# Food Habits of Reef Fishes of the West Indies

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## ABSTRACT

The stomach contents of 5,526 specimens of 212 species of reef and inshore fishes representing 60 families were analyzed. Most of these fishes were collected by spearfishing in Puerto Rico and the Virgin Islands. The principal plant and animal groups eaten by the fishes are listed by percentage volume of the stomach contents under fish family and species headings. When practicable, the food organisms were identified. Following the species accounts, the major groups of food organisms are discussed.

In the following summary, the various families, genera, and species of fishes are grouped into major feeding categories, based on their principal food habits as determined from the data of this report.

*Plant and detritus feeders* (food 50 per cent or more plant material) : The mullet *Mugil curema;* the porgies *Archosargus rhomboidalis* and *Diplodus caudimacula;* the sea chubs (Kyphosidae); the damselfishes *Abudefduf taurus, Microspathodon chrysurus, Pomacentrus fuscus,* and *P. variabilis;* the parrotfishes (Scaridae); the gobies *Coryphopterus glaucofraenum* and *Gnatholepis thompsoni* (and probably the other gobiids as well); the angelfish *Centropyge argi;* the surgeonfishes (Acanthuridae); the blennies *Blennius cristatus, B. marmoreus, Entomacrodus nigricans,* and *Ophioblennius atlanticus;* the triggerfish *Melichthys niger;* and the filefish *Alutera schoepfi.* In addition, the following omnivorous fishes feed heavily on marine plants: the halfbeak *Hemiramphus brasiliensis;* the damselfishes *Pomacentrus leucostictus* and *P. planifrons;* the angelfishes *Pomacanthus arcuatus* and *P. paru;* the filefishes *Alutera scripta, Cantherhines pullus,* and *Monacanthus ciliatus,* and the sharpnose puffer *Canthigaster rostrata.*

*Zooplankton feeders:* The herrings (Clupeidae); the round herrings (Dussumieridae); the garden eel *Taenioconger halis;* the halfbeak *Hemiramphus balao;* the soldierfish *Myripristis jacobus;* the silversides (Atherinidae); the creole fish *Paranthias furcifer;* the sea bass *Serranus tortugarum;* the fairy basslets (Grammidae); the hawkfish *Amblycirrhitus pinos;* the cardinalfishes (Apogonidae); the big-eyes (Priacanthidae); the sweeper *Pempheris schomburgki;* the boga *Inermia vittata;* the snapper *Ocyurus chrysurus* (except large adults); the drum *Equetus acuminatus;* the scads *Decapterus macarellus, D. punctatus,* and *Selar crumenophthalmus;* the damselfishes *Chromis cyanea* and *C. multilineata;* the razorfish *Hemipteronotus splendens;* and the jawfish *Opisthognathus aurifrons.* The following fishes also feed in part on animals of the plankton: the croaker *Odontoscion dentex;* the remoras (Echeneidae); the damselfish *Abudefdu saxatilis;* the wrasse *Thalassoma bifasciatum;* the triggerfishes *Canthidermis sufflamen* and *Melichthys niger;* and the filefishes *Monacanthus ciliatus* and *M. tuckeri.* In addition, the juveniles of many fishes such as the pomadasyids and carangids feed primarily on zooplankton.

*Sessile animal feeders: Abudefduf saxatilis* and to a lesser extent several other damselfishes; the spadefish *Chaetodipterus faber;* the butterflyfishes and angelfishes (Chaetodontidae) (except *C. argi*); the filefishes *Alutera scripta, Cantherhines macrocerus,* and *C. pullus;* and the trunkfishes *Acanthostracion polygonius, A. quadricornis,* and *Lactophrys bicaudalis.* The angelfishes and *C. macrocerus* feed primarily on sponges; the sharp-nose puffer *Canthigaster rostrata* and some of the trunkfishes also feed in part on sponges. *Abudefduf saxatilis* feeds on a wide variety of organisms, but the largest percentage of its stomach contents proved to be *Zoanthus.* The butterflyfishes consume mainly anthozoans (especially *Zoanthus)* and the tentacular crowns of tube-dwelling polychaetes. *Alutero scripta* is unusual in feeding heavily on stinging coral (*Millepora*) and gorgonians. The three trunkfishes appear to show a preference for tunicates. Many of these fishes also feed in part on plants.

*"Shelled"-invertebrate feeders:* The eagle ray *Aetobatis narinari;* the grunts *Anisotremus surinamensis, Haemulon carbonarium, H. macrostomum,* and to a lesser extent *H. plumieri* and *H. sciurus;* the porgy *Calamus bajonado,* and to a lesser degree other species of *Calamus;* the permit *Trachinotus falcatus;* the wrasses *Bodianus rufus, Halichoeres* spp. (except *maculipinna), Hemipteronotus novacula,* and *Lachnolaimus maximus;* the triggerfish *Balistes vetula;* the trunkfish *Lactophrys trigonus;* the puffer *Sphaeroides spengleri;* and the porcupinefishes (Diodontidae). All of these fishes are able to crush their prey of gastropods, pelecypods, echinoderms, crabs, and hermit crabs with their jaws or pharyngeal teeth.

*Generalized carnivores* (on a variety of mobile benthic animals such as crustaceans, worms, and small fishes): The stingray *Dasyatis americana;* the moray *Echidna catenata* (all crustaceans, mostly crabs); the snake eels *Myrichthys acuminatus* and *M. oculatus;* the squirrelfishes *Holocentrus* spp.; the groupers *Alphestes afer, Cephalopholis fulva, Epinephelus* spp., *Hypoplectrus spp., Petrometopon cruentatum,* and *Serranus tigrinus:* the soapfish *Rypticus saponaceus,* the snappers *Lutjanus* spp. (except *L. cyanopterus* which feeds on fishes, as to a lesser extent do *L. apodus. L. jocu,* and *L. mahogoni);* the grunts *Anisotremus virginicus, Haemulon album, H. aurolineatum, H. chrysargyreum, H. flavolineatum,* and *H. parra;* the mojarras (Gerreidae); the drums *Equetus lanceolatus* and *E. punctatus;* the goatfishes (Mullidae); the tilefish *Malacanthus plumieri:* the palometa *Trachinotus glaucus;* the wrasse *Halichoeres maculipinna;* the flounder *Bothus ocellatus;* the clinids *Labrisomus* spp.; the jawfishes *Opisthognathus* spp. (except *O. aurifrons);* the scorpionfishes (Scorpaenidae); the flying gurnard *Dactylopterus volitans;* the trunkfish *Lactophrys triqueter;* and the batfish *Ogcocephalus nasutus.*

*Ectoparasite feeders:* Juvenile porkfish *Anisotremus virginicus;* the shark suckers *Echeneis naucrates* and *Remora remora;* the wrasses *Bodianus rufus* and *Thalassoma bifasciatum* (the former as juveniles, the latter as juveniles and adults except the terminal male phase); the goby *Elacatinus* sp.; and juvenile angelfishes of the genera *Holacanthus* and *Pomacanthus.* In addition, the fairy basslet *Gramma loreto* and the young of the damsel-fish *Microspathodon chrysurus* occasionally feed in part on the crustacean ectoparasites of fishes. Probably none of these fishes are facultative "cleaners." The shark suckers, *Thalassoma bifasciatum,* and the young angelfishes appear to feed more on other organisms than on fish parasites.

*Fish feeders:* Sharks of the families Orectolobidae (reported to feed heavily on various invertebrates as well) and Carcharhinidae; the tarpon

[1] Contribution from the Institute of Marine Biology, University of Puerto Rico, Mayaguez, P. R.

*Megalops atlanticus* (also known to feed on crustaceans and other invertebrates); the lizardfishes (Synodontidae); moray eels of the genus *Gymnothorax;* the snake eel *Ophichthus ophis;* the needlefishes (Belonidae); the cornetfish *Fistularia tabacaria;* the trumpetfish *Aulostomus maculatus* (about ¼ of the diet was shrimps); the barracudas (Sphyraenidae); groupers of the genus *Mycteroperca;* the sea bass *Serranus tabacarius* (one specimen); the snapper *Lutjanus cyanopterus;* the cobia *Rachycentron canadum* (one specimen); jacks of the genera *Caranx, Oligoplites,* and *Seriola;* the little tuna *Euthynnus alletteratus* and mackerels of the genus *Scomberomorus;* the flounder *Bothus lunatus;* and the frogfishes *Antennarius multiocellatus* (about 1/5 of the food was crustaceans) and *A. scaber.* A number of the above piscivorous fishes fed in part on cephalopods, but in all cases except *Ophichthus ophis* (half of the stomach con-tents of four of these eels consisted of octopuses) and *Euthynnus alletteratus* (36.6 per cent squids), the cephalopods were less than 18 per cent by volume of the stomach contents.

## INTRODUCTION

In November, 1958, the Institute of Marine Science of the University of Miami commenced a marine-biological and fisheries survey of the Virgin Islands National Park from a small field station at Lameshur Bay, St. John. The program terminated in June, 1961. Some phases of the survey, including that of the present paper, were continued in Puerto Rico from July, 1961, to October, 1965, while the author was a member of the Biology Department and the Institute of Marine Biology of the University of Puerto Rico at Mayaguez.

Among the projects undertaken during the survey was a study of the food habits of fishes from inshore reefs and adjacent habitats. Emphasis was placed on fishes of sportfishing value because of partial support from the Dingell-Johnson program. The data presented for few of the fishes, however, may be regarded a definitive expression of their food habits. Analysis of the stomach contents of more specimens is needed, as well as additional underwater observation of their actual feeding. Since so little is known of the habits of West Indian reef fishes, in general, a decision was made to carry out research on many species rather than confine the study to just a few. For many of the fishes the data presented herein constitute the first published information on their food habits. It was realized that the information for some would be fragmentary. More field work, particularly on the smaller species, was planned; however, a move from the Caribbean precluded further collection of fishes. The present report is based on the examination of the stomach contents of a total of 5,526 specimens of 212 species.

A number of publications have appeared as a result of the marine biological survey in the Virgin Islands, most of which complement the research on food habits. In addition to systematic papers, there has been a report on the fisheries potential of St. John (Idyll & J. Randall, 1959), a study of mimicry and protective resemblance of tropical marine fishes (Randall & Randall, 1960), tagging studies of reef fishes (J. Randall, 1960, 1962a, 1963a), a chart of the marine environments of St. John (Kumpf & H. Randall, 1961), studies on the grazing effects of herbivorous fishes on marine plants (J. Randall, 1961a, 1965a), analysis of fish populations of natural and artificial reefs of St. John (J. Randall, 1963b), observations on the spawning of scarid and labrid fishes (Randall & Randall, 1963), biology of the West Indian topshell *(Cittarium pica)* (H. Randall, 1964), biology of the queen conch *(Strombus gigas)* (J. Randall, 1964a), biology of the echinoid *Diadema antillarum* (J. Randall, Schroeder, and Starck, 1964), and food habits of the hogfish *(Lachnolaimus maximus)* (J. Randall & Warmke, in press). Three additional papers are in progress which are pertinent to the present study. One by J. Randall and Willard D. Hartman will discuss sponge-feeding reef fishes. Another by J. Randall, Luis R. Almodóvar, and Francisco Pagán is concerned with the algae eaten by parrotfishes and the role of these fishes in the production of sediment. Jorge Rivera will report on the food habits and other aspects of the biology of sharks caught inshore off southwestern Puerto Rico. This study, which was initiated by the author, is supported by the Office of Naval Research.

The importance of obtaining the correct names of organisms in ecological studies cannot be overemphasized. Considerable effort was made in this report to correctly identify the fishes and food organisms. Determinations of identifiable plant and invertebrate animal remains from fish stomachs were made largely by systematists who specialize in the various groups or from reference collection material prepared by them. For data on classification of the fishes, the reader is referred to a forthcoming guidebook on West Indian fishes in preparation by the author.

The two most significant publications on the food habits of West Indian reef fishes are Beebe & Tee-Van's "Fishes of Port-au-Prince Bay, Haiti" (1928) and Longley & Hildebrand's "Systematic Catalogue of the Fishes of Tortugas, Florida" (1941). Information on the food habits of fishes from these works and other papers will be summarized in the Remarks section of individual species accounts.

The food-habit data are presented in approximate phylogenetic sequence by family. Within each family the individual fish accounts are given alphabetically by genus and species. When more than one species is discussed in a family, a short family discussion is included, primarily for remarks that apply to all of the species.

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## METHODS

The majority of the fishes taken for this food-habit study were collected in the Virgin Islands and Puerto Rico (a few were taken at other West Indian islands). Most were collected with a Hawaiian sling spear or a multi-prong spear. Although spearfishing is a time-consuming method of collecting fishes, it is free of certain problems associated with some of the other methods. Anything found in the stomach of a fish taken with a spear can be confidently regarded as having been normally ingested by the fish. Fishes captured in traps usually have empty stomachs. The trap-caught piscivorous fishes, on the other hand, may have full stomachs due to the opportunity to prey upon smaller fishes in the same trap. These small fishes might ordinarily elude the predators in the natural environment.

Studies of the stomach contents of carnivorous fishes taken with rotenone or other poisons may also be unreliable. The smaller fishes and certain invertebrates are usually killed by the poison first, and the larger fishes often feed freely upon them before they, in turn, succumb. Rotenone was used, however, to collect some of the smaller herbivorous fishes or fishes that feed primarily on sessile invertebrates.

Fishes taken on hook and line often have empty stomachs or contain only the bait or chum. Presumably, a fish with an empty stomach is more apt to take the hook. Also, during the struggle on the line, some fishes tend to regurgitate. This is particularly true of fishes caught in water deeper than about 50 feet. The gas bladder expands as a fish is brought rapidly to the surface and tends to force the stomach toward the mouth. Physoclistic fishes from deep water may be expected to have the stomach fully everted into the mouth. Regurgitation was often observed during the transport of speared fishes to the surface from depths of about 50 to 200 feet, but it was usually possible for the diver to recover this material. In spite of the higher percentage of empty stomachs among fishes taken by hook and line, this method of capture was used for several species such as king mackerel *(Scomberomorus cavalla)* and porgies of the genus *Calamus,* which are difficult to approach underwater.

A few fishes were taken for the study by seines, throw nets, and explosives.

Everything found in the stomach of a fish does not always represent what is specifically sought as food. Not infrequently sand, stones, or pieces of algae or seagrass were encountered in the stomachs of carnivores. These items were probably taken in accidentally with the prey or in the attempt to capture prey. Bottom-dwelling fishes often ingest inorganic sediment incidentally during feeding. Some of this material may be of organic origin. Examples are fragments of calcareous algae, foraminifera, sponge spicules, small pelecypod and gastropod shells or fragments of larger shells, chiton plates, spines and pieces of the test of echinoids, and ophiuroid fragments. Usually it was possible to identify such fragments as sediment by their eroded appearance, and in the light of the remaining material in the fish stomachs. It might be added that some sedimentary material in the alimentary tracts of fish may be present as a result of the digestion of sipunculids, holothurians, and certain polychaetes which had either ingested the sand themselves or utilized it to form tubes in which they lived. Inorganic material in the stomachs of fishes was not included in the analyses of the stomach contents; nor was plant material in the stomachs of carnivorous fishes. Mention is made, however, of significant amounts of indigestible stomach-content material in the Remarks section of individual species accounts.

Occasional small animals, especially crustaceans and mollusks, were noted among the algae or seagrass in the stomachs of herbivorous fishes. It was evident from their small size that these animals were not selected by the grazing fishes.

The stomachs of some carnivorous fishes were at times found with tiny copepods and other small planktonic organisms that seem too small to be normal prey. Although some large fishes may eat surprisingly small organisms, their stomachs may contain even smaller animals as a result of the liberation of the contents of the alimentary tracts of their prey. If an animal such as a salp or small fish is sufficiently crushed or digested to expose its food organisms, these could be erroneously attributed to the large predator.

When nocturnal habits become apparent for certain fishes by the consistent finding of empty stomachs during late morning and afternoon hours, further collecting was concentrated very early in the morning.

Data on the food habits of fishes were obtained throughout the period

of study, thus tending to eliminate any possible bias due to seasonal variation in food habits. Although tropical marine fishes would not be expected to show significant differences in their diet with season, some variation might be expected from local fluctuations in the abundance of food organisms. This would seem particularly true of larval stages or of adults aggregating for reproductive purposes.

Marked changes in food habits may be expected for most fishes as they grow from juveniles to adults. Most data for the present study were obtained from adult fishes. The adults, in general, have more impact on the reef community through their feeding than juveniles. Determination of the varying food habits of the different stages of the life histories of the reef fishes must await detailed autecological studies.

Many species of reef fishes occur in diverse reef habitats, and their food habits may differ profoundly from area to area. This was aptly demonstrated for the gray snapper *(Lutjanus griseus)* by Longley, Schmitt, & Taylor (1925) who stated that it would be possible from an average sample of 10 fish to determine from which of seven different sites at Dry Tortugas, Florida, that the snappers had been collected. For this reason an effort was made in the present study to collect in all environments in the Virgin Islands and Puerto Rico in which the fishes were encountered. The analysis of stomach contents of a few specimens from several different areas is usually more indicative of the full spectrum of the diet than the examination of many fish from a single area.

One source of error in food-habit studies of fishes which prey upon a variety of organisms is the result of the varying rate of digestion of the different food organisms. Soft-bodied animals such as ctenophores, salps, and certain worms are digested rapidly and may be difficult to identify even to major group after a relatively short sojourn in a fish stomach. On the other hand, organisms with hard parts are digested slowly, and the skeletal material may not be digested at all. The inevitable result is a bias in the data toward the less digestible organisms. Such a bias is greater if working with intestinal contents than with stomach contents; for this reason, only stomach-content analyses were made except for a few fishes such as the diodontids and *Lachnolaimus maximus* which feed almost exclusively on invertebrates with shells or exoskeletons.

Within a group of organisms certain ones with a distinctive morphological feature which is not readily digested may permit a relatively high percentage of identification to the lower taxonomic categories. It should be pointed- out, therefore, that large numbers of such distinctive animals listed from the stomachs is not necessarily an indication of their abundance relative to other forms. Examples of distinctive animals are the parrotfishes with their unmistakable beak-like fused teeth and characteristic pharyngeal mill, and the alpheid shrimps with their unique snapping chela.

Not infrequently only the chela of an alpheid was found in the stomach of a fish, indicating that the shrimp had escaped by way of autotomy of its claw. Detached crab chelae were also often detected in fish stomachs with no remains of the rest of the crabs.

In the stomach content analyses the term "shrimp," in general, refers to decapod shrimps. When identified, the mysid shrimps (Mysidacea) and euphausids (Euphausiacea) were considered as separate categories. In the grouping "crabs," however, the anomurans were not distinguished from the brachyurans except for the hermit crabs. The great majority of crabs from fish stomachs were brachyurans.

A reference collection of the common fishes and invertebrates was assembled at St. John. This and a comparable collection at the Institute of Marine Biology of the University of Puerto Rico were most useful in identifying the broken and digested remains of animals in fish stomachs. Still there was a considerable amount of material from the stomachs of many fishes that could not be identified to class or phylum.

The dentition of the fishes and the morphology of their digestive tracts are often indicative of the food habits. Information on the structure of teeth and digestive system may be found in certain systematic works such as Jordan & Evermann (1896-1900), and in Suyehiro (1942), and Hiatt & Strasburg (1960). Although the latter two studies concern species of fishes from Japan and the Marshall Islands, respectively, the remarks on morphology usually apply equally well to species of the same genera in the Atlantic. Information on the food habits of fishes in these two papers provides interesting comparison with that of the present work.

The lengths were recorded for all of the fishes that were examined. Usually the standard length (tip of snout to base of caudal fin) was tabulated. This is abbreviated in the species accounts as SL. Total length (TL) was used for sharks and eels, and fork length (FL) for most of the carangids and scombrids. Numbers in parentheses following the names of food organisms indicate the number of stations at which fishes were taken that fed upon these organisms. The abbreviation "juv." designates the food organisms as small juveniles, and "larv." as larvae or postlarvae.

The results of the stomach-content analyses are given in terms of the percentage volume of the different major groups of food organisms. The percentages were visually estimated for individual fish, and the totals computed from all of the stations combined.

Identifications of organisms from fish stomachs are given at the specific, generic, family, or higher category depending on the condition of the organism and the status of the knowledge of the classification of the group. The same species of shrimp, for example, might be labelled *Brachycarpus biunguiculatus, Brachycarpus* sp., palaemonid, caridean, shrimp, or simply as crustacean, depending on how thoroughly it was crushed when eaten or how extensively it had been digested. Most of the stomach-content data are grouped under the higher categories.

## FOOD HABITS

### ORECTOLOBIDAE (Nurse Sharks)

*Ginglymostoma cirratum* (Bonnaterre) NURSE SHARK

19 stations; 24 specimens: 605 to 2338 mm TL; 15 empty.

| FOOD | VOLUME (%) |
|---|---|
| Fishes | 89.0 |
| *Acanthurus sp.* | |
| *Cantherhines pullus* | |
| clupeid | |
| *Jenkinsia* sp. | |
| scarid | |
| Cephalopods | 11.0 |

*Remarks.*—Bigelow & Schroeder (1948) described *G. cirratum* as "proverbially sluggish" and stated that it feeds chiefly on invertebrates such as squids, shrimps, crabs, spiny lobsters, sea urchins, and also on small fishes. Only nine of the 24 specimens examined by the author contained food. Eight of these had eaten fishes, and the ninth had a cephalopod beak in its stomach. Beebe & Tee-Van (1928) reported two parrotfish in the stomach of one specimen. Admittedly the species seems sluggish; much of its diurnal time appears to be spent resting on the bottom. Its mouth and teeth are small; the teeth occur in from 7 to 12 functional bands in the jaws. Possibly its success in feeding on fishes is related to nocturnal habits. The nurse shark is observed more frequently on West Indian reefs than any other shark. It is disliked by fishermen because it often damages fish traps. It is popularly regarded as harmless to man; actually it is prone to bite when provoked (Randall, 1961b).

### CARCHARHINIDAE (Requiem Sharks)

This is the largest family of sharks. Species of the largest genus, *Carcharhinus,* may be difficult to identify. J. A. F. Garrick kindly assisted the author in the identification of some sharks of this genus. A few specimens of *C. limbatus* and *C. acronotus,* which were caught inshore, had empty stomachs or contained only bait. Limited data for offshore species are not included. The carcharhinids, in general, are nocturnal. Were this not the case, the number of shark attacks on man would probably be much greater. Some species such as the tiger shark *(Galeocerdo)* are rarely encountered inshore during the day but are often caught on set lines in shallow water at night. The teeth of sharks often provide clues to their feeding habits. Sharks that have slender, smooth-edged teeth tend to feed on fishes of relatively small size; those with broad, coarsely-serrate teeth are better equipped to-tear pieces from large prey. Bigelow & Schroeder (1948) should be consulted for details on the morphology and habits of western Atlantic species.

*Carcharhinus springeri* (Bigelow & Schroeder) SPRINGER'S SHARK

5 stations; 5 specimens: 935 to 1660 mm TL; 2 empty.

| FOOD | VOLUME (%) |
|---|---|
| Fishes | *100.0* |
| *Priacanthus arenatus* | |

*Remarks.*—*C. springeri* appears to be the most common inshore shark of the genus in the Virgin Islands. It is capable of lying motionless on the bottom like the nurse and lemon sharks. The 1660-mm specimen was speared when it was discovered lying on the bottom in a cave. Its stomach contained one bigeye *(P. arenatus),* which measured 245 mm SL.

*Galeocerdo cuvier* (Peron & LeSueur) TIGER SHARK

2 stations; 2 specimens: 2223 and 2340 mm TL.

| FOOD | VOLUME (%) |
|---|---|
| Fishes | 50.0 |
| *Diodon hystrix* | |
| *Monacanthus* sp. | |
| Sea turtles | 50.0 |
| *Caretta caretta* | |

*Remarks.*—The tiger shark is well known for the great variety of food organisms, as well as indigestible objects, that have been found in its stomach. Recent food-habit data from Puerto Rican specimens will be reported by Rivera (MS). The powerful jaws and coarsely serrate teeth enable this species to cut pieces from large prey including such durable animals as sea turtles. The loggerhead turtle cited above was taken from the stomach of a specimen collected in the Bahamas.

*Negaprion brevirostris* (Poey) LEMON SHARK

2 stations; 2 specimens: 632 and 1605 mm TL; 1 empty.

| FOOD | VOLUME (%) |
|---|---|
| Fishes | 100.0 |

Remarks.—Clark & von Schmidt (1965) listed five different species of fishes fed upon by lemon sharks from West Florida; also they reported octopods from the stomachs.

*Rhizoprionodon porosus* (Poey) SHARP-NOSE SHARK

4 stations; 5 specimens: 585 to 895 mm TL; 4 empty.

| FOOD | VOLUME (%) |
|---|---|
| Fishes | 100.0 |
| *Halichoeres* sp. | |

*Remarks.*—Prior to the review of the genus *Rhizoprionodon* by V. Springer (1964), the name *Scoliodon terraenovae* was used most often for this small species in the West Indies.

DASYATIDAE (Stingrays)

*Dasyatis americana* Hildebrand & Schroeder SOUTHERN STINGRAY
23 stations; 25 specimens: 320 to 1360 mm disc length; 2 empty.

| FOOD | VOLUME (%) |
|---|---|
| Fishes | 21.8 |
| *Acanthurus* sp. (juv.) | |
| engraulids | |
| *Opisthognathus* sp. (2) | |
| *Scorpaena plumieri* | |
| Sipunculids | 20.6 |
| *Aspidosiphon* sp. | |
| Crabs | 17.6 |
| calappid | |
| hippid | |
| majid | |
| portunids (3) | |
| *Portunus* sp. | |
| xanthid | |
| Polychaetes | 17.3 |
| Pelecypods | 10.8 |
| *Asaphis deflorata* | |
| Shrimps | 7.6 |
| alpheid | |
| penaeids (2) | |
| *Solenocera* sp. | |
| Hemichordates | 2.3 |
| Stomatopods | 2.0 |

*Remarks*.—Although not a resident of reefs, this ray is often seen cruising over reefs or lying at rest in small sand patches among reefs. It may make broad excavations in the sand when feeding. Bigelow & Schroeder (1953) listed the stomach contents of specimens from Florida, North Carolina. and the Bahamas as clams, crabs, shrimps, stomatopods, worms, and small bony fishes. Very few fragments of pelecypod shells were found in the stomachs. Clams are apparently crushed in the plate-like jaws of the rays, and only the soft parts selected. One 300-mm ray had 52 penaeid shrimps *(Solenocera* sp.) and 12 crabs *(Portunus* sp.) in its stomach.

MYLIOBATIDAE (Eagle Rays)

*Aetobatis narinari* (Euphrasen) SPOTTED EAGLE RAY
4 stations; 4 specimens: 600 to 1040 mm disc length; 1 empty.

| FOOD | VOLUME (%) |
|---|---|
| Gastropods | 53.4 |
| *Astraea tuber* | |
| *Strombus gallus* | |
| *Strombus gigas* | |
| Pelecypods | 46.6 |

*Remarks*.—In contrast to species of *Dasyatis* which are often encountered during the day at rest on the bottom, the spotted eagle ray is usually in motion, swimming gracefully over sand, grass, and mud flats and reefs. Bigelow & Schroeder (1953) reviewed its food habits. They stated that it feeds chiefly on bivalve mollusks; in some areas the rays are very destructive to commercially important clams and oysters. Randall (1964a) has discussed the depredations by this ray on the most valuable West Indian mollusk resource, the queen conch *(Strombus gigas*). The mollusks are crushed by the dental plates of the rays during feeding. Shell fragments are rarely encountered in the stomachs, however. Bigelow & Schroeder postulated that the rays separate out the shells by means of their buccal papillae. It seems more likely that an entire crushed mollusk is ejected from the mouth and only the fleshy part picked up. Randall noted that the horny opercula were missing from the *Strombus* which had been eaten. The operculum adheres strongly to the foot of a conch and would seem to require a separate wrenching action by a ray to remove it.

ELOPIDAE (Ladyfishes and Tarpons)

*Megalops atlantica* Cuvier & Valenciennes TARPON
4 stations; 4 specimens: 395 to 1100 mm SL; 2 empty.

| FOOD | VOLUME (%) |
|---|---|
| Fishes | 100.0 |
| *Allanetta harringtonensis* | |
| *Atherinomorus stipes* | |

*Remarks*.—Data on the food habits of the tarpon have been reported by Knapp (1949), Babcock (1951), Moffett & Randall (1957), Harrington & Harrington (1960), and Hildebrand in Bigelow *et al* (1963). The adults prey upon a wide variety of fishes, crabs, and shrimps. Several tarpon from west Florida were noted by the author to regurgitate ctenophores when boated. The juveniles feed principally on copepods, aquatic insects, and small fishes. *M. atlantica* is a fish of diverse habitats. In the Virgin Islands adult are most commonly seen off promontories, but they often range into shallow bays to feed on small schooling fishes. At times two or three were observed to attack simultaneously side by side; such a maneuver probably increases the efficiency of feeding.

CLUPEIDAE (Herrings)

The three clupeids for which food-habit data are presented are all schooling fishes which are often seen in shallow water. They may be found near the surface, in mid-water, or near the bottom. When they

swim over reefs they are often preyed upon by the resident carnivorous fishes. They feed primarily on zooplankton.

*Harengula clupeola* (Cuvier) FALSE PILCHARD
2 stations; 21 specimens: 70 to 107 mm SL; 9 empty.

| FOOD | VOLUME (%) |
|---|---|
| Copepods | 55.0 |
| *Candacia pachydactyla* | |
| *Undinula vulgaris* | |
| Crab larvae | 25.0 |
| Shrimp larvae | 8.0 |
| Polychaetes | 5.0 |
| Pteropods | 5.0 |
| *Creseis* sp. | |
| Fish eggs | 2.0 |

*Harengula humeralis* Cuvier & Valenciennes RED-EAR SARDINE
2 stations; 24 specimens: 60 to 93 mm SL.

| FOOD | VOLUME (%) |
|---|---|
| Fishes | 60.5 |
| Polychaetes | 29.0 |
| Shrimp larvae | 5.0 |
| Plants | 2.5 |
| *Enteromorpha* sp. | |
| *Thalassia* and *Cymodocea* | |
| Unidentified animal material | 2.0 |
| Crab larvae | 1.0 |

Remarks.—The fish material in the stomachs consisted primarily of small fish scales. Entire larval fishes were also present. The plants were mostly small fragments of seagrass and green algae; these fragments may have been ingested accidentally during feeding on the zooplankton. This species is probably not as different in its food habits from *clupeola* as the above data would suggest. The component organisms of the plankton may vary greatly from one area to another, and the stomach contents of plankton-feeding fishes vary accordingly. More samples of these two fishes would probably show a greater similarity in the diet.

*Opisthonema oglinum* (LeSueur) THREAD HERRING
5 stations; 23 specimens: 127 to 177 mm SL; 6 empty.

| FOOD | VOLUME(%) |
|---|---|
| Copepods | 26.6 |
| *Candacia pachydactyla* | |
| *Oithona* sp. | |
| *Temora stylifera* | |
| Polychaetes | 22.4 |
| Shrimps and shrimp larvae | 17.1 |
| carideans (larv.) | |
| *Lucifer* sp. | |
| Fishes | 9.8 |
| Crab larvae | 6.4 |
| Mysids | 5.5 |
| Tunicates | 3.0 |
| appendicularians | |
| Stomatopod larvae | 2.5 |
| Unidentified eggs | 2.5 |
| Gastropod larvae | 1.6 |
| Siphonophores | 0.7 |
| Pelecypod larvae | 0.6 |
| Ostracods | 0.5 |
| Fish eggs | 0.5 |
| Pteropods | 0.3 |

*Remarks.*—*Lowe* (1962) stated that *O. oglinum* feeds on zooplankton.

## DUSSUMIERIDAE (Round Herrings)

*Jenkinsia lamprotaenia* (Gosse) DWARF ROUND HERRING
7 stations; 28 specimens: 34 to 54 mm SL; 10 empty.

| FOOD | VOLUME (%) |
|---|---|
| Copepods | 74.0 |
| *Candacia pachydactyla* (3) | |
| *Corycaeus subulatus* | |
| *Euchaeta marina* | |
| *Metis holothuria* | |
| *Undinula vulgaris* (3) | |
| Shrimp larvae | 11.4 |
| Unidentified animal material | 4.2 |
| Crab larvae | 3.8 |
| Unidentified crustaceans | 3.8 |
| Amphipods | 1.7 |
| hyperiids | |
| Fish eggs | 1.1 |

*Remarks.*—The round herring *Jenkinsia lamprotaenia* is the most common small schooling fish of clear shallow water in the West Indies. It feeds on the smaller animals of the plankton. It may be found over sand and seagrass flats, near stands of mangrove, around pilings of docks and piers, and over reefs. It is often eaten by inshore predaceous fishes. In the Caribbean area *lamprotaenia* may school with other species of *Jenkinsia*. The round herrings are sometimes classified as a subfamily of the Clupeidae.

## SYNODONTIDAE (Lizardfishes)

The lizardfishes generally occur on sand or mud bottoms and are able to partially bury themselves in the sediment. They are carnivorous, as would be expected from their numerous sharp teeth which are inwardly depressible. Characteristically they feed by swimming very rapidly upward to seize their prey which usually consists of small fishes.

*Synodus intermedius* (Spix) SAND DIVER

30 stations; 38 specimens: 65 to 325 mm SL; 20 empty.

| FOOD | VOLUME (%) |
|---|---|
| Fishes | 94.5 |
| atherinid | |
| carangid | |
| *Jenkinsia* sp. | |
| *Haemulon* sp. | |
| *Harengula* sp. | |
| *Serranus* sp. | |
| Squids | 5.0 |
| Shrimps | 0.5 |

*Remarks.*—Of this species, Beebe & Tee-Van (1928) stated, "Our food records mention fish, especially engraulids and atherinids, and shrimps." *S. intermedius* is the largest and most common inshore lizardfish in the West Indies. It is a clear-water species usually found on a sand bottom, but it may also come to rest on a rock substratum. Not infrequently it is caught by fishermen trolling lures over shallows.

*Synodus foetens* (Linnaeus) INSHORE LIZARDFISH

4 stations; 9 specimens: 102 to 270 mm SL; 6 empty.

| FOOD | VOLUME (%) |
|---|---|
| Fishes | 100.0 |
| *Anchoa* sp. | |

*Remarks.*—*S. foetens* lives on both sand and mud bottoms in shallow water; it is rarely encountered on or near reefs. Linton (1905) recorded fishes, shrimps, small crabs, annelids, and a spatangoid sea urchin from 21 specimens from North Carolina with recognizable food in their digestive tracts. H. Smith (1907) reported small fish as the principal food of specimens from the same state; he added that crabs, shrimps, worms and other animals are also eaten. Reid (1954) examined 11 stomachs with food from West Florida; 10 contained fishes, including *Alutera schoepfi* and *Anchoa mitchilli,* and two contained penaeid shrimps. Reid (1955) found digested fish in three stomachs of *S. foetens* from Texas. Springer & Wood-burn (1960) examined 20 stomachs from West Florida; 13 were filled with fishes (among them *Gobiosoma robustum, Anchoa mitchilli,* and *Menidia beryllina);* five contained crustaceans (two of these mixed with fish), and the remaining four were empty.

*Synodus synodas* (Linnaeus) RED LIZARDFISH

2 stations; 4 specimens: 50 to 106 mm SL; 2 empty.

| FOOD | VOLUME (%) |
|---|---|
| Fishes | 100.0 |

## MURAENIDAE (Moray Eels)

Proverbially voracious carnivores, most morays are equipped with numerous long depressible canine teeth and powerful jaws. Although they may be lured from their holes by day to feed on animal matter that strongly stimulates their olfactory sense, they normally seek food only at night. Their feeding, however, seems to consist more of waiting for their prey to come within striking range of their holes than actively hunting for it. Night diving usually reveals more morays than do observations on reefs during daylight hours, but poison stations with rotenone invariably produce many more of these eels than an observer would notice by night or day.

*Echidna catenata* (Bloch) CHAIN MORAY

9 stations; 11 specimens: 250 to 450 mm TL; 3 empty.

| FOOD | VOLUME (%) |
|---|---|
| Crabs | 96.3 |
| *Acanthonyx petiverii* | |
| *Cronius tumidulus* | |
| majid | |
| *Mithrax* sp. | |
| Shrimps | 3.7 |
| *Lysmata moorei* | |

*Remarks.*—The chain moray occurs in very shallow water in reefs or along rocky shores. Unlike most morays, its teeth are short and blunt, hence adapted to feeding on crustaceans. An eel with needle-sharp teeth would have more difficulty rendering a crustacean into pieces than one with rounded teeth.

*Gymnothorax funebris* Ranzani GREEN MORAY

3 stations; 5 specimens: 340 to 1120 mm TL; 5 empty.

*Remarks. G. funebris is* the largest western Atlantic moray. Although the stomachs of all five specimens were empty, the intestine of a 900-mm individual speared among rocks near a sandy beach in the early morning contained the remains of a xanthid crab and a ghost crab *(Ocypode albicans).* Gudger (1929) reported fish in the stomachs of three specimens from Dry Tortugas.

*Gymnothorax moringa* (Cuvier) SPOTTED MORAY

12 stations; 26 specimens: 255 to 1090 mm TL; 20 empty.

| FOOD | VOLUME (%) |
|---|---|
| Fishes | 100.0 |
| *Haemulon aurolineatum* | |
| *Lutjanus griseus* | |

*Remarks.*—*G. moringa* is the most common moray of West Indian reefs. The stomach of the 1090-mm specimen contained a 200-mm gray snapper *(L. griseus);* however, the eel was caught in a trap. Gudger (1929) briefly discussed the mode of feeding on fishes, and Winn & Bardach (1959) and Bardach, Winn, & Menzel (1959) studied the role of the senses in feeding, and the nocturnal behavior.

*Gymnothorax vicinus* (Castelnau) PURPLEMOUTH MORAY
6 stations; 11 specimens: 260 to 770 mm TL; 7 empty.

| FOOD | VOLUME (%) |
|---|---|
| Fishes | 62.5 |
| *Scarus* sp. | |
| Crabs | 25.0 |
| Octopuses | 12.5 |

*Remarks.*—Additional data on the food habits of this species would probably reveal a higher percentage of fish in the diet than the 62.5 per cent indicated above. Bardach, Winn, & Menzel (1959) noted that this species, like the preceding, is nocturnal. They determined that the olfactory sense is used to detect distant food. Actual contact of the food with the snout stimulates taste receptors and elicits a grasping response.

## OPICHTHIDAE (Snake Eels)

The snake eels are primarily burrowing forms in mud or sand. They apparently do not live in permanent burrows but move freely in the sediment. Their sharp-pointed snouts and tails represent an adaptation for such existence. Little is known of their habits. The two species of *Myrichthys* discussed below may be seen on reefs occasionally by day, generally in motion from one part to another.

*Myrichthys acuminatus* (Gronow) SHARPTAIL EEL
5 stations; 8 specimens: 420 to 890 mm TL; 1 empty.

| FOOD | VOLUME(%) |
|---|---|
| Crabs | 86.0 |
| *Mithrax sculptus* | |
| Stomatopods | 7.0 |
| *Gonodactylus curacaoensis* | |
| Echinoids | 7.0 |

*Remarks.*—Most of the specimens of *M. acuminatus* and those of the following species were collected with rotenone. Since they emerged from the sand nearly dead from the effect of the rotenone, it may be presumed that all of the stomach content material was normally consumed prior to the dispersal of the poison. A few of both species were taken with spears. These eels may have freshly-ingested material in their stomachs in the afternoon, so they feed at least in part during daylight hours.

*Myrichthys oculatus* (Kaup) OCELLATED EEL
7 stations; 22 specimens: 309 to 700 mm TL; 6 empty.

| FOOD | VOLUME (%) |
|---|---|
| Crabs | 61.2 |
| portunid / xanthid | |
| majid | |
| Unidentified crustaceans | 18.7 |
| Stomatopods | 12.5 |
| Shrimps | 3.2 |
| Fishes | 3.2 |
| Polychaetes | 1.2 |

*Remarks.*—See *M. acuminatus.*

*Ophichthus ophis* (Linnaeus) SPOTTED SNAKE EEL
4 stations; 5 specimens: 552 to 1220 mm TL; 1 empty.

| FOOD | VOLUME (%) |
|---|---|
| Fishes | 50.0 |
| *Haemulon aurolineatum* | |
| Octopuses | 50.0 |

*Remarks.*—The head of this eel is occasionally seen protruding diagonally from sand by day, thus affording a target for a spear. The largest specimen weighed 1400 grams, and its stomach contained an octopus weighing 197 grams. An 843-mm eel ate a 122-mm *Haemulon aurolineatum,* and a 552-mm specimen an 82-mm grunt of the same species. *O. ophis* has sharp teeth of moderate size, and it is feared by fishermen as much as morays.

## CONGRIDAE (Conger Eels)

*Taenioconger halis* (Böhlke) ATLANTIC GARDEN EEL
3 stations; 12 specimens: 187 to 450 mm TL; 1 empty.

| FOOD | VOLUME (%) |
|---|---|
| Copepods | 66.3 |
| calanoids | |
| harpacticoids | |
| Tunicates | 18.6 |
| appendicularians | |
| Pteropods | 4.5 |
| Ostracods | 3.8 |
| Shrimp larvae | 2.5 |
| Unidentified eggs | 2.4 |
| Gastropod larvae | 1.9 |

*Remarks.*—Garden eels live in groups in permanent burrows in the sand. Beds of these eels occur in a region of current and are often encountered

near reefs. The eels are very slender (the depth of the body is contained about 60 times in the length). Approximately the anterior three-fourths of the body emerges for feeding (the posterior fourth which remains in the burrow is distinctly paler than the rest of the body); the anterior end is bent forward facing the oncoming current. Small planktonic organisms are picked one by one from the passing water mass. The feeding movements made by a group of these eels is a fascinating sight. As many as 600 copepods varying in length from 0.4 to 2.1 mm were found in the stomach of a single adult garden eel.

## BELONIDAE (Needlefishes)

The belonids are surface-dwelling fishes. They often swim over reefs, but they are not an integral part of the reef community. Their jaws are armed with an impressive array of needle-sharp teeth. The fulcrum arrangement and muscle attachment of the jaws is unique, providing for their opening and closing simultaneously with rapidity (Nelson, MS). The needlefishes feed voraciously on small fishes, especially clupeoids that school near the surface. They have been reported to drift slowly into range of their prey before making a quick rush. They are also capable of long skipping leaps on the surface, although such runs are probably associated more often with escaping predation than securing prey.

*Platybelone argalus* (LeSueur) KEELED NEEDLEFISH

6 stations; 15 specimens: 230 to 330 mm SL; 2 empty.

| FOOD | VOLUME (%) |
|---|---|
| Fishes | 97.0 |
| *Jenkinsia sp.* (10) | |
| Insects | 3.0 |
| carpenter ants | |

*Strongylura timucu* (Walbaum) TIMUCU

8 stations; 20 specimens: 159 to 378 mm SL; 5 empty.

| FOOD | VOLUME (%) |
|---|---|
| Fishes | 96.0 |
| *Anchoa parva* | |
| *Jenkinsia* sp. (5) | |
| Shrimps | 4.0 |

*Remarks.*—This needlefish is primarily an inshore species; it is often seen in mangrove sloughs and freely enters freshwater. It is closely related to and easily confused with *S. marina.* According to B. Collette (personal communication), only *timucu* occurs in the West Indies. The two species are found together in Florida and Central America to Brazil. Only *marina* ranges north of Florida. Linton (1905), H. Smith (1907), Hildebrand & Schroeder (1928), McClane (1965), Darnell (1959), and Springer & Woodburn (1960) reported on the food habits of *marina.* As with *timucu* of the present study, fishes predominated in the diet, but copepods, other crustaceans, annelids, and insects were also listed from the stomachs.

*Tylosurus acus* (Lacépède) AGUJON

9 stations; 13 specimens: 234 to 732 mm SL; 6 empty.

| FOOD | VOLUME (%) |
|---|---|
| Fishes | 96.3 |
| carangid | |
| *Tylosurus* sp. | |
| Hermit crab larvae | 1.4 |
| Insects | 1.4 |
| wasp | |
| beetle | |
| Stomatopod larvae | 0.9 |

*Remarks.*—Linton (1905) recorded small crustaceans and fragments of insects from a specimen from North Carolina.

*Tylosurus crocodilus* (Peron & LeSueur) HOUNDFISH

14 stations; 19 specimens: 250 to 1320 mm SL; 8 empty.

| FOOD | VOLUME (%) |
|---|---|
| Fishes | 90.9 |
| *Acanthurus* sp. (larv.) | |
| *Anchoa* sp. | |
| *Cetengraulis edentulus* | |
| *Harengula humeralis* | |
| *Mugil* sp. | |
| Shrimps | 9.1 |

*Remarks.*—*T. crocodilus* is the largest of the needlefishes; it occurs more inshore, in general, than the preceding species. Linton (1905) recorded menhaden and a few small crustaceans from the stomach of a specimen about 3 feet long from North Carolina. Jordan & Thompson (1905) observed individuals of this species prey upon sardines at Tortugas. They wrote, "After catching one they manipulate it very ingeniously with their jaws until it is pointed 'head on' toward the throat before any endeavor is made to swallow it."

## HEMIRAMPHIDAE (Halfbeaks)

The hemiramphids are primarily surface-dwelling fishes; some species are characteristic of coastal waters, and others completely pelagic. The inshore species often range over shallow reefs. On one occasion a halfbeak was observed to swim down to the bottom where a "cleaning" fish picked over its body, ostensibly in search of ectoparasites. Jordan & Evermann (1896) ascribed herbivorous habits to the halfbeaks, adding

that they feed chiefly on green algae. Uchida (1930) (reference from Suyehiro, 1942), however, reported a species of *Hemiramphus* as a zooplankton-feeder, and Hiatt & Strasburg (1960) found small fishes, plank-tonic crustaceans and other planktonic animals in the stomachs of two species of *Hyporhamphus*. The study by the author of the food habits of two West Indian *Hemiramphus* indicates that the food habits can vary markedly with the species. The family is more properly termed omnivorous than herbivorous. It is doubtful that they feed on green algae (see Remarks of *H. brasiliensis* below). Opinions differ on the possible use of the long lower jaw of the hemiramphids. Uchida concluded that it is not only useless in feeding but is actually a hindrance. J. Randall (MS) has suggested that it might serve as a cutwater.

*Hemiramphus balao* LeSueur — BALAO

6 stations; 16 specimens: 130 to 196 mm SL; 7 empty.

| FOOD | VOLUME (%) |
|---|---|
| Fishes | 39.1 |
| *Jenkinsia* sp. (larv. and juv.) (4) | |
| Pteropods | 31.4 |
| cavolinids | |
| Unidentified animal material | 11.8 |
| Polychaetes | 8.9 |
| Crab larvae | 4.7 |
| Shrimp larvae | 2.9 |
| Copepods | 1.2 |

*Remarks*.—This species occurs more offshore, in general, than the following. No plant material was found in its stomachs.

*Hemiramphus brasiliensis* (Linnaeus) — BALLYHOO

8 stations; 39 specimens: 164 to 246 mm SL.

| FOOD | VOLUME (%) |
|---|---|
| Seagrasses (and epiphytes) | 81.0 |
| *Cymodocea manatorum* | |
| *Thalassia testudinum* | |
| Fishes | 19.0 |
| *Jenkinsia* sp. (3) | |

*Remarks*.—Beebe & Tee-Van (1928) reported that three specimens of *H. brasiliensis* from Haiti had eaten *Thalassia,* algae, land plants, a spider, and insects, including a hymenopteran. Burkholder, Burkholder & Rivero (1959) stated that *Thalassia* is the principal food of the species. Randall (1965a) wrote that the stomach contents of ballyhoo in St. John consisted of manatee grass *(Cymodocea)* and *Jenkinsia* and noted that the halfbeaks fed upon the seagrasses as floating fragments. The pieces of seagrass are grasped at one end and drawn into the mouth apparently by the action of the pharyngeal mill which grinds the plant material to a fine pulp. *Thalassia* is also eaten as fragments on the surface. In a mixed flotsam of *Thalassia* and *Cymodocea,* the fish usually took the latter. They readily ate green, straw-colored, or brownish strands of seagrass, whether covered with epiphytic algae or not, but they avoided dark brown or black fragments. When pieces of land plants (several coarse grasses and the needles of Australian pine) were allowed to drift toward a school of feeding ballyhoo off the dock of the Institute of Marine Science of the University of Miami, these plants were not consumed. At times the fish took the land-plant fragments in their mouths but always rejected them.

## FISTULARIIDAE (Cornetfishes)

*Fistularia tabacaria* Linnaeus — CORNETFISH

3 stations; 4 specimens: 357 to 1000 mm SL; 2 empty.

| FOOD | VOLUME (%) |
|---|---|
| Fishes | 100.0 |
| *Monacanthus setifer* | |
| *Pseudupeneus maculatus* | |

*Remarks*.—The cornetfish appears to be a rare species in the West Indies. It was more often seen over beds of seagrass than reefs. The specimen containing the identified fishes measured 810 mm in standard length. The filefish in its stomach measured 38 mm SL, and the two goatfish about 60 mm. This cornetfish was itself taken from the stomach of a black grouper *(Mycteroperca bonaci)* 920 mm in SL which was speared in 60 feet off the Dominican Republic. Hiatt & Strasburg (1960) found only fish in the stomachs of nine specimens of the Indo-Pacific *Fistularia petimba.* These authors do not agree with Suyehiro (1942) (after Marukawa) that this fish takes only minute, floating creatures by utilizing its snout as a pipette.

## AULOSTOMIDAE (Trumpetfishes)

*Aulostomus maculatus* Valenciennes — TRUMPETFISH

32 stations; 80 specimens: 290 to 650 mm SL; 11 empty.

| FOOD | VOLUME (%) |
|---|---|
| Fishes | 73.5 |
| *Acanthurus* sp. (larv.) | |
| *Acanthurus bahianus* (larv.) *Anchoa* sp. | |
| apogonid | |
| blenniid | |
| clinids (2) | |
| *Chromis cyanea* | |
| *Haemulon aurolineatum* | |
| *Haemulon flavolineatum* | |

| | |
|---|---|
| *Holocentrus coruscus* | |
| *Holocentrus rufus* | |
| *Labrisomus kalisherae* | |
| *Malacoctenus gilli* | |
| *Myripristis jacobus* | |
| *Ophioblennius atlanticus* (3) | |
| *Pomacentrus* sp. | |
| *Pomacentrus pictus* | |
| *Pseudupeneus maculatus* | |
| *Quisquilius hipoliti* | |
| *Thalassoma bifasciatum* | |
| Shrimps | 26.5 |
| carideans (3) | |

*Remarks.*—Beebe & Tee-Van (1928) reported fish, including an engraulid and *Pomacentrus* sp., in the stomachs of three specimens of *Aulostomus* from Haiti. Trumpetfish were often observed on reefs in the Virgin Islands and Puerto Rico hovering vertically in the water over small bottom-dwelling fishes, and on several occasions they were seen darting down on them. Hiatt & Strasburg (1960) have suggested that the Indo-Pacific species *A. chinensis* might utilize its long tubular snout to probe into holes or interstices. Some of the fish taken from the stomachs of *A. maculatus* were surprisingly large. A 590-mm individual, for example, contained a fully intact, 128-mm squirrelfish *(Holocentrus rufus)*. Prey of this size seemed too large for the narrow snout of the trumpetfish until the distensible membraneous floor of the buccal region was noted. Since the trumpet-fish mouth is small and the teeth minute, it may be assumed that the prey is sucked in by the expansion of the floor of the snout and of the gill membranes. The same mode of feeding probably takes place in *Fistularia.* The acanthurids from the stomachs of trumpetfish were the transforming late postlarval stage known as the acronurus. Trumpetfish were found in the stomachs of the snappers *Lutjanus apodus* and *L. jocu* and the groupers *Mycteroperca venenosa, Cephalopholis fulva,* and *Epinephelus guttatus.* The elongate bodies of all of the trumpetfish were folded once in the predators' stomachs.

## HOLOCENTRIDAE (Squirrelfishes)

The squirrelfishes are nocturnal, as their large eyes would suggest. Although they may occasionally be taken on hook and line by day, their stomachs are almost invariably empty except during night and early morning hours. They tend to hide in holes and cracks in reefs during the day but forage actively at night. Stomachs sometimes contain fragments of seagrass along with the prey, thus indicating that the fish had been seeking food in grass beds away from their home reef. Crustaceans constitute the most important group of food organisms. Fish forms an insignificant part of the diet, as might be predicted from the small size of the teeth in the jaws.

*Holocentrus ascensions* Osbeck — SQUIRREL FISH

9 stations; 31 specimens: 125 to 235 mm SL; 11 empty.

| FOOD | VOLUME (%) |
|---|---|
| Crabs | 73.3 |
| *Actaea rufopunctata* | |
| *Chlorodiella longimana* | |
| *Macrocoeloma trispinosum* | |
| majids | |
| *Mithrax forceps* | |
| *Mithrax sculptus* (3) | |
| *Pitho* sp. | |
| *Platypodia spectabilis* | |
| portunid *Portunus* sp | |
| Shrimps | 10.6 |
| alpheids (2) | |
| penaeids | |
| Unidentified crustaceans | 10.6 |
| Polychaetes | 3.9 |
| Gastropods | 1.0 |
| *Tricolia adamsi* | |
| Isopods | 0.6 |

*Remarks.*—This species appears to be more inclined to forage over grass flats than the remaining holocentrids listed herein.

*Holocentrus coruscus* (Poey) — REEF SQUIRRELFISH

8 stations; 24 specimens: 45 to 102 mm SL; 5 empty.

| FOOD | VOLUME (%) |
|---|---|
| Shrimps | 70.0 |
| alpheid | |
| carideans | |
| penaeids (2) | |
| Crabs | 27.3 |
| *Ebalia stimpsonii* | |
| *Mithrax* sp. | |
| *Portunus* sp. | |
| *Sicyonia* sp. | |
| Unidentified crustaceans | 2.7 |

*Remarks.*—Beebe & Tee-Van (1928) reported a shrimp in the stomach of one specimen of this species.

*Holocentrus marianus* Cuvier & Valenciennes — LONGJAW SQUIRRELFISH

8 stations; 13 specimens: 82 to 113 mm SL; 4 empty.

| FOOD | VOLUME (%) |
|---|---|
| Shrimps | 51.7 |
| Crabs | 30.6 |
| Unidentified crustaceans | 13.3 |
| Stomatopod larvae | 3.3 |
| Copepods | 1.1 |

*Remarks.*—*H. marianus* occurs in deeper water, on the average, than the other squirrelfishes considered herein; it is rarely seen in less than 40 feet.

*Holocentrus rufus* (Walbaum) — LONGSPINE SQUIRRELFISH

16 stations; 55 specimens: 132 to 250 mm SL; 13 empty.

| FOOD | VOLUME (%) |
|---|---|
| Crabs | 56.9 |
| *Domecia hispida* | |
| *Euryplax nitida* | |
| majids (2) | |
| *Mithrax* sp. | |
| *Mithrax coryphe* | |
| *Mithrax forceps* | |
| *Mithrax sculptus* (2) | |
| *Pitho lherminieri* | |
| porcellanids | |
| xanthids (3) | |
| *Xanthodius denticulatus* | |
| Shrimps | 15.0 |
| alpheids (3) | |
| gnathophyllids (2) | |
| penaeids | |
| Gastropods | 7.8 |
| *Acmaea* sp. | |
| *Acmaea pustulata* | |
| acmaeid | |
| *Emarginula pumila* | |
| *Hyalina* sp. | |
| *Hyalina albolineata* | |
| *Hyalina avena* | |
| *Mitrella lunata* | |
| *Pseudostomatella coccinea* | |
| *Pseudostomatella erythrocoma* (2) | |
| *Purpura patula* | |
| Ophiuroids | 7.1 |
| *Ophionereis* sp. (2) | |
| *Ophiothrix* sp. | |
| Polychaetes | 4.5 |
| Unidentified crustaceans | 2.4 |
| Isopods | 1.5 |
| *Exocorallina antillensis* | |
| Mysids | 1.4 |
| Ostracods | 1.2 |
| Fishes | 1.2 |
| Chitons | 0.6 |
| *Acanthochitona pygmaea* | |
| Stomatopods | 0.4 |

*Holocentrus vexillarius* (Poey) — DUSKY SQUIRRELFISH

14 stations; 55 specimens: 45 to 118 mm SL; 13 empty.

| FOOD | VOLUME (%) |
|---|---|
| Crabs and crab larvae | 26.9 |
| *Domecia hispida* | |
| *Mithrax* sp. | |
| *Petrolisthes galathinus* (2) | |
| Gastropods | 25.1 |
| *Acmaea* sp. (2) | |
| *Acmaea antillarum* | |
| *Acmaea pustulata* | |
| acmaeids (2) | |
| *Diodora viridula* | |
| *Fissurella* sp. | |
| *Fissurella barbadensis* | |
| *Hyalina albolineata* | |
| *Nitidella nitida* | |
| *Persicula lavalleeana* | |
| *Pseudostomatella coccinea* | |
| *Synaptocochlea picta* | |
| Shrimps and shrimp larvae | 20.8 |
| alpheids (3) | |
| gnathophyllid | |
| *Gnathophylloides mineri* | |
| palaemonids | |
| Chitons | 10.3 |
| *Choneplax lata* | |
| Isopods | 5.7 |
| Fishes and fish larvae | 5.2 |
| *Acanthurus* sp. (larv.) | |
| Polychaetes | 4.0 |
| Unidentified crustaceans | 1.6 |
| Copepods | 0.4 |

*Remarks.*—*H. vexillarius* is the most common inshore squirrelfish in the West Indies. It is abundant in holes and beneath ledges along protected rocky shores. McKenney (1959) reported the stomach-content material of a series of *vexillarius* from young to adults to consist of copepods, ostracods, mysids, alpheid shrimps, crabs, isopods, barnacle appendages, gastropods and gastropod larvae, pelecypod larvae, chitons, octopuses, and brittle stars.

*Myripristis jacobus* Cuvier & Valenciennes BLACKBAR SOLDIERFISH
14 stations; 46 specimens: 69 to 180 mm SL; 12 empty.

| FOOD | VOLUME (%) |
|---|---|
| Shrimps and shrimp larvae | 30.3 |
| alpheids (3) | |
| carideans | |
| gnathophyllids | |
| penaeids | |
| Stomatopod larvae | 17.4 |
| *Gonodactylus* sp. | |
| *Nannosquilla* sp | |
| *Squilla* sp. | |
| Crabs and crab larvae | 14.9 |
| Mysids | 11.2 |
| Polychaetes | 7.0 |
| Fish larvae | 5.4 |
| chaetodontid | |
| Amphipods | 3.2 |
| hyperiids | |
| Unidentified crustaceans | 2.7 |
| Copepods | 2.4 |
| Isopods | 1.8 |
| Cephalopod larvae | 1.5 |
| Hermit crab larvae | 0.9 |
| Scyllarid larvae | 0.9 |
| Ostracods | 0.3 |
| Unidentified animal material | 0.1 |

*Remarks.*—In contrast to the species of *Holocentrus, Myripristis jacobus* feeds predominantly on planktonic organisms. Nearly all of the shrimps and crabs from the stomachs, for example, were larval forms.

*Plectrypops retrospinis* (Guichenot) CARDINAL SOLDIERFISH
8 stations; 10 specimens: 45 to 98 mm SL; 8 empty.

| FOOD | VOLUME (%) |
|---|---|
| Crab | 50.0 |
| xanthid | |
| Polychaete | 50.0 |

## MUGILIDAE (Mullets)

Mullets are characteristic of mud or sand bottoms. Most feed on fine detrital and bottom algal material. They usually ingest a large amount of fine sediment. Except for *Agonostomus* and two other small genera, they have thick-walled stomachs. This gizzard-like organ probably makes use of the sedimentary material to triturate the plant food. Thomson (1954) has written a review of the feeding of six mugilid species, including discussions of mouth structure.

*Mugil curema* Cuvier & Valenciennes WHITE MULLET
5 stations; 17 specimens: 200 to 290 mm SL; 4 empty.

| FOOD | VOLUME (%) |
|---|---|
| Plant material | 100.0 |
| diatoms | |
| *Lyngbya majuscula* | |
| *Rhizoclonium riparium* | |
| *Thalassia testudinum* | |
| *Vaucheria* sp. | |

*Remarks.*—The majority of the material in the stomachs of these mullet consisted of mud and fine silt. *Mugil curema* is the most common species of mullet in the West Indies. It occurs along sandy shores, in brackish mangrove sloughs, and in freshwater. Linton (1905) found mud, vegetable debris, and diatoms in one specimen from North Carolina. Hildebrand & Schroeder (1928) described the food as almost wholly minute organisms, mixed with quantities of mud and vegetable debris. Beebe & Tee-Van (1928) reported the stomach contents of freshwater specimens as mud, decayed vegetation, and bottom debris. Ebeling (1957) noted that the young may feed directly on attached algae; their stomachs contained primarily diatoms and algal filaments.

## SPHYRAENIDAE (Barracudas)

The barracudas are open-water predaceous fishes with notably long, sharp-edged teeth in the jaws and on the palate. They feed primarily on fishes. De Sylva (1963) noted from aquarium observations that *Sphyraena barracuda* may feed by taking its prey entire, either head-first or tail-first, fold it in mid-section before swallowing, or slice it into two or more pieces. The author observed the feeding by a large individual on the cero mackerel *(Scomberomorus regalis)* in the Virgin Islands. A very swift attack was made on the mackerel, resulting in its being cut into two approximately equal halves. The barracuda then circled slowly to pick up the halves. Another large barracuda was observed trying unsuccessfully to bite through a speared member of the same species slightly more than half its length. Barracudas, in general, are diurnal, although there are some reports of certain species feeding at night, particularly during periods of full moon.

Two of the three West Indian species enter the reef community in the sense that they may feed on reef fishes.

*Sphyraena barracuda* (Walbaum) GREAT BARRACUDA

78 stations; 104 specimens: 70 to 1070 mm SL; 46 empty.

| FOOD | VOLUME (%) |
|---|---|
| Fishes | 95.5 |
| *Ablennes hians* | |
| *Acanthurus bahianus* | |
| *Allanena harringtonensis* | |
| atherinids | |
| *Canthigaster rostrata* | |
| carangids (3) | |
| *Caranx fusus* | |
| clupeid | |
| *Decapterus* sp. | |
| *Diodon* sp. | |
| *Echidna catenata* | |
| *Haemulon* sp. (2) | |
| *Harengula clupeola* | |
| *Jenkinsia* sp. (2) | |
| *Ocyurus chrysurus* (2) | |
| scarid | |
| *Sphyraena picudilla* (2) | |
| *Trachinocephalus myops* | |
| Octopuses | 2.6 |
| Scyllarid lobster (larv.) | 1.9 |

*Remarks.*—*S. barracuda* is common in the West Indies; it is usually solitary. Nine of the specimens examined ranged from 70 to 125 mm SL; the remaining fish all exceeded 232 mm. The smaller barracuda fed upon schooling clupeoid and atherinid fishes. One 595-mm fish was caught while trolling on a bright moonlight night; the rest were collected by day, about half by hook and line and half by spearing. De Sylva (1963) reported on the examination of the stomachs of 901 barracudas, mostly taken by hook and line off Florida and the Bahamas. Fishes predominated in the diet. He noted that the size of prey is highly variable. This was substantiated by the author's analyses. A 1040-mm barracuda ate six *Diodon sp.* that ranged from 55 to 60 mm in standard length; an 840-mm fish contained only a 30-mm scyllarid. On the other hand, a 910-mm individual had eaten a 700-mm moray *(Echidna catenata);* it was folded in the stomach. Other prey fishes such as *Acanthurus bahianus, Aulostomus maculatus, Caranx fusus, Ocyurus chrysurus,* and *Sphyraena picudilla* were cut into two or three pieces. In the case of the former two, only the posterior halves were found in the barracuda stomachs. Most of the larger barracuda contained only a single fish. An exception was the largest specimen collected (1070 mm SL) which had eaten 18 false pilchards *(Harengula clupeola)* from 84 to 100 mm in standard length. No squids were found by the author in barracuda stomachs, but probably they are eaten now and then. A large barracuda was observed to chase a small school of *Sepiateuthis sepioides* into very shallow water, but it failed to catch any. Randall (1960) discussed the problem of barracuda which fed upon tagged reef fishes before they could reach the shelter of the reef after release from a boat. The following tagged fish were taken from the stomachs of two such marauding barracudas: *Acanthurus bahianus, A. coeruleus, Mulloidichthys martinicus, Pseudupeneus maculatus,* and *Sparisoma* sp.

*Sphyraena picudilla* Poey SOUTHERN SENNET

5 stations; 13 specimens: 265 to 395 mm SL; 6 empty.

| FOOD | VOLUME (%) |
|---|---|
| Fishes | 82.1 |
| Squids | 17.9 |

*Remarks.*—*S. picudilla* is a small schooling species of barracuda. Schools are occasionally seen over reefs, but more often encountered over seagrass beds. The species was not observed to be common in any region, however.

## ATHERINIDAE (Silversides)

The silversides are small schooling fishes. They are represented by two species which occur inshore throughout the West Indies. *Atherinomorus stipes* is the most common. These fishes feed primarily on zooplankton, and they, in turn, are fed upon heavily by jacks, barracudas, certain scombrids, and various piscivorous reef fishes.

*Allanetta harringtonensis* (Goode) REEF SILVERSIDES

4 stations; 23 specimens: 39 to 60 mm SL; 9 empty.

| FOOD | VOLUME (%) |
|---|---|
| Copepods | 89.2 |
| *Corycaeus* sp. | |
| *Labidocera scotti* | |
| *Paracalanus crassirostris* | |
| Fish larvae | 8.1 |
| Polychaete larvae | 2.7 |

*Atherinomorus stipes* (Muller & Troschel) HARDHEAD SILVERSIDES

4 stations; 20 specimens: 35 to 69 mm SL; 11 empty.

| FOOD | VOLUME (%) |
|---|---|
| Shrimp larvae | 35.6 |
| Copepods | 30.0 |
| *Calocalanus* sp. | |
| *Farranula gracilis* | |

| | |
|---|---|
| *Oncaea* sp. (2) | |
| *Paracalanus aculeatus* | |
| *Pontella* sp. | |
| Fish scales | 20.0 |
| Barnacle appendages and larvae | 10.0 |
| Fish eggs | 2.2 |
| Foraminifera | 2.2 |

## SERRANIDAE (Groupers and Sea Basses)

The serranids are among the most important carnivorous fishes of coral reefs. They are characteristically robust of build, with large mouths, numerous depressible inner teeth, and usually a few stout fixed outer canines in the jaws. Typically they are demersal. As C. Smith (1961) has noted, they eat primarily fishes and crustaceans. With the exception of the jewfish *(Epinephelus itajara),* the larger groupers tend to feed more on fishes than crustaceans. They feed both by night and day but are most active at dawn and dusk. The smaller serranids, in general, are primarily diurnal.

*Alphestes afer* (Bloch) MUTTON HAMLET

5 stations; 36 specimens: 127 to 195 mm SL; 6 empty.

| FOOD | VOLUME (%) |
|---|---|
| Crabs | 77.0 |
| *Chorinus heros* | |
| *Mithrax* sp. (2) | |
| *Pitho* sp. | |
| portunids (2) | |
| *Portunus* sp. | |
| Fishes | 7.0 |
| *Acanthurus* sp. (juv.) | |
| eels (2) | |
| Shrimps | 6.8 |
| alpheids | |
| Unidentified crustaceans | 6.7 |
| Octopuses | 2.5 |

*Remarks.*—*Alphestes afer* is a small grouper that is most often found in seagrass beds; only occasionally is it seen in natural reefs. When an artificial reef was built in a seagrass bed in the Virgin Islands, however, this species became the principal serranid fish which colonized it (Randall, 1963b); the individual mutton hamlets moved in as adults from the adjacent seagrass bed. The occurrence of bits of *Thalassia* or *Cymodocea* in the stomachs with the prey indicated that feeding took place, at least in part, in the grass bed.

*Cephalopholis fulva* (Linnaeus) CONEY

36 stations; 58 specimens: 146 to 240 mm SL; 29 empty.

| FOOD | VOLUME (%) |
|---|---|
| Fishes | 46.0 |
| *Acanthurus* sp. (juv.) (2) | |
| *Aulostomus maculatus* | |
| *Cantherhines pullus* | |
| *Monacanthus tuckeri* | |
| scarid | |
| *Sphaeroides* sp. | |
| *Starksia* sp. | |
| Shrimps | 20.7 |
| *stenopodid* | |
| *Stenopus hispidus* (2) | |
| Crabs | 17.2 |
| *Percnon gibbesi* | |
| porcellanid | |
| Stomatopods | 12.4 |
| *Gonodactylus* sp. | |
| *Gonodactylus oerstedii* | |
| Unidentified crustaceans | 3.7 |

*Remarks.*—The coney is relatively wary for a grouper, and it was difficult to obtain many specimens by spearfishing. It is one of the most common of the reef-dwelling serranids. Beebe & Tee-Van (1928) stated that most of their specimens from Haiti contained crustaceans, especially shrimps.

*Epinephelus adscensionis* (Osbeck) ROCK HIND

40 stations; 56 specimens: 122 to 395 mm SL; 25 empty.

| FOOD | VOLUME (%) |
|---|---|
| Crabs | 66.7 |
| *Domecia hispida* | |
| *Leptodius floridanus* | |
| *Mithrax* sp. | |
| *Mithrax sculptus* (2) | |
| *Percnon gibbesi* | |
| *Petrolisthes galathinus* (2) | |
| *Portunus sebae* (2) | |
| portunid | |
| *Stenorynchus seticornis* | |
| xanthid | |
| Fishes | 20.1 |
| *Cantherhines pullus* | |
| *Sparisoma* sp. | |
| Shrimps | 4.4 |
| Unidentified crustaceans | 4.0 |

| | |
|---|---|
| Gastropods | 3.2 |
| *Cittarium pica* | |
| Chitons | 1.6 |
| *Acanthochiton hemphilli* | |

*Remarks.*—Although it may be taken in more than 100 feet of water, the rock hind is most typically seen in shallow water on a rock bottom with some surf action. It is more difficult to approach than the closely related red hind. The gastropod remains in the stomach of one 390-mm fish consisted of two individuals of *Cittarium pica* without shell; they were identified from the characteristic opercula. As indicated by H. Randall (1964), it is highly unlikely that the rock hind crushed the shell of this stout gastropod. It probably obtained the meal after some other predator exposed the soft parts.

*Epinephelus guttatus* (Linnaeus) RED HIND

83 stations; 110 specimens: 82 to 450 mm SL; 60 empty.

| FOOD | VOLUME (%) |
|---|---|
| Crabs | 39.5 |
| *Calappa gallus* | |
| *Cronius ruber* | |
| majid | |
| *Panopeus* sp. | |
| *Portunus sebae* (2) | |
| *Stenorynchus seticornis* (2) | |
| Fishes | 21.1 |
| *Aulostomus maculatus* | |
| *Cantherhines pullus* | |
| *Gymnothorax* sp. (3) | |
| *Inermia vittata* | |
| *Mulloidichthys martinicus* | |
| scarid | |
| Stomatopods | 16.6 |
| *Gonodactylus oerstedii* | |
| Shrimps | 10.5 |
| *Stenopus hispidus* | |
| *Synalpheus* sp. | |
| *Trachypenaeus* sp. | |
| Octopuses | 7.0 |
| *Octopus briareus* | |
| Unidentified crustaceans | 3.3 |
| Echiuroids | 2.0 |

*Remarks.*—The red hind is the most abundant grouper in Puerto Rico and the Virgin Islands. It is more easily approached than any other West Indian grouper, hence highly vulnerable to spearfishing. Bardach & Menzel (1957) reported it as one of the most prevalent small groupers of the shallow reefs of Bermuda and the tamest in captivity. They conducted growth studies from the rearing of captive fish and tagging on Bermuda reefs. Randall (1962a) also studied the growth from tagging. Beebe & Tee-Van (1928) reported on the stomach contents of two individuals from Haiti, one of which had eaten a small parrotfish and shrimps. Menzel (1960) listed the principal food at Bermuda as crustaceans, especially crabs of the genus *Calappa* and aipheid shrimps; some fishes were eaten, especially the wrasse *Thalassoma bifasciatum.*

*Epinephelus itajara* (Lichtenstein) JEWFISH

9 stations; 9 specimens: 1250 to 1650 mm SL.

| FOOD | VOLUME (%) |
|---|---|
| Spiny lobsters | 45.6 |
| *Panulirus argus* (5) | |
| Scyllarid lobsters | 23.3 |
| *Scyllarides aequinoctialis* (2) | |
| Fishes | 13.3 |
| *Dasyatis americana* | |
| *Diodon* sp. | |
| Crabs | 12.2 |
| Sea turtles | 5.6 |
| *Eretmochelys imbricata* | |

Remarks.—Beebe & Tee-Van (1928) reported the remains of a parrotfish from the stomach of a 367-mm jewfish. Erdman (1956) listed three spiny lobsters *(Panulirus argus)* from an 187-pound specimen from Puerto Rico. C. Smith (1961) stated that *E. itajara* feeds chiefly on crustaceans. It is the largest reef fish in the Atlantic, attaining a weight of at least 680 pounds. It is not common in the West Indies, which is fortunate for fishermen seeking the valuable spiny lobster. As many as five adult lobsters have been taken from the stomach of a single jewfish. One fish of 150 pounds speared by the author in St. John contained two lobsters that weighed 6.75 and 3.5 pounds. The stomach of another from St. John of 340 pounds taken with spears contained the scutes of the carapace of a small hawksbill turtle, a spiny lobster, a slipper lobster, and fish remains.

*Epinephelus morio* (Cuvier & Valenciennes) RED GROUPER

5 stations; 5 specimens: 228 to 340 mm SL; 3 empty.

| FOOD | VOLUME (%) |
|---|---|
| Unidentified crustaceans | 50.0 |
| Crabs | 33.3 |
| Fishes | 16.7 |

Remarks.—Although a common species in Florida and the Gulf of Mexico, the red grouper is rare in the West Indies. Gudger (1929) reported fish, including a lutjanid and two sparids, from the stomachs of three specimens

from Dry Tortugas, Florida. Longley & Hildebrand (1941) stated that this species at Dry Tortugas feeds indifferently by day or night; they listed fishes, octopuses, and crustaceans such as shrimps, stomatopods, and spiny lobsters as the food.

*Epinephelus striatus* (Bloch) NASSAU GROUPER

166 stations; 255 specimens: 170 to 686 mm SL; 102 empty.

| FOOD | VOLUME (%) |
|---|---|
| Fishes | 54.0 |
| *Acanthurus* sp. | |
| *Anchoa lamprotaenia* | |
| atherinids | |
| *Cantherhines pullus* | |
| *Cephalopholis fulva* | |
| *Chromis cyanea* | |
| *Chromis multilineata* | |
| *Clepticus parrae* (3) | |
| *Enchelycore nigricans* | |
| engraulids | |
| *Gymnothorax moringa* | |
| *Haemulon aurolineatum* (2) | |
| *Haemulon flavolineatum* | |
| *Halichoeres bivittatus* (2) | |
| *Halichoeres garnoti* | |
| *Harengula clupeola* | |
| *Holocentrus* sp. | |
| *Holocentrus rufus* (2) | |
| *Hypoplectrus puella* | |
| *Jenkinsia lamprotaenia* (2) | |
| *Lactophrys* sp. | |
| *Lutjanus* sp. | |
| *Microspathodon chrysurus* | |
| *Muraena miliaris* | |
| muraenid | |
| *Myripristis jacobus* | |
| *Ocyurus chrysurus* (3) | |
| pomacentrid | |
| *Pomacentrus fuscus* | |
| *Priacanthus cruentatus* | |
| *Pseudupeneus maculatus* (2) | |
| scarids (11) | |
| *Scarus* sp. | |
| *Scarus vetula* | |
| *Sparisoma aurofrenatum* | |
| synodontid | |
| *Synodus intermedius* | |
| Crabs | 22.5 |
| *Calappa* sp. | |
| *Calappa flammea* | |
| calappids (2) | |
| *Cronius ruber* | |
| *Macrocoelema* sp. | |
| majids (4) | |
| *Mithrax* sp. | |
| *Mithrax cinctimanus* | |
| *Mithrax verrucosus* | |
| *Petrolisthes galathinus* | |
| porcellanids | |
| portunids (4) | |
| *Portunus sebae* (3) | |
| *Stenorynchus seticornis* (3) | |
| xanthids (3) | |
| Stomatopods | 5.5 |
| *Gonodactylus oerstedii* (4) | |
| *Pseudosquilla ciliata* | |
| Cephalopods | 5.2 |
| Shrimps | 5.0 |
| alpheids (2) | |
| carideans | |
| penaeids | |
| Spiny lobsters | 3.5 |
| *Panulirus argus* (3) | |
| *Panulirus guttatus* | |
| Gastropods | 1.6 |
| *Strombus gigas* (3) | |
| Hermit crabs | 1.2 |
| *Paguristes depressus* | |
| *Petrochirus diogenes* | |
| Pelecypods | 0.7 |
| *Barbatia cancellaria* | |
| Unidentified crustaceans | 0.6 |
| Isopods | 0.2 |

*Remarks.*—*Randall* (1965b) reported on the analysis of the stomach contents of 250 Nassau groupers. A summary of this study is presented above, with the addition of data from five more specimens (two empty, three with fishes in their stomachs). The larger Nassau groupers fed more upon fishes and less on crustaceans than the smaller individuals. The mollusks and hermit crabs from the grouper stomachs contained no shells or shell fragments. Cephalopod remains included both octopuses and squids.

*Hypoplectrus aberrans* (Poey) YELLOW-BELLIED HAMLET

17 stations; 25 specimens: 67 to 97 mm SL; 9 empty.

| FOOD | VOLUME (%) |
|---|---|
| Shrimps | 43.8 |
| Crabs | 18.7 |
| Unidentified crustaceans | 18.7 |
| Fishes | 11.9 |
| Stomatopods | 6.3 |
| Mysids | 0.6 |

Remarks.—This and the other species of *Hypoplectrus* are small compressed serranid fishes that live as adults on reefs. Unlike species of *Epinephelus* which frequently come in contact with the substratum, the hamlets usually swim a few inches off the bottom. They are slow-swimming, seemingly inquisitive, and easily approached. Beebe & Tee-Van (1928) described the food of hamlets, in general, as crustaceans and fishes. Randall & Randall (1960) stated that they feed mostly on benthic crustaceans of moderate size such as crabs, shrimps, and stomatopods, and occasionally on small fishes and polychaetes.

*Hypoplectrus chlorurus* (Cuvier & Valenciennes) YELLOWTAIL HAMLET

16 stations; 20 specimens: 65 to 110 mm SL; 5 empty.

| FOOD | VOLUME (%) |
|---|---|
| Shrimps | 51.2 |
| carideans | |
| *Periclimenes* sp. | |
| Fishes | 25.0 |
| blenniid | |
| Crabs | 17.1 |
| *Domecia hispida* | |
| *Pilumnus* sp. | |
| Unidentified crustaceans | 6.7 |

*Hypoplectrus nigricans* (Poey) DARK HAMLET

24 stations; 35 specimens: 67 to 123 mm SL; 18 empty.

| FOOD | VOLUME (%) |
|---|---|
| Fishes | 44.2 |
| Shrimps | 29.4 |
| Crabs | 17.6 |
| Mysids | 5.9 |
| Stomatopods | 2.9 |

*Hypoplectrus puella* (Cuvier & Valenciennes) BARRED HAMLET

21 stations; 38 specimens: 54 to 98 mm SL; 19 empty.

| FOOD | VOLUME (%) |
|---|---|
| Shrimps | 51.0 |
| alpheids | |
| *Brachycarpus biunguiculatus* | |
| *Periclimenes* sp. | |
| Crabs | 21.1 |
| *Petrolisthes* sp. | |
| Fishes | 10.0 |
| Mysids | 8.9 |
| Stomatopods | 5.3 |
| Isopods | 3.7 |

*Remarks.*—The most common of the species of *Hypoplectrus* in the West Indies.

*Mycteroperca bonaci* (Poey) BLACK GROUPER

5 stations; 6 specimens: 307 to 920 mm SL; 2 empty.

| FOOD | VOLUME (%) |
|---|---|
| Fishes | 100.0 |
| *Fistularia tabacaria* | |
| *Haemulon flavolineatum* | |

*Remarks.*—The black grouper, the largest of the Atlantic *Mycteroperca,* is a common fish in Florida and the Bahamas, but rare in Puerto Rico and the Virgin Islands. The stomach of the 920-mm fish contained a cornetfish *(Fistularia)* 810 mm in standard length; it was folded once in the stomach, and the snout projected from the grouper's gullet into the mouth. See Remarks under *Mycteroperca venenosa* for some general statements on the genus.

*Mycteroperca interstitialis* (Poey) YELLOWMOUTH GROUPER

8 stations; 8 specimens: 168 to 420 mm SL; 3 empty.

| FOOD | VOLUME (%) |
|---|---|
| Fishes | 100.00 |
| atherinids | |
| *Chromis multilineata* | |
| *Scarus croicensis* | |

*Remarks.*—*M. interstitialis* is not a common species of grouper in the West Indies. The 420-mm specimen contained two individuals of *Chromis multilineata,* 78 and 100 mm in standard length.

*Mycteroperca tigris* (Cuvier & Valenciennes) TIGER GROUPER

52 stations; 59 specimens: 153 to 572 mm SL; 25 empty.

| FOOD | VOLUME (%) |
|---|---|
| Fishes | 100.0 |
| *Acanthurus* sp. | |
| *Acanthurus bahianus* | |
| *Acanthurus coeruleus* (2) (juv.) | |
| atherinids | |
| *Cantherhines pullus* (juv.) | |

*Haemulon* sp.
*Haemulon flavolineatum* (2)
*Jenkinsia* sp. (2)
*Odontoscion dentex*
*Ophioblennius atlanticus* (2)
*Pomacentrus fuscus* (2)
*Pomacentrus planifrons*
*scarid*
*Sparisoma* sp.

*Remarks.*—The tiger grouper is the most easily approached of the species of *Mycteroperca* discussed herein; therefore, more specimens were speared per unit of effort than the other species of the genus. The two juvenile blue tangs and the one filefish from the grouper stomachs were all transforming from the late postlarval stage. The one specimen of *Acanthurus* sp., which measured 110-mm in standard length, was taken from the stomach of a 380-mm *M. tigris*.

*Mycteroperca venenosa* (Linnaeus) YELLOWFIN GROUPER

109 stations; 127 specimens: 175 to 745 mm SL; 76 empty.

| FOOD | VOLUME (%) |
|---|---|
| Fishes | 95.3 |
| *Abudefduf saxatilis* | |
| *Acanthurus bahianus* | |
| atherinids | |
| *Aulostomus maculatus* (3) | |
| *Caranx ruber* (2) | |
| *Chromis cyanea* (2) | |
| *Chromis multilineata* | |
| *Haemulon flavolineatum* | |
| holocentrid | |
| *Holocentrus* sp. | |
| monacanthid | |
| *Pomacentrus* sp. | |
| *Pomacentrus fuscus* (3) | |
| *Pomacentrus planifrons* | |
| scarids (5) | |
| *Scarus croicensis* | |
| *Scarus vetula* | |
| serranid | |
| *Synodus intermedius* | |
| *Thalassoma bifasciatum* | |
| Squids | 3.9 |
| *Sepiateuthis sepioidea* (2) | |
| Shrimps | 0.8 |
| *Tozeuma* sp. | |

*Remarks.*—The yellowfin grouper is the most common species of *Mycteroperca* in the West Indies. The species of this genus are less intimately associated with the bottom than those of *Epinephelus*. Also, in contrast to *Epinephelus* and other West Indian serranid genera, they feed almost exclusively on fishes. They are more slender-bodied (hence probably more rapid in their feeding rushes) and have better developed canine teeth; both of these characteristics would be expected of a predominantly piscivorous group of serranid fishes. That the yellowfin grouper can capture such swift-swimming fishes as the bar jack *(Caranx ruber)* would seem to indicate that it is more active than the more robust groupers such as species of *Epinephelus*. The bar jacks measured 150 and 160 mm in fork length and were taken from groupers that measured 450 and 485 mm, respectively, in standard length. The one lizardfish, which measured 182 mm SL, was found folded in the stomach of a 380-mm *M. venenosa*. Two of the groupers had fed on *Sepiateuthis sepioidea,* a squid which is often seen in small aggregations in shallow water in the West Indies. Two small hippolytid shrimps *(Tozeuma)* were found in the stomach of one 404-mm fish, along with a 35-mm damselfish *(Chromis cyanea)*.

*Paranthias furcifer* (Cuvier & Valenciennes) CREOLE FISH

7 stations; 13 specimens: 162 to 198 mm SL.

| FOOD | VOLUME (%) |
|---|---|
| Copepods | 61.7 |
| *Candacia pachydactyla* | |
| *Coryaceus* sp. | |
| *Eucalanus attenuatus* | |
| *Eucalanus monachus* | |
| *Euchaeta marina* | |
| *Paracalanus* sp. | |
| *remora stylifera* | |
| *Undinula vulgaris* (3) | |
| Tunicates | 12.2 |
| salps | |
| Shrimps and shrimp larvae | 11.9 |
| *Lucifer faxani* | |
| Unidentified animals | 7.7 |
| Amphipods | 3.1 |
| hyperiids | |
| Mysids | 2.3 |
| Fish larvae | 0.6 |
| Gastropod larvae | 0.2 |
| Unidentified crustaceans | 0.2 |
| Unidentified eggs | 0.1 |

*Remarks.*—*Paranthias furcifer* is a schooling serranid that feeds on zoo-

plankton. Typically, it rises well above reefs for its feeding, but descends for shelter with the approach of danger. The individual planktonic organisms are picked one by one from the passing water mass. This fish has a small mouth, small teeth, numerous gill rakers, fusiform body, and a deeply forked caudal fin — all representing departures from the typical grouper morphology, and all specializations for feeding in mid-water on zooplankton.

*Petrometopon cruentatum* (Lacépède) GRAYSBY

44 stations; 75 specimens: 124 to 260 mm SL; 49 empty.

| FOOD | VOLUME (%) |
|---|---|
| Fishes | 66.2 |
| *Abudefduf saxatilis* | |
| *Apogon pigmentarius* | |
| chaetodontid (juv.) | |
| *Coryphopterus* sp. | |
| *Coryphopterus personatus* | |
| *Haemulon* sp. | |
| *Holocentrus coruscus* | |
| Shrimps | 17.3 |
| alpheids | |
| Stomatopods | 8.9 |
| *Gonodactylus oerstedii* | |
| Crabs | 3.8 |
| Gastropods | 3.8 |
| *Strombus gigas* | |

*Remarks.*—A bold little grouper, the graysby will approach a diver closely and may even take food from his hand. It is frequently observed in caves on reefs.

*Serranus tabacarius* (Cuvier & Valenciennes) TOBACCO FISH

4 stations; 4 specimens: 92 to 135 mm SL; 3 empty.

| FOOD | VOLUME(%) |
|---|---|
| Fish | 100.0 |

*Remarks.--S. tabacarius,* like other species of *Serranus,* is usually encountered swimming a few inches off the bottom. Beebe & Tee-Van (1928) listed an engraulid fish as the sole contents of the stomach of one fish. Robins & Starck (1961) reported the stomach contents of three specimens to consist equally of fish and shrimp remains.

*Serranus tigrinus* (Bloch) HARLEQUIN BASS

13 stations; 26 specimens: 32 to 85 mm SL; 7 empty.

| FOOD | VOLUME (%) |
|---|---|
| Shrimps | 71.9 |
| carideans | |
| Fishes | 9.7 |
| Stomatopods | 8.9 |
| Crabs | 7.8 |
| Unidentified crustaceans | 1.7 |

*Remarks.—S. tigrinus* is the most common West Indian species of *Serranus,* and it is more characteristic of shallow-water reefs than other species of the genus. Beebe & Tee-Van (1928) stated that most of-their specimens of this species from Haiti had fed upon shrimps and other small crustaceans. Robins & Starck (1961) reported 99 per cent of the stomach contents of 22 specimens that contained food to consist of crustaceans (primarily shrimps), and only 1 per cent fish.

*Serranus tortugarum* Longley CHALK BASS

2 stations; 2 specimens: 21 and 45 mm SL.

| FOOD | VOLUME (%) |
|---|---|
| Copepods | 92.0 |
| *Coryaceus amazonicus* | |
| *Euterpina acutifrons* | |
| *Farranula gracilis* | |
| *Paracalanus aculeatus* | |
| *Paracalanus parvus* | |
| Fish eggs | 8.0 |

Remarks.—Robins & Starck (1961) examined the stomach contents of 14 specimens of *S. tortugarum* which contained food. The material in half of these stomachs was too digested to permit identification, but the remaining seven contained crustaceans, especially amphipods. These authors noted that *S. tortugarum* has numerous gill rakers and swims above the bottom. The copepods from the two stomachs examined for the present report consisted of calanoids, cyclopoids, and harpacticoids.

## GRAMMISTIDAE (Soapfishes)

*Rypticus saponaceus* (Bloch & Schneider) SOAP FISH

15 stations; 27 specimens: 98 to 224 mm SL; 15 empty.

| FOOD | VOLUME (%) |
|---|---|
| Fishes | 47.9 |
| *Halichoeres poeyi* | |
| *Quisquilius hipoliti* | |
| *Thalassoma bifasciatum* | |
| Shrimps | 34.2 |
| Crabs | 9.6 |
| *Percnon gibbesi* | |
| *Petrolisthes polita* | |
| Stomatopods | 8.3 |
| *Pseudosquilla ciliata* | |

Remarks.—Beebe & Tee-Van (1928) recorded eight specimens from Haiti (as *R. coriaceus)*. Of these specimens they wrote, "All fishes of this species examined had been feeding upon shrimps." The soapfish is named for the copious quantity of slime that it secretes, particularly when disturbed. The author inadvertently discovered, after spearing a specimen in the Florida Keys and placing it inside his swimming trunks, that the slime is strongly irritating. Marezki & del Castillo (1967) have determined that the mucus contains a protein toxin. The author has not found any soapfishes in the stomachs of predatory fishes. Feeding experiments might demonstrate that the toxic slime of *Rypticus* is repelling to predators.

## GRAMMIDAE (Fairy Basslets)

In the western Atlantic, this family consists of two species of *Gramma* and three of *Lipogramma*. These are very colorful reef fishes of small size that usually live in caves or beneath ledges; they retreat to holes in the reef when frightened. Beebe & Tee-Van (1928) described the food of *G. loreto* Poey merely as small crustaceans. Eibl-Eibesfeldt (1955) reported this species among those he observed picking at the bodies of other fishes at Bonaire, ostensibly to feed on ectoparasites. Böhlke & Randall (1963: Table 4) recorded the stomach contents of 56 specimens of *G. loreto*. The fish had fed primarily on small free-living crustaceans such as copepods, mysids, and shrimp larvae. A few parasitic crustaceans (one calagoid copepod and six larval gnathiid isopods) were found in the stomachs. The stomach contents of five specimens of *G. melacara* Böhlke & Randall were examined by the same authors. All of this material consisted of free-living planktonic crustaceans. The two species of *Gramma* normally do not move more than a few inches from the rock or coral substratum during feeding. No new data on the food habits of grammids are reported here.

## CIRRHITIDAE (Hawkfishes)

*Amblycirrhitus pinos* (Mowbray) HAWKFISH
10 stations; 16 specimens: 29 to 74 mm SL; 4 empty.

| FOOD | VOLUME (%) |
|---|---|
| Copepods | 45.8 |
| *Candacia pachydactyla* | |
| *Centropages hamatus* | |
| *Euchaeta marina* | |
| *Scolecithrix danae* | |
| *Undinula vulgaris* | |
| Shrimps and shrimp larvae | 21.1 |
| alpheids (2) | |
| carideans | |
| gnathophyllids | |
| palaemonids | |
| Crabs and crab larvae | 14.2 |
| Polychaetes | 12.1 |
| Isopods | 2.5 |
| flabelliferan | |
| *Stenetrium* sp. | |
| Amphipods | 2.1 |
| Tanaids | 1.4 |
| Unidentified animals | 0.8 |

*Remarks.—A. pinos,* the only western Atlantic hawkfish, is a small species which rests upon a hard substratum. Most of its prey consists of zooplanktonic organisms.

## APOGONIDAE (Cardinalfishes)

Food-habit data were obtained for only two of the 19 species of shallow-water western Atlantic cardinalfishes, *Apogon conklini* and *A. maculatus*. It seems likely from underwater observations, however, that the other species will be found to feed in a similar manner. These little fishes hide deep in the recesses of the reef by day; at night they come out to feed. Often they are several feet above the bottom where they appear to be feeding mainly on small crustaceans in the plankton. *Astrapogon stellatus* (Cope) is a commensal in the mantle cavity of the queen conch *(Strombus gigas)*. Plate (1908) concluded that this fish leaves the conch only at night to feed. He described its food as shrimps, sea lice, and other crustaceans.

*Apogon conklini* (Silvester) FRECKLED CARDINALFISH
4 stations; 29 specimens: 33 to 47 mm SL; 12 empty.

| FOOD | VOLUME (%) |
|---|---|
| Shrimp larvae | 24.1 |
| alpheids | |
| Amphipods | 18.8 |
| hyperiids | |
| Unidentified crustaceans | 18.2 |
| Crab larvae | 10.0 |
| Tunicates | 7.3 |
| appendicularians | |
| Polychaetes | 5.9 |
| Copepods | 5.9 |
| Isopods | 5.3 |
| Tanaids | 2.7 |
| Fish eggs | 1.8 |

*Apogon maculatus* (Poey) FLAMEFISH

5 stations; 22 specimens: 43 to 68 mm SL; 11 empty.

| FOOD | VOLUME (%) |
|---|---|
| Shrimps and shrimp larvae | 49.0 |
| carideans | |
| Crabs | 23.7 |
| Unidentified crustaceans | 12.7 |
| Copepods | 9.1 |
| Polychaetes | 3.7 |
| opheliid | |
| Isopods | 1.1 |
| Amphipods | 0.7 |

*Remarks.—Apogon maculatus* is the largest and probably the most common of inshore cardinalfishes in the West Indies. Beebe & Tee-Van (1928) and Longley & Hildebrand (1941) reported a shrimp from the stomach of a single specimen from Haiti and Dry Tortugas, respectively.

## PRIACANTHIDAE (Bigeyes)

Two species of *Priacanthus* occur with moderate frequency on West Indian reefs. Their large eyes are suggestive of nocturnal activity, and this has been confirmed by Longley & Hildebrand (1941) who wrote of *P. cruentatus*, "Feeding occurs chiefly at night." That they can feed by day as well is evident from the fresh food material in stomachs during various diurnal hours.

*Priacanthus arenatus* Cuvier & Valenciennes BIGEYE

18 stations; 29 specimens: 125 to 273 mm SL; 11 empty.

| FOOD | VOLUME (%) |
|---|---|
| Fishes and fish larvae | 37.5 |
| atherinids | |
| *Dactylopterus volitans* (larv.) | |
| *Lactophrys* sp. (larv.) | |
| Shrimps | 34.7 |
| carideans | |
| penaeids | |
| *Trachypenaeus* sp. | |
| Polychaetes | 11.1 |
| eunicids | |
| Crabs and crab larvae | 9.8 |
| *Cronius tumidulus* | |
| portunid | |
| Cephalopods | 2.2 |
| Stomatopod larvae | 1.7 |
| Isopods | 1.6 |
| Scyllarid larvae | 1.4 |

*Remarks.--Priacanthus arenatus* is most often seen at depths of about 50 feet or more. It is usually encountered in schools and is less inclined to hide in holes or crevices in the reef by day than *P. cruentatus.* Most of the fishes and crustaceans on which it feeds are larval forms, thus indicating a tendency to feed more on zooplanktonic than benthic organisms.

*Priacanthus cruentatus* (Lacépède) GLASSEYE

19 stations; 32 specimens: 116 to 215 mm SL; 7 empty.

| FOOD | VOLUME (%) |
|---|---|
| Fishes | 28.7 |
| *Dactylopterus volitans* (larv.) | |
| *Jenkinsia* sp. | |
| *Lactophrys* sp. (larv.) | |
| tetraodontid (larv.) | |
| Polychaetes | 16.8 |
| Crabs and crab larvae | 14.4 |
| oxystome | |
| Shrimps and shrimp larvae | 10.0 |
| alpheids | |
| Cephalopods and cephalopod larvae | 8.9 |
| Mysids | 7.8 |
| Stomatopod larvae | 5.4 |
| Isopods | 4.9 |
| Unidentified animals | 1.2 |
| Gastropods | 1.2 |
| Amphipods | 0.7 |

*Remarks.—Priacanthus cruentatus* is a shallow-water solitary species. Most of the food organisms consist of the larger animals of the plankton.

## PEMPHERIDAE (Sweepers)

*Pempheris schomburgki* Muller & Troschel GLASSY SWEEPER

5 stations; 19 specimens: 93 to 111 mm SL; 1 empty.

| FOOD | VOLUME (%) |
|---|---|
| Polychaetes | 27.3 |
| Crab larvae | 24.5 |
| Shrimp larvae | 18.9 |
| Stomatopod larvae | 16.7 |
| *Gonodactylus* sp. | |
| *Squilla hyalina* | |
| Hermit crab larvae | 5.4 |
| Octopus larvae | 3.3 |
| Unidentified crustaceans | 2.8 |
| Amphipods | 1.1 |

*Remarks.*—*P. schomburgki* is nocturnal. It appears to feed almost entirely on zooplankton.

## EMMELICHTHYIDAE (Bogas)

*Inermia vittata* Poey — BOGA

2 stations; 3 specimens: 130 to 184 mm SL.

| FOOD | VOLUME (%) |
|---|---|
| Copepods | 76.7 |
| *Candacia pachydactyla* | |
| *Farranula gracilis* | |
| *Miracia efferata* | |
| *Nannocalanus minor* | |
| *Oncaea* sp. | |
| *Rhyncalanus cornutus* | |
| *Undinula vulgaris* (2) | |
| Siphonophores | 16.7 |
| Fish scales | 3.3 |
| Crab larvae | 2.0 |
| Polychaetes | 1.3 |

*Remarks.*—*Inermia vittata* is a slender schooling fish that is generally seen in deep outer-reef areas where the water is clear and blue. It feeds on mid-water zooplankton, for which its highly protrusible mouth is probably very effective.

## LUTJANIDAE (Snappers)

The snappers are a large family of carnivorous fishes. In general, they are nocturnal. Although they are regarded as reef fishes, some of the species feed primarily on the animals that live on the sand and seagrass flats. Night diving revealed individual snappers foraging over these flats. By day they retire to reefs for cover, often in small aggregations. The larger the canine teeth of the lutjanid species, in general, the higher the percentage of fish in the diet. Within a species, the larger individuals feed proportionately more on fishes.

*Lutjanus analis* (Cuvier & Valenciennes) — MUTTON SNAPPER

55 stations; 66 specimens: 204 to 620 mm SL; 13 empty.

| FOOD | VOLUME (%) |
|---|---|
| Crabs | 44.4 |
| *Calappa gallus* | |
| calappids (3) | |
| *Cronius ruber* | |
| majid | |
| *Parthenope serrata* | |
| *Petrolisthes* sp. | |
| portunids (7) | |
| *Portunus* sp. | |
| *Portunus sebae* (2) | |
| *Ranilia muricata* | |
| Fishes | 29.8 |
| *Acanthurus bahianus* | |
| *Diodon* sp. (2) | |
| *Fistularia tabacaria* | |
| gobiid | |
| *Haemulon* sp. | |
| *Haemulon aurolineatum* | |
| *Halichoeres garnoti* | |
| *Holocentrus ascensionis* | |
| *Malacanthus plumieri* | |
| *Monacanthus* sp. | |
| *Monacanthus setifer* | |
| *Pseudupeneus maculatus* (2) | |
| scarid | |
| *Scorpaena plumieri* | |
| *Sphaeroides spengleri* | |
| Gastropods | 13.0 |
| *Fasciolaria tulipa* | |
| *Murex pomum* | |
| *Strombus* sp. (2) | |
| *Strombus gigas* (5) | |
| Octopuses | 3.1 |
| Hermit crabs | 2.8 |
| *Petrochirus diogenes* (2) | |
| Shrimps | 2.3 |
| penaeid | |
| Unidentified animal material | 1.9 |
| Spiny lobsters | 1.9 |
| *Panulirus argus* | |
| Stomatopods | 0.8 |
| *Lysiosquilla glabriuscula* | |

*Remarks.*—The mutton snapper is a highly esteemed food fish which is more of a roving species than the snappers of the genus *Lutjanus* discussed in the accounts which follow. It swims above the bottom over reefs but is more frequently encountered over sand, seagrass, or coral rubble (although often near reefs). It feeds both by day and by night. Beebe & Tee-Van (1928) reported the species as strictly carnivorous, specializing in small fishes, crustaceans such as shrimps and crabs, and mollusks. Longley & Hildebrand (1941) state that fishes (largely small grunts) predominated in the food taken from 29 stomachs at Dry Tortugas. They added that the only other food of importance consisted of shrimps. In

contrast to Longley & Hildebrand, the author found that crabs were the most important item of food in the 66 specimens examined from the West Indies. Gastropods represented 13 per cent by volume of the food material. Of particular importance were species of *Strombus,* especially *S. gigas*. These were found in the stomachs mostly as large adults, but without shell or shell fragments. *Lutjanus analis* does not have the jaw strength and dentition to crush an adult *Strombus gigas,* the shell of which is massive. Randall (1964a) postulated that the fish obtained the soft parts of these large gastropods only after they have been made available by other predators such as octopuses. The large hermit crabs *(Petrochirus diogenes)* were also found in the mutton snapper stomachs without their protective gastropod shells. One 572-mm individual contained a fully adult *P. diogenes,* a 191-mm *Pseudupeneus maculatus,* and a 76-mm *Halichoeres garnoti*. Seven mutton snappers in the range of 484 to 528 mm in standard length contained the following fishes (standard lengths given in parentheses): *Acanthurus bahianus* (137 mm), *Diodon* sp. (74 mm), *Fistularia tabacaria* (110 mm), *Haemulon aurolineatum* (130 mm), *Holocentrus ascensionis* (130 mm), *Malacanthus plumieri* (320 mm), *Monacanthus* sp. (50 mm), *Monacanthus setifer* (78 mm), and *Sphaeroides spengleri* (75 and 77 mm).

*Lutjanus apodus* (Walbaum) SCHOOLMASTER

90 stations; 117 specimens: 125 to 445 mm SL; 59 empty.

| FOOD | VOLUME (%) |
|---|---|
| Fishes | 60.7 |
| atherirrids | |
| *Aulostomus maculatus* (2) | |
| *Bodianus rufus* | |
| *Cantherhines pullus* (juv.) | |
| *Chromis multilineata* | |
| *Gymnothorax moringa* | |
| *Haemulon* sp. | |
| *Jenkinsia* sp. | |
| *Pomacentrus fuscus* | |
| scarids (3) | |
| *Scorpaena plumieri* | |
| scorpaenid | |
| serranids (2) | |
| *Sparisoma* sp. | |
| *Sparisoma aurofrenatum* | |
| Crabs | 22.2 |
| *Actaea acantha* | |
| calappid | |
| majid | |
| *Mithrax sculptus* | |
| *Pernon gibbesi* | |
| *Poriunus sebae* (2) | |
| portunids (3) | |
| Unidentified crustaceans | 6.0 |
| Stomatopods | 3.7 |
| Shrimps | 3.45 |
| Octopuses | 3.45 |
| Gastropods | 0.5 |

*Remarks.—L. apodus* appears to be more confined to reefs than other snappers. It is often seen among stands of *Acropora palmata* during the day. Beebe & Tee-Van (1928) examined the stomach contents of 25 specimens from Haiti. They found crabs, shrimps, and numerous fishes, especially *Anchoviella* sp., *Opisthonema oglinum,* and *Diodon hystrix,* in the stomachs. The porcupinefish were taken from 15 stomachs. Longley & Hildebrand (1941) reported on the examination of 241 stomachs from Dry Tortugas, Florida. Crabs were the most numerous; they included spider crabs *(Mithrax)* and porcelain crabs *(Porcellana* and *Petrolisthes).* Shrimps, such as the snapping shrimps *Alpheus* and *Crangon,* were next in importance. Fishes were notably less numerous than crabs and shrimps; among them were scarids and labrids. Other food items were polychaetes, octopuses (six stomachs), clam (one stomach), isopod (one stomach), and an amphipod (one stomach). These authors stated that feeding occurs at night. This fish also feeds heavily during daylight hours, however. The author often noted fresh food material in the stomachs of fish taken during various hours of the day. The high percentage of fish in the stomachs stands in contrast to the data of Longley & Hildebrand. Possibly this difference is due to smaller size of the Tortugas specimens that were examined by these authors. In general, the smaller snappers feed mostly on crustaceans and the larger ones more on fishes. Unfortunately Longley & Hildebrand did not give the size of their specimens. Fifty-two of those examined by the author ranged from 200 to 300 mm in standard length, and 34 exceeded 300 mm. The stomach of a 400-mm schoolmaster contained a scarid fish *(Sparisoma aurofrenatum)* 189 mm in length. A 340-mm snapper had eaten a 165-mm *Bodianus rufus*. A 288-mm one contained a 300-mm *Aulostomus maculatus* and a 255-mm one a 230-mm *Gymnothorax moringa*. The latter was well digested at 8:30 a.m., so was probably eaten during the night. The two specimens of *Portunus sebae* from schoolmaster stomachs measured 23 and 30 mm across the carapace; they were taken from fish which were 295 and 223 mm in standard lenfth, respectively. The latter also had eaten a 105-mm stomatopod.

*Lutjanus cyanopterus* (Cuvier & Valenciennes) CUBERA SNAPPER

11 stations; 11 specimens: 410 to 990 mm SL.

| FOOD | VOLUME (%) |
|---|---|
| Fishes | 100.0 |
| clupeid | |
| *Diodon* sp. (2) | |

*Haemulon aurolineatum*
*Haemulon sciurus*
scarids (2)
*Scarus coeruleus*

*Remarks.*—*Lutjanus cyanopterus* is the largest snapper in the western Atlantic. It is the least common of the shallow-water species in the West Indies and the most wary, hence the small number of specimens procured. The large canine teeth in the jaws are indicative of its piscivorous habits.

*Lutjanus griseus* (Linnaeus) GRAY SNAPPER

64 stations; 90 specimens: 120 to 400 mm SL; 62 empty.

| FOOD | VOLUME (%) |
|---|---|
| Crabs | 40.0 |
| *Callinectes* sp. | |
| goneplacid *(Speocarcinus)* | |
| portunids (3) | |
| xanthid | |
| Fishes | 39.1 |
| *Jenkinsia* sp. | |
| Shrimps | 13.2 |
| penaeids (3) | |
| Gastropods | 6.8 |
| *Strombus gigas* | |
| Scyllarid lobsters | 0.9 |

*Remarks*.—Longley (1923) noted that *L. griseus* is primarily a nocturnal bottom fish. It feeds individually over sand and seagrass flats by night and aggregates in reefs or other areas of cover by day. The large number of empty gray snappers recorded above reflects the nocturnal habits. Occasional fish, however, did have fresh food material in their stomachs during late morning or afternoon hours. Longley & Hildebrand (1941), Reid (1954), Springer & Woodburn (1960), Tabb & Manning (1961), Croker (1962), and especially Starck (in press) have all studied the food habits of the gray snapper. Juveniles in the seagrass beds feed by day mainly on amphipods, shrimps, and copepods. Larger individuals continue to eat shrimps but add crabs and fishes as major items to the diet. The largest snappers eat more fish than crustaceans. Other invertebrates such as annelid worms may be eaten when locally abundant.

*Lutjanus jocu* (Bloch & Schneider) DOG SNAPPER

65 stations; 92 specimens: 190 to 630 mm SL; 36 empty.

| FOOD | VOLUME (%) |
|---|---|
| Fishes | 60.7 |
| atherinids | |
| *Aulostomus maculatus* | |
| *Clepticus parrae* | |
| *Gymnothorax moringa* | |
| *Haemulon* sp. | |
| *Haemulon aurolineatum* | |
| *Haemulon plumieri* | |
| *Holacanthus tricolor* | |
| *Holocentrus* sp. (2) | |
| *Holocentrus rufus* | |
| *Jenkinsia* sp. | |
| *Myrichthys* sp. | |
| *ophichthid* | |
| *Opisthonema oglinum* | |
| *Pseudupeneus maculatus* (2) | |
| scarids (4) | |
| *Scarus* sp. | |
| *serranid (Cephalopholis?)* | |
| *Sparisoma* sp. (2) | |
| *Sparisoma viride* | |
| *Xanthichthys ringens* | |
| Crabs | 15.4 |
| *Carpilius corallinus* | |
| *Cronius ruber* (2) | |
| *Pitho lherminieri* | |
| portunids (2) | |
| *Portunus* sp. | |
| Octopuses | 7.0 |
| *Octopus vulgaris* | |
| Spiny lobsters | 6.6 |
| *Panulirus argus* | |
| *Panulirus guttatus* (3) | |
| Gastropods | 3.6 |
| *Strombus gigas* (2) | |
| Squids | 2.2 |
| Fish eggs (belonid) | 1.8 |
| Scyllarid lobsters | 1.8 |
| Unidentified crustaceans | 0.9 |

*Remarks*.—The dog snapper attains moderately large size. Sixty of the 92 specimens examined were 400 mm or more in standard length. The larger fish usually take relatively large prey. Eight dog snappers from 538 to 630 mm SL had eaten a 150-mm *Opisthonema oglinum,* four scarids (140 to 230 mm), *Holocentrus rufus* (150 mm), *Aulostomus maculatus* (250 mm), *Gymnothorax moringa* (450 mm), and *Myrichthys* sp. (600 mm). Four other snappers in the size range 368 to 418 mm ate *Holocentrus* sp., *Haemulon aurolineatum, H. plumieri,* and *Holacanthus tricolor* ranging from 100 to 145 mm in standard length. On the other hand, one 510-mm snapper contained 11 atherinid fish from 49 to 58 mm and a

crab 21 mm across the carapace. The dog snapper is both diurnal and nocturnal.

*Lutjanus mahogoni* (Cuvier & Valenciennes) MAHOGANY SNAPPER
16 stations; 27 specimens: 135 to 295 mm SL; 19 empty.

| FOOD | VOLUME (%) |
|---|---|
| Fishes | 75.0 |
| atherinid | |
| *Holocentrus sp.* | |
| *Saurida* sp. | |
| Shrimps | 12.5 |
| penaeid | |
| Octopuses | 9.4 |
| Crabs | 3.1 |
| portunid | |

*Remarks.*—The mahogany snapper appears to be strictly nocturnal. Stomachs of fish taken during afternoon hours were invariably empty. It is not a very common fish in the West Indies but is more frequently seen than the relatively few specimens cited above would indicate. It is moderately wary and hence difficult to collect with a spear.

*Lutjanus synagris* (Linnaeus) LANE SNAPPER
5 stations; 6 specimens: 148 to 280 mm SL; 4 empty.

| FOOD | VOLUME (%) |
|---|---|
| Crabs | 50.0 |
| goneplacid | |
| *Leiolambrus nitidus* | |
| portunid | |
| Stomatopods | 50.0 |
| *Lysiosquilla glabriuscula* | |

*Remarks.*—The lane snapper is a species of many habitats. It is known from the shore to depths of at least 220 fathoms, from coral reefs in clear water to murky brackish water over a mud bottom. Beebe & Tee-Van (1928) reported it as the most abundant species of the genus in Port-au-Prince Bay, Haiti. They examined 78 stomachs and found that fishes and crustaceans dominated the food material. In the following list the number in parentheses denotes the frequency with which they encountered the food item: eels (2), silversides (5), anchovies (5), porcupinefish (10), unidentified fish (8), stomatopods (2), crabs (15), shrimps (15), other crustaceans (3), mollusks (1), polychaete worms (3), purple holothurians (1), sponge spicules (1), and seaweed (2). Langley & Hildebrand (1941) found *Jenkinsia lamprotaenia* in one specimen from Dry Tortugas. Reid (1954) stated that crustaceans represented the main constituent of the diet of young lane snappers off West Florida. Of nine with food, eight contained shrimps, one had mysids, two had copepods, and two contained fish. Springer & Woodburn (1960) listed copepods, gammarid amphipods, shrimps, crustaceans, a fish and a gastropod in the stomachs of four juveniles. Lowe (1962) reported crustaceans and some fishes as the food of specimens from British Guiana. She specifically cited a batfish *(Ogcocephalus)* and *Squilla* from one lane snapper. Rodriquez Pino (1962) examined the stomach contents of 207 individuals from Cuba. Her results were summarized as follows: fishes (32 per cent), crustaceans (27 per cent), annelids (12 per cent), mollusks (1 per cent), algae (2 per cent), and unidentified (26 per cent).

*Ocyurus chrysurus* (Bloch) YELLOWTAIL SNAPPER
29 stations; 52 specimens: 114 to 440 mm SL; 10 empty.

| FOOD | VOLUME (%) |
|---|---|
| Crabs and larvae (15 % larv.) | 23.3 |
| *Calappa ocellata* | |
| *Mithrax sp.* | |
| *Mithrax sculptus* | |
| *Pitho aculeata* | |
| Shrimps and larvae (60% larv.) | 16.2 |
| carideans | |
| penaeids | |
| *Sicyonia laevigata* | |
| *Trachycaris restrictus* | |
| Fishes and fish larvae | 15.1 |
| *Jenkinsia* sp. | |
| Siphonophores | 7.1 |
| Pteropods | 6.1 |
| *Cavolina* sp. | |
| Copepods | 5.1 |
| Cephalopods and larvae | 3.8 |
| Mysids | 2.9 |
| Tunicates | 2.7 |
| appendicularians | |
| salps | |
| Ctenophores | 2.7 |
| Unidentified animal material | 2.5 |
| Gastropods (except pteropods) | 2.4 |
| *Strombus gigas* | |
| Stomatopods | 2.4 |
| *Gonodactylus oerstedii* | |
| *Pseudosquilla ciliata* | |
| Scyllarid larvae | 1.9 |
| Heteropods | 1.2 |
| Pelecypods | 1.2 |
| Fish eggs | 0.9 |
| Euphausids | 0.8 |
| Gastropod larvae | 0.7 |

| | |
|---|---|
| Amphipods | 0.5 |
| hyperiids | |
| Hymenopteran insect | 0.5 |

*Remarks*.—The yellowtail snapper is one of the most common reef fishes in the tropical Western Atlantic and one of the most highly esteemed as food. The young are abundant in seagrass areas. Both young and adults are active fishes which usually swim well above the bottom. Their somewhat slender bodies and deeply forked tails (compared with *Lutjanus)* are indicative of such a mode of life. The adults are difficult to approach underwater. Beebe & Tee-Van (1928) reported copepods and a pteropod in the stomach of a 40-mm specimen; 15 larger fishes had eaten bottom detritus, including coral fragments and sand grains, mud, algae, sponges, polychaete worms, crustaceans such as shrimps and crabs, and small fishes, notably anchovies. Longley & Hildebrand (1941) observed that *Ocyurus* is not as restricted in its feeding to night hours as other members of the family. They noted that the species will take food at the surface over the deeper part of the lagoon at Dry Tortugas. They listed the food organisms as *Jenkinsia lamprotaenia* and other small fishes, shrimps, crabs, stomatopods, and annelids. The smaller individuals among the 42 reported herein with food in their stomachs had fed mostly on zooplankton. Large adults were primarily responsible for the benthic animals from the stomachs, but they also fed on pelagic animals, including some of small size. A 253-mm yellowtail, for example, contained numerous slender pteropods 3 to 6 mm in length. One fish speared in 60 feet off southwestern Puerto Rico had eaten a wasp. Curiously, this insect represented a species not yet recorded from the island. The 2.4 per cent by volume of stomach-content material attributed above to gastropods consisted of the soft parts of one adult conch *(Strombus gigas)* (see discussion under *Lutjanus analis).*

## POMADASYIDAE (Grunts)

Like the snappers, the grunts are carnivorous (although rarely piscivorous) and primarily nocturnal. They are among the most abundant of reef fishes in the West Indies. From a trophic standpoint, however, they would more properly be classified as seagrass-bed and sand-flat feeders. Along with the lutjanids, they use the reefs primarily for protection from open-water predaceous fishes during daylight hours. Longley often made reference to the pomadasyids and lutjanids idling the day away among the corals. Some of the species such as *Haemulon chrysargyreum* tend to form schools in and about reefs. The prey animals of grunts, in general, vary from moderate to very small in size. Juvenile pomadasyids appear to feed primarily on zooplankton.

*Anisotremus surinamensis* (Bloch) BLACK MARGATE

45 stations; 62 specimens: 180 to 478 mm; 22 empty.

| FOOD | VOLUME (%) |
|---|---|
| Echinoids | 53.5 |
| *Diadema antillarum* (21) | |
| *Echinometra* sp. (3) | |
| *Echinometra lacunter* | |
| *Echinometra viridis* | |
| *Eucidaris tribuloides* (2) | |
| spatangoid | |
| Gastropods | 16.0 |
| acmaeids (2) | |
| *Acmaea antillarum* (2) | |
| *Acmaea pustulata* (2) | |
| *Alvania auberiana* | |
| *Anachis* sp. (2) | |
| columbellid | |
| *Diodora cayenensis* | |
| *Diodora listeri* | |
| *Fissurella barbadensis* (3) | |
| *Hemitoma octoradiata* | |
| *Hyalina* sp. | |
| *Mangelia* sp. | |
| *Mitrella lunata* | |
| *Nassarius albus* | |
| *Nitidella ocellata* | |
| *Olivella* sp. (2) | |
| *Persicula lavalleeana* | |
| *Pyrgocythara* sp. | |
| turrid | |
| Crabs | 9.9 |
| majids (2) | |
| xanthids (3) | |
| Ophiuroids | 5.3 |
| *Ophiocoma* sp. | |
| *Ophiocoma echinata* | |
| *Ophiothrix* sp. | |
| Hermit crabs | 2.9 |
| Stomatopods | 2.3 |
| Shrimps | 2.3 |
| alpheids (4) | |
| Asteroids | 1.75 |
| *Linckia guildingii* | |
| Fishes | 1.5 |
| Pelecypods | 1.3 |
| *Laevicardium* sp. | |
| *Papyridea soleniformis* | |
| *Tellina* sp. | |
| Unidentified crustaceans | 1.1 |

| | |
|---|---|
| Anthozoans | 0.75 |
| Scyllarid lobsters | 0.5 |
| Polychaetes | 0.4 |
| serpulid | |
| Ostracods | 0.25 |
| Unidentified animal matter | 0.12 |
| Sponge | 0.08 |
| Isopods | 0.05 |

*Remarks*.—The black margate, one of the largest of the grunts, is often seen during the day in caves near shore where the surf is not strong. It is nocturnal, at least as an adult. It feeds almost exclusively on invertebrates with hard parts. Intestinal contents of some of the specimens were analyzed along with stomach material. Echinoids strongly dominate the food of large adults, particularly *Diadema antillarum*. The spines and test of this formidable echinoid were found crushed into small pieces, along with soft parts, in the alimentary tracts of the fish. Randall, Schroeder, & Starck (1964) noted that the pale fleshy lips of the black margate often display purple dots as a result of penetration by the spines of this urchin, and the bones of the roof of the mouth may be stained purple, apparently from the tatooing effect of the pigment from countless spine wounds. The smaller fish feed more heavily on gastropods, particularly limpets. Three fish contained small amounts of algae; this was probably consumed accidentally.

*Anisotremus virginicus* (Linnaeus) PORKFISH

12 stations; 16 specimens: 112 to 264 mm SL; 3 empty.

| FOOD | VOLUME (%) |
|---|---|
| Ophiuroids | 16.5 |
| *Ophiothrix* (3) | |
| Crabs | 16.2 |
| Shrimps | 14.7 |
| alpheids (5) | |
| carideans | |
| Polychaetes | 14.0 |
| *Eunice* sp. | |
| Isopods | 8.2 |
| anthurids | |
| *Asellote* sp. | |
| *Cymodoce* sp. | |
| excorallanid | |
| sphaeromid | |
| Pelecypods | 5.5 |
| *Americardia guppyi* | |
| *Americardia media* | |
| *Chione* sp. | |
| *Chione cancellata* | |
| *Cumingia antillarum* | |
| *Papyridea semisulcata* (2) | |
| *Pecten* sp. | |
| Unidentified crustaceans | 5.1 |
| Stomatopods | 4.7 |
| Gastropods | 3.8 |
| *Columbella mercatoria* | |
| *Hyalina* sp. | |
| *Mitra* sp. | |
| *Modulus modulus* | |
| *Olivella* sp. | |
| *Zebina browniana* | |
| Amphipods | 3.0 |
| caprellids | |
| gammarid | |
| lysianassid | |
| metopid | |
| Copepods | 1.8 |
| harpacticoids | |
| Tunicates | 1.5 |
| *Tridemnum savignii* | |
| Tanaids | 1.1 |
| apseudid | |
| Ostracods | 0.9 |
| *Bairdoppilata carinata* | |
| *cypridinine* | |
| Chitons | 0.8 |
| Hermit crabs | 0.6 |
| Foraminifera | 0.5 |
| Nebaliaceans | 0.5 |
| *Nebalia* sp. | |
| Sipunculids | 0.4 |
| *Aspidosiphon* sp. | |
| Scaphopods | 0.2 |
| *Dentalium* sp. | |

*Remarks*.—The porkfish is not common in Puerto Rico or the Virgin Islands, in contrast to the Florida Keys where it is abundant on coral reefs. Beebe & Tee-Van (1928) stated that the stomach contents of their two specimens from Haiti were dominated by minute crustaceans, other comminuted animal remains, including many small elongate spines (which may have been spines from *Ophiothrix*), and small mollusks. Longley & Hildebrand (1941) reported the stomach contents of six individuals taken at daybreak to consist of ophiurans, mollusk shells, annelids, and fragments of crustaceans. They noted that small porkfish (which are colored differently than adults; they have two lengthwise black bands instead of a black bar through the eye and another anteriorly on the body) nibble and peck at the

surfaces of larger fishes, presumably to remove ectoparasites. The author has often observed the same behavior at West Indian localities. The young porkfish restrict themselves to small sectors of reef, and the other fishes in the vicinity come to these stations for "cleaning." No stomach contents of juvenile fishes were examined, but the observations strongly suggest that fish ectoparasites will be found in their stomachs. The food animals from adult porkfish stomachs were noteworthy for their small size. For example, none of the many and varied crustaceans and mollusks in the stomach of a 200-mm individual exceeded 5 mm in greatest dimension of the body or shell.

*Haemulon album* (Cuvier & Valenciennes) MARGATE

48 stations; 57 specimens: 278 to 535 mm SL; 18 empty.

| FOOD | VOLUME (%) |
|---|---|
| Sipunculids | 25.2 |
| *Aspidosiphon* sp. | |
| *Aspidosiphon speciosus* | |
| *Siphonosoma cumanensis* | |
| Echinoids | 19.9 |
| *Brissus brissus* | |
| *Clypeaster* sp. (4) | |
| *Lytechinus variegatus* | |
| *Moira atropus* | |
| spatangoids (4) | |
| Polychaetes | 14.0 |
| arabellids | |
| Crabs | 7.6 |
| *Albunea gibbesii* | |
| hippids (2) | |
| *Sesarma* sp. | |
| Pelecypods | 5.4 |
| *Laevicardium* sp. | |
| pinnid | |
| Ophiuroids | 5.2 |
| *Amphiura fibulata* | |
| *Ophiothrix* sp. | |
| Shrimps | 3.9 |
| alpheids (3) | |
| axiid | |
| Hemichordates | 3.5 |
| Unidentified crustaceans | 3.3 |
| Gastropods | 2.7 |
| *Oliva* sp. | |
| Fishes | 2.0 |
| monacanthid | |
| Unidentified animals (mostly worms) | 1.9 |
| Stomatopods | 1.4 |
| *Squilla tricarinata* | |
| Echiuroids | 1.0 |
| Chitons | 0.8 |
| Priapuloids | 0.8 |
| Amphipods | 0.5 |
| caprellids | |
| Hermit crabs | 0.5 |
| Scaphopods | 0.2 |
| *Dentalium* sp. | |
| *Dentalium semistriolatum* | |
| Sponges | 0.1 |
| Bryozoans | 0.1 |

*Remarks.*—The margate, a highly regarded food fish, is the largest grunt of the genus *Haemulon.* Although active by night, it also feeds heavily by day. It is most often seen over sand and seagrass near reefs. It has been observed to nose into the sand, and the large number of sand-dwelling animals in its diet is indicative of such a mode of feeding. The stomachs of five specimens contained fragments of *Cymodocea,* and one fish had ingested *Thalassia.* Probably these seagrasses were taken in incidentally while feeding. The same is true of some sand and bottom detritus. Cummings, Brahy, & Spires (1966) studied the feeding of *H. album* at Bimini. The stomach contents of 32 night-caught fish and 23 day-caught fish from 160 to 480 mm standard length were analyzed. The average food volume was greater for the night-caught fish; however it is possible that floodlights used in the study area at night and the plankton attracted by these lights promoted heavier-than-normal night feeding. These authors reported crabs to be eaten by the highest percentage of margates, with polychaetes, stomatopods, pelecypods, and fishes also of importance in the diet.

*Haemulon aurolineatum* Cuvier & Valenciennes TOMTATE

12 stations; 28 specimens: 97 to 170 mm SL; 12 empty.

| FOOD | VOLUME (%) |
|---|---|
| Shrimps and shrimp larvae | 33.6 |
| Polychaetes | 31.0 |
| *Chloeia* sp. | |
| Unidentified crustaceans | 8.8 |
| Unidentified eggs | 6.2 |
| Hermit crabs and larvae | 4.4 |
| Crabs and crab larvae | 3.7 |
| Amphipods | 3.4 |
| A*mpelisca* sp. | |
| *Elasmopus* sp. | |
| *Eurystheus* sp. | |
| *Megamphopus* sp. | |

| | |
|---|---|
| photid | |
| *Photis* sp. | |
| Copepods | 2.5 |
| *Undinula vulgaris* | |
| Gastropods | 2.1 |
| *Alvania auberiana* | |
| *Caecum pulchellum* | |
| *Retusa* sp. | |
| Pelecypods | 1.6 |
| *Solemya occidentalis* | |
| Barnacle larvae | 1.2 |
| Tanaids | 0.9 |
| Scaphopods | 0.4 |
| *Cadulus acus* | |
| *Dentalium* sp. | |
| Isopods | 0.2 |

*Remarks.—Haemulon aurolineatum,* sometimes classified in the genus *Bathystoma,* is one of the smallest and most common of the grunts in the West Indies. Beebe & Tee-Van (1928) stated that it is omnivorous and listed the principal items of food as follows: sand, mud, and bottom detritus, algae sometimes in very large amounts, worms of various kinds. mollusk shells, broken and entire. and crustaceans such as copepods, isopods, shrimps, and small crabs. Longley & Hildebrand (1941) noted that the species is less intimately associated with coral than some of the other Pomadasyidae, and indicated that copepods provide much of the food. They mentioned that an estimated 1000 were taken from the stomach of a 50-mm fish. The author would hesitate to regard this fish as an omnivore because large amounts of algae were found in the stomachs of some specimens by Beebe & Tee-Van. Since the family, in general, is carnivorous, it would seem more likely that the algae were consumed incidentally while feeding on invertebrates.

*Haemulon carbonarium* Poey — CAESAR GRUNT

18 stations; 30 specimens: 156 to 273 mm SL; 9 empty.

| FOOD | VOLUME (%) |
|---|---|
| Crabs | 38.3 |
| majids (2) | |
| *Pisosoma* sp. | |
| Gastropods | 15.2 |
| *Acmaea pustulata* | |
| acmaeids (2) | |
| *Columbella mercatoria* (2) | |
| *Diodora* sp. | |
| *Emarginula pumila* | |
| *Fissurella* sp. | |
| *Fissurella barbadensis* | |
| *Hyalina* sp. | |
| *Nitidella* sp. | |
| Echinoids | 10.9 |
| *Diadema antillarum* (4) | |
| *Echinometra* sp. | |
| *Echinometra viridis* | |
| Chitons | 9.8 |
| *Ischnochiton papillosus* | |
| Polychaetes | 8.0 |
| Ophiuroids | 6.0 |
| *Ophiocoma echinata* | |
| *Ophiothrix* | |
| Sipunculids | 4.85 |
| Shrimps | 4.1 |
| alpheids (3) | |
| Barnacle appendages | 1.9 |
| Fish | 0.7 |
| blennioid | |
| Amphipods | 0.2 |
| Ostracods | 0.05 |

*Remarks.*—Longley & Hildebrand (1941) wrote that *Haemulon carbonarium* feeds at night like the other grunts. The stomach contents of two Tortugas specimens consisted of small crabs, gastropods, starfish, and annelid worms. The author found echinoids only in the large adults.

*Haemulon chrysargyreum* Günther — SMALLMOUTH GRUNT

8 stations; 30 specimens: 97 to 180 mm SL; 13 empty.

| FOOD | VOLUME (%) |
|---|---|
| Crabs and crab larvae | 19.4 |
| *Herbstia* sp. | |
| majid | |
| *Mithrax* sp. | |
| xanthid | |
| Polychaetes | 19.1 |
| *Cariboa* sp. | |
| *Eunice* sp. | |
| flabelligerid | |
| *Semiodera* sp. | |
| Shrimps and shrimp larvae | 15.9 |
| alpheids | |
| *Alpheus* sp. | |
| penaeid | |
| Pelecypods | 14.7 |
| *Laevicardium* sp. | |
| Stomatopods | 5.9 |
| *Gonodactylus* sp. | |

| | |
|---|---|
| *Squillus* sp. | |
| Unidentified crustaceans | 5.7 |
| Amphipods | 5.7 |
| caprellids | |
| Isopods | 4.7 |
| Unidentified eggs | 3.5 |
| Hermit crabs | 1.8 |
| Gastropods | 1.8 |
| *Haminoea elegans* | |
| Sipunculids | 1.2 |
| *Aspidosiphon* sp. | |
| Fishes | 0.4 |
| Cephalopods | 0.2 |

*Remarks.*—As noted by Courtenay (1961), *Haemulon chrysargyreum* is a small shallow-water species which may be found in sizeable schools. Longley & Hildebrand (1941) observed that it remains close to corals, particularly *Acropora,* by day. Some were seen to be feeding high in the water, and one such fish contained 21 copepods, an amphipod, an ostracod, and a crab zoea. These authors added, however, that the species usually feeds at night and may be found hundreds of yards from its nearest daytime schooling places. Stomachs of these fishes contained shrimps.

*Haemulon flavolineatum* (Desmarest) FRENCH GRUNT

19 stations; 47 specimens: 113 to 228 mm SL; 17 empty.

| FOOD | VOLUME (%) |
|---|---|
| Polychaetes | 39.6 |
| capitellids | |
| *Eunice* sp. | |
| maldanids | |
| terebellids | |
| Crabs | 15.5 |
| Sipunculids | 10.2 |
| *Aspidosiphon* sp. | |
| Chitons | 5.7 |
| *Acanthochitona pygmaea* | |
| Holothurians | 5.0 |
| Isopods | 3.8 |
| Shrimps | 3.3 |
| Octopuses | 3.3 |
| Pelecypods | 3.2 |
| *Pitar* sp. | |
| *Tellina* sp. | |
| Ophiuroids | 3.1 |
| *Ophiothrix* sp. | |
| Unidentified crustaceans | 2.2 |
| Echinoids | 1.5 |
| *Diadema antillarum* (juv). | |
| spatangoid | |
| Scaphopods | 0.8 |
| *Cadulus* sp. | |
| *Dentalium* sp. | |
| Hermit crabs | 0.8 |
| Stomatopods | 0.7 |
| Amphipods | 0.6 |
| Gastropods | 0.5 |
| *Arene* sp. | |
| Unidentified animal material | 0.2 |

*Remarks.*—*H. flavolineatum* is the most common grunt on West Indian reefs. Beebe & Tee-Van (1928) cited food material only as echinoderms and crustacean remains. Longley & Hildebrand (1941) stated that this species will feed by day, but they believe most feeding takes place at night.

*Haemulon macrostomum* Günther SPANISH GRUNT

24 stations; 28 specimens: 147 to 360 mm SL; 9 empty.

| FOOD | VOLUME (%) |
|---|---|
| Echinoids | 86.8 |
| *Diadema antillarum* (15) | |
| spatangoid | |
| Crabs | 7.9 |
| Unidentified crustaceans | 5.3 |

*Remarks.*—*H. macrostomum* is nocturnal. The adults from the West Indies had fed primarily on echinoids, particularly *Diadema.* Longley & Hildebrand (1941) listed the recognizable food of four Tortugas examples as small crabs, fish, gastropods, sea urchins, starfish, amphipods, and an isopod.

*Haemulon parra* (Desmarest) SAILORS CHOICE

10 stations; 33 specimens: 115 to 280 mm SL; 12 empty.

| FOOD | VOLUME (%) |
|---|---|
| Shrimps | 37.6 |
| alpheids (3) | |
| carideans | |
| penaeids | |
| Crabs | 33.3 |
| majids | |
| portunids | |
| Amphipods | 7.1 |
| Gastropods | 5.1 |
| *Olivella* sp. | |
| Anemones | 3.4 |
| *Phyllactis flosculifera* | |
| Holothurians | 3.3 |

| | |
|---|---|
| Polychaetes | 2.9 |
| Pelecypods | 2.8 |
| *Gouldia cerina* | |
| *Pecten* sp. | |
| *Pitar* sp. | |
| *Solemya occidentalis* | |
| *Tellina* sp. | |
| Ophiuroids | 2.4 |
| Unidentified crustaceans | 0.9 |
| Isopods | 0.5 |
| Stomatopods | 0.5 |
| Scaphopods | 0.2 |
| *Cadulus* sp. | |

*Remarks.*—Longley & Hildebrand (1941) reported this species as feeding almost wholly at night. They found stomachs of specimens taken in the early morning to contain much sand, with algae, mollusks, and annelids. The stomachs of the 21 West Indian specimens reported herein with food material contained more sand, algae, and bottom detritus than most other pomadasyid species. The anemone which accounted for 3.4 per cent by volume of the food material was found in the stomach of one adult.

*Haemulon plumieri* (Lacépède) WHITE GRUNT

13 stations; 22 specimens: 130 to 279 mm SL; 7 empty.

| FOOD | VOLUME (%) |
|---|---|
| Crabs | 26.0 |
| *Mithrax* sp. | |
| Polychaetes | 14.5 |
| Echinoids | 12.4 |
| *Diadema antillarum* (2) | |
| *Eucidaris tribuloides* | |
| spatangoid | |
| SipuncuIids | 8.3 |
| *Aspidosiphon* sp. | |
| Gastropods | 6.9 |
| *Acmaea antillarum* | |
| *Strombus gigas* | |
| Shrimps | 5.8 |
| alpheids (2) | |
| Ophiuroids | 5.7 |
| *Ophiothrix* sp. | |
| Unidentified crustaceans | 5.3 |
| Fishes | 3.3 |
| Hemichordates | 3.3 |
| Unidentified animal material | 3.0 |
| Holothurians | 2.7 |
| *Thyone pseudofusus* | |
| Pelecypods | 1.3 |
| *Cumingia antillarum* | |
| Chitons | 0.7 |
| *Ischnochiton papillosus* | |
| Amphipods | 0.5 |
| Tanaids | 0.3 |

*Remarks.*—Beebe & Tee-Van (1928) listed the food of *H. plumieri* as echinoderms, polychaetes, mollusk shells, shrimps, crabs, fishes (including *Diodon hystrix)* and bottom debris. Breder (1929) stated that the species is omnivorous. Plant material is probably ingested occasionally, but in view of our existing knowledge of the food habits of this fish and that of related pomadasyids, it would seem doubtful that it actively selects plants *per se* as food. Longley & Hildebrand (1941) designated the species as nocturnal and reported the food of Tortugas examples as worms, gastropods, lamellibranchs, and crustaceans. Reid (1954) found crustaceans such as copepods and mysids in six stomachs from West Florida. Crushed *Diadema* formed most of the stomach and gut contents of two adults from St. John, Virgin Islands. The conch *(Strombus gigas*) was found in the stomach of a 204-mm fish; there was no shell or fragments thereof (had there been a shell it would have been about 80-mm long).

*Haemulon sciurus* (Shaw) BLUESTRIPED GRUNT

28 stations; 60 specimens: 105 to 312 mm SL; 26 empty.

| FOOD | VOLUME (%) |
|---|---|
| Crabs | 26.9 |
| portunids (2) | |
| xanthids (2) | |
| Pelecypods | 15.0 |
| *Macoma cerina* | |
| *Pitar fulminata* | |
| *Tellina caribaea* | |
| Shrimps | 10.0 |
| alpheids (2) | |
| axiid | |
| Echinoids | 8.7 |
| *Diadema antillarum* | |
| Ophiuroids | 5.6 |
| *Ophiothrix* sp. | |
| Unidentified animal material | 5.2 |
| Polychaetes | 5.0 |
| Gastropods | 4.5 |
| *Acmaea* sp. | |
| *Anachis* sp. | |
| *Arene* sp. | |
| *Bittium varium* | |
| *Cyclostremiscus ornatus* | |

| | |
|---|---|
| *Diodora* sp. | |
| *Hyalina* sp. | |
| *Hyalina albolineata* | |
| *Mangelia* sp. | |
| *Melampus coffeus* | |
| *Mitra barbadensis* | |
| *Modulus modulus* | |
| *Nitidella* sp. | |
| *Olivella* sp. | |
| *Persicula lavalleeana* | |
| *Rissoina* sp. | |
| *Strombus gigas* | |
| *Zebina browniana* | |
| Stomatopods | 4.4 |
| *Pseudosquilla ciliata* | |
| Sipunculids | 3.0 |
| Fishes | 2.9 |
| Amphipods | 1.9 |
| Unidentified crustaceans | 1.8 |
| Octopuses | 1.5 |
| Isopods | 1.4 |
| Tunicates | 1.0 |
| Ostracods | 0.6 |
| Bryozoans | 0.3 |
| Scaphopods | 0.2 |
| *Cadulus* sp. | |
| Tanaids | 0.07 |
| Hermit crabs | 0.03 |

*Remarks.*—Longley & Hildebrand (1941) noted that the bluestriped grunt is nocturnal. It schools around large coral stacks by day, and at night the schools break up for feeding. These authors listed the food material as mostly crustaceans, mollusks, and annelids, with some small ophiuroids. Five of the 34 specimens with full stomachs reported above contained small amounts of seagrass or algae.

## SPARIDAE (Porgies)

Three genera of porgies occur in the West Indies: *Archosargus, Diplodus,* and *Calamus*. The former two are omnivorous, and *Calamus* appears to be carnivorous. The teeth at the front of the jaws of sparids are conical or incisiform; those along the sides are molariform. The hard parts of invertebrates are crushed with the molariform teeth. Beebe & Tee-Van (1928) reported on the food habits of four species of *Calamus* from Haiti. According to Randall & Caldwell (1966), who reviewed this difficult genus, two of the four names used by Beebe & Tee-Van do not apply to known species in the West Indies. Also, one cannot be certain of the taxonomic entities from their descriptive information. Their data, therefore, should be regarded as applying to the genus, in general. The species of *Calamus* swim above but close to the bottom. They are diurnal. Although often seen over or near reefs, they are not tied to reefs for shelter. These fishes are very alert; characteristically they maintain a considerable distance between themselves and a potential source of danger, such as a spearfisherman. For this reason they are best collected by hook and line.

*Archosargus rhomboidalis* (Linnaeus) SEA BREAM

6 stations; 23 specimens: 105 to 220 mm SL.

| FOOD | VOLUME (%) |
|---|---|
| Seagrasses | 44.6 |
| *Cymodocea manatorum* | |
| *Thalassia testudinum* | |
| Algae | 38.8 |
| *Ceramium nitens* | |
| *Enteromorpha* sp. | |
| *Enteromorpha flexuosa* | |
| *Lyngbya majuscula* | |
| *Rhizoclonium riparium* | |
| Crabs | 4.8 |
| Gastropods | 4.3 |
| Unidentified invertebrate eggs | 3.5 |
| Pelecypods | 3.4 |
| *Pinctada radiata* | |
| Polychaetes | 0.4 |
| Amphipods | 0.2 |

*Remarks.*—*Archosargus rhomboidalis* is usually seen in mangrove sloughs. Only rarely may it be found near coral reefs. It feeds primarily on plants. Most of the seagrass material from its stomachs consisted of *Thalassia.*

*Calamus bajonado* (Bloch & Schneider) JOLTHEAD PORGY

9 stations; 10 specimens: 137 to 500 mm SL; 1 empty.

| FOOD | VOLUME (%) |
|---|---|
| Echinoids | 45.2 |
| *Diadema antillarum* (5) | |
| *Lytechinus variegatus* | |
| Crabs | 22.2 |
| Pelecypods | 13.4 |
| arcid | |
| *Musculus lateralis* | |
| *Ostrea* sp. | |
| Gastropods | 11.1 |
| *Turbo castanea* | |
| Polychaetes | 6.7 |

| | |
|---|---|
| Hermit crabs | 1.1 |
| *Clibanarius tricolor* | |
| *Paguristes* sp. | |
| *Paguristes anomalus* | |
| Unidentified animal material | 0.3 |

*Remarks.*—*Calamus bajonado* is the largest species of the genus. The three largest fish listed above (338 to 455 mm SL) and one of 247 mm had eaten only *Diadema.*

*Calamus calamus* (Cuvier & Valenciennes) SAUCEREYE PORGY

10 stations; 15 specimens: 190 to 250 mm SL; 3 empty.

| FOOD | VOLUME (%) |
|---|---|
| Polychaetes | 19.2 |
| Ophiuroids | 15.5 |
| *Ophioderma* sp. | |
| *Ophiothrix* sp. (2) | |
| Pelecypods | 15.0 |
| *Codakia orbicularis* | |
| *Gouldia cerina* | |
| *Pinna carnea* | |
| Hermit crabs | 13.4 |
| Crabs | 12.8 |
| majids | |
| Echinoids | 8.9 |
| *Diadema antillarum* | |
| Gastropods | 8.3 |
| *Nassarius albus* | |
| *Tegula* sp. | |
| *Tegula fasciata* | |
| Unidentified crustaceans | 3.6 |
| Chitons | 1.8 |
| Unidentified animal material | 0.9 |
| Sipunculids | 0.6 |
| *Aspidosiphon* sp. | |

*Calamus penna* (Cuvier & Valenciennes) SHEEPSHEAD PORGY

3 stations; 3 specimens: 190 to 283 mm SL; 2 empty.

| FOOD | VOLUME (%) |
|---|---|
| Crabs | 50.0 |
| portunid | |
| Gastropods | 50.0 |

*Calamus pennatula* Guichenot PLUMA

13 stations; 15 specimens: 127 to 270 mm SL; 5 empty.

| FOOD | VOLUME (%) |
|---|---|
| Crabs | 21.5 |
| calappid | |
| leucosid | |
| Ophiuroids | 14.2 |
| *Ophiothrix* sp. | |
| Polychaetes | 14.0 |
| Pelecypods | 12.3 |
| *Laevicardium* sp. | |
| *Trachycardium* sp. | |
| Gastropods | 8.2 |
| Hermit crabs | 8.0 |
| Shrimps | 5.8 |
| Sipunculids | 5.0 |
| Echinoids | 4.0 |
| *Diadema antillarum* | |
| Holothurians | 4.0 |
| Stomatopods | 3.0 |

*Remarks.*—*C. pennatula* is the most common species of the genus in the West Indies.

*Diplodus caudimacula* (Poey) ROUNDSPOT PORGY

3 stations; 5 specimens: 110 to 217 mm SL.

| FOOD | VOLUME (%) |
|---|---|
| Algae | 80.0 |
| *Centroceras clavulatum* | |
| *Ceramium* sp. | |
| *Dictyota dentata* | |
| *Ectocarpus* sp. | |
| *Udotea flabellum* | |
| Gastropods | 16.0 |
| acmaeids | |
| Chitons | 2.0 |
| Crabs | 2.0 |

*Remarks.*—*Diplodus caudimacula* is not common in the West Indies. Most individuals have been observed along steep rocky shores exposed to wave action, but they may also occur in a shallow, calm, rock-sand habitat. The stomachs of three of the specimens that were examined consisted of two-thirds algae and one-third sand.

## KYPHOSIDAE (Sea chubs)

The sea chubs are active diurnal fishes usually associated with rocky bottom. Although often seen near shore, they range to depths of at least 100 feet. Although they may occasionally be taken on hook and line with animal material as bait, they are characteristically herbivorous, at least as adults. Their incisiform teeth are well adapted for cropping algae. In addition to browsing on benthic algae, they feed on floating *Sargassum* and

occasional fragments of seagrass. Very little sedimentary material was found in the stomachs.

*Kyphosus incisor* (Cuvier & Valenciennes) YELLOW CHUB
5 stations; 6 specimens: 192 to 552 mm SL.

| FOOD | VOLUME (%) |
|---|---|
| Algae | 100.0 |
| *Dictyopteris delicatula* | |
| *Dictyota divaricata* (2) | |
| *Pocockiella variegata* | |
| *Sargassum fluitans* | |
| *Sargassum hystrix* (2) | |
| *Sargassum natans* | |
| *Turbinaria turbinata* | |

*Remarks*.—Longley & Hildebrand (1941) reported that this species at Dry Tortugas, Florida feeds chiefly on algae, including much *Sargassum.*

*Kyphosus sectatrix* (Linnaeus) BERMUDA CHUB
18 stations; 19 specimens: 130 to 590 mm SL.

| FOOD | VOLUME (%) |
|---|---|
| Algae | 99.5 |
| *Botryocladia occidentalis* | |
| *Bryothamnion triquetrum* (2) | |
| *Ceramium* sp. | |
| *Ceramium nitens* | |
| *Chondria littoralis* | |
| *Dictyopteris delicatula* (3) | |
| *Dictyopteris plagiogramma* | |
| *Dictyopteris justii* | |
| *Dictyota* sp. | |
| *Dictyota bartayresii* (2) | |
| *Dictyota ciliata* | |
| *Dictyota divaricata* (3) | |
| *Dictyota linearis* | |
| *Digenia simplex* | |
| *Eucheuma acanthocladum* | |
| *Gelidiella acerosa* | |
| *Gelidium corneum* (3) | |
| *Gracilaria mammillaris* | |
| *Hypnea musciformis* (2) | |
| *Jania capillacea* | |
| *Laurencia papillosa* (2) | |
| *Laurencia corallopsis* | |
| *Padina* sp. | |
| *Padina gymnospora* | |
| *Padina sanctae-crucis* | |
| *Pocockiella variegata* (3) | |
| *Polysiphonia* sp. (2) | |
| *Sargassum* sp. | |
| *Sargassum fluitans* | |
| *Sargassum hystrix* (3) | |
| *Sargassum* natans (4) | |
| *Sargassum platycarpum* (2) | |
| *Sargassum polyceratium* (3) | |
| *Sargassum rigidulum* | |
| *Sphacelaria tribuloides* | |
| *Spyridia filamentosa* | |
| *Turbinaria turbinata* | |
| Seagrasses | 0.5 |
| *Cymodocea manatorum* (2) | |

*Remarks*.—H. Smith (1907) reported that Linton examined four specimens from North Carolina that contained crabs, small bivalve shells, vegetable debris and sand. Beebe & Tee-Van (1928) found small crustaceans in the stomach of a 78-mm specimen. Gudger (1929) referred to the species as a herbivore and commented on the dentition and visceral anatomy. He pointed out that its specific name and one of its common names (rudder-fish) are derived from its habit of following in the wake of vessels probably to feed on wastes. The author has not observed this, but has seen an Indo-Pacific species of *Kyphosus* feed on offal released from an anchored ship in the Marshall Islands. In reference to Tortugas fish, Longley & Hildebrand (1941) described *K. sectatrix* as chiefly if not wholly herbivorous, feeding on the bottom and on floating *Sargassum. Sargassum* was found in the stomachs of 12 of the 19 West Indian specimens that were examined by the author. In eight of these it comprised from 25 to 100 per cent of the stomach-content material. The browns *Dictyota* and *Dictyopteris* were also prominent in the stomachs. Only one fish had eaten the very coarse *Turbinaria,* but this constituted 75 per cent of its stomach contents. The delicate red *Ceramium nitens,* on the other hand, represented 97 per cent of the stomach contents of one 264-mm specimen.

## GERREIDAE (Mojarras)

The mojarras are silvery fishes that usually occur over sand or mud bottoms. They feed at least in part by day. During feeding they may thrust their highly protrusible mouths into the sediment for subsurface in-vertebrates. Considerable amounts of sand may be expelled through the gill openings during the feeding process.

*Eucinostomus argenteus* Baird & Girard SANDFLAT MOJARRA
5 stations; 19 specimens: 75 to 152 mm SL.

| FOOD | VOLUME (%) |
|---|---|
| Amphipods | 41.8 |
| gammarids | |

| | |
|---|---|
| *Hyale* sp. | |
| Polychaetes | 19.5 |
| eunicids | |
| Crabs | 10.9 |
| calappids | |
| majid | |
| raninids | |
| Shrimps | 7.6 |
| alpheids | |
| *Callianassa* sp. | |
| Tanaids | 5.9 |
| Pelecypods | 3.4 |
| *Tellina* sp. | |
| Sipunculids | 2.6 |
| Unidentified crustaceans | 2.6 |
| Unidentified animal material | 2.1 |
| Copepods | 2.0 |
| harpacticoids | |
| Gastropods | 1.6 |

*Remarks*.—This mojarra is a solitary fish that occurs in shallow, clear-water areas over sand bottoms. It does not often swim over reefs but is frequently seen near them. Beebe & Tee-Van (1928) reported detritus of both animal and vegetable origin in specimens from Haiti; they identified their fish as E. *californiensis*. According to C. L. Hubbs and C. R. Robins (personal communication) *E. pseudogula is* also a probable synonym of *argenteus*.

*Gerres cinereus* (Walbaum) YELLOWFIN MOJARRA

34 stations; 51 specimens: 95 to 280 mm SL; 24 empty.

| FOOD | VOLUME (%) |
|---|---|
| Crabs | 27.0 |
| hippids (2) | |
| majids | |
| portunid | |
| Pelecypods | 23.0 |
| *Laevicardium* sp. | |
| *Macoma cerina* | |
| *Solemya occidentalis* | |
| *Tellina* sp. (2) | |
| *Yoldia perprotracta* | |
| Gastropods | 14.5 |
| *Acmaea antillarum* (2) | |
| *Fissurella barbadensis* | |
| *Hemitoma octoradiata* | |
| *Olivella* sp. | |
| *Tricolia tessellata* | |

| | |
|---|---|
| Polychaetes | 12.7 |
| Sipunculids | 6.0 |
| *Aspidosiphon* sp. | |
| Unidentified crustaceans | 4.4 |
| Shrimps | 4.3 |
| alpheids | |
| *Callianassa* sp. | |
| Stomatopods | 2.8 |
| *Gonodactylus oerstedii* | |
| Hemichordates | 1.9 |
| Ophiuroids | 1.9 |
| *Ophiothrix* sp. | |
| Unidentified animal material | 1.1 |
| Amphipods | 0.4 |

*Remarks*.—This mojarra, a larger species than the preceding, is often found over reefs or rocky areas and on sand flats. It may be observed feeding freely on a hard substratum (as indicated by the limpets and *Ophiothrix* in its stomach contents) and in sand patches among reefs. Beebe & Tee-Van (1928) reported it to be a general feeder and listed the food as an assortment of worms, mollusks, crustaceans, and parts of small fish. Longley & Hildebrand (1941) found the remains of a large worm and much sand and debris in the stomach of one fish from Tortugas.

## SCIAENIDAE (Croakers)

Most sciaenids are found on open sand or mud bottoms. Four West Indian species, however, are characteristic of reefs: *Odontoscion dentex* and three *Equetus*. They appear to be primarily nocturnal.

*Equetus acuminatus* (Bloch & Schneider) STRIPED DRUM
12 stations; 35 specimens: 68 to 152 mm SL; 16 empty.

| FOOD | VOLUME (%) |
|---|---|
| Shrimps and shrimp larvae | 73.2 |
| alpheids (2) | |
| palaemonid | |
| *Periclimenes* sp. | |
| *Processa* sp. | |
| penaeids (2) | |
| Unidentified crustaceans | 10.5 |
| Crabs | 5.3 |
| *Petrolisthes galathinus* | |
| Fishes and fish larvae | 3.7 |
| Isopods | 3.1 |
| Stomatopod larvae | 2.3 |
| Copepods | 1.6 |
| Amphipods | 0.3 |

*Remarks*.—*E. acuminatus* hides, often in the company of several others of the same species, in crevices or beneath rock ledges by day and emerges to feed at night. Most of the food organisms of the specimens listed above were planktonic.

*Equetus lanceolatus* (Linnaeus) JACKNIFE FISH
4 stations; 5 specimens: 116 to 145 mm SL; 1 empty.

| FOOD | VOLUME (%) |
|---|---|
| Shrimps | 62.5 |
| alpheid | |
| palaemonid | |
| Polychaetes | 31.3 |
| Crabs | 6.2 |

*Remarks*.—Lowe (1962) reported tiny *Triton*-like gastropods from the stomachs of specimens from British Guiana.

*Equetus punctatus* (Bloch & Schneider) SPOTTED DRUM
20 stations; 28 specimens: 76 to 216 mm SL; 12 empty.

| FOOD | VOLUME (%) |
|---|---|
| Crabs | 34.4 |
| *Cronius ruber* | |
| grapsoid | |
| *Mithrax* sp. | |
| Unidentified crustaceans | 22.5 |
| Shrimps and shrimp larvae | 20.6 |
| alpheids (2) | |
| hippolytids | |
| Hermit crabs | 11.3 |
| Polychaetes | 5.4 |
| Gastropods | 3.2 |
| *Hipponix subrufus* | |
| Isopods | 1.0 |
| Pelecypods | 0.6 |
| Fishes | 0.4 |
| Ostracods | 0.3 |
| Stomatopods | 0.3 |

*Remarks*.—*E. punctatus,* the largest of West Indian *Equetus,* was usually encountered as solitary individuals hiding beneath ledges in coral reefs by day. The stomachs of fish taken in late morning or afternoon hours were usually empty, but some individuals contained freshly ingested food material, thus indicating some daytime feeding.

*Odontoscion dentex* (Cuvier & Valenciennes) REEF CROAKER
6 stations; 75 specimens: 79 to 137 mm SL; 50 empty.

| FOOD | VOLUME (%) |
|---|---|
| Shrimps and shrimp larvae | 38.0 |
| alpheid | |

| | |
|---|---|
| carideans | |
| penaeids | |
| Fishes and fish larvae | 37.8 |
| Isopods | 17.8 |
| *Excorallana antillensis* | |
| Crabs | 5.2 |
| Stomatopod larvae | 1.2 |

*Remarks.*—*O. dentex* is a small fish which forms aggregations in caves in reefs by day. In contrast to the preceding three sciaenids, it has moderately well developed canine teeth in the jaws; thus the large amount of fish in the diet was not unexpected. The shrimps in the stomachs ranged from 2 to 13 mm in length.

## MULLIDAE (Goatfishes)

The goatfishes are most commonly found on sand or mud bottoms. They feed primarily on benthic invertebrates from the surface or beneath the surface of the sediments. They have a pair of long chin barbels which are well supplied with chemosensory organs (judging from the work of Sato, 1937, on *Upeneus bensasi).* During feeding, these barbels are rapidly moved over the substratum in front of the mouth or are thrust into the sediment. Often the entire snout is shoved deeply into the sand in search of subsurface prey. Such feeding is generally followed by the expulsion of considerable inorganic material. The mullids lack a crushing dentition. The larger food items from their stomachs are usually soft-bodied animals, such as worms. The hard-shelled invertebrates which are eaten are invariably very small. The adults of two West Indian species, *Mulloidichthys martinicus* and *Pseudupeneus maculatus,* are often seen on reefs, and the young are abundant in seagrass beds. The feeding by adults takes place primarily on sand bottoms adjacent to the reefs.

*Mulloidichthys martinicus* (Cuvier & Valenciennes) YELLOW GOATFISH
21 stations; 23 specimens: 148 to 280 mm SL; 9 empty.

| FOOD | VOLUME (%) |
|---|---|
| Polychaetes | 18.6 |
| Crabs and crab larvae | 15.9 |
| portunid | |
| Pelecypods | 13.1 |
| *Cumingia antillarum* | |
| *Laevicardium* sp. | |
| *Tellina* sp. (3) | |
| Shrimps and shrimp larvae | 11.9 |
| alpheid | |
| carideans | |
| penaeids | |
| Ophiuroids | 8.9 |
| *Amphipholis gracillima* | |
| *Ophiothrix* sp. | |
| Chitons | 7.9 |
| *Acanthochiton pygmaea* | |
| Sipunculids | 6.8 |
| *Aspidosiphon* sp. | |
| *Siphonosoma cumanense* | |
| Isopods | 5.7 |
| Amphipods | 4.3 |
| *Neomicrodentopus* sp. | |
| *Paraphoxus* sp. | |
| Ostracods | 1.6 |
| Unidentified animal material | 1.5 |
| Tanaids | 0.9 |
| Stomatopods | 0.8 |
| Gastropods | 0.7 |
| Scaphopods | 0.4 |
| Echinoids | 0.4 |
| Copepods | 0.3 |
| Unidentified crustaceans | 0.3 |

*Remarks.*—Longley & Hildebrand (1941) listed annelids, crabs, small ophiurans, and an occasional small fish from the stomachs of specimens from Dry Tortugas, Florida. Longley believed this species to be primarily nocturnal. It certainly feeds by day as well; all of the collections reported on above were made during daylight hours. Sand was present in most of the stomachs of the West Indian specimens; in one fish it constituted 25 per cent of the stomach contents. Most of the crustaceans and mollusks from the stomachs were extremely small. An exception was a 20-mm chiton from a 240-mm fish. The same fish also contained a crab 12 mm in carapace width.

*Pseudupeneus maculatus* (Bloch) SPOTTED GOATFISH
22 stations; 27 specimens: 128 to 218 mm SL; 1 empty.

| FOOD | VOLUME (%) |
|---|---|
| Crabs | 30.2 |
| calappids (2) | |
| grapsoid | |
| majids (3) | |
| portunids (2) | |
| xanthids (2) | |
| Shrimps | 21.8 |
| alpheids (3) | |
| carideans | |
| palaemonid | |
| penaeids | |
| *Tozeuma* sp. | |

| | |
|---|---|
| Polychaetes | 13.3 |
| Unidentified crustaceans | 7.3 |
| Pelecypods | 6.7 |
| *Pecten* sp. | |
| *Tellina* sp. | |
| Sipunculids | 4.4 |
| *Aspidosiphon cumingi* | |
| Fishes | 4.3 |
| *Coryphopterus personatus* | |
| syngnathids (2) | |
| Stomatopods | 3.2 |
| *Pseudosquilla ciliata* | |
| Unidentified animal material | 2.7 |
| Isopods | 1.9 |
| Amphipods | 1.8 |
| Ophiuroids | 0.8 |
| Gastropods | 0.8 |
| *Turbonilla* sp. | |
| Ostracods | 0.4 |
| Tanaids | 0.2 |
| Unidentified eggs | 0.2 |

*Remarks*.—Beebe & Tee-Van (1928) reported the food of Haitian examples as "bottom debris, organic and inorganic, animal and vegetable." Longley & Hildebrand (1941) stated that the species is diurnal and feeds almost exclusively on small animals. Some of the above specimens from Puerto Rico and the Virgin Islands had liberal amounts of sand mixed with their food (up to 10 per cent or more), but none contained any significant amount of plant material. Most of the polychaetes were subsurface species, and many were tube-dwelling. Some of the polychaetes or pieces thereof were as long as 90 mm. Most of the prey animals, however, were small. The calappid crab from the stomach of a 185-mm fish measured only 10 mm across the carapace. Seven crabs from the stomach of a 186-mm fish ranged from 7 to 15 mm in greatest carapace measurement.

## BRANCHIOSTEGIDAE (Tilefishes)

*Malacanthus plumieri* (Bloch) SAND TILEFISH

6 stations; 8 specimens: 285 to 417 mm SL; 1 empty.

| FOOD | VOLUME (%) |
|---|---|
| Ophiuroids | 21.9 |
| *Ophiocoma echinata* | |
| *Ophionereis* sp. | |
| Crabs | 18.5 |
| Stomatopods | 15.0 |
| *Gonodactylus* sp. | |
| Fishes | 12.4 |
| eel | |
| *Halichoeres* sp. | |
| Polychaetes | 7.2 |
| Sipunculids | 7.2 |
| Unidentified worms | 6.4 |
| Chitons | 5.7 |
| *Choneplax lata* | |
| Echinoids | 2.7 |
| spatangoids | |
| Amphipods | 1.6 |
| Shrimps | 1.4 |

*Remarks*.—*M. plumieri* is the only shallow-water representative of the family Branchiostegidae in the western Atlantic. It makes a burrow in a sand bottom. Often a patch of coral rubble and eroded shells lies near the entrance, apparently the result of excavation by the fish. It ranges over the open bottom a considerable distance from its burrow, but with the approach of danger it rapidly swims to the entrance and hovers over it nervously, entering head-first with further provocation.

## RACHYCENTRIDAE (Cobias)

*Rachycentron canadum* (Linnaeus) COBIA

1 station; 1 specimen: 840 mm SL.

| FOOD | VOLUME (%) |
|---|---|
| Fishes | 100.0 |
| *Lactophrys* sp. | |
| *Lactophrys triqueter* | |

*Remarks*.—The cobia is a rare species in the West Indies (only the single specimen listed above was collected), but it is not uncommon in continental waters of the tropical western Atlantic. H. Smith (1907) stated that it feeds primarily on crabs but also eats shrimps and small fishes. One of its local names in the eastern United States is crab-eater. Breder (1948) noted that it feeds on fishes and crabs. Knapp (1949) reported the following food organisms by percentage of occurrence in the stomachs of 22 cobias from the coast of Texas: fishes (95.5 per cent), crabs (50 per cent), shrimps (50 per cent), squids (13.7 per cent), and other invertebrates (59.1 per cent). Reid (1954) found a cowfish *(Acanthostracion tricornis)* and three catfish in the stomach of one of two specimens examined from Florida.

## ECHENEIDAE (Sharksuckers)

The echeneids are well known for their ability to attach to sharks, the larger bony fishes, and sea turtles with the sucking disc on the top of their head. It has long been presumed that they feed on scraps from their hosts' meals. Strasburg (1959), however, has shown that they may also feed on

zooplankton and the smaller nekton or on their hosts' ectoparasites. Although no species seems to fit exclusively into one of the three feeding categories, there is a tendency for some to concentrate in one or another.

*Echeneis naucrates* Linnaeus — SHARKSUCKER

10 stations; 12 specimens: 100 to 680 mm SL; 7 empty.

| FOOD | VOLUME (%) |
|---|---|
| Fishes | 40.0 |
| *Cantherhines pullus* (larv.) | |
| Unidentified animal material | 35.0 |
| Isopods | 20.0 |
| Unidentified crustaceans | 5.0 |

*Remarks.*—*E. naucrates* was observed both free-swimming and attached to sea turtles, sharks, rays, and many different bony fishes including the larger reef fishes. Once the author watched a small individual with its head inserted in the gill chamber of a large parrotfish. The unidentified animal material which comprised 35 per cent of the stomach contents seemed to be mostly vertebrate muscle tissue.

*Remora remora* (Linnaeus) — REMORA

5 stations; 7 specimens: 58 to 175 mm SL; 2 empty.

| FOOD | VOLUME (%) |
|---|---|
| Copepods | 22.0 |
| calagoid | |
| *Candacia pachydactyla* | |
| *Scolecithrix danae* | |
| Isopods | 20.0 |
| Vertebrate muscle tissue | 20.0 |
| Crab larvae | 10.0 |
| Fish remains | 10.0 |
| Unidentified crustaceans | 10.0 |
| Amphipods | 8.0 |
| hyperiid | |

*Remarks.*—The most common host of the remora is a shark, and frequently an offshore species. Szidat & Nani (1951) found caligid copepods in the stomachs of *R. remora;* Maul (1956) reported caligids and oxycephalid amphipods. Strasburg (1959) found a variety of fishes and planktonic crustaceans in the stomachs of seven Pacific specimens, but no parasitic forms. Only a single parasitic copepod was taken from the stomach of the West Indian specimens reported above; this was found in the smallest specimen, along with a free-living copepod and a hyperiid amphipod.

## CARANGIDAE (Jacks)

The jacks are swift-swimming, carnivorous fishes which sometimes run in small schools. They are not residents of reefs, but many enter the reef community by virtue of their preying upon reef animals. They appear to be primarily diurnal, but it is possible to catch some species on moonlight nights with hook and line. The family is divisible by food habits into three major groups: fish-feeders such as *Caranx* and *Seriola,* plankton-feeders such as *Decapterus* and *Selar,* and mollusk-feeders such as *Trachinotus.* The various species do not all fit perfectly into such categories, and some transcend the boundaries as they grow from young to adults. The following carangids were only occasionally seen over reef areas at West Indian localities, and the few specimens obtained all had empty stomachs or contained only bait or chum: *Alectis crinitus, Caranx hippos, Elagatis bipinnulatus,* and *Seriola rivoliana. Caranx hippos* was observed in clear-water regions only as solitary large adults. This species is more characteristic of turbid inshore waters, including regions of low salinity. Data on its food habits have been presented by Linton (1905), Hildebrand & Schroeder (1928), Knapp (1949), Reid (1954), Darnell (1959), and Tabb & Manning (1961). *Elagatis bipinnulatus* was described by Hiatt & Strasburg (1960) as more-or-less pelagic, and its food as "probably pelagic fish although it certainly will take swimming crustaceans or squid." *Chloroscombrus chrysurus, Selene vomer,* and *Vomer setapinnis* are all common in the tropical western Atlantic, but they were not observed in association with coral reefs.

*Caranx bartholomaei* (Cuvier & Valenciennes) — YELLOW JACK

6 stations; 7 specimens: 310 to 478 mm FL; 1 empty.

| FOOD | VOLUME (%) |
|---|---|
| Fishes | 100.0 |
| *Chaenopsis ocellata* | |
| *Halichoeres maculipinna* | |
| *Ocyurus chrysurus* | |
| *Sparisoma* sp. | |
| syngnathid | |

*Remarks.*—Longley & Hildebrand (1941) stated that the yellow jack swims near the bottom in its foraging. This is demonstrated by the fishes listed above from the stomachs of Virgin Islands specimens. The pike blenny and most pipefishes are strictly benthic, and the parrotfish and wrasse are usually found close to the bottom.

*Caranx fusus* Geoffroy — BLUE RUNNER

18 stations; 44 specimens: 190 to 520 mm FL; 27 empty.

| FOOD | VOLUME (%) |
|---|---|
| Fishes | 87.0 |
| atherinids | |
| engraulids | |
| *Jenkinsia* sp. | |
| *Pseudupeneus maculatus* | |
| Crabs | 5.9 |
| Stomatopods | 3.5 |

| | |
|---|---|
| Pteropods | 1.2 |
| *Cavolina* sp. | |
| Unidentified animal material | 1.1 |
| Siphonophores | 0.7 |
| Copepods | 0.6 |
| *Candacia pachydactyla* | |

*Remarks.*—The author follows Tortonese (1961) in regarding *Caranx crysos* a synonym of *fusus*. The blue runner is usually encountered as rapidly moving schools over open bottom. Only occasionally does it make excursions over reefs. McKenney, Alexander, & Voss (1958) examined the stomach contents of 128 larvae, postlarvae, and juveniles from 2.6 to 95.0 mm standard length. The young fish proved to be plankton-feeders, with cyclopoid and calanoid copepods strongly dominating the stomach contents. In reference to larger fish these authors stated, "...blue runners are normally caught trolling with small Japanese feathers or a piece of white cloth tied to the shank of the hook, indicating a predilection for somewhat larger food, and they are often taken with shrimp in their stomachs." The stomach contents of two of the West Indian specimens analyzed above consisted of 40 per cent planktonic organisms and the rest was fish remains. These two jacks measured 222 and 250 mm in fork length. With the exception of one 295-mm individual which had eaten a crab, all of the others contained only fishes. Most of the prey fishes were small silvery schooling species.

*Caranx lotus* Agassiz HORSE-EYE JACK

22 stations; 22 specimens: 145 to 640 mm FL; 10 empty.

| FOOD | VOLUME (%) |
|---|---|
| Fishes | 87.1 |
| atherinids | |
| *Harengula* sp. | |
| *Myripristis jacobus* (juv.) | |
| Pteropods | 8.4 |
| *Cavolina longirostris* | |
| Shrimps | 3.8 |
| penaeids | |
| Isopods | 0.7 |

*Remarks.*—Beebe & Tee-Van (1928) reported on the stomach contents of specimens from Haiti in the size range of 72 to 280 mm which were observed to be feeding on the animals that accumulated around a night light. Although worms were as abundant as small fishes at the light, only fishes were eaten by the jacks. Ten of the specimens of the present study had eaten only fishes. Another had 46 per cent fish by volume, and the last, a 12-pound horse-eye, was filled with pteropods *(Cavolina longirostris)* 3 to 4 mm in length.

*Caranx lugubris* Poey BLACK JACK

6 stations; 6 specimens: 400 to 680 mm FL; 4 empty.

| FOOD | VOLUME (%) |
|---|---|
| Fishes | 100.0 |

*Remarks.*—The black jack is rarely encountered in shoal areas. The specimens above were speared in the depth range of 70 to 190 feet, and all from water of high clarity.

*Caranx ruber* (Bloch) BAR JACK

80 stations; 96 specimens: 160 to 547 mm FL; 26 empty.

| FOOD | VOLUME (%) |
|---|---|
| Fishes | 91.5 |
| *Acanthurus* sp. (larv.) (3) | |
| *Acanthurus coeruleus* (juv.) (2) | |
| *Anchoa hepsetus* | |
| atherinids (3) | |
| engraulids | |
| *Entomacrodus nigricans* | |
| *Harengula clupeola* | |
| *Jenkinsia* sp. | |
| *Monacanthus* sp. | |
| mullid | |
| *Ophioblennius atlanticus* (2) | |
| *Pomacentrus planifrons* | |
| *Pseudupeneus maculatus* (3) | |
| scarids (3) | |
| *Scarus croicensis* | |
| *Sparisoma aurofrenatum* (2) | |
| *Sparisoma viride* | |
| *syngnathid* | |
| Shrimps | 3.4 |
| penaeids | |
| *Tozeuma* sp. | |
| Mysids | 2.2 |
| Squids | 1.4 |
| Stomatopods | 0.6 |
| Gastropods | 0.4 |
| Crabs | 0.4 |
| hippid | |
| Unidentified crustaceans | 0.1 |

*Remarks.*—*Caranx ruber* is the most abundant jack in clear, shallow-water areas of the West Indies. It is often seen over reefs. Not only does it prey in part upon fishes and other animals there, but it also receives the attention of reef-dwelling "cleaning" fishes. Longley & Hildebrand (1941) noted that it is groomed by *Thalassoma* and *Anisotremus*. The author has also observed it enter into this symbiotic relationship with *Bodianus rufus*.

When its ectoparasites are being removed, the bar jack may alter its hue from silvery white to deep bronze. It, in turn, has been observed to pick at the body of the great barracuda. The jacks were about 4 inches long and the barracuda about 3 feet. Fishes predominated in the stomach contents of *C. ruber*. Small silvery schooling forms such as clupeids, dussumierids, engraulids, and atherinids were found in the stomachs of 21 of the bar jacks. Because these small delicate fishes are digested rapidly, it was usually not possible to place them to family by gross external examination. The largest fish in a bar jack stomach relative to the size of the predator was a 130-mm (SL) spotted goatfish *(Pseudupeneus maculatus);* the jack containing it measured 380-mm in fork length. Also noteworthy for prey size was a 158-mm *Sparisoma aurofrenatum* from the stomach of a bar jack 475-mm in fork length. Only one of the jacks had eaten cephalopods; this was a 415-mm adult which contained three squids up to 60 mm in length. Mysids were found in the stomachs of two of the jacks, one of 165 mm and the other of 180 mm fork length. A few stomachs contained small amounts of sand, indicating that the jacks may at times take their prey directly from the bottom. Feeding rushes were observed on occasions in which the sand was disturbed.

*Decapterus macarellus* (Cuvier & Valenciennes) MACKEREL SCAD
2 stations; 2 specimens: 236 and 257 mm FL.

| FOOD | VOLUME (%) |
|---|---|
| Pteropods | 96.5 |
| Copepods | 1.2 |
| Unidentified crustaceans | 0.8 |
| Mysids | 0.5 |
| Shrimp larvae | 0.5 |
| Crab larvae | 0.5 |

*Decapterus punctatus* (Agassiz) ROUND SCAD
4 stations; 10 specimens; 131 to 171 mm FL.

| FOOD | VOLUME (%) |
|---|---|
| Copepods | 60.0 |
| *Candacia pachydactyla* (2) | |
| *Farranula gracilis* | |
| *Mirada efferata* | |
| *Oncaea* sp. | |
| *Scolecithrix danae* | |
| Gastropod larvae | 18.5 |
| Ostracods | 8.5 |
| Pteropods | 6.0 |
| Unidentified animal material | 6.0 |
| Shrimp larvae | 1.0 |

*Remarks.*—The two West Indian species of *Decapterus* are schooling, mid-water forms that feed on zooplankton. Beebe & Tee-Van (1928) reported copepods, zoea, and ostracods from the stomach of one 95-mm specimen of *D. punctatus* from Haiti, and Longley & Hildebrand (1941) found copepods in Tortugas examples. The unidentified material that represented 6 per cent by volume of the stomach contents of the 10 specimens listed above was soft and gelatinous; possibly it was the remains of ctenophores or salps.

*Oligoplites saurus* (Bloch & Schneider) LEATHERJACKET
3 stations; 11 specimens: 149 to 234 mm FL; 4 empty.

| FOOD | VOLUME (%) |
|---|---|
| Fishes | 98.7 |
| *Jenkinsia* sp. | |
| Shrimp larvae | 1.3 |

*Remarks.*—The leatherjacket is a small, swift, predaceous fish that usually runs in small groups near the surface. It is more frequently found where the water is turbid rather than clear. Its finlets make it suggestive of scombrids, and its feeding is probably similar to small *Scomberomorus.* At times it leaps flee of the surface, as indicated by occasional strandings inside small boats. Hildebrand & Schroeder (1928) found fish remains and plant tissue in the stomachs of two specimens from Chesapeake Bay, and Beebe & Tee-Van (1928) reported small anchovies in the stomachs of Haitian examples. Breder (1948) wrote that it feeds mainly on fishes. Tabb & Manning (1961) stated that it is a common fish of the muddy waters of northern Florida Bay where it feeds heavily on the snapping shrimp *Alpheus heterochaelis,* small pink shrimp, larval anchovies, and ladyfish.

*Selar crumenophthalmus* (Bloch) BIGEYE SCAD
4 stations; 26 specimens: 115 to 192 mm FL; 14 empty.

| FOOD | VOLUME (%) |
|---|---|
| Fish scales | 50.0 |
| Shrimp larvae | 25.0 |
| Crab larvae | 12.5 |
| Fishes and fish larvae | 9.6 |
| engraulids | |
| Copepods | 2.1 |
| *Candacia pachydactyla* | |
| *Nannocalanus minor* | |
| *Scolecithrix danae* | |
| *Undinula vulgaris* | |
| Gastropod larvae | 0.8 |

*Remarks.*—This circumtropical fish, sometimes classified in the genus *Trachurops,* is a schooling species which may occur in such shallow water that it can be taken with a throw net. Beebe & Tee-Van (1928) found a variety of small fishes and polychaete worms in the stomachs of two specimens from Haiti. Longley & Hildebrand (1941) reported that the

stomach of one from Dry Tortugas contained a large shrimp and a partly digested fish, probably *Harengula.* Hiatt & Strasburg (1960) examined the stomach contents of 27 specimens from the Marshall Islands. They found foraminifera in 60 per cent of the fish, followed in the order of importance by gastropods, fishes, and crustaceans. The scads had fed primarily on the benthonic fauna of the reef shallows. The fish scales which represented 50 per cent of the stomach content material of West Indian specimens (the only item in the stomachs of six fish) appeared to have been recently detached from small clupeoid fishes. Probably the scads ate the scales after an attack on a school of clupeoids by large predaceous fish.

*Seriola dumerili* (Risso) GREATER AMBERJACK

6 stations; 8 specimens: 890 to 1180 mm FL; 2 empty.

| FOOD | VOLUME (%) |
|---|---|
| Fishes | 100.0 |
| balistid | |
| *Calamus* sp. | |
| *Caranx ruber* | |
| *Haemulon aurolineatum* | |
| *Priacanthus arenatus* | |

*Remarks.*—The amberjack is a large roving predator that often makes excursions over reefs in quest of fishes (of which it is capable of eating sizeable quantities). The stomach of a 27-pound individual contained seven bigeyes *(Priacanthus arenatus)* 110 to 120 mm in standard length. A 30-pound fish had eaten a 220-mm *Caranx ruber,* two 150-mm individuals of *Haemulon aurolineatum,* and two other 100-mm fish. The balistid which was found in the stomach of an amberjack 1100 mm in fork length measured 200 mm in standard length; with it was a 40-mm piece of coral rubble.

*Trachinotus falcatus* (Linnaeus) PERMIT

8 stations; 8 specimens: 500 to 810 mm SL; 1 empty.

| FOOD | VOLUME (%) |
|---|---|
| Gastropods | 47.8 |
| *Astraea longispina* | |
| *Cerithium* sp. | |
| *Columbella mercatoria* | |
| *Oliva* sp. | |
| *Strombus gigas* | |
| *Tegula lividomaculata* | |
| *Turbo castanea* | |
| Echinoids | 25.0 |
| *Diadema antillarum* | |
| *Echinometra* sp. | |
| Pelecypods | 17.2 |
| *Arca zebra* | |
| *Glycymeris decussata* | |
| *Trachycardium magnum* | |
| Hermit crabs | 6.1 |
| *Paguristes grayi* | |
| Crabs | 3.9 |
| *Albunea gibbesii* | |
| porcellanid | |

*Remarks.*—*Trachinotus falcatus* is not a common fish in the West Indies, but it may be found in diverse habitats. It has been observed on sand flats and reefs from depths of a few to at least 100 feet. It has also been taken from mud-bottom areas (*T. carolinus,* however, is more apt to occur in the latter). Hildebrand & Schroeder (1928) found worms, crustaceans, mollusks, and fish in the stomachs of small permit from Chesapeake Bay. Longley & Hildebrand (1941) reported *Strombus bituberculatus* (= *raninus*), the large hermit crab *Petrochirus bahamensis* (= *diogenes*), echinoid spines and test, and fragments of the majid crab *Pitho* and other crustaceans in the guts of two adults from Dry Tortugas. Springer & Woodburn (1960) listed *Hippa* and *Donax* as the food of young individuals from the Tampa Bay area of Florida. One of the specimens collected by the author in the Virgin Islands (500 mm SL, 8 pounds), contained an assortment of crushed gastropods and pelecypods in its alimentary tract, including nine individuals of *Turbo castanea* with opercula 9 to 11 mm in diameter. Another permit was observed feeding on turbinids. These were picked up individually and crushed. Shell fragments were then seen passing out of the gill openings. Usually a number of shell fragments are swallowed with the soft parts, however. An 810-mm, 33-pound permit contained enough of the shell of a queen conch *(Strombus gigas)* to determine that the shell length was about 70 mm. Another individual had eaten *Strombus gigas,* but only the mantle and viscera which had been discarded from a dock where conchs had been cleaned. Randall, Schroeder, & Starck (1964) reported *T. falcatus* among the 15 species of West Indian reef fishes that feed upon *Diadema antillarum;* however, they pointed out that the one 610-mm individual which contained this echinoid was observed, before it was speared, to feed upon urchins that had been killed by the fish poison Pro-Noxfish on the previous day.

*Trachinotus goodei* Jordan & Evermann PALOMETA

11 stations; 28 specimens: 87 to 250 mm SL; 5 empty.

| FOOD | VOLUME (%) |
|---|---|
| Fishes | 85.2 |
| engraulids | |
| *Jenkinsia* sp. (3) | |
| Gastropods | 8.3 |
| *Littorina meleagris* | |
| *Tricolia tessellata* | |
| Pelecypods | 3.9 |

| | |
|---|---|
| Isopods | 1.7 |
| cymothoid | |
| Hermit crabs | 0.9 |

*Remarks.*—The palometa was most often encountered in very shallow clear water along sandy beaches. It seemed to be attracted to bathers, for small groups of fish would circle fearlessly around the feet of persons wading in the shallows. The attraction may have been small invertebrates exposed as the feet disturbed the sand. The large percentage of fish in the diet of *T. glaucus* was not expected. All but one of 14 specimens taken in a shallow bay in St. John where small schooling fishes were in great abun- dance had fed heavily on the small fishes. The results of this one station may have raised the percentage of fish higher than normal for the species as a whole. The invertebrates from the stomachs were much smaller than the fishes that were consumed. None of the gastropods and pelecypods from the stomach of a 202-mm palometa, for example, exceeded 4 mm in greatest measurement. About two-thirds of the shells from this fish were in pieces. The stomach contents of two other fish, which had eaten primarily gastropods, consisted of about 50 per cent green algae. Presumably this was ingested incidentally with the gastropods.

## SCOMBRIDAE (Mackerels and Tunas)

Most of the tunas and their allies are pelagic fishes that are rarely, if ever, associated with reefs except through feeding on the larval stages of reef animals that are carried offshore by currents. Two species of *Scomberomorus* and the little tuna *(Euthynnus alletteratus),* however, often range over reefs and feed in part on resident fishes.

*Euthynnus alletteratus* (Rafinesque) LITTLE TUNA

22 stations; 29 specimens: 240 to 690 mm FL; 14 empty.

| FOOD | VOLUME (%) |
|---|---|
| Fishes | 56.7 |
| *Allanetta harringtonensis* | |
| atherinids (2) | |
| clupeoids (larv.) | |
| engraulids | |
| *Jenkinsia* sp. (2) | |
| *Mulloidichthys martinicus* | |
| Squids | 36.6 |
| *Doryteuthis* sp. | |
| *Doryteuthis plei* (3) | |
| Polychaetes 6.7 | |

*Remarks.*—More than any other Atlantic tuna, *E. alletteratus* is characteristic of the green inshore water over continental or insular shelves. It swims rapidly in compact schools. When feeding, the schools become more diffuse as individuals dart this way and that in pursuit of their prey.

The presence of a feeding school of little tuna is often made known by a flock of diving birds overhead. The author once ran a small boat into the center of a feeding school in the Virgin Islands and dived into it with a face mask to observe the fish. It was noted that the dorsal fins were erected from their folded position in the groove on the back as the tuna made a rapid rush at the small prey fish at the surface. Longley & Hildebrand (1941) reported four halfbeaks *(Hemiramphus)* and one needlefish *(Strongylura raphidoma) (= Tylosurus crocodilus)* in the stomach of a little tuna from Dry Tortugas. Postel (1950, 1954) found a variety of fishes including clupeids, scombrids, carangids, hemiramphids, and exocoetids, in the stomachs of individuals from West Africa, along with cephalopods, shrimps, copepods, and mysids. Carlson (1952) recorded 33 per cent squids, 46 per cent round herring *(Etrumeus teres),* and the rest other fishes from specimens off the eastern coast of the United States. Anderson, Gehringer, & Cohen (1956a, 1956b) found fishes, squids and a few crustaceans in the stomachs of little tuna taken off the South Atlantic coast of the United States. De Sylva & Rathjen (1961) examined food from the stomachs of three specimens from Florida. One fish had eaten a round herring, another a shrimp *(Penaeus duorarum),* and the third a jack (*Caranx* sp.).

*Scomberomorus cavalla* (Cuvier) KING MACKEREL

19 stations; 22 specimens: 350 to 1022 mm FL; 9 empty.

| FOOD | VOLUME (%) |
|---|---|
| Fishes | 92.3 |
| carangid | |
| *Caranx ruber* | |
| engraulids (2) | |
| *Harengula humeralis* | |
| *Ocyurus chrysurus* | |
| *Opisthonema oglinum* | |
| *Parexocoetus brachypterus* | |
| Squids | 7.7 |

*Remarks.*—The kingfish or king mackerel is the largest species of the genus in the Atlantic. It may be observed as a solitary fish or in small groups, swimming in mid-water, but often nearer the bottom than the surface. It is not easily approached by a diver, and all of the specimens reported above were taken on hook and line. One was caught while trolling a halfbeak for bait on a moonlight night. The specimen of *Caranx ruber* was taken from the stomach of a 28-pound king mackerel. Only the caudal half of the jack was present, suggesting that this species may feed at times in the same manner as the great barracuda—i.e. cut the larger prey in two and circle back for the pieces. The 28-pound fish had also eaten a 250-mm yellowtail snapper. Knapp (1949) reported the following food animals by percentage of occurrence in the stomachs of 327 specimens

from the coast of Texas: menhaden (7.9 per cent), other fishes (42.7 per cent), shrimps (43.5 per cent), squids (25.1 per cent), crabs (0.6 per cent), and other invertebrates (0.9 per cent).

*Scomberomorus regalis* (Bloch) CERO
87 stations; 116 specimens: 269 to 703 mm FL; 31 empty.

| FOOD | VOLUME (%) |
|---|---|
| Fishes | 96.1 |
| *Allanetta harringtonensis* (4) | |
| atherinids (4) | |
| belonid | |
| *Caranx ruber* | |
| *Chromis cyanea* | |
| *Chromis multilineata* (2) | |
| *Clepticus parrae* | |
| engraulids | |
| *Harengula* sp. (2) | |
| *Harengula clupeola* (2) | |
| *Hemiramphus brasiliensis* | |
| *Jenkinsia* sp. (3) | |
| labrid | |
| *Opisthonema oglinum* | |
| *Selar crumenophthalmus* | |
| Squids | 2.3 |
| Unidentified crustaceans | 1.2 |
| Shrimps | 0.4 |

*Remarks.*—The cero, sometimes called the painted mackerel, is usually a solitary fish, but occasionally several appear to be travelling together. They are always on the move. They occur primarily in clear water inshore from a few feet above the bottom to just below the surface. They feed primarily on small schooling clupeoid and atherinid fishes. Their feeding rushes toward such small fishes are extremely rapid. Often they make a long low leap into the air and re-enter the water with little splash. Small fishes may at times scatter into the air at the site of re-entry. Robert E. Schroeder (personal communication) suggested that the cero leaps are executed in order to drop suddenly from the air into a group of small fishes for the purpose of feeding on them. Only the anterior or posterior halves were found of four of the larger fishes from cero stomachs *(Clepticus parrae, Hemiramphus brasiliensis,* and two individuals of *Chromis multilineata).* A bar jack 150 mm in fork length was the largest intact fish taken from a stomach; the cero which had eaten it measured 590 mm in fork length.

## POMACENTRIDAE (Damselfishes)

The damselfishes are small reef fishes which are often highly territorial and pugnacious. Most are omnivorous, feeding on a great variety of benthic and occasional planktonic organisms. Two species of *Chromis,* on the other hand, appear to be obligate zooplankton-feeders.

*Abudefduf saxatilis* (Linnaeus) SERGEANT
MAJOR 13 stations; 35 specimens: 101 to 135 mm SL; 2 empty.

| FOOD | VOLUME (%) |
|---|---|
| Anthozoans | 43.2 |
| *Zoanthus sociatus* | |
| Copepods | 13.6 |
| Candacia pachydactyla | |
| *Coryaceus subulatus* | |
| *Euchaeta marina* (2) | |
| *Euterpina acutifrons* | |
| *Microstella norvegica* | |
| *Miracia minor* | |
| *Nannocalanus minor* (3) | |
| *Oncaea* sp. | |
| *Scolecithrix danae* | |
| Algae | 8.8 |
| *Bryopsis pennata* | |
| *Ceramium* sp. | |
| *Champia parvula* | |
| *Cladophora delicatula* | |
| *Dictyopteris delicatula* | |
| *Dictyopteris plagiogramma* | |
| *Dictyota dentata* | |
| *Dictyota divaricata* | |
| *Hypnea spinella* | |
| *Jania rubens* | |
| *Laurencia papillosa* | |
| *Lyngbya majuscula* | |
| *Polysiphonia* sp. | |
| Tunicates | 7.1 |
| appendicularians | |
| Opisthobranchs | 5.3 |
| *Tridachia crispata* | |
| Fish eggs | 4.7 |
| Fishes | 4.5 |
| *Jenkinsia* sp. | |
| Unidentified animal material | 3.7 |
| Shrimp larvae | 3.2 |
| Barnacle appendages | 3.0 |
| Ants (winged) | 1.2 |
| Polychaetes | 0.9 |
| Siphonophores | 0.8 |

*Remarks.*—Longley & Hildebrand (1941) examined the contents of three

sergeant major stomachs. They found mostly algae mixed with some copepods; one fish had eaten a pelagic fish egg. Their data and the above indicate that this species is one of the most diversified of all fishes in its food habits. It may be observed well above reefs feeding on individual zooplankters (at which time it often occurs in small aggregations) or grazing on benthic algae or sessile animal life on the bottom. The food habits may vary markedly with the environment from which the fish are collected. Fish from a reef with a high cover of algae can be expected to have as much as 100 per cent algae in their stomachs. The high percentage of *Zoanthus sociatus* was the result of the analysis of 16 stomachs from fish taken in two stations from shallow reefs in southwestern Puerto Rico where this anthozoan is abundant. Many of these fish had eaten only *Zoanthus*. Sergeant majors beneath piers at Crashboat Basin, Aguadilla, Puerto Rico are in a zone of changing current rich in planktonic life. They feed mostly on zooplankton, but their stomachs contained an average of about 20 per cent barnacle appendages by volume. Nudibranchs, a rare item of fish diet, comprised the majority of the stomach contents of two fish. Fish eggs were taken from the stomachs of fishes from four different stations. Those from three of the stations were pomacentrid eggs (demersal, and elliptical in shape).

*Abudefduf taurus* (Müller & Troschel) NIGHT SERGEANT

9 stations; 17 specimens: 104 to 152 mm SL.

| FOOD | VOLUME (%) |
|---|---|
| Algae | 94.0 |
| *Amphiroa fragilissima* (3) | |
| *Bryopsis* sp. | |
| *Calothrix crustacea* | |
| *Caulerpa sertularioides* | |
| *Centroceras clavulatum* | |
| *Ceramium* sp. (2) | |
| *Ceramium byssoideum* | |
| *Chaetomorpha* sp. | |
| *Champia parvula* | |
| *Chondria* sp. | |
| *Coelothrix irregularis* (2) | |
| diatoms | |
| *Dictyopteris delicatula* | |
| *Dictyota divaricata* | |
| *Ectocarpus breviarticulatus* | |
| *Enteromorpha* sp. | |
| *Enteromorpha flexuosa* | |
| *Gelidium corneum* | |
| *Gelidium pusillum* | |
| *Gelidium rigidulum* | |
| *Gracilaria* sp. | |
| *Grateloupia cuneifolia* | |
| *Herposiphonia secunda* | |
| *Heterosiphonia wurdemanni* | |
| *Hypnea musciformis* | |
| *Jania* sp. | |
| *Jania capillacea* | |
| *Jania rubens* | |
| *Laurencia obtusa* (2) | |
| *Lyngbya* sp. | |
| *Polysiphonia* sp. (2) | |
| *Polysiphonia ferulacea* | |
| *Spyridia filamentosa* | |
| Anthozoans | 5.3 |
| *Zoanthus sociatus* | |
| Crabs | 0.3 |
| porcellanid | |
| Gastropods | 0.2 |
| Chitons | 0.1 |
| Hydroids | 0.1 |

*Remarks.—Abudefduf taurus* is the largest West Indian damselfish. It is characteristic of inshore, somewhat turbulent water and rocky bottom. Longley & Hildebrand (1941) wrote that this species hugs the bottom closely, in contrast to *A. saxatilis*. Longley observed it at Dry Tortugas "browsing greedily" on the bottom where algae such as *Laurencia* predominated. The gastropods and chitons found in the stomachs of the West Indian specimens were very small and could have been ingested incidentally with the algal food. The *Zoanthus,* on the other hand, formed nearly the entire stomach and intestinal contents of one 134-mm individual. A few individuals contained small amounts of sand mixed with the algae, but the stomachs of most were surprisingly free of sediment.

*Chromis cyanea* (Poey) BLUE CHROMIS

5 stations; 17 specimens: 43 to 83 mm SL.

| FOOD | VOLUME (%) |
|---|---|
| Copepods | 52.4 |
| *Calanopia americana* | |
| *Coryaceus* sp. | |
| *Miracia efferata* | |
| *Nannocalanus minor* | |
| *Paracalanus aculeatus* | |
| *Paracalanus parvus* | |
| *Oncaea* sp. | |
| *Temora turbinata* | |
| *Undinula vulgaris* | |
| Tunicates | 33.9 |
| appendicularians | |

| | |
|---|---|
| *Oikopleura* sp. | |
| Shrimp larvae | 8.4 |
| Siphonophores | 2.9 |
| Fish eggs | 2.1 |
| Ostracods | 0.3 |

*Remarks*.—This species and the following appear to feed only on the smaller zooplankton. They rise well above the reefs in loose aggregations, face the oncoming current, and pick the tiny copepods and other planktonic animals individually from the passing water mass. Analysis of motion pictures of blue chromis taken by the author revealed the jaws snapping rapidly outward during feeding. With the approach of danger, these damselfishes moved downward to the refuge of the reefs. They are more elongate and have more deeply forked caudal fins than other Atlantic pomacentrids. These morphological differences probably represent adaptations for the mid-water habitat. The bright iridescent blue color of *cyanea* appears to have some camouflage value when the fish are seen in offshore localities where the water is deep blue. Once a descending individual was observed to alter the brilliant blue to a dull grayish blue as it reached the shelter of the reef. As with other plankton feeders, the organisms comprising the food may vary greatly with their availability. Appendicularian tunicates, for example, comprised 90 per cent of the stomach contents at one station, 2 per cent at another, and 0 per cent at a third. Copepods ranged from 0 to 94 per cent by volume.

*Chromis multilineata* (Guichenot) BROWN CHROMIS

5 stations; 68 specimens: 58 to 109 mm SL; 5 empty.

| FOOD | VOLUME (%) |
|---|---|
| Copepods | 87.8 |
| *Candacia pachydactyla* | |
| *Corycaeus* sp. | |
| *Corycaeus amazonicus* | |
| *Farranula gracilis* | |
| *Miracia efferata* | |
| *Nannocalanus minor* | |
| *Oncaea* sp. | |
| *Paracalanus aculeatus* | |
| *Temora turbinata* | |
| *Undinula vulgaris* (3) | |
| Tunicates | 3.2 |
| Shrimp larvae | 2.1 |
| Siphonophores | 1.8 |
| Pteropods | 1.6 |
| Unidentified crustaceans | 1.3 |
| Unidentified animal material | 1.2 |
| Crab larvae | 0.8 |
| Ostracods | 0.2 |

*Remarks*.—See *Chromis cyanea*.

*Microspathodon chrysurus* (Cuvier & Valenciennes)

10 stations; 45 specimens: 78 to 125 mm SL; 3 empty. YELLOWTAIL DAMSELFISH

| FOOD | VOLUME (%) |
|---|---|
| Algae and organic detritus | 89.3 |
| *Anacystis* sp. | |
| *Ceramium byssoideum* (3) | |
| *Centroceras clavulatum* | |
| *Coelothrix irregularis* (2) | |
| *diatoms* | |
| *Enteromorpha* sp. | |
| *Gelidium rigidulum* | |
| *Herposiphonia* sp. | |
| *Herposiphonia secunda* | |
| *Lynghya* sp. (3) | |
| *Lynghya majuscula* (3) | |
| *Microcoleus* sp. | |
| *Oscillatoria* sp. | |
| *Polysiphonia* sp. (3) | |
| *Polysiphonia ferulacea* (2) | |
| *Plectonema nostocorum* | |
| *Wrangelia argus* (2) | |
| Unidentified animal material | 3.8 |
| Corals | 2.2 |
| Unidentified crustaceans | 1.8 |
| Shrimps | 1.2 |
| Ophiuroids | 1.0 |
| Sponges | 0.2 |
| Ostracods | 0.2 |
| Amphipods | 0.1 |
| Gastropods | 0.1 |
| Fish scales | 0.1 |

*Remarks*.—*Microspathodon chrysurus* is one of the most common fishes of coral reefs in the West Indies, and second only to *Abudefduf taurus* in size. It is strictly a bottom fish and is often associated, especially when young, with *Millepora*. It was never observed feeding on planktonic organisms. Beebe & Tee-Van (1928) stated that the stomach contents of a number of fish from Haiti consisted mostly of large quantities of chewed algae and bottom debris, with an occasional entomostracan. Longley & Hildebrand (1941) wrote that it browses on the delicate algae covering dead coral surfaces. That the algae on which it feeds is delicate is verified

by the stomach-content algae listed above. Most are finely filamentous blue-greens and reds. Considerable amounts (from 10 to nearly 50 per cent) of very fine calcareous silt were usually present with the algae in the stomachs. Along with the silt were sponge and gorgonian spicules and fragments of shelled invertebrates; these appeared to be primarily sedimentary in origin. Small fragments of live coral were found in one fish. A. Ciardelli (MS) has also found corals in the stomachs of this species. Randall (1958) reported observing a juvenile *M. chrysurus* picking over the body and fins of an angelfish *(Pomacanthus arcuatus)* in Florida, thus indicating apparent feeding on ectoparasites.

*Pomacenthus fuscus* Cuvier & Valenciennes — DUSKY DAMSELFISH

10 stations; 51 specimens: 50 to 98 mm SL; 8 empty.

| FOOD | VOLUME (%) |
|---|---|
| Algae and organic detritus | 56.2 |
| *Acanthophora spicifera* | |
| *Amphiroa fragilissima* | |
| *Anacystis marina* | |
| *Asterocystis ramosa* | |
| *Avrainvillea nigricans* | |
| *Bryopsis pennata* | |
| *Caulerpa racemosa* | |
| *Caulerpa sertularioides* | |
| *Centroceras clavulatum* | |
| *Ceramium* sp. (2) | |
| *Ceramium nitens* (2) | |
| *Cladophora* sp. | |
| *Codium intertextum* | |
| *Coelothrix irregularis* | |
| diatoms (3) | |
| *Dictyota* sp. | |
| *Enteromorpha* sp. | |
| *Halimeda* sp. | |
| *Heterosiphonia wurdemanni* | |
| *Lyngbya* sp. (2) | |
| *Polysiphonia* sp. | |
| *Polysiphonia ferulacea* | |
| *Spirulina* sp. | |
| *Wrangelia argus* | |
| Unidentified animal material | 8.6 |
| Polychaetes | 5.6 |
| Copepods | 5.2 |
| Fishes | 4.9 |
| Gastropods | 3.3 |
| *Columbella mercatoria* | |
| *Rissoina fischeri* | |
| turrid | |
| vermetid | |
| Anthozoans | 3.0 |
| *Zoanthus* sp. | |
| Crabs | 2.1 |
| Seagrasses | 1.9 |
| *Cymodocea manatorum* | |
| Isopods | 1.6 |
| Amphipods | 1.2 |
| Unidentified eggs | 1.2 |
| Scyphozoans | 1.1 |
| Mysids | 1.1 |
| Shrimps | 0.9 |
| Unidentified crustaceans | 0.9 |
| Pelecypods | 0.5 |
| Hermit crabs | 0.3 |
| Tunicates | 0.2 |
| Hydroids | 0.2 |

*Remarks.—Pomacentrus fuscus* is a drab shallow-water species of coral reefs and reef-sand areas. It is the species listed as *Eupomacentrus dorsopunicans* by Bailey, *et al* (1960). In many such areas it is the most com- mon damselfish and one of the most abundant of all reef fishes. It feeds primarily on sessile organisms, especially algae. A few stomachs contained as much as 25 per cent inorganic sediment. Although this was usually fine-grained sand, some pieces of gravel were as large as 3 mm in diameter. The teeth of this and other species of *Pomacentrus* are incisiform and occur in a close-set, rigid band; thus they are well adapted for grazing.

*Pomacentrus leucostictus* (Muller & Troschel) — BEAU GREGORY

5 stations; 41 specimens: 38 to 73 mm SL.

| FOOD | VOLUME (%) |
|---|---|
| Algae and organic detritus | 22.6 |
| *Centroceras clavulatum* | |
| *Ceramium* sp. (2) | |
| diatoms (2) | |
| *Halimeda opuntia* (small fragments) | |
| *Hypnea spinella* | |
| *Lyngbya* sp. | |
| *Lyngbya majuscula* | |
| *Polysiphonia* sp. (2) | |
| Eggs | 21.2 |
| mollusk | |
| pomacentrid | |
| Unidentified animal material | 18.2 |
| Polychaetes | 12.6 |

| | |
|---|---|
| Fish remains | 7.1 |
| Coelenterate polyps | 5.1 |
| Tunicates | 2.9 |
| Crabs | 2.9 |
| Amphipods | 1.6 |
| Corals | 1.5 |
| Foraminifera | 1.5 |
| Hermit crabs | 1.0 |
| Shrimps | 1.0 |
| Copepods | 0.5 |
| Gastropods | 0.3 |
| *Arene tricarinata* | |
| *Crassispira nigrescens* | |

Remarks.—The beau gregory is a very common small fish of calm, shallow, coral and sand areas. Sand was often present in the stomachs. In one fish it represented 42 per cent of the stomach contents.

*Pomacentrus planifrons* Cuvier & Valenciennes THREESPOT DAMSELFISH

4 stations; 18 specimens: 65 to 88 mm SL.

| FOOD | VOLUME (%) |
|---|---|
| Unidentified animal material | 25.9 |
| Algae and detritus | 24.4 |
| *Centroceras clavulatum* | |
| *Ceramium byssoideum* | |
| diatoms | |
| *Lyngbya* sp. | |
| *Lyngbya majuscula* | |
| *Microcoleus chthonoplastes* | |
| Anthozoans (except corals) | 19.4 |
| *Zoanthus* sp. | |
| Crustacean remains | 11.1 |
| Polychaetes | 5.6 |
| Seagrasses | 3.9 |
| *Thalassia testudinum* (small fragments) | |
| Echinoderm remains | 3.3 |
| Copepods | 2.8 |
| *Oncaea* sp. | |
| Unidentified eggs | 2.4 |
| Tunicates | 0.6 |
| appendicularians | |
| Corals | 0.6 |

*Remarks*.—On reefs off southwestern Puerto Rico this species is found in somewhat deeper water on the average than *Pomacentrus fuscus,* whereas the following species, *P. variabilis,* is usually taken in still deeper water. All three species are abundant.

*Pomacentrus variabilis* (Castelnau) COCOA DAMSELFISH

3 stations; 7 specimens: 70 to 80 mm SL.

| FOOD | VOLUME (%) |
|---|---|
| Algae and organic detritus | 51.5 |
| *Amphiroa fragilissima* | |
| *Avrainvillea* sp. | |
| *Enteromorpha* sp. | |
| *Herposiphonia* sp. | |
| Polychaetes | 15.7 |
| sabellids | |
| Isopods | 10.0 |
| *Excorallana* sp. | |
| excorallanid | |
| sphaeromid | |
| Unidentified animal material | 9.3 |
| Hydroids | 2.8 |
| Unidentified crustaceans | 2.6 |
| Sponges | 1.7 |
| Corals | 1.7 |
| Gastropods | 1.1 |
| *Diodora variegata* | |
| Shrimps | 0.85 |
| alpheid | |
| Ophiuroids | 0.85 |
| Amphipods | 0.7 |
| Pelecypods | 0.6 |
| Tanaids | 0.6 |

*Remarks*.—Algae varied from 0 to 65 per cent in the stomachs of this damselfish. Most of the polychaete material consisted of the tentacular crowns of sabellids.

## LABRIDAE (Wrasses)

With the exception of the plankton-feeding *Clepticus,* all of the tropical western Atlantic wrasses swim near the bottom. They tend to feed on invertebrates with hard parts such as mollusks and crustaceans. They crush these with their well-developed pharyngeal teeth. Since a large percentage of the fragments of the crushed animals is usually present, they apparently do not make much effort to eject the hard parts. Characteristically, the anterior canine teeth of labrids protrude prominently. Such teeth are probably useful for detaching gastropods and other adhering forms from rocks. The wrasses are diurnal. Most bury themselves in sand at night.

*Bodianus rufus* (Linnaeus) SPANISH HOGFISH

20 stations; 31 specimens: 125 to 275 mm SL; 1 empty.

| FOOD | VOLUME (%) |
|---|---|
| Crabs | 32.4 |
| majid | |
| *Mithrax* sp. (2) | |
| *Petrolisthes* sp. | |
| *Petrolisthes galathinus* | |
| *Porcellana sayana* | |
| xanthid | |
| Ophiuroids | 19.5 |
| *Ophiocoma riisei* | |
| *Ophioderma rubicundum* | |
| *Ophioderma squamosissimum* | |
| *Ophiothrix* sp. (11) | |
| Echinoids | 14.4 |
| *Diadema antillarum* (5) | |
| *Echinometra* sp. (3) | |
| *Echinometra viridis* | |
| Gastropods | 10.4 |
| *Anachis* sp. | |
| *Calliostoma javanicum* | |
| *Cerithiopsis emersoni* | |
| *Diodora listeri* | |
| *Nassarius* sp. | |
| *Nitidella ocellata* | |
| *Planaxis lineatus* | |
| turbinid | |
| turrids | |
| Pelecypods | 8.0 |
| *Arcot* sp. | |
| *Arcopsis adamsi* | |
| *Barbatia cancellaria* (2) | |
| *Brachidontes exustus* | |
| *Chlamys* sp. (2) | |
| *Isognomon radiatus* | |
| *Lima pellucida* | |
| *Lyropecten antillarum* | |
| *Microcardium* sp. | |
| *Pecten* sp. | |
| Shrimps | 6.0 |
| palaemonid | |
| Hermit crabs | 3.7 |
| *Clibanarius* sp. | |
| Unidentified crustaceans | 2.2 |
| Stomatopods | 1.2 |
| Isopods | 0.7 |
| *Paracerceis caudata* | |
| Chitons | 0.7 |
| *Calloplax janeirensis* | |
| Unidentified animal material | 0.6 |
| Polychaetes | 0.2 |

*Remarks.—Bodianus rufus* is a moderately large reef fish which lives at depths of about 10 to approximately 100 feet. In deeper water it tends to be replaced by *Bodianus pulchellus.* The latter species, however, is rare in the West Indies. Eibl-Eibesfeldt (1955), Limbaugh (1961), and Randall (1962b) have discussed the "cleaning" behavior of the young of the Spanish hogfish. Randall, Schroeder, & Starck (1964) noted that adults may feed on *Diadema.* One was observed in St. Croix feeding on several long spines after consuming the test to which they were attached.

*Clepticus parrae* (Bloch & Schneider) CREOLE WRASSE

7 stations; 15 specimens: 150 to 197 mm SL.

| FOOD | VOLUME (%) |
|---|---|
| Copepods | 43.6 |
| Candacia pachydactyla | |
| *Euchaeta marina* | |
| *Temora turbinata* (2) | |
| *Undinula vulgaris* (3) | |
| Siphonophores | 20.0 |
| Pteropods | 19.2 |
| Shrimp larvae | 5.0 |
| Tunicates | 4.7 |
| salps | |
| Crab larvae | 2.3 |
| Unidentified eggs | 1.7 |
| Ostracods | 1.5 |
| Gastropod larvae | 1.4 |
| Stomatopod larvae | 0.3 |
| Unidentified animal material | 0.3 |

*Remarks.—Clepticus parrae* exhibits a mode of life similar to that described for *Paranthias furcifer, Inermia vittata,* young *Ocyurus chrysurus, Chromis cyanea,* and *C. multilineata.* It is a reef fish only in the sense that it uses reefs for shelter from predators. Most of its time during daylight hours is spent in aggegations well above the bottom feeding on zooplankton. It does not strain numerous planktonic animals from the water but picks them up one by one. Its mouth and teeth are very small.

*Halichoeres bivittatus* (Bloch) SLIPPERY DICK

17 stations; 46 specimens: 67 to 153 mm SL.

| FOOD | VOLUME (%) |
|---|---|
| Crabs | 22.3 |
| majids (3) | |
| *Mithrax* sp. | |
| *Mithrax sculptus* (2) | |
| *Platypodia spectabilis* | |
| portunid | |
| xanthid | |
| Echinoids | 17.9 |
| *Diadema antillarum* | |
| *Lytechinus variegatus* (5) | |
| Polychaetes | 17.4 |
| ampharetid | |
| Gastropods | 12.4 |
| *Acmaea* sp. | |
| *Acmaea pustulata* | |
| acteonid | |
| *Arene* sp. | |
| *Arene tricarinata* | |
| *Bittium varium* | |
| *Bulla striata* (2) | |
| *Bullata ovuliformis* | |
| *Cerithium* sp. | |
| *Modulus modulus* (2) | |
| *Nassarius* sp. | |
| *Olivella* sp. | |
| *Planaxis lineatus* | |
| *Pseudostomatella coccinea* | |
| *Seila adamsi* | |
| *Smaragdia viridis* | |
| *Synaptocochlea picta* | |
| *Tegula lividomaculata* | |
| *Tricolia bella* | |
| *Tricolia tessellata* (3) | |
| turrid | |
| Ophiuroids | 7.3 |
| *Ophioderma* sp. | |
| *Ophiothrix* (3) | |
| Unidentified animal material | 4.0 |
| Pelecypods | 3.7 |
| *Aequipecten gibbus* | |
| *Americardia guppyi* | |
| *Brachidontes exustus* | |
| *Crassinella* sp. | |
| *Cumingia antillarum* | |
| *Ervilia nitens* | |
| *Isognomon* sp. | |
| *Laevicardium* sp. | |
| *Nuculana* sp. | |
| *Papyridea semisulcata* | |
| *Tellina listeri* | |
| *Trachycardium* sp. | |
| Shrimps | 3.5 |
| alpheid | |
| Chitons | 3.3 |
| *Acanthochiton pygmaea* | |
| *Ischnochiton* sp. | |
| Fish remains | 3.2 |
| Stomatopods | 3.0 |
| Unidentified crustaceans | 1.0 |
| Hermit crabs | 0.9 |
| diogenid | |
| pagurid | |
| Foraminifera | 0.1 |

*Remarks.—Halichoeres bivittatus* is the most common wrasse of the genus in the West Indies. It is a shallow-water species that is most abundant on sand bottoms with scattered small coral patches. It also ranges into seagrass beds. One series of five specimens which had eaten principally *Lytechinus variegatus* contained fragments of *Thalassia* that represented about 5 per cent by volume of the stomach contents. Germaine L. Warmke, who made the identifications of many of the mollusks of the present report, noticed that this fish tends to select the more brightly colored gastropods. Longley & Hildebrand (1941) wrote, "This species, according to the few stomach contents examined, seems to feed chiefly on fish. One individual had attempted to eat a pipefish, of which fully a sixth of the length projected from its mouth."

*Halichoeres garnoti* (Cuvier & Valenciennes) YELLOWHEAD WRASSE

13 stations; 14 specimens: 64 to 159 mm SL; 4 empty.

| FOOD | VOLUME (%) |
|---|---|
| Crabs | 20.5 |
| Ophiuroids | 15.5 |
| amphiurid | |
| *Ophiothrix* sp. (2) | |
| Unidentified crustaceans | 14.0 |
| Gastropods | 13.5 |
| *Caecum pulchellum* | |
| *Epitonium* sp. | |

| | |
|---|---|
| *Rissoina cancellata* | |
| vermetids | |
| *Zebina browniana* | |
| Unidentified animal material | 7.5 |
| Pelecypods | 7.0 |
| *Arcopsis adamsi* | |
| Polychaetes | 5.5 |
| Shrimps | 5.0 |
| Hermit crabs | 3.0 |
| Fish remains | 3.0 |
| Echinoids | 3.0 |
| *Echinometra* sp. | |
| Chitons | 2.0 |
| Sipunculids | 0.5 |

*Remarks.*—*H. garnoti* is not uncommon on reefs and reef-sand areas from shallow water to depths of at least 160 feet. Beebe & Tee-Van (1928) stated that the species is omnivorous, but listed the food as small crustaceans, sea urchins (spines and all), and mollusks and their shells. No plant material was found in the stomachs of the specimens reported upon in the present report.

*Halichoeres maculipinna* (Muller & Troschel) CLOWN WRASSE

11 stations; 24 specimens: 45 to 110 mm SL; 1 empty.

| FOOD | VOLUME (%) |
|---|---|
| Polychaetes | 47.1 |
| lumbrinerids | |
| nereids | |
| Copepods | 10.2 |
| *Euterpina acutifrons* | |
| harpacticoids (3) | |
| Shrimps | 6.5 |
| alpheids (2) | |
| Ostracods | 5.9 |
| Gastropods | 5.3 |
| *Caecum nitidum* | |
| *Caecum pulchellum* | |
| *Petaloconchus* sp. | |
| *Tricolia adamsi* | |
| vermetid | |
| Amphipods | 5.1 |
| gammarids | |
| hyperiids (2) | |
| Octopuses | 4.3 |
| Crabs | 3.1 |
| Pelecypods | 2.4 |
| Unidentified crustaceans | 1.9 |
| Isopods | 1.7 |
| Unidentified eggs | 1.6 |
| mollusk? | |
| Chitons | 1.5 |
| Tanaids | 1.5 |
| Sipunculids | 0.9 |
| Unidentified animal material | 0.8 |
| Scaphopods | 0.2 |

*Remarks.*—The clown wrasse is a moderately common reef fish. The analyses of the stomach contents above seem to indicate a preference for polychaetes. The stomachs of five individuals contained up to 50 per cent copepods. These were the five smallest specimens (45 to 50 mm SL). The remaining fish ranged from 71 to 110 mm SL, and few of these had eaten copepods (and then in small amounts). One 79-mm fish contained only a small octopus.

*Halichoeres poeyi* (Steindachner) BLACK-EAR WRASSE

12 stations; 34 specimens: 50 to 140 mm SL; 3 empty.

| FOOD | VOLUME (%) |
|---|---|
| Crabs | 24.5 |
| Gastropods | 21.3 |
| *Bittium varium* | |
| *Hemitoma octoradiata* | |
| *Modulus modulus* | |
| *Schismope* sp. | |
| Ophiuroids | 10.2 |
| *Ophiocoma echinata* | |
| *Ophiothrix* sp. | |
| Unidentified crustaceans | 7.4 |
| Echinoids | 6.8 |
| *Diadema antillarum* | |
| *Lytechinus variegatus* | |
| Sipunculids | 5.2 |
| Hermit crabs | 5.1 |
| Fish remains | 5.0 |
| Chitons | 4.4 |
| *Ischnochiton papillosus* | |
| Unidentified animal material | 3.9 |
| Pelecypods | 2.2 |
| ostreid | |
| *Tellina* sp. | |
| Polychaetes | 1.9 |
| Holothurians | 1.6 |
| Isopods | 0.3 |

| | |
|---|---|
| Stomatopods | 0.2 |
| *Gonodactylus* sp. | |

*Remarks.*—Although *H. poeyi* may occur on inshore reefs, it is more characteristic of seagrass beds. The remains of adult *Diadema* in the stomach of this species and *H. bivittatus* seem to be from larger-sized urchins than could be crushed by these wrasses. Probably the fish fed upon the *Diadema* after the latter were made available by a larger predator such as the queen triggerfish.

*Halichoeres radiatus* (Linnaeus) PUDDINGWIFE

22 stations; 32 specimens: 127 to 355 mm SL; 5 empty.

| FOOD | VOLUME (%) |
|---|---|
| Pelecypods | 25.1 |
| *Arca imbricata* | |
| *Arca umbonata* (2) | |
| *Barbatia cancellaria* (2) | |
| *Barbatia domingensis* | |
| *Brachidontes exustus* | |
| *Glycymeris* sp. | |
| *Isognomon* sp. | |
| *Isognomon alatus* | |
| *Isognomon radiatus* (3) | |
| *Musculus lateralis* | |
| *Pteria colymbus* | |
| Gastropods | 21.3 |
| *Acmaea leucopleura* (2) | |
| *Acmaea pustulata* (2) | |
| *Bittium varium* | |
| buccinid | |
| *Cittarium pica* | |
| *Columbella mercatoria* | |
| *Coralliophila caribaea* | |
| *Cymatium labiosum* | |
| *Daphnella lymneiformis* | |
| *Diodora* sp. | |
| *Diodora listeri* | |
| *Fissurella* sp. | |
| *Fissurella angusta* | |
| *Fissurella barbadensis* (4) | |
| *Hemitoma octoradiata* (2) | |
| *Hyalina* sp. | |
| *Nerita peloronta* | |
| *Olivella* sp. | |
| *Risomurex roseus* | |
| *Tegula excavata* | |
| *Tegula fasciata* | |
| *Turbo castanea* | |
| Echinoids | 19.9 |
| *Diadema antillarum* (6) | |
| *Echinometra viridis* | |
| *Eucidaris tribuloides* (2) | |
| *Lytechinus variegatus* (2) | |
| spatangoid | |
| Crabs | 18.8 |
| majid | |
| *Percnon gibbesi* | |
| Ophiuroids | 6.8 |
| *Ophiocoma echinata* (2) | |
| *Ophiothrix* sp. (2) | |
| Hermit crabs | 4.5 |
| Polychaetes | 1.4 |
| Unidentified crustaceans | 1.1 |
| Stomatopods | 0.9 |
| *Gonodactylus curacaoensis* | |
| Chitons | 0.2 |
| *Ischnochiton papillosus* | |

*Remarks.*—The puddingwife is the largest species of Atlantic *Halichoeres;* it is exceeded in maximum size among West Indian wrasses only by the hogfish. It is found on reefs and adjacent bottom habitats. Except during courtship and spawning; it was never seen much above the bottom. Beebe & Tee-Van (1928) reported the young of this species in Haiti to feed on floating bits of dead food, small crustaceans, etc. while the older individuals are browsers, taking sponge, coral, or other organic debris. These remarks certainly do not correspond closely with the food habit data collected by the author.

*Hemipteronotus novacula* (Linnaeus) PEARLY RAZORFISH

5 stations; 9 specimens: 85 to 150 mm SL; 1 empty.

| FOOD | VOLUME (%) |
|---|---|
| Gastropods | 38.5 |
| *Batillaria* sp. | |
| *Caecum* sp. | |
| *Drillia* sp. | |
| *Litiopa melanostoma* | |
| *Natica* sp. (juv.) | |
| Pelecypods | 27.9 |
| *Ervilia* nitens | |
| *Pitar* sp. | |
| Polychaetes | 7.5 |
| Shrimps | 6.3 |
| Unidentified animal material | 6.3 |

| | |
|---|---|
| Scaphopods | 5.6 |
| *Dentaiium* sp. | |
| Unidentified crustaceans | 4.2 |
| Isopods | 3.1 |
| Amphipods | 0.6 |

*Remarks.*—This species, most frequently known in the western Atlantic literature as *Xyrichthys psittacus,* and the other Atlantic razorfishes live over sand bottoms. With the approach of danger they rapidly thrust their bodies headfirst into the sand. If one is not successful in spearing them, they can still be collected by forcing liquid rotenone into the sand where they have sought refuge. Longley & Hildebrand (1941) reported several stomachs of Tortugas specimens to contain crabs and fragments of mollusk shells. Oliver & Massuti (1952) examined the stomach contents of 50 examples from the Balearic Islands. Their analysis from a histogram is approximately as follows: organic material (26 per cent), crustaceans (24 per cent), sand (16.4 per cent), gastropods (11.5 per cent), pelecypods (7.7 per cent), fishes (4.8 per cent), echinoderms (4.8 per cent), brachiopods (1.4 per cent), coelenterates (1.4 per cent), foraminifera (1 per cent), and bryozoans (1 per cent). In their discussion they indicated that mollusks seemed to have contributed primarily to the category "organic material." They noted that the gastropods and pelecypods were of small size, and several of both groups were identified. The echinoderm category consisted mostly of echinoids (believed to be either *Echinocardium flavescens* or *Echinocyamus pusillus).* There was a small ophiuroid in one stomach. Sand was present more-or-less abundantly in all stomachs. The author also noted that the animals eaten by West Indian specimens were all very small and that sand was present in most stomachs.

*Hemipteronotus splendens* (Castelnau) GREEN RAZORFISH

8 stations; 14 specimens: 57 to 108 mm SL; 2 empty.

| FOOD | VOLUME (%) |
|---|---|
| Copepods | 60.8 |
| *Candacia pachydactyla* | |
| *Euchaeta marina* | |
| *Nannocalanus minor* (2) | |
| *Oncaea* sp. | |
| *Sapphirina* sp. | |
| *Scolecithrix danae* | |
| *Undinula vulgaris* | |
| Amphipods | 12.5 |
| *Cymadusa* sp. | |
| Shrimp larvae | 11.2 |
| Gastropods | 5.0 |
| Pelecypods | 3.3 |
| Unidentified crustaceans | 3.3 |
| Unidentified animal material | 1.7 |
| Fish eggs | 1.4 |
| Isopods | 0.8 |

*Remarks.*—This is a smaller species than the preceding. Curiously, It appears to feed primarily on zooplankton. Even the largest example, 108 mm in standard length, had eaten copepods (especially *Candacia pachydactyla)* almost exclusively.

*Lachnolaimus maximus* (Walbaum) HOGFISH

49 stations; 80 specimens: 175 to 600 mm SL.

| FOOD | VOLUME (%) |
|---|---|
| Pelecypods | 42.6 |
| Gastropods | 39.7 |
| Crabs | 6.1 |
| Hermit crabs | 4.9 |
| Echinoids | 4.6 |
| Amphipods | 1.0 |
| Scaphopods | 0.6 |
| Barnacles | 0.5 |

*Remarks.*—The hogfish is the largest tropical Atlantic wrasse. It is usually found over open areas of sea bottom near reefs, especially where gorgonians are abundant. Evermann & Marsh (1902) wrote that it feeds chiefly upon small fishes and on bottom mollusks and crustaceans. The above results do not substantiate their statement with respect to fish in the diet. Longley & Hildebrand (1941) reported that the hogfish feeds freely by day on univalve and bivalve mollusks and *Echinometra.* Reid (1954) collected five specimens of the species from Cedar Key, Florida. The food of these fish consisted of crustaceans, pelecypods, and the gastropod *Mitrella.* The analysis of the stomach contents of the 80 West Indian specimens listed above was made by J. Randall & Germaine L. Warmke (in press, *Carib. Jour. Sci.).* Fifty-three gastropods and 42 pelecypods were identified to genus or species from hogfish stomachs by these authors.

*Thalassoma bifasciatum* (Bloch) BLUEHEAD

11 stations; 60 specimens: 36 to 105 mm SL; 8 empty.

| FOOD | VOLUME (%) |
|---|---|
| Copepods | 18.8 |
| calagoids | |
| calanoids | |
| *Undinula vulgaris* | |
| Crabs and crab larvae | 13.0 |
| majid | |
| Gastropods and gastropod larvae | 11.4 |
| *Acmaea pustulata* | |
| acmaeids | |

| | |
|---|---|
| Fishes | 8.7 |
| Unidentified crustaceans | 7.9 |
| Unidentified animal material | 7.7 |
| Ophiuroids | 7.5 |
| *Ophiothrix* sp. (4) | |
| Shrimps and shrimp larvae | 6.5 |
| alpheid | |
| Isopods | 6.0 |
| gnathiids (larv.) | |
| Polychaetes | 5.1 |
| onuphid | |
| polynoid | |
| Pycnogonids | 1.9 |
| Tanaids | 1.9 |
| Echinoids | 1.5 |
| *Diadema antillarum* | |
| Mollusk eggs | 1.3 |
| Stomatopods | 0.8 |

*Remarks.—Thalassoma bifasciatum* is one of the most abundant of West Indian reef fishes. It feeds on small benthic animals, zooplankton, and ectoparasitic crustaceans of fishes. Beebe & Tee-Van (1928) reported polychaete worms and crustaceans from specimens from Haiti. Longley & Hildebrand (1941) stated that small crustaceans seem to provide the greater part of the food of the species in Dry Tortugas. They were the first to record its habit of removal of ectoparasites from fishes, although were unable to demonstrate any parasitic forms from the stomach contents. They also reported feeding on the demersal eggs of *Abudefduf saxatilis*. Randall & Randall (1960) found a few crustacean ectoparasites of fishes, primarily small isopods, among 27 stomachs examined from the Virgin Islands and five from Florida. Most of the stomach-content material consisted of free-living pelagic crustaceans, especially copepods. The analyses of the 27 Virgin Islands specimens are included in the present report. Feddern (1965) reviewed the literature on the food and feeding of *T. bifasciatum*. He observed that juveniles most often form schools and roam close to the bottom picking at rocks, algae, and gorgonians, apparently searching for small benthic organisms. He stated that adults are most often in loose aggregations feeding on particulate plankton. Yellow-phase individuals of both sexes occasionally pick parasites off other fishes, but those of the bluehead phase were not observed to do this. Twelve of the 60 fishes examined by the author were in the bluehead phase. They ranged from 85 to 105 mm in standard length. No copepods or small planktonic crustaceans were found in any of these specimens. Their stomach contents by percent- age volume were as follows: ophiuroids (30.8 per cent), crabs (20.4 per cent), fishes (19.2 per cent), polychaetes (12.0 per cent), pycnogonids (8.4 per cent), unidentified (4.2 per cent), shrimps (3.3 per cent), and isopods (1.7 per cent). Oddly, there were no mollusks. A larger sample of this color form might well reveal gastropods in the stomachs, however. Although most of the gastropods eaten by yellowphase fish were small, one 67-mm specimen contained an intact limpet *(Acmaea pustulata)* which measured 4 by 5 mm. The remains of *Diadema antillarum* from yellow-phase fish consisted primarily of soft tissue. Probably the fish stole scraps of this echinoid while it was being fed upon by a larger predator.

## SCARIDAE (Parrotfishes)

The parrotfishes are among the most abundant of West Indian reef fishes. Randall (1963b) found them the dominant family on a weight basis in two large poison stations on fringing reefs in the Virgin Islands. They are diurnal and are frequently cited as herbivores. Bardach (1959) classified the adults as omnivores and the young as herbivores, but he gave no qualifying data. Hiatt & Strasburg (1960) reported all of the specimens that they examined from the Marshall Islands to have scraped coral polyps from living heads of coral, as well as algae from reef rock. The author and associates have failed to observe any scraping of live coral by West Indian species; nor have significant amounts of coral been found in any of the stomachs. The small amounts of coral that were detected in two species could have been ingested accidentally while the fishes were grazing algae. The fused teeth of scarids are well adapted for such scraping. More important in terms of nutrition is their distinctive pharyngeal mill. With this they grind the soft coral rock or sand together with the algae. The rock is rendered to a fine sediment, and the algae is well triturated and thus made much more digestible. The parrotfishes are also able to utilize the filamentous algae growing interstitially in the upper part of dead coral rock (this algae is sometimes referred to as boring algae or skeletal algae—see Odum & Odum, 1955). Longley (in Longley & Hildebrand, 1941) observed the direct feeding by *Scarus coeruleus* and *S. guacamaia* on sand. He wrote, "I have seen them feeding actively on what seemed a perfectly bare sand patch, taking up mouthful after mouthful of fine sand, grinding it to powder in their pharyngeal apparatus, and treating the whole with their digestive juices, presumably for the microscopic food in it." In the opinion of the author, this ingestion of sand may serve primarily the purpose of providing hard material to grind plant food in the pharyngeal mill. Parrotfishes feeding on high stands of algae or seagrass would not get much sedimentary material with which to grind the plant tissues. They might, therefore, take in mouthfuls of bare sand. When the available substratum for algal growth is limited (as on a well-developed reef with numerous live corals), the parrotfishes are probably superior competitors to other herbivorous fishes. If the algae has been reduced to a low stubble, little is left for the browser. The parrotfishes, by contrast, may still have an ample food supply. They

are at times, however, responsible, along with other herbivores such as the surgeonfishes, for the overgrazing of algae (Stephenson & Searles, 1960 and Randall, 1961a) and of seagrasses (Randall, 1965a). They also play a major role in the production of sediment, as discussed by Emery (1956), Cloud (1959), Bardach (1961), and Randall (1964b). Randall, Almodovar, & Pagan (MS) have made determinations of the percentage of inorganic material in the alimentary tracts of eight species of West Indian scarids. These data are repeated here for the individual species.

*Scarus coelestinus* Cuvier & Valenciennes MIDNIGHT PARROTFISH

8 stations; 14 specimens: 240 to 587 mm SL; 2 empty.

| FOOD | VOLUME (%) |
|---|---|
| Algae | 97.3 |
| *Acanthophora spicifera* | |
| *Amphiroa fragilissima* (3) | |
| *Bryothamnion triquetrum* | |
| *Centroceras* sp. | |
| *Coelothrix irregularis* | |
| *Corallina cubensis* | |
| diatoms | |
| *Dictyopteris delicatula* (2) | |
| *Enteromorpha* sp. (2) | |
| *Gelidium pusillum* (2) | |
| *Herposiphonia* sp. (2) | |
| *Jania rubens* (2) | |
| *Laurencia obtusa* | |
| *Laurencia papillosa* | |
| *Lithothamnion* sp. | |
| *Lyngbya* sp. | |
| *Polysiphonia* sp. (2) | |
| *Rhizoclonium* sp. | |
| *Spermothammion investiens* | |
| *Ulva lactuca* | |
| *Vidalia obtusiloba* | |
| Seagrasses | 1.3 |
| *Thalassia testudinum* | |
| Mollusk shells | 0.4 |
| Crustacean fragments | 0.4 |
| Foraminifera | 0.2 |
| Coral fragments | 0.2 |
| Echinoid fragments | 0.1 |
| Sponge spicules | 0.1 |

*Remarks*.—The midnight parrotfish is second only to *Scarus guacamaia* in size attained. It is moderately common on West Indian reefs. The invertebrates consumed were all small and fragmented. Probably they were ingested incidentally with the algae and soft coral rock. Inorganic sediment represented more than 50 per cent of most gut material. The dominant alga in the stomachs of three fish from northwestern Puerto Rico was *Amphiroa fragilissima*. Longley & Hildebrand (1941) reported that a bit of material found in the pharyngeal grinding apparatus of this species consisted of sand far coarser than that taken from the intestine, along with fragments of perhaps a half-dozen genera of algae. The only animal remains listed by them was one small amphipod.

*Scarus croicensis* (Bloch) STRIPED PARROTFISH

2 stations; 9 specimens: 111 to 227 mm SL.

| FOOD | VOLUME (%) |
|---|---|
| Algae | 100.0 |
| *Calothrix crustacea* | |
| *Centroceras* sp. | |
| *Centroceras clavulatum* | |
| *Coelothrix irregularis* (2) | |
| *Enteromorpha* sp. | |
| *Gelidium* sp. | |
| *Herposiphonia* sp. (2) | |
| *Lyngbya* sp. | |
| *Polysiphonia* sp. (2) | |

*Remarks*.—*Scarus croicensis* is the smallest Atlantic species of the genus and perhaps the most abundant on West Indian reefs. The terminal male phase was named S. *punctulatus* (taxomic discussion in Randall, 1963c). Beebe & Tee-Van (1928) recorded the food of *croicensis* as algae, small crustaceans, etc. The inorganic residue from the guts of nine specimens from Puerto Rico ranged from 15.7 to 96.5 per cent of the dried contents (mean 75.4 per cent).

*Scarus guacamaia* Cuvier RAINBOW PARROTFISH

6 stations; 15 specimens: 276 to 516 mm SL.

| FOOD | VOLUME (%) |
|---|---|
| Algae | 92.0 |
| *Amphiroa fragilissima* | |
| *Centroceras clavulatum* (2) | |
| *Cladophora* sp. *Coelothrix irregularis* (4) | |
| *Enteromorpha* sp. (2) | |
| *Gelidium* sp. (2) | |
| *Gelidium corneum* | |
| *Herposiphonia* sp. (4) | |
| *Jania rubens* | |
| *Laurencia* sp. (2) | |
| *Laurencia obtusa* | |
| *Lyngbya majuscula* | |

| | |
|---|---|
| *Polysiphonia* sp. (6) | |
| *Polysiphonia ferulacea* (3) | |
| *Spyridia filamentosa* | |
| Seagrasses | 8.0 |
| *Cymodocea manatorum* | |
| *Thalassia testudinum* | |

*Remarks.*—The rainbow parrotfish is the largest scarid in the Atlantic. The young are common around mangrove roots and seagrass beds, and the adults occur primarily on reefs. Longley & Hildebrand (1941) observed that filamentous algae constitute at least part of the food. Winn & Bardach (1960) noted that adults at Bermuda have home caves from which they move by day to feed inshore or in deep water. They return to the caves at the end of the day or when frightened on their feeding grounds. Winn, Salmon, & Roberts (1964) demonstrated that *S. guacamaia* and *S. coelestinus* are oriented in their movements over sand flats between the home caves and the feeding grounds by the azimuth of the sun. Inorganic sediment comprised 32.9 to 94.7 per cent (mean 71.3 per cent) of the dried material of the alimentary tracts of 12 specimens from Puerto Rico. The gut contents of one adult specimen from the Virgin Islands was dominated by *Cymodocea,* and large amounts of *Thalassia* were present in the digestive tracts of two individuals from La Parguera, Puerto Rico.

*Scarus taeniopterus* Desmarest PAINTED-TAIL PARROTFISH

4 stations; 8 specimens: 127 to 191 mm SL.

| FOOD | VOLUME (%) |
|---|---|
| Algae | 81.2 |
| *Centroceras* sp. (2) | |
| *Enteromorpha* sp. (2) | |
| *Gelidium* sp. (2) | |
| *Lyngbya* sp. | |
| *Microcoleus* sp. | |
| *Oscillatoria* sp. | |
| *Polysiphonia* sp. (2) | |
| *Polysiphonia ferulacea* | |
| *Rhizoclonium riparium* | |
| Seagrasses | 17.3 |
| *Thalassia testudinum* | |
| Sponges | 1.5 |

*Remarks.*—*S. taeniopterus* is a common reef species sometimes confused with *S. croicensis.* Inorganic material varied from 23.9 to 91.4 per cent of the dried contents of the alimentary tracts of eight specimens from Puerto Rico. The mean value was 73.6 per cent. *Polysiphonia ferulacea* constituted most of the organic material in the intestinal tract of one fish.

*Scarus vetula* Bloch & Schneider QUEEN PARROTFISH

6 stations; 14 specimens: 210 to 330 mm SL.

| FOOD | VOLUME (%) |
|---|---|
| Algae | 94.0 |
| *Acanthophora spicifera* | |
| *Centroceras* sp. (2) | |
| *Ceramium byssoideum* | |
| *Cladophora* sp. | |
| *Coelothrix irregularis* | |
| *Enteromorpha* sp. | |
| *Gelidium* sp. (3) | |
| *Gelidium corneum* | |
| *Herposiphonia* sp. (2) | |
| *Laurencia* sp. | |
| *Lyngbya* sp. | |
| *Polysiphonia* sp. (4) | |
| *Polysiphonia ferulacea* (3) | |
| *Rhizoclonium* sp. | |
| Seagrasses | 3.2 |
| *Thalassia testudinum* | |
| Gorgonians | 1.8 |
| Sponges | 1.0 |

*Remarks.*—The queen parrotfish is one of the most common of West Indian parrotfishes and seems to be closely restricted to the reef habitat. The percentage of sediment in the dried material from the alimentary tracts of 13 fish from Puerto Rico varied from 53.6 to 94.7 per cent (mean 76.9 per cent). The gorgonian and sponge material was in small quantity in the digestive tracts and was probably ingested incidentally with the algal food and inorganic material.

*Sparisoma aurofrenatum* (Cuvier & Valenciennes) REDBAND PARROTFISH

3 stations; 11 specimens: 120 to 175 mm SL.

| FOOD | VOLUME (%) |
|---|---|
| Algae | 97.8 |
| *Centroceras* sp. | |
| *Coelothrix irregularis* | |
| *Gelidium* sp. (2) | |
| *Herposiphonia* sp. | |
| *Lyngbya* sp. | |
| *Microcoleus* sp. | |
| *Microcoleus chthonoplastes* | |
| *Polysiphonia* sp. (3) | |
| Seagrasses | 1.3 |
| *Cymodocea manatorum* | |
| Gorgonians | 0.7 |
| Corals | 0.2 |

*Remarks.*—*Sparisoma aurofrenatum* is a moderately common, reef-dwelling species. The inorganic residue following the removal of organic matter from the dried contents of the alimentary tracts of ten fish constituted 8.0 to 93.8 per cent of the total contents (mean 75.5 per cent).

*Sparisoma chrysopterum* (Bloch & Schneider) REDTAIL PARROTFISH
2 stations; 6 specimens: 125 to 292 mm SL.

| FOOD | VOLUME (%) |
|---|---|
| Algae | 83.2 |
| *Enteromorpha* sp. | |
| *Gelidium* sp. | |
| *Herposiphonia* sp. | |
| *Laurencia* sp. | |
| Seagrasses | 16.8 |
| *Thalassia testudinum* (2) | |

*Remarks.*—*Sparisoma chrysopterum* occurs both on reefs and seagrass beds. It is second only to *S. radians* in abundance in the latter habitat in the West Indies. Beebe & Tee-Van (1928) reported the food of Haitian examples merely as vegetable matter. Inorganic sediment from the alimentary tracts of six specimens from Puerto Rico varied from 38.9 to 92.5 per cent of the total (mean value 69.5 per cent). Two had eaten large amounts of *Thalassia.*

*Sparisoma rubripinne* (Cuvier & Valenciennes) REDFIN PARROTFISH
5 stations; 18 specimens: 153 to 350 mm SL.

| FOOD | VOLUME (%) |
|---|---|
| Algae | 92.6 |
| *Acrochaetium* sp. | |
| *Anacystis marina* | |
| *Calothrix* sp. | |
| *Centroceras* sp. (2) | |
| *Ceramium* sp. (3) | |
| *Ceramium byssoideum* | |
| *Coelothrix irregularis* | |
| *Dictyota* sp. | |
| *Enteromorpha* sp. (3) | |
| *Gelidium* sp. | |
| *Gelidium corneum* | |
| *Halimeda* sp. | |
| *Herposiphonia* sp. | |
| *Laurencia obtusa* | |
| *Lomentaria uncinata* | |
| *Lyngbya* sp. (2) | |
| *Polysiphonia* sp. | |
| *Polysiphonia binneyi* | |
| *Polysiphonia ferulacea* | |
| *Rhizoclonium* sp. | |
| *Rhizoclonium riparium* | |
| *Sphacelaria* sp. | |
| Seagrasses | 7.0 |
| *Thalassia testudinum* (5) | |
| Sponges | 0.4 |

*Remarks.*—*Sparisoma rubripinne* is the most common member of the genus in the inshore portions of West Indian reefs. Randall & Randall (1963) noted that this species ordinarily spends much of the day grazing on benthic plant life (except during periods of reproductive activity). The specimens listed above varied greatly in the amount of sediment in their digestive tracts. Two of 16 fish analyzed had only 0.6 and 0.8 per cent by volume of inorganic material in their guts. The highest percentage was 98.6, and the mean was 68.6 per cent.

*Sparisoma radians* (Cuvier & Valenciennes) BUCKTOOTH PARROTFISH
2 stations; 5 specimens: 57 to 110 mm SL.

| FOOD | VOLUME (%) |
|---|---|
| Seagrasses | 88.0 |
| *Thalassia testudinum* | |
| Algae | 12.0 |
| *Acanthophora spicifera* | |
| *Dictyota* sp. | |

*Remarks.*—*S. radians* is the smallest species of the genus. It lives primarily in shallow beds of seagrass. There was almost no inorganic material mixed with the *Thalassia* and algae of the gut contents of the five specimens that were examined.

*Sparisoma viride* (Bonnaterre) STOPLIGHT PARROTFISH
5 stations; 20 specimens: 132 to 369 mm SL.

| FOOD | VOLUME (%) |
|---|---|
| Algae | 97.3 |
| *Centroceras* sp. | |
| *Ceramium* sp. | |
| *Enteromorpha* sp. (3) | |
| *Enteromorpha flexuosa* | |
| *Gelidium* sp. (5) | |
| *Herposiphonia* sp. | |
| *Laurencia papillosa* | |
| *Lyngbya* sp. (2) | |
| *Microcoleus chthonoplastes* (2) | |
| *Polysiphonia* sp. (5) | |
| *Polysiphonia ferulacea* | |
| *Rhizoclonium* sp. | |
| Seagrasses | 2.5 |
| *Thalassia testudinum* | |

| | |
|---|---|
| Sponges | 0.1 |
| Gorgonians | 0.1 |

*Remarks*.—Beebe & Tee-Van (1928) listed the food of this species as unrecognizable detritus. Longley & Hildebrand (1941) stated that the fish nip algae from dead coral, and on gravel bottom take bits of the weedy "stone" in their mouths and mumble them over. One may see them drop many of these, though some of the smaller ones are perhaps milled by the pharyngeal teeth. The percentage of inorganic sediment of the dried digestive tract material of 19 specimens from Puerto Rico varied from 45.1 per cent to 95.8 per cent with a mean of 72.9 per cent.

## BOTHIDAE (Lefteye Flounders)

Flatfishes of the family Bothidae are represented in the West Indies by two species that may be found on the sand patches in and around coral reefs. Like other flatfishes, they are able to alter their color to match that of the bottom. They also agitate the sand so that it settles on and partially obscures their form. They are believed to take their prey of small fishes and crustaceans from such a position of concealment.

*Bothus lunatus* (Linnaeus) PEACOCK FLOUNDER

9 stations; 11 specimens: 99 to 300 mm SL; 4 empty.

| FOOD | VOLUME (%) |
|---|---|
| Fishes | 85.7 engraulids |
| *Jenkinsia* sp. | |
| *Selar crumenophthalmus* | |
| Stomatopods | 11.4 |
| Octopuses | 2.9 |

*Remarks*.—The largest peacock flounder taken, a specimen from the Virgin Islands 300 mm in standard length, had two bigeye scads in its stomach which measured 84 and 90 mm in fork length. A 290-mm flounder contained two individuals of *Jenkinsia* about 52 mm SL and six engraulids about 40 mm in length. These small schooling fishes were at the surface 25 feet above the bottom when the flatfish was speared. It seems more likely that the small clupeoids had previously ventured closer to the bottom rather than postulate that the flounder had made a feeding rush from the bottom to the surface.

*Bothus ocellatus* (Agassiz) EYED FLOUNDER

8 stations; 9 specimens: 68 to 130 mm SL.

| FOOD | VOLUME (%) |
|---|---|
| Fishes | 28.3 |
| *Coryphopterus* sp. | |
| Crabs | 25.0 |
| *Calappa ocellata* | |
| majid | |
| Shrimps | 17.8 |
| Amphipods | 15.0 |
| isaeid | |
| Unidentified crustaceans | 11.1 |
| Stomatopods | 2.8 |
| *Pseudosquilla ciliata* | |

*Remarks*.—Among the amphipods taken from a 77-mm *B. ocellatus* from Curaçao is an undescribed genus and species of Isaeidae (determined by Barnard).

## GOBIIDAE (Gobies)

The gobies are the largest family of fishes in the West Indies. They are small, some only about an inch in length at maturity. Most are found on sand or mud bottoms, often in burrows, but many occur on coral reefs. Nearly all of the species rest upon the bottom, and most have the pelvic fins fused medially to form a sucking disc. The stomach contents of only a few specimens of four species were examined. Limited data on three are reported below. The food habits of the fourth, an undescribed species of *loglossus,* will be discussed by Randall (MS).

*Coryphopterus glaucofraenum* Gill BRIDLED GOBY

1 station; 4 specimens: 28 to 37 mm SL.

| FOOD | VOLUME (%) |
|---|---|
| Algae and detritus | 50.0 |
| Ostracods | 12.0 |
| Ophiuroids | 10.0 |
| Unidentified eggs | 10.0 |
| Pelecypods | 10.0 |
| Copepods | 8.0 |

*Remarks*.—*C. glaucofraenum* is perhaps the most common goby living on a sand or silty bottom in and around shallow reefs and seagrass beds in the West Indies. Large amounts of fine sand were present with food material in the stomachs.

*Gobiosoma* sp. WEST INDIAN CLEANING GOBY

1 station; 4 specimens: 21 to 26 mm SL; 3 empty.

| FOOD | VOLUME (%) |
|---|---|
| Isopods | 100.0 |
| gnathiids (larv.) | |

*Remarks*.—James E. Böhlke will describe this goby. It is a light bluish gray with a black stripe along the side of the head and body, and yellow above the stripe on the head and anteriorly on the body. It often occurs in pairs on West Indian reefs. It is restricted to a small section of reef, often

a prominent brain coral. Reef fishes in the vicinity are aware of its location and come to it for removal of ectoparasites. This goby is frequently encountered lying directly on live coral. With the approach of a host fish, it leaves the coral, swims to the fish, and moves leisurely over the surface of the body and fins; it may even enter the gill chamber and mouth of some fishes. It appears to make use of its ventral sucking disc to attach directly to the surface of the host fish. The larval gnathiid isopods from the stomach of one specimen appear to be fish parasites. More data on the food habits of this species would be of interest. It is expected that it will prove to be an obligate "cleaner." Longley & Hildebrand (1941) have described the parasite-picking activity of the related neon goby, *Gobiosoma oceanops (Elacatinus oceanops* of most authors) from Dry Tortugas, Florida (which is not known from the West Indies), and Eibl-Eibesfeldt (1955) and Randall (1958, 1962b) have made observations on the West Indian species.

*Gnatholepis thompsoni* Jordan — GOLDSPOT GOBY

2 stations; 10 specimens: 30 to 43 mm SL.

| FOOD | VOLUME (%) |
|---|---|
| Algae and detritus | 74.0 |
| Copepods | 18.0 |
| Amphipods | 4.0 |
| Ostracods | 2.0 |
| Unidentified crustaceans | 2.0 |

*Remarks.*—The stomachs of some of the specimens of *G. thompsoni* contained as much as 50 per cent fine sand.

## BLENNIIDAE (Blennies)

The blennies are small, strictly benthic, diurnal fishes which are characteristic of hard bottoms. The four species discussed below appear to feed primarily on algae and detritus. Limited data presented by Randall (1966) suggest that the blenniid genus *Hypleurochilus,* represented by two species in the West Indies (a third is known only from Cay Sal, Bahamas), is principally carnivorous.

*Blennius cristatus* Linnaeus — MOLLY MILLER

4 stations; 22 specimens: 52 to 87 mm SL; 1 empty.

| FOOD | VOLUME (%) |
|---|---|
| Algae and organic detritus | 99.2 |
| *Acanthophora spicifera* | |
| *Amphiroa fragilissima* | |
| *Bryopsis* sp. | |
| *Caulerpa* sp. | |
| *Ceramium* sp. | |
| *Ceramium byssoideum* | |
| *Dictyota* sp. | |
| *Dictyota divaricata* | |
| *Hypnea musciformis* | |
| *Laurencia gemnifera* | |
| *Laurencia obtusa* | |
| *Laurencia papillosa* (2) | |
| *Lyngbya* sp. | |
| Gastropods | 0.8 |
| acmaeid | |

*Remarks.*—*B. cristatus* lives along rocky shores. Sand, echinoid spine fragments, etc. were present in almost all of the stomachs, but in relatively small amounts (less than 10 per cent by volume). The algae seem to have been ingested in fairly large mouthfuls. The few gastropods that were detected in the stomach contents were very small and were probably not selected by the fish when feeding.

*Blennius marmoreus* Poey — SEAWEED BLENNY

* stations; 12 specimens: 33 to 76 mm SL.

| FOOD | VOLUME (%) |
|---|---|
| Algae and organic detritus | 79.2 |
| *Asterocystis ramosa* | |
| *Ceramium* sp. (2) | |
| diatoms | |
| *Dichothrix* sp. | |
| *Polysiphonia* sp. | |
| Ophiuroids | 9.2 |
| Polychaetes | 9.2 |
| Hydroids | 2.4 |

*Remarks.*—*Longley* & Hildebrand (1941) reported that this blenny feeds largely on filamentous algae, and to a lesser extent on a variety of animals including small tunicates, clams, amphipods, bryozoans, bits of sponge, etc. More sand was present in the stomachs of this species (up to 50 per cent) than the preceding.

*Entomacrodus nigricans* Gill — PEARL BLENNY

3 stations; 16 specimens: 35 to 56 mm SL; 2 empty.

| FOOD | VOLUME (%) |
|---|---|
| Algae and organic detritus | 96.4 |
| diatoms | |
| *Herposiphonia secunda* | |
| *Lyngbya majuscula* | |
| *Microcoleus* sp. | |
| *Polysiphonia* sp. | |
| *Polysiphonia ferulacea* | |
| Polychaetes | 3.6 |

*Remarks.*—Like *B. cristatus, E. nigricans* is an inshore species. Fine sand and calcareous debris were present in the stomachs in moderate amounts. In five specimens from one station they represented 50 per cent by volume of the stomach-content material.

*Ophioblennius atlanticus* (Cuvier & Valenciennes) REDLIP BLENNY

8 stations; 50 specimens: 35 to 89 mm SL.

| FOOD | VOLUME (%) |
|---|---|
| Algae and organic detritus | 99.5 |
| *Acanthophora spicifera* | |
| *Amphiroa fragilissima* | |
| *Anacystis marina* (2) | |
| *Callithamnion* sp. | |
| *Ceramium* sp. | |
| *Ceramium byssoideum* | |
| *Ceramium nitens* | |
| diatoms (3) | |
| *Enteromorpha* sp. | |
| *Herposiphonia* sp. | |
| *Herposiphonia tenella* | |
| *Lyngbya* sp. | |
| *Lyngbya majuscula* | |
| *Phormidium penicellatum* | |
| *Plectonema nostocorum* | |
| *Polysiphonia* sp. (2) | |
| *Polysiphonia ferulacea* | |
| Fish eggs | 0.5 |

*Remarks.*—*Ophioblennius atlanticus,* often classified in the genus *Rupiscartes,* is one of the most abundant fishes on shallow reefs in the West Indian region. Randall (1963b) found it the most numerous fish in a large poison station on a fringing reef at St. John, Virgin Islands, and the third in number in a second large collecting station at the same island. Beebe & Tee-Van (1928) stated that the food of their specimens from Haiti consisted only of organic detritus, apparently of both animal and vegetable origin. Diatoms and various bluegreen algae dominated the plant material in the stomachs of specimens from the Virgin Islands and Puerto Rico. Fine sand was often present, but in small quantities (no more than 15 per cent of the volume of the stomach contents). This species does not bite off large amounts of algae like *Blennius cristatus* but scrapes detrital material and fine filamentous algae from rock surfaces. *B. cristatus* is primarily an intertidal fish and feeds on the luxuriant algal flora there, whereas *O. atlanticus* lives in deeper (though still shallow) water and must compete for a meager algal supply with larger herbivores such as the acanthurids and scarids.

## CLINIDAE (Clinids)

The clinids are small blennioid fishes that usually live inshore on a rock substratum, but they may occur on sand or coral rubble. Information on their feeding is limited but suggestive of carnivorous habits. Robins & Randall (1965) analyzed the stomach contents of 19 specimens of *Chaenopsis limbaughi,* a species of the subfamily Chaenopsinae. Small crustaceans were the dominant food organisms.

*Labrisomus guppyi* (Norman) SHADOW BLENNY

3 stations; 6 specimens: 56 to 75 mm SL; 2 empty.

| FOOD | VOLUME (%) |
|---|---|
| Crabs | 72.5 |
| *Mithrax* sp. | |
| *Petrolisthes* sp. | |
| Chitons | 20.0 |
| Gastropods | 5.0 |
| *Acmaea* sp. | |
| Isopods | 2.5 |

*Labrisomus kalisherae* (Jordan) DOWNY BLENNY

1 station; 1 specimen: 62 mm SL.

| FOOD | VOLUME (%) |
|---|---|
| Ophiuroid | 100.0 |
| *Ophiocoma echinata* | |

*Labrisomus nuchipinnis* (Quoy & Gaimard) HAIRY BLENNY

8 stations; 22 specimens: 59 to 131 mm SL; 3 empty.

| FOOD | VOLUME (%) |
|---|---|
| Crabs | 27.2 |
| majid | |
| *Microphrys bicornutus* | |
| *Percnon* sp. | |
| *Petrolisthes galathinus* | |
| Gastropods | 16.5 |
| *Acmaea pustulata* | |
| *Cerithium eburneum* | |
| *Modulus modulus* | |
| *Olivella petiolita* | |
| *Tricolia adamsi* | |
| Ophiuroids | 12.3 |
| *Ophiocoma* sp. | |
| *Ophiocoma echinata* | |
| Echinoids | 10.5 |
| *Echinometra lacunter* | |
| Fishes | 10.5 |
| Polychaetes | 10.0 |

| | |
|---|---|
| Shrimps | 7.7 |
| Amphipods | 5.3 |

*Remarks.*—*Labrisomus nuchipinnis* is the largest and most common West Indian clinid. Some of the animals on which it feeds are of considerable size in comparison to its size. All of the gastropods in the stomachs were intact. A 95-mm fish contained an unbroken limpet *(Acmaea pustulata),* the shell of which measured 8 by 10 mm. *Modulus modulus* from a 117-mm individual was 9.5 mm in length. Two fish, 128 and 131 mm SL, each contained intact *Echinometra;* the tests of these echinoids, however, were only about 6 mm in diameter.

## OPISTHOGNATHIDAE (Jawfishes)

Jawfishes live in burrows in sediment which they line with stones or bits of shell or coral. Often small groups of burrows are encountered in the vicinity of reefs. The individual fish make short excursions for feeding or hover above the burrow to eat zooplankton. They back into their burrows tail first for shelter. They are diurnal, and at least one species *(Opisthognathus aurifrons)* covers the entrance to its burrow for the night by backing in with a large stone in its jaws.

*Opisthognathus aurifrons* (Jordan & Thompson) YELLOWHEAD JAWFISH

4 stations; 16 specimens: 46 to 68 mm SL.

| FooD | VOLUME (%) |
|---|---|
| Copepods | 85.0 |
| *Acartia negligens* | |
| *Calanopia americana* | |
| *Candacia pachydactyla* | |
| *Coryaceus subulatus* | |
| *Oncaea* sp. | |
| *Temora turbinata* | |
| *Undinula* | |
| *vulgaris* | |
| Shrimp larvae | 9.4 |
| Unidentified animal material | 1.9 |
| Fish eggs | 1.5 |
| Siphonophores | 1.3 |
| Barnacle larvae | 0.6 |
| Polychaetes | 0.3 |

*Remarks.*—Longley & Hildebrand (1941) described the burrow of *O. aurifrons* and its construction and repair. They stated that the jawfish are usually seen "floating" a foot or more above their burrows. With the approach of danger they settle in tail first but in an emergency they dart in head foremost. These authors stated that the fish feed on drifting plankton. In a small amount of material from the gut of one, W. L. Schmitt recognized a shrimp zoea, small hermit crab, two barnacle larvae, several ostracods, a tanaid, an amphipod, a dozen copepods representing several species, and several recently hatched snails. Böhlke & Thomas (1961) have postulated that the peculiar tear-drop shaped pupil of the eye, with its anteroventral-posterodorsal alignment, seems to be an adaptation to this hovering plankton-feeding existence. The antero-ventral lobe is oriented so that the fish probably has binocular vision along a plane parallel to the horizontal while maintaining a near-vertical position.

*Opisthognathus macrognathus* Poey SPOTFIN JAWFISH

1 station; 1 specimen: 100 mm SL.

| FOOD | VOLUME (%) |
|---|---|
| Shrimps | 100.0 |

*Opisthognathus maxillosus* Poey MOTTLED JAWFISH

9 stations; 14 specimens: 53 to 110 mm SL; 7 empty.

| FOOD | VOLUME (%) |
|---|---|
| Shrimps | 28.6 |
| Isopods | 28.6 |
| Fishes | 22.7 |
| Polychaetes | 14.3 |
| Mysids | 5.4 |
| Copepods | 0.4 |

*Remarks.*—This species, the preceding, and the following, were not observed hovering above their burrows to feed on plankton, at least as adults. Their stomach contents indicate that they feed primarily on benthic forms or free-swimming animals such as mysids which live near the bottom.

*Opisthognathus whitehurstii* (Longley) DUSKY JAWFISH

4 stations; 9 specimens: 33 to 65 mm SL; 4 empty.

| FOOD | VOLUME(%) |
|---|---|
| Shrimps | 54.0 |
| Fishes | 22.0 |
| Isopods | 11.0 |
| Ophiuroids | 8.0 |
| Crabs (juv.) | 5.0 |

## SCORPAENIDAE (Scorpionfishes)

The scorpionfishes are diurnal, solitary, and carnivorous. They sit upon the bottom, relying on their protective coloration and numerous dermal flaps and filaments to provide resemblance to the substratum. Characteristically, they wait for mobile prey to come within striking range of their relatively large mouths. In aquaria they have been observed to slowly stalk unsuspecting small fishes and crustaceans.

*Scorpaena brasiliensis* (Cuvier & Valenciennes) BARBFISH

5 stations; 13 specimens: 111 to 164 mm SL; 6 empty.

| FOOD | VOLUME (%) |
|---|---|
| Shrimps | 35.7 |
| penaeid | |

| | |
|---|---|
| Unidentified crustaceans | 28.6 |
| Stomatopods | 14.3 |
| Fishes | 14.3 |
| *Hippocampus* sp. | |
| Crabs | 7.1 |

*Remarks.*—The barbfish is not common in the West Indies. The only individual which had eaten a fish was speared on a sand bottom in 65 feet of water off St. John, Virgin Islands, beside a thallus of *Avrainvillea.* It was 164 mm in standard length, and the seahorse that it had eaten measured 58 mm from the top of the head to the bottom of the coiled tail.

*Scorpaena grandicornis* (Cuvier & Valenciennes) GRASS SCORPIONFISH

11 stations; 15 specimens: 37 to 102 mm SL; 7 empty.

| FOOD | VOLUME (%) |
|---|---|
| Shrimps | 75.0 |
| caridean | |
| stenopid | |
| Fishes | 12.5 |
| Unidentified crustaceans | 12.5 |

*Remarks.*—*Scorpaena grandicornis* is a shallow-water fish most often taken in beds of seagrass. Like the preceding species, it appears to feed more on crustaceans than fishes.

*Scorpaena inermis* Cuvier & Valenciennes MUSHROOM SCORPIONFISH

6 stations; 28 specimens: 36 to 71 mm SL; 12 empty.

| FOOD | VOLUME (%) |
|---|---|
| Shrimps | 85.3 |
| carideans | |
| palaemonids | |
| penaeids (2) | |
| *Penaeopsis* sp. | |
| Stomatopods | 7.5 |
| Unidentified animal material | 6.3 |
| Crabs | 0.6 |
| portunid | |
| Fishes | 0.3 |

*Remarks.*—*Scorpaena inermis* is a small species that is most frequently found on coral rubble bottoms in the depth range of a few to 30 feet. Eschmeyer (1965), however, has recorded it to a depth of 40 fathoms. Two series of specimens were collected from a sand bottom dominated by *Halophila.* One 60-mm fish taken from the stomach of *Antennarius scaber* contained 11 small shrimps (penaeids and carideans including palaemonids), a portunid crab, and fish remains.

*Scorpaena plumieri* Bloch SPOTTED SCORPIONFISH

19 stations; 28 specimens: 61 to 250 mm SL; 12 empty.

| FOOD | VOLUME (%) |
|---|---|
| Fishes | 42.2 |
| *Acanthurus* sp. (larv.) | |
| congrid | |
| *Jenkinsia* sp. | |
| Crabs | 31.3 |
| majid | |
| *Mithrax coryphe* | |
| *Pitho* sp. | |
| *Portunus anceps* | |
| *Portunus ordwayi* | |
| Shrimps | 18.7 |
| penaeid | |
| *Penaeopsis goodei* | |
| Octopuses | 6.2 |
| Hermit crabs | 1.6 |

*Remarks.*—*Scorpaena plumieri* is the most common species of the genus on shallow West Indian reefs. It is also the largest. Longley (in Longley & Hildebrand, 1941) wrote, "The body is hoary with dermal appendages like rags and tatters of weed. Among algae, combinations of green and yellow occur. I have sometimes found it almost necessary to brush the fish to convince myself that its color and covering were its own. The obliterative effect of its coloration is so pronounced that one may gaze almost directly at it without seeing it." He noted that it often remains motionless for long periods, but he saw it dash up from the bottom with rapidity to swallow a blenny that ventured too near. He found two such fishes, a portunid crab, and fragments of several other small crustaceans in the stomach of one specimen from Dry Tortugas.

*Scorpaenodes caribbaeus* Meek & Hildebrand REEF SCORPIONFISH

9 stations; 21 specimens: 38 to 90 mm SL; 10 empty.

| FOOD | VOLUME (%) |
|---|---|
| Shrimps | 65.9 |
| alpheids (2) | |
| carideans (3) | |
| Crabs | 17.3 |
| *Petrolisthes galathinus* | |
| porcellanid | |
| xanthid | |
| Unidentified crustaceans | 9.1 |
| Fishes | 7.7 |
| *Holacanthus* sp. (larv.) | |

DACTYLOPTERIDAE (Flying Gurnards)

*Dactylopterus volitans* (Linnaeus) FLYING GURNARD

6 stations; 7 specimens: 98 to 275 mm SL.

| FOOD | VOLUME (%) |
|---|---|
| Crabs | 61.7 |
| majid | |
| parthenopids | |
| portunids (2) | |
| *Portunus* sp. | |
| Stomatopods | 19.3 |
| *Gonodactylus* sp. | |
| Pelecypods | 7.2 |
| Shrimps | 5.4 |
| penaeids (2) | |
| Fishes | 5.0 |
| Amphipods | 1.4 |

*Remarks.*—The flying gurnard is a solitary benthic fish usually seen on sand bottoms. It is rare in the West Indies. Sluggish and easily approached, it "walks" on its pelvic fins and may utilize the free anterior rays of the pectoral fins like claws to scratch in the sand. When alarmed it spreads its long blue-spotted pectorals laterally, as if in a warning display (Breder, 1963). Beebe (1928) has attributed the ability to glide in the air to this fish. Longley & Hildebrand (1941) wrote, "It has been said at least since the time of Artedi that this fish flies. The statement seems scarcely credible, as the rays of the pectoral are so thin and flexible that the fin droops almost of its own weight."

EPHIPPIDAE (Spadefishes)

*Chaetadipterus faber* (Broussonet) SPADEFISH

22 stations; 29 specimens: 129 to 350 mm SL; 7 empty.

| FOOD | VOLUME (%) |
|---|---|
| Sponges | 32.7 |
| Zoantharians (except corals) | 18.5 |
| *Rhodactis sanctithomae* | |
| *Zoanthus* sp. (4) | |
| Polychaetes | 13.7 |
| *Sabellastarte magnifica* | |
| Tunicates | 12.6 |
| salps | |
| Gorgonians | 6.3 |
| *Muricea laxa* | |
| Algae | 5.0 |
| *Ceramium fastigiatum* | |
| *Cladophora* sp. | |
| diatoms | |
| *Giffordia mitchellae* | |
| Gastropod eggs | 3.2 |
| Holothurians | 2.3 |
| Corals | 2.3 |
| *Oculina diffusa* | |
| Seagrasses | 2.3 |
| *Cymodocea manatorum* | |
| Heteropods | 0.5 |
| Crab larvae | 0.2 |
| Spiny lobster larvae | 0.2 |
| Shrimp larvae | 0.1 |
| Amphipods | 0.1 |
| hyperiids | |

*Remarks.*—The nearly ubiquitous spadefish is one of the most generalized of fishes in its food habits. The adults are usually encountered in small schools which often approach divers closely. Spadefish may occur in turbid areas over mud bottoms or clear water over offshore reefs. They may lurk in the crevices in reefs and feed on sponges, algae, etc. or swim well above the bottom and ingest the larger zooplankton and smaller nekton. The young are common in shallow brackish environments where they resemble red mangrove seed pods in form and color (Breder, 1946). Linton (1905) recorded the food from three stomachs of North Carolina fish as fragments of annelids, crustaceans, diatoms, a gorgonian (*Leptogorgia* sp.), and possibly foraminifera. Hildebrand & Schroeder (1928) examined the stomach-content material of four small specimens (68 to 82 mm) from Chesapeake Bay. This consisted chiefly of vegetable debris with a few minute crustaceans intermixed. Smith (1907-reference from Hildebrand & Schroeder) wrote of the spadefish, "It frequents rocky patches, wrecks, and piling in search of food, which consists of small crustaceans, worms, etc." Townsend (1929) stated that *C. faber* is a hardy fish which will live many years in captivity, adding that it is reported to feed on the Portuguese man-of-war *(Physalia);* fishermen at Trinidad supposedly capture it with this jellyfish as bait. Lowe (1962) reported hydroids, sponges, and feather stars *(Tropimetra carinata)* from specimens from British Guiana. None of the highly varied material from the stomachs of the West Indian specimens appears to have been accidentally ingested. The stomach of one 340-mm fish contained three pieces of sea cucumber and 21 pieces of manatee grass (the latter 13 to 53 mm long). Two fish (280 and 307 mm) had eaten only salps up to 10 mm long. Two others, 220 and 232 mm, contained only the coralliomorpharian anemone *Rhodactis sanctihomae.* The stomach of a 265-mm individual was filled with *Zoanthus* and one piece of live coral *(Oculina diffusa)* 12 mm long and 2 to 3 mm in width. A 185-mm fish contained only the tentacular crowns of five sabellids *(Sabellastarte mag-*

*nifica)*. Two specimens (129 and 210 mm) taken with a trawl from a mud bottom off Mayaguez, Puerto Rico had eaten only an unidentified tube-dwelling polychaete.

## CHAETODONTIDAE (Butterflyfishes and Angelfishes)

The chaetodonts are deep-bodied, compressed, colorful fishes which live on coral reefs. They are usually seen as solitary individuals or in pairs, and they are diurnal. The butterflyfishes (subfamily Chaetodontinae) in the West Indies seem to feed primarily on the tentacular crowns of polychaetes and on anthozoans, especially *Zoanthus*. No data were obtained on the food habits of *Chaetodon ocellatus,* a moderately rare species in the West Indies (although common in Florida). A small amount of animal material was noted in the stomach of one 118-mm specimen from the Dominican Republic, but no organisms could be identified. With the exception of *Centropyge,* the West Indian angelfishes (Pomacanthinae) feed mostly on sponges. Large amounts of algae may occasionally be found in the two species of *Pomacanthus*. The sponges which are eaten by angelfishes include species with numerous silicious spicules. One would expect, *a priori,* that the digestive tracts of the fishes consuming such sponges would be injured by the spicules. The fishes appear to have obviated any such abrasive effect, however, by secreting a heavy coat of tough mucous around the food mass. Juvenile angelfishes feed in part on the ectoparasites of other reef fishes (Randall & Randall, 1960). Such feeding has also been reported for some species of *Chaetodon*. The author has not observed this among West Indian species of the genus, but it would not be unexpected if it occurred. Hiatt & Strasburg (1960) noted that the chaetodonts in the Marshall Islands were divisible into three groups, herbivores, omnivores, and carnivores. They either grazed algae, ingested both coral polyps and algae, or browsed strictly on coral. Coral polyps were not found in the stomachs of any West Indian specimens, but individuals of the genus *Chaetodon* have been observed feeding on coral in aquaria. If reefs in the Caribbean were as dominated by corals as some of those in the Marshall Islands, it seems likely that coral polyps would appear as a prominent item of diet in at least some of the West Indian butterflyfishes.

*Centropyge argi* Woods & Kanazawa — CHERUBFISH

3 stations; 5 specimens: 36 to 56 mm SL; 1 empty.

| FOOD | VOLUME (%) |
|---|---|
| Algae and detritus | 100.0 |
| *Cladophora* sp. | |
| *Enteromorpha* sp. | |
| *Lyngbya* sp. | |
| *Lyngbya majuscula* | |

*Remarks*.—The cherubfish, sometimes called the pygmy angelfish, is a moderately common reef fish at depths greater man about 100 feet in the West Indies, but rare in shallow water at most localities. Fine sand comprised 40 to 70 per cent of the stomach contents.

*Chaetodon capistratus* Linnaeus — FOUREYE BUTTERFLYFISH

11 stations; 29 specimens: 52 to 83 mm SL; 1 empty.

| FOOD | VOLUME (%) |
|---|---|
| Zoantharians | 38.6 |
| *Zoanthus* sp. (3) | |
| *Zoanthus sociatus* | |
| Polychaetes | 31.4 |
| serpulids (2) | |
| terebellids (2) | |
| Unidentified animal material | 16.8 |
| Unidentified eggs | 6.4 |
| Gorgonians | 4.7 |
| Tunicates | 2.1 |
| didemnid | |

*Remarks*.—*Chaetodon capistratus* is the most common butterflyfish on shallow reefs in the West Indies and the smallest species of the genus in the region. The polychaetes which it had eaten consisted of the tentacles of serpulids and terebellids. Most of the unidentified tissue in the stomachs appeared to be coelenterate. The gorgonian material was only polyps (this fish has been observed to nibble at the fronds of gorgonians). Unidentified eggs were found in the stomachs of five specimens; none were fish eggs.

*Chaetodon sedentarius* Poey — REEF BUTTERFLYFISH

3 stations; 3 specimens: 63 to 95 mm SL.

| FOOD | VOLUME (%) |
|---|---|
| Unidentified animal material | 43.3 |
| Polychaetes | 16.7 |
| Shrimps | 15.0 |
| *Lucifer* sp. | |
| Amphipods | 13.3 |
| caprellids | |
| Hydroids | 11.7 |

*Chaetodon striatus* Linnaeus — BANDED BUTTERFLYFISH

8 stations; 16 specimens: 66 to 114 mm SL.

| FOOD | VOLUME (%) |
|---|---|
| Polychaetes | 58.7 |
| sabellids (2) | |
| serpulids (3) | |
| terebellids (2) | |
| Anthozoans | 32.5 |
| *Bunodactis stelloides* | |

| | |
|---|---|
| *Zoanthus* sp. (2) | |
| Unidentified crustaceans | 6.3 |
| Mollusk eggs | 2.5 |

*Remarks.*—Beebe & Tee-Van (1928) described the food of examples from Haiti as very minute crustaceans, algae, and other organic matter too disintegrated to identify. No plant material was detected in the 16 specimens reported above. All of the polychaete tissue consisted of tentacles.

*Holacanthus ciliaris* (Linnaeus) QUEEN ANGELFISH

19 stations; 26 specimens: 151 to 315 mm SL.

| FOOD | VOLUME (%) |
|---|---|
| Sponges | 96.8 |
| Algae | 1.4 |
| *Dictyota dentata* | |
| *Dictyota divaricata* | |
| Tunicates | 0.9 |
| Hydroids | 0.5 |
| Bryozoans | 0.4 |

*Remarks.*—This colorful species is not abundant, but it is universal on reefs from shallow water to depths of at least 200 feet. The stomachs of all specimens contained a variety of sponges (33 genera). These will be discussed in a separate paper by the author and Willard D. Hartman. The young, which have pale blue bars on the body, have been observed picking at the bodies of other reef fishes. The stomach of one small specimen from the Bahamas contained filamentous algae and a few calagoid copepods.

*Holacanthus tricolor* (Bloch) ROCK BEAUTY

12 stations; 24 specimens: 129 to 210 mm SL.

| FOOD | VOLUME (%) |
|---|---|
| Sponges | 97.1 |
| Zoantharians | 2.1 |
| *Zoanthus* sp. | |
| Algae | 0.8 |
| *Avrainvillea rawsonii* | |
| *Dictyopteris* sp. | |
| Lyngbya *majuscula* | |

*Remarks.*—Beebe & Tee-Van (1928) reported the food of this angelfish as "algae and scrapings."

*Pomacanthus arcuatus* (Linnaeus) GRAY ANGELFISH

27 stations; 34 specimens: 95 mm and 107 to 345 mm SL.

| FOOD | VOLUME (%) |
|---|---|
| Sponges | 70.2 |
| Tunicates | 10.1 |
| didemnid (3) | |
| Algae | 8.3 |
| *Caulerpa mexicana* | |
| *Caulerpa cupressoides* (2) | |
| *Caulerpa prolifera* (2) | |
| *Caulerpa racemosa* (2) | |
| *Caulerpa sertularioides* (3) | |
| *Caulerpa taxifolia* | |
| *Coelothrix irregularis* | |
| *Colpomenia sinuosa* | |
| *Dictyopteris delicatula* | |
| *Dictyota* sp. | |
| *Dictyota bartayresii* | |
| *Dictyota divaricata* | |
| *Hypnea musciformis* | |
| *Penicillus pyriformis* | |
| *Pocockiella variegata* | |
| *Spatoglossum schroderi* | |
| *Ulva lactuca* (2) | |
| Zoantharians | 4.4 |
| *Zoanthus* sp. | |
| *Zoanthus sociatus* | |
| Unidentified animal material | 3.3 |
| Gorgonians | 1.6 |
| *Pterogorgia* sp. | |
| Unidentified eggs | 1.5 |
| Hydroids | 0.4 |
| Bryozoans | 0.1 |
| Seagrasses | 0.1 |
| *Ruppia maritima* | |

*Remarks.*—The gray angelfish, sometimes referred to as the black angelfish, is a large reef fish. The young have vertical yellow bars. The stomach contents of a 95-mm juvenile from the Virgin Islands were not included in the above analysis. The fish contained five parasitic copepods, one free-living copepod (copepods 25 per cent by volume) and filamentous algae (75 per cent). Juveniles of the gray angelfish and the following species of *Pomacanthus* were often observed picking at the bodies of other fishes. Information on the food habits of adults has been presented in five previous works. Beebe & Tee-Van (1928) found the stomachs of Haitian specimens to be filled with algae, hydroids, etc. Breder (1948) stated merely that it feeds mostly on invertebrates and vegetation. Gudger (1929) emptied the contents of the alimentary tract of a specimen 18.75 inches long from Dry Tortugas. He found 240 cc of crustacean remains, pieces of gorgonians, and fragments of algae of various kinds. He added, "I am inclined to think that its principal food is algae." Longley & Hildebrand (1941) wrote that the diet of Tortugas fish includes algae and a great

variety of sedentary animals. Lowe (1962) reported sponges as the food of specimens of this species and *P. paru* from British Guiana. Sponges clearly dominated the food of the adult West Indian specimens listed above. In one 310-mm individual, however, algae represented 75 per cent of the total food mass in the stomach, and in another *Zoanthus sociatus* comprised 95 per cent of the stomach contents.

*Pomacanthus paru* (Bloch) FRENCH ANGELFISH

22 stations; 23 specimens: 59 mm and 95 to 328 mm SL.

| FOOD | VOLUME (%) |
|---|---|
| Sponges | 74.8 |
| Algae | 13.4 |
| *Caulerpa cupressoides* | |
| *Caulerpa racemosa* | |
| *Caulerpa sertularioides* | |
| *Caulerpa taxifolia* | |
| *Centroceras clavulatum* | |
| *Cryptonemia crenulata* | |
| *Codium isthmocladum* | |
| *Dictyopteris delicatula* | |
| *Dictyota bartayresii* (2) | |
| *Halymenia florisia* | |
| *Hypnea musciformis* | |
| *Laurencia obtusa* | |
| *Padina gymnospora* | |
| *Sargassum platycarpum* | |
| *Spyridia filamentosa* | |
| Zoantharians | 4.9 |
| *Zoanthus sociatus* | |
| Tunicates | 4.8 |
| *Ascidia nigra* | |
| didemnids (2) | |
| Gorgonians | 1.4 |
| *Gorgonia flabellum* | |
| Hydroids | 0.3 |
| Bryozoans | 0.2 |
| Spermatophytes (including seagrasses) | 0.1 |
| *Cymodocea manatorum* | |
| *Halophila baillonis* | |
| Unidentified eggs | 0.1 |

*Remarks.*—Like the gray angelfish, the French angelfish attains large size. It also displays vertical yellow bars in the juvenile form. The young feed in part by removing ectoparasites from fishes. The food of the 59-mm juvenile was not included with the data from the larger specimens. This small specimen had eaten calagoid copepods (40 per cent by volume) and algae (60 per cent). The stomach-content material of larger angelfish was similar in composition to that of the gray angelfish. Sponges were the dominant food organisms. The stomach contents of a 95-mm individual consisted wholly of three species of sponges. The largest individual collected, however, had eaten only filamentous red algae, and a 128-mm fish contained 24 polyps of *Zoanthus* and a piece of ascidian.

*Prognathodes aculeatus* (Poey) LONGSNOUT BUTTERFLYFISH

6 stations; 8 specimens: 59 to 69 mm SL; 1 empty.

| FOOD | VOLUME (%) |
|---|---|
| Polychaetes | 38.5 |
| serpulids | |
| Unidentified animal material | 26.6 |
| Echinoid pedicellariae and tubefeet | 11.4 |
| *Diadema antillarum* | |
| Shrimps | 7.2 |
| Unidentified crustaceans | 5.7 |
| Copepods | 4.9 |
| cyclopoids | |
| siphonostomes | |
| Mysids | 4.7 |
| Tanaids | 1.0 |

*Remarks.*—*Prognathodes aculeatus* is not uncommon on West Indian reefs at depths greater than about 100 feet. Evidently its relatively long snout is useful to reach among the spines of echinoids to nip off the ends of tube-feet and pedicellariae. Hubbs (1963) reported (after Zaneveld) that it feeds on the tubefeet of echinoids. The stomach contents of two specimens examined by Hubbs and the author consisted of a nemertean, a mysid, a small caprellid, at least one copepod, and echinoid pedicellariae. Hubbs reported further (after Kristensen) that this butterfiyfish feeds in aquaria on *Mysis* and often browses. Among the copepods taken from specimens from Puerto Rico were several siphonostomes. These are usually commensals of sponges and other invertebrates.

## ACANTHURIDAE (Surgeonfishes)

The surgeonfishes are represented in the West Indies by three species of *Acanthurus* which are among the most common of reef fishes. They are herbivorous and diurnal. Their teeth are spatulate with denticulate margins, hence well adapted for feeding on filamentous algae. Their alimentary tracts are very long. Two of the species, *A. chirurgus* (usually listed as *hepatus* in the older literature) and *A. bahianus,* have thick-walled, gizzard-like stomachs. Their diet includes a large amount of inorganic sediment which probably serves to grind the algal food into finer particles and thus render more of the cell contents available for digestion. *A. coeruleus,* by contrast, has a thin-walled stomach, and it usually does not ingest sand.

*Acanthunus bahianus* Castelnau — OCEAN SURGEON

11 stations; 23 specimens: 93 to 175 mm SL.

| FOOD | VOLUME (%) |
|---|---|
| Algae and organic detritus | 91.8 |
| *Bryopsis pennata* | |
| *Centroceras clavulatum* | |
| *Ceramium* sp. (2) | |
| *Ceramium byssoideum* | |
| *Cladophora delicatula* | |
| diatoms (4) | |
| *Dictyota divaricata* (2) | |
| *Enteromorpha* sp. (2) | |
| *Enteromorpha flexuosa* | |
| *Eucheuma echinocarpum* | |
| *Galaxaura lapidescens* | |
| *Halimeda opuntia* | |
| *Herposiphonia* sp. | |
| *Hypnea musciformis* (2) | |
| *Hypnea spinella* | |
| *Jania capillacea* | |
| *Jania rubens* | |
| *Liagora ceranoides* | |
| *Lyngbya* sp. | |
| *Lyngbya majuscula* | |
| *Pocockiella variegata* | |
| *Polysiphonia* sp. | |
| *Polysiphonia ferulacea* | |
| *Rhizoclonium riparium* | |
| *Sargassum* sp. | |
| *Spyridia filamentosa* (2) | |
| *Ulva lactuca* | |
| Spermatophytes (including seagrasses) | 8.2 |
| *Cymodocea manatorum* (3) | |
| *Halophila baillonis* | |
| *Thalassia testudinum* (4) | |

*Remarks.*—Beebe & Tee-Van (1928) remarked that the food of specimens from Haiti consisted of finely disintegrated organic matter with traces of algae and worm tubes. Longley & Hildebrand (1941) noted that *A. bahianus* is a bottom fish whose distribution in shallow water is essentially that of the algae on which it may be seen cropping all day long. They added that algae seems to constitute by far the greater part of its food. The author determined that about half of the stomach contents of the West Indian specimens was fine sand, along with tiny shells, etc. The percentage of inorganic material ranged from as little as 5 per cent to as much as 80 per cent. Although plant fragments were usually small, occasional large pieces were found. Sections of *Cymodocea* in a 152-mm fish ranged from 7 to 25 mm in length. A 175-mm individual contained fragments of *Ulva lactuca* up to 37 mm long, *Eucheuma echinocarpum* to 10 mm, *Hypnea musciformis* to 8 mm, and *Thalassia* to 15 mm. Occasional gravel particles in this fish were as large as 3 mm in diameter.

*Acanthurus chirurgus* (Bloch) — DOCTORFISH

9 stations; 20 specimens: 135 to 237 mm SL.

| FOOD | VOLUME (%) |
|---|---|
| Algae and organic detritus | 93.9 |
| *Amphiroa fragilissima* | |
| *Anacystis* sp. | |
| *Centroceras clavulatum* | |
| *Ceramium* sp. (2) | |
| *Corallina cubensis* | |
| diatoms (2) | |
| *Dictyota* sp. (2) | |
| *Dictyota divaricata* | |
| *Gelidium corneum* | |
| *Herposiphonia* sp. | |
| *Jania capillacea* (2) | |
| *Laurencia obtuse* | |
| *Lyngbya majuscula* | |
| *Oscillatoria* sp. | |
| *Phormidium* sp. | |
| *Polysiphonia ferulacea* (2) | |
| *Sargassum platycarpum* | |
| *Spermothamnion investiens* | |
| *Ulva* sp. | |
| Seagrasses | 5.7 |
| *Cymodocea manatorum* | |
| *Thalassia testudinum* | |
| Annelid worm tubes (noncalcareous) | 0.2 |
| Gastropods | 0.1 |
| Nudibranch eggs | 0.1 |

*Remarks.*—Of the food of specimens of this species from Haiti, Beebe & Tee-Van (1928) wrote, "The powerful gizzard-like stomach contained unidentifiable vegetable and animal matter." Townsend (1929) stated, "Although largely herbivorous the Aquarium [New York] has kept specimens as long as five years on a fish and clam diet varied occasionally with seaweed." Longley & Hildebrand (1941) reported *A. chirurgus* from Dry Tortugas to be almost entirely herbivorous. They indicated that foreign material constituted two-thirds to three-fourths of the stomach contents. The author found that sand and other inorganic matter such as dead *Halimeda* fragments, sponge spicules and gorgonian spicules comprised

25 to 75 per cent of the stomach contents of West Indian specimens examined by him. Individual pieces of gravel were as large as 5 mm in diameter.

*Acanthurus coeruleus* Bloch & Schneider — BLUE TANG

12 stations; 27 specimens: 88 to 157 mm SL; 2 empty.

| FOOD | VOLUME (%) |
|---|---|
| Algae and organic detritus | 92.8 |
| *Amphiroa fragilissima* | |
| *Caulerpa racemosa* | |
| *Centroceras clavulatum* | |
| *Ceramium* sp. | |
| *Ceramium byssoideum* | |
| *Ceramium nitens* (2) | |
| *Cladophora* sp. | |
| *Cladophora delicatula* | |
| *Coelothrix irregularis* (2) | |
| diatoms (3) | |
| *Dictyosphaeria favulosa* | |
| *Dictyota* sp. | |
| *Dictyota divaricata* (2) | |
| *Ectocarpus* sp. | |
| *Enteromorpha* sp. | |
| *Enteromorpha flexuosa* | |
| *Galaxaura lapidescens* | |
| *Gelidium rigidulum* | |
| *Halimeda incressata* | |
| *Halimeda opuntia* | |
| *Hypnea spinella* | |
| *Lyngbya* sp. (2) | |
| *Lyngbya majuscula* (2) | |
| *Microcoleus* sp. | |
| *Oscillatoria* sp. | |
| *Phormidium* sp. | |
| *Polysiphonia* sp. (3) | |
| *Polysiphonia ferrulacea* | |
| *Rhizoclonium riparium* | |
| *Spirulina* sp. | |
| *Ulva* sp. | |
| Spermatophytes (including seagrasses) | 6.8 |
| *Cymodocea manatorum* | |
| *Halophila baillonis* | 0.3 |
| Unidentified crustaceans | 0.3 |
| Gorgonian fragments | 0.1 |

*Remarks*.—Longley, Schmitt, & Taylor first noted that *Acanthurus coeruleus* has a thin-walled stomach, in contrast to that of *A. chirurgus*. They further observed that its algal food is "quite free" of foreign matter, in contrast to that of *chirurgus*. Only a trace of sand was found by the author in the stomachs examined by him. The few crustaceans that were detected were very small and could have been ingested accidentally with the algae. The yellow juveniles of this species were observed browsing freely on fine filamentous algae. Longley & Hildebrand (1941) stated that the blue tang is less of a bottom fish than the other two acanthurids previously discussed, although it often swims in the company of *chirurgus*. Breder & Clark (1947) briefly discussed and diagrammed the visceral anatomy.

## BALISTIDAE (Triggerfishes)

The triggerfishes and other plectognaths have small mouths but powerful jaws with sharp cutting teeth. Their dentition enables them to prey upon a variety of armored invertebrates denied as food to most fishes. In spite of such advantage, one West Indian species shows a preference for feeding on plants and another on zooplankton. The balistids appear to be diurnal.

*Balistes vetula* Linnaeus — QUEEN TRIGGERFISH

65 stations; 95 specimens: 130 to 480 mm SL; 4 empty.

| FOOD | VOLUME (%) |
|---|---|
| Echinoids | 72.8 |
| *Diadema antillarum* (43) | |
| *Echinometra* sp. (3) | |
| *Echinometra viridis* | |
| *Eucidaris tribuloides* | |
| spatangoids (3) | |
| Crabs | 5.4 |
| calappid | |
| *Mithrax* sp. | |
| Pelecypods | 4.6 |
| *Arca zebra* | |
| *Atrina rigida* | |
| *Barbatia domingensis* | |
| *Brachidontes* sp. | |
| *Chama sarda* | |
| *Isognomon radiatus* | |
| *Lithophaga bisulcata* | |
| *Ostrea* sp. | |
| *Spondylus* sp. | |
| *Volsella* sp. | |
| Ophiuroids | 3.3 |
| *Ophiactis* sp. | |
| *Ophiocoma* sp. | |
| *Ophionereis* sp. | |
| Unidentified animal material | 2.5 |

| | |
|---|---|
| Polychaetes | 2.1 |
| Hermit crabs | 1.9 |
| *Dardanus venosus* | |
| Gastropods | 1.6 |
| *Columbella mercatoria* | |
| *Crucibulum auricula* | |
| *Nassarius* sp. | |
| *Strombus gigas* (2) | |
| *Tegula fasciata* | |
| Asteroids | 1.4 |
| *Ophidiaster* sp. | |
| *Oreaster reticulata* (3) | |
| Algae | 1.2 |
| *Amphiroa fragilissima* | |
| *Corallina subulata* | |
| *Dictyopteris delicatula* | |
| *Halimeda incrassata* | |
| *Halimeda opuntia* | |
| *Laurencia obtusa* | |
| *Sargassum* sp. | |
| *Udotea flabellum* | |
| Sipunculids | 0.9 |
| Shrimps | 0.8 |
| alpheids | |
| Tunicates | 0.6 |
| Fishes | 0.2 |
| Corals | 0.2 |
| *Cladocora arbuscula* | |
| Unidentified crustaceans | 0.2 |
| Chitons | 0.1 |
| Scyllarid lobster | 0.1 |
| *Scyllarides aequinoctialis* | |
| Stomatopods | 0.05 |
| Amphipods | 0.03 |
| Anthozoans (except corals) | 0.02 |

*Remarks.—Balistes vetula* is a common, benthic, solitary reef fish. It probably feeds mostly on reef-dwelling organisms but it makes occasional excursions over expanses of seagrass and sand. Randall (1963) reported it as the first species to appear as an adult on an artificial reef built in a seagrass bed in the Virgin Islands. The nearest natural reef was 120 meters away. Beebe & Tee-Van (1928) reported the food of two specimens from Haiti as *Thalassia* and small crustaceans. Randalls, Schroeder, & Starck (1964) listed it among the fishes which feed on *Diadema antillarum*. This echinoid is the principal item of the diet of adult queen triggerfish. The spines and test are eaten freely, along with soft tissue. The fish have been observed to attack the urchin from the oval surface where the spines are shorter. The smaller triggerfish feed less upon *Diadema* than adults. Randall (1964a) included *B. vetula* among the fishes which eat the queen conch *(Strombus gigas)*. A 202-mm fish contained the crushed remains of a conch about 70 mm long. A 330 mm-fish had eaten a 25-mm one. About half of the stomach contents of two adult fish consisted of a variety of algae. The remains of a scyllarid lobster taken from a 365-mm triggerfish consisted only of fragments of legs. The entire slipper lobster was estimated to have been about 6 inches long.

*Canthidermis sufflamen* (Mitchill) OCEAN TRIGGERFISH

5 stations; 5 specimens: 270 to 410 mm SL; 1 empty.

| FOOD | VOLUME (%) |
|---|---|
| Echinoids | 25.0 |
| *Diadema antillarum* | |
| Pteropods | 21.2 |
| *Cavolina* sp. | |
| *Cavolina longirostris* | |
| Unidentified animal material | 15.0 |
| Gastropod larvae | 13.2 |
| *Cymatium* sp. | |
| *Tonna* sp. | |
| Siphonophores | 8.5 |
| Amphipods | 6.0 |
| hyperiids (2) | |
| Crab larvae | 3.7 |
| Isopod larvae | 2.5 |
| Algae | 2.5 |
| *Sargassum* sp. | |
| Shrimp larvae | 1.2 |
| Barnacle larvae | 1.2 |

*Remarks.—C. sufflamen* was most often encountered in clear blue water over offshore reefs near drop-offs to deep water. It was usually observed in loose aggregations well above the bottom feeding on zooplankton. The unidentified animal material that constituted 70 per cent of the stomach contents of one fish was soft and gelatinous, hence probably salp, ctenophore, or scyphozoan. The largest specimen was speared in 10 feet of water in coral. It had fed entirely on *Diadema.*

*Melichthys niger* (Bloch) BLACK DURGON

11 stations; 17 specimens: 195 to 280 mm SL.

| FOOD | VOLUME(%) |
|---|---|
| Algae | 70.8 |
| *Acrochaetium* sp. | |
| *Amphiroa fragilissima* | |

| | |
|---|---|
| *Calothrix* sp. | |
| *Ceramium byssoideum* | |
| *Ceramium nitens* | |
| *Corallina cubensis* | |
| diatoms | |
| *Dichothrix penicillata* | |
| *Dictyopteris delicatula* | |
| *Galaxaura* sp. | |
| *Galaxaura squalida* | |
| *Gelidium pusillum* | |
| *Gracilaria verrucosa* | |
| *Halimeda opuntia* | |
| *Herposiphonia secunda* | |
| *Hypnea musciformis* | |
| *Jania capillacea* (2) | |
| *Jania rubens* | |
| *Nitophyllum* sp. | |
| *Padina sanctae-crucis* | |
| *Peyssonnelia* sp. | |
| *Pocockiella* sp. | |
| *Pocockiella variegata* (2) | |
| *Polysiphonia* sp. | |
| *Sargassum fluitans* | |
| *Sargassum natans* (3) | |
| *Sargassum pteropleuron* | |
| *Sphacelaria tribuloides* | |
| *Spyridia filamentosa* | |
| Pteropods | 5.5 |
| *Cavolina* sp. | |
| *Creseis* sp. | |
| Crabs and crab larvae | 4.9 |
| Seagrasses | 4.4 |
| *Cymodocea manatorum* (3) | |
| Fishes | 3.1 |
| Unidentified crustaceans | 2.9 |
| Siphonophores | 2.3 |
| Tunicates | 1.8 |
| salps | |
| Gastropod larvae | 1.3 |
| Hermit crabs | 1.2 |
| Corals | 0.6 |
| *Colpophyllia* sp. | |
| Shrimps and shrimp larvae | 0.6 |
| Copepods | 0.2 |
| Barnacle larvae | 0.2 |
| *Lepas* sp. | |
| Foraminifera | 0.1 |
| Pelecypod larvae | 0.1 |

*Remarks.—Melichthys niger,* sometimes classified as *M. radula,* is typically a species of outer reefs and clear water at depths of more than 50 feet; however, occasional individuals may be seen inshore in as little as 10 or 15 feet. Like *Canthidermis,* this fish is often seen well above the bottom. Both species are difficult to approach underwater. When sorely pressed, *M. niger* retires to the reef where it enters a small hole and wedges itself inside in typical balistid fashion. It is omnivorous but appears to feed more heavily on plants than animals. Most of the animals are planktonic. The algae in its diet may either be benthic or drifting at the surface. Individual fish may rise from the bottom in 70 feet or more of water to the surface to feed on *Sargassum* and fragments of seagrass. Some of the algae from the stomachs, such as *Calothrix* sp., *Dichothrix penicillata,* and *Nitophyllum* sp. are epiphytic on the floating *Sargassum.*

## MONACANTHIDAE (Filefishes)

The filefishes are similar in dentition and general morphology to the triggerfishes, and their habits are also similar. They are not such strong swimmers, however, and thus are more closely associated with the bottom. Jordan & Evermann (1898) referred to the monacanthids as herbivorous shore fishes. Hiatt & Strasburg (1960) reported three species in the Marshall Islands to feed almost exclusively on corals. The West Indian species show a great diversity in their diet. Only one specimen was found with a small amount of coral in its stomach, although other benthic coelenterates were often encountered. Filefishes are usually seen as solitary individuals or in pairs.

*Alutera schoepfi* (Walbaum) ORANGE FILEFISH

2 stations; 5 specimens: 345 to 350 mm SL.

| FOOD | VOLUME (%) |
|---|---|
| Seagrasses | 67.0 |
| *Cymodocea manatorum* (2) | |
| *Thalassia testudinum* (2) | |
| Algae | 31.8 |
| *Halimeda* sp. (2) | |
| Hermit crabs | 0.6 |
| *Clibanarius tricolor* | |
| Gastropods | 0.6 |
| *Columbella mercatoria* | |

*Remarks.—Alutera schoepfi,* sometimes classified in the genus *Cerata-canthus,* is a rare species in the West Indies. The only specimens collected by the author in Puerto Rico were taken with a seine in a seagrass area in southwestern Puerto Rico. H. Smith (1907) reported that Linton examined

small specimens from North Carolina that had eaten bryozoans, shrimps, amphipods, and sea lettuce. He added that captive fish fed on algae. Beebe & Tee-Van (1928) found *Sargassum* in the stomach of one 17-inch specimen from Haiti. Hildebrand & Schroeder (1928) also listed only plant material from a 460-mm individual from Chesapeake Bay. Reid (1954) examined the stomach contents of juveniles from West Florida. He found undetermined vegetation, bryozoans, and copepods. The stomach contents of three of the Puerto Rican specimens taken at one station consisted of 36 per cent *Thalassia,* 31 per cent *Halimeda,* 19 per cent *Cymodocea,* 12 per cent algae epiphytic on the seagrasses, 1 per cent pagurids, and 1 per cent gastropods. The animals were small and may have been ingested incidentally with the plant material.

*Alutera scripta* (Osbeck) SCRAWLED FILEFISH

8 stations; 8 specimens: 218 to 540 mm SL.

| FOOD | VOLUME (%) |
|---|---|
| Hydrozoans | 39.4 |
| hydroids | |
| *Millepora alcicornis* (3) | |
| Algae | 34.2 |
| *Acanthophora spicifera* | |
| *Amphiroa fragilissima* | |
| *Caulerpa sertularioides* | |
| *Ceramium* sp. | |
| diatoms | |
| *Dictyosphaeria favulosa* | |
| *Dictyota bartayresii* | |
| *Dictyota divaricata* | |
| *Halimeda monile* | |
| *Halimeda opuntia* (2) | |
| *Hypnea spinella* | |
| *Laurencia obtusa* | |
| *Laurencia papillosa* | |
| *Valonia ventricosa* | |
| Gorgonians | 12.6 |
| *Eunicea calyculata* | |
| *Muricea* sp. | |
| *Plexaura flexuosa* (3) | |
| Seagrasses | 9.0 |
| *Thalassia testudinum* (2) | |
| Zoantharians | 2.4 |
| *Palythoa* sp. | |
| *Zoanthus* sp. | |
| *Zoanthus pulchellus* | |
| Tunicates | 1.1 |
| *Tridemnum savignii* | |
| Gastropods | 0.6 |
| *Anachis* sp. | |
| *Bailya* sp. | |
| *Cerithium* sp. | |
| *Epitonium* sp. | |
| Sponges | 0.4 |
| Shrimps | 0.3 |
| alpheid | |

*Remarks.*—The scrawled filefish was also rarely encountered in the West Indies. It may be seen over reefs or beds of seagrass. The occurence of large amounts of *Millepora alcicornis* in the gut of four specimens of this species was surprising in view of the powerful nematocysts of this so-called "stinging coral." In one 540-mm fish this branching hydrozoan constituted 97 per cent of the gut contents. The cylindrical pieces ranged from 5 to 48 mm in length. *A. scripta* is also unusual in feeding on gorgonians. The gut of a 492-mm fish contained 34 sections of the fronds of *Plexaura flexuosa,* representing 52 per cent of the gut contents. This fish appears to feed with equal enthusiasm on plants; 95 per cent of the gut contents of a 508-mm individual consisted of *Thalassia* and ten different kinds of algae, particularly *Halimeda opuntia.*

*Cantherhines macrocerus* (Hollard) FALSE FILEFISH

7 stations; 10 specimens: 210 to 334 mm SL.

| FOOD | VOLUME (%) |
|---|---|
| Sponges | 86.5 |
| Hydrozoans | 5.0 |
| hydroids (3) | |
| *Millepora alcicornis* (4) | |
| Gorgonians | 4.8 |
| *Gorgonia flabellum* | |
| Algae | 2.9 |
| *Amphiroa fragilissima* | |
| *Centroceras clavulatum* | |
| *Ceramium* sp. | |
| *Dictyota divaricata* (2) | |
| *Dilophus guineensis* (2) | |
| *Enteromorpha flexuosa* | |
| *Gelidium pusillum* | |
| *Gracilaria debilis* | |
| *Liagora ceranoides* | |
| *Ulva lactuca* | |
| Holothurians | 0.8 |

*Remarks.*—Although this reef-dwelling species is rare, it was more often noted as a pair than as separate individuals. Sponges clearly dominated the

food of all specimens, ranging from 58 to 91 per cent of the stomach con-tents. Much of the algae in the stomachs was found adhering to bite-sized chunks of sponge, indicating that the sponge and not the algae was the probable objective in feeding. Large cylindrical sections of *Millepora alcicornis* were found in the stomach and intestines of four fish. In one 304-mm individual from Mona Island, they constituted 35 per cent of the total contents of the gut. The food-habit data of nine of the above ten specimens were reported on briefly by Randall (1964c) in a systematic review of the genus.

*Cantherhines pullus* (Ranzani) ORANGE-SPOTTED FILEFISH

19 stations; 27 specimens: 46 to 170 mm SL; 1 empty.

| FOOD | VOLUME (%) |
|---|---|
| Algae and organic detritus | 42.8 |
| *Amphiroa fragilissima* (4) | |
| *Bryopsis pennata* | |
| *Caulerpa vickersiae* | |
| *Ceramium* sp. | |
| *Ceramium byssoideum* | |
| *Cladophora* sp. | |
| *Coelothrix irregularis* | |
| Diatoms | |
| *Dictyopteris delicatula* | |
| *Dictyota* sp. (2) | |
| *Dictyota divaricata* | |
| *Gelidium pusillum* | |
| *Gracilaria* sp. | |
| *Halimeda opuntia* | |
| *Jania rubens* | |
| *Liagora ceranoides* | |
| *Polysiphonia* sp. | |
| *Ulva* sp. | |
| Sponges | 30.9 |
| Tunicates | 6.0 |
| didemnids (7) | |
| *Tridemnum savignii* (3) | |
| Spermatophytes (including seagrasses) | 4.6 |
| *Halophila baillonis* | |
| *Thalassia testudinum* (4) | |
| Hydroids | 3.1 |
| *Sertularia* sp. | |
| Unidentified animal material | 2.9 |
| Bryozoans | 2.3 |
| Ophiuroids | 1.9 |
| *Ophiothrix* sp. (2) | |
| Gorgonians | 1.7 |
| Zoantharians (except corals) | 1.7 |
| *Zoanthus* sp. | |
| Unidentified crustaceans | 0.8 |
| Corals | 0.7 |
| Pelecypods | 0.2 |
| Gastropod eggs | 0.1 |
| Shrimps | 0.1 |
| alpheid | |
| Amphipods | 0.1 |
| Echinoids | 0.1 |

*Remarks.—C. pullus* is the most common monacanthid fish of West Indian reefs. It is notably smaller than the preceding species. Beebe & Tee-Van (1928) reported the stomach contents of four specimens from Haiti as sponge spicules, minute crustaceans, and a portion of sea urchin. Randall (1964c) stated that this filefish "feeds on bottom growth, primarily sponge and algae, but stomachs often contain tunicates, bryozoans, and other sessile benthic invertebrates." His analysis was based on data from 20 of the 27 specimens listed above. All of the specimens examined had eaten at least some algae. The stomach contents of only two consisted entirely of algae. These two fish were juveniles, 46 and 65 mm in standard length. Sponges were found in all but two of the remaining specimens, the smallest of which was 98 mm in standard length.

*Monacanthus ciliatus* (Mitchill) FRINGED FILEFISH

6 stations; 14 specimens: 47 to 97 mm SL; 1 empty.

| FOOD | VOLUME (%) |
|---|---|
| Algae and organic detritus | 21.2 |
| *Cladophora* sp. | |
| *Eudesme zosterae* | |
| *Lyngbya* sp. | |
| *Microcoleus* sp. | |
| Seagrasses | 15.4 |
| *Thalassia testudinum* | |
| Copepods | 14.6 |
| Shrimps and shrimp larvae | 13.1 |
| carideans | |
| Unidentified crustaceans | 8.5 |
| Amphipods | 5.4 |
| *Colomastix* sp. | |
| *Leucothoe* sp. | |
| Tanaids | 4.6 |
| Polychaetes | 4.2 |
| Stomatopod larvae | 3.9 |
| Isopods | 3.1 |

| | |
|---|---|
| Pelecypods | 2.3 |
| *Papyridea* sp. | |
| Unidentified animal material | 1.9 |
| Gastropods | 1.5 |
| Hydroids | 0.3 |

*Remarks.*—As pointed out by Tabb & Manning (1961), this filefish is closely associated with vegetated areas, particularly *Thalassia.* Beebe & Tee-Van (1928) described the species as omnivorous and listed quartz pebbles, small crustaceans, algae and organic detritus from the alimentary tracts of specimens from Haiti. Reid (1954) collected more than 90 specimens from 13 to 60 mm in length at Cedar Key, Florida. He reported the food of individuals ranging from 39 to 55 mm in length as primarily copepods and mollusks. Shell debris from pelecypods and gastropods were found in most stomachs. Amphipods and ostracods were eaten by some of the fish. Springer & Woodburn (1960) also examined stomach contents of *M. ciliatus* from West Florida. They stated that their findings were essentially the same as Reid's.

*Monacanthus tuckeri* Bean — SLENDER FILEFISH

4 stations; 4 specimens: 22 to 70 mm SL; 1 empty.

| FOOD | VOLUME (%) |
|---|---|
| Unidentified organic material | 41.3 |
| Copepods | 35.0 |
| Gastropod larvae | 6.7 |
| Unidentified crustaceans | 6.7 |
| Tanaids | 4.0 |
| Isopods | 3.3 |
| Amphipods | 3.0 |

*Remarks.*—*M. tuckeri* is the smallest West Indian filefish. It was occasionally seen on reefs, especially near fronds of gorgonians.

## OSTRACIONTIDAE (Trunkfishes)

The trunkfishes are bottom-dwelling in various clear water habitats. They are slow swimming, as would be expected from the heavy external bony box with which they are encased and its limiting effect on body movement. Their food consists largely of sessile animals and plants. Some trunkfishes, at least, secrete a toxin from the mouth region and surface of the body. Possibly this toxic substance and the protective carapace give these fishes some immunity from predation. That this immunity is not complete is evident from finding *Lactophrys* in the stomachs of tiger sharks, a Nassau grouper, and a cobia (as juveniles in the latter two cases). Nevertheless, the occurrence of the larger species such as *Lactophyrys trigonus, L. bicaudalis,* and *Acanthostracion quadricornis* in exposed areas such as seagrass beds and even sand flats suggests that these species enjoy some freedom from predation. Other fishes that live as adults in the seagrasses are small, such as *Sparisoma radians* of the Scaridae and *Doratonotus* of the Labridae. The smallest of western Atlantic trunkfishes, *L. triqueter,* is primarily a reef-dweller.

*Acanthostracion polygonius* Poey — REEF COWFISH

3 stations; 4 specimens: 260 to 290 mm SL; 1 empty.

| FOOD | VOLUME (%) |
|---|---|
| Tunicates | 28.3 |
| Unidentified animal material | 25.0 |
| Alcyonarians | 23.3 |
| Sponges | 11.7 |
| Shrimps | 10.0 |
| alpheid | |
| gnathophyllid | |
| *Synalpheus* sp. | |
| Gastropods | 1.7 |
| *Vasum muricatum* | |

*Remarks.*—This species is the least common of the West Indian trunkfishes. It is usually seen on reefs. In most of the literature it has not been distinguished from *A. quadricornis.*

*Acanthostracion quadricornis* (Linnaeus) — COWFISH

6 stations; 6 specimens: 182 to 315 mm SL.

| FOOD | VOLUME (%) |
|---|---|
| Sponges | 30.7 |
| Tunicates | 18.3 |
| Unidentified animal material | 11.5 |
| Zoantharians | 10.8 |
| *Bunodosoma granulifera* | |
| *Phyllactis flosculifera* | |
| *Zoanthus pulchellus* | |
| Hermit crabs | 8.3 |
| *Pagurus bonairensis* | |
| Algae | 7.2 |
| bluegreens | |
| *Halimeda opuntia* | |
| Gcrgonians | 4.2 |
| *Muricea atlantica* | |
| Seagrasses | 3.0 |
| *Thalassia testudinum* (2) | |
| Scyphozoans | 2.5 |
| Polychaetes | 1.8 |
| Unidentified eggs | 0.8 |
| Pelecypods | 0.3 |

| | |
|---|---|
| Shrimps | 0.3 |
| Amphipods | 0.3 |

*Remarks*.—Typically, *A. quadricornis* lives in seagrass beds. Beebe & Tee-Van (1928) reported the food of three Haitian examples, 72 to 260 mm in length, as algae, sponges, and the spines of a small club-spined sea urchin. Breder & Clark (1947) briefly discussed and diagrammed the visceral anatomy of this species. Reid (1954) wrote that the diet of specimens from West Florida ranging from 13 to 165 mm consisted of undetermined vegetation, algae, and pelecypods.

*Lactophrys bicaudalis* (Linnaeus) SPOTTED TRUNKFISH

12 stations; 12 specimens: 101 to 326 mm SL; 2 empty.

| FOOD | VOLUME (%) |
|---|---|
| Tunicates | 19.5 |
| *Boltenia* sp. | |
| *Ecteinascidia turbinata* | |
| *Polycarpa insulsa* | |
| Holothurians | 19.0 |
| Ophiuroids | 12.5 |
| *Ophiocoma riisei* | |
| *Ophioderma rubicundum* | |
| Echinoids | 10.0 |
| *Diadema antillarum* | |
| Seagrasses | 8.0 |
| *Cymodocea manatorum* | |
| *Thalassia testudinum* | |
| Unidentified animal material | 7.0 |
| Algae | 7.0 |
| *Caulerpa racemosa* | |
| Polychaetes | 6.0 |
| Asteroids | 6.0 |
| *Oreaster reticulata* | |
| Crabs | 4.0 |
| Gastropods | 1.0 |

*Remarks*.—Beebe & Tee-Van (1928) recorded the food of a 101-mm specimen from Haiti as algae and unidentifiable material. The only specimen of the above 12 which were examined that contained algae was a 166-mm individual; 70 per cent of its stomach contents consisted of *Caulerpa racemosa*. The largest specimen collected by the author contained only the orange-red tunicate *Polycarpa insulsa* (which R.H. Millar has indicated may be a synonym of *P. obtecta)*. These tunicates were found from one end of the digestive tract to the other. Forty per cent of the gut contents of one 101-mm spotted trunkfish from Puerto Rico consisted of the viscera of a sea cucumber. There were no remains of the rest of the holothurian. One might speculate that the trunkfish harassed the sea

cucumber to such an extent (perhaps by biting it) that it eviscerated. The fish could then eat the viscera. Another trunkfish contained only holothurians, but these were small enough to be swallowed entire.

*Lactophrys trigonus* (Linnaeus) TRUNKFISH
6 stations; 21 specimens: 109 to 395 mm SL.

| FOOD | VOLUME (%) |
|---|---|
| Crabs | 44.9 |
| calappid (2) | |
| *Emerita* sp. | |
| majids (3) | |
| *Mithrax* sp. | |
| *Pitho* sp. | |
| portunids (2) | |
| xanthids (2) | |
| Pelecypods | 10.1 |
| *Atrina seminuda* | |
| *Codakia costata* | |
| *Musculus lateralis* | |
| *Tellina* sp. | |
| *Trachycardium muricatum* | |
| Polychaetes | 8.6 |
| glycerid | |
| pectinariid | |
| Echinoids | 7.1 |
| *Lytechinus variegatus* (2) | |
| Algae | 4.9 |
| *Acanthophora spicifera* | |
| *Centroceras clavulatum* | |
| *Ceramium* sp. | |
| *Ceramium byssoideum* | |
| *Dictyota* sp. | |
| *Halimeda* sp. | |
| *Halimeda monile* | |
| *Laurencia obtusa* | |
| *Spyridia filamentosa* | |
| Tunicates | 4.5 |
| *Microcosmus exasperatus* | |
| Seagrasses | 3.0 |
| *Cymodocea manatorum* (2) | |
| *Thalassia testudinum* (4) | |
| Unidentified animal material | 2.9 |
| Holothurians | 2.6 |
| *Holothuria arenicola* | |
| Asteroids | 2.4 |
| *Oreaster reticulata* | |
| Gastropods | 2.1 |
| *Acmaea pustulata* | |
| *Anachis sparsa* | |
| *Arene* sp. | |
| *Bulla* sp. | |
| *Haminoea elegans* | |
| *Nassarius* sp. | |
| *Olivella nivea* | |
| Amphipods | 1.8 |
| caprellid | |
| *Elasmopus* sp. | |
| Ophiuroids | 1.6 |
| *Ophioderma brevispinum* | |
| *Ophiothrix* sp. | |
| Unidentified worms | 1.0 |
| Unidentified eggs | 1.0 |
| Chitons | 0.8 |
| *Acanthochitona* sp. | |
| Hermit crabs | 0.4 |
| Shrimps | 0.3 |
| alpheid | |

*Remarks.*—This species is also primarily a resident of the seagrass habitat. It appears to be the largest of the genus, attaining at least 18 inches in total length. It is principally a carnivore. In only one specimen did plant material exceed 5 per cent of the stomach contents. The food of this individual, 109 mm in standard length, was one-third algae. Seventy per cent of the stomach and gut contents of the largest specimen consisted of the echinoid *Lytechinus variegatus*. Inorganic sediment constituted 4 per cent of the stomach contents of a series of 8 adults which varied from 300 to 375 mm in standard length.

*Lactophrys triqueter* (Linnaeus) SMOOTH TRUNKFISH
13 stations; 17 specimens: 93 to 250 mm SL; 2 empty.

| FOOD | VOLUME (%) |
|---|---|
| Polychaetes | 29.2 |
| onuphid | |
| syllid | |
| Sipunculids | 15.7 |
| *Aspidosiphon spinososcutatus* | |
| Crabs | 9.0 |
| majids (2) | |
| pinotherid | |
| *Upogebia* sp. | |
| Unidentified animal material | 8.2 |
| Shrimps | 7.1 |

| | |
|---|---|
| alpheids (2) | |
| carideans | |
| gnathophyllid | |
| Tunicates | 6.7 |
| *Ascidia nigra* | |
| *Tridemnum savignii* | |
| Sponges | 6.0 |
| Hemichordates | 3.3 |
| Gastropods | 2.9 |
| *Balcis intermedia* | |
| *Nitidella laevigata* | |
| *Trivia* sp. | |
| *Turbo castanea* | |
| Hermit crabs | 2.3 |
| *Paguristes* sp. | |
| *Spiropagurus* sp. | |
| Echinoids | 2.3 |
| *Lytechinus variegatus* | |
| Pelecypods | 1.7 |
| *Tellina* sp. | |
| Amphipods | 1.3 |
| Spermatophytes (including seagrasses) | 1.2 |
| *Halophila baillonis* | |
| *Thalassia testudinum* | |
| Unidentified worms | 1.0 |
| Algae | 0.9 |
| *Halimeda* sp. | |
| Chitons | 0.7 |
| Unidentified eggs | 0.3 |
| Ostracods | 0.2 |

*Remarks.*—Beebe & Tee-Van (1928) recorded the food of *L. triqueter* from Haiti as comminuted vegetable matter. Longley & Hildebrand (1941) noted that this species is a reef fish which feeds on both algal and sand-covered bottoms. They found large quantities of sand and algae in the digestive tract of Tortugas specimens. Plant material represented a small percentage of the stomach-content material of West Indian specimens, however, and the highest percentage of inorganic sediment was 10. Longley observed that this species often blows a stream of water on to the bottom from a nearly vertical position, throwing up a cloud of sand. The author has recorded this mode of feeding on motion picture film. The localized current probably serves to expose worms and other invertebrates on which the fish feeds. Longley noticed that the wrasses *Halichoeres bivittatus* and *Thalassoma bifasciatum* often accompany the smooth trunk-fish when it feeds in this manner; the wrasses probably capture animals that escape the trunkfish.

TETRAODONTIDAE (Puffers)

*Sphaeroides spengleri* (Bloch) BANDTAIL PUFFER

17 stations; 31 specimens: 40 to 100 mm SL; 2 empty.

| FOOD | VOLUME (%) |
|---|---|
| Crabs | 20.4 |
| majids (2) | |
| *Microphrys bicornutus* | |
| raninid | |
| Pelecypods | 16.0 |
| *Musculus lateralis* | |
| *Pinctada radiata* (2) | |
| Gastropods | 9.6 |
| *Bullata ovuliformis* | |
| Polychaetes | 7.6 |
| Echinoids | 6.9 |
| *Diadema antillarum* | |
| spatangoid | |
| Ophiuroids | 6.0 |
| *Ophiocoma riisei* | |
| *Ophioderma rubicundum* | |
| *Ophiothrix* sp. | |
| *Ophiothrix lineata* | |
| Amphipods | 5.7 |
| Shrimps | 5.5 |
| Spermatophytes (including seagrasses) | 5.3 |
| *Halophila baillonis* | |
| *Thalassia testudinum* (2) | |
| Algae and organic detritus | 3.5 |
| Hemichordates | 3.4 |
| Unidentified eggs | 2.1 |
| Unidentified animal material | 2.1 |
| Chitons | 1.4 |
| Isopods | 1.1 |
| Copepods | 0.9 |
| Tunicates | 0.9 |
| Hermit crabs | 0.9 |
| Fishes | 0.7 |

*Remarks.*—This small puffer is not common but occurs in many different shallow-water habitats such as beds of seagrass or *Halophila,* sand or coral rubble, and reef. The jaws are armed with sharp beak-like plates with which it can crush crustaceans, small mollusks, etc. Plant material did not exceed 25 per cent of the stomach contents of any specimen; usually it was less than 5 per cent by volume of the contents.

## CANTHIGASTERIDAE (Sharpnose Puffers)

*Canthigaster rostrata* (Bloch) SHARPNOSE PUFFER
9 stations; 26 specimens: 36 to 88 mm SL.

| FOOD | VOLUME (%) |
|---|---|
| Spermatophytes (including seagrasses) | 16.1 |
| *Cymodocea manatorum* (2) | |
| *Halophila baillonis* (2) | |
| Sponges | 15.0 |
| *Mycale* sp. | |
| Crabs | 9.8 |
| *Stenorhynchus seticornis* | |
| Unidentified animal material | 8.2 |
| Gastropods | 7.8 |
| alcidids | |
| *Atys* sp. | |
| *Atys riiseana* | |
| *Epitonium turritellulum* | |
| *Smaragdia viridis* | |
| Polychaetes | 7.2 |
| chaetopterid | |
| sabellids | |
| Pelecypods | 5.2 |
| *Crenella divaricata* | |
| *Musculus lateralis* | |
| *Tellina caribaea* | |
| Unidentified worms | 4.6 |
| Echinoids | 3.8 |
| *Diadema antillarum* | |
| Asteroids | 3.8 |
| *Astropecten* sp. | |
| Amphipods | 3.1 |
| *Corophium* sp. | |
| *Cymadusa filosa* | |
| *Photis* sp. (2) | |
| Shrimps | 2.9 |
| alpheid | |
| carideans | |
| Hydroids | 2.7 |
| *Pennaria* sp. | |
| Hermit crabs | 2.3 |
| Unidentified crustaceans | 2.3 |
| Algae and organic detritus | 2.2 |
| *Eucheuma echinocarpum* | |
| *Laurencia obtusa* | |
| Copepods | 1.2 |
| Pycnogonids | 1.2 |
| Tunicates | 0.6 |
| *Tridemnum* sp. | |

*Remarks.*—*Canthigaster rostrata* is a small omnivorous reef fish which may range into adjacent habitats such as seagrass beds. Plant material was clearly sought by the fish and not accidentally ingested; 78 per cent of the stomach contents of four fish from one station in Puerto Rico consisted of *Cymodocea manatorum*. The fish had nipped off the growing tips of the manatee grass. Twenty per cent of the stomach contents of another group of three fish was made up of the leaves of *Halophila*. The sabellid polychaete material from the stomachs of this puffer consisted only of tentacles. Hiatt & Strasburg (1960) reported the Indo-Pacific species *Canthigaster solandri* to be an omnivore; 81 per cent of its stomach contents was algae.

## DIODONTIDAE (Porcupinefishes)

The porcupinefishes are bottom-dwelling and are usually found in reefs, although some species are often encountered over bottoms without cover. Like the related puffers, they are able to crush hard-shelled invertebrates with their powerful beak-like jaws. Because of their large size they can feed upon some of the larger mollusks, echinoids, and crustaceans which smaller fishes would be unable to eat.

*Chilomycterus antennatus* (Cuvier) BRIDLED BURRFISH
5 stations; 5 specimens: 65 to 216 mm SL.

| FOOD | VOLUME (%) |
|---|---|
| Gastropods | 56.6 |
| *Anachis* sp. | |
| *Arene* sp. | |
| *Astraea* sp. | |
| *Cerithium* sp. | |
| *Cerithium litteratum* (2) | |
| *Columbella mercatoria* (2) | |
| *Crassispira fuscescens* | |
| *Marginella* sp. | |
| *Mitrella lunata* | |
| *Modulus modulus* | |
| *Nitidella ocellata* | |
| *Pusia* sp. | |
| *Pyramidella candida* | |
| *Smaragdia viridis* (2) | |
| *Tegula fasciata* (2) | |
| *Turbo* sp. | |
| *Turbo castanea* (2) | |

| | |
|---|---|
| Hermit crabs | 21.4 |
| diogenids | |
| pagurids | |
| Isopods | 20.6 |
| *Paracerceis caudata* | |
| Crabs | 1.0 |
| Shrimps | 0.4 |

*Remarks.*—Beebe & Tee-Van (1928) recorded the food of two specimens 111 and 127 mm'in length from Haiti as mollusks. The relatively large volume of isopods listed above was the result of inclusion of the stomach contents of the smallest specimen, 95 per cent of which consisted of isopods; 8 per cent of the food of an 88-mm burrfish was also isopod material.

*Diodon holacanthus* Linnaeus SPINY PUFFER

6 stations; 6 specimens: 97 to 380 mm SL; 2 empty.

| FOOD | VOLUME (%) |
|---|---|
| Gastropods | 67.7 |
| *Acmaea leucopleura* | |
| *Astraea* sp. | |
| *Calliostoma* sp. | |
| *Cerithium algicola* | |
| *Cerithium litteratum* | |
| *Crassostrea rhizophorae* | |
| *Fissurella* sp. | |
| *Modulus modulus* | |
| muricid | |
| *Nassarius* sp. | |
| *Oliva reticularis* | |
| *Polinices lacteus* | |
| *Siphonaria* sp. | |
| *Tegula fasciata* | |
| *Turbo castanea* (2) | |
| Pelecypods | 12.8 |
| *Pinctada* sp. | |
| Echinoids | 11.6 |
| *Eucidaris tribuloides* | |
| Hermit crabs | 4.2 |
| Crabs | 3.7 |
| majids | |

*Diodon hystrix* Linnaeus PORCUPINEFISH

38 stations; 42 specimens: 200 to 485 mm SL; 9 empty.

| FOOD | VOLUME (%) |
|---|---|
| Echinoids | 34.6 |
| *Diadema antillarum* | |
| *Echinometra* sp. (3) | |
| *Echinometra lacunter* (7) | |
| *Echinometra viridis* | |
| *Eucidaris tribuloides* (3) | |
| *Tripneustes esculentus* | |
| Gastropods | 31.3 |
| *Acmaea* sp. | |
| *Acmaea pustulata* (2) | |
| *acmaeid* | |
| *Astraea* sp. | |
| *Astraea caelata* | |
| *Astraea longispina* | |
| *Astraea tuber* | |
| *Calliostoma* sp. | |
| *Cerithium* sp. (2) | |
| *Cerithium algicola* | |
| *Columbella mercatoria* (2) | |
| *Conus juliae* | |
| *Fasciolaria tulipa* | |
| *Fissurella* sp. (2) | |
| *Fissurella barbadensis* (5) | |
| *Fissurella nodosa* | |
| *Hemitoma octoradiata* | |
| *Littorina angulifera* | |
| *Littorina ziczac* | |
| *Melampus cofleus* | |
| *Modulus modulus* | |
| *Murex* sp. | |
| *Murex pomum* | |
| *Muricopsis hexagonus* | |
| *Natica canrena Nitidella* sp. | |
| *Nitidella nitida* | |
| *Oliva caribaeensis* | |
| *Siphonaria* sp. | |
| *Strombus* sp. | |
| *Strombus gigas* | |
| *Tegula* sp. (3) | |
| *Tegula fasciata* (3) | |
| *turbinid* | |
| *Turbo castanea* (3) | |
| *Turritella* sp. | |
| Crabs | 14.9 |
| *Arenaeus cribrarius* | |
| *Calappa* sp. | |

| | |
|---|---|
| *Carpilius corallinus* | |
| *grapsid* | |
| *majids* (4) | |
| *Mithrax corphye* | |
| *Mithrax sculptus* (2) | |
| *Panopeus* sp. (2) | |
| *Percnon gibbesi* | |
| *Persephona punctata* | |
| *Portunus bahamensis* | |
| *Portumis ordwayi* | |
| *xanthid* | |
| Pelecypods | 13.0 |
| *Aequipecten gibbus* | |
| *Aequipecten lineolaris* | |
| *Antigona listeri* | |
| *Arca zebra* (2) | |
| *Brachidontes citrinus* | |
| *Chama* sp. (2) | |
| *Chione paphia* | |
| *Codakia pectinella* | |
| *Divaricella quadrisulcata* | |
| *Glycymeris pectinata* | |
| *Ostrea* sp. (2) | |
| *Pecten ziczac* | |
| *Pinctada* sp. | |
| *Pseudochama* sp. | |
| *Trachycardium magnum* | |
| Hermit crabs | 5.9 |
| *Calcinus sulcatus* | |
| *Calcinus tibicen* | |
| *Dardanus venosus* | |
| *Paguristes anomalus* | |
| *Paguristes grayi* | |
| *Paguristes wassi* | |
| *Pagurus miamensis* | |
| Unidentified animal material | 0.3 |

*Remarks.*—This unique plectognath is the most frequently encountered species of the family on West Indian reefs, but it is not very common. Although primarily diurnal, it apparently feeds at least in part by night, for one collected in a trawl off Mayaguez, Puerto Rico at midnight was filled with pelecypods, gastropods, and the leucosid crab *Persephona punctata.* Beebe & Tee-Van (1928) listed the food of Haitian specimens as bottom debris, crustaceans, sponges, algae, etc. Two of the specimens examined by the author contained small amounts of seagrass, and one had ingested some algae (*Dictyota* sp.), but it seems likely that these plants were not eaten intentionally. Hiatt & Strasburg (1960) found crushed gastropods, xanthid crab fragments, and foraminifera in a specimen 320 mm in standard length from the Marshall Islands. One would expect the spiny skin of this species and its ability to inflate itself to give it consider-able freedom from predation. Beebe & Tee-Van *(1928),* however, noted that the following fishes fed upon this diodontid: *Haemulon plumieri, Peprilus paru, Lutjanus analis, L. griseus, L. synagris,* and *Tylosurus raphidoma* (= *crocodilus*). As a result of the present study the author is able to add *Galeocerdo cuvier, Epinephelus itajara, Lutjanus cyanopterus,* and *Sphyraena barracuda* to this list.

## ANTENNARIIDAE (Frogfishes)

The frogfishes are well known for their sedentary nature and protective coloration, their "fishing" with a lure, and voracious habits. They are able to swallow prey of greater length than themselves. None of the species are abundant in the West Indies.

*Antennarius multiocellatus* (Cuvier & Valenciennes) LONGLURE FROGFISH

8 stations; 12 specimens: 31 to 99 mm SL; 7 empty.

| FOOD | VOLUME (%) |
|---|---|
| Fishes | 75.0 |
| *Haemulon carbonarium* | |
| Crabs | 12.5 |
| *Percnon gibbesi* | |
| Stomatopods | 12.5 |

*Remarks.*—This is the most common frogfish of rocky bottoms, coral reefs, pilings, etc. in the West Indies. Longley & Hildebrand (1941) reported a 50-mm clinid fish *(Malacoctenus macropus)* from the stomach of a 60-mm specimen from Dry Tortugas, Florida. The specimen of *Haemulon carbonarium* listed above was taken from the stomach of a 97-mm longlure frogfish; the grunt measured 102 mm in standard length. F. Mago Leccia (personal communication) informed the author that the stomach of a 70-mm *A. multiocellatus* from Venezuela contained an 89-mm squirrelfish *(Holocentrus ascensionis).*

*Antennarius scaber* (Cuvier) SPLITLURE FROGFISH

6 stations; 11 specimens: 47 to 103 mm SL; 6 empty.

| FOOD | VOLUME (%) |
|---|---|
| Fishes | 100.0 |
| *Diplectrum radiale* | |
| *Scorpaena inermis* | |

*Remarks.*—This species may be found on a mud bottom as well as hard substratum. The specimen of *Scorpaena inermis* was taken from the stomach of a 63-mm frogfish; the scorpaenid measured 60 mm in standard length.

OGCOCEPHALIDAE (Batfishes)

*Ogcocephalus nasutus* (Cuvier & Valenciennes) SHORTNOSE BATFISH
6 stations; 9 specimens: 120 to 220 mm SL.

| FOOD | VOLUME (%) |
|---|---|
| Crabs | 47.5 |
| *Emerita portoricensis* | |
| gonoplacids | |
| parthenopids | |
| Gastropods | 25.9 |
| *Haminoea elegans* | |
| *Mitrella nitens* (2) | |
| *Olivella* sp. | |
| *Sinum perspectivum* | |
| Algae | 11.1 |
| *Valonia utricularis* | |
| Fishes | 8.8 |
| tetraodontid | |
| Polychaetes | 4.4 |
| *Chloeia* sp. | |
| Pelecypods | 1.7 |
| *Corbula contracta* | |
| *Tellina* sp. | |
| Barnacles | 0.6 |

*Remarks.*—This sluggish fish is not a reef species; however, it may occasionally be encountered on flat bottoms of sand, coral rubble, or seagrass near reefs. It also occurs in turbid water on mud bottoms. Reid (1954) examined 20 stomachs of specimens from West Florida. Large quantities of mollusks were found in 15, polychaetes in two, and three were empty. Those specimens which had ingested mollusks usually contained hundreds of a wide variety of small pelecypods and gastropods. Eight gastropods were identified to genus or species. Although this fish has a lure in the form of a small tentacle which is retractible into a cavity in the forehead, the above food habit data suggest that it is not used extensively in feeding.

## DISCUSSION OF FOOD ORGANISMS

In the previous section of this report the food habits of 212 reef and inshore fishes have been analyzed from the standpoint of the species of fishes. Let us now examine the food organisms of these fishes by major groups in terms of the data of the present study.

## PLANTS

Plant life, fundamental to all ecosystems, is not so clearly evident on coral reefs as in most other environments. When one views a well-developed reef, one is usually struck by the abundance of animals and the paucity of plants. Depending on the type of reef, the corals, gorgonians, or sponges may dominate the scene. Tunicates, hydrozoans such as *Millepora,* soft corals, and zoantharians are also prominent among the sessile organisms, and fishes are the principal swimming forms. Plants may actually be hard to find, although there are reefs, of course, where benthic algae flourish. An ecologist contemplating a reef with an overwhelming preponderance of animal life may well ponder the plant support for the structure.

Six sources of plants are available as food to animals of coral reefs. These are benthic algae, boring algae, zooxanthellae, planktonic algae, plants drifting at the surface, and marine spermatophytes (primarily sea-grasses). The latter three sources are extralimital to the reef community. They enter the community via the zooplankton and fishes. Each is discussed separately below.

*Benthic algae.*—On reefs these algae grow primarily on rock and dead coral. They may, however, be seen on certain other dead invertebrates with hard parts such as mollusks, gorgonians, and *Millepora.* They even grow on the beaks of the larger parrotfishes (Winn & Bardach, 1960). All of the major groups of benthic algae, the bluegreens, greens, reds, browns, and diatoms, are well represented by many species in the West Indies. On reefs in which the sessile animals predominate, the larger species of algae are not often fully developed. Available substratum for algal growth may be so limited and the grazing activity of herbivorous fishes, gastropods, echinoids, and crustaceans so extensive that little more than a stubble of algae may be present. That algae on such reefs can actually be overgrazed has been demonstrated by Stephenson & Searles, 1960, and Randall, 1961a.

Three families of West Indian reef fishes are almost entirely herbivorous and depend on benthic algae as their primary source of food. These are the sea chubs (Kyphosidae), the parrotfishes (Scaridae), and the surgeonfishes (Acanthuridae). The blennies of the genera *Blennius, Entomacrodus,* and *Ophioblennius* are also herbivores. Algae form an important part of the diet (more than 20 per cent by volume) of the following omnivorous fishes: the porgies *Archosargus rhomboidalis* and *Diplodus caudimacula,* the damselfishes *Abudefduf taurus, Microspathodon chrysurus, Pomacentrus fuscus, P. leucostictus, P. planifrons,* and *P. variabilis,* the gobies *Coryphopterus glaucofraenum* and *Gnatholepis thompsoni* (and probably other gobiid species as well), the angelfish *Centropyge argi,* the triggerfish *Melichthys niger,* and the filefishes *Alutera schoepfi, A. scripta, Cantherhines pullus,* and *Monacanthus ciliates.* Most of these fishes feed principally on filamentous algae. The large coarse algae such as *Sargassum* are eaten by only the larger herbivorous and omnivorous fishes such as the two species of *Kyphosus,* the two species of *Pomacanthus,* and *Melichthys niger.*

*Boring algae.*—These filamentous plants, sometimes called skeletal algae, grow beneath the surface of both living and dead coral. They account for

the green layer one sees upon breaking a piece of coral rock. In dead coral they include bluegreens, greens, and reds, whereas only greens are known from living corals. The importance of these algae to the nutrition of the coral and of the animals which feed by grazing on coral was not fully realized until the study of Odum & Odum (1955) in the Marshall Islands. In the Caribbean area the parrotfishes appear to be the only fishes which make use of boring algae; their feeding is directed almost entirely to dead coral rock. They are able to scrape into this layer with their strong beaks. As discussed in the section on the Scaridae, these fishes grind up the coral rock and coarse sediment with their pharyngeal mill along with the surface and boring algae. The ability to graze on low turf algae and boring algae probably gives the parrotfishes a noteworthy advantage over other herbivorous fishes when the algal food supply is scarce.

*Zooxanthellae.*—These algae grow in the tissues of corals and certain other coelenterates. They are eaten by the few fishes which feed directly on these coelenterates (see below).

*Planktonic algae.*—No fishes were detected which feed directly upon dinoflagellates or other planktonic algae. This microscopic food supply becomes available to the reef community principally through copepods and other herbivorous planktonic animals, which in turn form the prey of fishes, corals, and other plankton-feeding reef animals, and by filter-feeding sessile animals such as sponges, tunicates, and pelecypods.

*Drifting plants.*—These consist mostly of *Sargassum natans, S. fluitans,* fragments of the seagrasses *Thalassia testudinum* and *Cymodocea manatorum,* occasional masses of bluegreens mixed with diatoms, and epiphytes. The seagrasses are benthic, but pieces detached by wave action, decay, and the activity of animals may float to the surface and drift with wind and current. The kyphosids and *Melichthys niger* swim to the surface from depths at least as great as 70 feet in order to feed on the drifting weed. The ballyhoo *(Hemiramphus brasiliensis),* which lives at or near the surface, feeds heavily on the floating seagrass fragments. The drifting plants may become so heavily overgrown with calcareous epiphytes that they no longer float. The author has observed herbivorous reef fishes rise slightly above the bottom to feed on slowly sinking fragments of seagrass.

*Marine spermatophytes.*—Three species of seagrasses (*Thalassia testudinum, Cymodocea manatorum,* and *Ruppia maritima)* and *Halophila baillonis* have been found in the stomachs of West Indian fishes. Only *Thalassia* and *Cymodocea* are eaten in significant quantities, however. The most important fishes which graze on these four spermatophytes in the islands of the West Indies are the parrotfishes, the surgeonfishes, the sea bream *Archosargus rhomboidalis,* the filefishes *Alutera schoepfi, A. scripta,* and *Monacanthus ciliatus,* the puffers *Canthigaster rostrata* and *Sphaeroides spengleri,* and the trunkfishes *Acanthostracion quandricornis, Lactophrys bicaudalis,* and *L. trigonus.* In the latter four species seagrasses represented only 3 to 8 per cent of the gut contents of the specimens reported herein. The sea bream, the filefishes, the puffer *S. spengleri,* the trunkfishes, and the small parrotfish *Sparisoma radians* live as adults in the seagrass beds (although they may occur in adjacent habitats). The remaining parrotfishes and the surgeonfishes, when adults, are tied to reefs for shelter. Their grazing effect on seagrasses is therefore concentrated on the plants which grow near the reefs. When these fishes are numerous, they may eliminate the seagrasses completely in a zone 30 feet or more in width contiguous to reefs (Randall, 1965a).

## ANIMALS

*Protozoa.*—A few fishes were found with foraminifera in their stomachs. In all except *Atherinomorus stipes,* these small organisms were probably not specifically selected as food by the fishes. They were mixed with sand and other bottom debris.

*Sponges.*—The pungent, disagreeable odor and spicules of most sponges would seem to protect them from predation; however, there are a few tropical marine fishes which feed extensively on them. Dawson, Aleem, & Halstead (1955) found sponges in the stomachs of the puffer *Arothron hispidus* and the butterflyfish *Chaetodon ephippium* at Palmyra, Central Pacific. Hiatt & Strasburg (1960) reported sponges as the principal item of food in the stomachs of two specimens of *Arothron mappa* and one of two specimens of the filefish *Amanses carolae (=Cantherhines dumerili)* in the Marshall Islands. Lowe (1962) listed sponges from the stomachs of the spadefish *(Chaetodipterus faber)* and the two angelfishes of the genus *Pomacanthus* from British Guiana. Bakus (1964) made observations on fishes which grazed sponges at Fanning Island. The stomachs of eight species of fishes from the West Indies contained more than 30 per cent sponges by volume. These fishes are as follows: *Chaetodipterus,* the two species of *Pomacanthus,* two of *Holacanthus,* two of *Cantherhines,* and *Acanthostracion quadricornis.* In addition, 11.7 per cent of the stomach contents of *A. polygonius* consisted of sponge, as did 6 per cent of another trunkfish, *Lactophrys triqueter;* 15 per cent of the stomach contents of *Canthigaster rostrata* was sponge. Several other fishes had eaten traces of sponge, but hardly enough to be regarded as an intentional item of the diet. It is of interest to note that all of the sponge-feeding fishes are among the higher teleosts (the more specialized percomorphs and the plectognaths). By contrast, the sponges are the most primitive of multicellular animals.

*Corals* —As pointed out by Hiatt & Strasburg (1960), coelenterates do not enter into the food web as intermediate forms in most marine communities. Probably their nematocysts discourage most potential predators. However, on reefs of the Marshall Islands in the tropical Pacific, where

luxuriant coral growth dominates the scene, certain fishes make substantial use of this food resource. Some chaetodonts and one monacanthid browse on the coral polyps; other species of *Chaetodon,* various scarids, one balistid, and another monacanthid graze directly on the living coral, scraping not only the soft polyps but also some of the individual corallites. Still other balistids, a monacanthid, several tetraodontids, and one species of *Canthigaster* bite off the tips of the branches of live coral.

In the West Indies, by contrast, corals are not utilized much for food by fishes. Only 10 species were found with corals in their stomachs, and in none of these did the coral volume exceed 2.3 per cent of the stomach contents (although a 5.1 per cent coelenterate polyp item from the stomachs of specimens of *Pomacentrus leucostictus* could have been from corals, at least in part). The fish whose stomach contained 2.3 per cent coral is the spadefish *(Chaetodipterus faber).* Only one specimen had eaten coral, however, and this consisted of a single piece of *Oculina diffusa.* Four damselfishes, notably *Microspathodon chrysurus,* grazed small amounts of living coral. Only two parrotfishes contained any coral tissues. In each of these fishes the corals represented only 0.2 per cent of the gut contents. Coral polyps were not found in the stomachs of butterflyfishes, although *Chaetodon capistratus* was observed to feed on coral polyps in an aquarium in Puerto Rico (personal communication, J. A. Rivero).

In view of the observations by Hiatt & Strasburg (1960) on the grazing of live corals by parrotfishes, as well as the algae on coral rock, a special effort was made to detect coral feeding by West Indian scarids. This was never observed, nor were their characteristic beak marks seen on live coral. A similar observation was made by J. H. Choat (personal communication; research for PhD thesis) who studied the ecology of reef flat fishes at Heron Island, Great Barrier Reef. He wrote, "I am regarding scarids as complete herbivores, as in this region at least, no parrotfish has been observed to feed selectively on living corals, conglomerate or otherwise." Instead they feed upon green, bluegreen, and red filamentous algae growing on calcareous surfaces. He noted that on occasions some individual parrotfishes grazed down to the living margins of corals, but both direct observation and subsequent examination of beak scars demonstrated that their grazing ceased fairly abruptly when the corals were encountered. Walter A. Starck, II (personal communication), on the other hand, has observed that parrotfishes occasionally scrape live coral in the Florida Keys. He added, "The amount of food taken in this way is insignificant compared to their normal grazing."

The greater utilization of corals by scarids in the Marshall Islands noted by Hiatt & Strasburg may be related to the high coral cover of the reefs there. When soft coral rock with a covering of algae is available as food, the parrotfishes may feed only on this. When such substratum is restricted by the growth of corals, the fishes may then turn to the live corals for nutriment.

*Zoantharians (other than corals).*—Sixteen fishes (families Pomadasyidae, Pomacentridae, Ephippidae, Chaetodontidae, Balistidae, Monacanthidae, and Ostraciontidae) of the present study were found with the remains of zoanthideans and sea anemones in their stomachs. For six of the species these soft-bodied coelenterates represented more than 10 per cent of the volume of the stomach contents. The volume was in excess of 32 per cent for *Abudefduf saxatilis, Chaetodon capistratus,* and *C. striatus.* The great majority of this food material consisted of *Zoanthus,* large patches of which may be seen in many shallow reef areas. Only six fishes had eaten sea anemones.

*Gorgonians.*—Vast areas of hard substratum in the West Indies are dominated by a wide variety of gorgonians. In view of their abundance and the fleshy nature of many of the species, it was expected that a number of fishes would feed on them. This is not the case, however. Only 11 species were found with gorgonians in their stomachs, and in seven of these the amount was very small (less than 2 per cent). Only *Alutera scripta* had eaten more than 5 per cent by volume of gorgonians (12.6 per cent of the stomach contents of eight specimens of this filefish). In addition to possessing nematocysts and spicules, gorgonians may be strong-smelling. Possibly the odor serves to repel at least some fish predators.

*Hydrozoans.*—Hydroids are not abundant on West Indian reefs. They were found in nine species of fishes, although in less than 1 per cent of the volume of the stomach contents of five of them. The fish with the largest amount of hydroid in its stomach was *Chaetodon sedentarius* (11.7 per cent by volume). 3.1 per cent of the stomach contents of the filefish *Cantherhines pullus* was hydroid, as was 2.7 per cent of the stomach contents of *Canthigaster rostrata.* Another hydrozoan, the stinging coral *Millepora alcicornis,* was eaten by two filefishes, *Alutera scripta* (39.4 per cent of the stomach contents of eight specimens) and *Cantherhines macrocerus* (5 per cent). It is difficult to conceive of a less desirable food item than *Millepora,* in view of its powerful nematocysts and the high percentage of hard skeletal material. This hydrozoan is common on West Indian reefs. One might expect that any species of fish which could feed upon it and the numerous gorgonians would itself be abundant. However, *A. scripta* and *C. macrocerus* are among the least common of West Indian reef fishes.

*Scyphozoans.*—Only two species of fishes of this study fed upon jellyfishes, *Pomacentrus fuscus* and *Acanthostracion quadricornis.* Probably more feed occasionally on these soft-bodied animals, but jellyfishes are so rapidly digested that they would soon be indetectable in the fish stomachs.

*Siphonophores.*—Because of the distinctive pneumatophore of these planktonic coelenterates, which resists digestion, they are recognized with greater frequency in the stomachs of fishes than the preceding group. Ten fishes were found with siphonophores in their stomachs. The three most important species in this respect are *Clepticus parrae* (20 per cent by volume), *Inermia vittata* (16.7 per cent), and *Canthidermis sufflamen* (8.5 per cent). In addition, the spadefish *(Chaetodipterus)* is reported in the literature as feeding on *Physalia.*

*Ctenophores.*—The comb jellies are even more soft-bodied than the scyphozoans. Their transparent gelatinous tissue is soon rendered unidentifiable in fish stomachs. Only the yellowtail snapper *(Ocyurus)* was found with ctenophores in its stomach (2.7 per cent of total stomach contents). Also the author once observed tarpon *(Megalops)* from West Florida regurgitate ctenophores. Probably other West Indian fishes, particularly the larger plankton-feeders, feed at least occasionally on comb jellies. Frequently the unidentified animal matter in fish stomachs is gelatinous with little or no structure. In plankton feeders this is most likely jellyfish, salp or ctenophore in origin.

*Bryozoans.*—The so-called moss animals are not among the more common benthic animals on West Indian reefs; therefore they were not expected to be prominent components of the stomach contents of fishes. They occurred in the stomach contents of six fishes, three of which are chaetodonts and two pomadasyids. Only the stomach contents of the filefish *Cantherhines pullus* contained more than 1 per cent by volume of bryozoans; its percentage was 2.3.

*Sipunculids.*—Twenty fishes of this study fed upon peanut worms. One is the stingray *Dasyatis americana* (20.6 per cent by volume sipunculids). Seven are pomadasyids of which *Haemulon album* is the principal species. Sipunculids were the foremost item of diet of 57 specimens of this grunt; these worms represented 25.2 per cent of its total stomach contents. Two of the sipunculid feeders are sparids, two are gerreids, two are mullids, one is the sand tilefish *(Malacanthus),* three are wrasses of the genus *Halichoeres,* one is the queen triggerfish *(Balistes vetula),* and one the smooth trunkfish (Lactophrys *triqueter)* (15.7 per cent sipunculids). Several of these fishes have been observed to shove their snouts into the sand during feeding, at which time they would be most apt to encounter sipunculids. A number of fishes contained unidentified nonsegmented worms which were so digested that they could not be identified. These may have included nemerteans, priapuloids, echiuroids, hemichordates, and sipunculids.

*Polychaetes.*—These annelids are one of the most important food sources for West Indian reef fishes. Their segmented bodies, setae, and for some species horny jaws, distinctive opercula or crowns of tentacles enable one to identify these worms in fish stomachs more often than most other soft-bodied animals. Sixty-two species of fishes, representing 24 families, were found with the remains of polychaetes in their stomachs. For seven of these fishes the polychaetes were the largest group of food organisms. These are listed as follows with the percentage of polychaetes that was found in their stomachs: *Chaetodon striatus* (58.7 per cent), *Halichoeres maculippina* (47.1 per cent), *Haemulon flavolineatum* (39.6 per cent), *Prognathodes aculeatus* (38.5 per cent), *Lactophrys triqueter* (29.2 per cent), *Pempheris schomburgki* (27.3 per cent), *Calamus calamus* (19.2 per cent), and *Mulloidichthys martinicus* (18.6 per cent). Other species in which polychaetes constituted more than 15 per cent of the stomach contents are the following: *Chaetodon capistratus* (31.4 per cent), *Haemulon aurolineatum* (31 per cent), *Harengula humeralis* (29 per cent), *Opisthonema oglinum* (22.4 per cent), *Eucinostomus argenteus* (19.5 per cent), *Haemulon chrysargyreum* (19.1 per cent), *Dasyatis americana* (17.3 per cent), *Priacanthus cruentatus* (16.8 per cent), and *Chaetodon sedentarius* (16.7 per cent). The polychaete material eaten by the spadefish *(Chaetodipterus),* four damselfishes *(Abudefduf saxatilis* and *Pomacentrus* spp.), four butterflyfishes *(Prognathodes* and *Chaetodon* spp.), and the sharpnose puffer *(Canthigaster)* consisted entirely or in part of the tentacular crowns of sabellids, serpulids, and terebellids.

*Chitons.*—The distinctive mollusks of the class Amphineura were not common in fish stomachs. The occurrence of many of these animals in the intertidal zone, their tendency to hide beneath rocks, and their ability to adhere strongly to the substratum reduce the opportunity for predatory fishes to feed upon them. The stomachs of 24 fishes listed in the present report contained chitons. Six are labrids, five are pomadasyids, two are sparids, two are holocentrids, and two are ostraciontids. Chitons represented more than 5 per cent of the stomach contents of only the following six of these 24 fishes: *Labrisomus guppyi* (20 per cent, however only four specimens with food), *Holocentrus vexillarius* (10.3 per cent), *Haemulon carbonarium* (9.8 per cent), *Mulloidichthys martinicus (7.9* per cent), *Haemulon flavolineatum* (5.7 per cent), and *Malacanthus plumieri* (5.7 per cent).

*Gastropods (except pteropods).*—Seventy-one species of fishes fed upon shelled gastropods, and ten on the larvae. In view of the protection afforded by the shell to these animals, 71 represents an unexpectedly high number of predators. The stomachs of 25 of these fishes contained more than 10 per cent by volume of gastropods. For the following 12 the percentage exceeded 20: *Diodon holacanthus* (67.7 per cent), *Chilomycterus antennatus* (56.6 per cent), *Aetobatis narinari* (53.4 per cent), *Calamus penna* (50 per cent), *Trachinotus falcatus* (47.8 per cent), *Lachnolaimus maximus* (39.7 per cent), *Hemipteronotus novacula* (38.5 per cent),

*Diodon hystrix* (31.3 per cent), *Ogcocephalus nasutus* (25.9 per cent), *Holocentrus vexillarius* (25.1 per cent). *Halichoeres poeyi* (21.3 per cent), and *Halichoeres radiatus* (21.3 per cent). Gastropods were the principal item of the diet of the first five of these fishes and *H. novacula*. Some of the fishes such as the holocentrids, mullids, and *Labrisomus* swallow the gastropods entire, and the shells are usually intact. Others such as *Diodon, Calamus,* and sting rays crush the shells in their jaws. Many such as the pomadasyids, labrids, and *Trachinotus* utilize their pharyngeal teeth to render the mollusk shells into fragments. A few of the serranids and lutjanids had only the soft parts of gastropods in their stomachs. Since these fishes lack crushing dentition, it seems likely that they stole their prey from other predators after the soft parts were exposed.

Only one specimen of one species of fish, *Abudefduf saxatilis,* contained recognizable remains of opisthobranchs in its stomach. This fish had eaten three green and orange nudibranchs *(Tridachia crispata)* which accounted for the majority of its stomach contents and 5.3 per cent of the total stomach-content volume of the 33 specimens of this damselfish which contained food. Possibly nudibranchs occur more frequently in fish stomachs than would be indicated by these data. Like the jellyfishes previously discussed, they could not be expected to resist digestion long. On the other hand, nudibranchs are known, in general, to have noxious qualities which probably serve to discourage predators. Usually they are brightly hued and conspicuous; their color patterns may serve the purpose of warning coloration.

*Pteropods.*—These small pelagic gastropods were found in the stomachs of 13 species of fishes, most of which are plankton-feeders. Four are carangids, two are clupeids, and two are balistids. The four species with the highest percentage of pteropods in their stomachs are as follows: *Decapterus macarellus* (96.5 per cent; only two specimens), *Hemiramphus balao* (31.4 per cent), *Canthidermis sufflamen* (21.2 per cent), and *Clepticus parrae* (19.2 per cent). The bulk of the diet of one 12-pound horse-eye jack *(Caranx latus)* consisted of *Cavolina longirostris* 3 to 4 mm in length, which gave an overall percentage of pteropods to this species of 8.4. Evidently pteropods often occur as swarms in the plankton, thus an occasional fish will have a large number in its stomach.

*Scaphopods.*—Ten fishes were found with tooth shells in their digestive tracts, but all but one contained fewer than 1 per cent by volume of these small mollusks. The exception is the razorfish *Hemipteronotus novacula* whose stomachs contained 5.6 per cent scaphopods by volume.

*Pelecypods.*—Forty-four West Indian fishes of this study fed upon pelecypods, and two upon the larvae. For 17, these mollusks represented 10 per cent or more of the stomach contents. The stomachs of the following six of the 17 contained more than 20 per cent by volume pelecypods: *Aetobatis narinari* (46.6 per cent), *Lachnolaimus maximus* (42.6 per cent and the main item of diet), *Hemipteronotus novacula* (27.9 per cent), *Halichoeres radiatus* (25.1 per cent and also the principal food item), *Halichoeres maculipinna* (24 per cent), and *Gerres cinereus* (23 per cent). The remarks above on the mode of feeding by fishes on gastropods apply also to pelecypods, in general.

*Cephalopods.*—Twenty-nine fishes fed upon octopuses and squids, only 10 of which were included among those which had eaten gastropods and pelecypods. The fishes which did not feed on the shelled mollusks are, for the most part, piscivorous types such as serranids, sphyraenids, and scombrids. Five of the 28 cephalopod-feeding fishes are lutjanids, four are pomadasyids, four are serranids, three are scombrids, two are priacanthids, and two are sphyraenids. Only five species, however, contained more than 10 per cent by volume cephalopod remains in their stomachs: *Ophichthus ophis* (50 per cent), *Euthynnus alletteratus* (36.6 per cent), *Sphyraena picudilla* (17.9 per cent), *Gymnothorax vicinus* (12.5 per cent), and *Ginglymostoma cirratum* (11 per cent). Relatively few specimens of all of these fishes were examined. Larger samples would probably reveal a lower percentage of cephalopods in the diet for most. Octopuses and squids are not abundant on West Indian reefs. The only squid observed in the vicinity of reefs by day is *Sepiateuthis sepioidea.* The squids in the stomachs of *Euthynnus* and *Scomberomorus* were mostly offshore pelagic species.

*Crustaceans.*—These arthropods are the most important food animals of the fishes of this report, both for plankton feeders and bottom feeders. They represent the dominant food class of 90 of these fishes. Apart from the unidentified crustaceans (which are listed from the stomachs of 74 species of fishes) and the Nebaliacea and the Euphausiacea (each found in only one species), the group is summarized briefly in the following 13 categories.

*Copepods:* Forty-seven West Indian fishes fed upon free-living copepods. For the following 17 of these, the percentage by volume of copepods in the stomachs exceeded 20: *Serranus tortugarum* (92 per cent; two specimens); *Allanetta harringtonensis* (89.2 per cent), *Chromis multilineata* (87.8 per cent), *Opisthognathus aurifrons* (85 per cent), *Inermia vittata* (76.7 per cent), *Jenkinsia lamprotaenia* (74 per cent), *Taenioconger* halls (66.3 per cent), *Hemipteronotus splendens* (60.8 per cent), *Decapterus punctatus* (60 per cent), *Harengula clupeola* (55 per cent), *Chromis cyanea* (52.4 per cent), *Amblycirrhitus pinos* (45.8 per cent), *Clepticus parrae* (43.6 per cent), *Monacanthus tuckeri* (35 per cent), *Atherinomorus stipes* (30 per cent), *Opisthonema oglinum* (26.6 per cent), and *Remora remora* (22 per cent). For all except *A. stipes* copepods were the

main item of diet. The species of copepods most commonly identified from fish stomachs were *Undinula vulgaris* and *Candacia pachydactyla.* A few calagoid copepods were found in the parasite-picking fishes.

*Ostracods:* Twenty fishes of this study fed upon ostracods. In only the following five did the percentage by volume of this crustacean subclass in the stomach contents equal or exceed 2: *Coryphopterus glaucofraenum* (12 per cent), *Decapterus punctatus* (8.5 per cent), *Halichoeres maculipinna* (5.9 per cent), *Taenioconger halis* (3.8 per cent), and *Gnatholepis thompsoni* (2 per cent).

*Barnacles:* Only two fishes were found with the remains of barnacles, including shells, in their stomachs, and the volumes were small. This is not surprising in view of the stout, fixed shell of the Cirripedia and the relative low number of individuals of this class on West Indian reefs. One of the two fishes is the large wrasse *Lachnolaimus maximus* (0.5 per cent barnacles by volume) and the other the batfish *Ogcocephalus nasutus* (0.6 per cent). In the former the barnacles were crushed. In one 145-mm specimen of the latter fish, which lacks crushing dentition, there was a single intact barnacle. Seven other fishes fed upon the thoracic appendages and/or the larvae of barnacles. The highest volume (10 per cent) was found in the silversides *Atherinomorus stipes.* This is a result of including one sample of three fish collected at Isla Venados, Venezuela, 30 per cent of the stomach contents of which consisted of barnacle larvae and a few appendages. The next highest volume of barnacle remains, 3 per cent barnacle appendages, was found in the sergeant major *(Abudefduf saxatilis).* This was due to the inclusion of a sample of these damselfish taken from beneath a pier off Crashboat Basin, Aguadilla, Puerto Rico. The fish evidently had been feeding by nipping off the thoracic appendages of the barnacles on the pilings. As pointed out by Newman (1960), the number of species of barnacles in tropic seas is high, but the number of individuals, particularly on coral reefs, is low. He attributes the paucity of barnacles on reefs to fishes which feed by rasping algae and other organisms on the limestone surface and remove substantial amounts of the substratum. The freshly-settled larval stages of barnacles and young individuals would be consumed even though they may not have been specifically sought by the feeding fishes. The same effect, of course, would be expected for the juvenile stages of other sessile animals.

*Mysids:* Swarms of opossum shrimps are frequently seen just off the bottom in and about Caribbean reefs. Often these little shrimps occur in the immediate vicinity of *Diadema antillarum* and move to a position among the spines of this formidable echinoid with the approach of danger (Randall, Schroeder, & Starck, 1964: Fig. 3). In spite of their apparent abundance and availability (as well as the ease with which they can be identified from their conspicuous statocysts even when partially digested), mysids were found in the stomachs of only 13 fishes. In only the following six of these did the percentage by volume exceed 3: *Myripristis jacobus* (11.2 per cent), *Hypoplectrus puella* (8.9 per cent), *Priacanthus cruentatus* (7.8 per cent), *Hypoplectrus nigricans* (5.9 per cent), *Opisthognathus maxillosus* (5.4 per cent), and *Prognathodes aculeatus* (4.7 per cent). The long snout of the latter chaetodont is probably useful in feeding upon small crustaceans in crevices in reefs or among echinoid spines.

*Tanaids:* The order Tanaidacea consists of small, slender, bottom-dwelling crustaceans allied to the isopods and cumaceans. They occurred in the stomachs of 14 fishes. In only the following four was the volume in the stomachs greater than 3 per cent: *Eucinostomus argenteus* (5.9 per cent), *Monacanthus ciliatus* (4.6 per cent), and *M. tuckeri* (4 per cent).

*Isopods:* Isopods were identified among the stomach contents of 43 fishes. In the following 12 the volume exceeded 5 per cent: *Gobiosoma* sp. (100 per cent, one specimen only), *Opisthognathus maxillosus* (28.6 per cent), *Chilomycterus antennatus* (20.6 per cent), *Echeneis naucrates* (20 per cent), *Remora remora* (20 per cent), *Odontoscion dentex* (17.8 per cent), *Opisthognathus whitehurstii* (11 per cent), *Pomacentrus variabilis* (10 per cent), *Anisotremus virginicus* (8.2 per cent), *Thalassoma bifasciatum* (6 per cent), *Mulloidichthys martinicus* (5.7 per cent), *Holocentrus vexillarius* (5.7 per cent), and *Apogon conklini* (5.3 per cent). The isopods from the stomachs of *Gobiosoma* sp. and *Thalassoma bifasciatum* were larval gnathiids which were probably removed by these "cleaning" fishes from host fishes.

*Amphipods:* These small crustaceans were found in 50 species of fishes considered in this report. Some such as the hyperiids were constituents of the food of plankton-feeding fishes. Most, however, are benthic types and appear in the stomach contents of bottom-feeding fishes. Amphipods represent more than 5 per cent by volume of the food of the following 13 species: *Eucinostomus argenteus* (41.8 per cent), *Apogon conklini* (18.8 per cent), *Bothus ocellatus* (15 per cent), *Chaetodon sedentarius* (13.3 per cent), *Hemipteronotus splendens* (12.5 per cent), *Remora remora* (8 per cent), *Haemulon parra* (7.1 per cent), *Canthidermis sufflamen* (6 per cent), *Haemulon chrysargyreum* (5.7 per cent), *Sphaeroides spengleri* (5.7 per cent), *Monacanthus ciliatus* (5.4 per cent), *Labrisomus nuchipinnis* (5.3 per cent), and *Halichoeres maculipinna* (5.1 per cent).

*Stomatopods:* Mantis shrimps occurred in the stomachs of 44 fishes, and their larvae in another 11 species. Because of their larger size they tend to constitute a higher percentage of the volume of the stomach contents than the groups of crustaceans previously discussed. More than 5 per cent of the volume of the stomach contents of 21 fishes consisted of stomatopods. For the following 11 the percentage was greater than 10: *Lutjanus synagris* (50 per cent, only two specimens), *Dactylopterus volitans* (19.3 per cent), *Myripristis jacobus* (17.4 per cent, all late

larval stomatopods), *Pempheris schomburgki* (16.7 per cent, also as larvae), *Epinephelus guttatus* (16.6 per cent), *Malacanthus plumieri* (15 per cent), *Scorpaena brasiliensis* (14.3 per cent), *Antennarius multiocellatus* (12.5 per cent), *Myrichthys oculatus* (12.5 per cent), *Cephalopholis fulva* (12.4 per cent), and *Bothus lunatus* (11.4 per cent). The stomatopod most commonly encountered in the fish stomachs was *Gonodactylus oerstedii* which displays a number of different color forms.

*Shrimps:* This category includes the decapod shrimps but not lobsters or anomurans. 115 species of fishes fed on shrimps and shrimp larvae; for 51 of these the percentage of shrimps in the stomachs exceeded 10; for 31 it exceeded 20, and for the following 22 it was in excess of 30: *Opisthognathus macrognathus* (100 per cent, one specimen), *Scorpaena inermis* (85.3 per cent), *Scorpaena grandicornis* (75 per cent), *Equetus acuminatus* (73.2 per cent), *Serranus tigrinus* (71.9 per cent), *Holocentrus coruscus* (70 per cent), *Scorpaenodes carribaeus* (65.9 per cent), *Equetus lanceolatus* (62.5 per cent), *Opisthognathus whitehurstii* (54 per cent). *Holocentrus marianus* (51.7 per cent), *Hypoplectrus chlorurus* (51.2 per cent), *H. puella* (51 per cent), *Apogon maculatus* (49 per cent), *Hypoplectrus aberrans* (43.8 per cent), *Odontoscion dentex* (38 per cent), *Haemulon parra* (37.6 per cent), *Scorpaena brasiliensis* (35.7 per cent), *Atherinomorus stipes* (35.6 per cent), *Priacanthus arenatus* (34.7 per cent), *Rypticus saponaceus* (34.2 per cent), *Haemulon aurolineatum* (33.6 per cent), and *Myripristis jacobus* (30.3 per cent). More shrimps from fish stomachs were identified as alpheids than any other group of shrimps. This was due, at least in part to the distinctive snapping chela of these carideans which was often intact in a stomach even when the rest of the shrimp was digested. At times only a single chela was present, indicating autotomy.

*Crabs:* Anomurans such as porcellanids and hippids are included under this heading, along with the more numerous brachyuran crabs, but the hermit crabs are considered in a separate category below. A total of 114 species of this study had eaten crabs and crab larvae. In 68 of these fishes the percentage by volume of crabs in the stomachs exceeded 10; in 46 it exceeded 20, and in the following 25 it exceeded 30: *Echidna catenata* (96.3 per cent), *Myrichthys acuminatus* (86 per cent), *Alphestes afer* (77 per cent), *Holocentrus ascensionis* (73.3 per cent), *Labrisomus guppyi* (72.5 per cent), *Epinephelus adscensionis* (66.7 per cent), *Dactylopterus volitans* (61.7 per cent), *Myrichthys oculatus* (61.2 per cent), *Holocentrus rufus* (56.9 per cent), *Lutjanus synagris* (50 per cent), *Plectrypops retrospinis* (50 per cent), *Calamus penna* (50 per cent), *Ogcocephalus nasutus* (47.5 per cent), *Lactophrys trigonus* (44.9 per cent), *Lutjanus analis* (44.4 per cent), *L. griseus* (40 per cent), *Epinephelus guttatus* (39.5 per cent), *Haemulon carbonarium* (38.3 per cent), *Equetus punctatus* (34.4 per cent), *Haemulon parra* (33.3 per cent), *Epinephelus morio* (33.3 per cent), *Bodianus rufus* (32.4 per cent), *Scorpaena plumieri* (31.3 per cent), *Holocentrus marianus* (30.6 per cent), and *Pseudupeneus maculatus* (30.2 per cent). Not infrequently, a single chela was the only remains of a crab found in the stomach of a fish.

*Spiny lobsters:* Only five fishes were found with the remains of lobsters in their stomachs, and one of these contained only the larval stage. The most important lobster predator is the jewfish *(Epinephelus itajara).* As many as five adult spiny lobsters *(Panulirus argus)* have been taken from a single fish. 45.6 per cent of the stomach contents of nine specimens of this large grouper consisted of *P. argus.* Second in importance, according to the data in the present report, is the dog snapper *(Lutjanus jocu);* 6.6 per cent of the stomach contents of 56 specimens consisted of lobsters, principally *P. guttatus.* One fish had eaten only parts of the antennae of this small species. The same is true for the Nassau grouper *(Epinephelus striatus),* 3.5 per cent of the stomach contents of which consisted of both species of lobsters.

*Scyllarid lobsters:* Slipper lobsters were fed upon by nine species of fishes, four of which had eaten just the late larval stage. Only the jewfish *(Epinephelus itajara)* contained more than 2 per cent volume of these highly-prized crustaceans; 23.3 per cent of the stomach contents of nine of these groupers consisted of scyllarids (primarily, if not entirely, *Scyllarides aequinoctialis).*

*Hermit crabs:* Thirty-eight fishes fed upon hermit crabs; four of these fishes ate only the larvae. Not unexpectedly, the fishes which fed on the adults were largely gastropod feeders as well. The 12 most important pagurid predators are as follows: *Chilomycterus antennatus* (21.4 per cent), *Calamus calamus* (13.4 per cent), *Equetus punctatus* (11.3 per cent), *Acanthostracion quadricornis* (8.3 per cent), *Calamus pennatula* (8 per cent), *Trachinotus falcatus* (6.1 per cent), *Diodon hystrix* (5.9 per cent), *Lachnolaimus maximus* (4.9 per cent), *Halichoeres radiatus* (4.5 per cent), and *Diodon holacanthus* (4.2 per cent). Most of the hermit crabs and their gastropod shells were found crushed in the stomachs of the diodontids, sparids, and labrids.

*Echinoids.*—The sea urchins and heart urchins represent another group which would seem, *a priori,* to be relatively free from attack by fishes. Once again, however, a surprising number of predators were demonstrated in the present study to feed on seemingly unappetizing prey. Thirty-four fishes were found with echinoid remains in their stomachs. Seven are pomadasyids, three are sparids, seven are labrids, and ten are plectognaths. The following 16 contained more than 10 per cent echinoids by volume: *Haemulon macrostomum* (86.8 per cent), *Balistes vetula* (72.8 per cent), *Anisotremus surinamensis* (53.5 per cent), *Calamus bajonado* (45.2 per cent), *Diodon hystrix* (34.6 per cent), *Canthidermis sufflamen* (25 per

cent), *Trachinotus falcatus* (25 per cent), *Haemulon album* (19.9 per cent), *Halichoeres radiatus* (19.9 per cent), *H. bivittatus* (17.9 per cent), *Bodianus rufus* (14.4 per cent), *Haemulon plumieri* (12.4 per cent), *Diodon holacanthus* (11.6 per cent), *Prognathodes aculeatus* (11.4 per cent), *Haemulon carbonarium* (10.9 per cent), and *Labrisomus nuchipinnis* (10.5 per cent). Echinoids represented the principal food of the first six of these fishes. Most of the fishes fed more heavily as large adults upon echinoids than as juveniles or subadults. Some of the wrasses such as the smaller *Halichoeres* and *Thalassoma bifasciatum* have been observed to feed on scraps of echinoids after the test had been broken by larger fishes such as the queen triggerfish.

*Ophiuroids*.—Brittlestars occurred in the stomachs of 33 fishes; the following 10 contained more than 10 per cent of these echinoderms: *Labrisomus kalisherae* (100 per cent, one specimen), *Malacanthus plumieri* (21.9 per cent), *Bodianus rufus* (19.5 per cent), *Anisotremus virginicus* (16.5 per cent), *Halichoeres garnoti* (15.5 per cent), *Calamus calamus* (15.5 per cent), *C. pennatula* (14.2 per cent), *Lactophrys bicaudalis* (12.5 per cent), *Labrisomus nuchipinnis* (12.3 per cent), and *Halichoeres poeyi* (10.2 per cent). Ophiuroids were the main food of *M. plumieri* and *A. virginicus*. *Ophiothrix* was the most common genus identified from the stomach contents. Part of the reason for this is the distinctive glassy spinules found on the arms. No matter how crushed and digested a brittle-star of this genus might be, its identity from the spinules is assured.

*Asteroids*.-Starfishes occurred in the stomachs of only five fishes. The largest amount, 6 per cent by volume, was found in the stomach of the trunkfish *Lactophrys bicaudalis*. This trunkfish had fed on *Oreaster reticulata,* a seagrass-dweller, as did *L. trigonus* and *Balistes vetula*. Only plectognaths such as these three fishes, with their cutting dentition and powerful jaws, would be expected to feed directly on this large, tough asteroid.

*Holothurians*.—Eight fishes utilized sea cucumbers as food, although only one, *Lactophrys bicaudalis,* consumed more than 4 per cent by volume. The stomach contents of ten specimens of this ostraciontid were 19 per cent holothurian in origin. As mentioned in the species account of this fish, 40 per cent of the food of one fish consisted only of the viscera of a large sea cucumber. It is possible that the fish secured this meal by sufficiently aggravating the sea cucumber to eviscerate. Another of these trunkfish had eaten several small holothurians which were largely intact.

*Hemichordates*.—Acorn worms were identified from the stomachs of only six species of fishes: *Haemulon album* (3.5 per cent), *Sphaeroides spengleri* (3.4 per cent), *H. plumieri* (3.3 per cent), *Lactophrys triqueter* (3.3 per cent), *Dasyatis americana* (2.3 per cent), and *Gerres cinereus* (1.9 per cent). All of these fishes feed in part on subsurface, sand-dwelling invertebrates. The actual number of fishes feeding on these worms is probably higher, and the percentage volume in the stomachs is also probably greater than indicated. Hemichordates are soft-bodied and undoubtedly digested rapidly by fishes.

*Tunicates*.—Twenty-eight fishes were found with tunicates in their stomachs. Twelve of these fishes fed upon appendicularians and salps. The four whose stomach contained more than 10 per cent pelagic tunicates are as follows: *Chromis cyanea* (33.9 per cent), *Taenioconger halis* (18.6 per cent), *Chaetodipterus faber* (12.6 per cent), and *Paranthias furcifer* (12.2 per cent). Sixteen fishes fed in part on benthic tunicates. The three most important of these are the trunkfishes *Acanthostracion polygonius* (28.3 per cent, and the main food), *Lactophrys bicaudalis* (19.5 per cent, and also the principal food), and *Acanthostracion quadricornis* (18.3 per cent).

*Fishes*.—The stomachs of a total of 112 West Indian fishes contained the remains of fishes and fish larvae, and another 14 had fed on fish eggs. Fish represented 50 per cent or more of the stomach contents of 48 species of fishes of the present study, and it was the principal food of another ten species. These fishes are as follows: five sharks, *Dasyatis americana, Megalops atlantica, Harengula humeralis,* three synodontids, two muraenids, *Ophichthus ophis,* four belonids, *Hemiramphus balao, Fistularia tabacaria, Aulostomus maculatus,* two sphyraenids, nine serranids, two priacanthids, four lutjanids, *Rypticus saponaceus, Rachycentron canadum* (one specimen), *Echeneis naucrates,* nine carangids, three scombrids, two bothids, *Scorpaena plumieri,* and two antennariids. Due to the emphasis placed in this study on the larger fishes and particularly those of value in sportfishing (see Introduction), a higher percentage of the piscivorous species is represented than other trophic groups. Several small open-water fishes such as *Atherinomorous stipes, Inermia vittata,* and *Selar crumenophthalmus* were found with fish scales (principally clupeoid) in their stomachs, but with no other fish remains. Probably these scales were eaten after they were detached from small schooling fishes as a result of the activity of predaceous species.

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