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Feeding Habits of Paua

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CONTENTS

FEEDING HABITS OF PAUA

(*Haliotis iris* Martyn)

ABSTRACT

The feeding of *Haliotis iris* in their natural environment is discussed. It was found that a variety of seaweeds were eaten in varying quantities. The proportion of any class of seaweed in the diet was a reflection of its abundance in the area. Paua showed a preference for certain seaweed and an avoidance of others.

INTRODUCTION

Only one paper has been published on the feeding habits of the paua *Haliotis iris*. Sinclair (1963) mentioned various species of seaweed found in the gut of *H. iris*.

Feeding studies have been carried out on Haliotidae in other countries although little has been published of the quantities of the same seaweed in the digestive system and growing in the environment. Croft (1929) discussed the selective feeding action of the European species *Haliotis tuberculata*. Analyses of the stomach contents of the Japanese paua *H. gigantea* and *H. kamtchatkam* were carried out by Ueda and Okada (1939-40). More lately Sakai (1962) investigated the feeding habits of *H. discus hannai* in relation to growth and gonad maturation and the preference of this species for particular varieties of seaweed. Controlled feeding experiments to study the diet and growth were made on the Californian abalone *H. cracherodii* by Leighton and Boolootian (1963).

and Brogniartiella.

The brown seaweeds (42.5%) were mainly Blossevillea and Carpophyllum and nearly equal in abundance to the red seaweeds.

Green seaweeds were less common (12.9%) with one dominant species Caulerpa sedoides (6.7%) and three less abundant varieties, Caulerpa brownii, Bryopsis and Ulva, (Table 1.).

The contents of the paua stomachs were predominantly brown seaweed (47.1%) with Champia (12.2%) second in abundance. Ulva and Chondria were equal in abundance followed by three red seaweeds Pterocladia capillacea, Sarcodia and Streblocladia, each less than 5.0%. Another eight varieties of both red and green seaweed were present in small amounts, (Table 2.).

In area 1 the paua had eaten similar quantities of brown and red seaweed (47.1 and 41.5%) and a lesser amount of green seaweed (11.4%). The proportion of each class of seaweed in the stomachs was similar to its abundance in the area.

Seven varieties of seaweed were the most often eaten, occurring in over 50.0% of the paua stomachs. Brown seaweed was the commonest, being found in every stomach. Five of the remaining were red seaweed, with Streblocladia the most important and eaten by 76.0% of the paua. Ulva was the only commonly eaten green seaweed, (53.0% of the paua).

The number of different seaweed species per stomach varied from 3 to 10 with an average of 6.5%. However, 84.0% of the paua had only two varieties of seaweed making up the bulk of the stomach content. In all except one stomach, they were brown seaweed and one of the following, Champia, Chondria, Pterocladia capillarea or Ulva. The one exception had a quantity of Plocamium costatum and Ulva. Two paua had four varieties of seaweed making up the bulk of the stomach content.

The open coast, area 2, differed from the previous area in a greatly increased volume of red seaweed, (57.0%) Champia (20.0%) and Corallina (9.0%) were of a similar abundance as in area 1, with the former still the most abundant red seaweed. Streblocladia had increased to 10.0% and Chondria to 6.0%. Sarcodia, absent in the first area, was now common, (9.0%). There was no change in the volume of green seaweed (12.0%), although two varieties, Caulerpa sedoides and Bryopsis had disappeared to be replaced by an increased volume of Ulva. Brown seaweed, however, had decreased to 31.0%.

The average stomach content was predominantly red seaweed, (62.1%) with three species of greatest and equal abundance. Two of these, Streblocladia and Chondria had increased in volume in the stomach as well as in the area, compared with area 1, but the third, Pterocladia capillacea had increased only in the stomach content. Seven other varieties of red seaweed were eaten in quantities from 8.0 to 0.05%, (Table 3.).

The volume of brown seaweed in the stomach (30.5%) was half that of the red seaweed, a comparable reduction as occurred with the same species growing in the area. It is again true, as for area 1, that the proportion of the seaweed in the stomachs was a reflection of its abundance in the area. Less Ulva was eaten, although it was slightly more abundant in the area. This reduced the consumption of green seaweed to 6.3%, half that of the first area.

Eight varieties of seaweed were most often eaten in area 2. Brown seaweed and Streblocladia were the two most common, being eaten by 88.0% of the paua. Three red seaweed, Pterocladia capillacea, Sarcodia and Chondria were next, followed by Ulva

and two other green seaweed, Caulerpa brownii and an unidentified variety. These same seaweeds, except for the last two mentioned, were also the most often eaten in area 1.

The number of seaweed species per stomach was similar to that in area 1, varying from 3 to 9 with an average of 6.7 Most paua, (76.0%), were similar to those in area 1, with the bulk of the stomach content of only 1 or 2 varieties, with the remainder of the paua with up to 4 seaweeds in equal volume in the stomach. The two varieties were always brown seaweeds and one of the following red seaweed, Pterocladia capillacea, Chondria, Sarcodia or Strebloclaadia; except in three cases where two of the above red seaweeds were most abundant. Two paua had each fed on a single variety, one on Champia, the other on brown seaweed. Four paua had each eaten various combinations of four of the following - brown seaweed, Champia, Chondria, Strebloclaadia, Pterocladia capillacea, Ulva or Sarcodia, (Table 3.).

The third area, the enclosed rock pool, differed from the previous two areas in a reduction in the number of varieties of seaweed, with 81% of only two species, Corallina (59.0%) and brown seaweed (22.0%). Hormasira was more abundant in this area (7.0%) with lesser amounts of the remaining seaweeds, Ulva (4.0%) and Caulerpa sedoides (4.0%).

Paua had eaten mostly brown seaweed (49.7%) and Corallina (42.7%) with small quantities of two species of red and four species of green seaweeds, (Table 4.).

There was a difference in the feeding habit of paua in this area, with brown and red seaweed being eaten out of proportion to their abundance in the area. A considerable quantity of Corallina was eaten in contrast to its small part in the diet of paua in areas 1 and 2.

The most often eaten seaweeds, (in more than 50% of the stomachs) were brown seaweed and Corallina, with one or both forming the bulk of the stomach content.

Seventeen varieties of seaweed were identified in the paua stomachs from the three areas. Ten seaweeds occurred in more than half of the paua sampled at any one time and were therefore the most commonly eaten. However, only six varieties were eaten in quantity (over 10.0%) and these were therefore the most important seaweed to the paua. They formed 60% of the food intake in the first area, 70% in area 2 and 92% in area 3. They were brown seaweeds, Corallina, Chondria, Champia, Streblocladia and Pterocladia capillacea.

In areas 1 and 2, the abundance of each class of seaweed in the stomachs was a reflection of the abundance of the same class of seaweed in the area. This did not apply, however, for individual species of seaweed indicating that paua did show a discrimination when feeding. A comparison of the abundance of the common seaweed species in the area and stomachs in Figure 2, reveals a preference of the paua for brown seaweed, Streblocladia, Chondria and Pterocladia capillacea. There was less of a preference for Ulva and Sarcodia and an avoidance of Corallina and Champia. Paua also showed a preference for certain of the less common seaweed such as Brogniartiella, Euptilota, Plocamium costatum, Euzoniella and Caulerpa brownii which were often eaten although sparse in the areas. In comparison Caulerpa sedoides and Hormosira which were more abundant in the areas, were avoided by the paua.

Paua appear to feed in a limited area. Two samples were taken at the same time from different positions in Area 2. (Table 2.). Specimens 1-7 were from a single boulder while 8-17

were from over the whole area. Most of the paua in the first group had similar quantities of the same seaweed in their stomachs and had evidently been feeding together in the same area. The second group of paua had a greater variety of seaweed in differing quantities per individual.

DISCUSSION

Haliotis iris is similar to other species of Haliotidae in feeding on seaweed although there is a difference in the types of seaweed eaten by the various species. Croft (1929) mentioned H. tuberculata preferring delicate red algae as well as coarser weeds. H. gigantea and H. kamtchatkana however feed mainly on brown algae and eel-grass, rarely taking red algae (Ueda and Okada 1939-40). The commercial Japanese abalone, H. discus hannai is also a macro-algal feeder, taking brown, red and green seaweed (Saki 1962).

No animal matter was found in the stomachs of H. iris although H. gigantea and H. kamtchatkana were recorded as taking hydrozoans and copepods. Ueda and Okada 1939-40). The Californian abalone H. cracherodii also ingested foraminifera, bryozoa, sponge spicules and shell fragments although their principal diet was brown and red seaweed. (Leighton and Boolootian 1963).

The similarity between the abundance of each class of seaweed in areas 1 and 2 and the stomachs of paua from the same areas, together with the large number of seaweed species in any one stomach, indicates a random feeding habit in these areas. This was not so in area 3 where the brown seaweed had been eaten in preference to the more abundant Corallina. The large

consumption of the seaweed in area 3, when it had been consistently avoided by the paua in the other areas, indicates that the paua had been forced to eat Corallina because of a scarcity of other seaweed. The Californian abalone H. cracherodii also showed a similar reluctance to eat Corallina although it was common in the area, and when eaten it generally passed out in an undigested condition (Leighton and Boolootian 1963).

Haliotis iris do show a preference when feeding, but it is for individual seaweed rather than for a whole class of algae. This disagrees with Sinclair (1945) who mentioned that H. iris up to 80 mm show a preference for red seaweeds and those over 80 mm a preference for brown seaweeds. Sinclair examined only the stomach contents, which would not indicate a preference, but only what was the predominant seaweed eaten at that time. Sakai (1962) mentions that H. discus hannai shows likes and dislikes in when two species of seaweed were simultaneously fed, they preferred Ulva pertusa to Carpopeltis affinis and Undaria pinnatifida to Ulva pertusa. Haliotis cracherodii fed in the laboratory also showed a preference for a number of common brown seaweed and a few species of red seaweed. (Leighton and Boolootian 1963).

The preference for particular seaweed shown by H. iris in their natural environment, is not as marked as that shown by other species of Haliotis in laboratory experiments. Haliotis iris showed rather a disinclination to eat only a few species, a random browsing on most of the seaweed in any particular area with a slight preference for certain of the filamentous types.

Seaweed avoided such as Hormosira, Corallina and Caulerpa sedoides, have a short stubby thallus and this could be the reason for their rejection. Several species of small, bottom growing, green and red seaweed, each with a light filamentous thallus, were scarce in the area, but were eaten by many of the

paua. The location, size and shape of this type of seaweed would make them very accessible to the paua and easily broken down and ingested, and this may account for their frequent occurrence in the stomachs. The selection that occurs would, therefore, be passive rather than active in that the paua would accent or reject any particular seaweed they came in contact with.

The correlation between seaweed in the stomach and in the immediate locality, indicates a limited movement when feeding. All the paua from one boulder had similar types of seaweed in their stomachs and must have been feeding together. The clean attachment areas on the rocks, also indicates a return by each paua to the same position after feeding and this must restrict the distance that a paua could move. (MacGinitie, N. and MacGinitie G.E., 1966) mentioned this limited movement and recorded H. corrugata with eroded tops to their shells from persistent attachment in the same confined rock crevices. The same species were also recorded as remaining in areas where the seaweed had died, even though the abalone were suffering badly from starvation. Haliotis iris tagged in area 3, were found to remain in the same rock pool, even though seaweed was scarce. These paua had a slower growth rate than others along the coast, yet made no attempt to leave the pool although escapement was possible at each high tide.

CONCLUSION

Haliotis iris browse at random taking most seaweed they come in contact with.

They show a discrimination when feeding, but this is towards individual species and not a class of seaweed. This discrimination is more a rejection of certain species rather than an active seeking out of preferred types.

This paper has dealt with the feeding of pre-commercial size paua, found in the inter-tidal zone, during their period of most rapid growth. A study of the feeding habits of mature paua in deeper water would complete this line of investigation.

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Table 1

PERCENTAGE VOLUME OF SEAWEED IN ALL STOMACHS AND EACH AREA

Seaweed Species	AREA 1		AREA 2		AREA 3	
	Stomach	Area	Stomach	Area	Stomach	Area
BROWN						
Brown Seaweeds	47.1	39.0	30.5	29.0	49.7	22.0
Hormosira	-	3.5	-	2.0	-	7.0
RED						
Brogniartiella	2.3	2.0	5.2	-	-	-
Champia	12.2	18.5	7.3	20.0	-	-
Chondria	7.7	3.2	13.6	6.0	0.3	-
Corallina	0.1	11.0	0.1	9.0	42.7	59.0
Euptilota	1.2	-	2.0	-	-	-
Plocamium costatum	2.3	-	0.05	-	-	-
Pterocladia capillacea	4.7	3.0	12.3	3.0	-	-
Pterocladia lucida	-	2.0	0.05	-	-	-
Sarcodia	5.3	-	8.0	9.0	0.2	-
Strebloclaclia	5.7	4.3	13.5	10.0	-	-
GREEN						
Ulva	8.4	1.0	2.4	9.0	-	4.0
Euzoniella	0.3	-	0.4	-	0.8	-
Caulerpa sedoides	0.3	6.7	0.4	-	0.3	4.0
Caulerpa brownii	1.1	2.5	1.8	2.0	3.8	-
Bryopsis	-	2.7	-	-	-	-
Unidentified	0.7	-	1.3	1.0	1.3	-

Table 2

STOMACH CONTENTS OF PAUA FROM AREA 1

Seaweed Species	Percentage Volume of Seaweed in 13 Stomachs													Average Percentage	No. of Times Seaweed Eaten
	1	2	3	4	5	6	7	8	9	10	11	12	13		
BROWN															
Unidentified Brown Seaweed	48	44	85	10	19	49	65	47	53	25	50	63	55	47.1	13
RED															
Brogniartiella	-	-	-	-	4	5	-	5	2	15	-	-	-	2.3	5
Champia	-	-	-	-	-	25	30	9	25	3	1	27	39	12.2	8
Chondria	25	41	3	-	4	3	-	9	4	-	-	5	6	7.7	9
Corallina	2	-	-	-	-	-	-	-	-	-	-	-	-	0.1	1
Euptilota	2	4	-	3	4	-	-	-	-	-	3	-	-	1.2	5
Plocamium costatum	-	-	-	30	-	-	-	-	-	-	-	-	-	2.3	1
Pterocladia capillacea	1	5	-	-	9	7	-	10	6	24	-	-	-	4.7	7
Sarcodia	3	2	1	-	15	5	-	-	-	10	31	2	-	5.3	8
Strebloclaclia	9	2	5	6	15	4	5	14	4	-	10	-	-	5.7	10
GREEN															
Ulva	3	-	-	50	25	-	-	6	-	20	3	3	-	8.4	7
Euzoniella	-	-	-	-	4	-	-	-	-	-	-	-	-	0.3	1
Caulerpa sedoides	-	-	-	-	-	-	-	-	4	-	-	-	-	0.3	1
Caulerpa brownii	-	-	6	-	-	2	-	-	2	3	2	-	-	1.1	5
Unidentified	5	2	-	1	1	-	-	-	-	-	-	-	-	0.7	4
Number of Seaweed Species	9	7	5	6	10	8	3	7	8	7	7	5	3		

Table 3

STOMACH CONTENTS OF PAUA FROM AREA 2

Seaweed Species	Percentage Volume of Seaweed in 17 Stomachs																	Average Percentage	No. of Times Seaweed Eaten
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17		
BROWN																			
Brown Seaweeds	60	8	-	20	25	50	-	25	19	85	48	58	25	64	21	6	5	30.5	15
RED																			
Brogniartiella	-	-	50	-	3	1	30	5	-	-	-	-	-	-	-	-	-	5.2	5
Champia	-	-	-	-	-	-	-	20	4	-	-	-	-	-	-	90	10	7.3	4
Chondria	10	2	1	-	-	-	1	26	63	-	-	-	59	-	1	-	69	13.6	9
Corallina	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	0.1	1
Euptilota	-	5	25	2	-	-	1	-	-	-	-	-	-	-	-	-	-	2.0	4
Plocamium costatum	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	0.05	1
Pterocladia capillacea	-	15	-	30	20	-	35	4	1	2	50	25	3	19	2	-	3	12.3	13
Pterocladia lucida	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	0.05	1
Sarcodia	10	3	5	8	20	2	3	2	4	-	-	-	-	5	75	-	-	8.0	11
Streblocladia	15	65	10	35	20	45	-	15	4	2	1	2	2	6	-	4	4	13.5	15
GREEN																			
Ulva	-	2	2	3	5	-	20	-	1	2	-	4	-	-	-	-	3	2.4	9
Euzoniella	3	-	1	-	-	-	3	-	-	-	-	-	-	-	-	-	-	0.4	3
Caulerpa sedoides	-	-	-	-	-	-	-	-	-	-	-	8	-	-	-	-	-	0.4	1
Caulerpa brownii	-	-	5	-	3	-	1	2	-	5	1	-	4	1	-	-	2	1.8	9
Unidentified	1	-	1	-	1	1	5	1	3	2	-	1	3	5	1	-	1	1.3	13
Number of Seaweed Species	6	7	9	6	8	6	9	9	9	7	4	6	6	6	5	3	8		

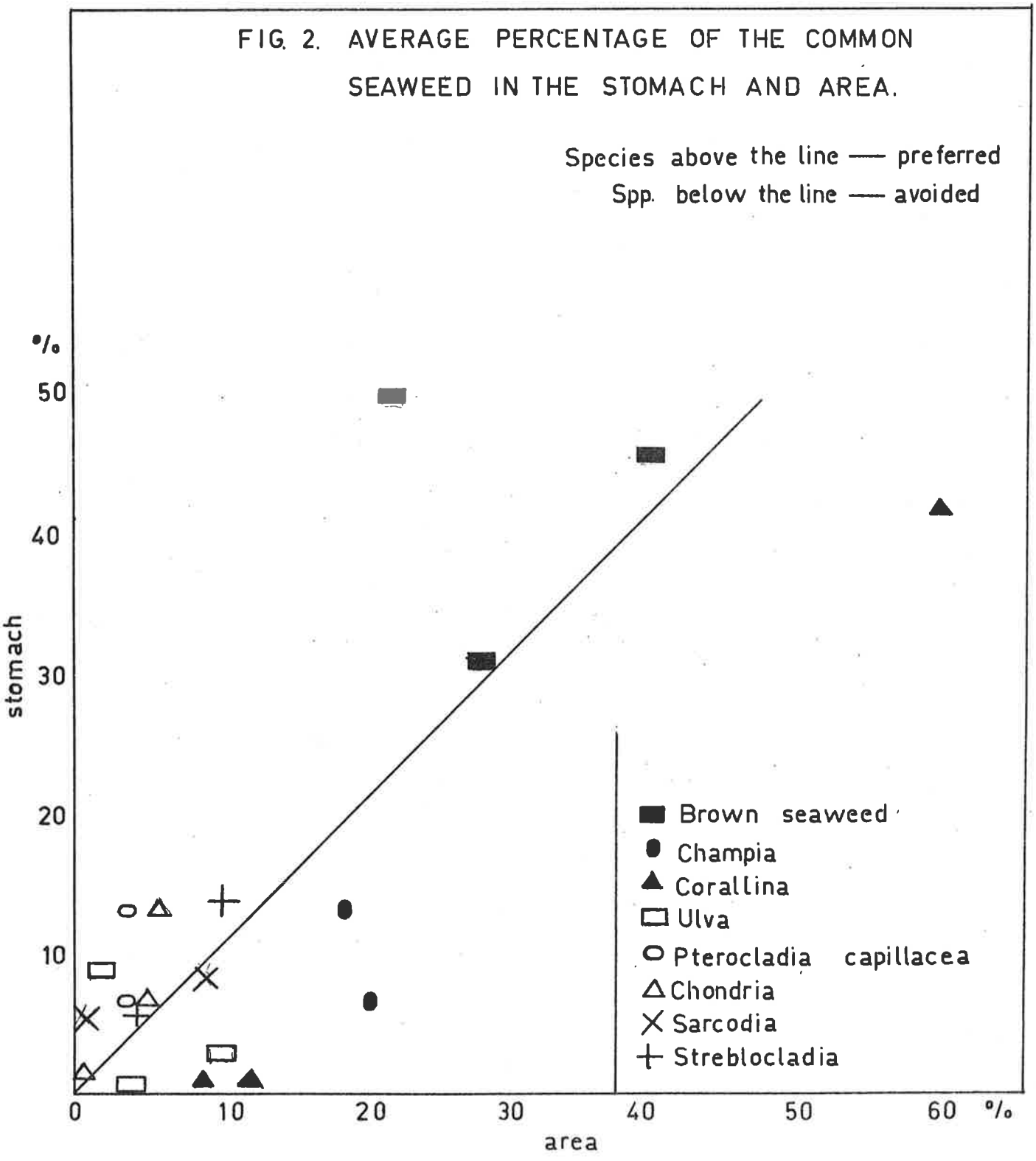
Table 4

STOMACH CONTENTS OF PAUA FROM AREA 3

Seaweed Species	Percentage Volume of Seaweed in 7 Stomachs							Average Percentage	No. of Times Seaweed Eaten
	1	2	3	4	5	6	7		
BROWN									
Brown Seaweeds	4	40	23	94	60	50	77	49.7	7
RED									
Chondria	-	-	2	-	-	-	-	0.3	1
Corallina	92	45	70	2	40	50	-	42.7	6
Sarcodia	-	-	-	-	-	-	3	0.2	1
GREEN									
Caulerpa brownii	-	15	-	-	-	-	12	3.8	2
Caulerpa sedoides	-	-	2	-	-	-	-	0.3	1
Euzoniella	-	-	-	-	-	-	6	0.8	1
Unidentified	2	-	3	2	-	-	2	1.3	4
Number of Seaweed Species	3	3	5	3	2	2	5		

FIG. 1. STOMACH CONTENTS OF HALIOTIS IRIS.

FIG. 2. AVERAGE PERCENTAGE OF THE COMMON SEAWEED IN THE STOMACH AND AREA.



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