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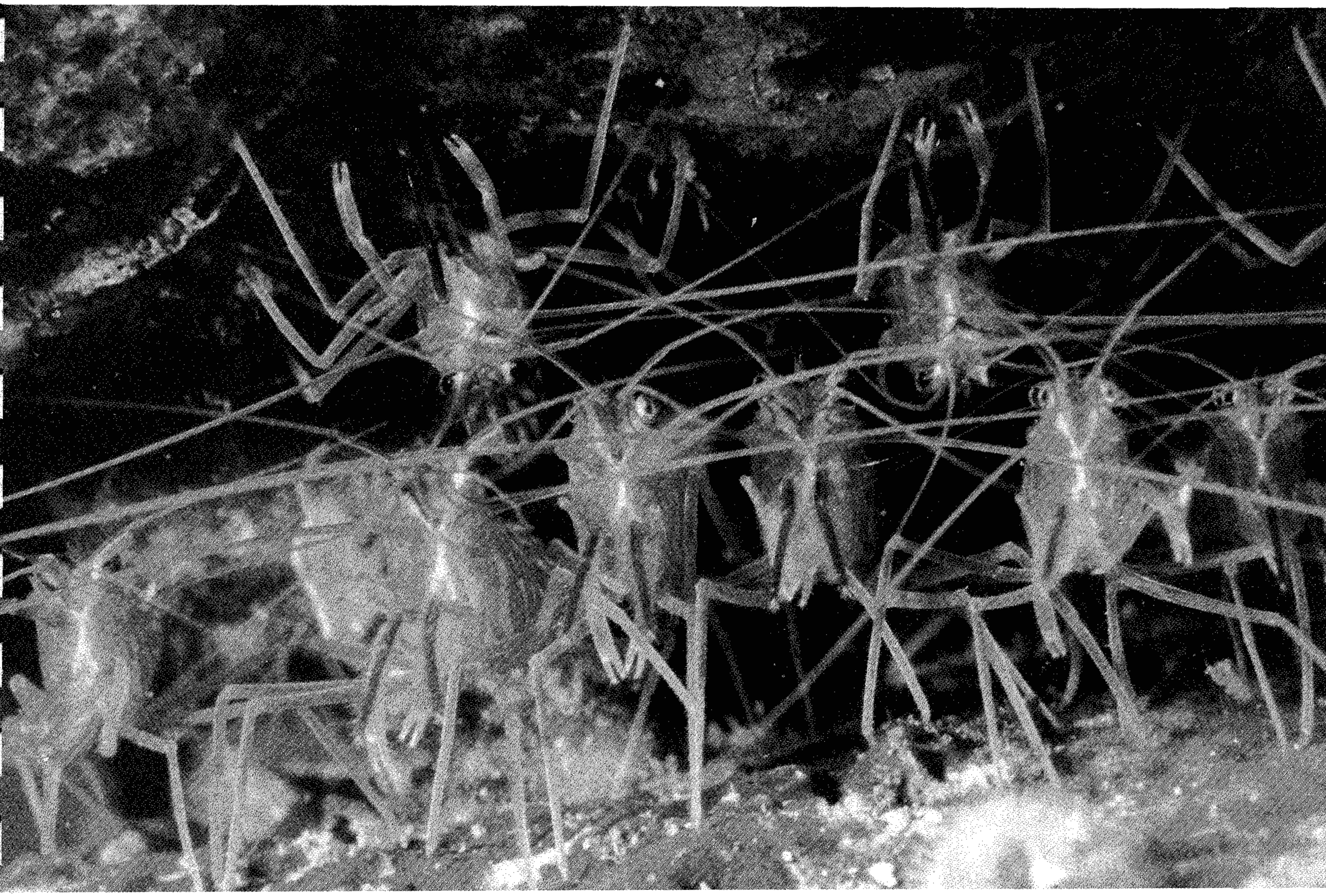

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
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Cover photo- An aggregation of the caridean shrimp *Lysmata californica* under a ledge.

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CONTENTS

INTRODUCTION

This is an account of the benthic invertebrates in four distinct marine habitats at Santa Catalina Island, off southern California (Fig. 1). Although based on samples taken to identify foods of fishes, it is, to our knowledge, the most comprehensive published account of species composition on rocky reefs. Also, in representing varied settings at this centrally located island, the findings permit comparisons with results of similar studies elsewhere in southern California. Potential for still more insight comes from lists of predators on each species, as trophic relations are key elements of ecological systems (Hobson 1994).

The presentation is meant as a source of information that can be used several ways. Because the assessments were made from 1973 to 1975, they describe conditions that were in place immediately before the extended period of elevated sea temperatures that began in about 1976 (McLain 1983, Cole and McLain 1989). Some investigators, therefore, may find the information useful as a basis for measuring effects of the post 1976 warming on organisms and their environment. This warming has had profound effects among pelagic organisms (e. g., Roemmich and McGowan 1995, MacCall 1996), and might be expected to have had similar effects among benthic organisms. The information provided here may provide baselines needed to examine this expectation.

The information presented may also be useful in the great extent that it defines the species involved. There is widespread contention that loss of species diversity is among the more damaging effects of human activities on ecological systems (e. g., Ehrlich and Wilson 1991, Lubchenko et al. 1991, Hughes and Noss 1992), and obviously one needs measures of the diversity to document such loss. But measures of ben-

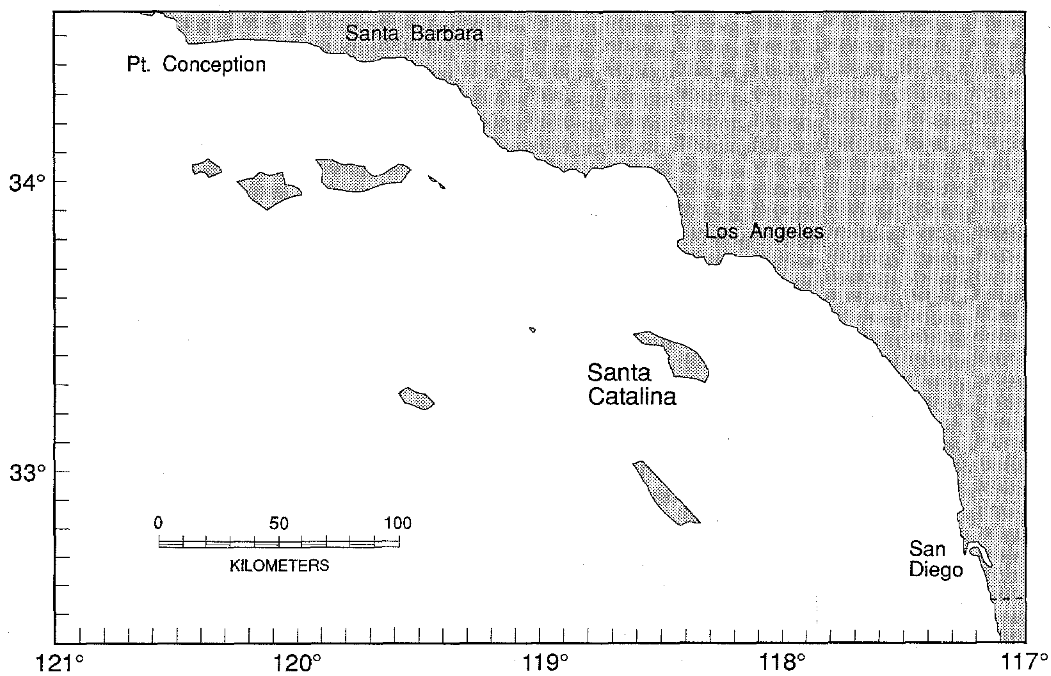

Figure 1. Area of the sea off southern California, with Santa Catalina Island.

thic diversity are invariably compromised by problems in the collection and identification of organisms. The nature and extent of these problems become clear on the pages that follow, which show what can be expected in measures of species diversity in the nearshore benthos.

METHODS

Sampling

The benthos was assessed using SCUBA at sites off the western end of the Island (Fig. 2). Occurrences of invertebrates and algae were characterized with a standard set of samples and observations in 4 x 25-m transects at each of four primary sites: Isthmus Reef, Fisherman's Cove, West End and Eagle Rock. The first two represented leeward habits, the last two windward habitats. Three other leeward sites—Ship Rock, Lion's Head and Bird Rock—provided much supplemental information. The comprehensive assessments at the four primary sites were made between 0900 and 1500 hours, thus reducing the complexities of diel variability. Despite this emphasis on mid-day conditions, our conclusions incorporate a broad knowledge of diel variations based on our other studies at this location (Hobson and Chess 1976, 1986; Hobson et al. 1981). The standard set of samples at each of the primary sites were taken during the month/year as follows: Isthmus Reef—5/73, 9/73, 1/74, 3/74, 7/74, 10/74, 2/75 and 7/75; Fisherman's Cove—5/73, 11/73, 3/74, 5/74, 8/74, 1/75, 4/75 and 7/75; West End—2/73, 5/73, 10/73, 2/74, 6/74, 8/74 and 7/75; Eagle Rock—5/73, 9/73, 1/74, 5/74, 7/74 and 7/75.

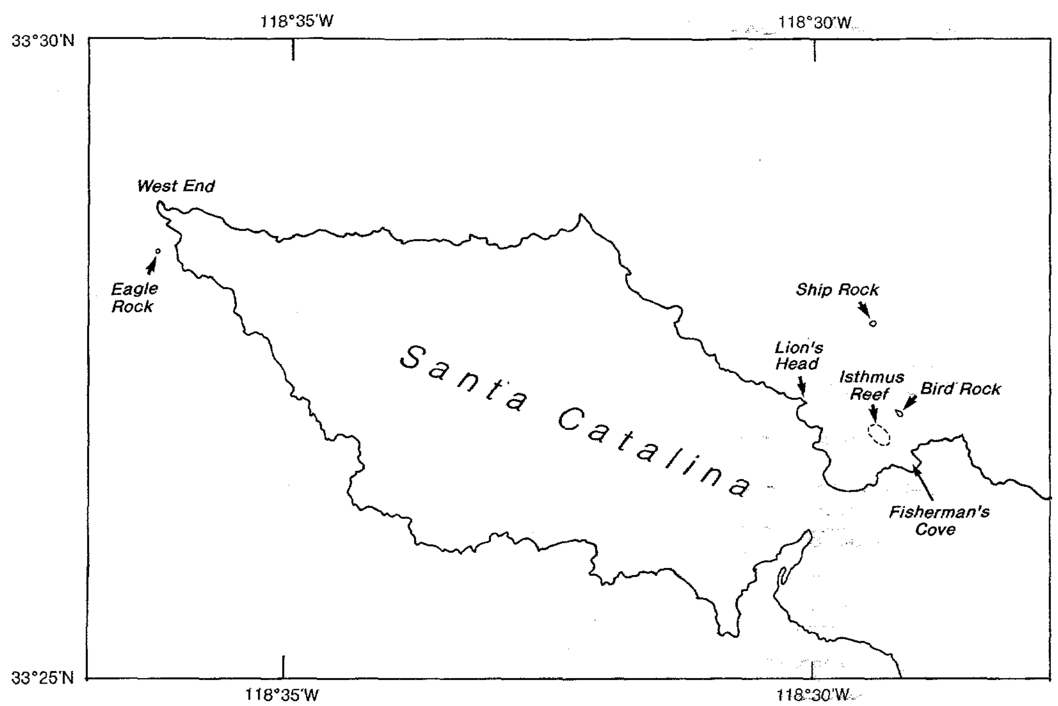

Figure 2. Sites of assessments off western Santa Catalina Island.

The samples were of several types: Larger, exposed organisms were censused with visual counts, while others too small or cryptic to be enumerated this way were sampled with various collecting devices. Organisms on rock were sampled with an airlift (Fig. 3), while organisms on algae were sampled by collecting turf, and organisms in sediments were sampled with coring devices. Each of these procedures will now be described in more detail.

Visual Assessments

Organisms quantified visually included the algae and certain large, conspicuous invertebrates, e. g., various sponges, anthozoans, molluscs and echinoderms. The algae were assessed several ways. Components of the benthic turf were assessed by an observer that hovered in the water column and estimated the percentage each major species contributed to the total algal cover on the sea bed below. Larger algae growing above the turf were quantified by counting individual plants and stipes. Also included were subjective evaluations of such features as canopy thickness, general condition and coverage by encrusting organisms. Invertebrates assessed visually were those seen in the transects. Most of these were relatively large, sedentary (if not sessile) forms ineffectively sampled by the other methods. Only those of uncertain identity were collected.

Collections of the Benthos

Organisms on rock surfaces were sampled with an airlift (Fig. 3), which uses a tank of compressed air to generate suction that pulls material from substrata into an intake nozzle (5 cm in diameter) and then through a 2.5 m-long tube to a nitex-mesh (0.333-mm) bag (20 x 50 cm). Each collection sampled a 0.25-m^2 quadrat. The more loosely attached organisms were dislodged by scraping the intake nozzle on the substrate, but this technique generally was ineffective with strongly attached forms. See Chess (1978) for more information on this device.

Organisms on benthic turf were sampled with collections of the major turf algae. These were collected in bags (20 x 40 cm) of nitex mesh (0.333 mm) that were placed over each plant and then closed while pulling the plant free. Each sample consisted of a series of subsamples (typically three, all of one species and totalling about 300 grams) that were taken at different points along the transect line. Usually these samples included the dominant three to four species.

Upon returning to the boat, the collections of turf algae were placed in a 5-gal bucket and covered with sea water. If the collection was to be processed within 2 hrs, MgCl was added to narcotize the invertebrates, but this additive was unnecessary with longer delays because anoxia or warming of the water in the bucket had a narcotizing effect. The invertebrates were separated from the algae with repeated rinsing and retained by sieving the rinse-water through a 0.25-mm screen. Most organisms collected this way were readily detached motile forms. The many sessile forms that periodically encrusted these algae—e. g., ascidians, bryozoans and hydroids—tended to be greatly underrepresented in our assessments. Based on weight of the algae after rinsing, data from each sample were adjusted for equivalence to what would have been expected from a sample of 100 grams.

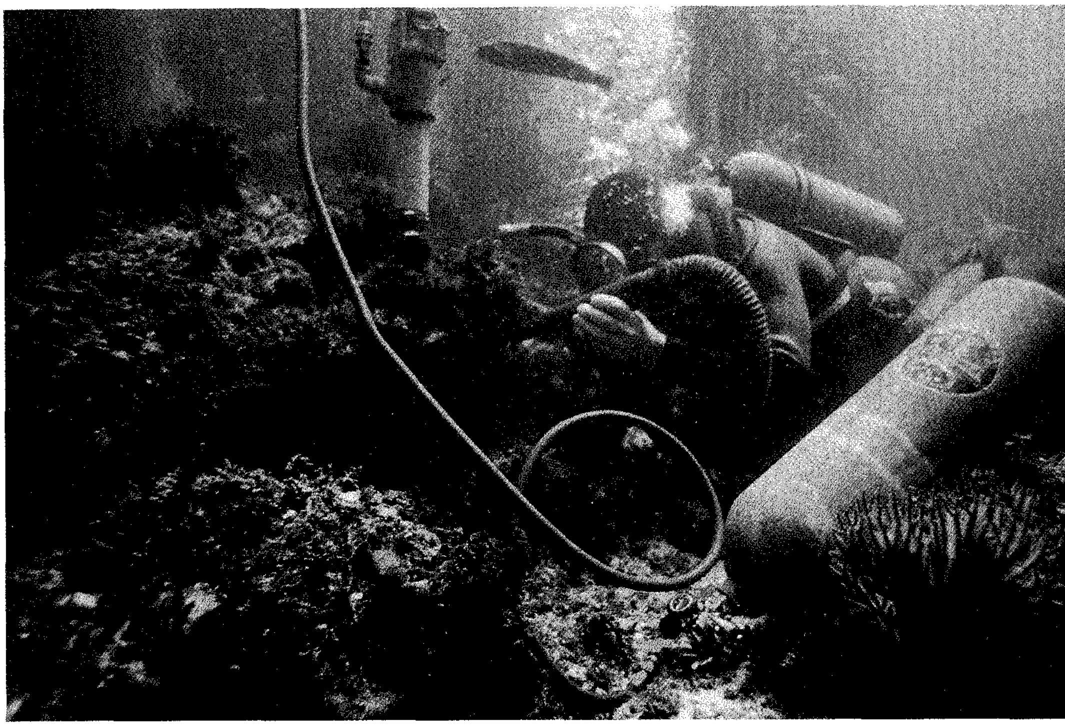

Figure 3. Samples of the benthos being collected with the airlift.

Despite the prominence of the giant kelp, *Macrocystis pyrifera*, at or near all four major study sites, this massive plant was not among the algal substrata regularly sampled. This was because we anticipated the availability of results from a concurrent study of organisms associated with *Macrocystis* at Santa Catalina (Coyer 1979) that intended to use methods similar to ours. We present samples of organisms from *Macrocystis* among our irregular, unscheduled collections, however.

Organisms in sediments were sampled most effectively with coring devices, but this method was adopted only during the latter part of the study. At the outset we used the airlift because we wanted samples that would be comparable to the airlift collections from rocks. The airlift proved only marginally effective in sediment, however, so we switched to the corers. Here we combine the results of both methods, limited to collections of sediment under the turf of Fisherman's Cove (the only one of our major sites where sediment was consistently a major substrate). The corers, 10 cm in diameter, were inserted 5 cm into the sediment at roughly 3-m intervals along the length of the transect, for a total of 10 during each sampling session. This is the method we used to sample the sediments in Ripper's Cove, 7 km east of Fisherman's Cove (Hobson and Chess 1986).

Organisms on other benthic substrata, including in crevices and in caves, were sampled irregularly—often just once. Although many of these added collections were made at the major study sites, their results are not included with results of the standard sampling sessions.

Processing Samples of the Benthos

Collections taken with the airlift, algae grabs and corers were fixed and stored in formalin until analysis. In preparation for analysis, the collections were soaked and rinsed in water, then sieved to retain organisms >0.25 mm. These were sieved to retain organisms >0.5 mm, and only these were analyzed; the smaller forms were preserved and stored so that they could be examined later if necessary. Although most samples were analyzed in their entirety, those too large to manage were split using a Folsom splitter or by analyzing pie-wedge (36°) aliquots in a circular dish. After analysis, the samples were stored in 70% ETOH for later rechecking and possible additional study.

Presentation

To organize the presentation, particularly the tables, the invertebrate taxa sampled were assigned to one or another of 23 higher categories (as listed in table of contents, p. iii). These vary in taxonomic level, from phylum e.g., sponges, to suborder, e.g., gammaridean amphipods. A few older names, e.g. bryozoans, are used because we believe they remain generally more familiar than newer alternatives to non-specialists.

To select taxa for consideration and to establish order of presentation within a taxonomic group, we adopted a *Ranking Index*. This was calculated from the collection data as frequency of occurrence x either mean number or mean percent of sample volume x 100, whichever is larger. Generally we used the former with very small forms, like amphipods, and the latter with larger forms, like certain crabs, and forms that could not be enumerated, like bryozoans. There were variations depending on characteristics of specific groups, however, and these are defined and explained below where appropriate. Invertebrate species considered in this report are those with a ranking index of one or more. A few that did not meet this criterion were included because, as documented elsewhere (Hobson and Chess ms), they were ranked prey of fishes and therefore may have been undersampled by our collecting methods.

Generally taxa are grouped by family and listed in alphabetical order, but some text accounts of poorly sampled forms consider them in order of relative prominence in the environment. Sizes reported in the text accounts generally are those of maximum dimension, whether length, width or height. Tables list forms of same taxonomic level alphabetically and those of different taxonomic level in ascending phylogenetic order (i. e., genus before family, etc.). All tabulated values are to nearest integer, with <1 representing <0.5. The first column under each substrate (%) lists proportion of samples with that taxon (x100). The last two categories in each list of taxa (in tables) need clarification. "Others (identified)" are forms identified at least to family that were not numerous enough to be ranked, whereas "Undetermined" are forms that could not be identified to family, typically because they represented early life-stages that lacked diagnostic features.

Fish Predators

The listings of fish predators draw primarily from fish specimens collected concurrently with the samples of the benthos, but also from our published works on trophic relations in these same habitats (Hobson and Chess 1976, 1986; Hobson et al. 1981). In noting the various benthic invertebrates as being ranked or unranked as prey of these fishes, we refer to measures of relative abundance in the fish diets based on calculations much like those used to measure relative abundance in the environment, defined above. Although index values for diet are presented elsewhere (Hobson and Chess ms), ranked prey are those with index values of one or more, and which could be identified among the gut contents of at least 5% of our specimens of that fish species (or in at least 2 when our samples of that fish species were less than 20).

STUDY SITES

Isthmus Reef

Isthmus Reef rises sharply from an expanse of open sand at depths of 20 to 30 m in the center of Isthmus Cove, on the northwestern side of the Island (Fig. 2). Its top, an area of about six hectares, is under 5 to 10 m of water (except one place that breaks the surface at low tide). The primary sampling site here was a shelf approximately 25 m wide about a third of the way down the reef's seaward face. There was about 15 m of water above this shelf and its surface was essentially rock variably overgrown by a turf of tufted or bush-like algae. Many of the reef's horizontal surfaces were covered by a superficial, highly variable layer of sediment, but there were relatively few sediment-associated organisms in the irregular core samples taken there.

A permanent belt transect (4 x 25 m) was established at this site in April 1973, at which time about 90% of the area was covered by a benthic turf dominated by *Dictyopteris undulata*. In places a prominent larger alga, *Eisenia arborea*, spread out a meter or so above the others, but we considered it as comprising a sub-canopy and not being part of the bottom cover. A forest of giant kelp, *Macrocystis pyrifera*, occupied the center of the reef, but its nearest edge was about 30 m away. There were several isolated *Macrocystis* in the transect, but they barely reached the surface and had little apparent influence on the habitat.

Within a month after the transect had been established, the habitat entered a period of rapid change that began with a strong recruitment of *Macrocystis*. Seventy young sporophytes were counted within the transect during late May, most attached to rock outcroppings, but some to small rocks and even mollusc shells. Growing rapidly, the young *Macrocystis* reached 10 to 15 m above the seabed by September, and once at the water's surface spread out to form a canopy that thickened with continued growth. As the *Macrocystis* canopy developed, there was a sharp decline in the benthic turf, which by January 1974 covered only about 3% of the transect—almost all of it *Cystosiera neglecta*. *Dictyopteris undulata*, the species that had dominated nine months earlier, was now represented by just a few ragged individuals. With this transformation, the site had become a typical kelp forest (Fig. 4).

The *Macrocystis* forest remained in place through the next two years, but no further recruitment was noted and there was a progressive deterioration of the plants. Encrustation of forms such as spirorbid polychaetes and the bryozoan *Membranipora membranacea* (Fig. 5) created problems with buoyancy, photosynthesis and assimilation of nutrients (Wing and Clendenning 1971). *Macrocystis* often suffers lack of nutrients in these leeward habitats (Zimmerman and Kremer 1984), and when thus

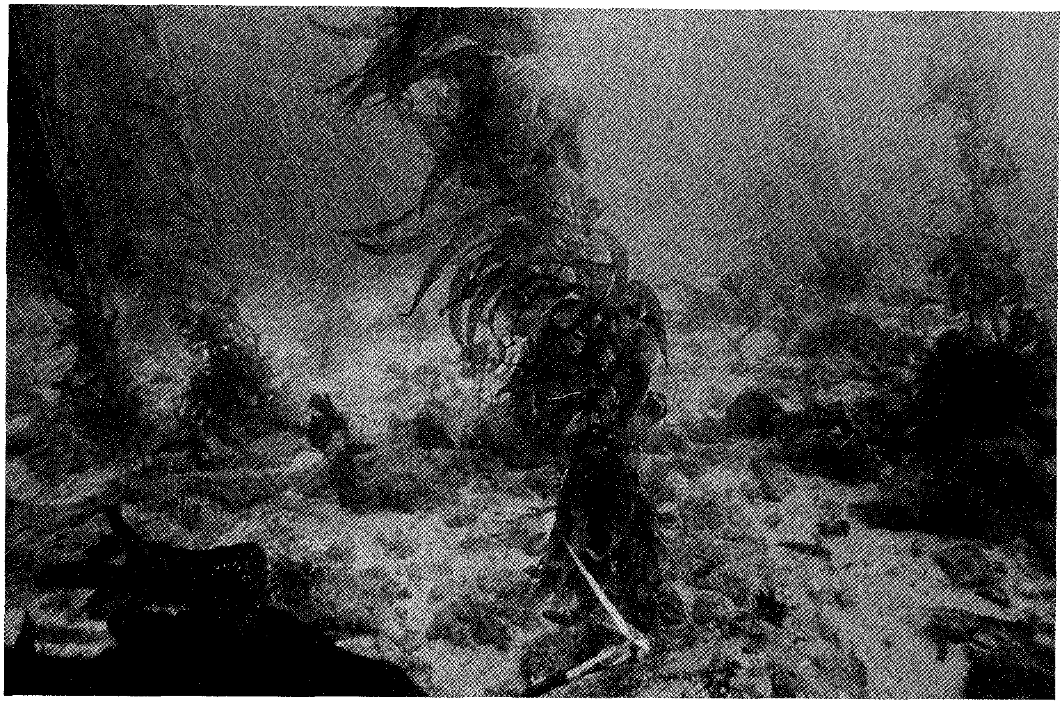

Figure 4. Transect on Isthmus Reef, January 1974.

stressed may be especially vulnerable to invasion by encrusters. Also, epiphytic organisms caused damage by being food of carnivorous fishes that tore away pieces of the kelp in consuming prey. And herbivores that grazed on *Macrocystis*, including various mollusks and echinoids, sometimes did great damage, particularly when in large numbers on the plant's holdfast and at the base of stipes (Fig. 6).

There was a particularly noticeable thinning of the canopy during late summer and fall of 1974, when about 20% of the fronds on established plants rotted at their tips. At that same time, there was an increase in the turf, which by October had

Figure 5. *Macrocystis pyrifera* encrusted by the bryozoan *Membranopora membranacea*.

expanded to cover 15% of the transect. Even with this deterioration of *Macrocystis*, however, the forest appeared in reasonably good condition when we left the Island in September 1975, two months after the last assessment in this series.

Figure 6. Mollusks grazing on a *Macrocystis* holdfast.

Fisherman's Cove

Fisherman's Cove, an embayment about 300 x 300 m in area (Fig. 2), is the site of the Catalina Marine Science Center and many past scientific investigations. There is a cobble beach at the head of the cove, but precipitous rock cliffs drop abruptly into the water along its flanks (see Hobson and Chess 1976, Fig. 1). The western side of the cove was rimmed by a *Macrocystis* forest that was anchored to a narrow band of large rocks extending 30-40 m offshore from the cliff base. From the outer edge of these rocks, where the water was about 10 m deep, an expanse of coarse sediment (much of it nodules and fragments of the coralline alga *Lithothamnion australe*) sloped gently for about 50 m to where the water was about 15 m deep, and then dropped abruptly to depths of about 30 to 35 m.

A belt transect (4 x 25 m) was established at depths of 10 to 12 m on this expanse of sediment during November 1973, with one end about 15 m from the alongshore *Macrocystis* forest. The water column in the vicinity of this transect was the site of our study of trophic interactions among the fishes and zooplankters (Hobson and Chess 1976).

The expanse of sediment was variably overgrown by turf algae similar to Isthmus Reef, but here mostly attached to tubes of the polychaete *Chaetopterus variopedatus*. With *Dictyopteris undulata*, *Pachydiction coriaceum* and *Desmarestia viridis* dominating, this turf was richest during late summer (Fig. 7) and diminished during late winter (Fig. 8). When the turf expanded during the spring of 1974, however, it did so under a thick growth of the epiphyte *Acinetospora nicholsoniae* (Fig. 9).

When the turf died back during the following winter, *A. nicholsoniae* declined with it. And when the turf developed in the spring of 1975, *A. nicholsoniae* also was rejuvenated—but not on the turf. This time it grew to cover the extensive stands of *Sargassum muticum* that developed that year. *S. muticum* had been a minor presence in previous years, but during the summer of 1975 occupied much of the inner regions of Fisherman's Cove (but not

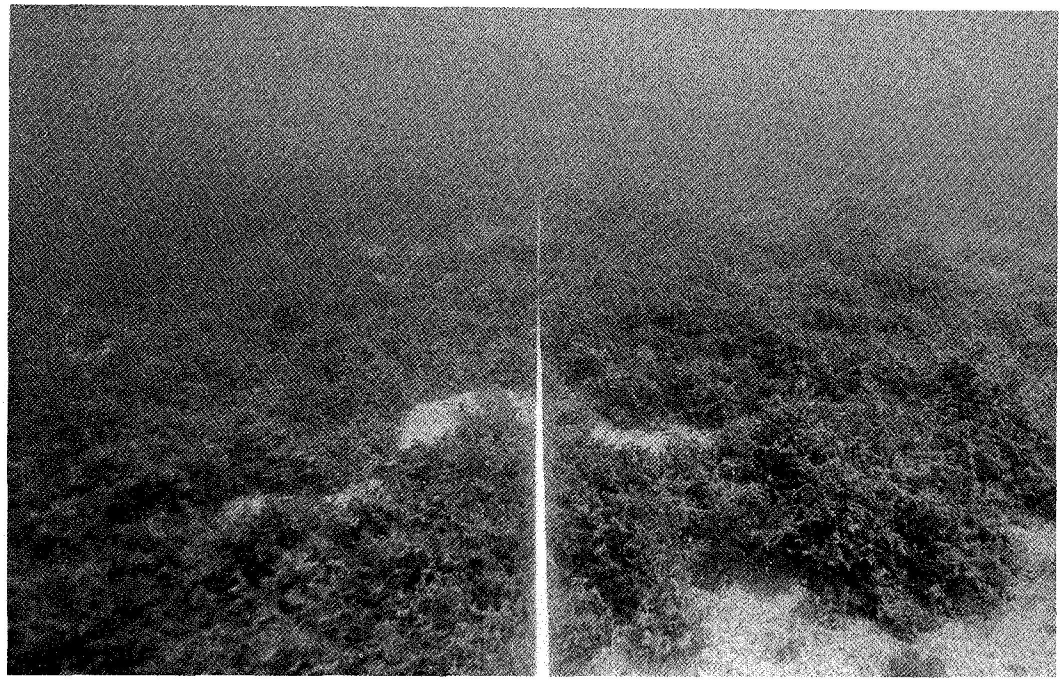

Figure 7. Transect in Fisherman's Cove during summer.

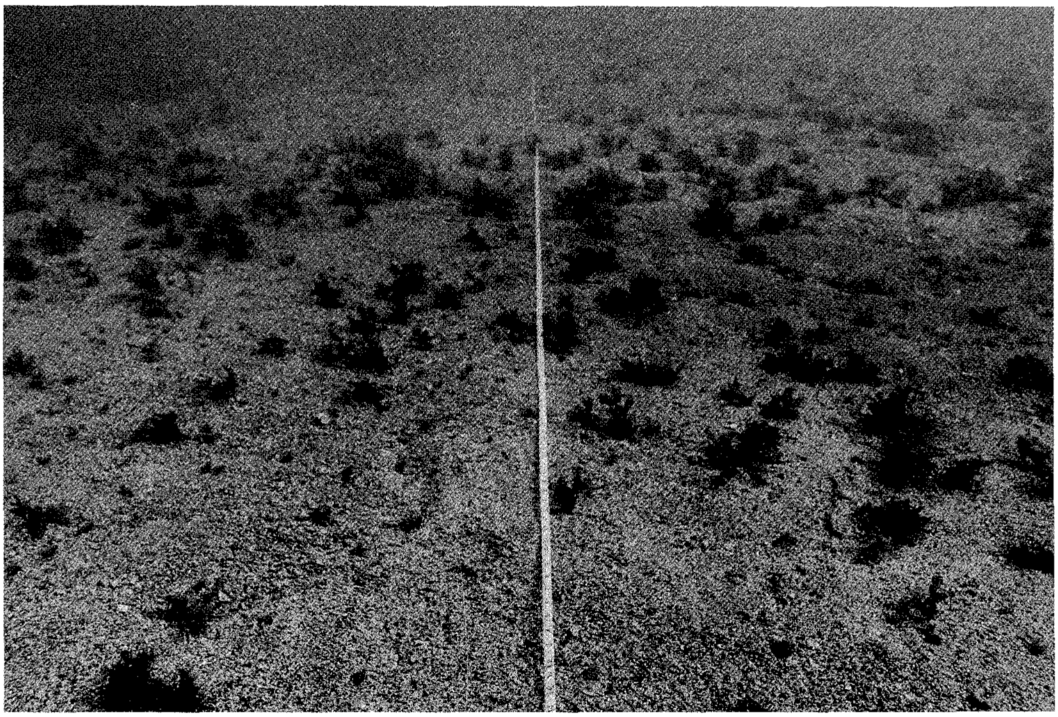

Figure 8. Transect in Fisherman's Cove during winter.

the transect). When *S. muticum* was abundant at Isthmus Reef the following year, its growth was reduced to the extent that it was considered part of the turf; but in Fisherman's Cove during the summer of 1975, it grew from sea bed to surface in dense beds much like *Macrocystis*.

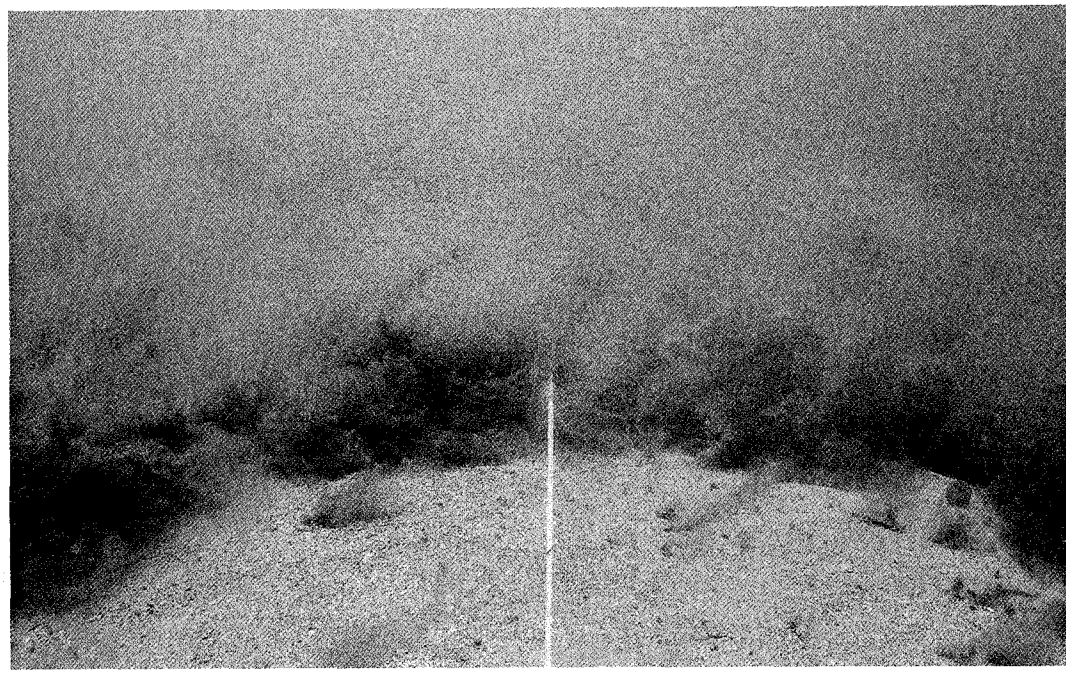

Figure 9. The transect in Fisherman's Cove under a mat of *Actinotospora nicholsoni*, an epiphyte, during summer of 1974.

Many *Macrocystis* sporophytes settled in the transect during early spring of 1974 and 1975 (when recruitment was not evident in the established forest at the Isthmus Reef transect), but in the absence of proper anchors (most were attached to the shells of molluscs, tubes of embedded polychaetes or loose stones), only a few remained at mid summer. For example, of 17 that were counted during May of 1974, just 2 were present in August. The only ones to persist were those few that had found relatively secure footing—in most cases, a heavy piece of debris, but even these were gone by the next year.

West End

The West End site was on the north side of the island, 100 m from its tip (Fig. 2), where large boulders (2-5 m in diameter) sloped from shore to a depth of about 30 m. The transect was established on this slope during February 1973, parallel to shore at a depth of about 10 m (Fig. 10). This windward setting was frequently swept by high seas, which rarely occurred at the relatively tranquil Isthmus Reef and Fisherman's Cove sites. Also, sea temperatures tended to be several °C lower at West End than at the leeward stations.

The general character of the habitat at West End remained relatively unchanged throughout the study, in contrast to the changing nature of the two leeward sites. Nevertheless, there were seasonal changes not evident to casual observation. The seabed was mostly large boulders covered by a dense turf of rhodophytes, and while *Plocamium cartilageum* and *Pterocladia capillacea* dominated this turf throughout the year, *P. cartilageum* experienced its greatest growth in winter and *P. capillacea* its greatest growth in summer.

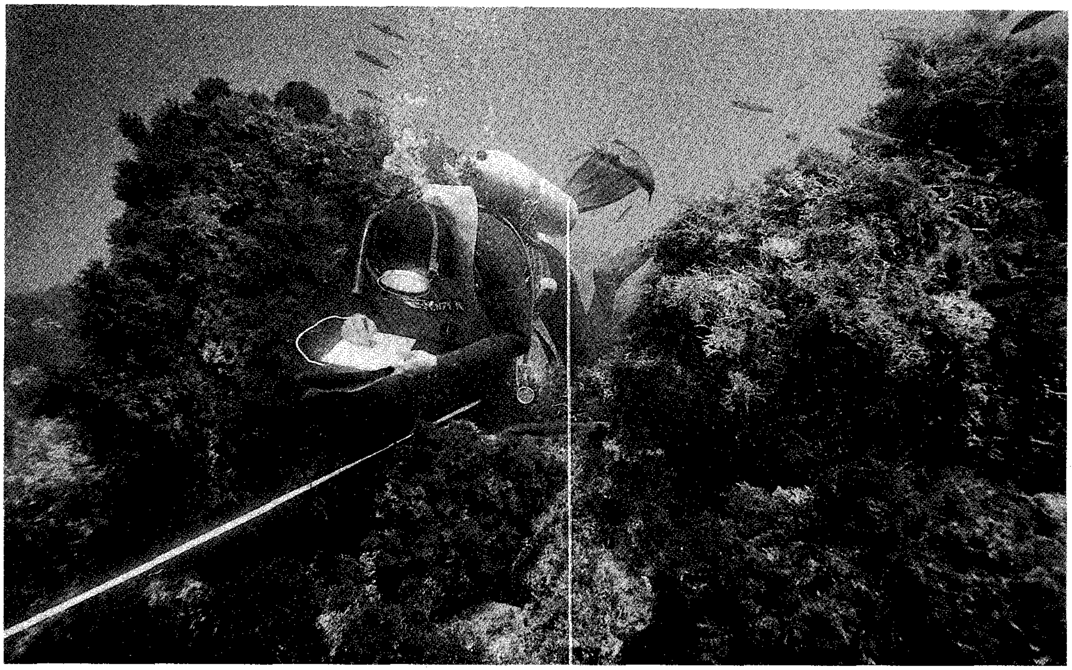

Figure 10. A visual assessment of organisms in the West End Transect.

Eagle Rock

Eagle Rock juts from the sea 300 m from shore, 800 m south of the point at West End (Fig. 2), where it marked our second windward station. A belt transect (4 x 25 m) was established during May 1973 on large boulders (Fig. 11) at depths from 8 to 12 m midway between the rock and shore. It ran perpendicular to shore and, at the outset of this work, its shoreward edge was within 5 m of a *Macrocystis* forest. There were several isolated *Macrocystis* sporophytes in the transect, but the major alga was the articulated coralline *Calliarthron tuberculosum* that grew in dense boulder-top patches. The vegetation, however, was concentrated in the shoreward half of the transect—the boulder tops were increasingly exposed seaward. As at West End, the site was frequently swept by high seas and experienced sea temperatures several degrees lower than those of the leeward stations.

In contrast to the relatively stable West End habitat, however, the Eagle Rock habitat experienced major change during the study. As at the two leeward sites, the change was most evident in the vegetation; however, whereas change in the vegetation at Isthmus Reef and Fisherman's Cove occurred mainly in response to physical factors, change in the vegetation at Eagle Rock came mainly from grazing by the echinoid *Strongylocentrotus franciscanus* (Fig. 12).

The initial assessment at Eagle Rock on 22 May 1973 estimated that 50% of the transect was covered by patches of benthic algae, and while not enumerated at that time, *S. franciscanus* was noted as "abundant." Four months later the coverage of benthic algae was estimated to be 30 to 40%, with growth somewhat denser inshore, and it was noted that the substrate "seems relatively more barren than before." (This was late summer, when one

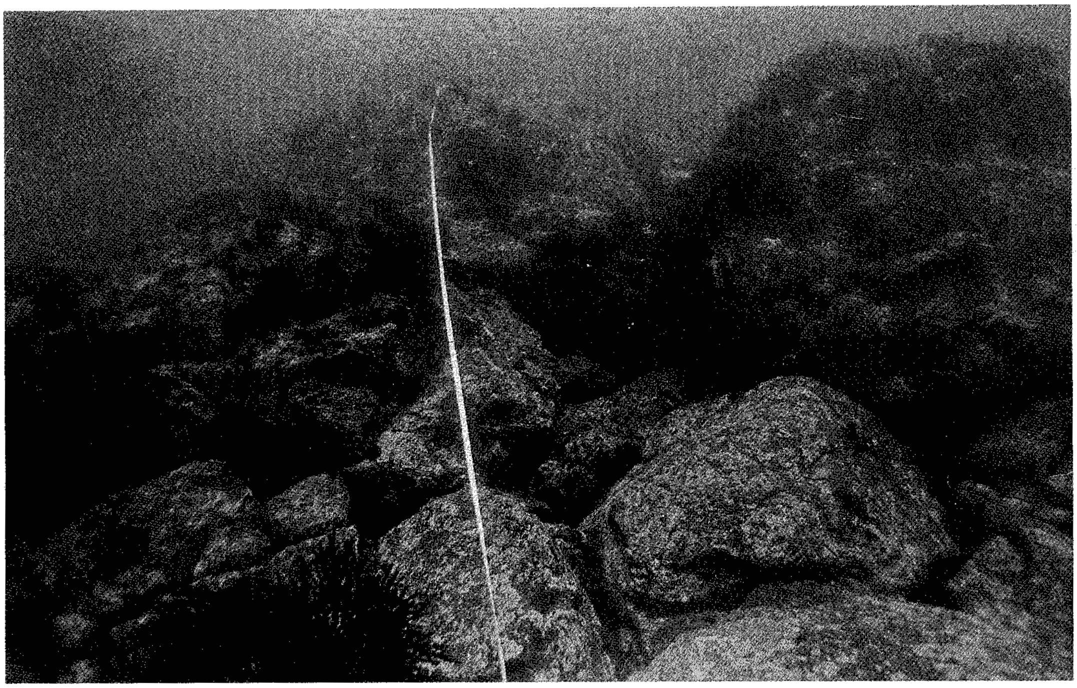

Figure 11. The transect near Eagle Rock.

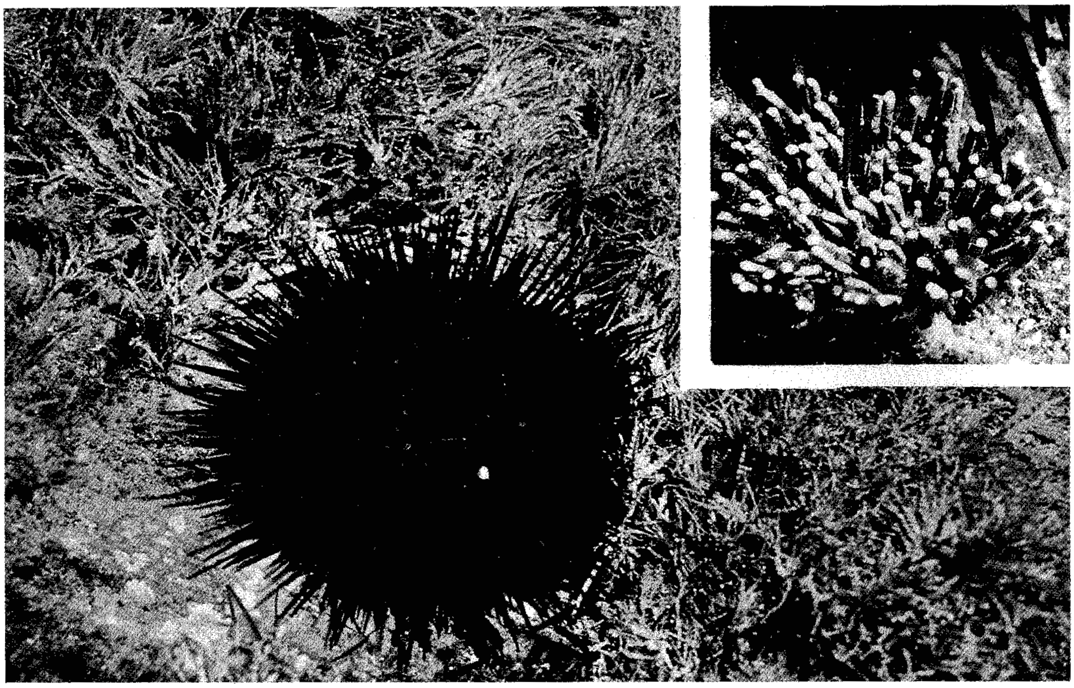

Figure 12. Red Sea Urchin, *Strongylocentrotus franciscanus*, grazing on the coralline alga *Calliarthron tuberculosum* in the Eagle Rock Transect. Inset shows stubs of grazed alga.

would have expected coverage of benthic algae to have increased.) It was also noted that *S. franciscanus* was "very common," but the connection between urchins and vegetation had not yet been made.

By January it had become obvious what was happening. In the 5 m of transect nearest shore, coverage of algae was estimated at 60%, with most of it being *C. tuberculosum* in boulder-top patches. The next 3 to 4 m of the transect were under heavy grazing by *S. franciscanus*, and seaward from there coverage of algae was estimated to be 5%, with most of the *C. tuberculosum* reduced to stubble. There were urchins in the transect's shoreward five meters, but only at boulder bases, as it became clear that grazing began at the base and then progressed up the sides to the top. Urchins also were concentrated to graze on holdfasts of the few *Macrocystis* sporophytes in that part of the transect—except two at the inner edge, which they had not yet reached. Overall, 620 *S. franciscanus* were counted in the transect.

By the time of our next assessment four months later, in May, the count of *S. franciscanus* had decreased to 327 and the front of foraging urchins had moved through the shoreward end of the transect to a point about 10 m beyond. Coverage of benthic algae throughout the transect was estimated to be 5%, with virtually all of the *C. tuberculosum* reduced to stubble (Fig. 13). The only remaining *Macrocystis* sporophytes in the transect were the two at the shoreward edge, and these were by then under attack by urchins.

Two months later, in July, the estimated coverage of algae was 10% and *C. tuberculosum* remained limited to stubble. But growth to 5 cm was noted among other species, and while the two mature *Macrocystis* sporophytes at the shoreward edge of the transect were gone, several recruits had recently settled nearby. Much of the area left barren by the grazing urchins was now covered by a fine filamentous alga, but this was not included in the assessment. The number of *S. franciscanus* in the transect was about the same—370 were counted—and it did not seem that grazing inshore had progressed since the previous assess-

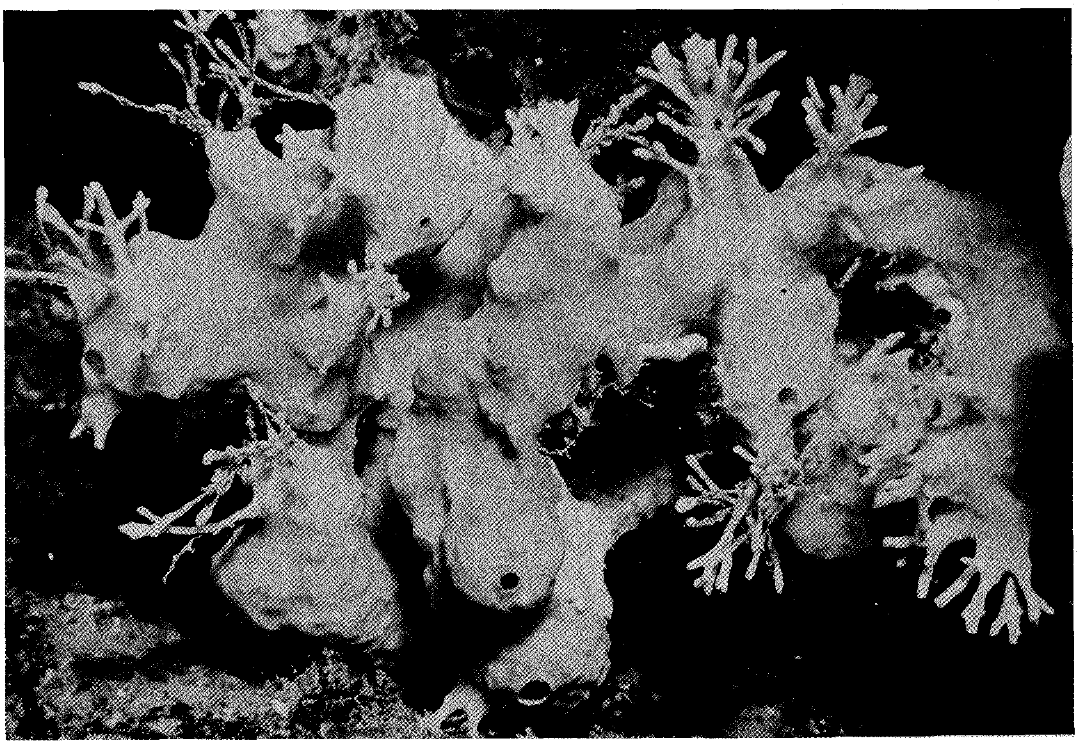

Figure 13. The sponge *Verongia aurea.*

ment. As before, boulders more than 10 m in that direction remained crested with rich patches of turf.

The next and final assessment at this station came a year later, in July, and again evidenced little change. Coverage of algae was estimated at 12%, and while some growth was noted in *C. tuberculosum*, generally it remained stubble as before. *S. franciscanus* continued to graze heavily throughout the transect—407 were counted—but the tops of boulders 10 m shoreward from the transect were still covered with vegetation. There were numerous echinoid tests and fragments of tests among the rocks, however, suggesting that it may have been mortality rather than movement that caused the decline in urchin counts within the transect after January 1974.

BENTHIC INVERTEBRATES

The major groups of benthic invertebrates are considered here in standard phylogenetic sequence, but coverage is variable because some were sampled more effectively than others. The phylogenetic order is for some tenuous, however, because it draws unevenly from a wide variety of sources and includes many inferred relationships. Still, the organisms characterized below are representative of Santa Catalina communities from 1973 through 1975.

Sponges

Sponges were relatively inconspicuous, and only minor foods of the fishes examined. Species distinguished (identities based on de Laubenfels 1932) represented two major groups: the class Calcarea, which have calcareous spicules, and the class Demospongia, which have siliceous spicules. Of the major species, *Leucandra heathi* (a calcareous form) occurred mostly as small (<10 mm) colonies nestled among the branches of algae and bryozoans, and was a minor food of *Semicossyphus pulcher.* Fragments of two other calcareous sponges, *Leucetta losangelensis* and *Leucilla nuttingi*, occurred occasionally among the gut contents of *S. pulcher* and another unidentified form was a minor food of both *S. pulcher* and *Hypsypops rubicundus*.

Other sponges identified in samples of the benthos or observed in the transects included the calcareous *Leucosolenia* sp. (probably *L. eleanor*) and several Demospongiae, including *Aplysina fistularis, Axinella mexicana, Hymenamphiaster cyanocrypta, Tethya aurantia and Verongia aurea* (Fig. 13). Although none of these were identified among food of the fishes, small amounts of unidentified sponges occurred in both *S. pulcher*, and *H. rubicundus,* as well as in *Embiotoca jacksoni, Oxyjulis californica, Halichoeres semicinctus* and *Coryphopterus nicholsii*. So whereas sponges are major foods of certain fishes on coral reefs (Randall 1967, Hobson 1974, Sano et al. 1984), they were only infrequently ingested by fishes at Santa Catalina.

Hydroids

Hydroids attached to algae (identities based on Fraser 1937) were abundant but poorly sampled, as noted above. It was readily evident, however, that *Sertularella turgida* and *Sertuaria* sp., along with other species, were particularly numerous on the basal stipes of the phaeophyte *Cystoseira neglecta.* Others frequently noted attached to fragments of algae collected by the airlift (but not quantified) included *Aglaphenia* sp., *Clytia* sp., *Eucopella everta, Halecium* sp., *Obelia* sp., *Pasythea quadridentata*, and *Plumularia* sp.

Of the hydroids listed above, the following (in alphabetical order) occurred among gut contents of the fishes: *Aglaophenia* spp. were in *Oxylebius pictus, Girella nigricans, Medialuna californiensis, E. Jacksoni, H. rubicundus*, and *O. californica.* *Clytia* sp. was in *H. rubicundus*; *Obelia* sp. and *Plumularia* sp. were in *G. nigricans, M. californiensis* and *H. rubicundus*; while *Sertularella turgida* was in *E. jacksoni, H. rubicundus*, and *S. pulcher.* There were other hydroids, including unidentified forms, among the gut contents of these fishes and also in *Orthonopias triacis, Paralabrax clathratus* and *Lythrypnus zebra.* Most of the hydroids that had been ingested by the fishes examined were of species known to be epiphytes on major fish foods, so probably at least many were taken incidentally.

Anthozoans

Anthozoans (identities based on Given and Lees 1967) were among the most prominent invertebrates at Santa Catalina, but they are poorly represented here owing to limitations of our sampling procedures. The gorgonians *Muricea californica* and *M. fruticosa* were particularly prominent, but difficult to differentiate because their main distinguishing feature—polyp color—often was hidden as the polyps contracted in response to our presence. These two forms may, in fact, be not only conspecific, but also synonymous with the more northern *Muricea appressa* (Haderlie et al. 1980). Another gorgonian, *Lophogorgia chiliensis,* was abundant in deeper water, but because our study sites were near the shallow end of its depth range, it was only a relatively minor presence there.

Prominent on rock substrata, but not enumerated or collected, were two zooanthideans, *Parazoanthus lucificum* and *Epizoanthus induratum,* and also the corallimorpharian *Corynactis californica.* Similarly numerous but poorly sampled were the scleractinians *Astrangia lajollensis* and *Paracyanthus stearnsi.* The polyps of these two were attached to rocks—the former in colonies, the latter as solitary individuals—but being inconspicuous, they often went unnoted. Another form frequently unnoted was the ceriantharian *Pachycerianthus fimbriatus* (Fig. 14). The figure shows this species in its regular position, made highly conspicuous by its expanded polyp, but when disturbed—as generally it was by our approach—it quickly withdraws from sight.

The main reason that we gave so little attention to anthozoans is that they rarely occurred among the foods of fishes, which were our major concern. Of the anthozoan species noted above, there was just a fragment of *Muricea* sp. in a single *Hypsypops rubicundus.* There were a few fragments of other species (some unidentified) in three other *H. rubicundus*, but otherwise the only anthozoan among the gut contents of fishes was an unidentified actinarian in one *Semicossyphus pulcher.* It would appear that the fishes' feeding mechanisms and our sampling devices shared certain limitations as collectors.

Polychaetes

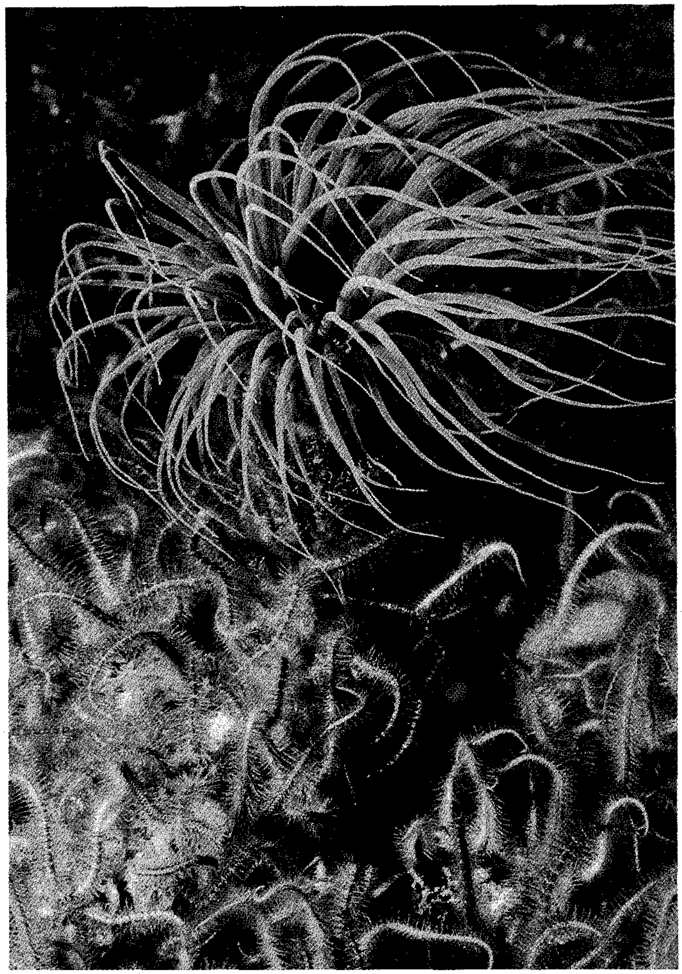

Figure 14. The anthozoan *Pachycerianthus fimbriatus, surrounded by brittle stars, Ophiothrix spiculata. (Photo from Santa Barbara Island).*

The polychaetes were poorly sampled by our collecting methods. Many were so small and cryptic that it was impractical to include them in our routine visual assessments, and those living in tubes or buried in sediments generally were represented in the airlift collections only as fragments. In contrast, many of the fishes consumed these organisms as major prey. Despite the prominence of polychaetes in the diets of the fishes, however, there were problems identifying species among gut contents. This was because damage to the specimens often obliterated key morphological features. So while some of the more prominent species were distinguished, most identifications were at the family level. Our determinations and the order of presentation are based on Hartman (1968, 1969). The first six families listed are errantiates; the rest are sedentariates.

Family Polynoidae

Polynoids were widespread and consistently present in collections of turf, rock and sediment from all four primary sites (maximum densities: turf— 4/100 g *Cystoseira neglecta* from Isthmus Reef; rock—12/0.25 m^2 at Isthmus Reef and Eagle Rock; and sediment—64/0.25 m^2 in Fisherman's Cove). Our specimens, probably at least most of them juveniles, were 3 to 16 mm long. Polynoids were prey of *Embiotoca jacksoni, Halichoeres semicinctus* and *Coryphopterus nicholsii.*

Family Chrysopetalidae

Chrysopetalum occidentale, the one member of this family identified in our collections, reportedly grows to 18 mm and inhabits rocky substrata of California and Mexico (Hartman 1968). We collected representatives (to 12 mm) at all four sites (maximum density: 24/0.25 m^2 of rock on Isthmus Reef), but found none among the foods of fishes.

Family Syllidae

Syllids of 1 to 38 mm were widespread and occasionally abundant on rocks and turf at all four sites. There were 658 (2 to 4 mm) in one airlift collection from a rock substrate at Isthmus Reef, but this number was exceptional; otherwise, the most taken in one collection was 17 (3 to 8 mm)/0.25 m^2 of a rock substrate at Eagle Rock. The maximum density from turf was 15 (3 to 10 mm)/100 g of *Pterocladia capillacea* from West End. Syllids were less important as food of fishes than one might expect based on their numbers in the environment. A total of seven were recovered from gut contents: one in each of two *Orthonopias triacis*, one *Medialuna californiensis*, two *Hypsypops rubicundus* and two *Halichoeres semicinctus*.

Family Nereidae

More of the polychaetes in our samples were of this family than any other. Although generally the species remained undetermined, the dominant form appeared to be *Nereis latescens*, which has been reported to attain lengths of 20 to 40 mm in Californian subtidal rocky habitats (Hartman 1968). The nereids in our samples ranged from 1.4 to 60.0 mm, but most were less than 15 mm. They were numerous at all four sites and on all substrata sampled (maximum densities: 320/100 g *Dictyopteris undulata* and 30/0.25 m^2 of sediment, both from Fisherman's Cove, and 77/0.25 m^2 of rock from Eagle Rock).

Nereids were prey of fishes less often than might have been expected based on their widespread abundance in the environment. Individuals of 4 to 40 mm were found in diurnal benthivores, including *Embiotoca jacksoni, Hypsypops rubicundus, Semicossyphus pulcher, Gibbonsia elegans* and *Coryphopterus nicholsii*, but only as unranked prey. Epitokes of 5 to 20 mm that were found in nocturnal planktivores, including *Hyperprosopon argenteum* and *Xenistius californiensis*, presumably were captured after they had entered the water column at night to reproduce (Hobson and Chess 1976).

Family Onuphidae

Onuphids are tubiculous inhabitants of sediments, which explains why, of the sites examined here, they were prominent only in Fisherman's Cove. The major species was *Diopatra ornata*, which has been reported to 170 mm in littoral sediments of California and Mexico (Hartman 1968). The ends of their tubes protrude from the sediment, and we counted 1 to 4, $\bar{x} = 1.4$, of them in 16 of 25 haphazardly placed 0.25 m^2 quadrats in the Fisherman's Cove transect. *D. ornata* feeds by extending its head and anterior segments into the water column to reach drifting fragments of algae. Although in this exposed position it might seem vulnerable to predators, we found the species in just one fish, a *Pleuronichthys coenosus*. This fish, however, had consumed the head and anterior segments of six individuals.

Family Lumbrineridae

Most of the lumbrinerids in our collections were identified only to family, although at least most were *Lumbrineris* sp.. The 18 species of lumbrinerids recorded from California by Hartman (1968) were reported only from sediments, and while most of our specimens came from the sediments of Fisherman's Cove (maximum density 191/0.25 m^2), we collected some from rock substrata (maximum density: 8/0.25 m^2 at Isthmus Reef). Lumbrinerids were ranked prey of *Leiocottus hirundo* and *Pleuronichthys coenosus* and an unranked prey of *Coryphopterus nicholsii.*

Family Orbiniidae

The one species of this family prominently represented in our samples—*Naineris* sp.—was collected from rock substrata at Isthmus Reef and Eagle Rock (maximum density 19/0.25 m^2 at Isthmus Reef). Our specimens were similar to *N. dentitica*, which according to Hartman (1968) inhabits sandy mud and the holdfasts of sea grasses. The only fish that we determined to be a predator on orbiniids was in a single *Leiocottus hirundo* collected in Ripper's Cove.

Family Spionidae

Spionids were at times numerous on sediments at Santa Catalina, but we made no attempt to distinguish the many species reported from southern California. Most of our specimens were from sediments of Fisherman's Cove (maximum density: 668/0.25 m^2), but we also collected some in sand patches on reefs (maximum density: 128/0.25 m^2 from Eagle Rock). Those we collected were only 2 to 6 mm long, so probably were juveniles, as spionids are known to exceed 20 mm in southern California (Hartman 1968). Despite the abundance and seemingly vulnerable size of spionids in the environment, however, we found them in just two fish—an *Orthonopias triacis* that contained two, and a *Medialuna californiensis* that contained one.

Family Chaetopteridae

Chaetopterus variopedatus was the most visually conspicuous polychaete at Santa Catalina, particularly in leeward habitats. Although most abundant in sediments, as in Fisherman's Cove, it also occurred in reef crevices, as on Isthmus Reef. This animal, which can be up to 250 mm long and 10 mm wide, forms parchment-like tubes in U-shaped burrows that open to the surface of the substrate at both ends (Hartman 1968). The exposed ends of these tubes serve as anchors for benthic algae, and thus are points of attachment for the turf that overlies sediment in many areas, such as in Fisherman's Cove. We counted the tips of 1 to 10, x = 5.2, tubes in 24 of 25 haphazardly placed 0.25 m^2 quadrats in the Fisherman's Cove transect. Although the only evidence we found of *C. variopedatus* among gut contents of fishes was one 40-mm section in a *Semicossyphus pulcher* at Isthmus Reef, the species is known to be a regular prey of the bat ray, *Myliobatus californica* (Feder et al. 1974). We frequently observed *M. californica* excavating sediments in Fisherman's Cove, apparently in attempts to get at these and probably other buried organisms (Fig. 15).

Another chaetopterid, *Spiochaetopterus costarum*, was more numerous in the Santa Catalina sediments than *C. variopedatus*, but its translucent tubes, 2 to 3 mm in diameter, were less conspicuous than the parchment-like tubes of the other. In the Fisherman's Cove

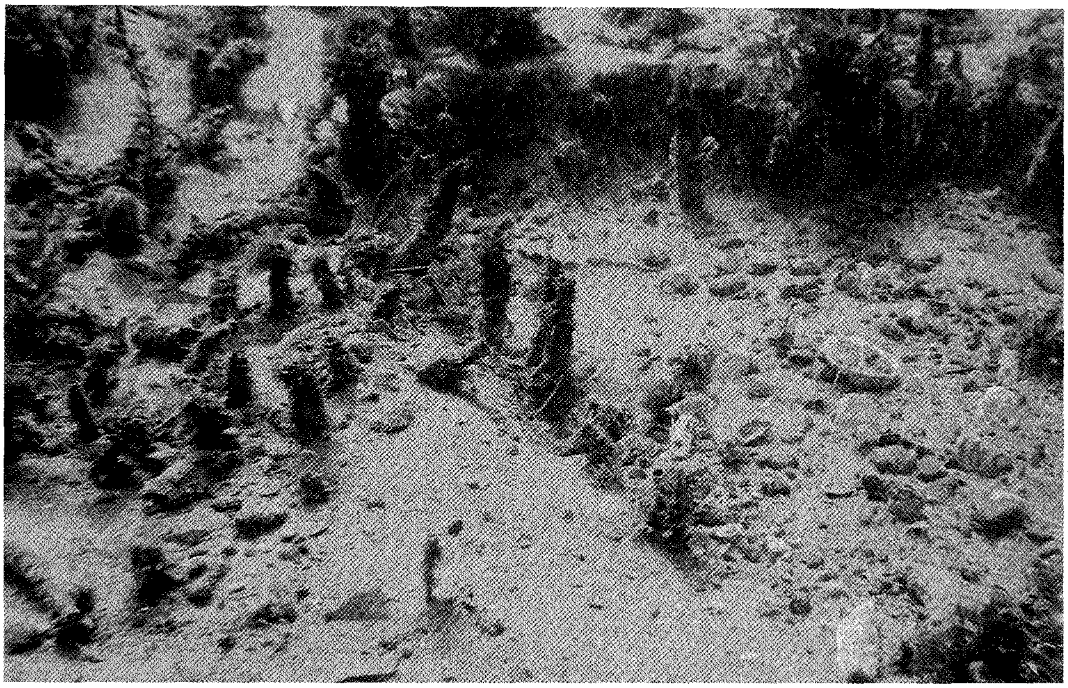

Figure 15. Tubes of the chaetopterid polychaete *Chaetopterus variopedatus* that have been exposed in excavations made by the myliobatid ray *Myliobatis californica.*

transect, for example, we counted 3 to 53, $\bar{x} = 23.1$, tubes of *S. costarum* in 25 haphazardly placed 0.25 m^2 quadrats. Although these tubes can be more than 600 mm long (Hartman 1968), usually only the tips protrude from the sediment. These tips were frequent components of the gut contents of fishes, including those of *Medialuna californiensis, Embiotoca jacksoni, Hypsypops rubicundus, Halichoeres semicinctus, Semicossyphus pulcher, Coryphopterus nicholsii, and Pleuronichthys coenosus.* Only occasionally were these tube fragments accompanied by pieces of the worm, however. This could be because the worm usually evades the predator by withdrawing into the depths of its tube, but it could also be that the worm was not the target of at least some of these fishes. Many of the worm tubes are occupied by a gammaridean amphipod, *Photis* sp., which occurred in the diets of all the fish species listed above (and ranked as a major prey of *E. jacksoni, H. rubicundus, and H. semicinctus*). We suspect that at least some of the tube fragments ingested by these fishes were taken in attempts to capture the amphipod (Hobson and Chess 1986).

Fragments of tubes similar to those of *S. costarum* occurred in some of the airlift collections from rocky substrata, but generally went unidentified. One from Isthmus Reef, however, was identified as the tube of *Phylochaetopterus prolifica.* Some of the tubes from gut contents identified as *S. costarum*, especially from fishes collected in reef habitats, may have been of this species.

Family Cirratulidae

Two species of *Doecaceria* were present in the study sites—*D. concharum* and D. fewkesi, but generally identifications to species in the environment were tentative because only anterior segments were seen or collected. Both species are reported to range from Canada to southern California (Hartman 1968), with *D. concharum* occurring in "galleries drilled into shells or *Lithothamnion* or other calcareous structures" and *D. fewkesi* occurring in "colonies of calcareous tubes on rock faces" (Berkeley and Berkeley 1954, p. 326). The relatively few fragments in our collections came from Isthmus Reef and West End, but neither species was effectively sampled. The difficulties we had collecting these forms apparently were shared by the fishes, as the only material among gut contents referable to either one occurred in two *Hypsypops rubicundus* from Lion's Head.

Family Flabelligeridae

Pherusa inflata, the major flabelligerid in our collections, has been reported to attain 60 mm and to inhabit U-shaped burrows in shale and limestone from Oregon to Mexico (Hartman 1968). Our specimens were 2 to 16 mm long and came from rock substrata or sediments at all four primary sites. A collection of 104 individuals from a 0.25 m^2 quadrat on rock at Isthmus Reef was exceptionally large; otherwise, the most in a collection was 14 from a 0.25 m^2 quadrat on rock at West End. *P. inflata* (5.8 to 18.0 mm) occurred among the gut contents of four fish: there were four in a *Embiotoca jacksoni* and one each in a *Damalichthys vacca*, a *Halichoeres semicinctus*, and a *Semicossyphus pulcher*.

Family Opheliidae

Polyophthalmus pictus, the major opheliid in our collections, has been reported to attain 25 mm and to inhabit rocky areas overgrown by algae in central and southern California (Hartman 1968). Our specimens were 4 to 15 mm long and came from rocks or turf at all four primary sites (maximum density: 79/0.25 m^2 of rock at Eagle Rock). Two occurred among the gut contents of fishes: one in a *Orthonopias triacis* and the other in a *Pleuronichthys coenosus*.

Family Terrebellidae

Terebellids were common but never abundant in the Santa Catalina habitats. Most were in tubes deeply embedded in the substrate, with only their tentacles visible, and even our collections were limited to tentacles and parts of tubes. As a result, the only species consistently recognized—in either the environment or the collections—was *Lanice conchilega*, which has a distinctive tube; however, while this species has been reported to attain 200 mm (Hartman 1968), the largest specimen in our collections was a 26-mm tube segment. Although *L. conchilega* reportedly lives in sediment (Hartman 1968), we observed it deeply embedded among rocks, with a maximum density of 4 tubes/0.25 m^2 of rock surface at Isthmus Reef.

Most fishes that prey on terebellids feed almost entirely on the tentacles, presumably because this is all that is exposed. Nevertheless, terebellid tentacles are major prey, being ranked elements in the diets of *Orthonopias triacis, Hypsypops rubicundus* and *Pleuronichthys coenosus*, and unranked prey of *Paralabrax clathratus* and *Coryphopteris nicholsii*. Of the fishes that we studied, only *Leiocottus hirundo* regularly fed on terebellid parts other than tentacles, but for this species the anterior segments of the worm were a ranked food. The only other occurrence of a terebellid part among the gut contents of a fish was a tube fragment representing *L. conchilega* in a *Halichoeres semicinctus*.

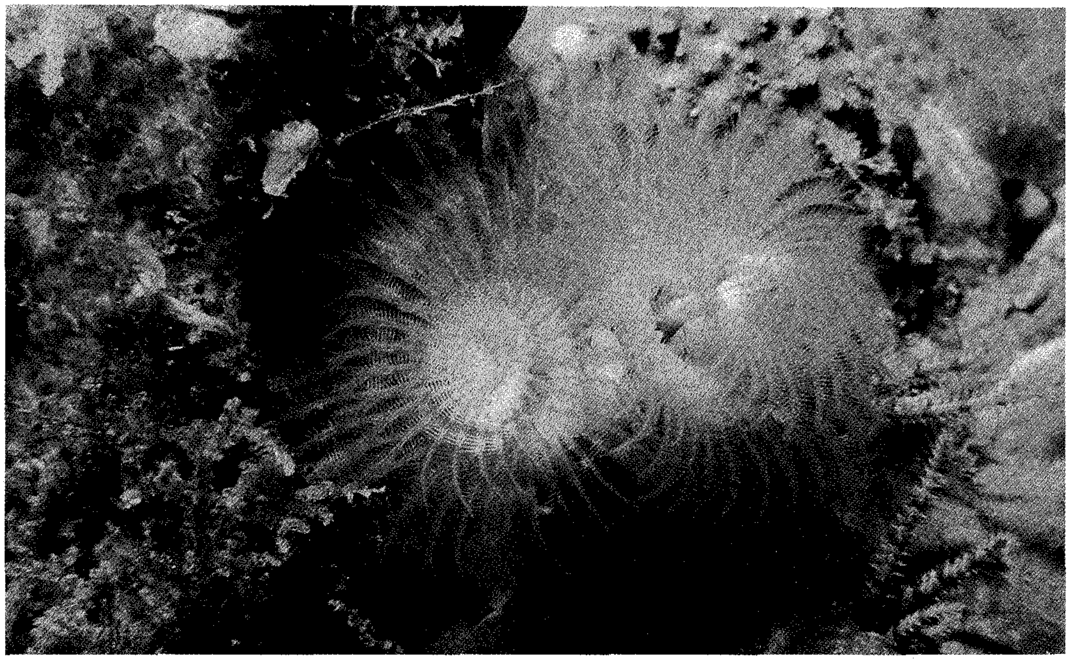

Figure 16. The serpulid polychaete *Spirobranchus spinosus.*

Family Serpulidae

The most prominent serpulid at Santa Catalina was *Spirobranchus spinosus* (Fig. 16). This species is known only from the Channel Islands, where reportedly it attains 30 mm and inhabits calcareous tubes on rocks (Hartman 1968). We found it numerous on all reefs examined, with densities of up to thousands/m^2 on shaded, vertical faces. But despite this prominence, its heavily calcified tubes were so strongly cemented to the substrate that our airlift samples succeeded in collecting only a relatively few opercula and anterior segments. Thus, while the maximum density indicated by these collections was 6/0.25 m^2 at Isthmus Reef, an irregular visual assessment at that site noted 35 /0.25 m^2. *S. spinosus*, however, was not among species regularly included in our visual assessments.

The major fish predators on *S. spinosus* were *Halichoeres semicinctus* and *Semicossyphus pulcher.* These two have jaw and pharengeal teeth suited to pull armored prey from rock surfaces and crush them before swallowing. Another species taking this worm as a ranked prey was *Embiotoca jacksoni*, but this one consumed far fewer than the other two. In addition, *S. spinosus* was an unranked prey of *Orthonopias triacis, Brachyistius frenatus, Damalichthys vacca, Hypsypops rubicundus, Oxyjulis californica* and *Alloclinus holderi.* Generally, however, these fishes took only the worm's opercula and anterior segments.

Family Spirorbidae

The spirorbids have been considered a subfamily of the Serpulidae (e. g. by Hartman 1968), but to emphasize their uniqueness as a group in the trophic system at Santa Catalina, we follow those that recognize them as a distinct family. The taxonomy of species that occur in California has long been confused, but all occupy tightly coiled, calcareous tubes, 0.5 to about 3.0 mm in diameter, that are attached to algae (Fig. 17), rocks or other substrata

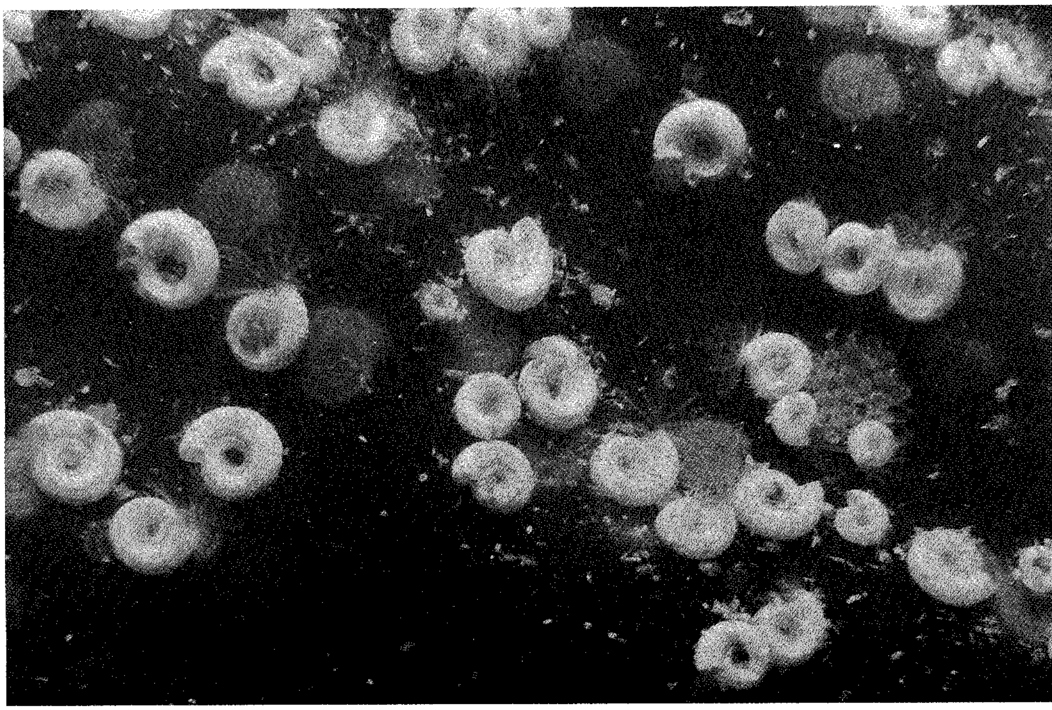

Figure 17. Spirorbid polychaete on *Macrocystis.*

(Abbott and Reish 1980). They were exceptionally numerous at Santa Catalina, but because their identities are uncertain, we group them at the family level. Although they were among the more prominent organisms in the environment, spirorbids were difficult to quantify. Visual assessments were unfeasible because their small coiled tubes virtually covered some substrata, and like other firmly attached forms, they were poorly sampled by our collecting methods. But even though our samples were inaccurate as measures of abundance in the environment, occasionally we collected large numbers (maximum: 446/100 g *Cystoseira neglecta* and 515/0.25 m^2 of rock, both from Isthmus Reef).

The major fish predator on spirorbids was *Oxyjulis californica*, which has feeding morphology and behavior suited to pluck tiny shelled prey from substrata. Taking spirorbids less often, but nevertheless as ranked prey, were *Embiotoca jacksoni, Brachyistius frenatus* and *Halichoeres semicinctus*; taking them as unranked prey were *Paralabrax clathratus* and *Coryphopteris nicholsii.*

Gastropod Molluscs

Family Haliotidae

Haliotis corrugata

The pink abalone attains a diameter of about 25 cm and occurs from shore out to depths of about 60 m from central Baja California northward through southern California (Cox 1962). We observed this species at Isthmus Reef and Eagle Rock, where individuals of 10 to 20 cm in diameter were clamped to rocks in the manner typical of abalones. At Santa Catalina, as apparently elsewhere (McLean 1978), *H. corrugata* was most abundant where there was *Macrocystis*. Thus, it was present during all seven visual counts at *Macrocystis*-rich Isthmus Reef (2 to 6, $\bar{x} = 3.6$ individuals/100 m^2), but in only three of five counts at the *Macrocystis*-poor Eagle Rock site (one individual present during each assessment).

Our regular collecting devices failed to sample *H. corrugata* effectively, however. The adults were too large and too firmly attached to rocks, and the juveniles were too far beneath rocks and into crevices. That the juveniles were abundant in these places became evident when we overturned rocks incidental to other work. Probably for the same reasons that both adults and juveniles were unavailable to our sampling equipment, they also appeared generally unavailable to fishes. Thus, our only record of *H. corrugata* in fish gut contents was a single 5-mm juvenile in a *Damalichthys vacca*. However, judging from the large number of empty *H. corrugata* shells found at Isthmus Reef that had been bored by octopods, the species was a frequent prey of those predators.

Family Scissurellidae

Sinezona rimuloides

The largest individual of this species in our collections was only 1 mm long, which made it the smallest gastropod sampled at Santa Catalina. Although small, this nevertheless matched the largest size recorded for the species—a relatively common form in gravel and under kelp from Chile to central California (McLean 1978). We collected it at three of the four primary sites, mostly from rocks (Table 1; maximum density: 75/0.25 m^2 at West End), but also from algae (maximum density: 20/100 g *Plocamium cartilageum* from West End) and bryozoans (maximum density: 6/100 g *Bugula neritina* at Isthmus Reef). We did not find *S. rimuloides* at Fisherman's Cove or among the gut contents of fishes, however.

Family Fissurellidae

Megathura crenulata

The giant keyhole limpet occurs on subtidal rocks from Baja California to central California (McLean 1978). Individuals of over 100 mm were a regular presence on rock substrata at Santa Catalina, and most effectively assessed by visual counts (as numbers seen in the 100-m^2 transects). They were recorded during all seven counts at Isthmus Reef (1 to 9, $\bar{x} = 3.0$), in 4 of 5 counts at West End (2 to 6, $\bar{x} = 3.0$) and in 4 of 5 counts at Eagle Rock (9 to 25, $\bar{x} = 11.2$). This species was not seen among gut contents of fishes.

Family Trochidae

Lirularia spp.

There were two species of *Lirularia* in our collections—*L. acuticostata* and *L. succincta*—but they are combined here because we were unable to see the distinguishing features of many specimens. These are minute near-shore forms up to 5-mm long , the former reported to occur in course gravel from northern Baja California through southern California, the latter in rocky areas from northern Baja California to Alaska (McLean 1978). Although some in our collections were up to 5 mm, the vast majority were 1 to 3 mm, with those at the lower end particularly difficult to distinguish. Most of our specimens came from sediments in Fisherman's Cove (Table 1; maximum density: 220/0.25 m^2), so one

Table 1. Gastropod molluscs in the environment.

TAXA	ISTHMUS REEF						FISHERMAN'S COVE						WEST END						EAGLE ROCK					
	Turf			Rock/Sedim't			Turf			Sediment			Turf			Rock			Turf			Rock		
	n=10			n=8			n=14			n=6			n=21			n=6			n=15			n=6		
	%	x̄no	SE	%	x̄no	SE	%	x̄no	SE	%	x̄no	SE	%	x̄no	SE	%	x̄no	SE	%	x̄no	SE	%	x̄no	SE
Scissurellidae																								
Sinezona rimuloides	0	0	0	22	9	8	0	0	0	0	0	0	5	<1	<1	33	4	3	0	0	0	33	<1	<1
Trochidae																								
Calliostoma annulatum	20	<1	<1	25	1	<1	0	0	0	0	0	0	5	<1	<1	50	2	1	13	<1	<1	67	3	2
Lirularia spp.	0	0	0	49	7	7	21	<1	<1	83	52	35	0	0	0	0	0	0	0	0	0	17	<1	<1
Tegula aureotincta	0	0	0	0	0	0	21	<1	<1	33	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Skeneidae																								
Parviturbo acuticostatus	0	0	0	38	2	1	0	0	0	0	0	0	0	0	0	100	6	2	0	0	0	33	2	1
Turbinidae																								
Lithopoma undosum	20	<1	<1	25	<1	<1	7	<1	<1	17	<1	<1	0	0	0	17	<1	<1	0	0	0	0	0	0
Phasianellidae																								
Tricolia pulloides	70	25	16	25	1	1	79	62	27	33	3	2	100	258	75	100	222	176	100	39	18	67	24	20
Lacunidae																								
Lacuna unifasciata	40	1	<1	25	1	<1	43	3	1	0	0	0	33	<1	<1	33	1	1	20	<1	<1	17	<1	<1
Rissoidae																								
Alvinia spp.	30	1	1	88	114	63	0	0	0	0	0	0	0	0	0	100	26	17	0	0	0	67	5	3
Amphithalamus inclusus	30	3	2	88	109	78	64	23	8	33	7	5	10	<1	<1	50	18	15	0	0	0	67	87	79
Barleeia acuta	0	0	0	38	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	33	1	1
B. californica	20	3	2	0	0	0	50	4	2	0	0	0	52	12	5	83	18	15	7	<1	<1	17	1	1
Caecidae																								
Caecum californicum	0	0	0	63	34	22	14	<1	<1	33	1	<1	0	0	0	33	11	10	0	0	0	67	16	13
C. dalli	10	2	2	88	72	33	0	0	0	17	<1	<1	0	0	0	50	6	5	0	0	0	83	56	51
Cerithiidae																								
Bittium sp.	0	0	0	50	4	30	0	0	0	0	0	0	0	0	0	67	11	5	0	0	0	17	<1	<1
Cerithiopsis spp.	30	1	1	74	4	2	21	1	<1	0	0	0	24	1	<1	80	9	4	27	2	2	80	3	2
Calyptraeidae																								
Crepidula spp.	0	0	0	25	1	1	14	<1	<1	67	2	2	10	<1	<1	17	<1	<1	27	1	<1	0	0	0
Crepipatella lingulata	60	10	4	88	47	20	57	5	2	33	8	6	57	7	2	100	30	10	47	3	1	100	12	6
Muricidae																								
Ocenebra sp.	10	<1	<1	56	3	2	0	0	0	0	0	0	0	0	0	50	1	<1	7	<1	<1	33	2	2
Marginellidae																								
Cystiscus jewettii	0	0	0	50	10	6	0	0	0	0	0	0	0	0	0	67	27	17	0	0	0	0	0	0
C. politulus	0	0	0	63	4	2	0	0	0	0	0	0	0	0	0	33	3	2	0	0	0	83	17	17
Granulina margaritula	10	<1	<1	38	11	7	0	0	0	0	0	0	5	<1	<1	83	10	6	0	0	0	50	3	2
Columbellidae																								
Alia carinata	30	1	1	38	1	<1	71	7	3	33	1	<1	29	1	<1	50	4	2	40	1	<1	17	1	1
Amphissa versicolor	10	<1	<1	63	3	1	0	0	0	0	0	0	10	<1	<1	83	9	2	0	0	0	50	2	2
Nassarina penicillata	0	0	0	88	8	2	21	<1	<1	17	<1	<1	48	1	<1	67	8	4	13	<1	<1	67	2	1
Conidae																								
Conus californicus	20	<1	<1	63	5	3	21	<1	<1	33	<1	<1	0	0	0	17	<1	<1	0	0	0	33	2	2
Scaphandridae																								
Acteocina harpa	0	0	0	25	5	3	0	0	0	0	0	0	0	0	0	33	2	2	0	0	0	33	2	2
Diaphana californica	0	0	0	50	4	3	0	0	0	0	0	0	0	0	0	33	4	3	0	0	0	0	0	0
Rissoellidae																								
Rissoella sp.	20	1	1	0	0	0	0	0	0	0	0	0	48	73	43	83	40	18	0	0	0	33	5	4
Pyramidellidae																								
Turbonilla kelseyi	0	0	0	75	4	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Others (identified)	100	7	5	100	23	15	64	16	16	83	6	5	67	5	3	100	18	10	47	12	12	100	8	5
Undetermined	40	4	2	75	155	81	0	0	0	17	<1	<1	33	7	4	50	16	8	7	<1	<1	33	67	67

might infer based on the reported habitats of the two species, above, that probably most of these were *L. acuticostata*. Similarly, one might infer that specimens collected regularly but in much lower numbers from rock substrata at Isthmus Reef and Eagle Rock were mostly *L. succincta* (maximum density: 5/0.25 m^2 rock from Isthmus Reef). *Lirularia* spp. were absent in collections from algae-covered rocks at West End, and their infrequent occurrences in turf at the other sites probably were incidental.

Lirularia spp. were ranked prey of *Damalichthys vacca, Halichoeres semicinctus* and *Semicossyphus pulcher*, which agrees with our earlier assertion that the latter two are adapted to detect cryptic prey in sand (Hobson and Chess 1986). We found only two other fish that had eaten these mollusks: one *Oxyjulis californica* (which had ingested 160 of them) and one *Coryphopterus nicholsii* (which had ingested just one).

Tegula aureotincta

The solid, relatively heavy shell of this gastropod grows to about 40 mm, and the species is not uncommon in rocky areas near shore from Central Baja California to southern California (McLean 1978). We found many specimens of this species at the leeward sites, but none at the windward sites (Table 1). Individuals up to 20 mm occurred in samples of turf (maximum density: 11/100 g *Dictyopteris undulata* from Fisherman's Cove) and in airlift collections from rocks and sediment (maximum density: 5/0.25 m sediment from Fisherman's Cove). The species also was present in 16 of 25 0.25 m^2 quadrats haphazardly placed on sediment within the Fisherman's Cove transect (1-10, $\bar{x} = 3.4$ individuals/quadrat).

Predation on *T. aureotincta* by fishes was limited. Four *Semicossyphus pulcher*, benefiting from their specialized ability to crush heavily armored prey (Hobson and Chess 1986), had consumed 1 to 9 ($\bar{x} = 3.0$) of them; otherwise, the only occurrence of *T. aureotincta* as food of fishes was a single individual in one *Embiotoca jacksoni*.

Family Skeneidae

Parviturbo acuticostatus

This minute gastropod is common in gravel and under kelp from the Gulf of California to central California (McLean 1978). We collected specimens of up to 3 mm from rock substrata at Isthmus Reef and the two windward sites, but generally in relatively low numbers (Table 1; maximum density: 14/0.25 m^2 from West End). This species was not found among prey of the fishes examined.

Family Turbinidae

Lithopoma undosum

This massive (to 110 mm), conical gastropod, long recognized as *Astrea undosa,* occurs from central Baja California northward through southern California to Point Conception (McLean 1978). The larger individuals at our sites were exposed on rock substrata and thus readily enumerated by visual counts (maximum density: 18/100 m^2 at Isthmus Reef). Smaller individuals, however, went unseen during the visual counts and were only infrequently collected (Table 1).

Despite the visual prominence and accessibility of the larger adults, however, none of these had been taken by the fishes examined. The only evidence of this species as food of fishes involved two subadults—one of 20 mm in a *Halichoeres semicinctus* and one of 4 mm in a *Semicossyphus pulcher.*

Family Phasianellidae

Tricolia spp.

Our initial assessment referred all specimens of *Tricolia* to *T. pulloides*, which thus became the most abundant gastropod in our collections. *T. pulloides* is recognized to be a common species of 4 to 6 mm in shallow near-shore water from southern Baja California to Puget Sound (McLean 1978). Our specimens were up to 5 mm and numerous at all four sites, mainly on turf (Table 1; maximum density: 940/100 g *Pterocladia capiliacea* at West End), but also on rocks (maximum density: 430/0.25 m^2 at West End).

Uncertainties in our original identifications to species, however, prompted a reanalysis of 26 randomly selected samples of turf algae—14 from leeward sites and 12 from windward sites. This reanalysis determined there were two other species of *Tricolia* present—*T. rubrilineata* and *T. substriata* (although the distinction could not be made among smaller individuals). The former occurred in all 12 windward samples (3 to 63, $\bar{x}$ = 15.8/100 g algae), but was absent from all leeward samples, while the latter occurred only as a small (and uncertain) proportion of 248 *Tricolia* from the one sample reanalyzed from Fisherman's Cove. The very similar *T. pulloides* remained the dominant species of *Tricolia*, however, occurring in all 26 of the reanalyzed samples (1 to 66, $\bar{x}$ = 16.6/100 g algae). Because the species were not distinguished in most of the samples (or in any of the gut contents of predators), they are grouped here as *Tricolia* spp.

Consistent with their widespread abundance in the environment, *Tricolia* spp. were important food of fishes. They were ranked prey of *Brachyistius frenatus, Embiotoca jacksoni, Halichoeres semicinctus* and *Semicossyphus pulcher*; in fact, they dominated among gastropods taken by the first three. And they were unranked prey of *Paralabrax clathratus, Damalichthys vacca, Oxyjulis californica* and *Gibbonsia elegans*.

Family Lacunidae

Lacuna unifasciata

This thin-shelled gastropod was widespread but never abundant on turf at all four sites (Table 1; maximum density: 17/100 g *Dictyopteris undulata* from Fisherman's Cove). It is considered common on near-shore algae off southern California, and although it can attain 7 mm (McLean 1978), the largest of our specimens was 4 mm. Although not taken often enough to be ranked as prey of any fishes, *L. unifasciata* was an unranked prey of two diurnal benthivores: one 4-mm individual had been taken by a *Damalichthys vacca* and seventeen 2- to 5-mm individuals by a *Halichoeres semicinctus*. In addition, two were found among zooplankters in the gut contents of nocturnal planktivores: one 2-mm individual in each of two *Sebastes atrovirens* that had been feeding in the water column at night.

Family Rissoidae

Alvinia spp.

The specimens of *Alvinia* in our collections (none >3-mm) represent multiple species, but generally we were unable to distinguish them (Table 1). It was clear, however, that the dominant form was *A. aequisculpta*, which is reported to inhabit gravel from northern Baja

California to central California (McLean 1978). *Alvinia* is a highly speciose, largely tropical genus (Keen 1971), but in the first few years of this study, it was represented in our collections by just a few specimens. Then in 1974 it became a major presence on leeward rock substrata (maximum density: 444/0.25 m^2 at Isthmus Reef).

Alvinia spp. occurred among the gut contents of *Embiotoca jacksoni, Halichoeres semicinctus, Coryphopterus nicholsii, and Lythrypnus dalli*, but despite their increased numbers during the latter part of the study, they were not taken often enough to be listed as a ranked prey.

Amphithalmus inclusus

This minute gastropod has been reported to only 1.3 mm, but common in gravel under kelp and to occur from southern California south into the Gulf of California (McLean 1978). We found it numerous on rock and turf substrata at both windward and leeward sites (Table 1; maximum densities: 650/0.25 m^2 from rock and 380/100 g *Dictyopteris undulata*, both from Isthmus Reef). It was a ranked prey of *Embiotoca jacksoni* and *Halichoeres semicinctus*, and an unranked prey of *Medialuna californiensis, Damalichthys vacca, Oxyjulis californica, Semicossyphus pulcher* and *Coryphopterus nicholsii.*

Barleeia californica

With a reported maximum size of 2.3 mm, this gastropod is recognized as commonly associated with kelp from central Baja California to southern California (McLean 1978), and as being abundant on *Macrocystis* at Santa Catalina (Coyer 1986). We found it relatively numerous up to 2 mm on both windward and leeward turf (Table 1; maximum density: 80/100 g of *Gelidium purpurescens* at West End), but sparse on rock. Although not a ranked prey species, it occurred among the gut contents of *Brachyistius frenatus, Embiotoca jacksoni, Halichoeres semicinctus, Oxyjulis californica, Alloclinus holderi, Coryphopterus nicholsii* and *Lythrypnus dalli.*

Barleeia acuta

We found *B. acuta* to be less abundant than *B. californica*, and limited to rock substrata (Table 1; maximum density: 6/0.25 m^2 at Isthmus Reef), but it grew larger (to 3 mm). Although both species have the same southern limit, *B. acuta* ranges northward to British Columbia (McLean 1978). We did not find it among the gut contents of fishes.

Family Caecidae

Caecum californicum

With a tubular shell of no more than about 3 mm, this mollusc has been reported subtidally abundant in gravel from central Baja California to central California (McLean 1978). We found it occasionally numerous to 2 mm on rock (maximum density: 165/0.25 m^2 at Isthmus Reef), but sparse on algae or sediments, at both leeward and windward sites (Table 1). It was a ranked prey of *Embiotoca jacksoni* and an unranked prey of *Halichoeres semicinctus, Semicossyphus pulcher* and *Coryphopterus nicholsii.*

Caecum dalli

This species has essentially the same reported size and range as *C. californicum* (McLean 1978), and the two occurred similarly in our collections. We found individuals of up to 2 mm numerous on both windward and leeward rocks (maximum density: 310/0.25 m^2 at Eagle Rock), but there were only a few, perhaps incidental, occurrences on turf and sediment (Table 1). Its importance as prey of fishes was negligible, as it occurred only as an unranked item in the diet of two *Halichoeres semicinctus*—three in one and one in the other.

Family Cerithiidae

Cerithiopsis spp.

There were at least two species of *Cerithiopsis* present, *C. cosmia* and *C. carpenteri,* but we could only distinguish mature individuals and most of our specimens were immature. Although both species have been reported to attain 7 mm (McLean 1978), our largest specimens were 4 mm. The southernmost record of both is northern Baja California, but while *C. carpenteri* has been collected northward throughout California, *C. cosmia* is known only to central California (McLean 1978). One or both were common if not especially numerous in our collections from rock and from turf on rock (Table 1; maximum densities: 80/0.25 m^2 at West End and 23/100 g of *Plocamium pacificum* at Eagle Rock). *Cerithiopsis* spp. were unranked prey of *Embiotoca jacksoni, Damalichthys vacca, Halichoeres semicinctus* and *Coryphopterus nicholsii.*

Family Calyptraeidae

Crepidula spp.

With their shells of up to 40 mm formed to the irregularities of the substrate, these sedentary gastropods filter their food from the water (McLean 1978, Abbott and Haderlie 1980). At least six species have been reported from southern California (McLean 1978), but we were unable to distinguish forms collected from the Santa-Catalina environment because all were juveniles. Only a relatively few were taken from turf or rock (Table 1), most of these being 2 to 3 mm, but many up to 6 mm in diameter occurred in an unscheduled collection of *Macrocystis* from Isthmus Reef. This agrees with Coyer (1979, 1986), who listed juvenile *Crepidula* sp. as the most numerous mollusc on *Macrocystis.*

That *Crepidula* spp. were in fact abundant at Santa Catalina was demonstrated by their prominence as food of the fishes. They were a ranked prey of *Embiotoca jacksoni, Damalichthys vacca, Halichoeres semicinctus, Oxyjulis californica, Semicossyphus pulcher* and *Coryphopterus nicholsii,* and unranked prey of *Brachyistius frenatus, Alloclinus holderi and Lythrypnus dalli.* Although some taken by the fishes were up to 10 mm, most were 2 to 5 mm.

Crepipatella lingulata

Adult *C. lingulata* (but not juveniles) are like *Crepidula* spp. in having shells molded to fit substrate contours. They have been reported from central Baja California to the Berring Sea and to attain 25 mm in California (McLean 1978). We found *C. lingulata* numerous on both turf and rock substrata at all four primary sites (Table 1; maximum densities, both from Isthmus Reef: on turf—76 in a 100 g sample of *Dictyopteris undulata*; on rock—161 from a

0.25 m^2 quadrat). But while those from rock were up to 18 mm in diameter, the largest from turf were 5 mm and most were under 3 mm. (Because the larger *C. lingulata* on rocks are firmly attached, probably the abundance of these is understated here.)

C. lingulata was the gastropod most often noted in fish diets. It was a ranked prey of *Embiotoca jacksoni, Halichoeres semicinctus, Oxyjulis californica, Semicossyphus pulcher* and *Coryphopteris nichosii*, and an unranked prey of *Brachyistius frenatus* and *Damalichthys vacca*. All except those in *S. pulcher* were of 6 mm or smaller, which are sizes of the less firmly attached individuals on turf. Those in 10 of the 13 *S. pulcher* were of 7 to 16 mm, which are sizes of the more sedentary forms attached to rocks.

Family Muricidae

Ocenebra spp.

Our collections included *Ocenebra foveolata* and *O. minor*, but most specimens of this genus could not be identified to species. According to McLean (1978), both *O. foveolata* and *O. minor* occur from Baja California to central California—the former to a size of 38 mm, the latter to only 10 mm. *Ocenebra* spp. were never numerous in our samples, but individuals up to 9 mm were collected at all four primary sites (Table 1; maximum density: 15/0.25 m^2 at Isthmus Reef). Neither occurred among the gut contents of fishes.

Family Buccinidae

Kelletia kelleti

With a heavy shell of up to about 170 mm, this gastropod is common on rock and gravel substrata from central Baja California northward through southern California (McLean 1978). It was prominent on rocks at Isthmus Reef and Eagle Rock, but was too large to be sampled by our regular collecting equipment, and so was assessed with visual counts. It was noted during all seven counts at Isthmus Reef (3 to 14, $\bar{x}$ = 6.9 individuals/100 m^2), in four of five counts at Eagle Rock (1 to 3, $\bar{x}$ = 1.8 individuals 100 m^2) and in one of five counts at Fisherman's Cove (3 individuals/100 m^2). Our collections took just one juvenile—a 6-mm individual from sediment in Fishermen's Cove—and we never found the species among gut contents of fishes.

Family Columbellidae

Alia carinata

This gastropod, to 11 mm, is common on vegetation near shore from southern Baja California to Alaska (McLean 1978), where reportedly it is mimicked by the gammaridean *Pleustes platypa* (Crane 1969). Although it has been described as at times the most abundant animal on the blades and stipes of *Macrocystis* (Abbott and Haderlie 1980), we found only a single individual in our one large sample of that massive plant. Furthermore, Coyer (1986) reported only a few individuals of this species (as *Mitrella carinata*) in his assessment of *Macrocystis* associates at Santa Catalina. Virtually all of our specimens were from turf (Table 1). The species was particularly abundant on *Dictyopteris undulata* in Fisherman's Cove (maximum density: 31/ 100 g), but also occurred on various turf algae at the other three sites. The largest of them was 10 mm. This gastropod was a ranked prey of *Halichoeres semicinctus* and an unranked prey of *Semicossyphus pulcher*.

Amphissa versicolor

This gastropod has been reported common in kelp holdfasts from Baja California to northern California (Abbott and Haderlie 1980), and Coyer (1979) found juveniles commonly associated with giant kelp at Santa Catalina. However, it was never abundant in our collections (Table 1; maximum density: 15/0.25 m^2 on rock at West End), and while we took specimens to 11 mm, it did not occur in gut contents of the fishes.

Nassarina penicillata

This small gastropod, which grows to about 5 mm, is reported as fairly common near shore from central Baja California to central California (McLean 1978). Our specimens were to 6 mm and came from turf and rock or sediment at all four sites (Table 1). They were more numerous at the two windward sites, but despite being relatively widespread, they were never abundant (maximum densities: 4/100 g of *Plocamium cartilagineum* and 22/0.25 m^2 of algae-covered rock, both at West End). *N. penicillata* was a ranked prey of *Halichoeres semicinctus*, and an unranked prey of *Damalichthys vacca, Embiotoca jacksoni, Hypsypops rubicundus* and *Semicossyphus pulcher.*

Family Marginellidae

Cystiscus jewetti

With known occurrences from central Baja California to central California, and sizes to 5.5 mm (McLean 1978), this species was limited in our collections to specimens up to 3 mm from rock at Isthmus Reef and West End (Table 1; maximum density: 106/0.25 m^2 at West End). Our only evidence of it as food of fishes was four individuals in a single *Damalichthys vacca.*

Cystiscus politus

This species attains 3.3 mm and occurs from southern Baja California through southern California (McLean 1978). Our specimens were up to 3 mm and from rock at Isthmus Reef, West End and Eagle Rock (Table 1; maximum density: 46/0.25 m^2 at Eagle Rock). The only representatives we found in fishes were one and two in a pair of *Coryphopterus nicholsii* and one in an *Embiotoca jacksoni.*

Granulina margaritula

Known to range from Panama to Alaska and to attain 3 mm (McLean 1978), *G. margaritula* was collected by us on rocks and turf at Isthmus Reef, West End, and Eagle Rock (Table 1; maximum densities: 49/0.25 m^2 on rock and 1.4/100 g of *Cystoseira neglecta*, both from Isthmus Reef), where it reached its recorded maximum of 3 mm. According to Coyer (1986), this species ranked second only to *Crepidula* sp. among molluscs associated with *Macrocystis* (although, as noted above, his perception of *Crepidula* sp. may represent multiple species). It feeds using an extensible proboscis (Coan and Roth 1966), which Coyer (1979) suggested may facilitate its feeding on the bryozoan *Lichenopora novae-zelandiae*. *G. margaritula* was an unranked prey of *Embiotoca jacksoni, Halichoeres semicinctus* and *Coryphopterus nicholsii.*

Family Conidae

Conus californicus

Individuals up to 40 mm occur on rocks and sand from southern Baja California to central California (McLean 1978). Representatives in our collections, however, were mostly 2- to 10-mm juveniles, although individuals of up to 20 mm often were taken from rocks and the basal stipes of turf algae (Table 1; maximum density: 24/0.25 m^2 from rock at Isthmus Reef). *C. californicus* did not occur among gut contents of the fishes examined.

Family Scaphandridae

Acteocina harpa

This elongate gastropod, to 6 mm, is common in gravel from Baja California to British Columbia (McLean 1978). However, all our specimens, which are to 4 mm, come from rock substrata of both windward and leeward reefs (Table 1; maximum density: 21/0.25 m^2 at Isthmus Reef). *A. harpa* was a ranked prey of *Coryphopterus nicholsii*, the only fish species in which it was found.

Diaphana californica

Attaining 5 mm on near-shore rocks and kelp holdfasts, *D. californica* has been reported from the Mexican border to Point Conception (Behrens 1980). The few collected by us were 3 mm or less and came from rock substrata at Isthmus Reef and West End (Table 1; maximum number 25/0.25 m^2 at Isthmus Reef). Only two were found among the gut contents of fishes, one in a *Coryphopterus nicholsii* and another in a *Lythrypnus zebra*.

Family Rissoellidae

Rissoella sp.

Our specimens of *Rissoella* sp., which were up to 2 mm and collected with turf algae at both windward and leeward sites, represent an undescribed species (J. M. McLean, pers. comm., March 1992). They occurred on phaeophytes at Isthmus Reef (maximum density: 20/100 g *Dictyopteris undulata*), but were most numerous on rhodophytes at West End (Table 1; maximum density: 891/100 g of *Pterocladia capillacea). Rissoella* sp. was an unranked prey of *Girella nigricans, Brachyistius frenatus, Embiotoca jacksoni, Halichoeres semicinctus, Semicossyphus pulcher* and *Coryphopterus nichosii.*

Family Pyramidellidae

Turbonilla kelseyi

This small gastropod has been reported to 4.7 mm from central Baja California to southern California (McLean 1978), but all our specimens, to 5 mm, came from Isthmus Reef. There, however, they occurred in most collections from rock substrata (Table 1; maximum density: 20/0.25 m^2). Only two were found among gut contents of the fishes, one in each of two *Semicossyphus pulcher.*

Bivalve Molluscs

Family Solemyidae

Solemya valvulus

A thin, fragile-shelled species in sediment from shore to depths of 360 m, this mollusc occurs from Sonora Mexico to San Pedro California (Keen 1971). None of our specimens exceeded 8 mm and so probably they were immature. All came from sediments in Fisherman's Cove (Table 2; maximum density: 21/0.25 m^2). Apparently these were generally unavailable to most fishes. We found one in a *Halichoeres semicinctus* and another in a *Semicossyphus pulcher*, but otherwise they occurred in just *Leiocottus hirundo*. For that species, however, *S. valvulus* (to 10 mm) was a ranked prey.

Table 2. Bivalves in the environment.

TAXA	ISTHMUS REEF						FISHERMAN'S COVE						WEST END						EAGLE ROCK					
	Turf			Rock/Sedim't			Turf			Sediment			Turf			Rock			Turf			Rock		
	n=10			n=8			n=14			n=6			n=21			n=6			n=15			n=6		
	%	x̄no	SE	%	x̄no	SE	%	x̄no	SE	%	x̄no	SE	%	x̄no	SE	%	x̄no	SE	%	x̄no	SE	%	x̄no	SE
Solemyidae																								
Solemya valvulus	0	0	0	0	0	0	0	0	0	33	4	3	0	0	0	0	0	0	0	0	0	0	0	0
Philobryidae																								
Philobrya setosa	50	3	1	88	20	11	29	1	1	0	0	0	71	9	3	100	21	6	33	1	<1	50	4	4
Mytilidae																								
Crenella decussata	0	0	0	13	<1	<1	7	<1	<1	50	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Gregariella chenui	10	<1	<1	38	1	1	0	0	0	0	0	0	0	0	0	50	1	1	0	0	0	50	1	<1
Pectinidae																								
Crassadoma giganteum	20	<1	<1	63	2	1	0	0	0	0	0	0	24	<1	<1	83	9	5	0	0	0	83	2	<1
Limidae																								
Limaria hemphili	0	0	0	63	7	3	0	0	0	0	0	0	0	0	0	67	6	3	0	0	0	50	2	0
Anomiidae																								
Anomia peruviana	10	<1	<1	25	<1	<1	0	0	0	0	0	0	5	<1	<1	17	1	1	0	0	0	0	0	0
Chamidae																								
Chama arcana	0	0	0	88	11	5	0	0	0	0	0	0	0	0	0	83	7	4	0	0	0	17	<1	<1
Kelliidae																								
Epilucina californica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cardiidae																								
Americardia biangulata	0	0	0	0	0	0	0	0	0	50	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Laevicardium substriatum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tellinidae																								
Tellina modesta	0	0	0	50	13	10	0	0	0	17	<1	<1	0	0	0	67	4	2	0	0	0	50	4	3
Bernardinidae																								
Halodakra subtrigona	60	9	4	88	21	14	86	33	13	17	<1	<1	19	1	<1	0	0	0	7	<1	<1	33	2	1
Hiatellidae																								
Hiatella arctica	50	10	5	100	18	6	29	1	1	0	0	0	62	11	5	100	38	10	27	1	<1	100	11	4
Others (identified)	30	<1	<1	75	4	4	14	<1	<1	83	7	7	10	<1	<1	33	6	6	20	<1	<1	67	44	44
Undetermined	10	<1	<1	63	71	42	0	0	0	17	<1	<1	10	<1	<1	67	12	7	7	<1	<1	50	3	2

Family Philobryidae

Philobrya setosa

This pear-shaped bivalve has been reported to 5 mm from Alaska to the Gulf of California and to attach to substrata with a bundle of byssal threads (Keen 1971). The attachment must be weak, however, because our specimens were readily rinsed free from algae. We found this species common on turf and rock substrata at all major sites (Table 2; maximum densities: 115/100 g *Dictyopteris undulata* and 91/0.25 m^2 of rock, both from Isthmus Reef).

P. setosa occurred among gut contents of just three fish species—the labrids *Halichoeres semicinctus, Oxyjulis californica* and *Semicossyphus pulcher,* none of which took it as a ranked prey. Probably these three were better able than others to feed on this mollusc because they are particularly well adapted to pluck tiny attached forms from rocks.

Family Mytilidae

Crenella decussata

This is a widely distributed species in sand and mud from Peru to Alaska (Soot-Ryen 1955), and virtually all our specimens came from sediment of Fisherman's Cove. Probably the species is greatly underrepresented in our collections (Table 2), however, as the methods used to sample sediment in Fisherman's Cove were only marginally effective, as noted above. The companion study at Ripper's Cove was designed to sample sediments, and there it was determined that *C. decussata* (as .*C. divaricata*) was a major component of the community (Hobson and Chess 1986).

That *C. decussata* was in fact more numerous in Fisherman's Cove than our environmental samples indicate is evident in its ranked status as prey of *Damalichthys vacca.* It was also an unranked prey of *Embiotoca jacksoni, Halichoeres semicinctus* and *Semicossyphus pulcher.* All of this predation occurred in Fisherman's Cove, which is consistent with all our specimens from the environment coming from the sediments of that location. The Ripper's Cove study, referred to above, found C. decussata (as *C. divaricata)* a ranked prey of *E. jacksoni* and *H. semicinctus* and an unranked prey of *O. californica* (*D. vacca* was not part of that study.) Here we follow Eugene Coan (California Academy of Science, pers. comm., February 1992) in considering *C. decussata* and *C divaricata* synonymous.

Gregariela chenui

This species attains 6.5 mm and is known from Peru to central California (Keen 1971). Most of the relatively few specimens in our collections from the environment are from rocks at Isthmus Reef and the two windward sites (Table 2; maximum density: 4/0.25 m^2 at West End), but our regular collections may have missed its primary habitat. The largest number (five) came from our one sample of the bryozoan *Bugula neritina.* The only representatives from turf were two individuals in a sample of *Cystoseira neglecta. G. chenui* is included here because it was a ranked prey of *Semicossyphus pulcher.* It was also an unranked prey of *Halichoeres semicinctus* and *Coryphopterus nicholsii.*

Family Pectinidae

Crassedoma giganteum

The adults of *C. giganteum,* which can be up to 250 mm (McLean 1978, as *Hinnites giganteus*), are fixed in place by one valve cemented to the substrate, but some juveniles (up to about 25 mm) are motile (Haderlie and Abbott 1980, as *Hinnites giganteus*). Most juveniles, however, are weakly attached by a byssus (Yonge 1951, as *Hinnites multirogosus*). Our collecting methods were ineffective in sampling adults, but took juveniles of 1 to 11 mm at all the major sites. Most were from rocks, but many came from turf/algae (Table 2; maximum density 32/0.25 m^2 from rock at West End). The adults were assessed visually, but only at Isthmus Reef, where 12 counts recorded 1 to 6, $\bar{x} = 2.4$ individuals/100 m^2. Juvenile *C. giganteum* were ranked prey of *Halichoeres semicinctus* and an unranked prey of *Embiotoca jacksoni, Oxyjulis californica* and *Semicossyphus pulcher.* There were no adults among the gut contents of fishes.

Family Limidae

Limaria hemphilli

This is one of the file shells, which are similar to scallops in their ability to swim by valve adduction. It has been reported up to 30 mm on near-shore rocks, from central Mexico to central California (McLean 1978, as *Lima hemphilli*). Our largest was 18 mm, but most were juveniles of 2 to 4 mm. They occurred at all four sites, mostly on rocks, but some on turf (Table 2; maximum densities: 28/0.25 m^2 of rock and 8/100 g *Dictyopteris undulata,* both from Isthmus Reef). This species was a ranked prey of *Embiotoca jacksoni,* and *Semicossyphus pulcher,* and an unranked prey of *Halichoeres semicinctus* and *Coryphopterus nicholsii.*

Family Anomiidae

Anomia peruviana

A cryptic and sessile form that assumes the sculpture of the substrate, this thin-shelled species attains a diameter of up to 60 mm and has been reported common on near-shore rocks and clam shells from Peru to central California (McLean 1978). This species only occasionally occurred in our collections from the environment (Table 2), and those taken were >20 mm. Some came from turf (never more than one in a collection), and some came from rocks (up to three in a collection).

Despite its scarcity in our collections from the environment, however, *A. peruviana* was a ranked prey of *Semicossyphus pulcher* and an unranked prey of *Damalichthys vacca, Halichoeres semicinctus, Oxyjulis californica* and *Coryphopterus nicholsii.* Those taken by fishes ranged from 3 mm (in *C. nicholsii)* to 15 mm (in *S. semicossyphus*), so it would appear that fishes, like our collecting devices, were unable to take the larger, more firmly attached individuals.

Family Chamidae

Chama arcana

This is a sessile form that grows to a diameter of 60 mm and fixes itself in position during transformation from the larval stage by cementing its left valve to rock (McLean 1978). Adults virtually covered the sides of some near-shore rocks at Santa Catalina, but among our study sites, they were numerous only on vertical rock surfaces between depths of 3 and 7 m at Lion's Head. Because they were so sparse at our primary sites, the adults were not included in our visual counts. Like other firmly attached organisms, they were poorly sampled by our standard collecting methods, and none were found among the gut contents of fishes.

Juvenile *C. arcana* (most 2-10 mm) were unlike adults in being collected from rock substrata at all three major reef sites (Table 2: maximum density 38/0.25 m^2 from Isthmus Reefs). They were taken with the airlift, so probably were recently settled individuals still insecurely attached to the substrate. Even weak attachments would have reduced their availability to the airlift, however, so presumably the numbers sampled represented a conservative estimate of the numbers in the environment. Perhaps because they were attached, but more likely because of their heavy shells, juvenile *C. arcana* were among the gut contents of just one fish species, *Semicossyphus pulcher.* For that one, however, they were a ranked prey. Presumably the exceptionally strong jaw teeth and pharyngeal plates of this fish, along with its ability to pluck attached forms from a substrate, made *S. pulcher* an especially effective predator on at least the smaller *C. arcana.*

Family Lucinidae

Epilucina californica

Another sand dweller that was underrepresented in our assessments, *E. californica* is common up to 35 mm in gravel near rocks from Baja California to northern California (McLean 1978). We noted its shells during visual assessments in Fisherman's Cove, but did not count them, and they did not occur in our collections. It occurred among the gut contents of just two *Damalichthys vacca*, but one of these contained over 300 of them. Although none were more than 8 mm, their numbers ranked the species among the prey of this fish (thus qualifying it for inclusion here). Although in this case the ranking was justified because the species is known to be abundant (though unsampled) as an adult, undoubtedly there are cases in which large numbers of juveniles settle in habitats where there is no chance for survival.

Family Cardiidae

Americardia biangulata

A fairly common species in gravel near rocks from Equador to southern California, this cockle attains 35 mm (McLean 1978). Its shells were common on the surface of sediments in Fisherman's Cove during the visual assessments, but no living specimens were seen, presumably because they were buried. We collected specimens as large as 15-mm (Table 2; maximum density 4/0.25 m^2), but even larger individuals may have been buried beyond the sediment depths sampled. All were from sediments of Fisherman's Cove, except a pair of 2-mm individuals from rock at Isthmus Reef (which may have been in a pocket of sand).

This heavy-shelled bivalve was a ranked prey of *Damalichthys vacca* and *Semicossyphus pulcher*, but otherwise occurred in the diets of just individual *Hypsypops rubicundus* and *Halichoeres semicinctus*.

Laevicardium substriatum

This bivalve, to 30 mm, occurs in near-shore sand from Baja California to southern California (McLean 1978). Its shells were generally present (but not enumerated) on the surface of the sediment during visual assessments of the Fisherman's Cove transect, but no living specimens were taken in our collections (Table 2)—presumably because these were below the depths of sediment sampled. The only fish found to feed on *L. substriatum* was *Damalichthys vacca*, but it was a ranked prey of this species (thus accounting for its inclusion here).

Family Tellinidae

Tellina modesta

Because our study area was within the ranges of at least six species of *Tellina* (Coan 1971), there was uncertainty about the identity of some of the smaller specimens in our collections (the vast majority were <5 mm in length). Only one species was distinguished—*T. modesta*—and even this identification was tentative (Donald Cadien, Marine Biological Consultants, Costa Mesa, CA, pers. comm., 30 June 1975). *T. modesta* attains 10-15 mm and is common on sandy bottoms from central Baja California to Alaska (McLean 1978). Our specimens (Table 2), which were up to 8 mm, came from sediment in Fisherman's Cove (maximum density 95/0.25 m^2 of surface area) and from rock substrata at Isthmus Reef and the two windward sites (maximum density 63/0.25 m^2 at Isthmus Reef). Those taken from rock may have been in pockets of sand.

This species was abundant in sand at Ripper's Cove (maximum density 318/0.25 m^2), where it was a ranked prey of *Semicossyphus pulcher* (taken by all six specimens sampled) and an unranked prey of *Halichoeres semicinctus* (Hobson and Chess 1986). During the present study, however, the total number found in all gut contents examined was three—one in each of a *Damalichthys vacca*, a *S. pulcher* and a *Coryphopterus nicholsii.*

Family Bernardinidae

Halodakra subtrigona

Two species of *Halodakra* are recognized from southern California, *H. salmonea* and *H. subtrigona*—the former being the more common (Coan 1984); however, all our specimens (Table 2) appeared to be *H. subtrigona* (it was the most abundant bivalve in our leeward collections). This small species (to 4.5 mm) occurs in near-shore rocky rubble from Peru to central California (Coan 1984). Most of our specimens were taken from turf algae (maximum density: 230/100 g *Dictyopteris undulata* from Fisherman's Cove) although the species also occurred, sometimes abundantly, in collections from rocks (maximum density: 118/0.25 m^2 of surface at Isthmus Reef). Although abundant at the two leeward sites, it was infrequently collected at the two windward stations. This is a motile form that was observed fully exposed crawling over the surface of algae on its expanded foot. We collected specimens of up to 4 mm, but the vast majority were <2 mm.

Adults of this ovoviviparous species brood young in their mantle cavity. Broods were observed throughout the year and included eggs, embryos and juveniles with shells. The brooding adults were 1.6 to 2.4 mm, with the smaller carrying 1 to 3 young (with shells) and the larger up to 30. The shelled young ranged from 0.2 to 0.5 mm, with the largest size seen in broods also being the smallest size seen free in the environment.

Consistent with its great abundance in exposed positions, *H. subtrigona* was a ranked prey of *Embiotoca jacksoni*, juvenile *Damalichthys vacca, Halichoeres semicinctus, Oxyjulis californica* and *Coryphopterus nicholsii*. It was also an unranked prey of *Brachyistius* *frenatus* and *Semicossyphus pulcher.* Although an important prey of juvenile *D. vacca*, it was not found to be food of the adults, probably because it was too small to be ingested by the larger of that species.

Family Hiatellidae

Hiatella arctica

This common bivalve, to 25 mm, nestles in pholad holes, crevices and kelp holdfasts from Panama to the Arctic Ocean (McLean 1978). It also bores into soft rocks (Haderlie and Abbott 1980). We found it numerous, nestled in turf and rocks at both windward and leeward stations (Table 2; maximum densities: 113/100 g of *Plocamium cartilageum* and 65/0.25 m^2 of algae-covered rock, both at West End). Although we collected specimens to 14 mm, the vast majority were less than 4 mm, and so were presumed to be juveniles.

Although typically nestled in crevices, *H. arctica* was a ranked prey of *Medialuna californiensis, Embiotoca jacksoni, Halichoeres semicinctus, Semicossyphus pulcher* and *Coryphopterus nicholsii* and an unranked prey of *Brachyistius frenatus, Damalichthys vacca,* and *Alloclinus holderi.*

Cephalopod Molluscs

Family Octopodidae

Octopus bimaculatus (Fig. 18)

Although common from the Gulf of California through southern California (Hochberg and Fields 1980), the highly cryptic *O. bimaculatus* was only infrequently seen during the transect counts. Evidence of its presence was widespread, however, as accumulations of mollusc shells—most with the distinctive hole as bored by an octopus—marked the entrance to octopus lairs throughout the Santa Catalina habitats. Possibly, some of these accumulations marked lairs of the very similar *O. bimaculoides*, which has been reported to co-occur with *O. bimaculatus* (Hochberg and Fields 1980), but all specimens that we collected or were able to identify in the environment were of *O. bimaculatus*.

The inclusion of *O. bimaculatus* in this report is based on occurrences of accumulated mollusc shells assumed to have been its prey. The major prey, judging from the accumulations, were pink abalone, *Haliotes corrugata*, of 3 to 15 cm (most 5 to 8 cm). Others included the gastropods *Lithopoma undosum, Norrisia norrisi, Tegula aureotincta*, and *T. regina*, as well as the bivalve *Ventricolaria fordi*. We found no evidence of decapods among its prey, even though these are recognized by some as major foods (e. g., Hochberg and Fields 1980). Possibly the absence of decapods in the diet of *O. bimaculatus* related—either as cause or effect—to the relative scarcity of these organisms in our samples from the environment (see below).

It is generally recognized that octopods use their radulas to bore through the shells of their prey and inject venom (Arnold and Arnold 1969), but among the abalone shells accumulated at octopus lairs in the Santa Catalina habitats, only the mid-sized shells (of about 5 to 10 cm) had been consistently penetrated by the boring process. Many of the smallest shells (<5 cm) showed no sign of a bore, and many of the larger shells (10 cm) had not been

Figure 18. The octopod *Octopus bimaculatus*.

penetrated. *O. bimaculatus* that we held in aquaria took the smaller abalone so quickly they appeared to simply wrench them from the substrate, but they enveloped the larger abalone for up to 16 hours before pulling them free. That the larger abalone often lost their grip on the substrate before their shells had been penetrated suggests they may have been weakened by chemical secretions (Bidder 1966), or by anoxia as the enveloping arms and interbranchial web of the octopus effectively sealed them off from the environment.

Our study determined that *O. bimaculata* was a ranked prey of *Scorpaena guttata* and an unranked prey of *Sebastes atrovirens*, but otherwise did not occur among foods of the fishes examined. McCleneghan (1973) found it the major prey of *Gymnothorax mordax*, the moray eel, but we did not examine the diet of this predator.) *Octopus* that we retrieved from gut contents were >60 mm and could not be positively identified because of damage from digestion, but we consider them *O. maculatus* because there seemed no other species of this genus widespread at Santa Catalina. Some uncertainty exists, however, because we collected a few *O. micropyrsus* within gastropod shells from Fisherman's Cove. This is one of the smallest octopods known (Hochberg and Fields 1980). The eggs of *O. bimaculatus* (identified based on Hochberg and Fields 1980) were minor prey of *Hypsypops rubicundus* and *Oxyjulis californica*.

Family Loliginidae

Loligo opalescens

This is a common squid in pelagic coastal waters from southern Baja California to British Columbia (Hochberg and Fields 1980), but we have observed it in the vicinity of nearshore reefs only when large numbers aggregated to spawn over adjacent expanses of sand. This activity, which occurs during the winter in southern California (Recksiek and Frey 1978), involves mating and depositing egg capsules in masses up to 12 m in diameter

(McGowan 1954). Only a few small aggregations and egg masses were seen during the present study, all during winter months on sand seaward of the study reefs, but we observed massive spawning activity in the area during the preceding decade (e. g., Hobson 1965).

The inclusion of *L. opalescens* in this report is based on the prominence of 12 to 19 cm adults as prey of *Scorpaena guttata* collected within an hour of sunrise during February and March. Presumably these had been consumed during the night on spawning grounds over sand adjacent to the reef on which the fish were collected. The only other occurrences of *L opalescens* in the diets of fishes examined here were single 3-mm juveniles in each of two nocturnal planktivores, both *Xenistius californiensis* collected in Ripper's Cove shortly before dawn during June.

When *L. opalescens* aggregates to spawn in large numbers, it becomes major prey of a wide variety of birds, marine mammals and fishes (Morejohn et al. 1978). That so few were taken by the fishes examined here is consistent with having seen so few individuals and only a few small egg masses during the course of this study.

Ostracods

Subclass Myodocopa

Family Cypridinidae

Vargula tsujii (Fig. 19A).

Our specimens of *V. tsujii* from the environment (Table 3) were of 0.6 to 2.8 mm, with most from rock substrata at Isthmus Reef (maximum density: 648/0.25 m^2). Nevertheless, while none occurred with our regular sediment samples, we took five from sediment in an unscheduled, non-quantitative collection in Fisherman's Cove. (Some of the paratypes are from this collection: Kornicker and Baker 1977.) Furthermore, the species was numerous in nocturnal plankton collections from the water column above the Fisherman's Cove transect (Hobson and Chess 1976, as *V. americana*).

During the day, *V. tsujii* was a ranked prey of *Embiotoca jacksoni* and *Coryphopterus nicholsii* and a lesser prey of *Hypsypops rubicundus, Halichoeres semicinctus, Oxyjulis californica, Semicossyphus pulcher* and *Lythrypnus zebra.* Individuals in the diets of these diurnal benthivores were of 1 to 3 mm, which was slightly larger than size range from the environment.

Those *V. tsujii* that enter the water column at night are exposed to nocturnal planktivores. According to Morin (1986, p.10), when *Vargula* spp. are attacked by planktivorous fishes "...they invariably produce a brilliant and massive (several cm) bomb-like cloud of luminescence that...sometimes results in the predator regurgitating the ostracod and probably startles ('boo' effect) and temporarily blinds (flashbulb effect) the predator." Despite any advantage that V. tsujii might gain from its luminescence, however, all nocturnal planktivorous fishes sampled above the Fisherman's Cove transect included it in their diets. It was a major prey of *Sebastes atrovirens*, subadult *Sebastes serranoides* and *Seriphus politus*, and a secondary prey of *Xenistius californiensis* and *Hyperprosopon argenteum*.

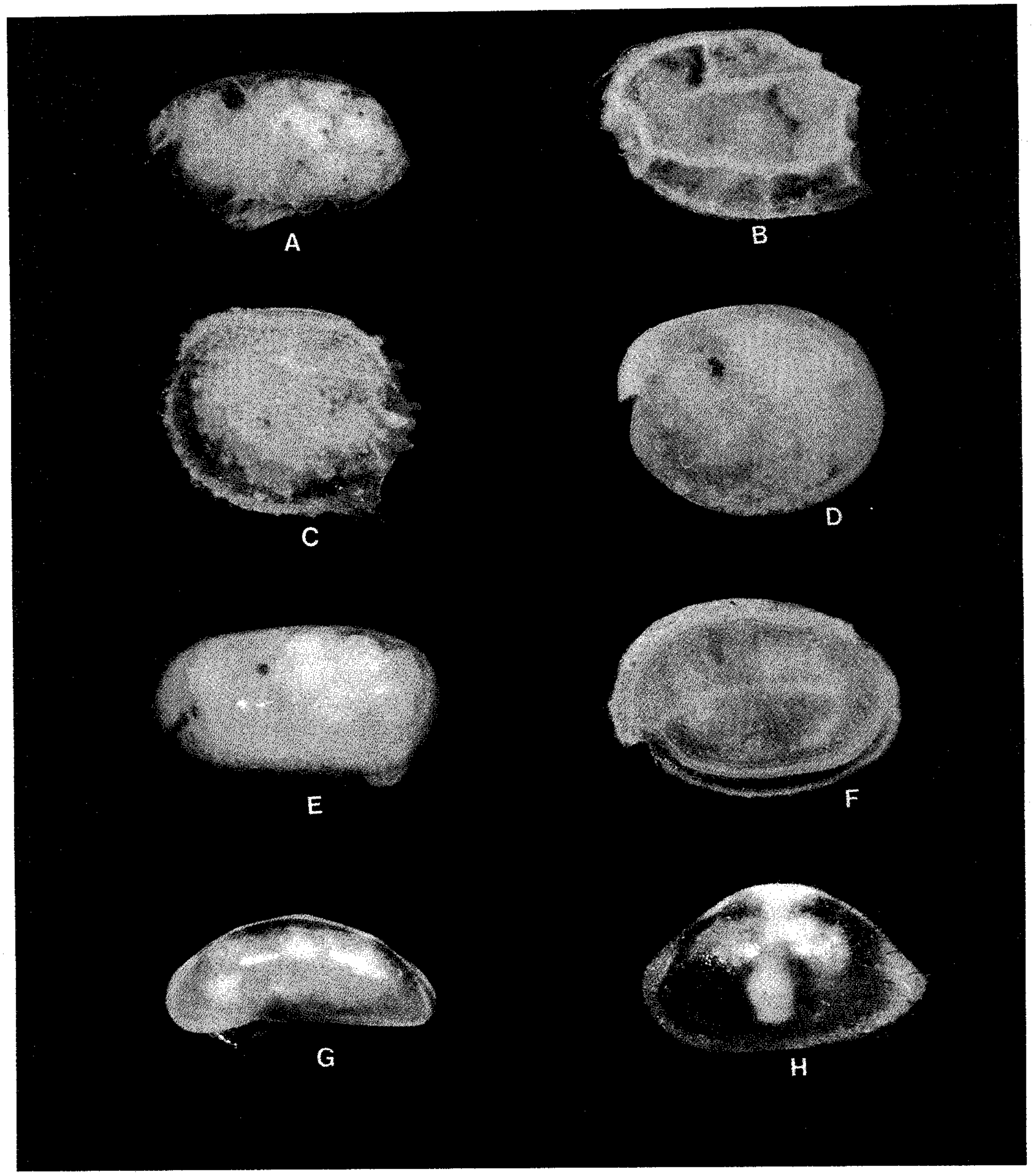

Figure 19. Ostracods at Santa Catalina. A. *Vargula tsujii*; B. *Rutiderma chessi*; C. *Eusarsiella pseudospinosa*; D. *Lauroleberis sharpei*; E. cylindroleberdid; F. *Asteropella slatteryi*; G. *Macrocyprina barbara; H. Neonesidea phlegeri*.

V. tsujii can interact with fishes as predator as well as prey. According to Stepien and Brusca (1985, p. 92), nocturnal swarms of this ostracod attack "adult fishes located near the benthos, much like swarms of biting dipteran insects." The attacks involved not only individuals that attached to the external body and gills of the fishes, but also by others that enter the body cavity through the anus and consume gonads and liver. The fishes thus attacked were captive in traps, however, so it remains to be determined how vulnerable fishes are to ostracods under normal conditions.

Table 3. Ostracods and Cumaceans in the environment.

TAXA	ISTHMUS REEF						FISHERMAN'S COVE						WEST END						EAGLE ROCK					
	Turf			Rock/Sedim't			Turf			Sediment			Turf			Rock			Turf			Rock		
	n=10			n=8			n=14			n=6			n=21			n=6			n=15			n=6		
	%	$\bar{x}$no	SE	%	$\bar{x}$no	SE	%	$\bar{x}$no	SE	%	$\bar{x}$no	SE	%	$\bar{x}$no	SE	%	$\bar{x}$no	SE	%	$\bar{x}$no	SE	%	$\bar{x}$no	SE
OSTRACODS																								
MYODOCOPA																								
Cypridinidae																								
Vargula tsujii	0	0	0	88	166	93	7	<1	<1	13	<1	<1	0	0	0	0	0	0	0	0	0	50	3	2
Rutidermatidae																								
Rutiderma spp.	10	<1	<1	75	72	44	0	0	0	20	<1	<1	5	<1	<1	67	2	1	0	0	0	100	15	9
Sarsiellidae																								
Eusarsiella pseudospinosa	0	0	0	88	12	12	0	0	0	0	0	0	0	0	0	33	1	1	0	0	0	50	2	1
Cylindroleberididae																								
Leuroleberis sharpei	0	0	0	0	0	0	0	0	0	47	1	<1	0	0	0	0	0	0	0	0	0	0	0	0
Asteropella slatteryi	10	<1	<1	0	0	0	0	0	0	40	4	3	0	0	0	0	0	0	0	0	0	0	0	0
cylindroleberdinae	20	<1	<1	100	477	262	7	<1	<1	83	145	88	5	<1	<1	17	1	1	0	0	0	67	12	7
Others (identified)	23	<1	<1	38	16	16	7	<1	<1	7	<1	<1	5	<1	<1	33	1	<1	0	0	0	33	1	<1
Undetermined	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PODOCOPA																								
Macrocypriidae																								
Macrocyprina barbara	30	1	1	100	1338	835	36	3	1	60	11	7	5	<1	<1	67	9	7	0	0	0	50	6	4
Baridiidae																								
Neonesidea phlegeri	30	13	11	100	599	321	36	2	1	27	12	11	14	1	1	83	38	14	0	0	0	83	70	83
Others (identified)	20	12	12	50	59	38	64	44	16	7	<1	<1	29	8	3	17	1	1	0	0	0	33	1	1
Undetermined	20	5	4	38	19	16	21	8	8	13	80	80	24	7	4	17	1	1	0	0	0	0	0	0
Undetermined Ostracods	0	0	0	50	40	36	7	<1	<1	0	0	0	0	0	0	17	<1	<1	0	0	0	0	0	0
CUMACEANS																								
Bodotriidae																								
Cyclaspis *nubila*	0	0	0	0	0	0	0	0	0	33	28	20	0	0	0	0	0	0	0	0	0	0	0	0
Nannastacidae																								
Cumella spp.	10	1	1	100	190	118	0	0	0	20	15	12	0	0	0	100	11	6	0	0	0	50	22	7
Others (identified)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Undetermined	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Family Rutidermatidae

Rutiderma spp. (Fig. 19B).

At the time of our collections and sample analyses, the status of *Rutiderma* species in southern California was uncertain. We distinguished two species—*R. lomae* and *R. rotundum* —but lacked confidence in many of our designations, and many specimens went unidentified. The major problems were later resolved by Kornicker and Myers (1981), who drew heavily from our collections. They determined that at least most of the specimens we had identified as *R. lomae* represented an undescribed species, which they named *R. chessi*, and they found a fourth species, *R. judayi*, among our unidentified specimens. But because of the uncertainties with the initial identifications, we combine these species here as *Rutiderma* spp.

Despite the uncertainties, it was evident that *R. rotundum* was the major species of *Rutiderma* at our study sites (Table 3). It occurred at all four major sites and on all substrata sampled, but was most numerous on rock (maximum density: 210/0.25 m^2 at Isthmus Reef). The largest of our specimens was 1.6 mm in diameter and none were found among the gut contents of fishes. The subsequent reanalysis identified *R. chessi* as the next most numerous (maximum density 90/0.25 m^2 of rock at Isthmus Reef), but there is still considerable uncertainty because many of the samples were not reanalyzed. Our largest specimens of both were 2 mm in diameter, and the only specimen of *Rutiderma* found in the gut contents of a fish that had been feeding during the day (*Embiotoca jacksoni*) was identified as *R. lomae*. Individuals identified as *R. lomae* in Fisherman's Cove were taken in a nocturnal plankton collection and from the gut contents of a nocturnal planktivore (Hobson and Chess 1986), but these specimens were unavailable for reexamination after the taxonomic problems had been resolved.

Family Sarsiellidae

Eusarsiella pseudospinosa (Fig. 19C).

This species was not described until 1977, and only two specimens, both from southern California, were available to the describer (Baker 1977). Although there were enough representatives in our collections to give the species ranked status (Table 3), it was not among the abundant ostracods at Santa Catalina. Individuals of 0.7 to 3.0 mm were taken from rocks at the three reef sites, most abundantly at Isthmus Reef (maximum density: 79/0.25 m^2), but not from other substrata or from the gut contents of fishes.

Family Cylindroleberididae, subfamily Cyclasteropinae

Leuroleberis sharpei (Fig. 19D).

Although this species occurs from the Gulf of California northward to central California, and possibly Alaska, it was only recently described (Kornicker 1981). All of our specimens came from sediment of Fisherman's Cove (Table 3), where most collections included representatives of 1.4 to 5.0 mm (maximum density 14/0.25 m^2). Although strictly benthonic by day, the species occurred throughout the water column of Fisherman's Cove at night (Hobson and Chess 1976, as *Cycloleberis lobiancoi).*

L. sharpei was an infrequent prey of diurnal benthivores, which is consistent with its relative scarcity in our collections from the daytime benthos. There were 1 or 2 in 4 *Coryphopterus nicholsii*, 2 and 5 in 2 *Embiotoca jacksoni*, and, under what must have been exceptional circumstances, 60 in 1 *Semicossyphus pulcher.* Apparently *L. sharpei* is more vulnerable to predators when it leaves the benthos at night, however, as it was among the prey of all nocturnal planktivores sampled after dark in Fisherman's Cove. At that time, it was a ranked prey of *Sebastes atrovirens*, subadult *S. serranoides* and *Hyperprosopon argenteum*, and an unranked prey of *Xenistius californiensis* and *Seriphus politus* (Hobson and Chess 1976, as *Cycloleberis lobiancoi).*

Family Cylindroleberdidae, subfamily Cylindroleberdinae (Fig. 19E).

We did not distinguish members of this subfamily as they are superficially very similar. They included some of the largest (to 3 mm) and most numerous ostracods in our collections from both sediment and rocks (Table 3; maximum densities: 2139/0.25 m^2 of rock at Isthmus Reef and 477/0.25 m^2 in sediments of Fisherman's Cove). Although we lacked confidence in our identifications, two genera reported from California—*Parasterope* and *Bathyleberis* (Baker 1978, 1979)—appeared to be represented in our collections (Table 10).

Although the members of this subfamily were strictly benthonic by day, many were planktonic at night (Hobson and Chess 1976, 1986, as *Parasterope* sp.). Consistent with this diel pattern, they were frequent prey of diurnal benthivores, including *Embiotoca jacksoni, Hypsypops rubicundus, Halichoeres semicinctus, Oxyjulis californica, Semicossyphus pulcher, Coryphopterus nicholsii* and *Lythrypnus dalli*, but were not among prey of diurnal planktivores (Hobson and Chess 1976, 1986). And at night they were taken not only by benthivores, e. g. *Chilara taylori* and *Umbrina roncador,* but also by planktivores, e. g., *Sebastes serranoides, Seriphus politus* and *Hyperprosopon argenteum* (Hobson and Chess 1976, 1986, as *Parasterope* sp.).

Family Cylindroleberididae, subfamily Asteropteroninae

Asteropella slatteryi (Fig. 19F).

Although this species has been known only from Monterey Bay and Halfmoon Bay in central California (Kornicker 1981), individuals of 0.8 to 2 mm occurred in most of our collections from sediment in Fisherman's Cove (maximum density 191/0.25m^2). There were none in any of our other collections, however, except for a single individual taken with *Sargassum muticum* from Isthmus Reef (Table 3).

Despite the common occurrence of *A. slattteryi* in or on sediment in Fisherman's Cove, its presence among gut contents of fishes from that site was limited to two 1-mm individuals in a nocturnal planktivore, *Hyperprosopon argenteum*, that was collected at night. Two others, both 2 mm, occurred among the food of a *Coryphopterus nicholsii* collected during the day at Eagle Rock. Otherwise, all records of it as food of fishes are from our earlier study at Ripper's Cove (Hobson and Chess 1986), where two were found in each of two *Halichoeres semicinctus* collected during the day, and one in each of two *Cymatogaster aggregata* collected at night (included among "others" in that report).

Subclass Podocopa

Family Macrocyprididae

Macrocyprina barbara (Fig. 19G).

This ostracod (identity based on Maddocks 1990) was widespread and abundant at Santa Catalina. Although of only 0.7 to 1.2 mm, it occurred on all types of substrata sampled, though only sparsely at the windward sites (Table 3). The greatest numbers were from rock surfaces at Isthmus reef (maximum density 6880/0.25 m^2).

Consistent with its distribution in the environment, *M. barbara* was often among the foods of fishes from the leeward sites, but only occasionally among the foods of fishes from the windward sites. Taking it as a ranked prey were *Embiotoca jacksoni* and *Coryphopterus nicholsii*; taking it as an unranked prey were *Girella nigricans, Medialuna californiensis, Brachyistius frenatus, Hypsypops rubicundus, Halichoeres semicinctus, Oxyjulis Californica, Semicossyphus pulcher and Alloclinus holderi.* Considering its very small size, and the feeding capabilities of the fishes involved, we believe that at least many of those ingested were taken incidentally.

Family Baridiidae

Neonesidea phlegeri (Fig. 19H).

This ostracod (identity based on Maddocks 1969) was like *M. barbara* in occurring at all sites and on all substrata sampled. It was also like the other in being most numerous in collections from rocks at Isthmus Reef (maximum density 2208/0.25 m^2) and in being represented by a similar range of sizes, 0.8 to 1.3 mm. But it differed in being relatively abundant at the windward sites (Table 3).

N. phlegeri was food of essentially the same array of fishes as *M. barbara.* Taking it as a ranked prey were *Girella nigricans, Medialuna californiensis, Embiotoca jacksoni, Coryphopterus nicholsii* and *Lythrypnus zebra*; taking it as an unranked prey were *Orthonopias triacis, Oxylebius pictus, Brachyistius frenatus Hypsypops rubicundus, Halichoeres semicinctus, Oxyjulis californica,* and *Semicossyphus pulcher.* We believe that, as with *M. barbara,* at least many were taken incidentally when the fish ingested other foods.

Copepods

■ Calanoids and Cyclopoids

The calanoids and cyclopoids at Santa Catalina were major components of the plankton and primary prey of diurnal planktivores (Hobson and Chess 1976); however, we collected only a few in our many samples of the benthos (which we assume were incidental occurrences) and so do not consider them elements of the benthic fauna. Some investigators would disagree. For example, Hammer (1981) concluded that calanoids (e. g., *Acartia* spp., *Calanus* spp. and *Clausocalanus* spp.) and cyclopoids (e. g., *Coryceus* spp., and *Oithona* spp.) can be part of the Santa Catalina benthos based on his assumption that those he trapped close to the bottom near Fisherman's Cove had emerged from sand. He was also influenced by reports of *Calanus* spp. digging into sediment (Kos 1969) and of various other calanoids and cyclopoids feeding on organic debris from the bottom of aquaria (Lebour 1922). We have seen benthonic calanoids elsewhere, e. g., *Paramisophria* spp. in the central Pacific (Hobson and Chess 1979), and occasionally collected benthic cyclopoids at Santa Catalina (e. g., *Clausidium* sp.), but the morphologies of these species clearly reflected their relation to the benthos. The species referred to here are typical holoplankters.

Although we do not consider these calanoids and cyclopoids as benthonic, they were important , if not primary, prey of various fishes that occur on or close to rocks, sand or algae. Included were *Brachyistius frenatus, Oxyjulis californica, Lythrypnus dalli* and *Coryphopterus nicholsii.* There is no evidence, however, that this predation involved the benthos. All fish species with calanoids or cyclopoids among their gut contents were seen feeding in the water column. Indeed, *B. frenatus* and *O. californica* were featured as planktivores in our earlier paper on planktivory at this location (Hobson and Chess 1976). In that paper we pointed out that individuals of both species switch from being mainly planktivorous to mainly benthivorous when they are about 100 mm SL, but that even the largest among them remain to some varying extent planktivorous. Two other species that include calanoids or cyclopoids among their major prey—*C. nicholsii* and *L. dalli*—were frequently seen darting up from their resting places on the reef and snapping at plankters in the lower part of the water column. Only one other species included copepods in its diet as major prey, *Medialuna californiensis,* and we believe that these were taken as feces of planktivores (Hobson and Chess ms). Probably the same was true of the one remaining species that had taken copepods—*Hypsypops rubicundus*, two of which (190 and 205 mm SL) had consumed 14 and 320 calanoids, respectively. Although this was not enough to place copepods among the ranked prey of this fish, the numbers that occurred among the gut contents leads us to conclude they were taken as feces of planktivores, either from the sea bed or as the feces drifted through the water column. Although generally *H. rubicundus* is benthivorous, we have seen individuals in the water column among feeding planktivores.

Certainly we would expect calanoids and cyclopoids to swim freely within crevices in rocky substrata and among the branches of turf algae—these are spacious openings to these tiny organisms. But if they had been a meaningful presence on or in the benthos, they should have occurred among the gut contents of predators like *Embiotoca jacksoni* and *Halichoeres semicinctus*, which feed so broadly on the benthos. Their absence from the diets of such fishes, and their scarcity in our samples of the environment, argues against them being benthonic.

■ Harpacticoids

In contrast to the calanoids and cyclopoids, many of the harpacticoids at Santa Catalina were benthonic by day, although a few of them flitted about close above the bottom at this time (Hobson and Chess 1976). Most were 1 mm or less, but a few were as large as 2 mm. We were unable to identify the majority of our specimens, but probably at least two species of *Porcellidium* were present, one of them *P. viride*. This was most abundant harpacticoid in our samples, and while it did not exceed 1 mm, it was numerous on turf (and in lesser numbers on rocks and sediment) at all four major stations (maximum density: 200/100 g of *Cystoseira neglecta* from Isthmus Reef). Probably the others included at least some of the species that Coyer (1979) identified from *Macrocystis*, i. e., *Dactylopodia* sp., *Eudactylopis* sp., *Paralteutha* sp., *Scutellidium lamellipes, Tisbe* sp. and *Zaus spinatus*. Another species, *Eupelta* sp. (identified by Abraham Fleminger, Scripps Institution of Oceanography, pers. comm., 10 February 1975) was taken in just two collections (both from rock), but one of these (from Isthmus Reef) contained 117 individuals. Many of the harpacticoids that were benthonic by day occurred throughout the lower half of the water column at night (Hobson and Chess 1976).

Despite the widespread abundance of harpacticoids, they were ranked prey of just two species, *Lythrypnus dalli* and *L. zebra*—both diurnal feeders and the smallest of the fishes examined. They were, however, taken as unranked diurnal prey by most of the diurnal benthivorous fishes sampled: *Girella nigricans, Medialuna californiensis, Brachyistius frenatus, Embiotoca jacksoni, Hypsypops rubicundus, Halichoeres semicinctus, Oxyjulis californica, Semicossyphus pulcher, Coryphopterus nicholsii* and *Alloclinus holderi*. Probably at least most of these were taken incidentally when the fish ingested some other organism. Similarly, the many harpacticoids that entered the water column at night experienced only limited threats from the fishes considered here. Of the many nocturnal planktivores that preyed so heavily on gammaridean amphipods and other benthonic forms that are planktonic after dark, only the two smallest—juvenile *Sebastes serranoides* and *Brachyistius frenatus*—consumed harpacticoids (*Porcellidium* spp.), and neither took enough to make harpacticoids ranked prey (Hobson and Chess 1976).

Mysids

Family Mysidae

Siriella pacifica

This was the most widespread mysid at the Santa Catalina study sites (identity based on Tattersall 1951). It spent the day close to vegetation, including benthic turf and *Macrocystis*, where its mobility enabled most to evade our collecting procedures. Those few in our daytime collections from the environment, all from the two leeward sites, were up to 13 mm. *S. pacifica* was more effectively sampled by Coyer (1984), who, by enveloping large portions of *Macrocystis* with a 1 x 3-m net, determined it to be among the ten most abundant invertebrates in the mid and lower portions of that plant. This mysid is a nocturnal predator that swims into open regions of the water column about 40 min after sunset. There it hunts smaller planktonic crustacea until returning to shelter among the algae about 40 min before sunrise (Hobson and Chess 1976).

During its daytime association with algae, *S. pacifica* was a ranked prey of *Paralabrax clathratus*, but otherwise we found it among the gut contents of just a single *Brachyistius frenatus*. In contrast, during its nighttime ventures in the water column, *S. pacifica* suffered heavy predation from all nocturnal planktivores sampled: *Sebastes atrovirens*, juvenile *S. serranoides, Xenistius californiensis, Seriphus politus, Hyperprosopon argenteum* and those *Brachyistius frenatus* that foraged after dark (Hobson and Chess 1976).

Family Mysidae, subfamily Mysinae

Amathimysis trigiba

Our specimens of *A. trigiba*, which include the holotype and paratypes, represent the first records of the genus *Amathimysis* in the Pacific Ocean (Murano and Chess 1987). Although new to science, this small, fragile species of up to 5.0 mm was numerous amid organic detritus above sediment and from rock at the two leeward sites (maximum density 412/0.25 m^2 of rock surface at Isthmus Reef). It also was collected on turf phaeophytes (maximum density 16/100 g *Cystoseira neglecta* from Isthmus Reef), but not on turf rhodophytes, including those that dominated the benthos at West End. Although strictly benthonic by day, *A trigiba* was numerous in the water column at night (Hobson and Chess 1976, as erythropinid sp.).

During the day, *A trigiba* was a ranked prey of *Paralabrax clathratus*, but only an unranked prey of other diurnal benthivores, including *Embiotoca jacksoni, Halichoeres semicinctus, Oxyjulis californica, Hypsypops rubicundus, Alloclinus holderi* and *Lythrypnus zebra*. At night, however, those that entered the water column were ranked prey of nocturnal planktivores, including *Sebastes atrovirens*, larger juvenile *S. serranoides, Xenistius californiensis* and *Seriphus politus* (Hobson and Chess 1976, as erythropinid sp.). In addition, at least some were taken by those *Paralabrax clathratus* that foraged close to sand after dark.

Heteromysis sp.

This is a robust, cryptic species that apparently is undescribed (Donald B. Cadien, Los Angeles County Sanitation District, pers. comm., January 1990). Although never abundant, we collected specimens of 3 to 7 mm from rock substrata, including crevices and caves, at Isthmus Reef and West End (maximum density 27/0.25 m^2 at Isthmus Reef). It was an infrequent prey of the fishes examined, however, with just a single individual in each of four fish—three *Paralabrax clathratus* and one *Brachyistius frenatus*. Those taken by predators tended to be larger than those collected in the environment, with individuals of up to 12 mm occurring among gut contents. There was no evidence that this mysid enters the water column at night.

Holmesimysis costata

The species considered at the time of our work to be *Acanthomysis sculpta* (e. g., Clutter 1967, Smith and Carlton 1975, Hobson and Chess 1976, Coyer 1979) is now recognized as *Holmesimysis costata* (Holmquist 1979). This was the predominant mysid observed and collected in the *Macrocystis* canopy, where it aggregated in small openings among the kelp fronds during the day (Hobson and Chess 1976; Coyer 1984, as *A. sculpta*). It feeds on plant materials, including *Macrocystis*, as well as on planktonic crustaceans, particularly copepods. No differences were detected in feeding between day and night. Specimens collected 30 min before sunrise had essentially the same stomach contents as specimens collected during mid afternoon: about 85% full, with a plant/animal ratio of about 70/30 (Hobson and Chess 1976). Perhaps related to the prominence of plant material in their diets, most remained close to the kelp at night, although some moved into adjacent open regions (Hobson and Chess 1976). Our largest specimen was 13 mm.

During the day, *H. costata* occurred among the gut contents of just *Paralabrax clathratus*, but not as a ranked prey. Probably this was because it concentrated in the *Macrocystis* canopy, and *P. clathratus* was mainly near the sea floor. At night, however, it was an important prey of many nocturnal planktivores. It was consumed by species that also took *Siriella pacifica*, but in different proportions based on differences in distribution (Hobson and Chess 1976). *H. costata* tended to stay close to *Macrocystis* and was taken mainly by *Sebastes atrovirens*, which foraged primarily in mid water close to kelp stipes and the kelp canopy. Because *S. pacifica* ranged away from the kelp forest at night, it was little threatened by *S. atrovirens*, but was the major prey of *Xenistius californiensis*, which foraged high in the water column above open expanses of turf (and did not take any *H. costata*). The other nocturnal planktivores sampled—large juvenile *Sebastes serranoides, Seriphus politus* and *Hyperprosopon argenteum*—foraged along the outside edge of *Macrocystis* forests, but more over the open areas seaward, and while these consumed both *H. costata* and *S. pacifica*, they took far more of the latter.

Cumaceans

Family Bodotriidae

Cyclaspis nubila (Fig. 20A).

As is typical of cumaceans, this species, described from southern California by Zimmer (1936), occurred only in sediments; thus, virtually all specimens collected by us during these assessments (Table 3) came from Fisherman's Cove (maximum density: 148/0.25 m^2). It also occurred in sand patches from reef sites and was a major component of the open-sand community in Ripper's Cove (Hobson and Chess 1986). Our specimens from the environ-

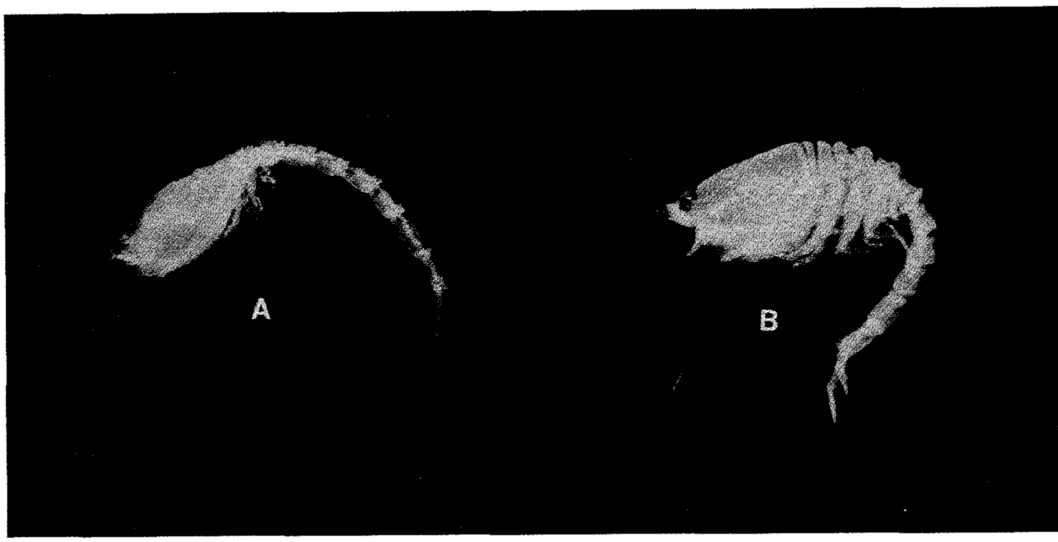

Figure 20. Cumaceans from Santa Catalina. A. *Cyclaspis nubila*; B. *Cumella* sp.

ment were of 2 to 5 mm. Although strictly benthonic by day, *C. nubila* is numerous in the water column at night (Hobson and Chess 1976).

C. nubila was only a minor prey of the diurnal fishes: one or two of 2 to 6 mm occurred among the gut contents of one *Brachyistius frenatus,* one *Embiotoca jacksoni*, two *Semicossyphus pulcher,* and five *Coryphopterus nicholsii.* It was far more important as food of fishes at night, as it occurred in all nocturnal planktivores sampled; thus, individuals of 2 to 6 mm were ranked prey of subadult *Sebastes serranoides, Xenistius californiensis* and *Hyperprosopon argenteum* and unranked prey of *Sebastes atrovirens* and *Seriphus politus* (Hobson and Chess 1976). They were also prey of those *Paralabrax clathratus* that foraged close above sand at night, and of the nocturnally benthivorous *Chilara taylori* (Hobson and Chess 1986).

Family Nannastacidae

Cumella sp. (Fig. 20B).

Probably there was more than one species of *Cumella* at Santa Catalina (Robert Given, Catalina Marine Science Center, pers. comm.), but we were unable to determine this. Most of our specimens were of 1 to 2 mm, but some were up to 3 mm. They occurred at all four major study sites, where they were most abundant on rock substrata (Table 3; maximum density: 415/0.25 m^2 at Isthmus Reef). This is unusual for cumaceans, which generally are considered to be inhabitants of sediment (e. g., Gladfelter 1975). Although *Cumella* sp. occurred on sediment only in relatively low numbers, a congener, *C. vulgaris* reportedly occurs only on sand (Weiser 1956). Despite being strictly benthonic by day, *Cumella* was even more abundant than *Cyclaspis nubila* in the water column at night (Hobson and Chess 1976).

Although apparently more widely abundant than *Cyclaspis nubila*, *Cumella* sp. was no more important as prey of the diurnal fishes: there were one or two of 1 to 3 mm in two *Embiotoca jacksoni,* one *Hypsypops rubicundus,* one *Halichoeres semicinctus* and seven *Cory-*

phopterus nicholsii. Furthermore, even though *Cumella* sp. was more abundant than *C. nubila* in the water column at night, it was not, like *C. nubila*, an important prey of the nocturnal planktivores. We found it among the gut contents of just two species—subadult *Sebastes serranoides* and *Hyperprosopon argenteum*, which were the smallest of the nocturnal planktivores regularly sampled.

Tanaids

Family Apseudidae

Parapseudes latifrons (Fig. 21A).

This species (identity based on Lang 1966, as *P. pedispinnis*) was represented by specimens of 0.5 to 5.0 mm in most of our airlift collections from rocks at Isthmus Reef, West End and Eagle Rock (Table 4; maximum density: 66/0.25 m^2 at West End), but was not collected elsewhere. Although not a ranked prey of the fishes examined, it occurred in the gut contents of three *Embiotoca jackson*, two *Halichoeres semicinctus*, and one *Semicossyphus pulcher.* Individuals taken as prey, being 1.2 to 5.3 mm long, tended to be larger than those in our samples from the environment.

Synapseudes intumescens (Fig. 21B).

Represented by specimens of 0.5 to 2.5 mm, this species (identity based on Menzies 1953) was the smallest of the tanaids in our collections. All samples from the environment came from rocks at Isthmus Reef and West End (Table 4; maximum density 37/0.25 m^2 at West End), and occurrences in fishes were limited to three 2-mm individuals in two *Embiotoca jacksoni*, one from each of these two sites.

Family Tanaidae

Anatanais normani (Fig. 21C).

Although sparse, *A. normani* (identity based on Miller 1968) occurred widely on rock and sediment, particularly where there was also an overgrowth of algae. We collected specimens of 2 to 5 mm at West End and at the two leeward sites (Table 4; maximum densities: 12/0.25 m^2 of sediment-algae substrate in Fisherman's Cove and 34/0.25 m^2 of rock-algae substrate at West End). The species was not found among the gut contents of fishes.

Family Paratanaidae

Leptochelia dubia (Fig. 21D).

This species has been reported as abundant and widespread in tropical and temperate marine habitats world-wide (Lee and Miller 1980). Consistent with an ability to adapt to a wide range of benthic habitats, representatives of 1 to 5 mm (identity based on Miller 1968) were numerous in our collections from a variety of Santa Catalina substrata (Table 4). Many came from sediment overgrown by algae (maximum density 410/0.25 m^2 in Fisherman's Cove) and occasionally they were abundant in collections from turf and rock (maximum densities 78/100 g *Cystoseira neglecta* and 268/0.25 m^2 rock, both from Isthmus Reef). Al-

Table 4. Tanaids and isopods in the environment.

TAXA	ISTHMUS REEF						FISHERMAN'S COVE						WEST END						EAGLE ROCK					
	Turf			Rock/Sedim't			Turf			Sediment			Turf			Rock			Turf			Rock		
	n=10			n=8			n=14			n=6			n=21			n=6			n=15			n=6		
	%	x̄no	SE	%	x̄no	SE	%	x̄no	SE	%	x̄no	SE	%	x̄no	SE	%	x̄no	SE	%	x̄no	SE	%	x̄no	SE
TANAIDS																								
Apseudidae																								
Parapseudes latifrons	0	0	0	25	13	9	0	0	0	0	0	0	0	0	0	83	22	11	0	0	0	50	3	2
Synapseudes intumescens	0	0	0	25	1	1	0	0	0	0	0	0	0	0	0	83	11	6	0	0	0	0	0	0
unidentified apseudids	0	0	0	50	2	1	0	0	0	5	<1	0	4	<1	<1	17	<1	<1	0	0	0	17	1	1
Tanaidae																								
Anatanais normani	0	0	0	13	<1	<1	21	1	0	50	3	0	10	1	<1	67	10	4	0	0	0	0	0	0
Paratanaidae																								
Leptochelia dubia	20	8	0	100	46	0	14	<1	0	83	77	0	24	1	<1	83	20	8	13	1	0	67	4	0
Others (identified)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	<1	<1	0	0	0	17	<1	<1
Undetermined	10	1	0	0	0	0	36	2	0	33	1	0	0	0	0	0	0	0	7	<1	<1	17	<1	<1
ISOPODS																								
Gnathiidae																								
juveniles & females	10	<1	<1	100	18	11	7	<1	<1	17	<1	<1	5	<1	<1	83	4	2	7	<1	<1	33	3	2
Idoteidae																								
Idotea resecata	0	0	0	0	0	0	7	<1	<1	0	0	0	24	<1	<1	33	<1	<1	33	1	1	17	<1	<1
Anthuridae																								
Cyathura munda	0	0	0	0	0	0	0	0	0	17	<1	<1	5	<1	<1	17	<1	<1	0	0	0	50	6	5
Mesanthura occidentalis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	83	2	1
Aegidae																								
Rocinela belliceps	0	0	0	0	0	0	7	<1	<1	83	2	1	0	0	0	0	0	0	0	0	0	0	0	0
Cirolanidae																								
Cirolana diminuta	0	0	0	13	<1	<1	0	0	0	0	0	0	29	<1	<1	100	12	6	20	1	<1	33	4	3
Sphaeromatidae																								
Dynamenella sp.	0	0	0	0	0	0	0	0	0	0	0	0	52	28	14	83	25	9	33	34	21	50	10	5
Exosphaeroma rhomburum	0	0	0	0	0	0	0	0	0	67	9	6	0	0	0	0	0	0	0	0	0	0	0	0
Paracerceis cordata	60	20	15	50	5	3	100	28	10	0	0	0	86	49	22	100	117	85	93	35	11	100	51	32
Jaeropsidae																								
Jaeropsis dubia	30	3	2	100	47	37	50	2	1	50	1	1	95	75	31	100	162	34	47	7	5	83	40	18
Janiridae																								
Ianiropsis sp.	40	5	3	50	28	27	43	1	1	17	<1	<1	62	58	20	100	159	54	47	4	2	67	105	77
Munnidae																								
Munna spp.	20	1	1	50	169	71	79	11	3	33	1	1	29	3	2	83	13	6	20	6	4	67	38	30
Others (identified)	10	<1	<1	67	8	7	57	1	1	83	4	3	100	6	5	100	4	4	73	5	4	33	4	3
Undetermined	0	0	0	13	<1	<1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

though strictly benthonic by day, some *L. dubia* enter the water column at night (Hobson and Chess 1976, 1986).

During the day, *L. dubia* was a ranked prey of *Medialuna californiensis* and *Embiotoca jacksoni* and an unranked prey of *Orthonopias triacis, Paralabrax clathratus, Brachyistius frenatus, Hypsypops rubicundus, Halichoeres semicinctus, Oxyjulis californica, Semicossyphus pulcher, Coryphopterus nicholsii, Lythrypnus dalli* and *L. zebra*. At night, some were prey of nocturnal benthivores, including *Cymatogaster aggregata* and *Umbrina roncador,* and some were prey of nocturnal planktivores, including subadult *Sebastes serranoides, Xenistius californiensis* and *Hyperprosopon argenteum* (Hobson and Chess 1976, 1986).

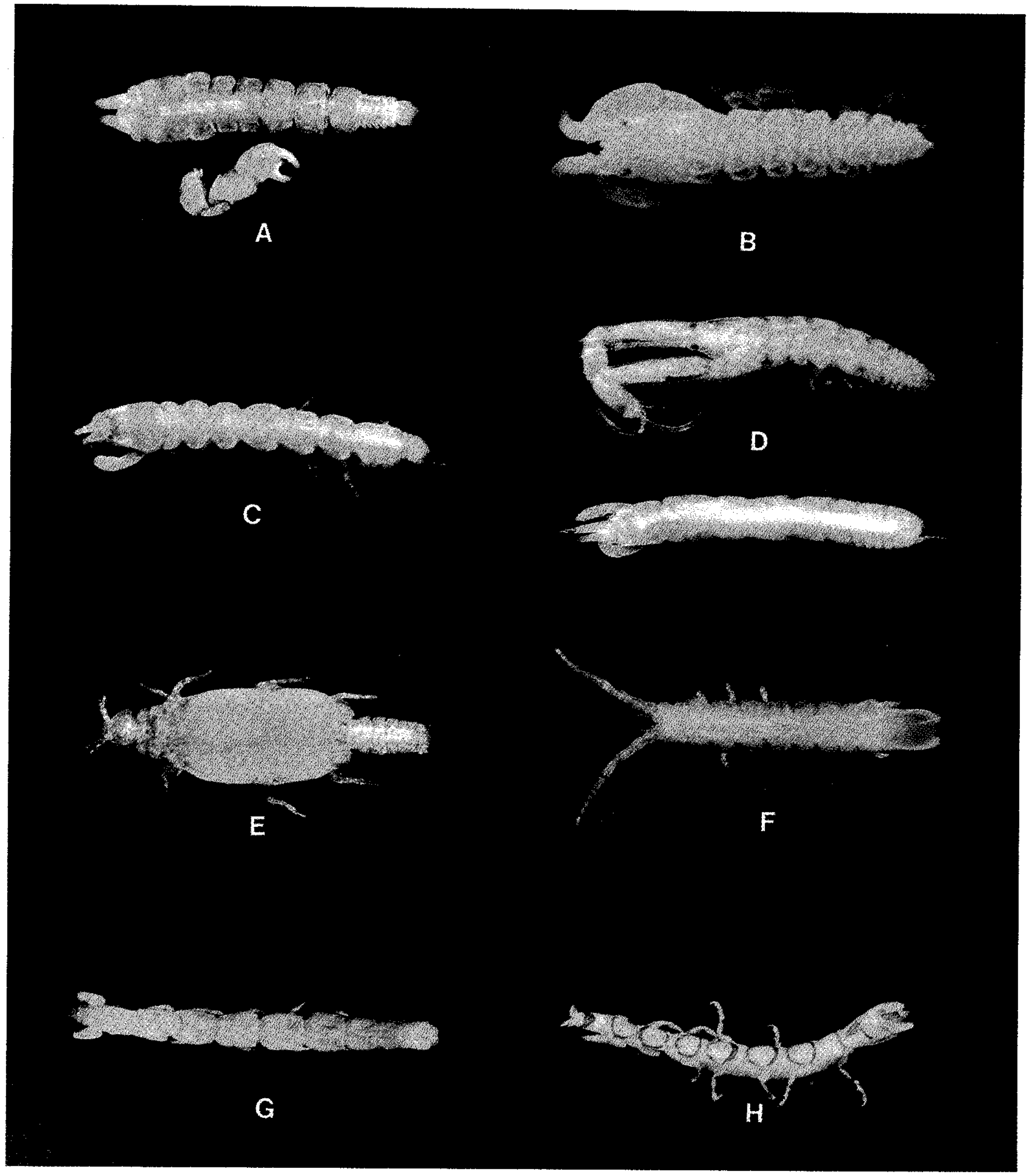

Figure 21. Tanaids and isopods from Santa Catalina. Tanaids: A. *Parapseudes latifrons; B. Synapseudes intumescens*; C. *Anatanais normani*; D. *Leptochelia dubia* (top) male, (bottom) female. Isopods: E. gnathiid female; F. *Idotea resecata*; G. *Cyathura munda*; H. *Mesanthura occidentalis*.

Isopods

Family Gnathiidae

Gnathiid spp. (Fig. 21E).

We were unable to distinguish species of gnathiids at Santa Catalina. The vast majority of our specimens (in collections from the environment, as well as gut contents of fishes) were females and juveniles (Table 4), and these are particularly difficult to identify to species (Menzies and Barnard 1959). Furthermore, we found females readily distinguishable from juveniles only when ovigerous and so their occurrences are combined in Table 4. Our specimens were 0.7 to 4.0 mm long (most 1 to 2 mm) and occurred at all sites, being most abundant in samples from rocks (maximum density 70/0.25 m^2 at Isthmus Reef). In addition to these benthic occurrences, juveniles were common ectoparasites on the fishes (Hobson 1971) and also were free in the water column, particularly at night (Hobson and Chess 1976).

The major predator on juvenile/female gnathiids was *Oxyjulis californica*, which probably relates to juveniles being ectoparasites on fishes, and *O. californica* being the major cleaner fish in California waters (Hobson 1971). The only other fish species that consumed these isopods as ranked prey during the day was *Lythrypnus zebra,* which occurs in crevices on the rock substrata inhabited by these isopods. Taking gnathiids as unranked prey were *Orthonopias triacis, Oxylebius pictus, Paralabrax clathratus, Brachyistius frenatus, Halichoeres semicinctus, Semicossyphus pulcher, Alloclinus holderi, Gibbonsia elegans* and *Lythrypnus dalli.* That juvenile/female gnathiids become abundant in the water column at night was evident in the numbers of them taken by nocturnal planktivores. They were ranked prey of *Sebastes atrovirens*, subadult *Sebastes serranoides*, *Xenistius californiensis* and *Hyperprosopon argenteum*, and unranked prey of *Cymatogaster aggregata* and *Seriphus politus* (Hobson and Chess 1976). Other than when eaten by cleaners, therefore, it would appear that juvenile/female gnathiids are most threatened by fish predators when among the plankton at night.

Adult males were very different in form and distribution from the juveniles and females and therefore are not included in Table 11. Our specimens were 1 to 4 mm long (most were 2 to 3 mm) and collected infrequently. They occurred in just three of our regular collections, each from rock substrata at Isthmus Reef (1 to 14 individuals); however, an unscheduled airlift collection from beneath a rock ledge at Isthmus Reef yielded 52 individuals. These data suggest that the males were underrepresented in our collections because of secretive habits. Furthermore, the infrequency of their occurrences in gut contents suggests they were as unavailable to the fishes as apparently they were to our standard sampling procedures. In contrast to the many fishes of various species that had taken the juveniles and females, only three fish—two *Lythrypnus dalli* and one *Alloclinus holderi*—had taken adult males.

Family Idoteidae

Idotea resecata (Fig. 21F).

Probably because it is relatively large and readily recognized, *I. resecata* has been the isopod most frequently identified in accounts of southern Californian kelp communities (e. g. Limbaugh 1955, Quast 1968). Individuals of up to 39 mm have been reported common on near-shore vegetation throughout California (Lee and Miller 1980) and the species has been collected in the water column at night (Menzies 1950). Despite reports of its abundance and large size, we collected relatively few individuals and the largest was only 17 mm (Table 4). Most of our specimens came from turf rhodophytes at West End and Eagle Rock (maximum densities: 12/100 g *Plocamium cartilagineum* from Eagle Rock). There was never more than one in our collections from rock substrata.

Perhaps our collections would have included more had we regularly sampled *Macrocystis*, as it has been suggested that *I. resecata* has an affinity to this particular alga (Coyer

1979). In fact, one study concluded that if its numbers were not controlled by heavy predation from the labrid *Oxyjulis californica*, it would destroy the *Macrocystis* canopies (Berstein and Jung 1979). The strength of this affinity is questioned, however, by the abundance of *I. resecata* on other forms of vegetation elsewhere in California where *Macrocystis* is sparse or absent (Menzies 1950).

During the day, *I. resecata* was a ranked prey of *Halichoeres semicinctus* and *Gibbonsia elegans*, and an unranked prey of *Sebastes atrovirens*, *Brachyistius frenatus*, *Embiotoca jacksoni* and *Oxyjulis californica*. Its diurnal occurrence in *S. atrovirens*, a nocturnal planktivore, consisted of one 34-mm individual in a fish that had been at rest on Isthmus Reef during mid afternoon. All other *I. resecata* found in fishes during the day were 4 to 18 mm long. At night, *I. resecata* was a ranked prey of *S. atrovirens* and *Hyperprosopon argenteum*, which are nocturnal planktivores that presumably had fed on individuals that entered the nocturnal water column (Hobson and Chess 1976, 1986). One was found in a *Paralabrax clathratus* that had been collected over an algal turf on sand in Fisherman's Cove during the hour before dawn, which agrees with reports that this fish sometimes feeds on or close above sand at night (Hobson et al. 1981). *I. resecata* taken at night were 6 to 33 mm long.

Family Anthuridae

Cyathura munda (Fig. 21G).

An infrequently collected species, *C. munda* qualified for listing here on the basis of a single airlift collection on rock substrata at Eagle Rock that took 28 individuals. Otherwise there were just 1 to 3 of them in a few collections from turf and rock at Eagle Rock, West End and Isthmus Reef (Table 4). Our specimens (identity based on Menzies 1951) were 3 to 9 mm long. We did not find this isopod among the gut contents of fishes.

Mesanthura occidentalis (Fig. 21H).

Another infrequently sampled anthurid (identity based on Menzies and Barnard 1959), this species was collected only at Eagle Rock (Table 4); nevertheless, the consistency of its occurrence in low numbers on rock substrata there (maximum density: 8/0.25 m^2) suggests an affinity to some microhabitat at that site. Consistent with what would appear to be a highly limited distribution, this isopod was not found among the gut contents of fishes.

Family Aegidae

Rocinela belliceps (Fig. 22A).

This isopod was taken from the environment only in samples of sediment from Fisherman's Cove, where individuals of 3 to 9 mm (identity based on Schultz 1969) were consistently present but never abundant (Table 4; maximum density: 6/0.25 m^2). In agreement with this, the species was found among gut contents only of fishes that had been foraging in Fisherman's Cove. Individuals of 3 to 12 mm were unranked prey of *Halichoeres semicinctus* and *Semicossyphus pulcher*, which are diurnal feeders. However, this finding is misleading—at least for *S. pulcher*—because *R. belliceps* lives in sediment and the prey rankings are biased by the larger number of fishes sampled from reefs. In fact, 6 of the 12 *S.*

pulcher collected in Fisherman's Cove had taken 1 to 6 individuals of this isopod. (There was no evidence that *H. semicinctus* in Fisherman's Cove similarly preyed heavily on this isopod.) Those taken as prey were 5 to 12 mm long.

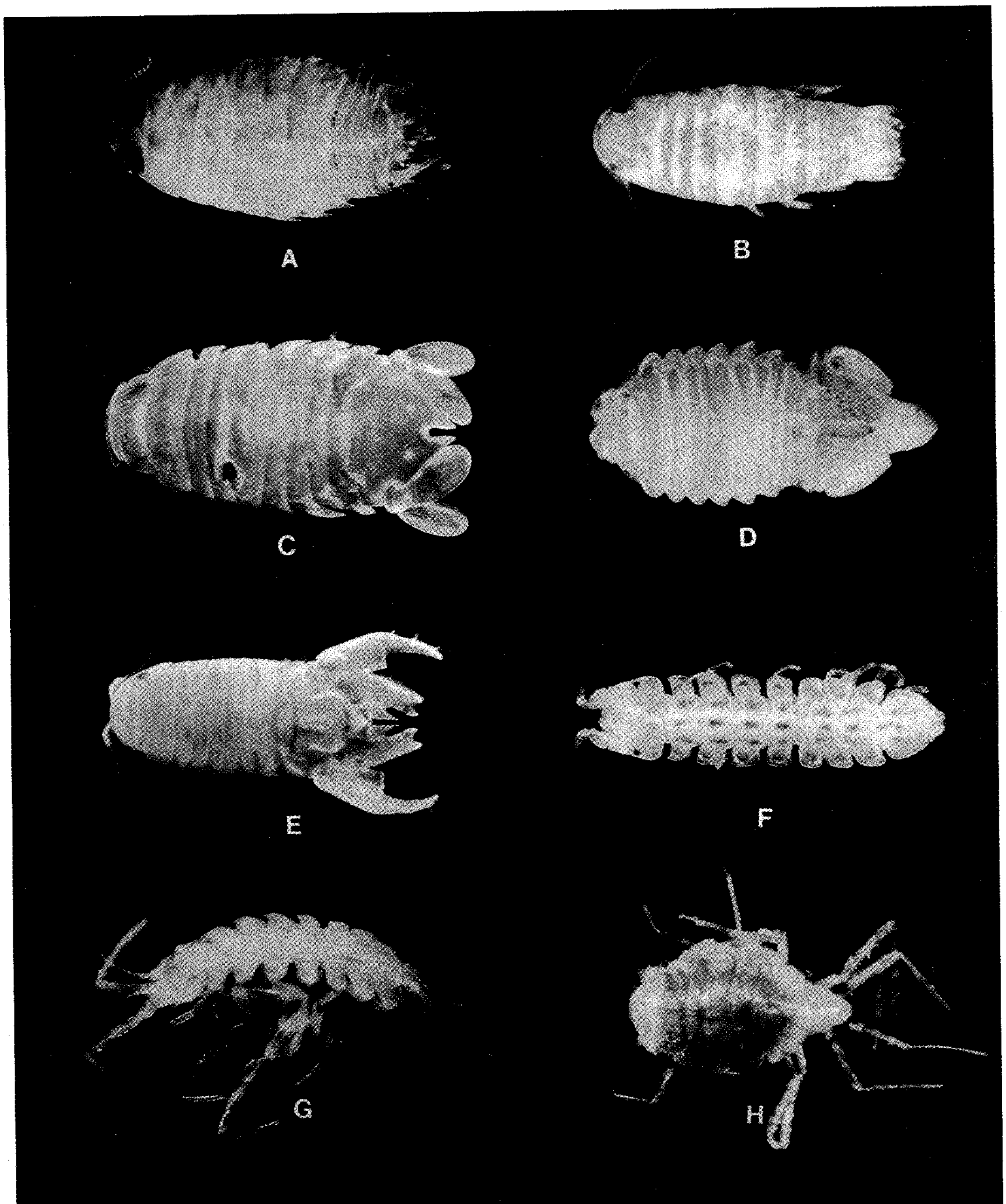

Figure 22. Isopods from Santa Catalina (continued). A. *Rocinela belliceps*; B. *Cirolana diminuta*; C. *Dynamenella* sp.; D. *Exosphaeroma rhomburum*; E. *Paracerceis cordata*; F. *Jaeropsis dubia*; G. *Ianiropsis* sp.; H. *Munna* sp.

Family Cirolanidae

Cirolana diminuta (Fig. 22B).

An inhabitant of turf and rocks, this species was most numerous at the two windward sites (Table 4; maximum densities: 5/100 g *Plocamium cartilagineum* and 42/0.25 m^2 of rock, both from West End). Those in our collections (identity based on Menzies 1962) were 1.5 to 7 mm long. *C. diminuta* has a predilection for crevices and interstices—but only during the day, as many individuals enter the water column at night.

Perhaps because of its secretive habits during the day, *C. diminuta* was only infrequently taken by diurnal benthivores. There were one or two among the gut contents of five *Embiotoca jacksoni* (which were enough to qualify the species as a ranked prey of that fish), but otherwise there was just one in a *Orthonopias triacis* and another in a *Semicossyphus pulcher.* Those taken as prey during the day were 2 to 8 mm. Clearly it was more vulnerable at night, especially when it entered the water column. Individuals of 3 to 7 mm were prey of *Sebastes atrovirens*, *S. serranoides*, *Xenistius californiensis* and *Hyperprosopon argenteum*, which are nocturnal planktivores, and of *Umbrina roncador*, a nocturnal benthivore (Hobson and Chess 1976, 1986).

C. diminuta has been reported to attack fishes confined in traps at night, inflicting not only external damage to body and gills, but also internal injury after entering the body cavity through the anus (Stepien and Brusca 1985). It is said to be attracted to chemicals released by injured fishes and thus drawn to fishes initially injured by the ostracod *Vargula tsujii* (see above).

Family Sphaeromatidae

Dynamenella sp. (Fig. 22C).

This was one of the more numerous isopods in collections from both turf and rock at West End and Eagle Rock (maximum densities: 312/100 g *Gelidium* robustum from West End and 60/0.25 m^2 rock at Eagle Rock), but it was not collected from the environment at Fisherman's Cove or Isthmus Reef (Table 4). Although six species of *Dynamenella* have been reported from California, all our specimens—which were 1 to 6 mm long—appear to be *D. glabra* (as defined by Schultz 1969).

The distribution of *Dynamenella* sp. in samples of the environment was reflected in its occurrences among gut contents of the fishes. It was a ranked prey of *Embiotoca jacksoni* and *Gibbonsia elegans* based entirely on specimens collected at the two windward sites. It also occurred there as unranked prey in *Oxylebius pictus*, *Girella nigricans*, *Brachyistius frenatus*, *Halichoeres semicinctus*, *Oxyjulis californica*, and *Semicossyphus pulcher.* Those taken as prey were 1 to 5 mm.

Exosphaeroma rhomburum (Fig. 22D).

This species was collected with sediments from Fisherman's Cove (maximum density 37/0.25 m^2), but was not taken at the other three sites (Table 4). It inhabits sediments and was a major species in the sand at Ripper's Cove, where its mean density was reported to be 11.8/0.25 m^2 (Hobson and Chess 1986). Our specimens (identity based on Schultz 1969) were 1 to 4 mm long. Although strictly benthic by day, some enter the lower levels of the water column at night (Hobson and Chess 1976, 1986).

E. rhomburum occurred among the gut contents of just two fish that had been feeding by day—an *Embiotoca jacksoni* from West End, which contained three (presumably from an unsampled sand patch), and a *Coryphopterus nicholsii* from Fisherman's Cove, which had taken one. These prey were 2 to 3 mm long. The infrequency of *E. rhomburum* as prey of diurnal fishes agrees with its absence from the diets of fishes studied earlier that had been feeding during the day in Ripper's Cove (Hobson and Chess 1986). The situation changes at nightfall, however, when *E. rhomburum* becomes prey of a variety of fishes. In Fisherman's Cove it was consumed by the planktivorous *Hyperprosopon argenteum* as well as by the benthivorous *Pleuronichthys coenosus*, thus indicating threats both on the substrate and in the water column. Similarly, in Ripper's Cove it was prey of *H. argenteum* and also of *Paralabrax clathratus* (subadult) and *Cymatogaster aggregata*, which feed at the base of the water column at night (Hobson and Chess 1986). Those taken after dark were of 1 to 5 mm. These findings suggest that *E. rhomburum* rests hidden in the sediment by day and moves actively about close above and on the sediment at night.

Paracerceis cordata (Fig. 22E).

Probably the most ubiquitous and widespread isopod in our samples (Table 4), *P. cordata* has been reported from coralline algae and kelp holdfasts along exposed shores, and from sand and mud in Bays (Lee and Miller 1980). It was the most abundant isopod in diurnal collections of *Macrocystis* (Coyer 1979) and in nocturnal collections of plankton (Hobson and Chess 1976). We found individuals 0.5 to 8.0 mm long (identity based on Schultz 1969) widespread and abundant on turf (maximum density: 282/100 g *Dictyopteris undulata* from Fisherman Cove) and rocks (maximum density: 430/0.25 m^2 at West End), but found none in sediment.

P. cordata was similarly abundant in the gut contents of fishes. It was the top-ranked isopod in the diets of all species that had consumed it during the day: *Girella nigricans*, *Brachyistius frenatus*, *Embiotoca jacksoni*, *Halichoeres semicinctus*, *Alloclinus holderi* and *Gibbonsia elegans*, which took it as a ranked prey, and *Oxylebius pictus*, *Paralabrax clathratus* and *Semicossyphus pulcher*, which took it as an unranked prey. These are fishes that had been feeding on algal or rock substrata when collected, and they had consumed *P. cordata* of 1 to 15 mm. At night, as reported earlier (Hobson and Chess 1976), *P. cordata* was the top-ranked isopod in the diet of *Sebastes atrovirens*, subadult *S. serranoides*, *Seriphus politus*, *Hyperprosopon argenteum* and *Brachyistius frenatus*, and the second-ranked isopod taken by *Xenistius californiensis*. These are fishes that had been feeding in the water column at night, and they had consumed *P. cordata* of 1 to 11 mm as ranked prey.

Family Jaeropsidae

Jaeropsis dubia (Fig. 22F).

One of the more widespread and abundant isopods on turf and rock substrata at Santa Catalina, *J. dubia* has been reported from algae in Californian coastal waters (Menzies and Barnard 1959). We found it prominent at all four primary sites, but most abundantly on turf rhodophytes and rock/algae substrata at West End (Table 4; maximum densities: 340/100 g *Plocamium cartilagineum* and 240/0.25 m^2 rock/algae). Our specimens from the environment (identity based on Menzies 1951) were of 0.5 to 4.0 mm.

Despite its widespread abundance in the environment, just one fish species—*Embiotoca jacksoni*—took *J. dubia* as a ranked prey. Taking it as unranked prey, however, was an assortment of species: *Oxylebius pictus, Orthonopias triacis, Paralabrax clathratus, Brachyistius frenatus, Hypsypops rubicundus, Alloclinus holderi, Coryphopterus nicholsii* and *Lythrypnus zebra*. Individuals consumed by fishes were 2 to 4 mm long.

Family Janiridae

Ianiropsis sp. (Fig. 22G).

Individuals referable to the genus *Ianiropsis* (based on Menzies 1952) were among the most abundant and widespread isopods at Santa Catalina, but from available information we were unable to distinguish with confidence more than one species (Table 4). In fact, many of our specimens failed to match the descriptions of any known species. Some or all may be *I. epilittoralis*, which Coyer (1979) identified as the most abundant species of *Ianiropsis* on *Macrocystis*, but we remain unconvinced of this. If, as reported by Menzies (1952), there are seven species of this genus off northern California (according to R. Brusca, pers. comm., February 1992, there are eight), probably there is more than one at Santa Catalina. Pending resolution of the problem, however, we consider our specimens, which were 0.5 to 4.5 mm in length, to be representatives of one species.

Ianiropsis sp. was most numerous at the two windward stations, occurring on both turf rhodophytes and rocks (maximum densities: 360/100 g *Pterocladia capillacea* and 480/0.25 m^2 of rock at Eagle Rock). The form was less numerous on turf phaeophytes at the two leeward sites (maximum density 34/100 g Cystoseira neglecta), but was prominent and occasionally abundant on rock substrata there (maximum density: 221/0.25 m^2 of rock at Isthmus Reef).

This isopod was a frequent food of fishes at all stations, with individuals among gut contents being of 1 to 5 mm.. It was a ranked prey of *Orthonopias triacis*, *Oxylebius pictus*, *Embiotoca jacksoni*, *Alloclinus holderi*, *Gibbonsia elegans* and *Lythrypnus zebra* and an unranked prey of *Paralabrax clathratus*, *Brachyistius frenatus*, *Hypsypops rubicundus*, *Oxyjulis californica*, *Semicossyphus pulcher*, and *Lythrypnus dalli*.

Family Munnidae

Munna spp. (Fig. 22H).

There appeared to be more than one species of *Munna* in our collections (based on Schultz 1969), but only *M. ubiquita* was recognized among our specimens. There have been five species of *Munna* described from California, and there are some undescribed species there as well (R. Brusca, pers. comm., February 1992). Individuals referable this genus were widespread and abundant at all four sites, where they occurred on rock, turf and sediment under turf (Table 4; maximum densities: 444/0.25 m^2 rock at Isthmus Reef, 60/100g *Plocamium cartilagineum* at Eagle Rock and 6/0.25 m^2 sediment in Fisherman's Cove). They were 0.5 to 3.0 mm long, with most 1.0 mm or less.

Considering the widespread abundance of *Munna* spp. in the environment, relatively few had been consumed by the fishes. They were ranked prey of *Orthonopias triacis* and *Lythrypnus zebra*—two of the smallest species—and an unranked prey of *Oxylebius pictus*, *Brachyistius frenatus*, *Embiotoca jacksoni*, *Hypsypops rubicundus*, *Halichoeres semicinctus*, *Oxyjulis californica*, *Alloclinus holderi* and *Coryphopterus nicholsii*. That they were not taken by *Lythrypnus dalli*, one of the smallest predators, may relate to that species being mainly planktivorous. The size range of specimens from gut contents matched the size range of specimens from the environment—0.5 to 3 mm—but whereas most from the environment were at the lower end of that range, most in the gut contents were at the upper end.

Gammaridean Amphipods

Family Bateidae

Batea transversa (Fig. 23A)

This was one of the most abundant amphipods at the two leeward sites (Table 5), where (with identities based on Barnard 1962) we collected individuals up to 6 mm long in turf phaeophytes and on rock (maximum density: 482/100 g *Desmarestia viridis* at Fisherman's Cove). It also was among the most numerous gammarids collected by Coyer (1984) in lower regions of *Macrocystis*. Although strictly benthonic by day, many individuals rise into the water column at night (Hobson and Chess 1976, Hammer and Zimmerman 1979).

B. transversa was among the gammarideans most often eaten by fishes. During the day it was a ranked prey of *Oxylebius pictus*, *Paralabrax clathratus*, *Girella nigricans*, *Embiotoca jacksoni* and *Halichoeres semicinctus* and an unranked prey of *Orthonopias triacis*, *Brachyistius frenatus*, *Semicossyphus pulcher* and *Gibbonsia elegans*. Among those individuals that entered the water column at night were major prey of *Sebastes atrovirens*, *S. serranoides*, *Seriphus politus*, *Hyperprosopon argenteum* and *Xenistius californiensis* (Hobson and Chess 1976,1986, Hobson et al. 1981).

Family Eusiridae

Eusiroides monoculoides (Fig. 23B).

Our specimens of *E. monoculoides* (identity based on Barnard 1964) were up to 11 mm, with most from rocks at the windward sites (Table 5; maximum density: 70/0.25 m^2 of rock at West End). Turf occurrences were so infrequent they may have been incidental. That *E. monoculoides* favored rocks at the colder windward sites seems inconsistent with Barnard's (1969a) characterization of the species as a tropical form with its northern range limit in southern California.

This gammaridean was not among gut contents of fishes from Fishermen's Cove, perhaps because required rock substrata were lacking there, but it was food of fishes at the three reef sites. *Embiotoca jacksoni* took it as a ranked prey, and it was an unranked prey of *Oxylebius pictus*, *Paralabrax clathratus*, *Rhacochilus toxotes*, *Oxyjulis californica*, *Semicossyphus pulcher* and *Gibbonsia elegans*.

Table 5. Gammaridean amphipods in the environment.

TAXA	ISTHMUS REEF						FISHERMAN'S COVE						WEST END						EAGLE ROCK					
	Turf			Rock/Sedim't			Turf			Sediment			Turf			Rock			Turf			Rock		
	n=10			n=8			n=14			n=6			n=21			n=6			n=15			n=6		
	%	x̄no	SE	%	x̄no	SE	%	x̄no	SE	%	x̄no	SE	%	x̄no	SE	%	x̄no	SE	%	x̄no	SE	%	x̄no	SE
Bateidae																								
Batea transversa	80	66	28	100	39	14	93	119	42	50	12	9	0	0	0	0	0	0	13	<1	<1	50	10	6
Eusiridae																								
Eusiroides monoculoides.	0	0	0	63	6	4	7	<1	<1	0	0	0	5	<1	<1	100	29	11	7	<1	<1	100	8	3
Pleustidae																								
Parapleustes pugettensis	40	15	6	25	4	3	36	8	4	0	0	0	52	19	7	83	124	45	27	23	21	83	9	7
Pleustes platypa	60	2	1	13	<1	<1	64	3	1	0	0	0	76	20	8	100	20	12	67	2	1	17	<1	<1
Amphilochidae																								
Amphilochus neopolitanus	0	0	0	0	0	0	36	15	8	0	0	0	14	2	2	17	<1	<1	7	1	1	33	3	3
Gitanopsis vilordes	10	41	41	63	9	4	7	10	10	0	0	0	19	4	3	50	25	21	20	3	3	0	0	0
unidentified amphilochids	50	18	11	38	67	34	0	0	0	0	0	0	24	17	10	50	35	27	20	8	8	17	1	1
Stenthoidae																								
Stenothoe estacola	0	0	0	13	4	4	0	0	0	0	0	0	48	42	14	83	65	33	7	2	2	0	0	0
Hyalidae																								
Hyale frequens	60	24	13	0	0	0	86	55	25	17	1	1	100	238	59	100	196	75	73	39	15	67	11	4
Phliantidae																								
Pariphinotus escabrosus	0	0	0	38	1	1	36	3	3	83	5	4	0	0	0	0	0	0	0	0	0	0	0	0
Lysianassidae																								
Ocosingo borlus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	<1	<1	0	0	0	50	3	2
unidentified lysianassids	0	0	0	50	2	2	0	0	0	0	0	0	0	0	0	83	5	2	0	0	0	33	2	1
Iphimediidae																								
Coboldus hedgpethi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	67	5	3	0	0	0	17	2	2
Dexaminidae																								
Polycheria osborni	10	19	19	13	2	2	0	0	0	0	0	0	0	0	0	17	1	1	0	0	0	17	<1	<1
Ampeliscidae																								
Ampelisca lobata	10	1	1	25	1	1	0	0	0	0	0	0	0	0	0	33	1	1	0	0	0	100	4	1
Melitidae																								
Elasmopus antennatus	0	0	0	25	13	11	21	1	1	7	<1	<1	52	10	3	100	134	47	13	3	3	100	18	6
Maera spp.	0	0	0	22	3	3	0	0	0	7	<1	<1	10	<1	<1	67	8	6	7	1	1	67	3	2
Ampithoidae																								
Ampithoe spp.	85	19	10	50	4	4	79	25	11	27	2	1	100	26	8	100	55	29	92	7	4	83	15	11
Isaidae																								
Chevalia inaequalis	20	27	26	63	9	6	7	<1	<1	0	0	0	0	0	0	50	12	8	7	<1	<1	50	14	12
Gammaropsis thompsoni	10	<1	<1	25	3	2	0	0	0	0	0	0	10	<1	<1	67	19	13	0	0	0	33	2	1
Photis spp.	15	79	79	63	71	65	50	7	3	20	2	1	48	11	5	100	64	36	33	42	33	83	378	343
Ischyroceridae																								
Jassa slatteryi	0	0	0	0	0	0	0	0	0	0	0	0	67	76	27	83	82	39	40	36	26	50	16	11
Ischyrocerus litotes	0	0	0	13	<1	<1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aoridae																								
Aoroides spp.	10	5	5	38	3	2	64	23	9	7	1	1	0	0	0	0	0	0	0	0	0	50	3	1
Corophiidae																								
Cerapus tubularis	0	0	0	0	0	0	7	<1	<1	0	0	0	0	0	0	0	0	0	47	6	4	0	0	0
Ericthonius brasiliensis	50	76	48	25	1	1	79	24	17	7	<1	<1	81	42	17	100	102	28	80	12	4	100	46	18
Podoceridae																								
Podocerus brasiliensis	0	0	0	13	2	2	0	0	0	7	<1	<1	5	<1	<1	83	25	14	0	0	0	0	0	0
Podocerus cristatus	50	31	23	62	10	6	71	9	4	17	1	1	48	4	2	50	78	36	27	2	1	100	36	14
Others (identified)	30	4	3	75	4	3	7	<1	<1	83	3	3	29	1	1	33	12	12	0	0	0	50	1	1
Undetermined	70	60	23	100	190	96	100	141	67	67	11	6	95	161	68	100	48	14	80	84	37	83	75	50

Family Pleustidae

Parapleustes pugettensis (Fig. 23C).

This gammaridean was most abundant at the two windward sites, where individuals of up to 8 mm (identity based on Barnard and Given 1960) were collected from turf and rock surfaces (Table 5; maximum densities: 310/100 g *Gelidium robustum* from Eagle Rock and

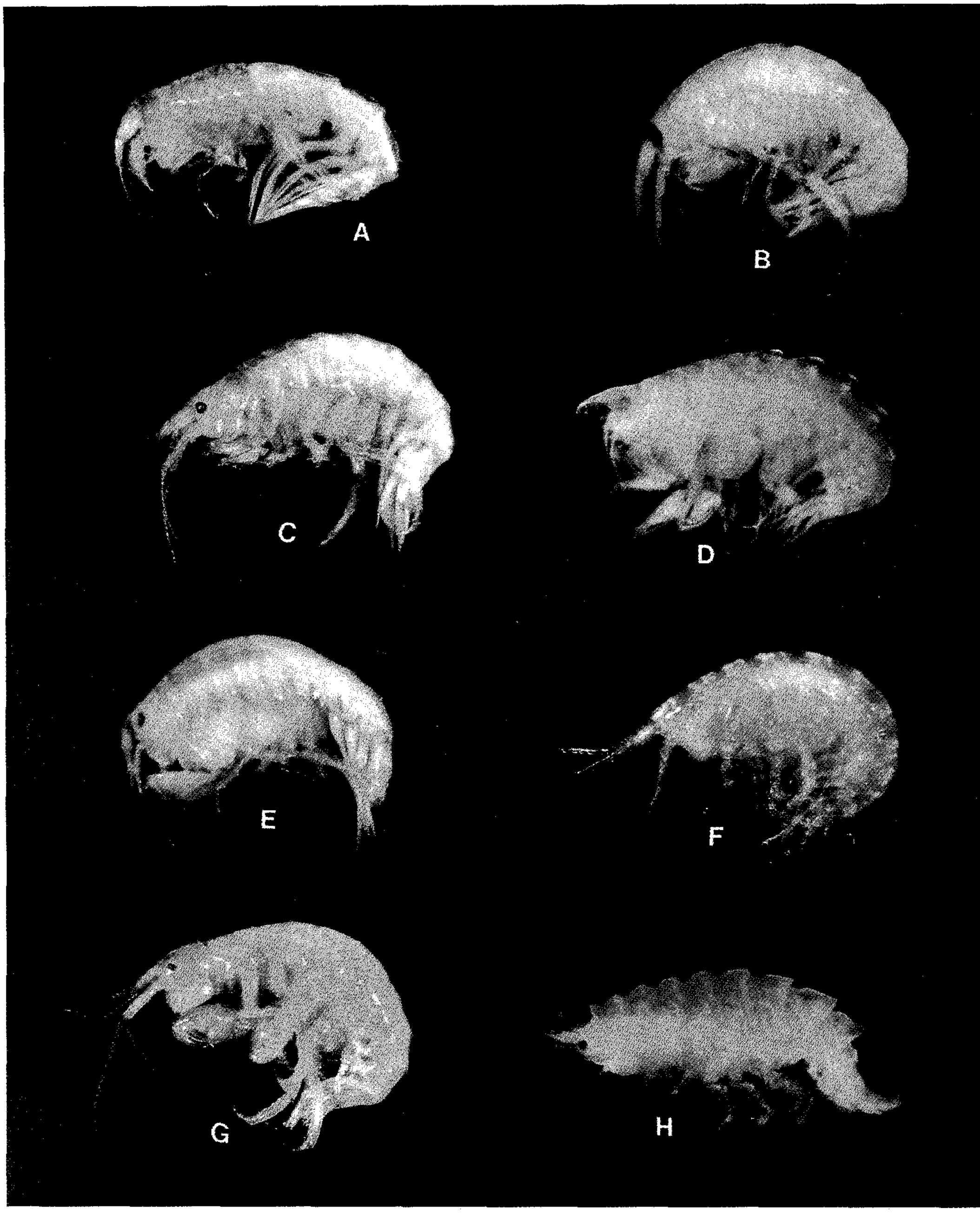

Figure 23. Gammarideans from Santa Catalina. A. *Batea transversa*; B. *Eusiroides monoculoides*; C. *Parapleustes pugettensis*; D. *Pleustes platypa*; E. *Gitanopsis vilordes*; F. *Stenothoe estacola*; G. *Hyale frequens*; H. *Pariphinotus escabrosus*.

310/0.25 m^2 of rock at West End). It also occurred on turf and rocks at the two leeward sites (maximum densities: 52/100 g *Dictyopteris undulata* from Fisherman's Cove and 24/0.25 m^2 of rock surface at Isthmus Reef). According to Barnard and Given (1960), this species concentrates at densities up to 72/m^2 on substrata dominated by the polychaete *Diopatra* sp.

The occurrence of *P. pugettensis* in the gut contents of fishes was consistent with its occurrence in collections from the environment. It was most numerous in the diets of fishes from the windward sites, where it was a ranked prey of *Oxylebius pictus*, *Embiotoca jacksoni*, and *Gibbonsia elegans*, and an unranked prey of *Paralabrax clathratus* and *Alloclinus holderi*. Its only occurrences as prey at the two leeward sites were two individuals in a *Brachyistius frenatus* from Fishermen's Cove.

Pleustes platypa (Fig. 23D).

This species (identity from Barnard and Given 1960) was most numerous in turf rhodophytes and on rock at the two windward sites (Table 5; maximum densities: 158/100 g *Gelidium nudifrons* and 80/0.25 m^2 of rock, both from West End), but it also occurred on turf phaeophytes and rock in leeward communities (maximum densities: 6/100 g of *Dictyopteris undulata* from Fisherman's Cove and 4/0.25 m^2 of rock at Isthmus Reef). It also was among the ten most numerous gammarideans collected by Coyer (1984) from *Macrocystis* in a leeward kelp forest. Our specimens were of up to 9 mm, with most from the daytime benthos, but some from the nighttime plankton (Hobson and Chess 1976).

This species appears to mimic various benthic features. It has been described with the color, shape and posture of the gastropod *Alia carinata* (Crane 1969), and we have seen a white speckled form that strongly resembled small patches of the ascidian *Trididemnum opacum* (Fig. 33). According to Carter and Behrens (1980), the closely related *P. depressa* mimics varied forms of *A. carinata* off central California and we believe *P. platypa* and *P. depressa* are conspecific, or at least taxonomically confused (based on our more recent work in northern California). Furthermore, mimicry has been reported among close relatives, as Field (1974) suggested that the closely related *Stenopleustes* sp. gains protection from predatory fishes by mimicking gastropods.

There is evidence that *P. platypa* enjoys unusual protection from predators during the day, and it may come from its ability to mimic. Despite being numerous and widespread in the benthos, it was only an unranked prey of diurnal benthivores, including *Brachyistius frenatus*, *Embiotoca jacksoni*, *Halichoeres semicinctus* and *Gibbonsia elegans*. In contrast, the relatively few that entered the water column at night were major prey of at least one nocturnal planktivore, *Sebastes atrovirens* (Hobson and Chess 1976). Obviously their ability to mimic benthic organisms would not conceal them in the water column.

Family Amphilochidae

Gitanopsis vilordes (Fig. 23E).

This relatively small species (identity based on Barnard 1962) was more abundant than our collection data indicate. Subadults were difficult to distinguish from subadults of other amphilochids, at least two of which (including *Amphilochus neapolitanus*) co-occurred with *G. vilordes* at Santa Catalina. The problem of identification was increased by the small size and large number of individuals present. Virtually all of our specimens were of 1 to 2 mm, with only a few to 3 mm.

Despite the conservative representation in our data, specimens recognized as *G. vilordes* were numerous on rock and turf at both leeward and windward sites (Table 5; maximum densities: 130/0.25 m^2 of rock surface at West End and 405/100 g *Dictyopteris undulata* from Isthmus Reef). Furthermore, this amphipod ranked second in abundance among gammarideans on *Macrocystis* in the leeward kelp forest studied by Coyer (1984). While strictly benthonic during the day, many individuals enter the water column at night (Hobson and Chess 1976).

Although recognized as abundant in a variety of settings, *G. vilordes* was only infrequently identified among the gut contents of fishes. An earlier report (Hobson and Chess 1976) reported this species a ranked prey of smaller *Brachyistius frenatus* (<100 mm SL), but there were only a few among the gut contents of the larger *B. frenatus* (>100 mm SL) examined here. The only occurrences of this amphipod in gut contents of diurnal predators during the present study were eight in a *Halichoeres semicinctus* and one in a juvenile *Semicossyphus pulcher.* Furthermore, only a few were found in fishes that had been feeding at night—a subadult *Paralabrax clathratus* and two adult *Xenistius californiensis* (Hobson and Chess 1976, 1986; Hobson et al. 1981). Although one might attribute the apparent infrequency of *G. vilordes* as prey to its small size, recent analyses made with improved ability to identify this species have indicated that it may have gone unrecognized in the partially digested state routinely encountered in gut contents.

Family Stenothoidae

Stenothoe estacola (Fig. 23F).

This was one of the more abundant gammarideans in our samples from turf and rock substrata at West End, with individuals (identified according to Barnard 1962) being 1.5 to 5 mm long (maximum densities: 190/100 g *Gelidium nudifrons* and 200/0.25 m^2 of rock). It was, however, infrequently collected elsewhere (Table 5). Consistent with this distribution, *S. estacola* occurred among gut contents only of fishes from West End, where it was a ranked prey of *Brachyistius frenatus* and *Embiotoca jacksoni* and an unranked prey of *Orthonopias triacis*, *Medialuna californiensis*, *Hypsypops rubicundus*, *Oxyjulis californica*, *Alloclinus holderi* and *Gibbonsia elegans*.

Family Hyalidae

Hyale frequens (Fig. 23G).

Individuals of up to 8 mm (identity based on Barnard 1962, as *H. nigra*) were variably abundant in turf at all four sites (Table 5; maximum density: 1060/100 g *Plocamium pacificum* from West End). A few collected on rock probably were incidental occurrences. Thus, while abundant in early samples from Isthmus Reef (maximum density 130/100 g *Gelidium nudifrons*), it was absent in samples of the benthos at that site after the turf died off with development of the *Macrocystis* canopy. This species ranked fourth in abundance among gammarideans that Coyer (1984) collected in *Macrocystis* canopies, and it was also collected by Hammer and Zimmerman (1979) in holdfasts of that plant as well on turf and sand-pebble substrata.

During the day, *H. frequens* was a ranked prey of *Oxylebius pictus*, *Paralabrax clathratus*, *Brachyistius frenatus*, *Girella nigricans*, *Embiotoca jacksoni*, *Halichoeres semicinctus*, *Oxyjulis californica* and *Gibbonsia elegans*, all of which had been feeding on benthic turf when collected. At night it occurred among the gut contents of several nocturnal planktivores, i. e., *Sebastes atrovirens*, *S. serranoides*, *Brachyistius frenatus* and *Hyperprosopon argenteum* (Hobson and Chess 1976, as *H. nigra*), all of which had been feeding in the water column above benthic turf. Although we did not collect *H. frequens* in our nocturnal plankton collections, Hammer and Zimmerman (1979) trapped it above the substrate at night.

Family Phliantidae

Pariphinotus escabrosus (Fig. 23H).

All representatives of this species in our collections from the environment (identity based on Barnard 1969b, as *Heterophlias seclusus escabrosus*) came from the two leeward sites, and they were never abundant (Table 5). They were up to 6 mm long and came from both turf and rock substrata (maximum density 28/0.25 m^2 of rock at Isthmus Reef), as well as from turf-covered sediment (11/0.25 m^2 in Fisherman's Cove).

This species was consumed by fishes more often and in more places than would be expected based on its occurrences in the environment, including the windward sites. Among diurnal benthivores, it was a ranked prey of *Embiotoca jacksoni*, *Halichoeres semicinctus* and *Oxyjulis californica*, and an unranked prey of *Oxylebius pictus* and *Brachyistius frenatus*. It also occurred among prey of two nocturnal planktivores, *Xenistius californiensis* and *Hyperprosopon argenteum*. Although it did not occur in our nocturnal plankton collections (Hobson and Chess 1976), Hammer and Zimmerman (1979) trapped it above the bottom at night.

Family Lysianassidae

Ocosingo borlus (Fig. 24A).

All our specimens of this small species (identity based on Barnard 1964), the largest being of 3 mm, were in 4 collections from rock at the 2 windward sites (Table 5)—13 in 1, but just 1 or 2 in the others. According to Barnard (1969a), this species is rare on a variety of substrata, including sponges and *Macrocystis* holdfasts, but abundant in association with a compound ascidian *Aplidium* sp. (as *Amaroucium* sp.). We collected this ascidian only twice (one from Eagle Rock, the other from West End), but one of these was the collection that took 13 *O. borlus*. We did not find this amphipod among the gut contents of fishes.

Family Iphimediidae

Coboldus hedgpethi (Fig. 24B).

This gammaridean occurred on rock surfaces at both windward sites (Table 5), but most abundantly at West End (maximum density 20/0.25 m^2). A few were collected in an unscheduled air-lift collection under a rock at Isthmus Reef, but these were not part of the regular assessments. Our specimens (identity based on Barnard 1969b, as *Panoplea hedgpethi*) were up to 6 mm long.

Consistent with *C. hedgpethi*'s scarcity in the environment, its only occurrences in the gut contents of fishes were a single individual in each of three fish—an *Oxylebius pictus* from West End and two *Halichoeres semicinctus* from Isthmus Reef.

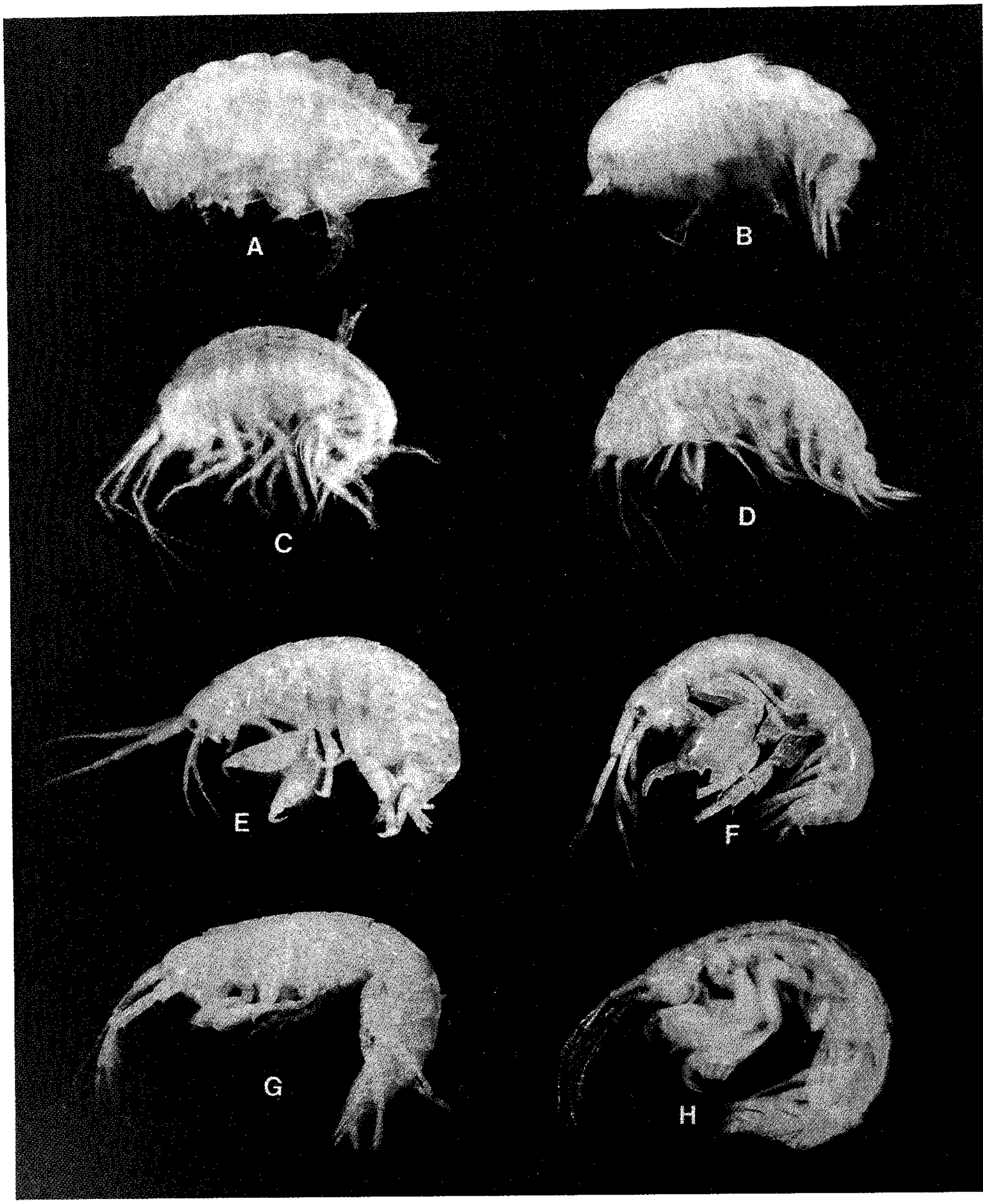

Figure 24. Gammarideans from Santa Catalina (continued). A. *Ocosingo borlus*; B. *Coboldus hedgpethi*; C. *Polycheria osborni*; D. *Ampelisca lobata*; E. *Elasmopus antennatus*; F. *Maera* sp.; G. *Ampithoe plumulosa*; H. *Chevalia inaequalis*.

Family Dexaminidae

Polycheria osborni (Fig. 24C).

This gammaridean burrows into the tests of ascidians (Skogsberg and Vansell 1928), which probably explains why it was infrequently taken in our collections (Table 5). It occurred in just one turf sample (although this one, *Cystoseira neglecta* from Isthmus reef, equated to 186 individuals/100 g of turf) and in just three samples from rock substrata—one each from Isthmus reef (12 individuals), West End (2 individuals) and Eagle Rock (4 individuals). It became apparent that our collections under represented the occurrence of this amphipod in the environment when we later recognized it to be a commensal of the highly abundant ascidian *Trididemnun opacum*. All our specimens of *P. osborni* from turf and rock were in collections that also included *T. opacum*, and it now seems likely that the amphipods had been housed in the ascidean.

Probably *P. osborni* was present but unnoted in many of our samples of *T. opacum*. Although occurrences of *P. osborni* with *T. opacum* were limited, they were widespread and certainly significant considering this ascidean's great abundance. The slits in the surface of the ascidian (Fig. 33) that marked chambers harboring the amphipod were commonly noted. Dissection of specimens bearing slits invariably revealed amphipods up to about 4 mm long lying on their backs inside the chambers, their appendages protruding through the slits. The obvious conclusion is that *P. osborni* benefits from its association with *T. opacum* by gaining protection from predators, especially as it was never noted among the gut contents of fishes. But *T. opacum* is itself a major prey of some fishes (see below), so that one would expect at least some *P. osborni* to be incidental prey of fishes that are after the ascidian. An earlier reference to *P. osborni* as a commensal of ascidians (Skogsberg and Vansell 1928) involved *Aplidium* spp. (as *Amaroucium* spp.), which have much tougher tissues than do *Trididemnum* spp. Above we note that another amphipod, *Ocosingo borlus*, may live together with the relatively few colonies of *Aplidium* sp. that occurred in our study sites. Perhaps the advantage gained by amphipods in this commensal relationship comes mostly from the ascidians being less edible.

Family Ampeliscidae

Ampelisca cristata

This gammaridean was a major component of the sand community at Ripper's Cove (identity based on Barnard 1954b), but inexplicably did not occur in our collections from sediment in Fisherman's Cove (Table 5). Its inclusion here is based on its prominence as prey of fishes from Fisherman's Cove, which suggests that its absence in collections from that environment reflected the sampling problems noted earlier. Nevertheless, some uncertainty remains, because in Ripper's Cove it was frequent prey both day and night (Hobson and Chess 1986), while in Fisherman's Cove virtually all predation was at night. Evidence of diurnal predation in Fisherman's Cove is limited to one individual in a *Leiocottus hirundo*, but nocturnal predation is documented by numerous records involving both benthivores and planktivores. Benthivores that consumed *A. cristata* in Fisherman's Cove at night included *Chilara taylori*, *Paralabrax clathratus*, *Umbrina roncador*, *Cymatogaster aggregata*, *Citharichthys stigmaeus* and *Pleuronichthys coenosus*. All were identified previously as nocturnal predators on this amphipod in Ripper's Cove (Hobson and Chess 1986). Planktivores that consumed this species in Fisherman's Cove at night included subadult *Sebastes serranoides*, *Sebastes atrovirens*, *Seriphus politus* and *Hyperprosopon argenteum* (Hobson and Chess 1976, as *Ampelisca* sp.). The only one of these studied at Ripper's Cove, *H. argenteum*, included *A. cristata* in its diet. This amphipod was not taken by our nocturnal plankton collections in Fisherman's Cove (Hobson and Chess 1976), presumably because, as determined in the Ripper's Cove study, only a very small proportion of the population leaves the bottom, and these stay at the base of the water column (Hobson and Chess 1986).

Ampelisca lobata (Fig. 24D).

Although most species of *Ampelisca* live in sediments, *A. lobata* inhabits reefs. Our specimens from the environment (identity based on Barnard 1954b) were up to 7 mm long, and except for seven individuals in a sample of *Cystoseira neglecta* from Isthmus reef, all were collected on rock (Table 5; maximum density: 7/0.25 m^2 at Eagle Rock). This species was reported among demersal zooplankters that entered the water column at night from a variety of reef substrata, including turf, sand, pebbles and *Macrocystis* holdfasts (Hammer and Zimmermann 1979).

Consistent with its relatively low numbers in collections from the environment, few *A. lobata* were found among the gut contents of fishes. The species was an unranked prey of *Embiotoca jacksoni*, *Halichoeres semicinctus*, *Oxyjulis californica*, *Semicossyphus pulcher*, *Alloclinus holderi* and *Coryphopterus nicholsii*.

Family Melitidae

Elasmopus antennatus (Fig. 24E).

The characters that readily distinguish *E. antennatus* are limited to the adult male, so our data underrepresent the occurrence of this species in the environment (even though immature individuals collected with identifiable adults were considered conspecifics). Our specimens (identity based on Barnard 1962) were 3 to 12 mm long, and most came from West End (Table 5). Although collected from both rock and turf, more were from rock (maximum densities: from turf, 54/100 g *Pterocladia capillacea*, and from rock, 360/0.25 m^2—both at West End). The species has been reported to inhabit shallow-water algae and sea grasses (Barnard 1962).

E. antennatus was a ranked prey of *Gibbonsia elegans* (which, like this amphipod, was most numerous at West End), and an unranked prey of *Orthonopias triacis*, *Embiotoca jacksoni*, *Oxyjulis californica*, *Halichoeres semicinctus*, *Semicossyphus pulcher*, *Oxylebius pictus*, *Alloclinus holderi* and *Lythrypnus dalli*. Consistent with its occurrences in collections from the environment, 16 of the 25 fish in which it occurred came from West End.

Maera spp. (Fig. 24F).

Although readily recognized at the generic level (based on Barnard 1962), species of *Maera* in the Santa Catalina habitats—including *M. reishi* and *M. simile*—often could not be distinguished. Our specimens, 2 to 7 mm long, came mainly from rocks at the two windward sites (Table 5; maximum density: 35/0.25 m^2 at West End), but they were only minor components of the communities.

Consistent with their relative scarcity in the environment, *Maera* spp. were relatively unimportant as food of fishes. They were unranked prey of *Embiotoca jacksoni*, *Hypsypops rubicundus*, *Halichoeres semicinctus*, *Oxyjulis californica* and *Semicossyphus pulcher*.

Family Ampithoidae

Ampithoe spp. (Fig. 24G).

At the time that our collections were analyzed, most specimens of *Ampithoe* spp. could not be distinguished as species. This was because diagnostic characteristics then recognized were generally limited to mature males and most of our specimens were immature or female. That such a large proportion of our specimens were identified only to genus made it impractical to incorporate Conlan and Bousfield's (1982) revision of the group, which assigned some of the species to a second genus, *Perampithoe*.

The gammarideans grouped here under the earlier scheme as species of *Ampithoe* occurred by day in tubes of their own construction and were prominent on turf at all four sites (Table 5; maximum density: 90/100 g *Dictyopteris undulata* at Fisherman's Cove). Although strictly benthonic by day, some enter the water column at night (Hobson and Chess 1976, Hammer and Zimmerman 1979).

Despite the uncertain identities, it was apparent that the forms grouped here represent at least six species (based on Barnard 1965), and that each favors a specific setting (judging from the distribution of identifiable adults, which were among the largest gammarideans in our collections). *A. lacertosa* (to 22 mm) occurred mainly on turf rhodophytes at West End, while *A. plumulosa* (to 16 mm) was most abundant on *Dictyopteris undulata* at Fisherman's Cove. *A. tea* (to 11 mm) was numerous on turf phaeophytes (especially *Dictyopteris undulata* from Fisherman's cove and Isthmus Reef), and also in an unscheduled collection of *Macrocystis* at Isthmus Reef. This may be the form from *Macrocystis* that Coyer (1979) identified as *A. plea*, a similar species that we did not see. *A. raymondi* (to 14 mm) had the widest distribution, with specimens collected at all four sites and from turf (phaeophytes and rhodophytes) as well as rocks. In contrast, our few specimens of *A. sectimanus* (to 6 mm) all were in two airlift collections on rock—one from West End, the other from Isthmus Reef. The sixth species, probably *A. simulans*, was represented by just one specimen (6 mm) from rock at West End.

Ampithoe spp. were important foods of diurnal benthivores. They were ranked prey of *Girella nigricans*, *Brachyistius frenatus*, *Embiotoca jacksoni*, *Halichoeres semicinctus*, *Semicossyphus pulcher* and *Gibbonsia elegans* and unranked prey of *Hypsypops rubicundus* and *Coryphopterus nicholsii*. And those *Ampithoe* spp. that entered the water column at night were important foods of nocturnal planktivores, including *Sebastes serranoides*, *Xenistius californiensis*, *Hyperprosopon argenteum*, *Seriphus politus*, and *Brachyistius frenatus*—the last being one of the few fishes that feed on zooplankters during both day and night (Hobson and Chess 1976, 1986; Hobson et al. 1981).

Family Isaeidae

Chevalia inaequalis (Fig. 24H).

Some *C. inaequalis* (identity based on Barnard 1962, as *Chevalia aviculae*) were free-living, but others were in chambers of 2 to 3 cm formed by a thin parchment-like covering on the underside of various turf algae (especially *Cystoseira neglecta* and *Dictyopteris undulata).* (maximum density: 264/100 g *Cystoseira neglecta* at Isthmus Reef; Table 5).

Often a single adult female shared a chamber with 20-30 juveniles, and sometimes several adults occurred together. Although the laterally compressed body of this amphipod, up to 6 mm, would seem adapted to lying within its chamber, flush against the algae, most individuals collected from the bryozoan *Bugula neritina* and from rock apparently were without chambers. According to Hammer and Zimmerman (1979), this species enters the water column at night.

Considering how numerous it was in the environment, *C. inaequalis* occurred in the diet of relatively few fishes. It was a ranked prey of just one, *Embiotoca jacksoni*, and an unranked prey of two others, *Brachyistius frenatus* and *Halichoeres semicinctus*. Despite the report of its nocturnal occurrence in the water column (Hammer and Zimmerman's 1979), it was not found among gut contents of the nocturnal planktivores.

Gammaropsis thompsoni (Fig. 25A).

Attaining a size of 9 mm, this gammaridean (identity based on Barnard and Reish 1959, as *Eurystheus thompsoni*) was a relatively minor species in our collections (Table 5). It was relatively abundant on rock at West End (maximum density 84/0.25 m^2), but otherwise samples were limited to a few individuals on West End turf and on rocks and turf at Eagle Rock and Isthmus Reef. Occurrences as food of fishes were similarly limited to one or two in three fish from West End—a *Paralabrax clathratus*, a *Oxyjulis californica* and a *Oxylebius pictus*—and one in a *Embiotoca jacksoni* from Eagle Rock.

Photis spp. (Fig. 25B).

Usually we were unable to distinguish the species of *Photis* because, as was the case with *Ampithoe* spp., they are defined largely by features of adult males (Barnard 1962), and most of our specimens were females or juveniles. Probably *P. brevipes* predominated, because most of the identifiable adult males in our collections were of this species, but other species were present, including *P. bifurcata*, *P. californica* and *P. conchicola*. Because of this uncertainty, we group them as *Photis* spp.

Photis spp. were prominent at all four major sites, occurring in collections from turf, rock and sediment (Table 5; maximum densities: 450/ 100 g *Plocamium pacificum* and 1980/0.25 m^2 of rock, both from Eagle Rock; these two collections were exceptional, as most contained <50). This diversity of habitat probably reflects the involvement of multiple species. Most were 3 mm or less, but a few were up to 7 mm. Hammer and Zimmerman (1979) reported *Photis* spp. among species that enter the water column at night, but there were none in our nocturnal plankton collections (Hobson and Chess 1976, 1986).

As a group, they were ranked prey of *Medialuna californiensis*, *Embiotoca jacksoni*, *Hypsypops rubicundus*, *Halichoeres semicinctus*, *Oxyjulis californica*, *Alloclinus holderi*, and *Lythrypnus zebra*, and unranked prey of *Orthonopias triacis*, *Oxylebius pictus*, *Girella*

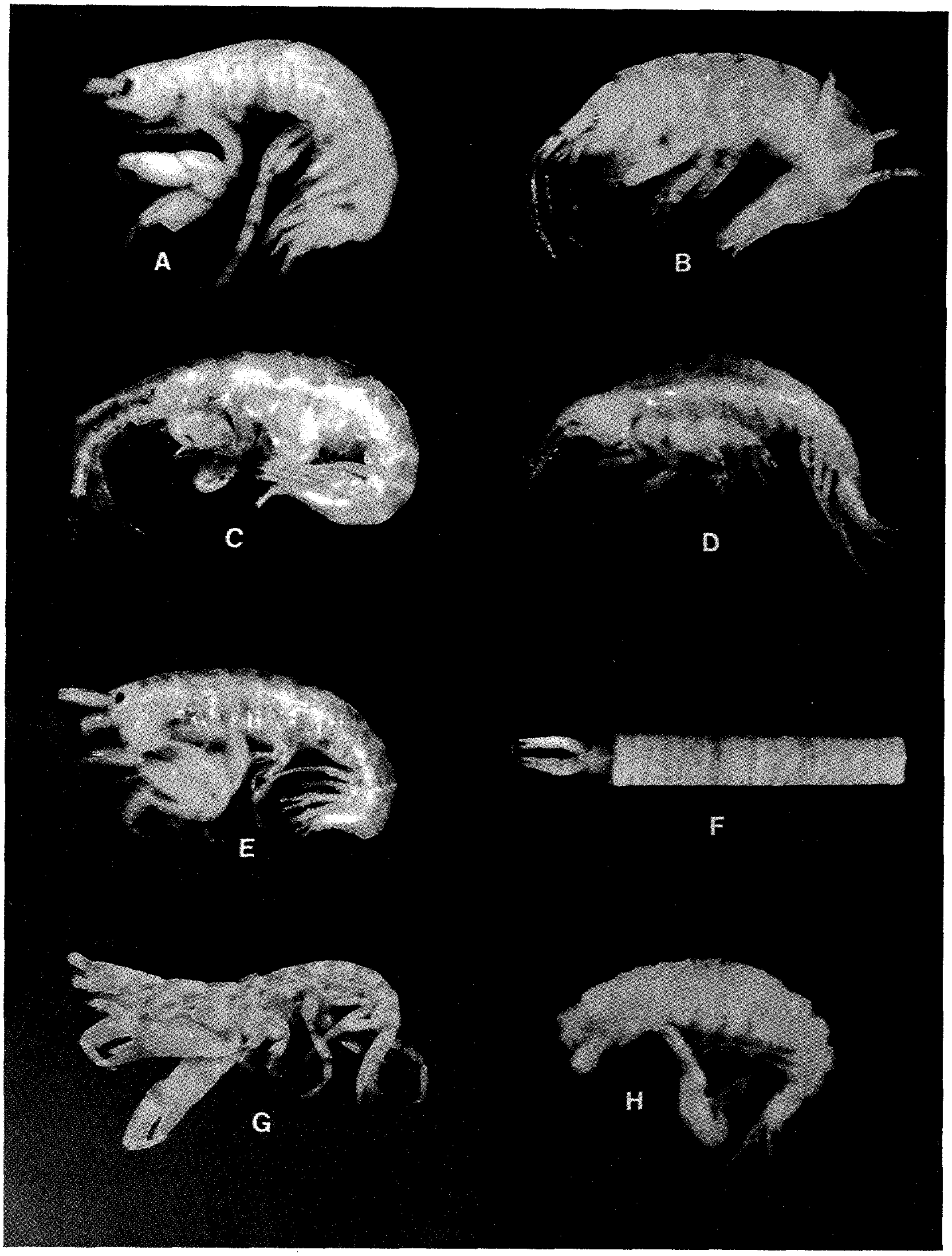

Figure 25. Gammarideans from Santa Catalina (continued). A. *Gammaropsis thompsoni*; B. *Photis* sp.; C. *Jassa slatteryi*; D. *Ischyroceros litodes*; E. *Aoroides exilis*; F. *Cerapus tubularis*; G. *Ericthonius brasiliensis*; H. *Podocerus brasiliensis*.

nigricans, *Semicossyphus pulcher*, and *Coryphopterus nicholsii*. In earlier studies, *Photis* spp. were important prey of both diurnal and nocturnal benthivores in Ripper's Cove (Hobson and Chess 1986), and a single individual was found among the gut contents of *Hyper-*

prosopon argenteum—a nocturnal planktivore—in Fisherman's Cove (Hobson and Chess 1976).

Family Ischyroceridae

Jassa slatteryi (Fig. 25C).

The genus *Jassa* was revised by Conlan (1990) subsequent to our work at Santa Catalina, and seven of her new species occur in California; nevertheless, all of the specimens in a representative sample from our study sites proved to be *J. slatteryi* (Kathleen Conlan, Canadian Museum of Nature, pers. comm., March 1991). All of our *Jassa* material is therefore considered to represent this species (Table 5), even though some of its congeners may be included. Individuals of up to 6 mm were abundant at the two windward sites, both on turf dominated by rhodophytes and on rock (maximum densities: 510/100 g *Pterocladia capillacea* and 210/0.25 m^2 of rock, both from West End). There were no species of *Jassa* in collections from the environment at the two leeward sites.

J. slatteryi was a ranked prey of *Orthonopias triacis*, *Hypsypops rubicundus*, *Brachyistius frenatus*, *Embiotoca jacksoni*, *Oxyjulis californica*, and *Gibbonsia elegans* and an unranked prey of *Oxylebius pictus*, *Medialuna californiensis*, *Semicossyphus pulcher*, and *Coryphopterus nicholsii*. It also was an unranked prey of a few individuals of several of the above species at the leeward sites, showing that despite its absence from the environmental samples, it did occur in those habitats. Also, two 4-mm individuals were found in a *S. atrovirens*—a nocturnal planktivore—collected during morning twilight, which suggests that some may enter the water column at night.

Ischyroceros litotes (Fig. 25D).

This was the most numerous gammaridean on *Macrocystis*, based on the extensive assessments of Coyer (1979) and our one collection of this plant (an unscheduled and nonquantitative sample from Isthmus Reef). It was not present in our collections from turf/algae, and was represented by just a single specimen from rock substrata—that one from Isthmus Reef (Table 5). Previously referred to as *Microjassa litotes* (based on Barnard 1954a), this species was reported from *Macrocystis* holdfasts by Hammer and Zimmerman (1979).

The occurrences of *I. litodes* in the diets of fishes were consistent with its occurrences in the environment. It was a ranked prey of *Brachyistius frenatus*, the fish most closely associated with *Macrocystis*, but otherwise its only occurrences among the gut contents of fishes were two in a *Paralabrax clathratus* and one in a *Hyperprosopon argenteum*. This last occurrence was in a nocturnal planktivore collected shortly before first morning light, suggesting that some *I. litotes* may enter the water column at night.

Family Aoridae

Aoroides spp. (Fig. 25E).

All our specimens referable to *Aoroides* were considered during the work at Santa Catalina to be *A. columbiae*. In concurring with this judgement, Coyer (1984) found it among the major organisms associated with *Macrocystis*. Since then, however, it has been determined that *A. columbiae* as recognized at that time included five distinct forms from Canada to Mexico (Conlan and Bousfield 1982). Furthermore, subsequent examination of a representative sample from our collections determined that 10 of 11 specimens from Isthmus Reef were *A. exilis* (the 11th was *A. columbiae*) and all 8 from Fisherman's Cove were *A. spinosa* (Kathleen Conlan, Canadian Museum of Nature, pers. comm., September 1991). Although the sample examined was too small to make much of this result, the possibility that at least two species of *Aoroides* are prominent at Santa Catalina—*A. exilis* on leeward reefs and *A. spinosa* on leeward sediment—should be considered when evaluating the data in Table 5.

We found *Aoroides* spp. up to 6 mm abundant on turf phaeophytes at the two leeward sites (maximum densities 120/100 g *Dictyopteris undulata* at Fisherman's Cove and 54/100 g *Cystoseira neglecta* at Isthmus Reef). And one or more were prominent in our one sample of *Macrocystis*. Although strictly benthonic by day, some *Aoroides* spp. enter the water column at night (Hobson and Chess 1976, Hammer and Zimmerman 1979, as *A. columbiae*).

During the day *Aoroides* spp. were ranked prey of *Orthonopias triacis* and *Halichoeres semicinctus* and unranked prey of *Paralabrax clathratus*, *Medialuna californiensis*, *Embiotoca jacksoni*, *Semicossyphus pulcher* and *Coryphopterus nicholsii*. In addition, many of those that entered the water column at night were consumed by nocturnal planktivores, including *Sebastes atrovirens*, *S. serranoides*, and *Brachyistius frenatus* (Hobson and Chess 1976, as *A columbiae*). While none occurred in our collections of sediments, there were some among the gut contents of nocturnal benthivores—*Chilara taylori*, *Cymatogaster aggregata* and *Citharichthys stigmaeus*—that had been foraging in sediment during the night, some in Fisherman's Cove and others shoreward of Isthmus Reef.

Family Corophiidae

Cerapus tubularis (Fig. 25F).

Although we follow Barnard (1962) in identifying this form as *C. tubularis*, Don Cadian (Biology Laboratory, Los Angeles County Sanitation Districts) believes it is an undescribed species (pers. comm., May 1992). We found specimens moderately abundant in collections from turf rhodophytes at Eagle Rock (maximum density 68/100 g *Gelidium nudifrons*). They were relatively small—the largest was of 3 mm—and occurred in portable, self-constructed tubes which they carried along when moving about. Otherwise, occurrence of this species in our collections was limited to one individual from turf in Fisherman's Cove. The distribution of *C. tubularis* among gut contents of fishes essentially matched its distribution among collections from the environment. It was an unranked prey of *Embiotoca jacksoni*, *Halichoeres semicinctus* and *Semicossyphus pulcher* from Eagle Rock, but otherwise occurred as just two individuals in a single *H. semicinctus* from Fisherman's Cove.

Ericthonius brasiliensis (Fig. 25G).

This tubiculous species, perhaps the most widespread and abundant gammaridean at Santa Catalina, was numerous in virtually every sample from the environment (Table 5; maximum density 1200/100 g *Dictyopteris undulata* at Isthmus Reef). However, it was only a minor presence in Coyer's (1984) collections from *Macrocystis*, and ranked 7th of 10 gammaridean species in our one sample from that alga. Our specimens (identity based on Barnard 1962) were up to 8 mm long, and while many were in tubes, others were without tubes. Many of those without tubes were collected in the water column at night (Hobson and Chess 1976, 1986, Hammer and Zimmerman 1979).

During the day *E. brasiliensis* was a ranked prey of many diurnal benthivores, including *Orthonopias triacis*, *Paralabrax clathratus*, *Brachyistius frenatus*, *Embiotoca jacksoni*, *Halichoeres semicinctus*, *Semicossyphus pulcher*, *Alloclinus holderi* and *Gibbonsia elegans*. It was an unranked prey of *Girella nigricans* and *Medialuna californiensis*, both of which are primarily herbivorous. At night, many of the *E. brasiliensis* that entered the water column were consumed by nocturnal planktivores, including *Sebastes atrovirens*, *S. serranoides*, *Xenistius californiensis* and *Hyperprosopon argenteum*; and many others on open sand were taken by nocturnal benthivores, including *Chilara taylori* and *Umbrina roncador* (Hobson and Chess 1976, 1986).

Family Podoceridae

Podocerus brasiliensis (Fig. 25H).

This species (identity based on Barnard 1962) was prominent up to 5 mm on rocks at West End (Table 5; maximum density: 70/0.25 m^2), but was absent or only sparsely represented elsewhere. Consistent with its general scarcity in the environment, the only occurrence of this amphipod among the gut contents of fishes was a single individual in a *Lythrypnus zebra* from Lion's Head.

Podocerus cristatus (Fig. 26A)

Attaining up to 8 mm, this gammaridean (identity based on Barnard 1962) was numerous on turf algae and rocks at both leeward and windward sites (Table 5; maximum densities: 230/100 g *Cystoseira neglecta* from Isthmus Reef and 240/0.25 m^2 of rock at West End). Although strictly benthonic by day, *P. cristatus* entered the water column at night (Hobson and Chess 1976, Hammer and Zimmerman 1979).

Consistent with its prominence in the environment, *P. cristatus* was a ranked prey of *Oxylebius pictus*, *Orthonopias triacis*, *Embiotoca jacksoni*, *Alloclinus holderi* and *Gibbonsia elegans* and an unranked prey of *Paralabrax clathratus*, *Halichoeres semicinctus*, *Oxyjulis californica* and *Coryphopterus nicholsii*—all diurnal benthivores. At night it was taken by *Sebastes atrovirens*, and subadult *S. serranoides*—both nocturnal planktivores (Hobson and Chess 1976).

Caprellidean Amphipods

Family Phtiscidae

Perotripus brevis (Fig. 26B).

This relatively small caprellid (identity based on Laubitz 1970) was most abundant in collections from rock substrata at Isthmus Reef (Table 6; maximum density 280/0.25 m^2). Our largest specimens were of 7 mm. Its usual habitat, however, may be the bryozoan *Bu-*

Table 6. Caprellid amphipods in the environment.

TAXA	ISTHMUS REEF						FISHERMAN'S COVE						WEST END						EAGLE ROCK					
	Turf			Rock/Sedim't			Turf			Sediment			Turf			Rock			Turf			Rock		
	n=10			n=8			n=14			n=6			n=21			n=6			n=15			n=6		
	%	$\bar{x}$no	SE	%	$\bar{x}$no	SE	%	$\bar{x}$no	SE	%	$\bar{x}$no	SE	%	$\bar{x}$no	SE	%	$\bar{x}$no	SE	%	$\bar{x}$no	SE	%	$\bar{x}$no	SE
Phtiscidae																								
Perotripus brevis	10	<1	<1	100	73	38	0	0	0	33	2	1	5	<1	<1	0	0	0	0	0	0	33	2	1
Aeginellidae																								
Aciconula acanthosoma	40	18	12	50	50	32	29	5	3	0	0	0	10	<1	<1	83	5	2	0	0	0	17	2	2
Deutella venenosa	30	95	83	13	<1	<1	0	0	0	0	0	0	29	1	<1	83	6	3	20	1	<1	50	6	3
Mayerella banksia	0	0	0	0	0	0	0	0	0	50	41	30	0	0	0	0	0	0	0	0	0	0	0	0
Tritella laevis	40	2	1	0	0	0	0	0	0	0	0	0	81	11	3	83	15	11	67	6	2	33	1	<1
Caprellidae																								
Caprella brevirostris	0	0	0	0	0	0	0	0	0	0	0	0	62	25	9	67	13	7	40	3	2	17	1	1
C. californica	92	110	50	50	40	39	86	102	41	33	1	1	29	9	5	0	0	0	40	2	1	83	5	2
C. equilibra	0	0	0	50	4	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	33	3	2
C. penantis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	57	32	14	47	38	34	0	0	0
C. pilidigita	40	9	5	25	<1	<1	100	149	80	33	7	4	0	0	0	0	0	0	0	0	0	17	<1	<1
C. uniforma	20	3	3	0	0	0	0	0	0	0	0	0	33	4	2	17	1	1	20	2	1	0	0	0
C. verrucosa	8	<1	<1	11	<1	<1	0	0	0	0	0	0	91	130	34	100	58	28	87	52	46	50	2	1
C. sp.	20	14	11	25	1	1	0	0	0	17	<1	<1	0	0	0	33	2	1	0	0	0	17	<1	<1
Others (identified)	0	0	0	25	14	10	0	0	0	0	0	0	14	4	4	0	0	0	0	0	0	0	0	0
Undetermined	30	35	33	50	54	27	21	10	9	0	0	0	48	26	13	17	<1	<1	60	18	11	33	1	1

gula neritina. There were 210 individuals in our one collection of this bryozoan (100 g), and all airlift collections from rock surfaces that included *P. brevis* also included *B. neritina*. The occurrence of *P. brevis* in our collections of turf was limited to two individuals in one sample, and it was infrequently collected at the windward sites.

P. brevis occurred among gut contents of fishes from all leeward sites except Fisherman's Cove, but did not occur in fishes from the windward sites. It was a ranked prey of *Medialuna californiensis* and *Lythrypnus zebra* and an unranked prey of *Paralabrax clathratus*, *Embiotoca jacksoni*, *Alloclinus holderi*, *Coryphopterus nicholsii* and *Lythrypnus dalli*.

Family Aeginellidae

Aciconula acanthosoma (Fig. 26C).

Another relatively small caprellid (identity based on Chess 1989), this species was widespread and abundant on both turf and rocks—especially at the leeward sites (Table 6; maximum densities: 95/100 g *Cystoseira neglecta* and 226/0.25 m^2 of rock, both at Isthmus Reef). The largest of our specimens were 8 mm long. The species was a ranked prey of *Embiotoca jacksoni* and *Alloclinus holderi* and an unranked prey of *Halichoeres semicinctus*, *Semicossyphus pulcher* and *Coryphopterus nicholsii*.

Deutella venenosa (Fig. 26D).

The only previous record of this species is from Chile (Mayer 1890), but we have collected it off both northern and southern California. It is a relatively small species—the largest in our samples was 7 mm—that occurred on turf and rocks of reefs at both windward and leeward sites (Table 6). It was most abundant on turf at Isthmus Reef (maximum density: 838/100 g *Cystoseira neglecta*), but was not collected with turf from Fisherman's Cove, perhaps because the setting there was on sediment.

Figure 26. Gammarideans (continued) and caprellideans from Santa Catalina. Gammaridean: A. *Podocerus cristatus*; Caprellideans: B. *Perotripus brevis*; C. *Aciconula acanthosoma*; D. *Duetella venenosa*; E. *Mayerella banksia*; F. *Tritella laevis*; G. *Caprella brevirostris*.

Consistent with its relatively small size, *Deutella venenosa* was preyed on most heavily by *Orthonopias triacis*, one of the smaller fish species examined. It was also a ranked prey of *Oxylebius pictus*. Otherwise, its occurrences as prey were as unranked elements in the diets of *Paralabrax clathratus*, *Medialuna californiensis*, *Brachyistius frenatus*, *Embiotoca jacksoni*, *Gibbonsia elegans*, *Coryphopterus nicholsii* and *Lythrypnus dalli*.

Mayerella banksia (Fig. 26E).

This relatively small species (identity based on Laubitz 1970) inhabits sediments, and was collected only in Fisherman's Cove (Table 6; maximum density: 1081/0.25 m^2). It was also a major species on sand in Ripper's Cove, where its estimated mean density was 297/m^2 (Hobson and Chess 1986). The largest of our specimens was 6 mm long.

M. banksia occurred only twice as prey of fishes during this study—once in a *Coryphopterus nicholsii* from Fisherman's Cove and once in a *Chilara taylori* that had been foraging at night in the sand shoreward from Isthmus Reef. In contrast, it was consumed by many fishes—both diurnal and nocturnal—that were feeding in sand at Ripper's Cove (Hobson and Chess 1986). There it was taken during the day by *Paralabrax clathratus*, *Embiotoca jacksoni*, *Halichoeres semicinctus* and *Citharichthys stigmaeus*, and at night by *Cymatogaster aggregata* and *Pleuronichthys coenosus*.

Tritella laevis (Fig. 26F).

This species was most consistently abundant on foliose rhodophytes from the two windward sites (maximum density 45/100 g of *Plocamium cartilagineum* from West End). Its occasional abundance in collections from rock surfaces (68/0.25 m^2 in one from West End) may have depended on mats of short algae on those rocks. Our specimens (identity based on Laubitz 1970) were up to 11 mm long and typically were of a reddish hue that matched the turf where they were most abundant. That this species is distributed more widely than is indicated by our environmental collections (Table 6) becomes evident from Hammer and Zimmerman's (1979) record of its occurrence in *Macrocystis* holdfasts at Isthmus Reef.

Consistent with its greater numbers on foliose rhodophytes, *T. laevis* was found more often in gut contents of fishes from West End (where rhodophytes predominate) than in fishes from elsewhere. Thus, 40 were found in 12 fish of 5 species from West End alone, compared to 44 from 9 fish of 7 species from all other sites combined. Curiously, *T. laevis* was absent in samples of foliose rhodophytes and fish gut-contents from Ship Rock (where *Caprella verrucosa* was numerous), and yet occurred in low numbers on turf phaeophytes and in the diet of a few fishes from Isthmus Reef.

Taking *T. laevis* as a ranked prey were *Brachyistius frenatus*, *Embiotoca jacksoni*, *Oxyjulis californica*, *Halichoeres semicinctus* and *Gibbonsia elegans*. Furthermore, despite relatively low numbers on turf phaeophytes, this caprellid was found in a specimen of the nocturnally planktivorous *Hyperprosopon argenteum* that had been collected at midnight above the phaeophyte-dominated turf in Fisherman's Cove (Hobson and Chess 1976).

Family Caprellidae

Caprella brevirostris (Fig. 26G).

This was one of three similarly sized species of *Caprella* that were most numerous on turf rhodophytes at the two windward sites (Table 6). The other two were *C. penantis* and

C. verrucosa. All three were collected in greatest numbers at West End (maximum density of *C. brevirostris*: 160/100 g of *Gelidium nudifrons*), where a turf of foliose rhodophytes persisted throughout the period of study. They also were numerous on foliose rhodophytes at Eagle Rock, but were scarce on the coralline rhodophytes that constituted a larger part of the turf there. How the three shared the West End habitat is described in the accounts of those species, below. They also were collected from algae-covered rocks, but in lesser numbers (maximum density of *C. brevirostris*: 44/0.25 m^2 at West End). Our specimens of *C. brevirostris* (identity based on McCain 1975) were up to 10 mm long.

Figure 27. *Caprella Californica* typically poised amid hydroids (*Sertularia* sp.) and bryozoans (*Aetea anguina*) on the surface of a macro alga.

C. brevirostris was a ranked prey of *Brachyistius frenatus* and *Embiotoca jacksoni* and an unranked prey of *Girella nigricans, Halichoeres semicinctus, Oxyjulis californica* and *Gibbonsia elegans*. Although this caprellid was not collected from the environment at leeward sites, single individuals were found among gut contents of two fishes from there: a *H. semicinctus* from Isthmus Reef and a single *O. californica* from Ship Rock. It was also found in a subadult of the nocturnally planktivorous *Sebastes serranoides* from Fisherman's Cove, indicating that at least a few of them enter the water column at night (Hobson and Chess 1976).

Caprella californica (Fig. 28A).

This was the dominant caprellid at Santa Catalina, at least in leeward habitats (identity based on Laubitz 1970). It occurred widely on both turf and rock substrata (Table 6; maximum densities: 430/100 g *Cystoseira neglecta* and 310/0.25 m^2 of rock, both from Isthmus Reef), and was represented by specimens of up to 21 mm—the largest caprellids sampled. Although strictly benthonic by day (Fig. 27), *C. californica* was often among the plankton at night (Hobson and Chess 1976, Hammer and Zimmerman 1979).

Consistent with its widespread distribution in the environment, *C. californica* was the caprellid most often found in gut contents of fishes. It was a ranked prey of *Paralabrax clathratus, Brachyistius frenatus, Embiotoca jacksoni, Halichoeres semicinctus, Oxyjulis*

Figure 28. Caprellideans from Santa Catalina (continued). A. *Caprella californica*; B. *Caprella equilibra*; C. *Caprella penantis*; D. *Caprella pilidigita*; E. *Caprella uniforma*; F. *Caprella verrucosa*.

californica, and *Alloclinus holderi*; and an unranked prey of *Girella nigricans*, *Damalichthys vacca* and *Hypsypops rubicundus*. It was also a major prey of nocturnal planktivores, including subadult *S. serranoides* and *Hyperprosopon argenteum* (Hobson and Chess 1976).

Caprella equilibra (Fig. 28B).

Our one quantitative collection of the bush-like bryozoan *Bugula neritina*, a 100-g sample (from Isthmus Reef), contained 90 *C. equilibra* (identity based on Laubitz 1970). Otherwise, this caprellid occurred only in low numbers in samples from rocks at Isthmus Reef and Eagle Rock (Table 6; maximum density: 21/0.25 m^2 from Isthmus Reef). It was never collected from turf.

Consistent with its limited distribution in the environment, *C. equilibra* occurred among the gut contents of only three fish species—*Oxylebius pictus*, *Orthonopias triacis* and *Alloclinus holderi*. It was a ranked prey of *O. pictus*, with 10 to 43 ($\bar{x} = 30.7$) among the gut contents of six fish of this species from Eagle Rock. Obviously *C. equilibra* can be an important food of fish able to hunt in the right place. It was also a ranked prey of *O. triacis*, but this was based on just one individual in each of three fish. And it was an unranked prey of *A. holderi*, its occurrence here being limited to a single individual in one fish.

Caprella penantis (Fig. 28C).

This caprellid was most abundant on foliose turf rhodophytes at the two windward sites (Table 6; maximum density: 145/100 g *Plocamium cartilagineum* at West End), where two congeners, *C. brevirostris* (above) and *C. verrucosa* (below) also were collected in greatest numbers. The largest of our specimens from regular collections (identity based on McCain 1968) was 13 mm long, so in addition to being similarly distributed, the three are about the same size. The pattern of their occurrences at West End provided some understanding of how they share the habitat. Here we consider *C. penantis* and *C. brevirostris*, leaving *C. verrucosa* to the account of that species, below.

C. penantis and *C. brevirostris* were distributed differently among the major species of foliose turf rhodophytes during these observations. The dominant turf algae at West End were *Plocamium cartilagineum*, *Gelidium nudifrons* and *Pterocladia capillacea*. Often only *C. penantis* was on *P. cartilagineum* and only *C. brevirostris* was on *G. nudifrons*; furthermore, although both species were at times numerous on *Pterocladia capillacea*, usually when one was present the other was absent. Their distributions, therefore, seemed influenced by a mixture of preference for specific algae and some level of mutual exclusion.

Fishes preyed on *C. penantis* most heavily at West End and Eagle Rock, which is consistent with the distribution of this caprellid in the environment. But several took it at Ship Rock (where the rhodophyte *Gelidium robustum* was prominent) and Fisherman's Cove, demonstrating its presence even though not present in our environmental samples from leeward habitats. Taking *C. penantis* as ranked prey were *Oxylebius pictus*, *Brachyistius frenatus* and *Oxyjulis californica*; taking it as unranked prey were *Orthonopias triacis*, *Embiotoca jacksoni*, *Halichoeres semicinctus*, *Semicossyphus pulcher* and *Gibbonsia elegans*. In addition, it was preyed on at night by nocturnal planktivores, including *Sebastes atrovirens*, and *Hyperprosopon argenteum*, indicating that some were in the water column after dark (Hobson and Chess 1976).

Caprella pilidigita (Fig. 28D).

This species (Table 12) was a dominant form on turf phaeophytes at the leeward sites (identity based on Laubitz 1970), particularly on turf over sediment in Fisherman's Cove (Table 6; maximum density: 1124/100 g *Desmarestia viridis*); it was never collected from turf rhodophytes at the windward sites, however. Also, limited numbers were taken from sediment, including open sand (Hobson and Chess 1986), but it was rare on rocks (a total of three individuals in two collections). This species is morphologically similar to *C. equilibra*, above, but the two occurred on different substrata. Whereas *C. pilidigita* was collected mainly on turf, *C. equilibra* was widespread but never abundant in collections from rock, and may be abundant only on bryozoans—perhaps just *Bugula neritina* (see account of *C. equilibra*, above). In addition, *C. pilidigita* was the caprellid most often collected in the water column at night (Hobson and Chess 1976). The largest of our specimens was 16 mm long.

C. *pilidigita* was a ranked prey of *Orthonopias triacis*, *Oxylebius pictus*, *Paralabrax clathratus*, *Medialuna californiensis*, *Brachyistius frenatus*, *Halichoeres semicinctus* and *Alloclinus holderi*. And it was an unranked prey of *Girella nigricans*, *Embiotoca jacksoni*, *Semicossyphus pulcher* and *Coryphopterus nicholsii*. It was also a ranked prey of nocturnal planktivores, including subadult *Sebastes serranoides*, *Xenistius californiensis*, and *Hyperprosopon argenteum* (Hobson and Chess 1976). Consistent with the distribution of *C. pilidigita* in our collections from the environment, most of this predation was at leeward sites. Of just 26 individuals consumed at windward sites, all were taken at Eagle Rock by two *Oxylebius pictus*—the species that preyed heavily on the similar *C. equilibra* at this same site.

Caprella uniforma (Fig. 28E).

Although present in collections from both windward and leeward reefs—mainly from turf—this caprellid (identity based on McCain 1975) was never abundant (Table 6). Probably the relative scarcity of *C. uniforma* in our collections (maximum density: 29/100 g *Dictyopteris undulata* at Isthmus Reef) can be attributed to a lack of sampling *Macrocystis*. During Coyer's (1979) study of organisms associated with *Macrocystis* at Santa Catalina, *C. uniforma* was the most abundant caprellid on that alga.

Consistent with its apparently limited distribution, *C. uniforma* was prey of just three of the fish species examined: *Brachyistius frenatus*, *Embiotoca jacksoni*, and *Oxyjulis californica*.

Caprella verrucosa (Fig. 28F).

This species, like *C. brevirostris* and *C. penantis* (above), was most numerous on foliose turf rhodophytes at the two windward stations (identities based on Laubitz 1970). It was more dominant in the collections, however, occurring in every sample of turf algae from West End, and outnumbering its congeners virtually whenever they co-occurred (Table 6). There was no indication of negative interactions between *C. verrucosa* and either *C. brevirostris* or *C. penantis*, as there appeared to be between those two, but *C. verrucosa* did seem to favor *Pterocladia capillacea* as a substrate (even though the maximum density recorded was 690/100 g of *Gelidium purpurescens* from Eagle Rock). Although *C. brevirostris* and *C. penantis* were found at leeward sites only among the gut contents of fishes, *C. verrucosa* was taken there with a collection of *Gelidium nudifrons* from Isthmus Reef.

The pattern of predation on *C. verrucosa* reflected its association with foliose rhodophytes rather than with windward or leeward habitats. Thus, while *C. verrucosa* were recovered from 27 individuals of 12 species among fishes that had been feeding among foliose rhodophytes at West End, the species occurred in just 2 individuals of 2 species among fishes that had been feeding amid turf dominated by coralline rhodophytes at Eagle Rock. Furthermore, *C. verrucosa* occurred in 26 individuals of 6 species among fishes that had been feeding amid turf rich in foliose rhodophytes at Ship Rock, while at Isthmus Reef, where rhodophytes were just a small part of a turf dominated by phaeophytes, the species occurred in just 3 individuals of 2 species.

C. verrucosa was taken as ranked prey by *Oxylebius pictus*, *Medialuna californiensis*, *Brachyistius frenatus*, *Embiotoca jacksoni*, *Halichoeres semicinctus*, *Oxyjulis californica*, *Semicossyphus pulcher* and *Gibbonsia elegans* and as an unranked prey by *Paralabrax clathratus* and *Alloclinus holderi*.

Brachyuran Decapods

Family Majidae

Pugettia dalli

This was the crab most often collected at Santa Catalina. It occurred mainly on rock substrata at the two windward sites (maximum density: 90/0.25 m^2 at West End), but was also collected on turf and sediment. Our specimens (identity based on Garth 1958) were 2 to12 mm wide, although most were juveniles of <4 mm. Consistent with its numbers in samples from the environment, *P. dalli* was also the crab most frequently eaten by the fishes. It was a ranked prey of *Paralabrax clathratus*, *Embiotoca jacksoni*, *Halichoeres semicinctus*, *Semicossyphus pulcher* and *Gibbonsia elegans*, and an unranked prey of *Oxylebius pictus* and *Girella nigricans*.

Family Canceridae

Cancer sp.

Specific identifications were difficult because many individuals recognized as *Cancer* sp. were juveniles or fragmented body parts among gut contents. Only one species was recognized—*C. jordani*—so probably at least most were of this species. Our specimens (identity based on Schmitt 1921) were of 2 to 29 mm and came from rock, sand and turf, including all four major sites (maximum density: 9/0.25 m^2 of rock and 9/100 g of *Pterocladia capillacea*, both from West End).

The major predator on *Cancer* sp. was the diurnal benthivore *Semicossyphus pulcher*, eight of which (6 % of those sampled), 206 to 265 mm SL, had consumed 1 to 3 individuals, 10 to 15 mm wide. Only one other diurnal predator, *Gibbonsia elegans*, consumed this crab as a ranked prey, with each of three (16 % of the number sampled), 74 to 92 mm SL, having taken one *Cancer* sp., 3 to 5 mm. Consuming *Cancer* sp. as an unranked prey were *Leiocottus hirundo*, *Oxylebius pictus* and *Damalichthys vacca*—all diurnal benthivores. The only evidence of this crab in the diet of nocturnal predators was a 32-mm specimen (the largest *Cancer* sp. recovered from a fish gut) in a 195-mm (SL) *Scorpaena guttata*, a benthivore, that had been collected during the hour before dawn.

Family Xanthidae

Paraxanthias taylori

Individuals of this species in our collections (identity based on Schmitt 1921) were 5 to 18 mm wide, and from rock substrata—most from the two windward sites (maximum density: 4/0.25 m^2 at West End). Relatively few were collected, however, and the species is included here only because it was a ranked prey of *Sebastes serriceps* and *Semicossyphus pulcher*. It was also an unranked prey of *Scorpaena guttata* and *Halichoeres semicinctus*.

Individuals taken by *S. serriceps* and *S. guttata* were up to 38 mm wide, and captured among the rocks at night, whereas individuals taken by *S. pulcher* and *H. semicinctus* were captured in the same places but during the day (sizes unavailable because these two crush their prey on ingestion).

That those in gut contents included individuals much larger than any taken from the environment suggests that our collecting methods were ineffective in sampling the larger, more cryptic individuals. Perhaps the larger *P. taylori* are sparsely distributed forms sought out by those relatively few predators capable of consuming them. Or it may be that this species is disproportionately represented in our gut content data because even fragments of its distinctive exoskeleton are readily identified.

Caridean Decapods

Family Alpheidae

Alpheus clamator

This shrimp was relatively common in collections from rock substrata, where specimens 2 to 28 mm long were especially numerous at the two windward sites (maximum density 28/0.25 m^2 from West End). This was the only species of *Alpheus* identified in samples from the environment (based on Schmitt 1921), so fragments from gut contents identifiable only as *Alpheus* sp. are referred to this taxon (even though one gut contained an individual identifiable as *A. bellimanus*).

Representatives among gut contents were 4 to 32 mm long, and, consistent with the species' distribution in the environment, most came from fishes collected at West End and Eagle Rock. *A. clamator* was a ranked prey of *Scorpaena guttata*, *Oxylebius pictus*, *Orthonopias triacis*, *Embiotoca jacksoni*, *Halichoeres semicinctus*, *Semicossyphus pulcher*, *Alloclinus holderi* and *Gibbonsia elegans;* and it was an unranked prey of *Sebastes serriceps*, *Paralabrax clathratus* and *Hypsypops rubicundus*.

Family Hippolytidae

Heptacarpus fuscimaculatus

Our specimens of *H. fuscimaculatus* were 4 to 17 mm long, and occurred on both rock and turf (maximum densities: 94/0.25 m^2 on rock at Eagle Rock and 4/100 g *Pachydictyon coriacium* at Fisherman's Cove). This was the only species of *Heptacarpus* identified in collections from the environment (based on Wicksten 1986), so damaged specimens from gut contents identifiable only as *Heptacarpus* sp. are referred to this taxon.

H. *fuscimaculatus* was a ranked prey of *Paralabrax clathratus* and *Gibbonsia elegans*, and an unranked prey of *Sebastes serriceps*, *Oxylebius pictus*, *Orthonopias triacis*, *Embiotoca jacksoni* and *Semicossyphus pulcher.* Those in gut contents were 5 to 14 mm long, which essentially matched the sizes of those collected in the environment. All were in fish that had been collected during early afternoon, except two freshly ingested specimens in the one *S. serriceps* collected at midnight.

Hippolyte clarki

This shrimp was collected from all sites and on all substrata (except coralline turf), but was most numerous on phaeophytes (maximum density: 37/100 g *Desmarestia viridis* from Fisherman's Cove). A closely related species, *H. californiensis*, occurs mainly among sea grasses, especially *Zostera* (Mary Wicksten, Texas A & M University, pers. comm., October 1991). Consistent with this assessment, Coyer (1979) listed *H. clarki* among the ten most abundant invertebrates associated with *Macrocystis*. Our specimens were 4 to 16 mm long. *H. clarki* is a nocturnal predator that remains on substrata by day and hunts smaller zooplankters throughout much of the water column at night (Hobson and Chess 1976).

H. clarki experienced the heaviest predation when in the water column at night, where it was consumed by *Sebastes atrovirens*, subadult *S. serranoides*, *Xenistius californiensis*, *Seriphus politus* and *Hyperprosopon argenteum*, which are nocturnal planktivores (Hobson and Chess 1976). Other nocturnal predators consumed it on or near the bottom, including *Sebastes serriceps* and those *Paralabrax clathratus* that forage over sand after dark (Hobson et al. 1981, Hobson and Chess 1986). In addition, one had been taken by a *Chilara taylori*, which is strictly a nocturnal benthivore that forages in sediment (Hobson and Chess 1986).

Most predation during the day came from *Paralabrax clathratus*, as 23 of the 35 predators that had taken this shrimp in daylight (66%) were of that species. Other predators taking *H. clarki* during the day were *Orthonopias triacis* (1), *Brachyistius frenatus* (2), *Embiotoca jacksoni* (1), *Hypsypops rubicundus* (1), *Halichoeres semicinctus* (3), *Oxyjulis californica* (2) and *Semicossyphus pulcher* (2).

Lysmata californica

Our collections from the environment took only an occasional individual of this species, probably because they were concentrated in crevices and caves during the day (Fig. 29), rather than spread about the habitat as they are at night. Our specimens (identity based on Word and Charwat 1976) were 9 to 27 mm long. Often, if not generally, individuals of this species were clustered about a moray eel, *Gymnothorax mordax*, which they have been reported to clean (Limbaugh 1961). Although these concentrations were conspicuous and frequently observed, *L. californica* qualifies for inclusion in this report only because it was a ranked prey of fishes.

Taking this shrimp as a ranked prey were *Scorpaena guttata*, *Sebastes serriceps* and *S. atrovirens*, which are nocturnal feeders. Although the first two forage among rocks, the third feeds in the midwaters, indicating that at least some *L. californica* enter the water column at night. The only evidence of diurnal predation was a single 30-mm individual in a *Paralabrax clathratus*, which raises the possibility that *L. californica* is protected from diurnal predators by its association with *G. mordax*. This large eel is piscivorous (McCleneghan 1973) and may keep the relatively small diurnal predators at a distance. On the other hand, *L. californica* can be a particularly large shrimp—those taken by the predators listed above were 11 to 70 mm long—and may in fact be too large for most of the diurnal fishes considered here.

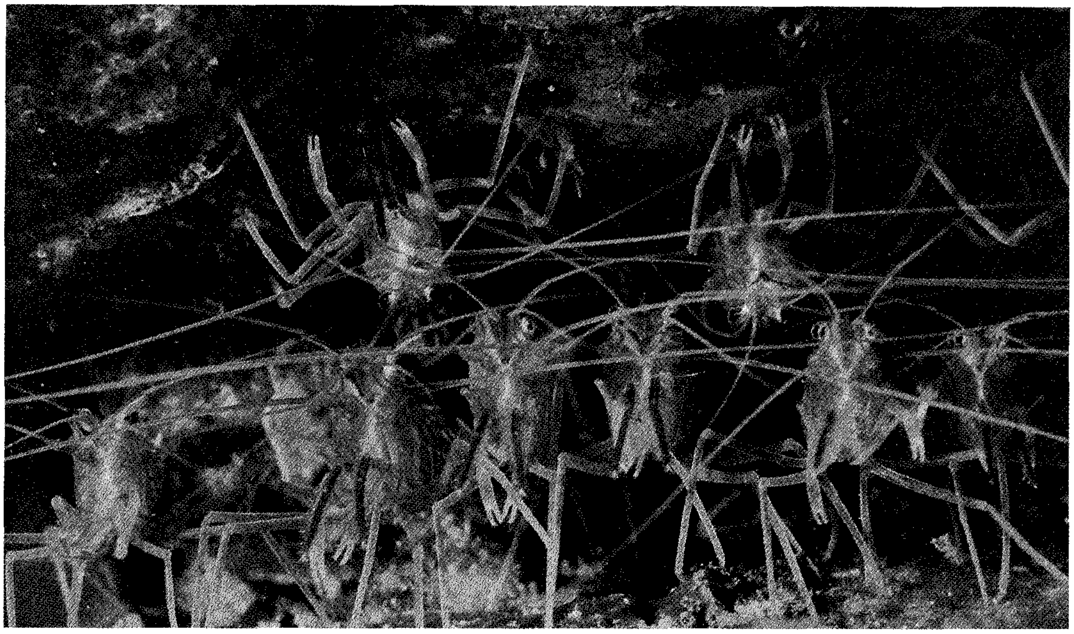

Figure 29. Aggregation of the caridean *Lysmata californica* under a ledge.

Bryozoans

Over 50 species of bryozoans were collected from Isthmus Reef alone (identities based on Osburn 1950, 1952 and 1953), with various combinations of them attached to virtually every rock and algae substrate. They occurred as colonies of many small (generally <1 mm) budding zooids, some growing upright from a common base, others joined together as encrustations on a substrate. Although those attached to algae were poorly quantified, as noted above, the airlift collected a reasonable representation of the major species on rock substrata. These highly ubiquitous organisms occur among the gut contents of virtually all benthivorous fishes, but while it was clear that much of this material is taken purposefully by such species as *Oxyjulis californica*, probably more is taken incidentally.

■ Order Cyclostomata

Bicrisia edwardsiana

Small bush-like colonies of this species, up to about 3 cm high, were abundant in turf rhodophytes and on rock substrata at the two windward sites. On the leeward side of the Island, however, they were collected only at Isthmus Reef, where they were sparse or absent in turf phaeophytes and relatively few on rocks. This distribution was consistent with occurrences in the gut contents of fishes.

B. edwardsiana was a ranked prey of *Embiotoca jacksoni*, *Oxyjulis californica* and *Semicossyphus pulcher*, and an unranked prey among the gut contents of *Girella nigricans*, *Hypsypops rubicundus*, *Coryphopterus nicholsii* and *Lythrypnus zebra*. There were none in fishes from Fisherman's Cove, however, and only one fragment in an *O. californica* from Isthmus Reef. Nevertheless, the species had been consumed by fishes collected over rhodophyte-rich turf at Ship Rock and Bird Rock, suggesting that the distribution of this bryozoan is influenced by the presence of turf rhodophytes rather than by differences between windward and leeward conditions.

Crisia maxima

Colonies of this species were most abundant among branches of rhodophytes at West End and Eagle Rock, where they occurred as erect tufts about 5 cm high. They occurred less abundantly in smaller colonies at Isthmus Reef and other leeward sites, where they were collected mainly from rock substrata but also occurred on turf algae. That this species was taken in greater abundance in the turf collections from the two windward sites than the two leeward sites probably reflected the larger size of colonies there. There was at least one other species of *Crisia* present, *C. occidentalis*.

C. maxima was a ranked prey of *Embiotoca jacksoni*, *Halichoeres semicinctus*, *Oxyjulis californica* and *Semicossyphus pulcher*, and was also among the gut contents of *Hypsypops rubicundus* and *Coryphopterus nicholsii*. It was taken by these fishes at both windward and leeward sites, but more often and in greater abundances at the windward stations. Thus, it constituted 0.1 to 62%, $\bar{x} = 8.3$ % of the diet of 25 fish from the two windward sites, but only 0.1 to 30%, $\bar{x} = 4.9$% of the diet of 10 fish from four leeward sites.

Crisulopora occidentalis

The colonies of this species grew erect as tangled tufts 2 to 3 cm high on rocks and occasionally on older parts of perennial phaeophytes. Although widespread on rock substrata at Isthmus Reef and the two windward stations, it occurred among gut contents of just two *Embiotoca jacksoni*, three *Halichoeres semicinctus* and one *Semicossyphus pulcher*.

Diaperoecia californica (Fig. 30).

The heavily calcified, coral-like colonies of this species usually occurred on rock, but sometimes were on the older parts of perennial phaeophytes. Although these colonies were up to 30 cm in diameter at depths below about 20 m , they did not exceed about 10 cm at the 15-m depth of the Isthmus Reef transect. These colonies were poorly represented in our collections, however, as only fragments were taken. Apparently the fishes had similar difficulties sampling this species, as it occurred in their diets only as fragments in two *Embiotoca jacksoni*, one *Halichoeres semicinctus*, and one *Semicossyphus pulcher*.

Filicrisia spp.

Two species, *F. franciscana* and *F. geniculata*, were common but never abundant as delicate, bushy colonies to about 1.5 cm high on rocks and stipes of perennial phaeophytes. Often the two were not distinguished in gut contents of fishes, where one or both occurred as minor items in *Embiotoca jacksoni*, *Hypsypops rubicundus*, *Oxyjulis californica*, and *Semicossyphus pulcher*.

Tubulipora spp.

Colonies of *Tubulipora* spp. encrusted as small patches less than about 0.3 cm wide on substrata at all four primary sites, mostly on algae. Most were immature, so their identities were uncertain, but *T. pacifica* appeared to dominate (although at least one other, *T. tuba*, was present). Consuming these forms as minor prey were *Brachyistius frenatus*, *Embiotoca jacksoni*, *Halichoeres semicinctus*, *Oxyjulis californica* and *Semicossyphus pulcher.*

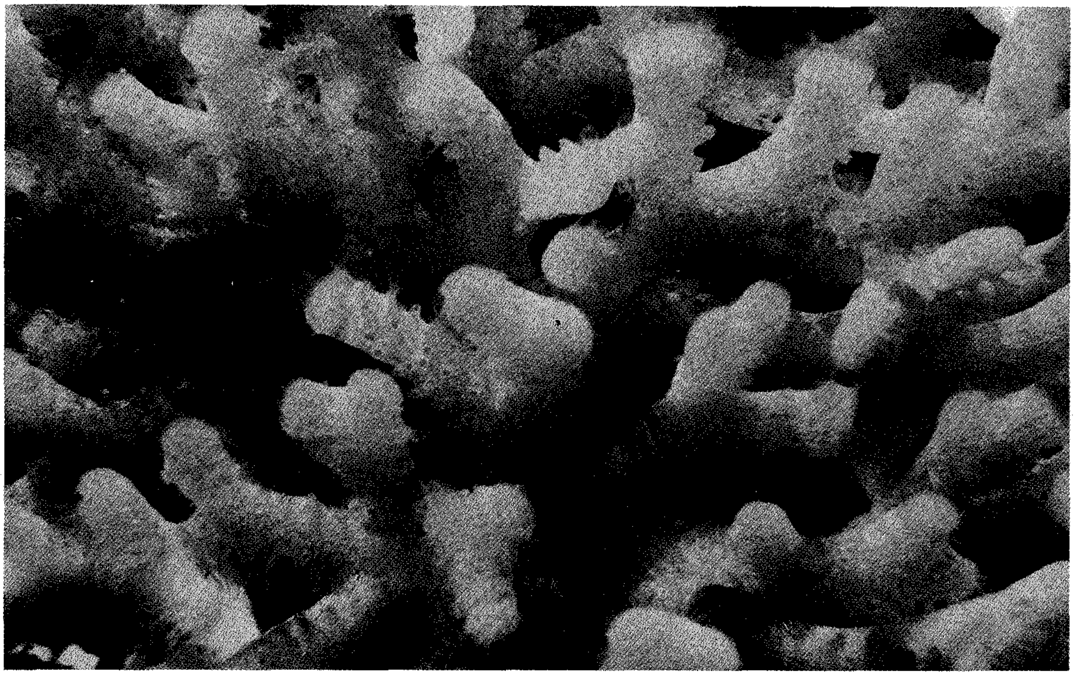

Figure 30. A colony of the bryozoan *Diaperoecia californica*.

■ Order Cheilostomata

Aetea anguina (Fig. 31).

Colonies of *A. anguina* were prominent at all four primary sites. Individual zooids grew upright from stolons that spread over the surfaces of all species of algae examined, but were especially abundant on the rhodophytes *Gelidium nudifrons* and *Pterocladia capillacea.* Only occasionally were these colonies collected from bare rock. Appearing as white fuzz, they at times virtually covered basal parts of the plants. They also occurred on terminal parts of rapidly growing algae, thus demonstrating the rapidity of their own growth.

Despite widespread abundance, *A. anguina* was only infrequently prey of the fishes examined, and probably these occurrences were incidental. Although taken by six *Embiotoca jacksoni*—enough to rank it as prey of that species—the only others to take it were two *Halichoeres semicinctus* and one *Semicossyphus pulcher.*

Bugula neritina (Fig. 32).

This was perhaps the most prominent bryozoan at Isthmus Reef, where bush-like colonies up to about 20 cm wide and 15 cm high were attached to rocks. In contrast to most bryozoans, which are calcified and thus rigid, the non-calcified colonies of *B. neritina* are flexible. Often smaller colonies occurred as epiphytes on *Macrocystis*, but only rarely on

Figure 31. The bryozoan *Aetea anguina* on the rhodophyte *Gelidium nudifrons*.

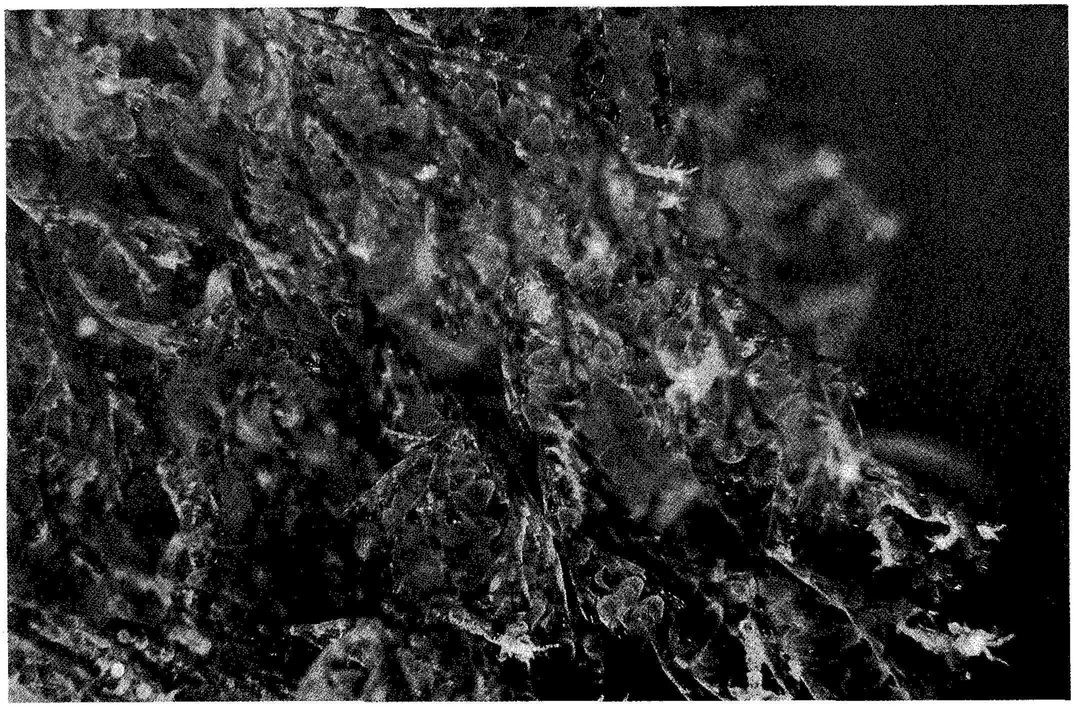

Figure 32. The bryozoan *Bugula neritina*, with numerous caprellids attached.

other algae. It was less abundant, though prominent at the two windward sites, but did not occur in the Fisherman's Cove transect—presumably because that location lacked hard substrata.

B. neritina was a ranked prey of *Hypsypops rubicundus* and *Oxyjulis californica* and an unranked prey of *Brachyistius frenatus*, *Embiotoca jacksoni*, *Halichoeres semicinctus*, *Semicossyphus pulcher*, and *Coryphopterus nicholsii*. Probably at least some of this ingestion was incidental, however. This bryozoan has an epifauna that is essentially like that which draws these same predators to turf algae, and which includes many of their major prey, e. g., caprellids (Fig. 32).

Cellaria mandibulata

Growing erect as branched colonies about 6 cm high, this species was common in dense patches on rocks and in smaller colonies on algae. It was the dominant form among the gut contents of a few *Halichoeres semicinctus*, but not often enough to make it a ranked prey of that species. Otherwise, it was only an occasional presence in the diets of fishes, including *Girella nigricans*, *Embiotoca jacksoni*, *Hypsypops rubicundus*, *Oxyjulis californica*, and *Semicossyphus pulcher*.

Membranipora membranacea (Fig. 5).

Although apparently there has been confusion regarding *M. membranacea*'s distribution in California (Soule et al. 1980), we elect to follow most previous authors (e. g., Woollacott and North 1971) in referring the Santa Catalina form to this species. Its colonies encrusted algae, especially *Macrocystis*, and sometimes virtually covered the plant (Fig. 5). Although Coyer (1979) did not include it in his assessment of invertebrates associated with *Macrocystis*, it is clear from his remarks that this was a dominant form on the plants he examined. Despite its prevalence on *Macrocystis* and other algae, however, this bryozoan was poorly represented in our collections owing to limitations in our sampling methods, as noted above.

In contrast to the many organisms poorly sampled by our collecting methods that were also poorly sampled by the fishes, *M. membranacea* was a frequent food of certain species; in fact, *Oxyjulis californica* took this species more often and in greater abundance than it did any other prey. Others consuming it as ranked prey were *Hypsypops rubicundus*, *Halichoeres semicinctus* and *Semicossyphus pulcher*. Taking it as unranked prey were *Girella nigricans*, *Medialuna californiensis*, *Damalichthys vacca*, *Embiotoca jacksoni*, and *Coryphopterus nicholsii*.

Scrupocellaria bertholetti

Colonies of this bryozoan, which occurred as tangled tufts up to 4 cm high on rocks and algae, occurred at all four primary sites. Although observed regularly on algae, however, the vast majority of our samples, like those of other attached forms, were from airlift collections on rock substrata. This species was only infrequently ingested by fishes, however. Of all the fishes examined, it occurred among gut contents of only two *Halichoeres semicinctus*, both from Isthmus Reef.

Thalamoporella californica

From a crustose base on rocks and algae, colonies of *T. californica* grew as stiff, articulated branches that formed tangled masses to about 5 cm high. We found this to be one of the more prominent bryozoans at all four primary sites, especially on the windward side, and it has been reported to constitute about 50% of the biomass of sessile organisms on some *Macrocystis* off southern California (Woollacott and North 1971).

T. californica was the bryozoan most often taken as prey by the fishes. It was especially prevalent in the diet of *Halichoeres semicinctus*, being present among the gut contents of a third of all individuals examined—more than any other prey species. It was also a ranked prey of *Embiotoca jacksoni*, *Hypsypops rubicundus*, *Oxyjulis californica* and *Semicossyphus pulcher*, and an unranked prey of *Gibbonsia elegans*, *Girella nigricans* and *Medialuna californiensis*.

Tricellaria occidentalis

Small, bushy colonies of *T. occidentalis*, about 1.5 cm high, occurred at all four primary sites, and were noted as present, but not quantified, in many collections from turf. The species was prey of few fishes, however. Although it ranked as prey of *Embiotoca jacksoni*, there were never more than a few fragments in any single fish, and probably these had been ingested incidentally (a likelihood increased by the way this fish feeds). Otherwise, it occurred in just one *Girella nigricans*, one *Gibbonsia elegans* and three *Halichoeres semicinctus* (although in two of the last, it constituted 60 and 63% of the gut contents).

■ Order Ascophora

Celleporaria brunnea

The colonies of *C. brunnea* were rough, encrusting nodules on rocks and algae stipes and common at all four primary sites. Despite being widespread and abundant in the environment, however, this species was an infrequent food of the fishes. It occurred among gut contents of just four fish: two *Embiotoca jacksoni*, one *Hypsypops rubicundus* and one *Semicossyphus pulcher*.

Lichenopora sp.

Some of our specimens of *Lichenopora* were recognized as *L. novae-zelandiae*, which Woollacott and North (1971) and Coyer (1979) found to be a major form on *Macrocystis*. We were unable to identify many others, however, so it remains uncertain whether one or more species is involved here. Although this encrusting form occurred mainly on algae, small collections were taken from rocks. It was not collected in Fisherman's Cove (either from the environment or from the diet of fishes), but was a persistent though never dominant presence in collections from reef sites elsewhere.

Lichenopora sp. was only occasionally ingested by the fishes examined. It never constituted more than 3% of gut-content volume and occurred in just eight fish: two *Embiotoca jacksoni*, one *Hypsypops rubicundus*, two *Halichoeres semicinctus*, one *Oxyjulis californica* and two *Semicossyphus pulcher*.

Asteroids

Family Ophidiasteridae

Linckia columbiae

This sea star occurs in shallow water from southern California southward to the Galapagos Islands, and over this range attains a diameter of 90 mm (Feder 1980). It was the most common asteroid at Santa Catalina (identity based on Johnson and Snook 1955), but was strictly a reef dweller that seemed to favor the Island's leeward side (probably a reflection of its tropical affinities). Larger individuals lying on the seabed were exposed and immobile, which made them readily assessed with visual counts. Numbers counted in 100-m^2 transects on each of the study reefs were as follows: Isthmus Reef (n =7) 4 to 13, $\overline{x} = 7.6$; West End (n = 4) 0 to 4, $\overline{x} = 2.6$; and Eagle Rock (n = 5) 0 to 9, $\overline{x} = 4.4$. Individuals counted in the transects were estimated to be 30 to 80 mm in diameter, whereas diameters of those taken in the collections were 4 to 70 mm. Nevertheless, while it was clear that smaller individuals went uncounted, it remains uncertain whether this is because they were under cover or simply unseen. Either way, there were none of any size among gut contents, suggesting that the fishes find them inedible.

Family Asteriidae

Pisaster giganteus

A common form from Vancouver, Canada, to Baja California, this large sea star can attain a diameter of over 300 mm (Feder 1980). It was widespread on rock substrata at Santa Catalina, where individuals estimated to be 100 to 230 mm in diameter lay immobile and exposed—most abundantly on the windward reefs. These highly visible animals (identity based on Johnson and Snook 1955) were readily assessed by visual counts. Numbers recorded in each of the 100-m^2 transects were as follows: Isthmus Reef (n = 7) 0 to 4, $\overline{x} = 0.9$; West End (n = 5) 3 to 14, $\overline{x} = 8.8$; Eagle Reef (n = 5) 9 to 24, $\overline{x} = 14.5$. There was no evidence of these readily accessible animals in gut contents, suggesting that the fishes find them inedible.

Ophiuroids

Family Amphiuridae

Amphipholis squamata

This relatively small ophiuroid, with disk diameters to 5 mm, is abundant worldwide in algal holdfasts, under rocks and in reef crevices from intertidal to depths of 823 m (Austin and Hadfield 1980). It was the most abundant brittle star at Santa Catalina, with occurrences at all four sites on all substrata sampled (maximum densities: 122/0.25 m^2 of rock surface and 7/100 g *Dictyopteris undulata*, both from Isthmus Reef, and 78/0.25 m^2 of sediment surface in Fisherman's Cove). Our specimens (identity based on Boolootian and Leighton 1966) had disk diameters of 0.6 to 4 mm.

A. squamata was a ranked prey of *Halichoeres semicinctus* and an unranked prey of *Embiotoca jacksoni* and *Pleuronichthys coenosus*. If, as surmised, most of the many unidentified ophiuroids among gut contents were of this species, *Hypsypops rubicundus*, *Oxyjulis californica*, *Semicossyphus pulcher*, and *Coryphopterus nicholsii* would be added to the list of predators.

Family Ophiotricidae

Ophiothrix spiculata

A common species under rocks, in reef crevices and algal holdfasts from central California to the Galapagos Islands, this ophiuroid attains disk diameters up to 18 mm (Austin and Hadfield 1980). In some places around the Channel Islands and elsewhere in southern California, it occurs in dense mats that cover the seabed (Fig. 14). Individuals in these aggregations are anchored to the substrate by one or two arms that entwine among rocks or crevices while the other arms reach up into the water and entrap drifting particles of organic matter on sticky secretions from their podia (Austin and Hadfield 1980). Although dense mats were not seen at Santa Catalina, *O. spiculata* nevertheless was abundant among rocks and turf at the three reef sites (maximum density: 54/0.25 m^2 of rock and 35/100 g *Cystoseira neglecta*, both from Isthmus Reef).

O. spiculata occurred among the gut contents examined more often than any other brittlestar, but to some unknown extent this may have been because its highly distinctive anatomical features made it more recognizable than the others, especially when in a fragmented, semi-digested state. Nevertheless, it ranked as a major prey of *Halichoeres semicinctus* and as an unranked prey of *Embiotoca jacksoni*, *Hypsypops rubicundus*, *Semicossyphus pulcher* and *Coryphopterus nicholsii*—essentially the same group of predators that took *Amphipholis squamata*, above.

Family Ophiactidae

Ophiactis simplex

A locally abundant species on rocky shores from southern California to Panama, this ophiuroid can attain a disk diameter of 6 mm, but more commonly is 2 to 3 mm (Austin and Hadfield 1980). We collected it from both turf and rock at the three reef sites (maximum densities: 5/100 g *Sargassum muticum* and 27/0.25 m^2 of rock, both at Isthmus Reef). It has been found concentrated in the pores of large sponges (Brusca 1980, Austin and Hadfield 1980). Our specimens (identity based on Boolootian and Leighton 1966) had disk diameters of 1.0 to 3.9 mm.

The only evidence of predation on *O. simplex* was its presence in the gut contents of three *Embiotoca jacksoni*—two from Isthmus Reef and one from West End. Those taken by these fish had disk diameters of 3 to 4 mm.

Echinoids

Family Diadematidae

Centrostephanus coronatus

Attaining a test diameter of over 60 mm, this representative of a tropical family occurs in sheltered rock habitats from southern California to Mexico and the Galapagos Islands (Durham et al. 1980). It was not seen at the two windward sites nor on the sediment of Fisherman's Cove, but was a major presence at Isthmus Reef, where seven counts in the 100-m^2 transect noted 7 to 84, $\bar{x} = 36.7$ individuals (identity based on Clark 1948). We collected no small echinoids that could be identified as this species, which was in contrast to the many small *Strongylocentrotus* spp. taken by airlift and with turf (see below). Although the absence of smaller juveniles could mean we failed to sample the proper habitat, we consider it more likely that it means there had been no recent recruitment.

C. coronatus aggregates in reef crevices by day and disperses over the reef at night. More extensive, longer-term changes in distribution are suggested by the variable transect counts presented above. During daylight the spines of many *C. coronatus* sheltered concentrations of the gobiid fish *Lythrypnus dalli.*

We would expect *C. coronatus* to be prey of larger *Semicossyphus pulcher,* which are well known to feed on sea urchins (e. g., Limbaugh 1955), but its characteristic hollow, thorny spines were never found among the gut contents of this or any other fish species. The only evidence we found of predation on this urchin was the presence of its distinctive pedecellariae in *Lythrypnus zebra.*

Family Strongylocentrotidae

Strongylocentrotus purpuratus

This sea urchin, which can have a test diameter to >100 mm (but usually is under 50 mm), is common off exposed rocky shores from British Columbia to Baja California (Durham et al. 1980). It tended to be cryptic at Santa Catalina, with most sightings made after rocks were overturned. Those seen (identity based on Clark 1948) were estimated to have test diameters of about 30 to 60 mm. None were counted in the two windward transects and the relatively few spotted during five of seven counts at Isthmus Reef (1 to 10, $\bar{x} = 5$ individuals) were not a meaningful measure of the numbers present because so many occurred unseen beneath rock cover.

Probably at least most of the juvenile echinoids collected with samples of turf and from rock at the three reef sites were of either this species or *S. franciscanus*. These two are the only southern Californian species of *Strongylocentrotus*, a genus readily recognized even in fragmented, partially digested states by solid spines, distinctive pedicellaria and polyporus ambulacral plates. Our specimens ranged from 0.4 to 10.0 mm (test diameter), with the vast majority <4 mm.

It was difficult to distinguish the two species of *Strongylocentrotus* among gut contents because those large enough to identify (more than about 10 mm) tend to be eaten by fishes that crush their prey on ingestion. Thus, while only *Halichoeres semicinctus* and *Semi-*

cossyphus pulcher were identified with certainty as predators on *S. purpuratus*, certainly there were others among fishes that contained crushed material or small juveniles identifiable only as "echinoids." These others included *Damalichthys vacca, Embiotoca jacksoni, Hypsypops rubicundus, Oxyjulis californica*, and *Coryphopterus nicholsii.*

Strongylocentrotus franciscanus

This large sea urchin (test diameter often 100) occurs subtidally across the perimeter of the north Pacific from Japan to Alaska and south to Baja California (Durham et al. 1980). It was abundant in windward habitats at Santa Catalina, particularly at Eagle Rock, but was far less numerous at leeward sites, including Isthmus Reef. Numbers counted in 100-m^2 transects on each of the study reefs were as follows: Isthmus Reef (n = 7) 0 to 11, $\bar{x}$ = 4.1; West End (n = 5) 42 to 77, $\bar{x}$ = 57.3; Eagle Rock (n = 5) 327 to 620, $\bar{x}$ = 431.3. Those counted (identity based on Clark 1948) had test diameters estimated to be 50 to 100 mm.

The adult *S. franciscanus* were identified as prey of just one species of fish—*Semicossyphus pulcher*—and they occurred as fragments in just three of these. Presumably they would have ranked higher in the diet of this fish if we had examined the gut contents of more larger individuals. As noted above for *S. purpuratus*, probably much of the fragmented material among gut contents that was identifiable only as *Strongylocentrotus* sp. or echinoid sp., actually was of this species (see above for list of these predators).

Holothurians

Family Stichopodidae

Parastichopus parvimensis

This was the only conspicuous holothurian in the transects (identity based on Brumbaugh 1980, who reported a maximum length of 25 cm). It occurred on both sediment and rock at all sites, with results of counts in each of the 100-m^2 transects as follows: Fisherman's Cove (n = 5) 0 to 31, $\bar{x}$ = 12.6; Isthmus Reef (n = 6) 8 to 32, $\bar{x}$ = 22.8; West End (n = 4) 0 to 3, $\bar{x}$ = 0.8; Eagle Rock (n = 5) 0 to 145, $\bar{x}$ = 97.4. Generally it was more abundant at these near shore sites during periods of lower sea temperatures. This would seem in conflict with its consistently low numbers at West End, where sea temperatures usually were lower than at either of the leeward sites, but perhaps its reduced occurrence there came from an aversion to the turbulent sea conditions or foliose rhodophytes that characterize that location.

Although this species rests exposed on the sea bed, we found no evidence of it in the gut contents of fishes. Only two holothurians were recovered from gut contents: a 17-mm individual, probably *Leptosynapta albicans*, in a *Leiocottus hirundo* from Isthmus Reef, and an unidentified 10-mm individual in a *Hypsypops rubicundus* from Lion's Head.

Ascideans

The ascideans can be distinguished as solitary, social or compound, depending on whether individuals are isolated, clustered in groups (and joined at their base), or embedded together in a common tunic. Although this grouping is without taxonomic significance (Abbott 1975), it is more appropriate than the standard taxonomic arrangement for use here because it more effectively brings together ecologically similar species. All are sedentary forms attached to hard substrata, and only one—*Trididemnum opacum*, a compound form—was abundant in both samples from the environment and in gut contents.

Family Didemnidae

Trididemnum opacum (Fig. 33).

This species occurs as encrusting sheets up to 20 cm in diameter and 1 to 4 mm thick on rocks and algae from northern California to Baja California (Abbott and Newberry 1980). Most of the colonies at Santa Catalina, however, were much smaller than this—perhaps 5 cm or less. *T. opacum*, the most widespread and abundant ascidean at Santa Catalina, was prominent at all study sites. Nevertheless, while common on turf algae—especially on the basal portions of *Cystoseira neglecta* and other perennial phaeophytes—it was poorly sampled with our collections of turf. Colonies on rock substrata were sampled more effectively; in fact, *T. opacum* averaged 9 and 10% of the volume of all airlift collections from Isthmus Reef and West End, respectively, and from 2% to 83% of the airlift collections from Eagle Rock. It was not taken from Fisherman's Cove, however.

Consistent with its abundance in the environment, *T. opacum* was important as food of fishes. It was a ranked prey of *Embiotoca jacksoni*, *Hypsypops rubicundus*, *Halichoeres*

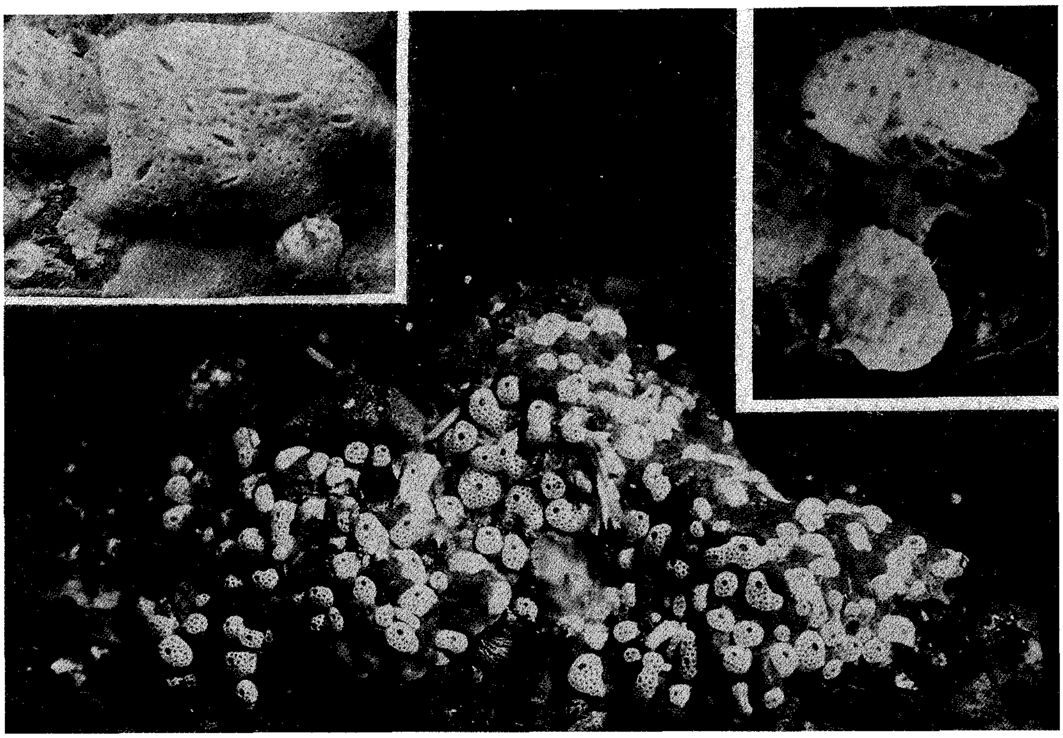

Figure 33. Colonies of the ascidean *Trididemnum opacum* encrusting a rock. Inset at upper left: each slit marks chamber of a gammarid amphipod, *Polycheria osborni*. Inset at upper right: the gammarid *Pleustes platypa* (top) mimics colony of *T. opacum* (bottom).

semicinctus, *Oxyjulis californica* and *Semicossyphus pulcher*, and an unranked prey of *Brachyistius frenatus*. Above we suggest that two gammaridean amphipods, *Pleustes platypa* and *Polycheria osbourni*, gain protection from predators by associating with *T. opacum*—the former as an apparent mimic of small colonies, the latter as an occupant of chambers in the ascidean's tunic. One might ask how they gain such protection when *T. opacum* itself is frequent prey, but predators on *T. opacum* seem limited to species with pharyngeal crushing mechanisms, which excludes many of the major predators on gammarideans, including cottoids, hexagrammoids, gobioids and blennioids.

Other compound ascideans that occurred only occasionally in our collections—*Aplidium* spp., *Distaplia* sp. and *Ritterella aequalisiphonus*—were nevertheless unranked prey of *Embiotoca jacksoni*, *Hypsypops rubicundus*, *Halichoeres semicinctus* and *Semicossyphus pulcher* (virtually the same species that were predators on *T. opacum*).

Two ascideans of the social type—*Metandrocarpa taylori* and *Pycnoclavela stanleyi*—were prominent on reefs, often in densities estimated to be hundreds/m^2, but so firmly attached that relatively few occurred in our samples. Despite their abundance and accessibility, however, they were infrequently ingested by the fishes, occurring only as unranked prey of *Embiotoca jacksoni* and *Halichoeres semicinctus*. A third social form common on reefs, *Euherdmania claviformis*, was more readily sampled by the airlift, but nevertheless was underrepresented in our collections (maximum density 42/0.25 m^2 of rock at Isthmus Reef). The only other social ascidean noted in the Santa Catalina habitats was *Clavellina huntsmani*, which was only occasionally seen. Solitary ascideans, which were only occasionally seen or collected, included *Ascidea ceratodes*, *Pyura haustor*, and *Styela clava*.

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