THE OPISTHOBRANCHS OF CAPE ARAGO, OREGON,

WITH NOTES ON THEIR NATURAL HISTORY AND

A SUMMARY OF BENTHIC OPISTHOBRANCHS

KNOWN FROM OREGON

by

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The opisthobranch molluscs of Oregon have been little studied, and
little is known about the biology of many species. The present study
consisted of field and laboratory observations of Cape Arago opistho-
branchs. Forty-six species were found, extending the range of six north-
ward and two southward. New food records are presented for nine species;
an additional 20 species were observed feeding on previously recorded
prey. Development data are given for 21 species. Twenty produce plank-
totrophic larvae, and Doto amyra produces lecithotrophic larvae, the
first such example known from Eastern Pacific opisthobranchs. Hallaxa
chani appears to be the first eudoridacean nudibranch known to have a
subannual life cycle. Development, life cycles, food and competition,

ranges, and the ecological role of nudibranchs are discussed. Nudi-

branchs appear to significantly affect the diversity of the Cape Arago

encrusting community. The 66 (possibly 71) benthic opisthobranchs cur-

rently known from Oregon are listed and discussed.

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INTRODUCTION

The opisthobranch molluscs of Oregon have been little studied compared with those of California to the south and those of the San Juan Archipelago-Vancouver Island region to the north. Sowell (1949) studied the natural history of opisthobranchs in the Coos Bay-Cape Arago area in the late 1940's and lists 19 species from that area. Since then two relatively brief studies of Oregon opisthobranchs have been made. Sphon (1972) reviewed the literature mentioning Oregon opisthobranchs and reported on a six day collecting trip made in five Oregon localities. Belcik (1975) lists species not reported by Sphon that he found in the Coos Bay-Cape Arago area while studying parasites of molluscs and fish. A total of 43 benthic opisthobranchs were reported in these three studies, 21 from Cape Arago.

Members of the order Nudibranchia comprise most of the rocky intertidal opisthobranchs. While little is known about the biology and ecology of many Northeastern Pacific species (Beeman and Williams, 1980), those nudibranchs that have received study have all been shown to be carnivores which prey, as a group, on a wide variety of sessile

invertebrates (Thompson, 1976; McDonald and Nybakken, 1978; Beeman and Williams, 1980). Little is known about the effects of their predation on the encrusting communities to which they belong.

In this paper I report on observations, scattered over a 45 month period beginning in December 1979 and ending in September 1983, of rocky intertidal opisthobranchs from Cape Arago. The purpose of this research was to 1) determine which species occur at Cape Arago, 2) find out as much as possible about aspects of their biology, including their food, feeding methods, larval development, and, in a few cases, their life cycles, and 3) attempt to gain some understanding of the effects of their predation on the encrusting community at Cape Arago. Observations are presented for each of the 46 species I found, followed by a general discussion and a list and discussion of the benthic opisthobranchs presently known from Oregon.

STUDY AREA AND DATES OF FIELD OBSERVATION

Cape Arago contains one of the widest, most physically and biolog-
ically diverse intertidal areas between Cape Mendocino, California and
Cape Flattery, Washington (Dr. P.W. Frank, pers. comm.; Dr. J.J. Gonor,
pers. comm.; per. obs.). The study area included North, Middle, and
South Coves of Cape Arago and one small cove located just south of Cape
Arago which I call Good Witch Cove (Fig. 1). Cape Arago is situated 7.3
km southwest of the entrance to Coos Bay. Charleston and the Oregon In-
stitute of Marine Biology are located just inside the south side of the
mouth of Coos Bay.

North Cove

North Cove has the largest intertidal area of the four coves. At
low tide one can walk beyond Shell Island to the outer boulder field and
edge of the Macrocystis-Nereocystis kelp bed located just inside Simpson
Reef. North Cove contains a mixture of sandstone shelves, outcrops,
and boulders of variable size and is protected from large surf by
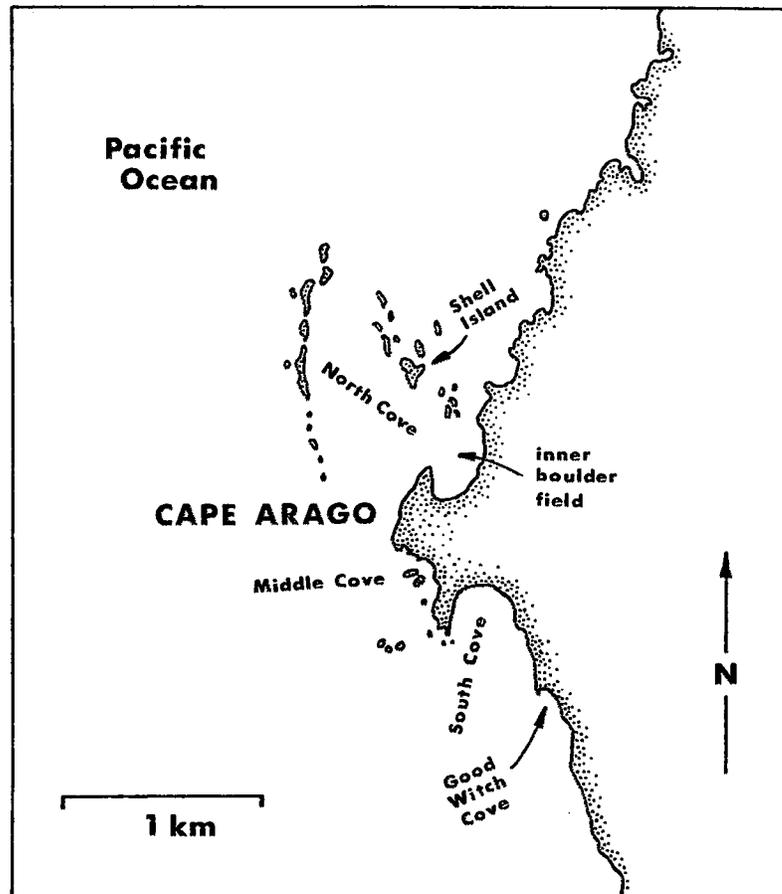
Figure 1. Cape Arago (43°20'N; 124°22'W)

Simpson Reef. Forty-two of 65 trips comprising this study were made to the inner boulder field, one of the most sheltered parts of North Cove (Fig. 1). This boulder field consists of roughly half fissured and pocketed bedrock and half boulders averaging 0.25 to 0.5m in diameter. During the calmer months (spring and summer) much of the inner boulder field is subject to silt and detritus accumulation. Few sea urchins are present, and the area is dominated by the algae _Egregia menziesii_, _Hedophyllum sessile_, _Iridea flaccida_, _Cystoseira osmundacea_, _Laminaria_ sp., the introduced _Sargassum muticum_, and the surfgrass _Phyllospadix_. The undersides of boulders and ledges support a rich variety of sessile invertebrates – the prey of most nudibranchs – and it is under and among these boulders that the greatest number of opisthobranch species and individuals occurring at Cape Arago are found (38 out of the Cape Arago total of 46).

A total of 44 trips were made to North Cove in the following months: 12/79; 3,5,6,7/80; 6/81-5/82; 8,9/82; and 3-9/83. Trips from 10/81 to 2/82 were at night and covered a relatively small portion of the inner boulder field.

Middle Cove

Middle Cove contains the next largest intertidal area of Cape Arago, and, like North Cove, contains a mixture of sandstone bedrock, boulders, and outcrops of varying size. However, Middle Cove is more exposed to surf and possesses a number of invertebrates rare or absent in the North

Cove inner boulder field. Among these are the hydrocoral _Allopora porphyra_ (Fisher, 1931), the coral-like ectoproct _Heteropora alaskensis_ Borg, 1933, and the solitary coral _Balanophyllia elegans_ Verrill, 1864. An undescribed white alcyonacean octocoral (see _Tritonia festiva_) is abundant. Where sea urchins are sparse, Middle Cove supports diverse and luxuriant invertebrate and algal communities. Middle Cove appears to possess the highest hydroid and sponge diversity of any of the coves. In ten trips here (made in months of 3,7,8/80; 6,8,/81; 5-8/83) I found 28 species of opisthobranchs.

South Cove

The west side of South Cove consists of a small boulder field semi-protected from surf. As one moves toward the point separating Middle and South Coves, surf exposure increases and the substrate becomes solid rock with deep surge channels. Not as many species and individuals of opisthobranchs occur at South Cove. I found 10 species on five trips 2,5/80; 5/81; 6,7/82), and none of the species was ever abundant. The low number of opisthobranchs here may be related to the smaller size of the low-intertidal boulder field - much of the area consists of urchin or _Phyllospadix_-dominated bedrock. For unknown reasons hydroids are rare at South Cove.

Good Witch Cove

This is the most surf-exposed of the coves and is accessible only on the lowest tides when the swell is small. The substrate consists of pocketed and fissured bedrock overlain with patches of boulders. Many of these boulders are relatively barren of organisms – probably the result of grazing by the large numbers of urchins, limpets, and chitons present and perhaps also the result of boulder-overturning by surf. However, the undersides of many ledges and larger boulders support a rich invertebrate fauna. I found 18 opisthobranch species here on six trips (5,6,7/80; 5/82; 5,7/83).

METHODS

Opisthobranch prey species were determined by observing close assoc-
iation of the opisthobranch and its possible prey in the field and by
laboratory observation of feeding. Gut contents also were occasionally
examined.

Observations on egg masses and larval development were largely re-
stricted to species for which no other data currently exist. To make
these observations, opisthobranchs were first separated by species into
dishes or jars. A newly laid egg mass was scraped off the side of the
container, examined, and transferred to a separate, labelled jar. The
water in these jars was changed every one or two days, and all jars were
kept in a flowing seawater bath (10° to $17^{o}C$). Separated egg masses
were examined daily until veligers had hatched, at which time veliger
shell lengths were measured. All measurements of eggs and veligers
were made with a compound microscope equipped with an ocular micrometer.

Owing to the discontinuity of field observations little can be con-
cluded about the seasonality of most of the opisthobranch species. North
Cove was observed in every month of the year (though continuously only

for one year), and conclusions about seasonality are presented for a

few of the species found there. These should be considered tentative.

NATURAL HISTORY OBSERVATIONS

Acanthodoris nanaimoensis O'Donoghue, 1921

This dorid occurred rarely at all four coves. I found a total of seven specimens ranging in length from 5 to 22mm.

Adalaria sp.

I found ten specimens of this white dorid, ranging in length from 4 to 15mm in March, April, August, and September at North Cove. Sandra Millen (pers. comm.) informs me that this is one of three *Adalaria* species found in British Columbia and is not species 138 in Behrens (1980). She further states: "It can be recognized by the elongate body, wider at the front end, and by the spicules which project out of the top of the tubercles in a radiating pattern."

Five *Adalaria* sp. were found on the anascan bryozoan *Hincksina minuscula* (Hincks, 1882) on the undersides of boulders. Laboratory observations confirmed that *Adalaria* sp. feeds on this bryozoan. The

Onchidorididae are known to use the radula to open the frontal membranes or opercula of their bryozoan prey and then use a muscular buccal diverticulum as a pump to suck out the zooids (Thompson, 1976). After placing fresh pieces of Hincksina minuscula with Adalaria sp. specimens for a day, such feeding was evidenced by the many empty zooecia possessing partially attached frontal membranes.

The egg mass of Adalaria sp. is a white ribbon laid on edge in a coil of 2 to 4 turns. Egg masses are 1 - 2mm high and 4 - 10mm in diameter. For data on the larval development of this and other species see Table 1.

Aeolidia papillosa (Linnaeus, 1761)

This eolid is frequent at North Cove. Specimens ranged in length from 5 to 55mm and often occurred next to Epiactis prolifera Verrill, 1869, an abundant anemone upon which Aeolidia papillosa readily feeds in the laboratory (pers. obs.).

Aldisa cooperi Robilliard and Baba, 1972

I found three specimens, one at Middle Cove in June 1981, and two at Good Witch Cove in May and July 1983. The first two were 22mm and 27mm long respectively, orange-yellow in color, and had, respectively, 9 and 8 small black dots on the midline of the dorsum between the rhinophores and gills.

Aldisa cooperi was originally described as a subspecies of Aldisa

Table 1. Larval development of Cape Arago opisthobranchs

Species	Diameter of ova (μm)			ova per capsule	Embryonic period (days)	Culture Temp. (°C)	shell type[4]	Length of veliger shell[5] (μm)		eyespots at hatching
	range[1]	month[2]	N[3]					range[1]	N[3]	
Adalaria sp.	81.2 83.7	April	3	1	11	10-12	1	136.0 143.5	3	no
Ancula pacifica	58.3 59.0	June	2	1	9	14-16	1	103.8	1	no
Anisodoris nobilis	83.0	June	1	up to 20	14	14-17	1	152.8	1	no
Aplysiopsis smithi	66.0	July	1	1	7	15-17	1	112.9	1	no
Berthella californica	92.6	May	1	1-2	18	11-14	1	152.7	1	yes
Cadlina modesta	91.0 92.0	April	3	1	16-19	12-15	1	155.6 158.4	4	no
Catriona columbiana	99.7	July	1	1	10	15-17	2	273.9	1	yes
Crimora coneja	71.6 74.2	April	3	1	17-18	10-14	1	115.5 123.5	3	no

Table 1 (cont.)

Species	Diameter of ova (μm)			ova per capsule	Embryonic period (days)	Culture Temp. (°C)	shell type[4]	Length of veliger shell[5] (μm)		eyespots at hatching
	range[1]	month[2]	N[3]					range[1]	N[3]	
Cuthona cocoachroma	96.3	July	1	1	6	15–17	2	256.7	1	no
Diaphana californica	73.2	Sept.	1	1	7–8	12–16	1	122.1 123.6	2	no
Discodoris heathi	76.8	June	1	4–7	15	14–17	1	144.8	1	no
Doto amyra	149.6 154.3	May	4	1	19–21	15–17	1	236.0 238.5	2	yes
Doto kya	~75	July	1	1	7	15–17	1	122.3	1	no
Eubranchus rustyus	92.9	July	1	1	6	15–17	2	240.1	1	yes
Hallaxa chani	79.6 82.6	May	4	1	15–17	11–15	1	147.9 154.1	3	no
Laila cockerelli	95.4	April	1	1	17	10–13	1	141.8	1	no

Table 1 (cont.)

Species	Diameter of ova (μm) range[1]	month[2]	N[3]	ova per capsule	Embryonic period (days)	Culture Temp. ($^{\circ}$C)	shell type[4]	Length of veliger shell[5] (μm) range[1]	N[3]	eyespots at hatching
Onchidoris muricata	75.0 77.3	April	2	1	10-11	7-11	1	128.5 135.6	3	no
Onchidoris sp.	62.6 64.0	Sept.	4	1	9-11	12-16	1	113.3 116.6	4	no
Precuthona divae	107.1	July	1	1	8	15-17	2	249.1	1	no
Triopha catalinae	——	Aug		1	10	14-18	1	~130	1	no
Tritonia festiva	78.9	June	1	1	12	14-17	1	125	1	yes

[1] Range of Means means calculated from measurements (usually ten) of ova (or veliger shells) from a single egg mass

[2] month in which egg masses laid

[3] N = number of egg masses in which ova (or veliger shell lengths) measured

[4] See Hurst (1967)

[5] Length = longest dimension of shell

sanquinea. However, Bertsch and Johnson (1982), on the basis of sympatry,
and Millen (pers. comm.), on the basis of anatomy, consider them to be
separate species. With this in mind, I kept one specimen of both species
together in a jar to see if mating and egg-laying would occur. The A.
cooperi measured 27mm in length, and the A. sanquinea 20mm. After one
month in captivity (12°-16°C), and what appeared to be a number of mat-
ings, the A. sanquinea laid an egg mass. The embryos stopped developing
at about the 32-cell stage. While I can not rule out other factors,
this may indicate that interbreeding occurred but resulted in inviable
hybrid embryos, and thus support the conclusion that A. cooperi and A.
sanquinea are distinct species.

Aldisa sanquinea (Cooper, 1863)

One bright red specimen, 26mm long and lacking dark spots on the
dorsum, was collected at North Cove by the spring 1982 Oregon Institute
of Marine Biology invertebrate zoology class. I found another specimen,
red-orange in color, 20mm long, and also lacking dark spots, at Good
Witch Cove in May 1983.

Ancula pacifica MacFarland, 1905

This species is frequent at North Cove and was most common during
spring and early summer. Ancula pacifica usually occurred under boulders,
and in June 1983 I found eight specimens with egg masses among the ento-
proct Barentsia sp. on the undersides of boulders. Many of these

Barentsia individuals lacked a calyx - most likely as a result of grazing by Ancula pacifica. Ancula pacifica is known to feed on Barentsia ramosa (Robertson, 1900) in California (McDonald and Nybakken, 1978).

Before spring 1983, all the Ancula pacifica I had observed at Cape Arago had the color pattern described by Robilliard (1971b) for the two specimens he found in Washington. These specimens lack orange lines on the body but do possess orange-tipped rhinophores, accessory rhinophore papillae, gills, and extrabranchial papillae. In spring and summer 1983 I noticed the above form of Ancula pacifica as well as the more typical form (which has orange lines on the body and is common in California) at North Cove. Northern and southern forms of Ancula pacifica may exist.

The egg mass of Ancula pacifica is a white, slightly flattened, tapering cord. The cord is not laid in a spiral.

Anisodoris lentiginosa Millen, 1982

On 18 May 1980 I found one specimen crawling on bare rock in a pool at Good Witch Cove. It was about 90mm long, light yellow in color, and had six small, dark brown blotches scattered on the central part of the anterior two-thirds of the dorsum. This specimen represents a southern range extension of 615 km and is also the first intertidal record of the species (Millen, 1982).

Anisodoris nobilis (MacFarland, 1905)

Anisodoris nobilis is moderately common at Cape Arago, occurs at all four coves, and can be found all year long at North Cove. I observed specimens less than 10mm long in December and April. One March specimen measured about 200mm in length. In the field A. nobilis was found feeding on the yellow sponges Mycale macginitiei de Laubenfels, 1930, Zygherpe hyaloderma de Laubenfels, 1932, Tedania gurjanovae Koltun, 1958, and Lissodendoryx firma (Lambe, 1895). Anisodoris nobilis readily feeds on these sponges in the laboratory, and three individuals also ate Ophlitaspongia pennata (Lambe, 1895) in the laboratory. Tedania gurjanovae and Ophlitaspongia pennata are new food records for A. nobilis (McDonald and Nybakken, 1978; Bloom, 1981).

On 30 April 1982 I found one Anisodoris nobilis about 50mm long under a boulder feeding on a Lissodendoryx firma individual covering an area of 680cm^2 (total boulder undersurface = 4900cm^2). Some of the sponge had already been grazed off the rock. On 21 August 1982 only a few square centimeters of the sponge remained and no A. nobilis (nor any other possible predators of the sponge) were present. Though I can not rule out that other A. nobilis or other predators of L. firma had visited the rock, it is possible that the above A. nobilis ate all of the missing sponge.

By area covered, Zygherpe hyaloderma is the most abundant of the above yellow sponges at North Cove (pers. obs.). Mycale macginitiei, which covers considerably less area (but is a thicker sponge) is next most common. I conducted a crude experiment to try to determine which

of these two sponges is preferred by Anisodoris nobilis. Small pieces
(0.25cm^2) of each sponge were placed about 2cm apart and directly in
front of a crawling slug. I observed which sponge was contacted first
and which was ingested. A total of eight trials were made on two days,
using three slugs the first day and two the second. The slugs had been
starved for four days before the trials and ranged from 4 to 10cm in
length. The results (Table 2) suggest that Anisodoris nobilis prefers
Mycale over Zygherpe but will often eat the first sponge it contacts.
Further study of the food preferences of A. nobilis and the effects of
length of starvation, previous diet, and age would be interesting.

The ribbon of one egg mass laid by a 14cm long individual measured
2.7 x 40cm and contained about 2.1 million eggs. Larval development
data are presented in Table 1.

Aplysiopsis smithi (Marcus, 1961)

This sacoglossan occurred in a few high-intertidal pools between
South and Good Witch Coves. I examined these pools for Aplysiopsis
smithi monthly from June 1980 through July 1981. The sacoglossan and
its egg masses were abundant in late spring and early summer 1980, and,
with the exception of one specimen found in December 1980, disappeared
in September 1980 and did not reappear until May 1981. It was abundant
until at least July 1981, though not as common as in the previous year.
In these pools A. smithi feeds exclusively on the green algae Cladophora
sp. Greene (1970) reported southern California A. smithi feeding on
Cladophora trichotoma.

Table 2. Results of <u>Anisodoris nobilis</u> food preference experiment

Outcome of Trial		Frequency
<u>Sponge Contacted First</u>[1]	<u>Sponge Eaten</u>	
<u>Zygherpe hyaloderma</u> (Z)	Z	3
<u>Mycale macginitiei</u> (M)	M	0*
Z	M	1
M	Z	0*
Z & M	Z	0
Z & M	M	4

[1] contact by anterior edge of mantle

* <u>Mycale macginitiei</u> was not contacted first in any of the trials

My observations of the egg masses and veligers match those of Greene
(1968). He observed white and yellow colored egg masses. I noticed
that laboratory specimens laid yellow egg masses at first, but later
egg masses were faint yellow to white. The newly hatched planktotrophic
veligers lack eyespots and possess a granular black pigment scattered on
the edge of the mantle that folds over the outer lip of the shell. Such
pigmentation is unique among the veligers observed in this study. Lar-
val development data are presented in Table 1.

Archidoris montereyensis (Cooper, 1863)

Archidoris montereyensis is fairly common at Cape Arago and occurs
year-round. Specimens ranged in length from 4 to 65mm. Individuals less
than 10mm long were found from November to April, and individuals greater
than 50mm were observed in December, January, April, May, and July. Eggs
were observed in the field in May and July. I sometimes found A.
montereyensis stranded out of water feeding on Halichondria panicea
(Pallas, 1766) and on the massive and densely spiculate sponge Suberites
sp. One specimen, 10mm long, was found at Good Witch Cove embedded in a
soft, unidentified, orange, encrusting sponge.

Archidoris odhneri (MacFarland, 1966)

This species is quite common at Good Witch and Middle Coves but also
occasionally occurs at North and South Coves. With the exception of one
13mm long specimen found in June 1983 at North Cove, all specimens were

7 - 10cm long. <u>Archidoris</u> <u>odhneri</u> rarely occurred on sponges. Two specimens, including the above 13mm individual, were on <u>Hymeniacidon</u> <u>ungodon</u> de Laubenfels, 1932, and ate this sponge in the laboratory. One 9cm long specimen, brownish-yellow in color (and the only <u>A</u>. <u>odhneri</u> I found that was not pure white), was found on a large <u>Suberites</u> sp. individual of the same color - the sponge appeared to have been grazed. <u>Archidoris</u> <u>odhneri</u> has not been reported feeding on either of these sponges (McDonald and Nybakken, 1978; Bloom, 1981).

<u>Berthella</u> <u>californica</u> (Dall, 1900)

This pleurobranchomorph is common on the submerged, relatively barren boulders at Good Witch Cove and also occurs occasionally at the other three coves. Behrens (1980) considers <u>Pleurobranchus</u> <u>denticulatus</u> to be synonymous with <u>Berthella</u> <u>californica</u> and gives Crescent City, California as the northern range limit of <u>B</u>. <u>californica</u>. However, Lambert (1976) reported <u>Pleurobranchus</u> <u>denticulatus</u> from Pearse Island, British Columbia.

The egg mass of <u>Berthella</u> <u>californica</u> is a white ribbon, 3 - 4mm wide, laid on edge in a loose spiral. The newly hatched veligers are distinctive in possessing a dark, red wine colored patch of tissue on the right side next to the anus, as well as a shell whose oldest portion has a brown tinge (similar to the pigmentation on the veliger shells of <u>Hallaxa</u> <u>chani</u>, but not as dark or extensive).

Cadlina luteomarginata MacFarland, 1966

This species is moderately common at all the coves of Cape Arago. I occasionally found it feeding on the pink sponge Apysilla glacialis (Dybowski, 1880). This sponge has previously been reported as the food of C. flavomaculata MacFarland, 1905, and C. modesta, but not C. luteomarginata (McDonald and Nybakken, 1978). One individual was found feeding on a light grayish-tan colored A. glacialis individual, and a number of C. luteomarginata starved in the laboratory fed on Halisarca sp. One specimen, 23mm long at collection, has survived seven months in the laboratory without any food except for one day of feeding on Aplysilla glacialis one month after collection.

On 1 May 1982 I noted an Aplysilla glacialis individual covering an area of 126cm^2 on the underside of a North Cove boulder. The boulder had 630cm^2 of undersurface. I tagged the boulder to keep track of the sponge. On 21 August 1982 one 27mm Cadlina luteomarginata and a 15mm Cadlina modesta were observed feeding on this Aplysilla. They had eaten 18cm^2 of the sponge, but the sponge had grown an approximately equal amount since May. On 26 March 1983 both slugs were still present (though I can not rule out that they were different individuals or that additional individuals of Cadlina had visited the rock) and had eaten all but 4.5cm^2 of the sponge. The C. luteomarginata measured 42mm and had laid two egg masses (one recently laid; the larvae of the other had already hatched). The C. modesta measured 20mm. On 15 April 1983 both dorids were gone and only a trace of Aplysilla remained.

O'Donoghue and O'Donoghue (1922, p. 138) stated that the egg masses of <u>Cadlina luteomarginata</u> "...were not found so frequently as those of <u>Archidoris montereyensis</u> and <u>Diaulula sandiegensis</u> although the animal itself is quite common." and Costello (1983, p. 331) noted that "...the egg ribbons are less vertical than in...other forms.". My observations agree. I saw only two egg masses in the field, both in March 1983. The egg mass ribbon slants toward the center of the tightly wound coil and overlaps itself in the preceding turn. One egg mass had 5 turns and a diameter of 16mm.

<u>Cadlina modesta</u> MacFarland, 1966

Before April 1982 I had only seen two <u>Cadlina modesta</u> at Cape Arago. After April 1982 I found 15 specimens. All 17 specimens were observed in spring and summer at North Cove. Two individuals were feeding on <u>Aplysilla glacialis</u> and two on <u>Halisarca</u> sp., a previously unreported sponge prey. One individual, 6mm long and found on <u>Halisarca</u> sp., survived in the laboratory at 8° - 16° C for 17.2 months. This specimen was sporadically fed <u>Halisarca</u> sp. for the first 5 months, and grew to 20mm in length. It was then starved for 6 months. During the following 6 months it was again sporadically given <u>Halisarca</u> sp., and it ate a total of $13cm^2$ of the sponge (<u>Halisarca</u> sp. averages 2 to 3mm in thickness). The specimen did not appear to eat any of the <u>Halisarca</u> sp. present for the last month of its life, and it never laid eggs.

Concerning the color of the rhinophores of <u>Cadlina modesta</u>, MacFarland (1966) wrote, "Rhinophores light, seldom dusky...", and

Bertsch (1969) stated, "The color of the rhinophores varied from whitish to dusky brown.". In laboratory specimens of Cadlina modesta the rhinophores changed from whitish or light yellow to brown with increasing age.

The egg mass of Cadlina modesta is a cream colored ribbon 2 - 3mm high laid in a loose spiral of 1 - 3 turns. Mean egg mass area was 115.3mm^2 (sd = 52.0mm^2, n = 13 egg masses laid in laboratory by 3 specimens 15 - 20mm long). At a mean density of 180 eggs per mm^2 of egg mass (sd = 33 eggs/mm^2, n = 3), the "average" egg mass of Cadlina modesta contains about 20,750 eggs.

Catriona columbiana (O'Donoghue, 1922)

Catriona columbiana is frequent at Cape Arago and was usually on, or near, the stolons of Tubularia marina (Torrey, 1902) on which it feeds. C. columbiana appears to be most abundant in spring and summer, particularly at North and Middle Coves. Two color forms exist, one with orange cephalic tentacles and one with white cephalic tentacles (both forms have orange on the distal half of the rhinophores). I did not observe any differences in the radula, mandibles, egg masses, and veligers of these two forms.

This species lays small, sac to crescent-shaped egg masses (type D of Hurst, 1967). There is one egg per capsule, and the capsules are deposited in an irregular coil, 2 - 3 capsules wide, in the egg mass.

Crimora coneja Marcus, 1961

With the exception of a single specimen reported from "near Humboldt Bay, Humboldt County, California" (McDonald, 1983), this delicate and rare dorid was previously known only from the type locality of Point Loma, San Diego County, California (Behrens, 1980; McDonald, 1983). On August 29, 1981 Katheryn Young and Tom Wayne of O.I.M.B. collected two individuals from under a boulder in the North Cove inner boulder field. Both specimens were 16mm long. Since then I have observed seven specimens, ranging in length from 14 to 19mm, at North Cove (one in December 1981, one in April 1983, two in August 1983, and three in September 1983) and one 12mm specimen at Middle Cove in July 1983. These eight specimens were on Hincksina minuscula on the undersides of boulders approximately 0.3m in diameter.

Laboratory observations confirmed that Crimora coneja feeds on Hincksina minuscula. One individual overnight ate almost every zooid in a 1cm^2 piece of bryozoan. The zooecia were empty and the frontal membranes missing, indicating that Crimora uses its radula to rasp out entire zooids (contrast with the feeding method of Adalaria sp.).

The egg mass of Crimora coneja is a thin ribbon laid flat (not on edge like most dorids) in a spiral of 4 - 6 turns, and measures 9 - 12mm in diameter. The ribbon is about 1mm wide, contains 1 - 2 layers of eggs and lacks striations of any sort. In different egg masses the eggs vary from white to pale orange in color. Because of its thinness and form, the egg mass is difficult to discern when laid on bryozoan-encrusted substrates.

Cuthona abronia (MacFarland, 1966)

This eolid can be common during the spring and summer at North and Middle Coves. While occasionally seen crawling on submerged algae or on the surface of calm tidepools, it usually occurs among minute, unidentified, thecate hydroids under boulders in areas subject to little accumulation of silt and detritus (purple sea urchins are often in the vicinity). In April 1982 I found five specimens and about 20 egg masses on the underside of a single small boulder.

Cuthona albocrusta (MacFarland, 1966)

Cuthona albocrusta occurred at Middle Cove (2 specimens in August 1980 and 4 in July 1983) and North Cove (5 in May 1980, 1 in July 1981, and over 11 in July and August 1983). In August 1983 I found five specimens clustered among minute, unidentified, unbranched, thecate hydroids (probably of the family Campanulinidae). These hydroids were partially covered by a fine, light greyish-tan colored silt - the eolids were quite cryptic in this microhabitat.

Cuthona cocoachroma Williams and Gosliner, 1979

Three specimens of this rare eolid were seen at Middle Cove, one in July 1980, one in June 1981, and one in June 1983. The range of Cuthona cocoachroma is extended 255km from Trinidad Head, Humboldt County, California (Jaeckle, 1981). I also found one specimen of C. cocoachroma at Cape Blanco (50km south of Cape Arago) in April 1982.

The egg mass of Cuthona cocoachroma is a white cord laid in a small rosette.

Cuthona flavovulta (MacFarland, 1966)

I found seven specimens crawling on submerged algae or on the surface of calm pools at Middle and North Coves in summer 1983. The range of Cuthona flavovulta is thus extended from Palmer's Point, Humboldt County, California (Jaeckle, 1981).

Cuthona fulgens (MacFarland, 1966)

Four specimens were found crawling on submerged algae or on the surface of calm pools at North and Middle Coves in summer 1983. The range of Cuthona fulgnes is extended from Duxbury Reef, California (Gosliner and Williams, 1970).

Dendronotus frondosus (Ascanius, 1774)

I observed few Dendronotus frondosus at Cape Arago until June and July 1983, when over 20 specimens were seen on a small unidentified species of Obelia in the very low intertidal of Middle Cove. Dendronotus frondosus can be abundant during the spring and summer, feeding on the much larger and highly branched species of Obelia on the docks of the Charleston boat basin (pers. obs.). All Cape Arago specimens were less than 2cm long, and a number of individuals were on hydroids growing on the brown alga Cystoseira. D. frondosus occurred in low numbers at all the coves of Cape

Arago.

Dendronotus subramosus MacFarland, 1966

I found only two specimens of Dendronotus subramosus at Cape Arago, both at Middle Cove. One specimen, 4mm long, was under a small boulder, and one 2mm specimen was on hydroid-covered Cystoseira.

Diaphana californica Dall, 1919

One specimen, with a 3mm long shell, of this minute Bullomorph was collected from the North Cove inner boulder field in August 1981. I found three more (shell lengths of 3.3mm, 3.0mm, and 2.1mm) in the same location in September 1983. Much of the mantle and viscera is visible through the thin translucent shell. The range of this species is extended 610km from Duxbury Reef, California (Gosliner and Williams, 1970).

The egg mass of Diaphana californica is a fragile and very extensible cord attached to the substrate along its entire length. The cord of one egg mass was laid straight, varied from 0.1 to 0.5mm in diameter, and measured 20mm in length. Two other egg masses were C-shaped, with the cord varying from 0.75 to 1.5mm in diameter; one of these was 7mm long, the other 10mm.

Diaulula sandiegensis (Cooper, 1863)

This species is common at Cape Arago and is often seen under ledges and boulders feeding on Haliclona sp. A of Smith and Carlton (1975, p.45). Specimens ranged in size from 5 to 70mm. Specimens less than 15mm were found in January, March, April, June, and July, and specimens over 50mm long were found in May through July, and in October, and January. Small to medium size individuals are often at the end of a "path" they have eaten into Haliclona sp. and, owing to the resemblance of their dorsal brown rings or spots to the oscula of the sponge, are quite cryptic.

Dirona albolineata Cockerell and Eliot, 1905

This species was abundant at North Cove during the latter part of summer in 1980, 1981 and 1982. It was rare or absent in the other seasons I looked. In 1983 I did not see any until early September, when only two were found. Dirona albolineata is usually crawling on algae and rocks in pools along with Janolus fuscus and Triopha catalinae.

Discodoris heathi MacFarland, 1905

I found five specimens ranging in size from 7 to 90mm during the summer months at North Cove, and one 20mm individual in August at Middle Cove. An 11mm specimen was embedded in Mycale macginitiei under a boulder and ate this sponge in the laboratory. A 60mm slug are a 30mm diameter Mycale macginitiei individual overnight. This is a new food record for Discodoris heathi.

Discodoris heathi lays large yellow egg masses in the typical dorid form.

Doto amyra Marcus, 1961

I observed this species only at Middle Cove: one in July 1980, five in June 1981, and 22 (with egg masses) in May and July 1983.

Despite the taxonomic confusion surrounding Eastern Pacific Doto species (Marcus, 1961 described four new species, but Behrens, 1980 and McDonald and Nybakken, 1980 only list two of those), I am calling this species Doto amyra after McDonald and Nybakken (1980). With the exception of one, all the specimens I examined matched their description and photograph of Doto amyra (Marcus's original description mentions little about the living animal). The cerata cores varied from light yellow to light orange-brown; the gonads were yellow, and the cerata tubercles were translucent white and contained slightly opaque white grains (these grains are larger and less dense than the opaque white grains present in the distal parts of the rhinophores and their sheaths). The exceptional specimen mentioned above, while possessing all the above characteristics, also possessed a subcutaneous black pigment in the body similar to that in the body of Doto kya. However, this slug laid eggs identical to those of the other Doto amyra, and, as seen below, the eggs of Doto amyra are very different from those of Doto kya.

Most of the Doto amyra, and all of the egg masses, were on colonies of the thecate hydroid Abietinaria sp., a previously reported prey of Doto amyra (Beeman and Williams, 1980). Slugs occurred on both the

stolons and upright portions of the hydroid. Egg masses were usually
attached to the bases of the colonies.

Doto amyra feeds on Abietinaria sp. by rasping a circular hole in
the perisarc with its radula and then sucking out the hydroid tissues
by means of muscular contractions of its esophagus (pers. obs.). One
5mm long slug rasped a hole 32   in diameter in the perisarc.

Doto amyra lays yellowish egg masses that are laterally flattened,
slightly crescent-shaped with rounded ends, and laid on edge. The thick
jelly attachment sheet is translucent white with parallel white stria-
tions; the rest of the egg mass jelly is clear. Egg masses measure up
to 1.5mm high by 4mm long and derive their yellow color from the yellow
eggs.

The larvae of Doto amyra hatch out as crawling veligers possessing
large eyespots, a large foot, a small velum, and poor swimming abilities.
In the presence of Abietinaria sp., they metamorphose into juvenile
slugs within a few days after hatching (pers. obs.). Doto amyra is the
first eastern Pacific nudibranch known to produce lecithotropic larvae
(type 2 development of Thompson, 1967) (Hurst, 1967; Thompson, 1967;
Bonar, 1978; present study). I examine this development more closely
elsewhere (ms in preparation).

Doto kya Marcus, 1961

In May and June 1980 I found four specimens at North Cove. Two of
these were among Plumularia sp. and a short unidentified hydroid of the
family Campanulinidae – both hydroids were growing on the perennial

portion of the brown alga _Cystoseira_. Three more were seen at Middle Cove in July 1983. All specimens match the photograph of _Doto kya_ in Behrens (1980).

The white egg masses of _Doto kya_ are laterally flattened (more flattened than the egg masses of _Doto amyra_), slightly wavy or folded crescents to semi-circles laid on edge and measure up to 3mm in length.

Eubranchus olivaceus (O'Donoghue, 1922)

Two specimens, 6mm and 8mm long, were found at North Cove in June and July 1983. The radula from the latter one has 42 rows of teeth and does not taper. As Marcus (1961, p. 49) noted, the nontapering radula is at present the major anatomical character distinguishing _E. olivaceus_ from _E. rustyus_.

Eubranchus rustyus (Marcus, 1961)

I found a few _Eubranchus rustyus_ in the summer months at North and Middle Coves. Six specimens 0.5 - 5mm long occurred with egg masses on _Plumularia_ sp. at Middle Cove in July 1983. _E. rustyus_ eats this hydroid in the laboratory (pers. obs.). The radula from a 6mm long specimen has 57 rows of teeth and tapers distinctly.

<center>Flabellina trilineata (O'Donoghue, 1921)</center>

Flabellina trilineata is the most abundant eolid at Cape Arago and
occurs at all four coves. It is commonly found feeding on Tubularia
marina, an abundant hydroid at Cape Arago. Both species appear to be
most abundant during the spring. I have observed F. trilineata feeding
on Eudendrium californicum Torrey, 1902 in California (and McDonald and
Nybakken (1978) report it feeding on Eudendrium sp.). Although large
Eudendrium californicum colonies occur at Middle Cove, often in close
proximity to F. trilineata and Tubularia marina, I never observed the
eolid on them. This suggests that F. trilineata prefers Tubularia
marina to Eudendrium californicum.

Many individuals of F. trilineata lacked orange pigment on the
rhinophores and cephalic tentacles. MacFarland (1966, p. 321) also
noted this variability in color pattern.

<center>Hallaxa chani Gosliner and Williams, 1975</center>

Since first reporting two specimens of Hallaxa chani from North
Cove, Cape Arago (Goddard, 1981), I have seen over 70 individuals in
the North Cove inner boulder field, and as many as 14 specimens on a
single low tide. H. chani is usually on or near its sponge prey
Halisarca sp. underneath mid- to low- intertidal boulders.

In the laboratory Hallaxa chani of all sizes readily feed on
Halisarca sp. and do not feed on the white colonial tunicate (either
Didemnum carnulentum Ritter and Forsyth, 1917 or Trididemnum opacum

(Ritter, 1907) that is common under North Cove boulders and was previously suspected to be eaten by H. chani (see Goddard, 1981). I have never observed H. chani feeding on any other organisms.

Hallaxa chani blends in well on Halisarca sp. Both organisms are light to yellowish-tan in color, and the reddish-brown flecks and subcutaneous dark spots on H. chani match the dark spots on Halisarca sp. (The "dark spots" on Halisarca sp. are caused by the sponge structure rather than pigmentation. They appear to be associated with the water canal system.) Moreover, when feeding, H. chani tends to spread out its semi-translucent dorsum, thus taking on some of the sponge color and also making the thin edge of the dorsum difficult to discern. Small H. chani are very cryptic.

Observations indicate that Hallaxa chani grows rapidly for a dorid of its size, reaches maturity in a few months, and lives approximately six months. One individual, 5mm long (wet weight of 20mg) at collection, kept in 10° C water, and given Halisarca sp. every few weeks, grew to a wet weight of 360mg in 44 days, and laid an egg mass 44 days after collection. It weighed 121mg on day 132, and was moribound after 152 days. Four other specimens of similar initial weight (including one that was kept isolated and never laid eggs - this individual reached a length of 28mm and a weight of 957mg) lived 150 days or less under similar conditions.

The egg mass of Hallaxa chani is a cream colored ribbon 2 - 3mm high laid in a loose spiral of 1 - 3 turns. The hatching veligers lack eyespots and possess type 1 shells whose oldest portion is a translucent

brown color.   Specimens of H. chani less than 5mm long occurred in all seasons, and egg masses were found in all seasons except winter, indicating that reproduction occurs most of the year.

Hermaea vancouverensis O'Donoghue, 1924

I found four specimens, 6 - 8mm long, of this sacoglossan on brown algae in the North Cove inner boulder field in June 1981.

Hermissenda crassicornis (Eschscholtz, 1831)

Hermissenda crassicornis was not very common at Cape Arago.   In June 1981 I found over 20 specimens at Middle Cove, but on other occasions never more than six.   Interestingly, H. crassicornis is abundant on the docks of the Charleston boat basin during spring and summer. Most of the H. crassicornis at Cape Arago and the boat basin are the variety possessing a bluish-white stripe on the cerata (see Behrens, 1980, p. 93, lower photograph).   H. crassicornis occurs in all four coves.

Janolus fuscus O'Donoghue, 1924

Gosliner (1982) recently reinstated Janolus fuscus as a distinct species from the more southerly Janolus (Antiopella) barbarensis (Cooper, 1863).   Cape Arago Janolus are all Janolus fuscus and, the Antiopella barbarensis reported from Oregon by Sphon (1972) were undoubtedly also J. fuscus.

Janolus fuscus occurred from April to October at North Cove only.
During August and September it is one of the most abundant and conspicu-
ous nudibranchs at North Cove. It is usually found crawling on rocks
or on the algae Sargassum, Egregia, and Phyllospadix in the large pools
of the inner boulder field where it searches for the arborescent bryo-
zoans upon which it feeds (McDonald and Nybakken, 1978; pers. obs.).

Laila cockerelli MacFarland, 1905

Laila cockerelli was uncommon at Cape Arago until spring and
summer 1983 when I found a total of 20 specimens at North and Middle
Coves. It also occurs at South and Good Witch Coves. A number of in-
dividuals were observed on the light orange bryozoan Hincksina velata
(Hincks, 1881) and ate this bryozoan in the laboratory. Laila
cockerelli has been reported feeding on Hincksina velata in California
(McDonald and Nybakken, 1978).

My observations of the pink colored egg mass of Laila cockerelli
generally match those of O'Donoghue (1922). However, he described it
as a "...slightly flattened string...wound in a close, tight-fitting
spiral.". Egg masses I observed were a ribbon laid flat in a close
spiral. It is very similar in morphology to the egg mass of Crimora
coneja. One egg mass had 4.5 turns, a diameter of 15mm, and a ribbon
whose width varied from 1.5 to 20.mm.

Onchidoris muricata (Müller, 1776)

This small dorid is sporadically common at North Cove. It usually occurs under boulders on Eurystomella bilabiata (Hincks, 1884), an abundant bryozoan which it eats in the laboratory (pers. obs.). Onchidoris muricata that have been feeding on this bryozoan possess a deep red colored digestive gland visible through the foot. I also found O. muricata on Microporella cribosa (Osburn, 1952) and Hincksina minuscula but did not confirm feeding on these two species.

Onchidoris muricata can be difficult to distinguish from Adalaria sp. in the field. However, O. muricata is usually shorter, rounder, and has bulbous, fairly smooth dorsal papillae. The pointed spicules in the papillae of O. muricata barely protrude above the surface of the papillae; those of Adalaria sp. protrude very far.

Hurst (1967) described the egg mass of Onchidoris muricata. Like many other dorids, O. muricata sometimes only lays a small portion of an egg coil (pers. obs.).

Onchidoris sp. (cf. Onchidoris hystricina)

This species is referred to as Onchidoris hystricina by Behrens (1980, pp. 66 and 67), McDonald and Nybakken (1980, pp. 44 and 45), and Beeman and Williams (1980, p. 328). However, Onchidoris sp. disagrees with Bergh's 1878 and 1880 descriptions of O. hystricina, as well as Marcus's (1961) description of O. hystricina. The dorsal papillae, gills, and radula are very different (Sandra Millen, pers. comm.; pers.

obs.). It appears to be undescribed.

Onchidoris sp. was observed at North Cove in August and September of 1981, 1982, and 1983. It was common in these months all three years.

The white egg mass of Onchidoris sp. is a cord, 0.75 - 1.0mm in diameter, laid in a disorderly spiral of 1 - 4 turns measuring up to 5mm in diameter.

Placida dendritica (Alder and Hancock, 1843)

I found this species feeding on Codium fragile in pools between South and Good Witch Coves. Behrens (1980) reports San Francisco Bay as the northern limit of this species, but Lambert (1976) found it on the northern tip of Vancouver Island, British Columbia.

Polycera atra MacFarland, 1905

Three specimens were observed in September 1983 at North Cove. Polycera atra occurred by the hundreds feeding on arborescent bryozoans in the Charleston boat basin in June 1983, but repeated observation in mid-July only turned up a single specimen. The range of Polycera atra is extended from Humboldt Bay, California (Jaeckle, 1981).

Precuthona divae Marcus, 1961

This eolid occurred in low numbers at North and Middle Coves in the spring and summer. One specimen from Middle Cove was 32mm long. I have also found Precuthona divae at Cape Blanco (50km south) feeding on the

pink colonies of Hydractinia sp. The egg mass of P. divae is a round,
hemispherical-shaped rosette. Robilliard (1971) reported egg masses of
P. divae from San Juan Island, Washington as being white; those at my
study sites were pink.

Rostanga pulchra MacFarland, 1905

Rostanga pulchra is abundant at Cape Arago and occurs with its egg
masses throughout the year. I observed it feeding on Ophlitaspongia
pennata and also found it (and its eggs) on Antho lithophoenix (de
Laubenfels, 1927) and Hymedesmia sp. A (of Smith and Carlton, 1975,
p. 51). I also found R. pulchra close to, but not on, Plocamia
karykina de Laubenfels, 1927 and Axocielita originalis (de Laubenfels,
1930). R. pulchra has previously been reported feeding on, or occurring
on, all of the above sponges except for Hymedesmia sp. A (McDonald and
Nybakken, 1978).

Triopha catalinae (Cooper, 1863)

One of the most common dorids at Cape Arago, Triopha catalinae
occurs year-round but is most abundant during summer and fall, espec-
ially at North Cove. Individuals ranging in size from less than 10mm
to 70 or 80mm can be found in nearly any month; this suggests a long
breeding season and a probable lack of synchrony of reproduction among
individuals. I've never seen T. catalinae egg masses in the field.
Egg masses laid in aquaria are large, pinkish-white, coiled ribbons

laid on edge.

At Cape Arago Triopha catalinae feeds on unidentified species of
arborescent and encrusting bryozoans. Small individuals are often
found on bryozoans on the undersides of boulders, and large individuals
are usually out in the open, crawling on submerged algae and rocks.

Triopha maculata MacFarland, 1905

I found five orange specimens during summer 1983 at North Cove.
All were 10 - 20mm long, and three were observed on bryozoans underneath
boulders.

Tritonia festiva (Stearns, 1873)

Tritonia festiva occurs at all four coves but is most common at
Middle and Good Witch Coves. It usually occurs on or near a white
Alcyonacean octocoral upon which it feeds. Sowell (1949) also reported
finding T. festiva "on or near" this octocoral but did not confirm
feeding. The octocoral is in the form of low, rounded colonies up to
15mm in diameter and is undescribed (Dr. F.M. Bayer, pers. comm.).
Large aggregations of fairly evenly spaced colonies are common under
wave-exposed, low-intertidal ledges at Cape Arago. Tritonia festiva
has been reported to feed on octocorals of the orders Stolonifera,
Gorgonacea, and Pennatulacea, but not Alcyonacea (McDonald and
Nybakken, 1978).

The feeding process is remarkable. Upon contacting an expanded colony with the very sensitive, slender processes on its frontal veil, the slug immediately stops crawling and raises the anterior half of its body off the substrate, reaches over the edge of the colony without contacting it, and then quickly comes down on the polyps while extending its buccal mass and jaws. A few polyps are bitten off, and the rest of the colony contracts. Extension of the buccal mass and the actual biting occur very rapidly. Tritonia festiva will not attack contracted colonies (probably because it cannot penetrate the tough and densely spiculate coenenchyme), and in all of the instances I've observed, contact of a colony by Tritonia's frontal veil never resulted in polyp contraction.

I also found Tritonia festiva next to Clavularia sp., a stoloniferan octocoral which I observed T. festiva eating in the laboratory and which has previously been reported as a prey item of T. festiva (McDonald and Nybakken, 1978). T. festiva from Cape Arago also attacked specimens of Gersemia rubiformis (Pallas) collected from Cape Blanco and an unidentified pink gorgonian dredged offshore by local fishermen. T. festiva has not previously been reported feeding on Gersemia rubiformis.

The white egg mass of Tritonia festiva is a flattened cord laid in a close spiral and attached to the substrate by a thin, egg-free jelly sheet (type B egg mass of Hurst, 1967). The cord is somewhat convoluted, giving the egg mass a rosette appearance. Dimensions are: egg mass diameter, 10 - 20mm; height, 1mm; cord diameter, 0.5mm. The egg mass is delicate, and the eggs are not embedded in a jelly matrix.

DISCUSSION

Life Cycles

Most of the dorid nudibranchs, and all of the eudoridaceans, whose life cycles have been studied have been shown to possess annual life cycles (Clark, 1975; Eyster and Stancyk, 1981; Miller, 1962; Potts, 1970; Swennen, 1961; Thompson, 1964, 1976; Todd, 1978, 1979). Dorids known or suspected to possess subannual life cycles are generally smaller, bryozoan-feeding members of the families Corambidae, Goniodorididae, Onchidorididae (the species of Onchidoris thus far studied, though, are annuals), and Polyceridae (Clark, 1975; Miller, 1962; Perron and Turner, 1977; Swennen, 1961).

Data presented above on the lifespan of Hallaxa chani strongly suggest that this eudoridacean is subannual. Combining the observations on lifespan, egg-laying, and larval development, and assuming a 1 month planktonic existence and 1 or 2 months for the juvenile to reach a length of 5mm, generation time appears to be about 4 or 5 months at 10° C. It could be shorter at higher temperatures.

The relatively rapid growth and short generation time of Hallaxa

chani appear to be adaptations for exploiting its sponge prey Halisarca

sp. A species of Halisarca from New Zealand grows rapidly compared to

most other sponges and has a generation time of 4 - 5 months (Bergquist,

1978). I observed one group of Halisarca sp. individuals under a

marked boulder at Cape Arago increase in area from $8cm^2$ to $16cm^2$ between

6/29/83 and 9/7/83 (70 days), and I can not rule out the possibility

that they were preyed upon during this period and thus actually grew

more. The North Cove Halisarca sp. population is composed of widely

distributed individuals averaging only a few square centimeters in area

(pers. obs.). Laboratory and field observations indicate that Hallaxa

chani are capable of eating these individuals in a matter of days or

weeks. Instead of relying on energetically expensive, and thus growth-

slowing, skeletal and chemical defenses against predators like many

other sponges, natural selection appears to have favored the fugitive

tactics of rapid growth, high fecundity, and larval dispersal in

Halisarca as a means of escaping overpredation. These same life cycle

characteristics appear to have been selected for in Hallaxa chani,

enabling them to reproduce and find new Halisarca sp. individuals. The

largest Halisarca sp. I found at Cape Arago occurred under boulders at

Middle Cove, where I have never observed Hallaxa chani. Occasional

large Halisarca sp., which have apparently escaped predation by H. chani

(at least temporarily) also occur at North Cove.

Observations on the longevity of Cadlina luteomarginata and

Cadlina modesta suggest that these dorids live at least a year, and

thus possess life cycles more similar to those known for other eudoridaceans. One Cadlina modesta survived a period of starvation longer (and at higher temperatures) than the entire lifespan of regularly fed Hallaxa chani. Although this Cadlina modesta never laid eggs, observations by Thompson (1961), Todd (1978), and Eyster (1981), as well as the above observations on one Hallaxa chani that never laid eggs, all indicate that lack of reproduction can result in larger size, but does not significantly affect lifespan.

Development

Data on the larval development of Cape Arago opisthobranchs are summarized in Table 1. Aplysiopsis smithi, Onchidoris muricata, and Triopha catalinae are the only species in this Table whose development has previously been examined (Hurst, 1967; Greene, 1968; Beeman and Williams, 1980).

The development times, sizes of eggs and veligers, and the production of veligers that lack a propodium, usually lack eyespots, and possess a mantle fold that attaches intermittently to the shell lip all indicate that, with the exception of Doto amyra, every species in Table 1 produces planktotrophic veliger larvae (type 1 development of Thompson, 1967) (Thompson, 1967; 1976). As mentioned previously, Doto amyra produces lecithotrophic veligers (type 2 development).

Of the 20 species in Table 1 that produce planktotrophic larvae, four (20%) produce veligers possessing eyespots at hatching. This is

rather high considering that the veligers of only one of the 30 North-eastern Pacific opisthobranchs studied by Hurst (1967) have eyespots at hatching, and the statement by Thompson (1976) that hatching plankto-trophic veligers usually lack eyespots. Planktotrophic veligers develop eyespots before metamorphosis, and species with lecithotrophic or direct development always possess eyespots at hatching (Thompson, 1976). As Bonar (1978, p. 187) states, "The eyes...usually develop rather late in embryogenesis, and along with the appearance of an enlarged propodium signal the approach of metamorphic competence." It thus seems likely that the above four species will be found to possess relatively short obligatory planktonic stages compared to many other species with plankto-trophic larvae.

The data in Table 1 generally support Thompson's (1976, p. 86) gen-eralization that "Within development-type 1, species with the largest eggs have a longer embryonic period, and, moreover, give rise to larger veliger larvae."

Food and Competition

While most nudibranch species are known to eat a number of prey species (Thompson, 1964, 1976; McDonald and Nybakken, 1978), a few species appear to be monophagous over their entire ranges. Of the species found at Cape Arago, only Adalaria sp., Ancula pacifica, Hallaxa chani, Laila cockerelli, and Precuthona divae, so far as is known, fit into this latter category (McDonald and Nybakken, 1978;

Beeman and Williams, 1980; Goddard, 1981; present study). Crimora coneja apparently feeds only on Hincksina minuscula at Cape Arago, but it is doubtful that this latter species occurs in San Diego County, California, one of the other locations where C. coneja occurs (Osburn, 1950). The generalist species at Cape Arago appear to include Anisodoris nobilis, Dirona albolineata, Hermissenda crassicornis, Rostanga pulchra, and Triopha catalinae (Robilliard, 1971a; Nybakken and Eastman, 1977; McDonald and Nybakken, 1978; Beeman and Williams, 1980; Bloom, 1981; present study). I suspect that most nudibranch species will be found to eat relatively few prey species belonging to a few genera. Data obtained in this study on the prey of Cape Arago nudibranchs are summarized in Table 3. These data are incomplete. With the possible exceptions of Cadlina modesta and Hallaxa chani, more data are needed on the prey of all Cape Arago nudibranchs.

The alcyonacean octocoral prey of Tritonia festiva often occurs in large aggregations of fairly evenly spaced colonies, and, as mentioned earlier, T. festiva will not attack colonies with contracted polyps. How long do the polyps remain contracted after an attack by T. festiva? What sort of foraging path do T. festiva make through aggregations of colonies? Feeding interference between individuals of T. festiva could be considerable at higher densities of T. festiva (i.e., at high densities of T. festiva most of the octocoral polyps would be contracted). In this regard it is interesting to note that T. festiva are aggressive towards each other in the laboratory and often take large bites out of each other. In one instance I placed two newly collected individuals

Table 3. Prey of Cape Arago opisthobranchs

nudibranch species	prey
Adalaria sp.	Hincksina minuscula*
Aeolidia papillosa	Epiactis prolifera
Ancula pacifica	among Barentsia sp.
Anisodoris nobilis	Mycale macginitiei Zygherpe hyaloderma Lissodendoryx firma Tedania gurjanovae* Ophlitaspongia pennata (L)*
Archidoris montereyensis	Halichondria panicea Suberites sp. unidentified orange encrusting sponge
Archidoris odhneri	Hymeniacidon ungodon* on Suberites sp.
Cadlina luteomarginata	Aplysilla glacialis Halisarca sp. (L)*
Cadlina modesta	Aplysilla glacialis Halisarca sp.*
Catriona columbiana	Tubularia marina
Crimora coneja	Hincksina minuscula*
Cuthona abronia	among small thecate hydroids
Cuthona albocrusta	among small thecate hydroids
Dendronotus frondosus	Obelia sp.
Diaulula sandiegensis	Haliclona sp. A
Discodoris heathi	Mycale macginitiei*
Doto amyra	Abietinaria sp.
Doto kya	among Plumularia sp. and small thecate hydroids

Table 3 (cont.)

Eubranchus rustyus	Plumularia sp.
Flabellina trilineata	Tubularia marina
Hallaxa chani	Halisarca sp.
Janolus fuscus	arborescent bryozoans
Laila cockerelli	Hincksina velata
Onchidoris muricata	Eurystomella bilabiata* on Hincksina minuscula on Microporella cribosa
Polycera atra	arborescent bryozoans
Precuthona divae	Hydractinia sp.
Rostanga pulchra	Ophlitaspongia pennata on Antho lithophoenix on Hymedesmia sp. A near Plocamia karykina near Axocielita originalis
Triopha catalinae	arborescent bryozoans
Triopha maculata	arborescent and encrusting bryozoans
Tritonia festiva	undescribed alcyonacean octocoral* Clavularia sp. Gersemia rubiformis (L)

sacoglossan species

Aplysiopsis smithi	Cladophora sp.
Placida dendritica	Codium Fragile

* new food record

(L) opisthobranch species not found associated with their
    prey in field, but ingestion of prey observed in laboratory

(20 and 35mm long) together in 500ml of water. After one day of captiv-

ity the larger ate the smaller specimen. Does aggressive behavior occur

in the wild as a mechanism for reducing slug density? and if so, how

does reproductive behavior fit in? How widespread is cannibalism? Can

T. festiva detect conspecific mucus trails? A study of foraging behavior

(for both food and mates) in this species would be fascinating.

Large numbers of Triopha catalinae, Janolus fuscus, and Dirona

albolineata are found together in the North Cove inner boulder field dur-

ing late summer and early fall. T. catalinae and J. fuscus feed on ar-

borescent bryozoans (Nybakken and Eastman, 1977; McDonald and Nybakken,

1978; pers. obs.), and D. albolineata eats a wide variety of prey in-

cluding bryozoans (Robilliard, 1971a). It seems likely that some comp-

etition for food occurs between these species during periods of co-

occurrence.

When Janolus fuscus are crowded in the laboratory they often bite

each other, sometimes tearing off and ingesting cerata. This aggressive

behavior may be a mechanism for maintaining a certain amount of space,

and thus food, per individual. Study of the relationship between food

supply, density and age of J. fuscus and the frequency of aggressive

and reproductive interactions should prove interesting.

Triopha catalinae are rarely found in close proximity to one

another (Nybakken and Eastman, 1977, p. 282; pers. obs.), suggesting

that aggressive interactions may also occur between individuals of this

species. The feeding method of T. catalinae (in which whole branches of

arborescent bryozoans are ripped off and ingested), and the laboratory

observation of a large T. catalinae attacking and taking a sizable bite
out of a Laila cockerelli (pers. obs.) indicate that T. catalinae are
physically capable of such aggression. Furthermore, does any inter-
specific aggression or predation occur between T. catalinae, Janolus
fuscus, and Dirona albolineata?

Ranges

The range extensions reported above for Cuthona flavovulta, C.
fulgens, and Polycera atra, and the occurrence in spring and summer 1983
of the form of Ancula pacifica common in California may be related to
events associated with the strong El Niño of 1982-83 (Philander, 1983).
These events have included above normal ocean temperatures off the coast
of North America (Dr. K.T. Briggs, Univ. of Calif. at Santa Cruz, pers.
comm.; A. McGee, Oregon Dept. Fish and Wildlife, pers. comm.) and prob-
ably a reversal of the usually south-moving California current (Chelton,
1981), as well as an intensification of the nearshore, north-moving
Davidson current that occurs in late fall and early winter (Bolin and
Abbott, 1963; Schwartzlose and Reid, 1972). If the above species have
been transported north (as veligers) with these anomalous events, their
occurrence at Cape Arago may be brief. On the other hand, they may occur
relatively consistently, but in low numbers, at Cape Arago and may have
been previously overlooked - this appears to be the case for Crimora
coneja, Cuthona cocoachroma, and Diaphana californica, all of which were
found at Cape Arago before the onset of the above anomalous conditions.

I would like to recommend that dates of observation always be given with range extensions and reports of unusual occurrence. For with increasing monitoring and understanding of coastal hydrographic conditions, it may become possible to explain better the occurrence of many species at the edges of their ranges, or to explain why a species appears in an area for a time and then disappears for long periods. For example, is it possible that the Hopkinsia rosacea reported from Oregon by Steinberg (1963b) (see below) were carried north (as veligers) from California with the warm waters and currents associated with the intense El Niño of the late 1950's? Mention of the date of observation would have helped evaluate such a possibility. It is interesting that Eurystomella bilabiata, the only known prey of H. rosacea, is abundant at Cape Arago year-round, but H. rosacea is usually absent (pers. obs.).

The known range of Crimora coneja is puzzling. Despite extensive field observation of nudibranchs in central California, only one specimen has been reported between San Diego and Cape Arago (McDonald, 1983).

The Effects of Nudibranch Predation on the Diversity of the Encrusting Animal Community at Cape Arago

Low-light habitats at Cape Arago (crevices, caves, and the undersurfaces of boulders and ledges) support a diverse encrusting community composed primarily of sponges, bryozoans, colonial tunicates, and cnidarians. The amount of free space varies depending, in part, on the habitat and degree of physical disturbance. For example, the undersurfaces

of low intertidal ledges and stable boulders exposed to little sedimentation tend to have little free space, whereas the undersurfaces of boulders exposed to seasonal sedimentation and overturning by waves tend to possess large amounts of free space (pers. obs.).

As in any community, part of the encrusting animal diversity at Cape Arago can be explained by the spatial complexity (heterogeneity), coupled with niche diversification and the evolution of habitat selection. However, the coexistence of large numbers of species on relatively uniform surfaces suggests that other factors must be involved in regulating species diversity. Factors that have been implicated in affecting the diversity of other communities and which are probably important at Cape Arago include: predation and disease, fluctuations in the physical and biotic environments, physical disturbance in the form of sedimentation, boulder-overturning by surf, and erosion (boring clams play a major role in erosion and production of spatial complexity at Cape Arago), and the existence of competitive networks among the encrusting species (Connell, 1972, 1978; Dayton, 1971; Huston, 1979; Hutchinson, 1961; Jackson and Buss, 1975; Paine, 1974; Sousa, 1979). The first three factors can maintain relatively high levels of diversity by preventing competitive equilibrium (at which competitively inferior species are excluded from the community) from being reached. Of course, at high enough levels, these same factors can keep diversity low. The existence of complex competitive networks can increase the time necessary for competitive exclusion to occur (relative to the time required if only competitive hierarchies exist) or mean that major competitive dominants just do not

exist in the community (Jackson and Buss, 1975; Jackson, 1979, 1981).

As Connell (1978) and Huston (1979) have discussed, a number of these

factors probably operate simultaneously in any particular community,

with the relative importance of each factor varying in different com-

munities. The observed diversity in a community is thus the result of

a "dynamic equilibrium" between the growth rates of the component pop-

ulations and the rates of the above mentioned factors (Huston, 1979).

Nudibranchs, which are known to be important predators in some en-

crusting communities (Bloom, 1981; Clark, 1975; Dayton et. al., 1974;

Ryland, 1970; Thompson, 1964; and, on the basis of abundance, Nybakken,

1974, 1978), appear to be among the most abundant and important preda-

tors of encrusting organisms at Cape Arago (pers. obs.). Other signif-

icant predators of these organisms at Cape Arago include prosobranchs

such as Diodora aspera (Rathke, 1833) and members of the family

Lamellaridae, and probably various chitons, asteroids, and fish (Morris

et. al., 1980, pers. obs.). Certain flatworms, polychaetes, crustaceans,

and pycnogonids are known to eat encrusting animals (Morris et. al.,

1980) and may also be important - especially with regard to predation on

newly settled organisms.

Not knowing which encrusting species are competitively dominant at

Cape Arago, I can not say to what extent nudibranchs prey on such species.

But, because nudibranchs can eat large amounts of sessile organisms (see

data on Anisodoris nobilis, Cadlina luteomarginata, C. modesta,

Discodoris heathi, and Hallaxa chani), and eat such a wide variety of

prey, many of which are among the more abundant species (pers. obs.),

they probably significantly affect the competitive relationships in the encrusting community at Cape Arago[1]. Some examples of their effects follow.

Other than reducing the abundance of their prey, the most obvious result of nudibranch predation on encrusting communities is the creation of free space available for larval recruitment or intrusion by surrounding organisms. By consuming entire individuals or colonies, nudibranchs could also alter the species composition under a boulder or ledge.

Overgrowth is one of the primary mechanisms of competition between encrusting organisms (Jackson, 1979). In some cases nudibranchs (and other predators) could undo overgrowth events between encrusting species by preying on the overgrowing species. This probably only applies to sessile organisms which can be completely grazed off the overgrown species (i.e., certain sponges, tunicates, and perhaps fleshy bryozoans). The sponge Halisarca sp. frequently overgrows the bryozoan Eurystomella bilabiata. I have also seen it overgrowing the alcyonacean octocoral prey of Tritonia festiva. On a number of occasions I collected E.

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[1]Though I do not have good estimates of nudibranch abundance at Cape Arago, I can say that 2 to 3 hours of searching (by an experienced observer) in an area of about $3000m^2$ in the North Cove inner boulder field will turn up about 50 to 100 individuals of 10 to 15 species of nudibranchs. Two factors make this a gross underestimate of actual abundance: 1) only a part of the area is occupied by encrusting animals - the rest is either dominated by algae or is barren. 2) not all ledges and boulder undersurfaces are examined. Nudibranch abundance at North Cove appears comparable to that of central California, but the number of species is lower (pers. obs.).

bilabiata overgrown by *Halisarca* sp. to feed the sponge to laboratory
Hallaxa *chani*. The dorids grazed the sponge cleanly off the bryozoan,
and within a day or two the bryozoan lophophores were extended and feed-
ing. Of course, the viability of the overgrown organism will depend on
how long and how extensively it has been overgrown and on its sensitiv-
ity to any allelopathic substances made by the overgrowing organism.
The large individual of *Aplysilla* *glacialis* I observed eaten by *Cadlina*
luteomarginata and *C*. *modesta* (see notes on *C*. *luteomarginata* had
partially overgrown some *Cliona* *celata* Grant, 1826. The *Cliona* *celata*
appeared healthy after the *Aplysilla* had been grazed away. This is not
too surprising, however, considering the shell-boring abilities of *Cliona*,
and it also suggests that *Aplysilla* *glacialis* has little or no allelo-
pathic effect on *Cliona* *celata*.

Partial predation, which results in decreased feeding and reproduc-
tive abilities of the grazed organism, and can also expose it to settle-
ment by possibly superior competitors (Jackson and Palumbi, 1979), is
probably widespread. It is inevitable in spatially complex microhabitats
where predators can not reach all of their prey. Moreover, how many
predators, given the chance, actually graze all of a sponge or every
bryozoan zooid? Some predators are just not capable of consuming entire
colonies (e.g. *Tritonia* *festiva* feeding on alcyonacean octocorals, pos-
sibly *Ancula* *pacifica* on *Barentsia* sp., and probably many hydroid-eating
eolids which consume the hydranths, but not the stalks and stolons from
which hydranths can regenerate). An important question is, how much can
a sessile organism lose to predation and still survive with its

regenerative abilities?

The feeding of _Tritonia festiva_ on alcyonacean octocorals is a vivid example of partial predation. I have observed octocoral colonies being overgrown by _Halisarca_ sp., colonial tunicates, and the social tunicate _Metandrocarpa taylori_ Huntsman, 1912. It would be interesting to compare overgrowth of the octocoral in the presence or absence of _Tritonia festiva_.

Partial predation grades into parasitism. The small, abundant dorid _Rostanga pulchra_ feeds on the upper layers of orange sponges (pers. obs.) and appears to be more parasitic than predatory (though more data are needed on its movements, feeding rates, and sponge growth rates). By damaging the sponge, such superficial grazing may increase the sponge's susceptibility to overgrowth or speed up overgrowth interactions already begun. On the other hand, such feeding could possibly facilitate release of allelopathic chemicals and prevent or slow overgrowth.

One vivid example I have of the possible relationship between nudibranchs and the encrusting community is a photograph of about $60 cm^2$ of boulder undersurface. The area is completely covered by the bryozoans _Eurystomella bilabiata_ and _Hincksina velata_ and the sponge _Zygherpe hyaloderma_. Two clumps of an unidentified arborescent bryozoan are growing on the _Hincksina_. _Eurystomella_ and _Hincksina_ are overgrowing each other in different parts of the area, and the sponge is overgrowing _Hincksina_, but is being overgrown by _Eurystomella_. Each of these organisms has at least one nudibranch predator at Cape Arago.

The competitive relationships between encrusting organisms can be very complex. Overgrowth outcomes vary between the same two species and often depend on encounter angle (Jackson, 1979). Overgrowth may not be complete and certainly does not always result in mortality. Moreover, growth, regeneration, and recruitment rates of the encrusting species can all affect the observed diversity (Karlson and Jackson, 1981). If one adds predation (complete and partial) by organisms like nudibranchs to this already complex system, as well as the other factors affecting diversity previously mentioned, what one is left with is an extraordinarily complex community for which competitive equilibrium seems unlikely. Rather, there is probably a "dynamic equilibrium", changing on both long and short time scales, between the rates of competitive displacement and the rates at which the other factors act to prevent competitive exclusion (Huston, 1979). Organisms do the best they can to cope with these factors, and, to paraphrase some evolutionary theory, the fit is by no means perfect – it only works.

Benthic Opisthobranchs Known from Oregon

The 66 benthic opisthobranch species presently known from Oregon are listed in Table 4. Forty-seven of these have been found at Cape Arago. Twenty-six are new records for Oregon, and 28 are new to Cape Arago. The ranges of _Adalaria_ sp. and _Anisodoris lentiginosa_ are extended southward, and those of _Crimora coneja_, _Cuthona cocoachroma_, _C. flavovulta_, _C. fulgens_, _Diaphana californica_, and _Polycera atra_

Table 4. Benthic opisthobranchs known from Oregon

Species	Reference*	Occurs at Cape Arago
Acanthodoris hudsoni MacFarland, 1905	2	
Acanthodoris nanaimoensis O'Donoghue, 1921	2,5,6,8	x
Adalaria sp.	8	x
Aeolidia papillosa (Linnaeus, 1761)	1,4,5,8	x
Alderia modesta (Loven, 1844)	4,5,8	
Aldisa sanquinea (Cooper, 1863)	1,8	x
Aldisa cooperi Robilliard and Baba, 1972	8	x
Ancula pacifica MacFarland, 1905	8	x
Anisodoris lentiginosa Millen, 1982	8	x
Anisodoris nobilis (MacFarland, 1905)	1,4,5,8	x
Aplysiopsis smithi (Marcus, 1961)	4,5,8	x
Archidoris montereyensis (Cooper, 1863)	1,2,5,8	x
Archidoris odhneri (MacFarland, 1966)	4,8	x
Armina californica (Cooper, 1863)	3,5	

Table 4 (cont.)

Species	Reference*	Occurs at Cape Arago
Bathydoris sp.	4,5	
Berthella californica (Dall, 1900)	8	x
Cadlina flavomaculata MacFarland, 1905	1	
Cadlina luteomarginata MacFarland, 1966	1,4,5,8	x
Cadlina modesta MacFarland, 1966	8	x
Catriona columbiana (O'Donoghue, 1922)	2,8	x
Crimora coneja Marcus, 1961	8	x
Cumanotus beaumonti (Eliot, 1906)	8	
Cuthona abronia (MacFarland, 1966)	2,8	x
Cuthona albocrusta (MacFarland, 1966)	2,8	x
Cuthona cocoachroma Williams and Gosliner, 1979	8	x
Cuthona flavovulta (MacFarland, 1966)	8	x
Cuthona fulgens (MacFarland, 1966)	8	x

Table 4 (cont.)

Species	Reference*	Occurs at Cape Arago
Dendronotus frondosus (Ascanius, 1774)	1,2,5,8	x
Dendronotus subramosus MacFarland, 1966	8	x
Diaphana californica Dall, 1919	8	x
Diaulula sandiegensis (Cooper, 1863)	1,2,5,8	x
Dirona albolineata Cockerell and Eliot, 1905	1,2,5,8	x
Dirona picta MacFarland in Cockerell and Eliot, 1905	4,5	
Discodoris heathi MacFarland, 1905	1,4,5,8	x
Doto amyra Marcus, 1961	8	x
Doto columbiana O'Donoghue, 1921	4,5	x
Doto kya Marcus, 1961	8	x
Elysia hedgpethi (Marcus, 1961)	8	
Eubranchus olivaceus (O'Donoghue, 1922)	8	x
Eubranchus rustyus (Marcus, 1961)	8	x
Fiona pinnata (Eschscholtz, 1831)	5,8	

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Table 4 (cont.)

Species	Reference*	Occurs at Cape Arago
Flabellina fusca O'Donoghue, 1921	2	
Flabellina trilineata (O'Donoghue, 1921)	2,5,8	x
Hallaxa chani Gosliner and Williams, 1975	8	x
Hermaea vancouverensis O'Donoghue, 1924	1,8	x
Hermissenda crassicornis (Eschscholtz, 1831)	1,2,5,8	x
Hopkinsia rosacea MacFarland, 1905	7	
Janolus fuscus O'Donoghue, 1924	1,2,4,5,8	x
Laila cockerelli MacFarland, 1905	1,2,5,8	x
Melanochlamys (Aglaja) diomedea (Bergh, 1894)	3,5	
Melibe leonina (Gould, 1852)	3	
Onchidoris bilamellata (Linnaeus, 1767)	1,4,5,8	
Onchidoris muricata (Müller, 1776)	8	x
Onchidoris sp. (O. hystricina)	8	x

Table 4 (cont.)

Species	Reference*	Occurs at Cape Arago
Phyllaplysia taylori Dall, 1900	3,5	
Placida dendritica (Alder and Hancock, 1843)	8	x
Polycera atra MacFarland, 1905	8	x
Polycera zosterae O'Donoghue, 1924	8	
Precuthona divae Marcus, 1961	8	x
Rostanga pulchra MacFarland, 1905	1,2,5,8	x
Tochuina tetraquetra (Pallas, 1788)	4,5	
Triopha catalinae (Cooper, 1863)	1,2,5,8	x
Triopha maculata MacFarland, 1905	8	x
Tritonia diomedea Bergh, 1894	3,5	x
Tritonia festiva (Stearns, 1873)	1,2,5,8	x
Tritonia sp.	4,5	

Table 4 (cont.)

Questionable Species	Reference*	Occurs at Cape Arago
Cadlina pacifica Bergh, 1879	1	x
Cuthona (Trinchesia) sp.	4	
Eubranchus sp.	2	
Pleurobranchus sp.	2	
Pleurobranchus sp.	4,5	x

* 1 Sowell (1949)
  2 Sphon (1972)
  3 references cited by Sphon (1972)
  4 Belcik (1975)
  5 Belcik (1965)
  6 Steinberg (1963a)
  7 Steinberg (1963b)
  8 present study

northward. Depending on the status of the questionable species listed in Table 4 (see below), the Oregon total could rise to 71 and the Cape Arago total to 49.

Both Sphon (1972) and Belcik (1975) reported finding a Pleurobranchus sp., Sphon from Strawberry Hill, and Belcik from Cape Arago. These specimens could be different from each other and Berthella californica, or one (or both) could be B. californica.

The Trinchesia sp. (which I have listed as Cuthona sp.) reported by Belcik (1975) on Tubularia sp. in the Charleston boat basin could well be Catriona columbiana. In my experience in the area, only Catriona columbiana, Flabellina trilineata, and Hermissenda crassicornis occur on Tubularia marina (and Cumanotus beaumonti on Tubularia crocea).

Until the Eubranchus sp. collected by Sphon (1972) can be re-examined, it is impossible to ascertain whether it is an already described Eubranchus species (including one of the two in Table 4) or belongs to an undescribed species.

Sowell's (1949) report of Cadlina pacifica from Cape Arago is questionable. To my knowledge no other specimens of this dorid have been found since Bergh's (1879) description of three specimens collected by Dall in Alaska. Sowell reported finding at least five specimens and does not describe any aspect of them except (p. 22) that they were "... always white about the same as the ground color of Cadlina marginata." My guess is that these were specimens of Archidoris odneri, a white dorid that was undescribed at the time.

Belcik (1965) found T. festiva and T. diomedea (= T. exsulans),
the two species of Tritonia presently known from the Pacific Northwest.
It thus seems likely that the "whitish" Tritonia sp. he reported dredged
off Cape Arago (Belcik, 1965, 1975) is an undescribed species, possibly
that pictured by Behrens, 1980, p. 103. For this reason I have not
listed Tritonia sp. under the "questionable species" in Table 4.

Belcik's (1965) Master's thesis on the parasitic copepod Ismaila
monstrosa Bergh contains an appendix listing 32 species of Oregon
opisthobranchs that he had examined for parasites. 15 of these species
were not found by Sphon (1972) and became the basis of Belcik's 1975
paper. However, Belcik (1975) includes an additional two species
(Trinchesia sp., which I have listed as Cuthona sp., and Archidoris
odhneri) that were not mentioned in his Master's thesis. And the appen-
dix to his thesis contains one species (Fiona pinnata) which Sphon did
not find but which Belcik, for some reason, did not include in his 1975
paper. An "Eolis sp." is also mentioned in the thesis and not in the
1975 paper. Presumably this is the same as the Trinchesia sp. mentioned
above, and thus I have not included it in Table 4. I have included
Belcik (1965) as a reference in Table 4 in order to present the 17 ad-
ditional species he found, but did not include in his 1975 paper. Both
Behrens (1980) and McDonald and Nybakken (1980) list Dillon Beach,
Marin County, California as the northern limit of Dirona picta. However,
Belcik (1975) found it on the docks of the Charleston boat basin. I saw
one specimen of D. picta collected by the summer 1983 O.I.M.B. Inverte-
brate Zoology class. The collection location is unknown.

Sowell reported finding a form of _Hermissenda crassicornis_ at North Cove "...among _Laminaria_ and _Costaria_ and in association with _Triopha carpenteri_ and _Dirona albolineata_." He further states, "This form appears to be specifically distinct from _H. crassicornis_, but has not been definitely determined." This form is undoubtedly _Janolus fuscus_ which occurs in large numbers in the same habitat as _Triopha catalinae_ and _Dirona albolineata_. Belcik (1975) wrote that Sowell "...confused this form with _Coryphella_ sp. or _Antiopella_ spp."

Steinberg (1963b) recorded Coos Bay, Oregon as the northern limit of _Hopkinsia rosacea_. This is the only record of _H. rosacea_ north of Gualala, Mendocino County, California (Marcus, 1961, p. 29). Specimens of _H. rosacea_ from Coos Bay were apparently collected by Lawrence Andrews, whom Steinberg (1963a) cited as her source of opisthobranch specimens from Coos Bay. The only other species Steinberg (1963a or b) reported from Coos Bay was _Acanthodoris nanaimoensis_.

Belcik (1975) reported _Alderia modesta_ as uncommon on _Vaucheria_ mats on mudflats in Coos Bay. At least during the summer, _A. modesta_ can be found in abundance feeding on mats of _Vaucheria_ sp. in the South Slough of Coos Bay (pers. obs.).

Five additional species that I have observed in the Coos Bay area, but not at Cape Arago, are _Cumanotus beaumonti_, _Elysia hedgpethi_, _Fiona pinnata_, _Onchidoris bilamellata_, and _Polycera zosterae_. _C. beaumonti_ occurs on _Tubularia crocea_ (Agassiz, 1862) in the Charleston boat basin; a single specimen of _E. hedgpethi_ was collected in Coos Bay by the summer 1983 O.I.M.B. invertebrate zoology class; _F. pinnata_ occurs offshore on

floating objects covered with its prey, the gooseneck barnacle _Lepas_ sp.;
_O_. _bilamellata_ is found among _Balanus_ _glandula_ Darwin, 1854 on the pil-
ings and breakwater of the Charleston boat basin; and a single _P_.
zosterae was collected from a piling in the Charleston boat basin.

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