda vancouverensis southward; and, that of Triopha carpenteri, Sphaerostoma festiva and Aldisa sanguinea northward on the West Coast of North America. The southern extension of the range of two holohepatica species and one cladohepatica species; and the northern extension of three holohepatica species lends support to the assumption that the ratio of holohepatica to cladohepatica might actually be greater for the Coos Bay region than that which has been established for the Vancouver Island region.



## Description of Plates

## Plate I

Figure 1                      *Archidoris montereyensis*

Figure 2                      *Diaulula sandiegensis*

## Plate II

Figure 1                      *Archidoris montereyensis*

Figure 2                      *Lialia cockerelli*

## Plate III

Figure 1                      *Anisodoris nobilis*

Figure 2                      *Triopha carpenteri*

## Plate IV

Figure 1                      *Aldisa sanguinea*

Figure 2                      *Sphaerostoma festiva*

## Plate V

Figure 1                      *Cadlina pacifica*

Figure 2                      *Onchidorus fusca*

## Plate VI

Figure 1                      *Hermisenda* sp.

Figure 2                      *Dirona albolineata*

## Plate VII

Figure 1                      *Aeolidia papillosa*

Figure 2                      *Cadlina marginata*

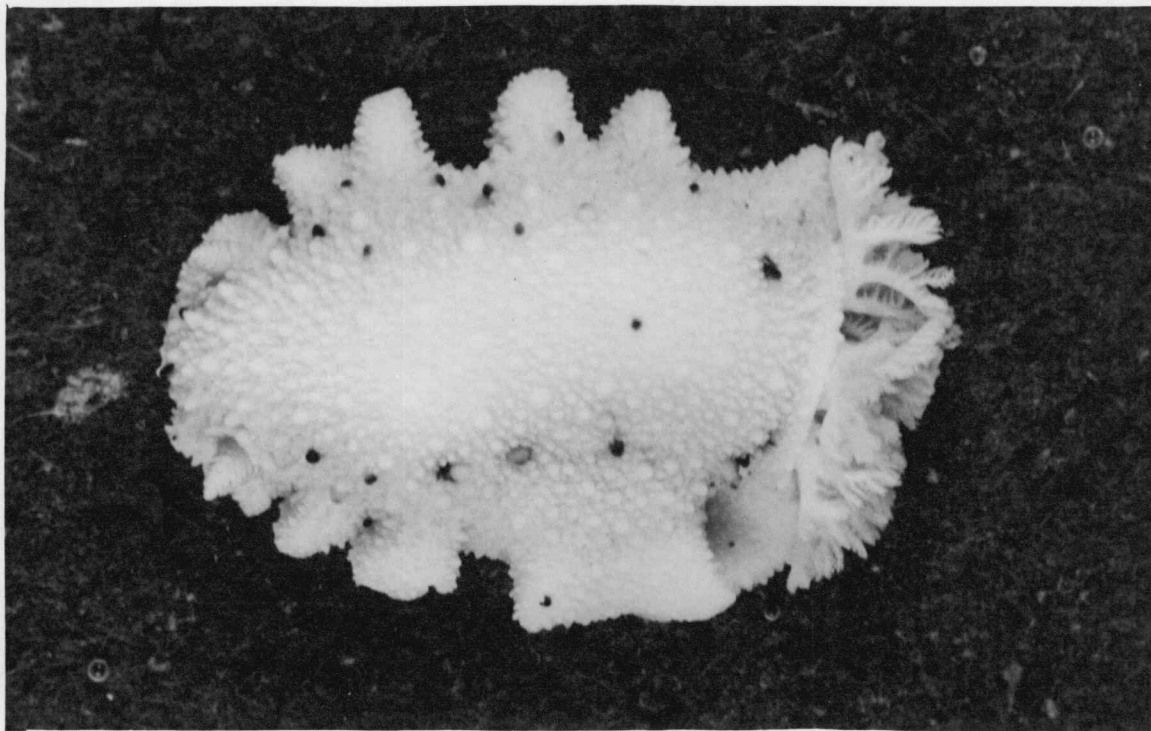
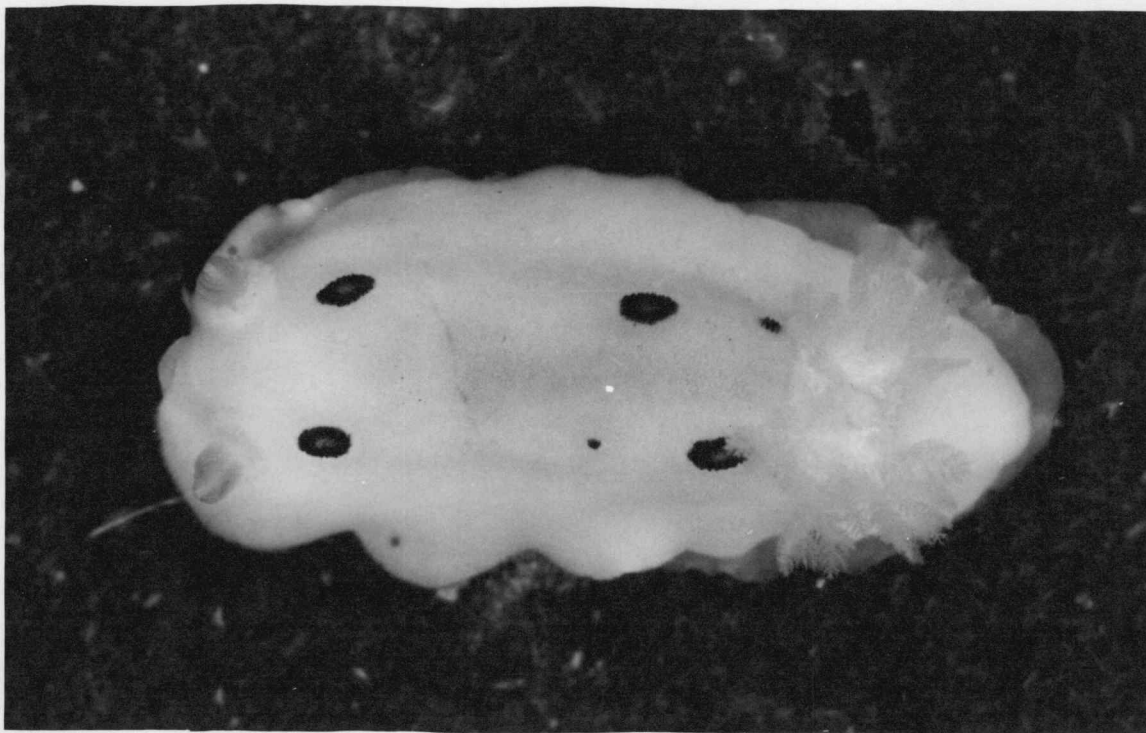


Figure 1

Figure 2





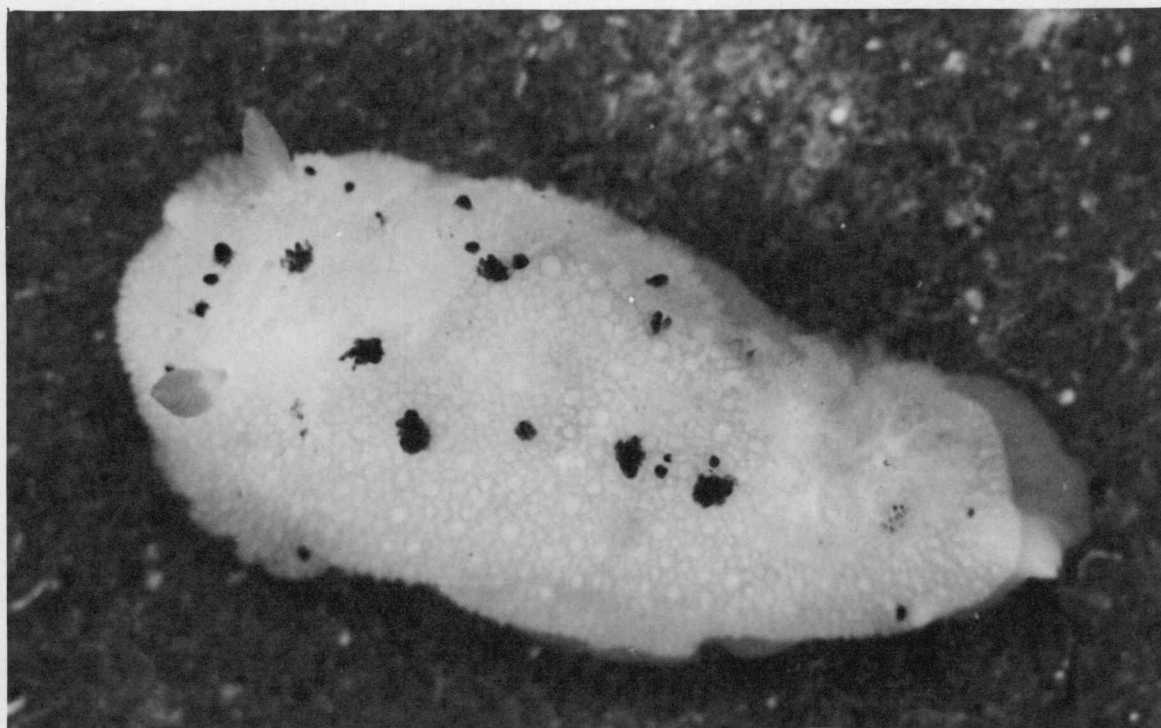


Figure 1

Figure 2



## Plate III

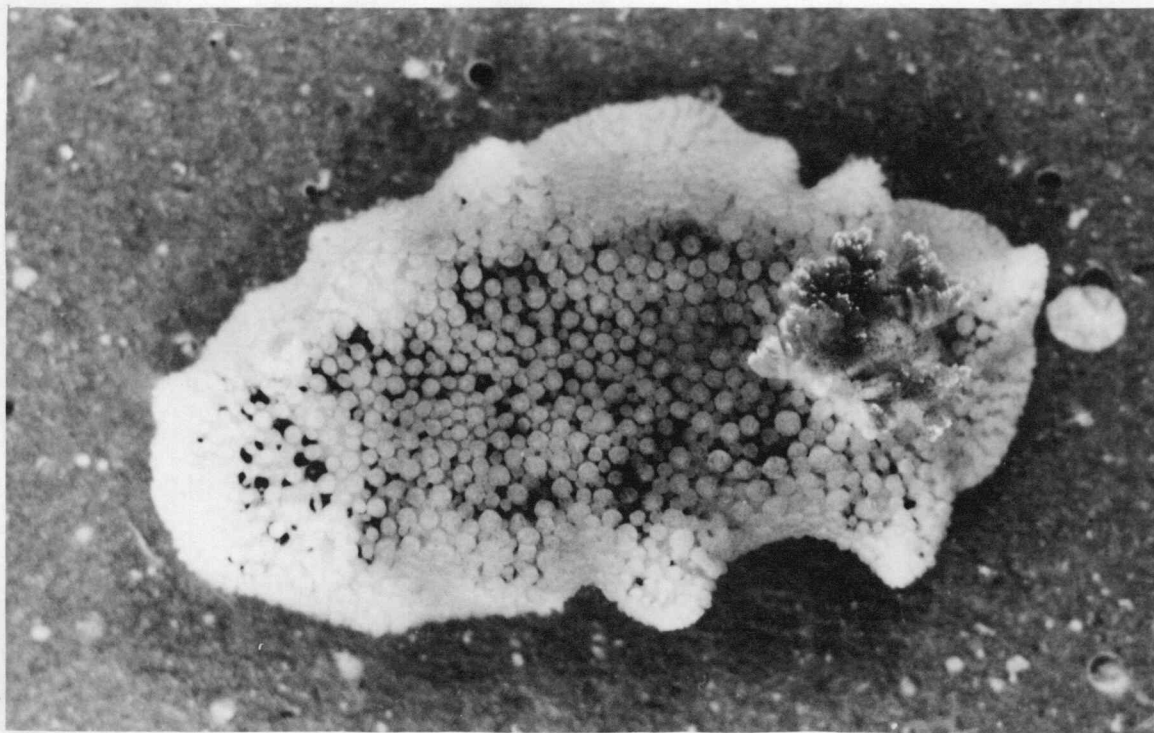
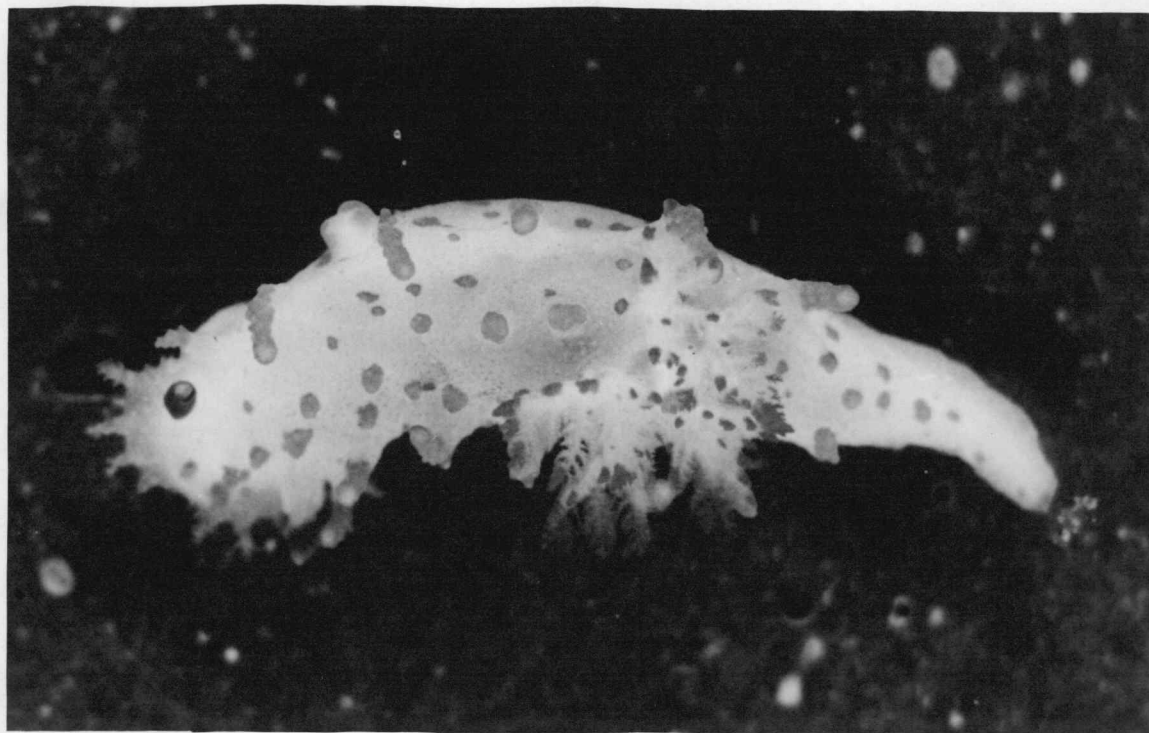


Figure 1

Figure 2





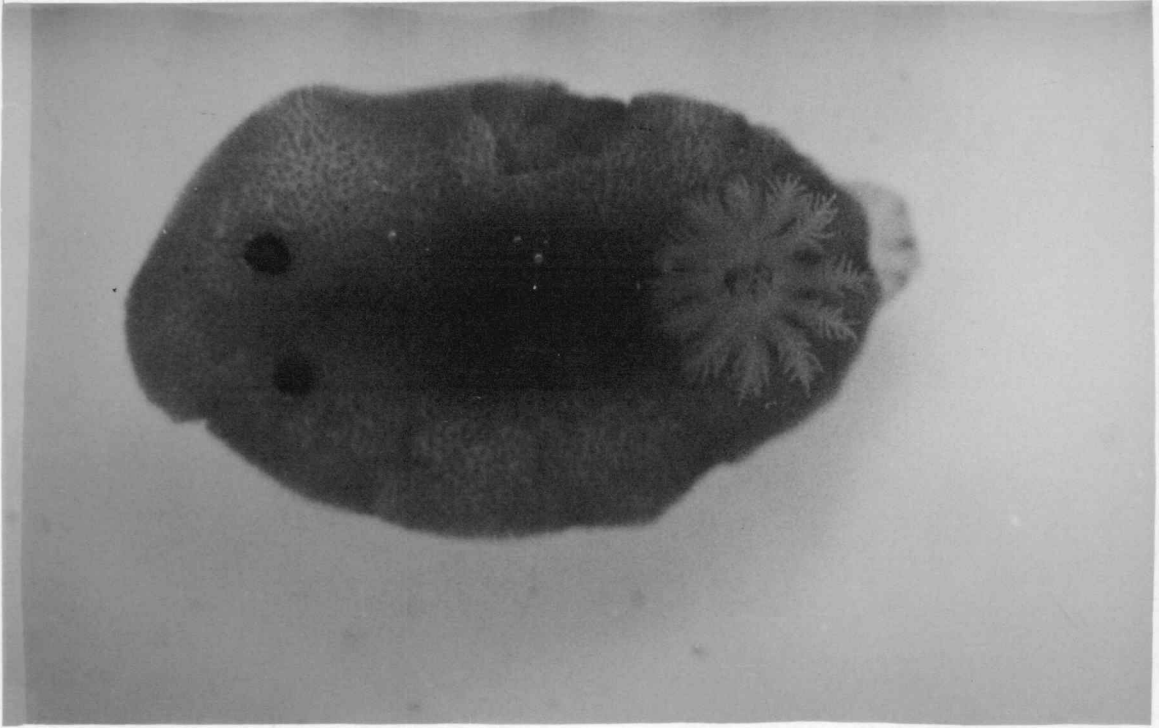
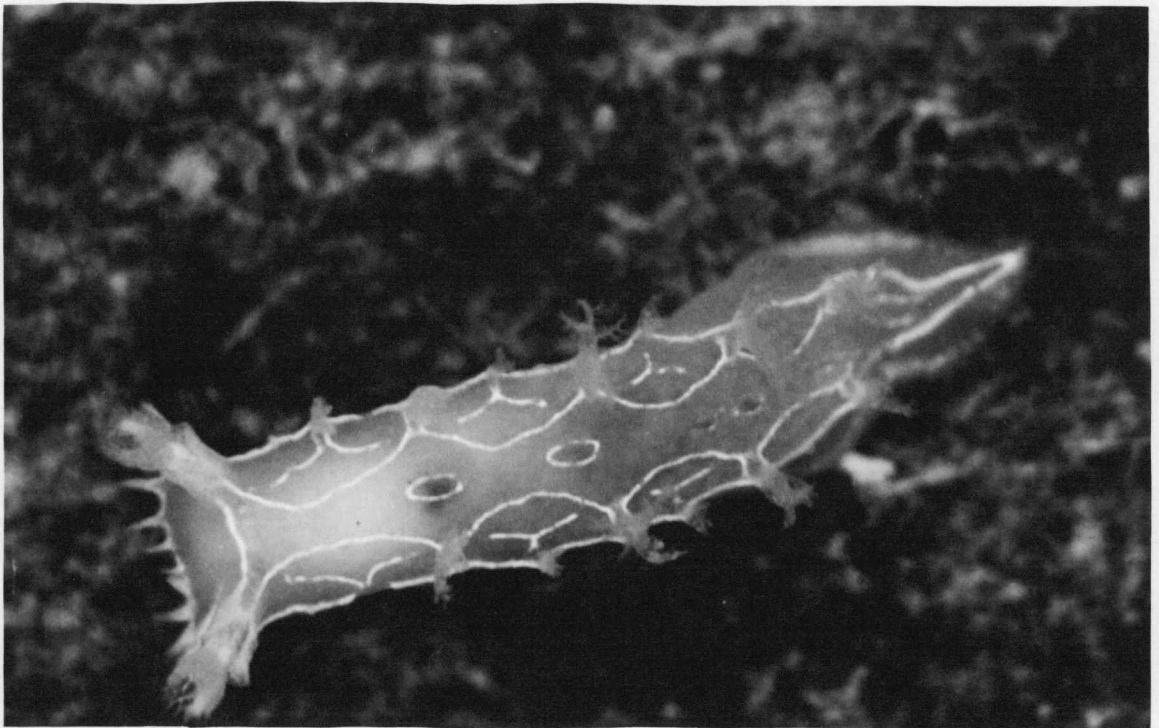


Figure 1

Figure 2



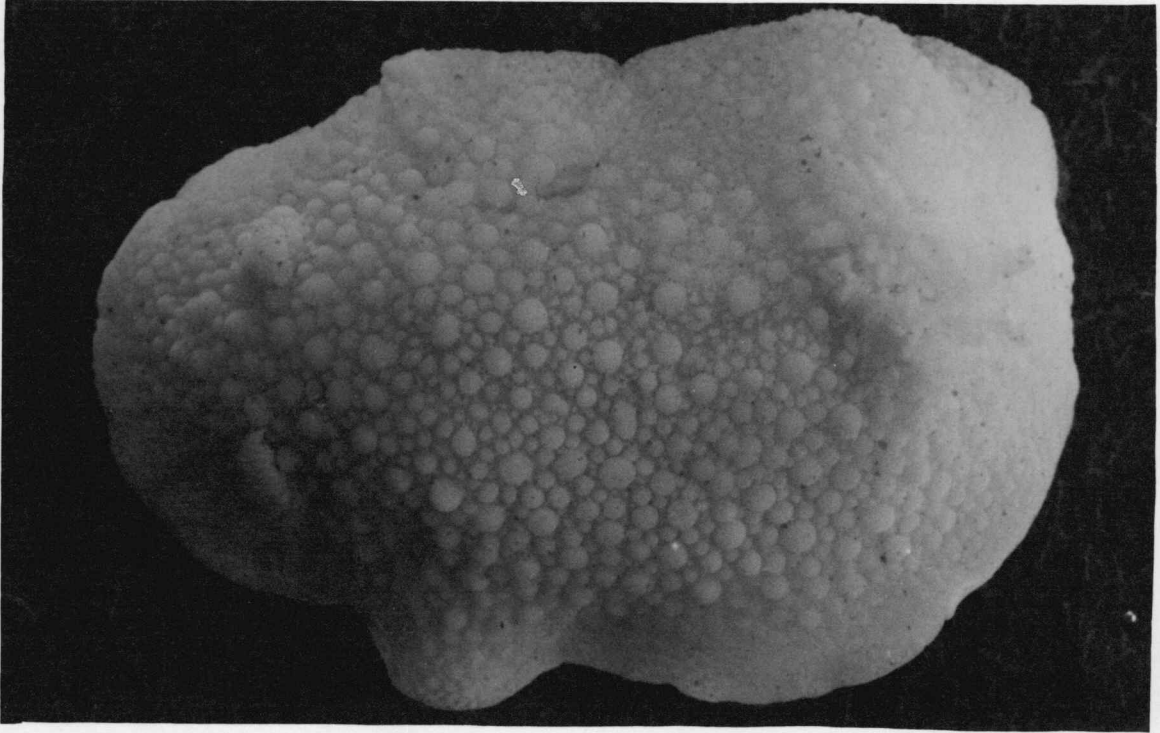


Figure 1

Figure 2

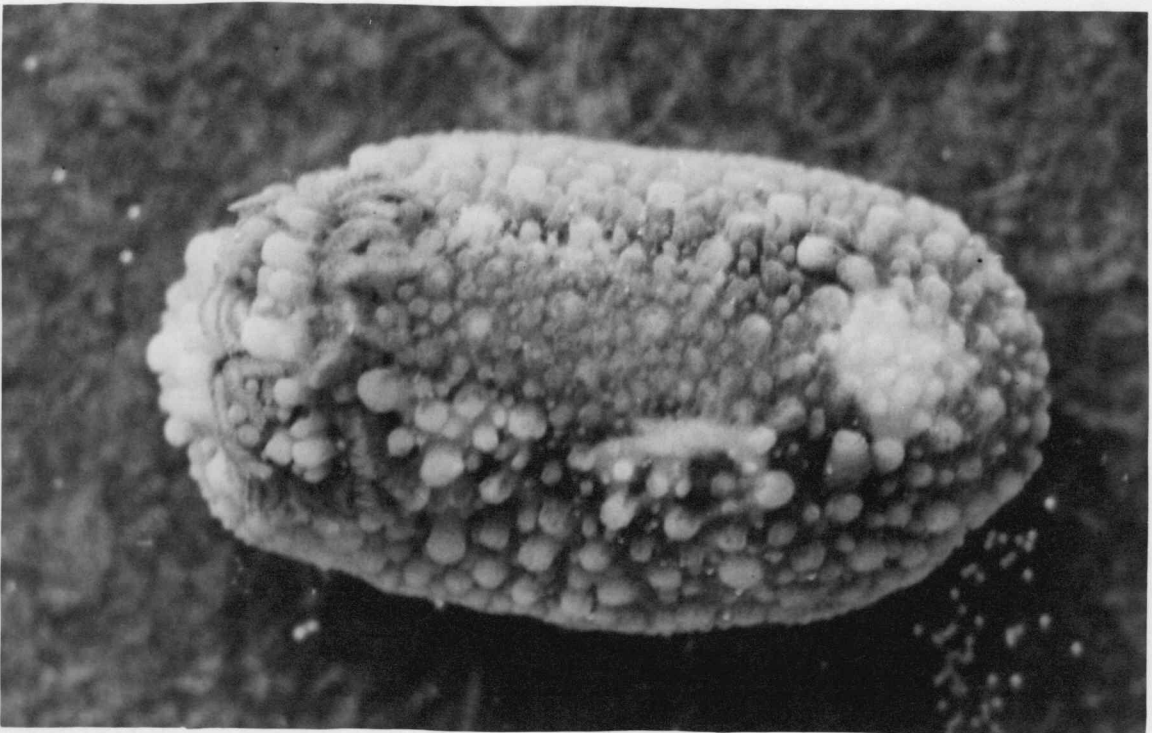






Figure 1

Figure 2

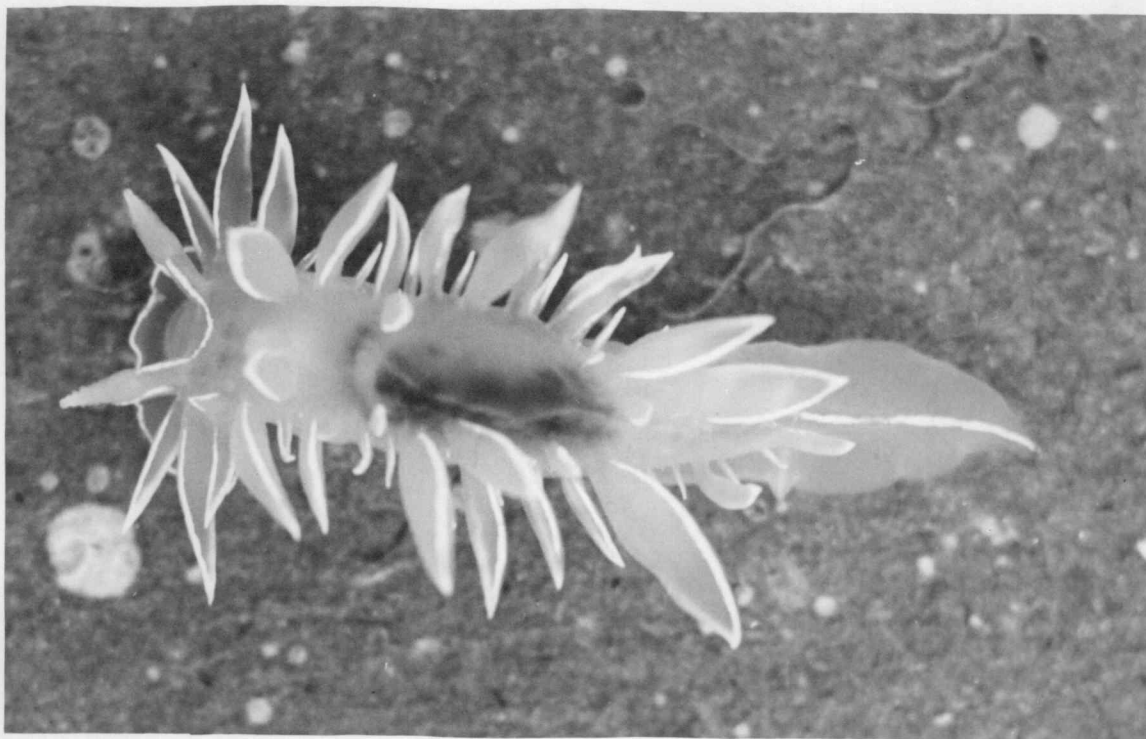
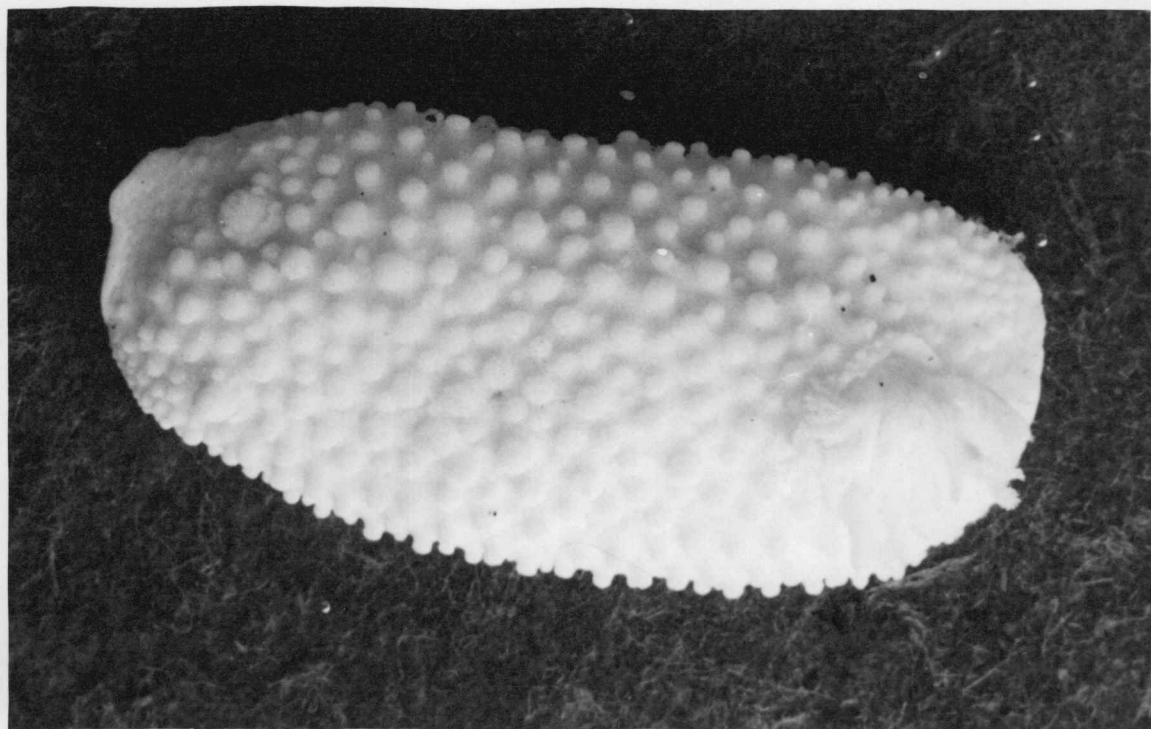




Figure 1

Figure 2





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