

ACKNOWLEDGMENTS

ABSTRACT

DISTRIBUTION OF INSHORE FISHES AT CANTON ATOLL

We are indebted to the U.S. Navy for the use of the LST-1150, the USS LST-1150, during the period in February and March 1962. Data from this survey are being compiled and analyzed for the Canton Atoll project. The distribution of inshore fishes was studied from 20 stations and 20 species were identified for representative distribution. Several representative species of the inshore fishes are listed in the table. Individual and species data are given in the table and in the text. In the last column, abundance is given as a percentage of the total catch.

by

J. G. Grovhoug

and

R. S. Henderson

ABSTRACT

Inshore fishes at Canton were surveyed by visual sampling during a 2-week period in November and December 1973. Data from this survey expand the cumulative checklist for Canton Atoll fish species to 264 species from 50 families. The distribution of inshore fishes was analyzed from transect data, and 20 species were selected for representative distributional display. Several representative patterns of fish distribution emerge. Fish abundance (both individuals and species) is highest immediately outside and in the pass region. In the lagoon, abundance decreases with increasing distance from the pass.

ACKNOWLEDGMENTS

We are grateful for diving locker support from members of the Canton Diving Club and to Ed Bennett, who provided boat maintenance throughout the survey. Special thanks are given to Chuck Peterson, NUC photographer, who freely contributed his time not only to provide complete photographic documentation of the survey, but also to perform a variety of additional supportive tasks. Dr. John E. Randall of the B. P. Bishop Museum, Honolulu, provided assistance in the taxonomic identification of certain fishes. Other members of the general survey team graciously assisted Inshore Fish Survey efforts.

ABSTRACT

ACKNOWLEDGMENTS

We are indebted for diving locker support from members of the Canyon Diving Club and to Ed Bennett, who provided boat maintenance throughout the survey. Special thanks are given to Chuck Larson, NUC program manager who freely contributed his time and effort to provide complete photographic documentation of the dives. It is a pleasure to perform a variety of additional supportive tasks. Dr. John E. Kendall of the U.S. Fish and Wildlife Service provided assistance in the laboratory identification of certain fishes. Other individuals members of the research survey team graciously assisted in the field and in the laboratory. Special thanks are given to the following individuals for their efforts.

INTRODUCTION

There have been few studies describing the fish fauna of the Phoenix Islands. Schultz (1943) collected 208 species of fishes belonging to 45 families from Canton, Hull, and Enderbury Atolls during the 1939 expedition of the USS Bushnell. Most of that sampling was accomplished by seining and rotenone poisoning; consequently those collections were heavily weighted with species which are members of bottom-dwelling, inconspicuous (cryptic or nocturnal) groups, such as gobies, blennies, and ophichthid eels. Halstead and Bunker (1954) conducted toxicity tests on more than 93 species of fishes (identifications for scarids and labrids were incomplete) from Canton, Enderbury, Hull, and Sydney Atolls from December 1950 through April 1951. Fishes were collected for that study by hook and line, beach seine, spear, throw net, dip net, and rotenone poisoning.

The above studies provide useful general background information; however, these studies do not present quantitative distributional data. Distributional data for other coral atolls have recently been gathered by various visual transect methods. Fishes are often collected for identification and analyzed for specific food preferences when possible. Chave and Eckert (1974) conducted such a study at Fanning Atoll and discuss fish distributions in terms of seven general habitat types. Losey (1973) undertook a similar study at Kwajalein Atoll. Jones and Larson (1972) have conducted transecting studies around Guam and other Micronesian islands.

The purposes of this study are to expand the species list from Canton Atoll and to examine fish distribution within and immediately outside the atoll lagoon. Some explanations for observed distributional patterns are included.

METHODS

During the inshore fish survey, two visual methods of assessing fish species distribution and abundance were used. In areas having high fish diversity and abundance, a weighted 30-m transect line was laid across the bottom; for locations having varied relief and substrata (such as patch reefs or along an outer reef shelf), the transect line was oriented so that it crossed a representative variety of habitats. Biologists with scuba gear swam along either side of the transect line, recorded numbers of individuals, and estimated average

lengths (standard lengths, in centimeters) for all observable species. Figure 33 illustrates this transecting procedure. Each biologist counted fishes within an approximately 2-m-wide by 3-m-high corridor adjacent to his side of the line. Counts by the two divers were combined (see the Appendix). The area sampled along each transect was approximately 120 m^2 ; water volume was about 360 m^3 . Use of such a small corridor minimized the effects of reduced visibility, which could invalidate inter-area comparison. The nine stations inventoried in this manner were designated "fish transect stations" and are marked with an "FT" prefix in the Appendix.

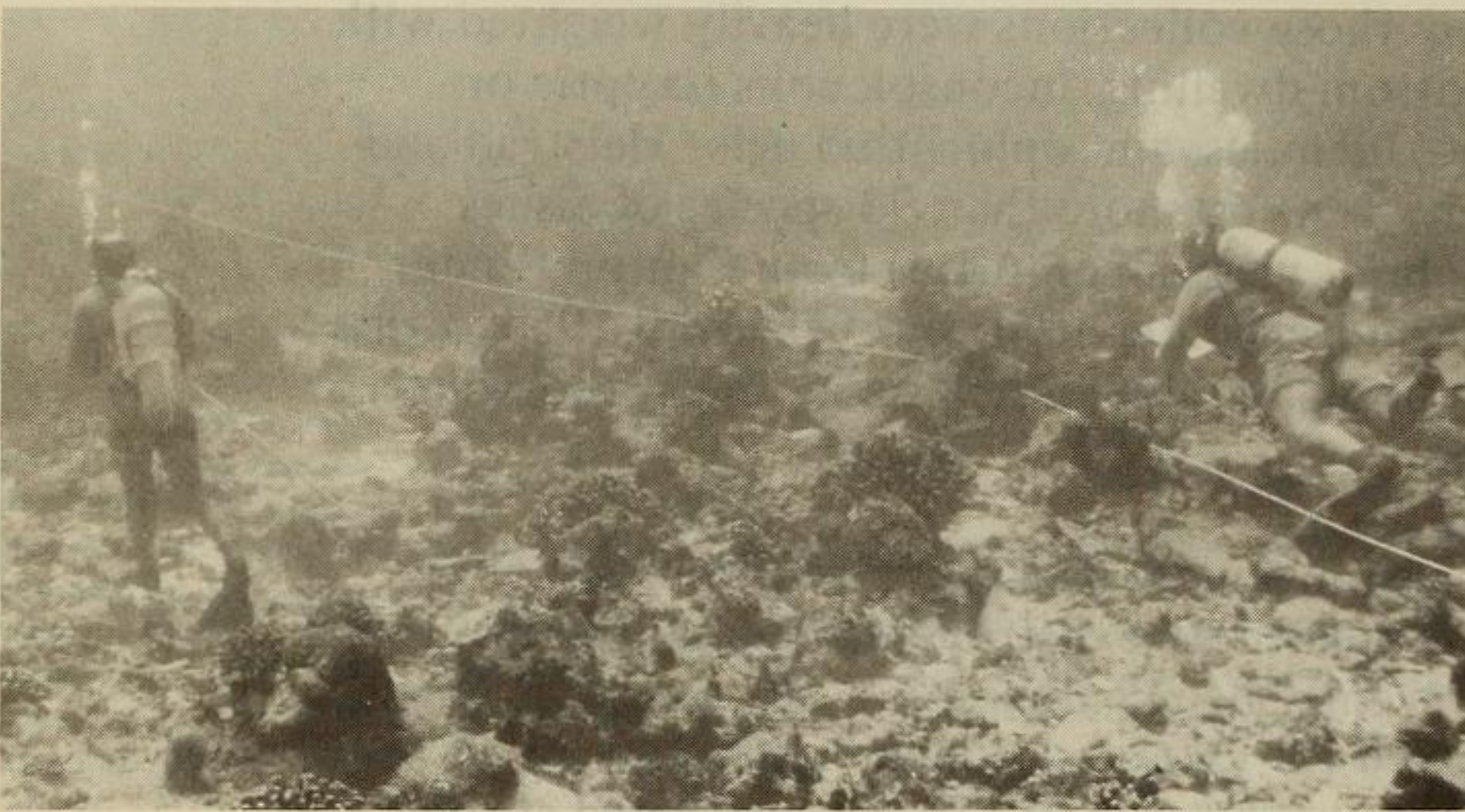


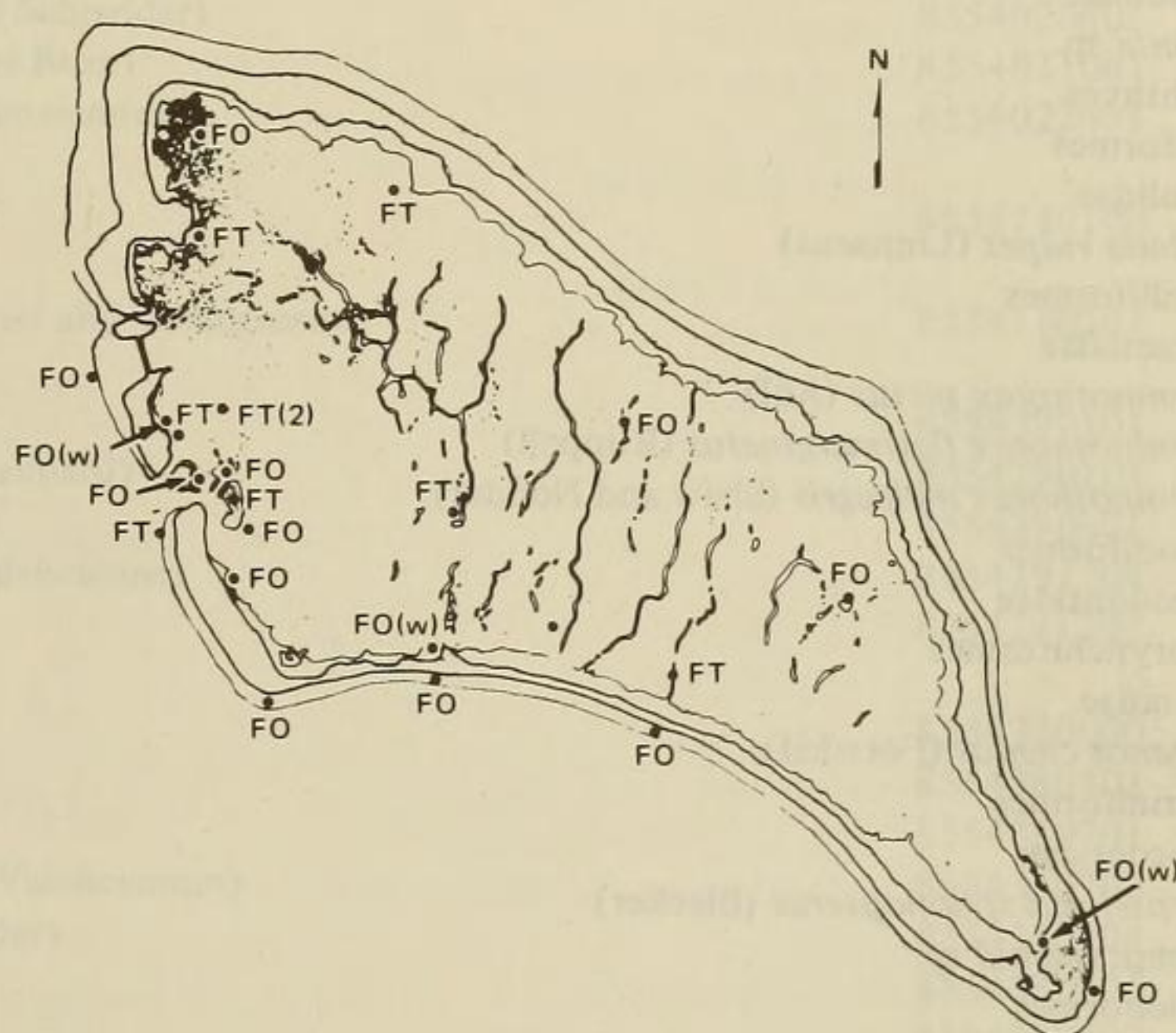
Figure 33. Biologist conducting a fish transect at ocean station.

In areas of low fish abundance (typically intertidal ocean reef shelf and nearshore shallow lagoon sand flats), scuba gear and transect line were not used. Two biologists with snorkeling gear swam along a path of predetermined length and orientation, recording species present (with notes on abundance and length). At three nearshore shallow-water stations, observations were made by wading along the shore. Fifteen such snorkeling and wading stations ("fish observation stations") are labelled "FO" or "FO (w)" in the Appendix. Locations of sampling stations are shown in Fig. 34.

For most transects and observations, a "horizontal identifiable visibility" (HIV) was estimated. The HIV is defined as "the maximum distance through the water (in a horizontal plane) at which a stationary or slow-moving fish (10 cm or longer) can be readily seen and identified by a competent diving biologist, that is, one familiar with the fish fauna of the area under study," Evans (1973). Such HIV values, although subjective, provide data useful for survey intercomparisons and are therefore included in the Appendix. Bottom profiles and composition, dominant coral types and coverage, current characteristics, and other incidental observations are also included in the station descriptions.

Most species encountered could be identified in the field, or described sufficiently well for subsequent identification. Specimens of some species were speared to enable later positive identification. One acanthurid (surgeonfish) could not be identified with existing keys. That specimen was given to Dr. John E. Randall (Bernice P. Bishop Museum, Honolulu). Randall has other specimens of this same species from Washington Island (Line Island Group). He is presently describing these as a new species. The specimen from Canton will be used as a paratype. Two specimens of *Dascyllus trimaculatus* (three-spot damselfish) were also given to Randall. These will probably be described as Phoenix and Line Island color variants of that species.

Figure 34. Fish survey stations. FT = fish transect; FO = fish observation (snorkeling); FO (w) = fish observation (wading).



RESULTS

General Distributional Patterns

From the 24 fish transect and fish observation stations, 146 species were observed (see checklist, Table 20); 61 species were new reports for the Phoenix Islands. These records, with the data from Schultz (1943) and Halstead and Bunker (1954), bring the new total to 264 species from 50 families. These numbers are comparable with inshore fish fauna data gathered in other Central Pacific Island groups. The Phoenix Islands are a major component of the Central Pacific faunal "subregion," which includes the Marshall, Gilbert, Line, and Hawaiian Island groups. This subregion is the northeastern component (described by Gosline, 1971) of the extensive Indo-West Pacific faunal region. Strasburg (1953) reported 250 species belonging to 51 families from the southern Marshalls at Arno Island. Randall (1955) recorded 396 species of inshore marine and pelagic fishes from the Gilbert Islands. Gosline (1971) reported 235 species belonging to 40 families from the Line Islands; Chave and Eckert (1974) reported 217 species belonging to 37 families from Fanning Atoll alone. Brock *et al.* (1965) reported 184 species belonging to 46 families from Johnston Island. Gosline and Brock (1960) listed 448 species of inshore or surface-living species from the Hawaiian Islands.

Table 20. Checklist of fishes observed during the 1973 Canton Atoll survey.

Group/Species*	Hawaii Coastal Zone Data Bank No.**
Chlordata/Vertebrata	
Chondrichthyes	
Lamnida	
Carcharinidae	
<i>Carcharhinus melanopterus</i> (Quoy and Gaimard)	8516120501
Hypotremata	
Dasyatidae	8517090000
Mobulidae	
<i>Manta</i> sp.	8517110200
Osteichthyes	
Elopiformes	
Albulidae	
<i>Albula vulpes</i> (Linnaeus)	8521060101
Anguilliformes	
Muraenidae	
<i>Gymnothorax pictus</i> (Ahl)	8522050603
<i>Gymnothorax flavimarginatus</i> (Rüppell)	8522050605
<i>Gymnothorax meleagris</i> (Shaw and Nodder)	8522050606
Salmoniformes	
Synodontidae	8531470000
Gonorynchiformes	
Chanidae	
<i>Chanos chanos</i> (Forsskal)	8533060101
Atheriniformes	
Exocoetidae	
<i>Cypselurus spilonopterus</i> (Bleeker)	8544010603
Hemiramphid sp.	8544015000
Beryciformes	
Holocentridae	
<i>Adioryx spinifer</i> (Forsskal)	8546180101
<i>Adioryx lacteoguttatus</i> (Cuvier)	8546180103
<i>Adioryx caudimacula</i> (Rüppell)	8546180111
<i>Adioryx violaceus</i> Bleeker	8546180116
<i>Myripristis murdjan</i> (Forsskal)	8546180403
<i>Myripristis amaenus</i> (Castelnau)	8546180404
<i>Myripristis kuntee</i> (Cuvier and Valenciennes)	8546180405
<i>Flammeo sammara</i> (Forsskal)	8546180501
Gasterosteiformes	
Aulostomidae	
<i>Aulostomus chinensis</i> (Linnaeus)	8549060101
Fistulariidae	
<i>Fistularia</i> sp.	8549070100
Syngnathidae	8549120000
Scorpaeniformes	
Scorpaenidae	
<i>Pterois antennata</i> (Bloch)	8552010202

(Contd)

Table 20. (Contd)

Group/Species*	Hawaii Coastal Zone Data Bank No.**
Perciformes	
Serranidae	
Serranid sp.	8554020000
<i>Epinephelus merra</i> Block	8554020306
<i>Epinephelus microdon</i> (Bleeker)	8554020314
<i>Cephalopholis argus</i> Bloch and Schneider	8554020801
<i>Cephalopholis urodelus</i> (Bloch and Schneider)	8554020802
<i>Gracila albomarginatus</i> (Fowler and Bean)	8554021001
<i>Anyperodon leucogrammicus</i> (Valenciennes)	8554022001
Kuhliidae	
<i>Kuhlia</i> sp.	8554140100
Apogonidae	
<i>Cheilodipterus quinquelineata</i> Cuvier and Valenciennes	8554180501
Carangidae	
<i>Scomberoides sancti-petri</i> (Cuvier)	8554290101
<i>Elegatis bipinnulatus</i> (Quoy and Gaimard)	8554290201
<i>Gnathanodon speciosus</i> (Forsskål)	8554290801
<i>Caranx melampygus</i> Cuvier and Valenciennes	8554291204
<i>Caranx</i> sp.	8554291200
Lutjanidae	
Lutjanid sp.	8554380000
<i>Aprion virescens</i> Valenciennes	8554380401
<i>Lutjanus bohar</i> (Forsskål)	8554380701
<i>Lutjanus monostigma</i> (Cuvier and Valenciennes)	8554380703
<i>Lutjanus fulvus</i> (Bloch and Schneider)	8554380704
<i>Lutjanus kasmira</i> (Forsskål)	8554380705
<i>Lethrinus</i> sp.	8554380800
Sparidae	
<i>Monotaxis grandoculis</i> (Forsskål)	8554450101
<i>Gnathodentex aureolineatus</i> (Lacépède)	8554450201
Mullidae	
<i>Mulloidichthys samoensis</i> (Günther)	8554470201
<i>Mulloidichthys auriflamma</i> (Forsskål)	8554470202
<i>Parupeneus bifasciatus</i> (Lacépède)	8554470306
<i>Parupeneus barberinus</i> (Lacépède)	8554470307
<i>Parupeneus trifasciatus</i> (Lacépède)	8554470309
<i>Parupeneus</i> sp.	8554470300
Kyphosidae	
<i>Kyphosus cinerascens</i> (Forsskål)	8554530101
Chaetodontidae	
<i>Forcipiger longirostris</i> (Broussonet)	8554570402
<i>Heniochus acuminatus</i> (Linnaeus)	8554570502
<i>Heniochus permutatus</i> Cuvier	8554570503
<i>Heniochus varius</i> (Cuvier)	8554570504
<i>Chaetodon kleini</i> Bloch	8554570703

(Contd)

Table 20. (Contd)

Group/Species*	Hawaii Coastal Zone Data Bank No.**
Chaetodontidae (continued)	
<i>Chaetodon ephippium</i> Cuvier	8554570705
<i>Chaetodon auriga</i> Forsskål	8554570706
<i>Chaetodon unimaculatus</i> Bloch	8554570707
<i>Chaetodon lunula</i> (Lacépède)	8554570708
<i>Chaetodon trifasciatus</i> Mungo Park	8554570710
<i>Chaetodon ornatissimus</i> Solander	8554570711
<i>Chaetodon quadrimaculatus</i> Gray	8554570712
<i>Chaetodon ulietensis</i> Cuvier and Valenciennes	8554570717
<i>Chaetodon semeion</i> Bleeker	8554570718
<i>Chaetodon meyeri</i> Bloch and Schneider	8554570719
<i>Chaetodon bennetti</i> Cuvier	8554570720
<i>Megaprotodon strigangulus</i> (Gmelin)	8554570801
<i>Centropyge loriculus</i> (Günther)	8554575304
<i>Centropyge flavissimus</i> (Cuvier)	8554575305
<i>Centropyge bicolor</i> (Bloch)	8554575308
<i>Pygoplites diacanthus</i> (Boddaert)	8554575401
Pomacentridae	
<i>Dascyllus aruanus</i> (Linnaeus)	8554640102
<i>Dascyllus trimaculatus</i> (Rüppell)	8554640104
<i>Abudefduf sordidus</i> (Forsskål)	8554640201
<i>Abudefduf imparipennis</i> (Sauvage)	8554640203
<i>Abudefduf phoenixensis</i> Schultz	8554640205
<i>Abudefduf glaucus</i> (Cuvier and Valenciennes)	8554640208
<i>Abudefduf septemfasciatus</i> (Cuvier and Valenciennes)	8554640209
<i>Abudefduf amabilis</i> (De Vis)	8554640210
<i>Plectroglyphidodon dickii</i> (Lienard)	8554640302
<i>Pomacentrus albofasciatus</i> Schlegel and Muller	8554640402
<i>Pomacentrus coelestis</i> Jordan and Starks	8554640403
<i>Pomacentrus nigricans</i> (Lacépède)	8554540405
<i>Pomacentrus</i> sp.	8554640400
<i>Chromis margaritifer</i> Fowler	8554640507
<i>Chromis caeruleus</i> (Cuvier and Valenciennes)	8554640512
<i>Chromis</i> sp.	8554640500
<i>Amphiprion chrysopterus</i> Cuvier	8554640607
<i>Amphiprion</i> sp.	8554640600
Cirrhitidae	
Cirrhitid sp.	8554660000
<i>Paracirrhites arcatus</i> (Cuvier and Valenciennes)	8554660101
<i>Paracirrhites forsteri</i> (Bloch and Schneider)	8554660102
<i>Paracirrhites xanthus</i> Randall	8554660105
<i>Cirrhitichthys aprinus</i> Cuvier and Valenciennes	8554660603
Mugilidae	
<i>Chelon vaiensis</i> (Quoy and Gaimard)	8555010301
<i>Crenimugil crenilabis</i> (Forsskål)	8555010401

(Contd)

Table 20. (Contd)

Group/Species*	Hawaii Coastal Zone Data Bank No.**
Sphyraenidae	
<i>Sphyraena</i> sp.	8555030100
Labridae	
<i>Labroides bicolor</i> Fowler and Bean	8555070402
<i>Labroides dimidiatus</i> (Cuvier and Valenciennes)	8555070403
<i>Labroides rubrolabiatus</i> Randall	8555070404
<i>Epibulus insidiator</i> (Pallas)	8555070501
<i>Cheilinus undulatus</i> Rüppell	8555070703
<i>Pseudocheilinus hexataenia</i> (Bleeker)	8555070804
<i>Thalassoma lunare</i> (Linnaeus)	8555071403
<i>Thalassoma amblycephalus</i> (Bleeker)	8555071410
<i>Thalassoma hardwickei</i> (Bennett)	8555071411
<i>Gomphosus varius</i> Lacépède	8555071501
<i>Coris gaimardi</i> (Quoy and Gaimard)	8555071604
<i>Stethojulis balteata</i> (Quoy and Gaimard)	8555071801
<i>Anampses caeruleopunctatus</i> Rüppell	8555072103
<i>Halichoeres centriquadrus</i> (Lacépède)	8555072202
<i>Halichoeres trimaculatus</i> (Quoy and Gaimard)	8555072205
<i>Hemigymnus melapterus</i> (Bloch)	8555072302
Scaridae	
<i>Calotomus</i> sp.	8555090100
<i>Scarus sordidus</i> Forsskål	8555090304
<i>Scarus forsteri</i> Cuvier and Valenciennes	8555090305
<i>Scarus frenatus</i> Lacépède	8555090306
<i>Scarus ghobban</i> Forsskål	8555090308
<i>Scarus jonesi</i> (Streets)	8555090311
<i>Scarus pectoralis</i> Cuvier and Valenciennes	8555090313
<i>Scarus</i> sp. (juvenile)	8555090320
<i>Chlorurus gibbus</i> (Rüppell)	8555090601
Gobiidae	
Gobiid sp.	8555600000
<i>Bathygobius fuscus</i> (Rüppell)	8555600802
<i>Amblygobius phalaena</i> (Valenciennes)	8555601802
Acanthuridae	
<i>Acanthurus triostegus</i> (Linnaeus)	8555690101
<i>Acanthurus guttatus</i> Bloch and Schneider	8555690102
<i>Acanthurus achilles</i> Shaw	8555690103
<i>Acanthurus glaucopareius</i> Cuvier	8555690104
<i>Acanthurus olivaceus</i> (Block and Schneider)	8555690109
<i>Acanthurus xanthopterus</i> (Cuvier and Valenciennes)	8555690111
<i>Acanthurus lineatus</i> (Linnaeus)	8555690114
<i>Acanthurus</i> sp.	8555690100
<i>Ctenochaetus strigosus</i> (Bennett)	8555690201
<i>Ctenochaetus striatus</i> (Quoy and Gaimard)	8555690203
<i>Zebrasoma veliferum</i> (Bloch)	8555690302
<i>Zebrasoma scopas</i> (Cuvier)	8555690304

(Contd)

Table 20. (Contd).

Group/Species*	Hawaii Coastal Zone Data Bank No.**
Acanthuridae (continued)	
<i>Naso lituratus</i> (Bloch and Schneider)	8555690401
<i>Naso brevirostris</i> (Cuvier and Valenciennes)	8555690403
<i>Zanclus canescens</i> (Linnaeus)	8555695101
Tetraodontiformes	
Balistidae	
<i>Rhinecanthus rectangulus</i> (Bloch and Schneider)	8558020301
<i>Rhinecanthus aculeatus</i> (Linnaeus)	8558020302
<i>Melichthys vidua</i> (Solander)	8558020402
<i>Sufflamen chrysoptera</i> (Bloch and Schneider)	8558020505
<i>Balistapus undulatus</i> (Mungo Park)	8558020601
<i>Balistoides viridescens</i> (Bloch and Schneider)	8558020701
<i>Balistoides flavimarginatus</i> (Rüppell)	8558020703
Tetraodontidae	
<i>Arothron hispidus</i> (Linnaeus)	8558060302
<i>Canthigaster solandri</i> (Richardson)	8558065107

*Group/Species—taxonomic list follows the phylogenetic order proposed by Greenwood *et al.* (1966).

**HZCDB No.—a numerical computer listing maintained by University of Hawaii/Hawaii Institute of Geophysics; all fish data from this report are stored in this bank.

Figure 35 shows the number of species recorded at each station (as dots with areas proportional to the number of species observed). The number of species is plotted against distance from the lagoon pass (Fig. 36). A pronounced decline in the number of species is seen with increasing distance from the pass. These data are consistent with the well-documented preference of most reef species for habitats with substrata of varied relief and generally high live coral coverage (Key, 1973). These habitat types provide protective cover and food for fishes and a large variety of other reef organisms, as seen in the photographs taken adjacent to Spam Island in the pass region (Fig. 37). Regions of abundant and diverse coral coverage are also normally "healthy" areas with good circulation and near-oceanic physicochemical conditions capable of sustaining most reef-associated biota (Smith and Jokiel, this report; Jokiel and Maragos, this report; Kay, this report). Accordingly, the areas with sparse live coral coverage and low relief (see substrata key in Fig. 36) are uniformly low in fish diversity and abundance. In such environments, available habitats appear to overshadow the effects of circulation and overall water quality.

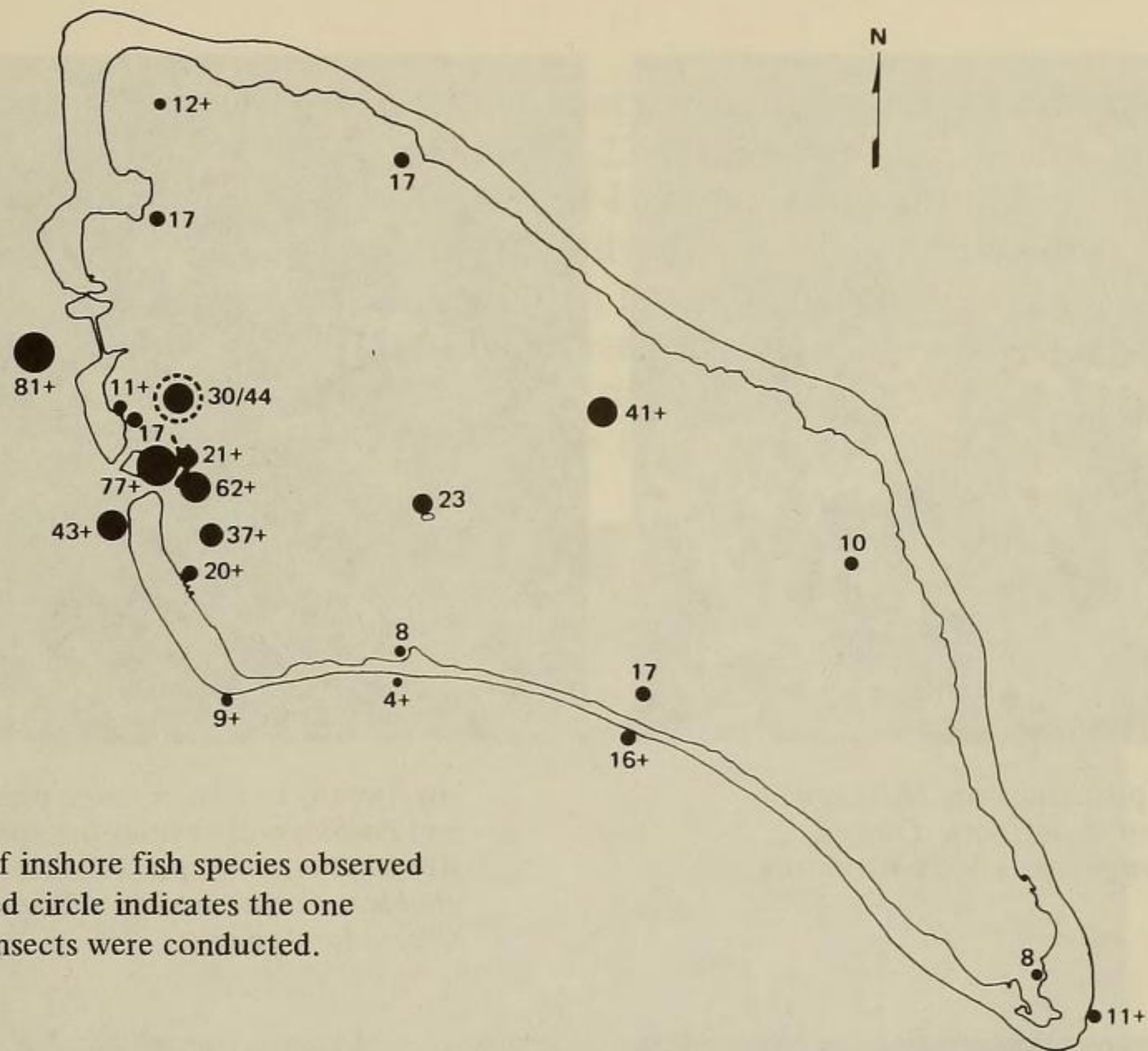


Figure 35. Numbers of inshore fish species observed at 24 locations. Dashed circle indicates the one station where two transects were conducted.

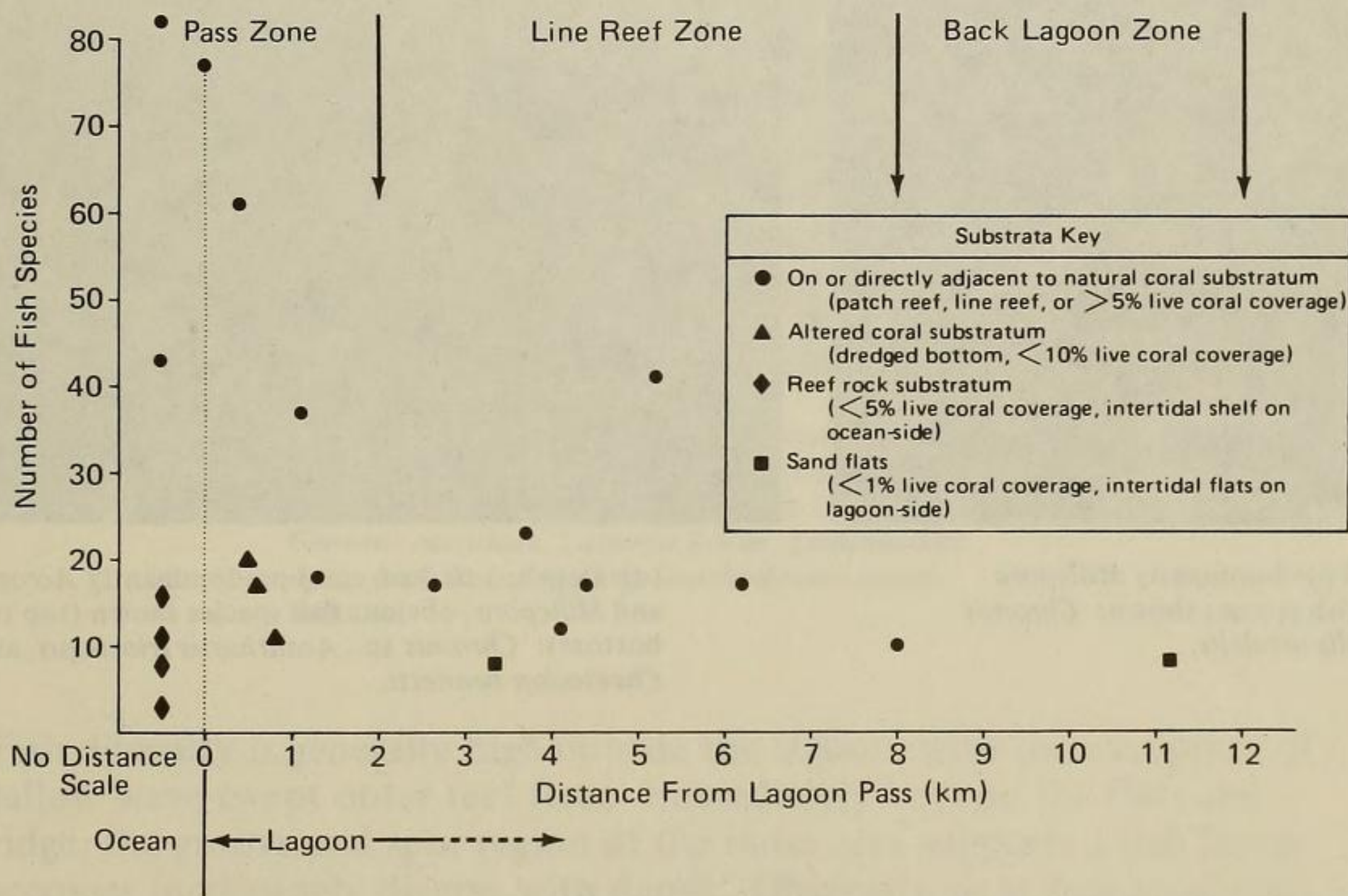
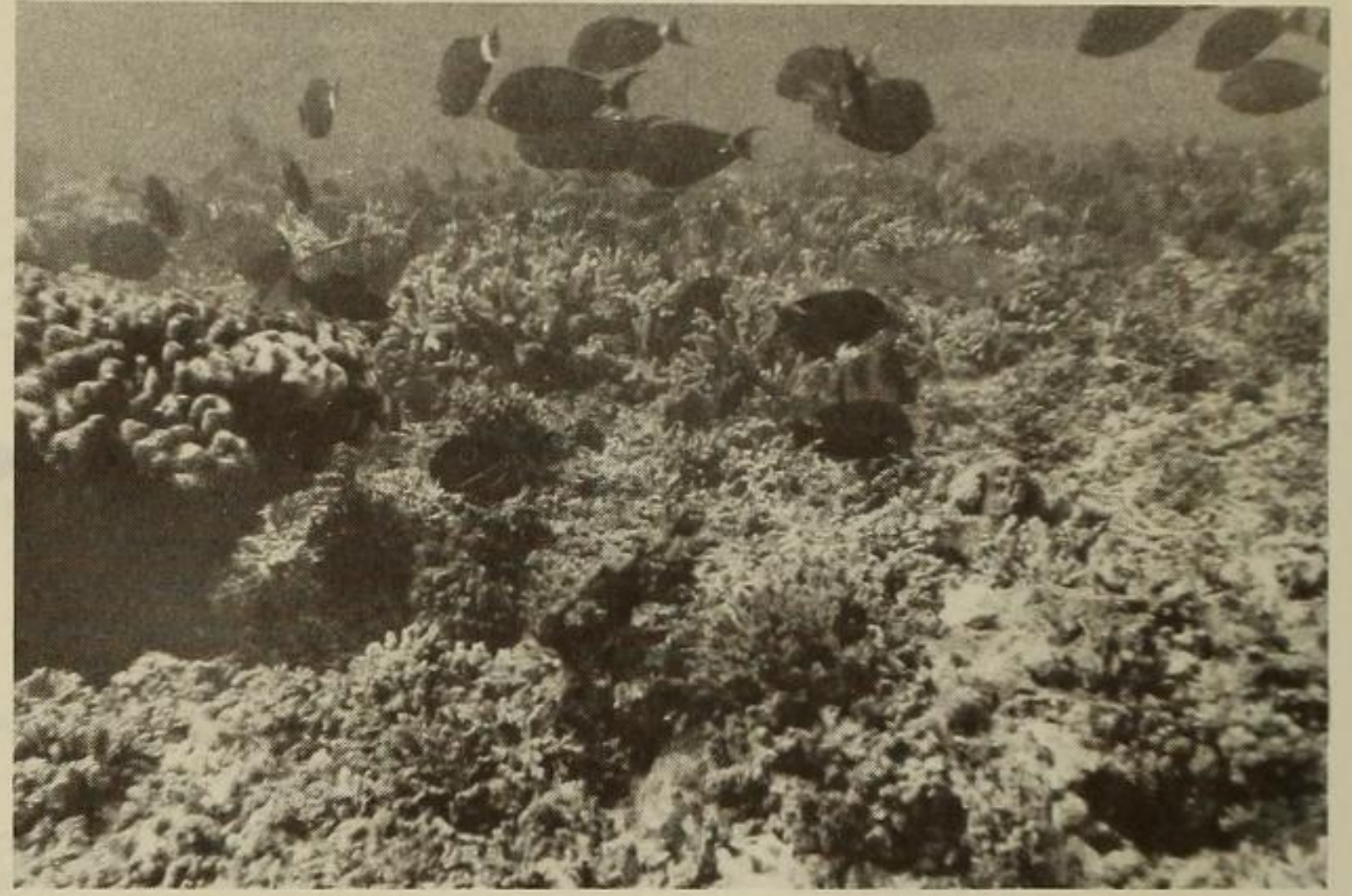


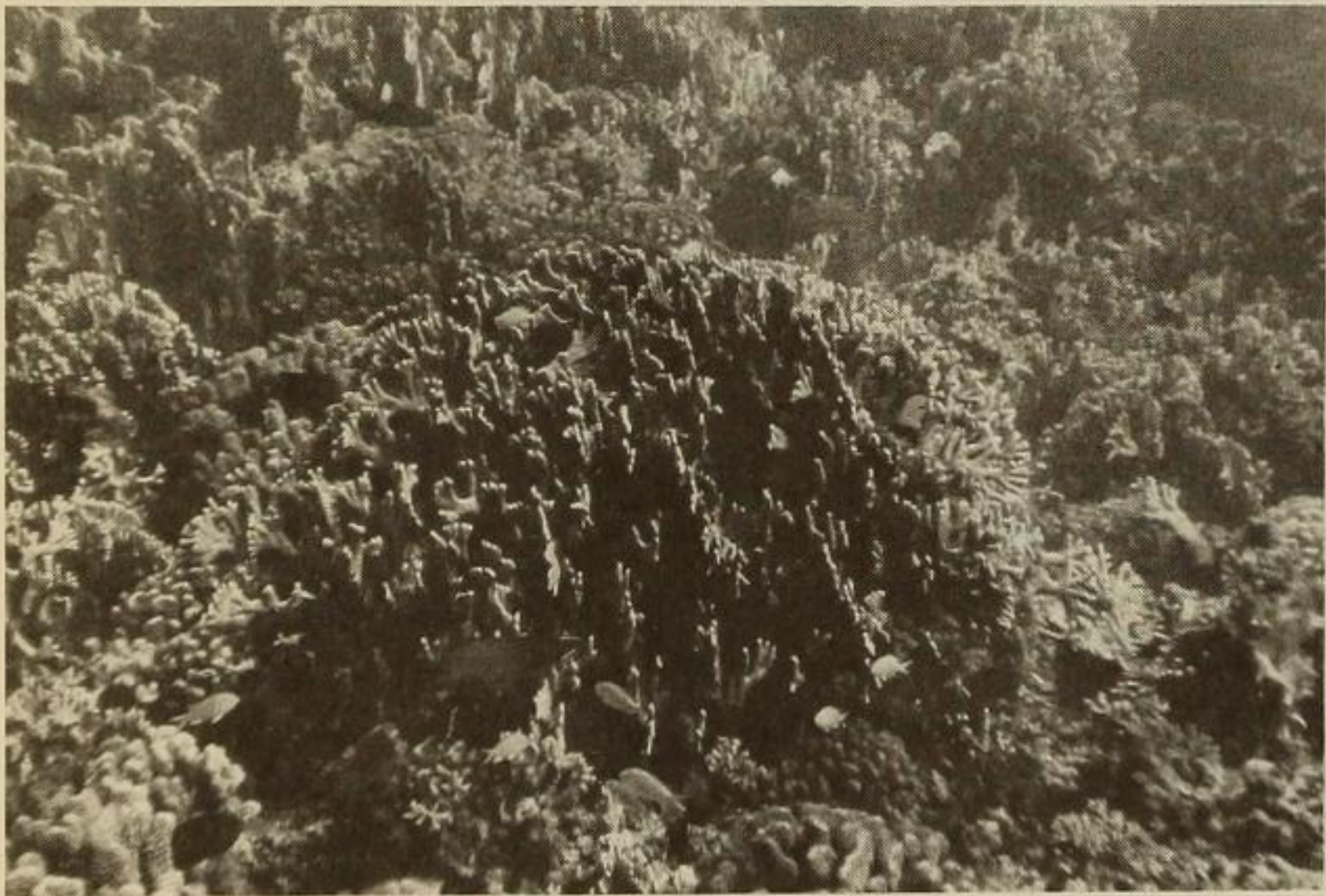
Figure 36. Numbers of fish species versus distance from lagoon pass over four general substrata types at Canton Atoll.



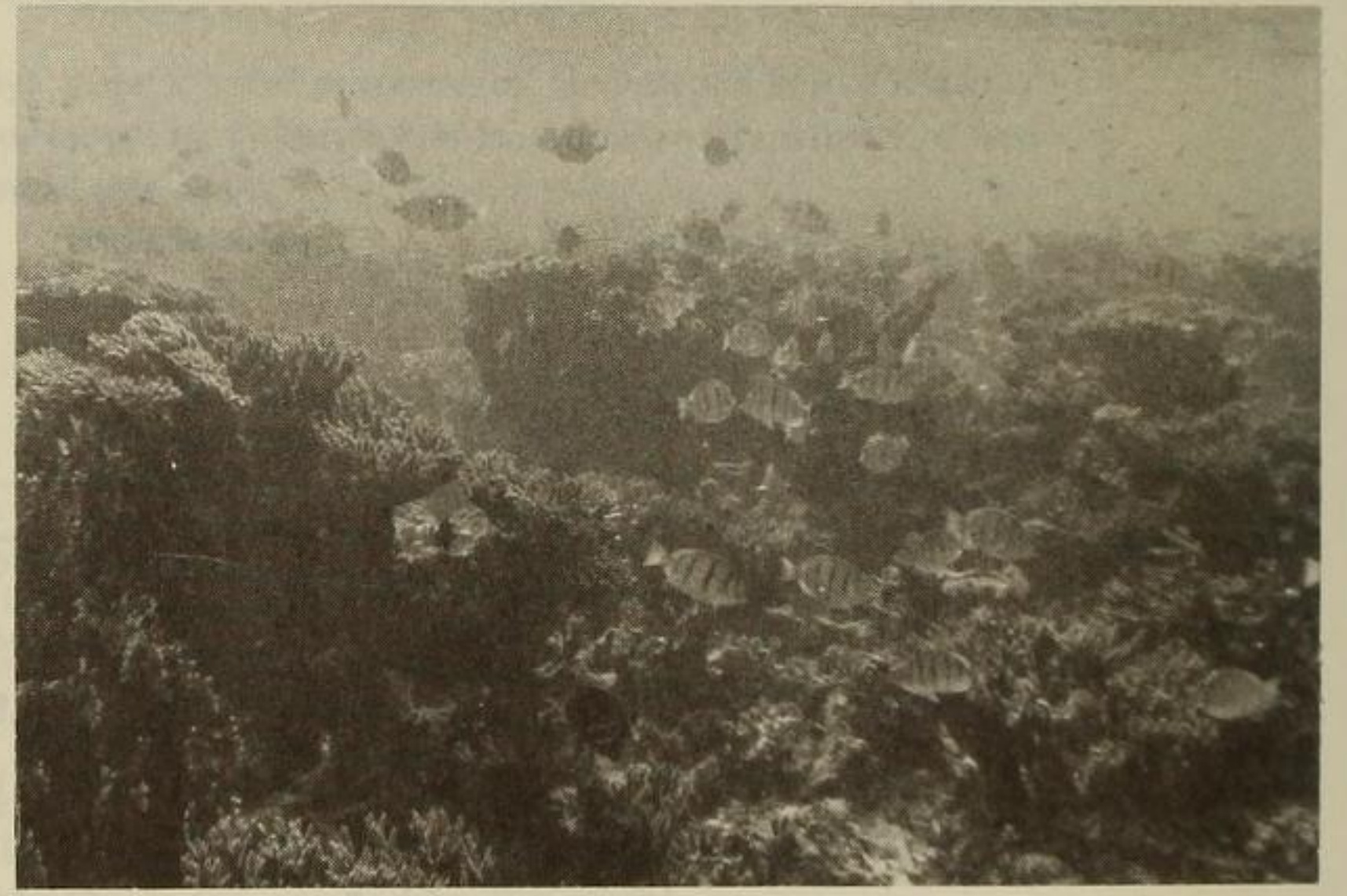
(a) Depth, $\frac{1}{2}$ to 1 m; coral predominantly *Millepora*; obvious fish species seen (top to bottom): *Chromis caeruleus*, *Amphiprion chrysopterus*, and *Pomacentrus nigricans*.



(b) Depth, 1 to $1\frac{1}{2}$ m; coral predominantly *Acropora* and *Pocillopora*; obvious fish species (top to bottom): *Acanthurus xanthopterus*, *Acanthurus* sp., *Scarus ghobban*, *Scarus oviceps*, *Chaetodon ulietensis*, and *Chaetodon bennetti*.



(c) Depth, 1 to 2 m; coral predominantly *Millepora* and *Pocillopora*; obvious fish species shown: *Chromis caeruleus* and *Cephalopholis urodelis*.



(d) Depth, 1 to 3 m; coral predominantly *Acropora* and *Millepora*; obvious fish species shown (top to bottom): *Chromis* sp., *Acanthurus triostegus*, and *Chaetodon bennetti*.

Figure 37. Shallow reef top environment, lagoonside of Spam Island.

Within the lagoon the number of fish species generally decreases radically beyond a 2-km radius from the pass to about 8–23 species per location for most shoreline and lagoon reef areas. Some mid-lagoon regions along certain line reefs possess luxuriant coral growth (primarily *Acropora* and *Millepora*), with an accompanying diverse and abundant fish fauna. One station (Fig. 38), where over 41 fish species were observed, is typical of such locations. Along the crests and shallower slopes of the line reef structures, tidal currents are increased in speed. This intensified flow appears to enhance biotic diversity.

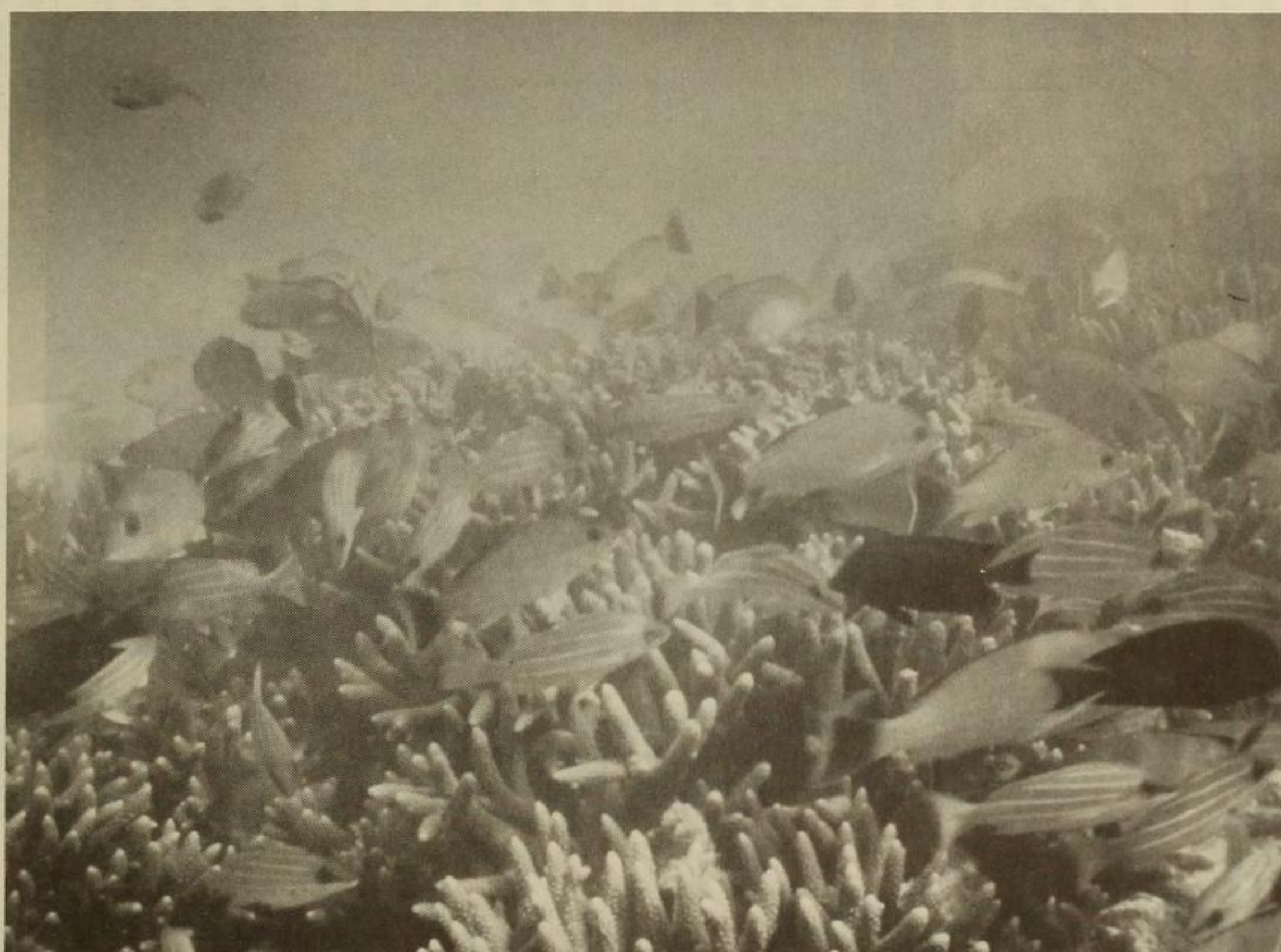


Figure 38. Line reef crest environment, mid-lagoon station; depth, 1½–2 m; coral predominantly *Acropora*; obvious fish species shown (top to bottom): *Chromis caeruleus*, *Lutjanus fulvus*, *Lutjanus kasmira*, *Acanthurus* sp., and *Gnathodentex aureolineatus*.

Fish diversity is generally high outside the lagoon, with the exception of the shallow wave-swept outer reef flats. Immediately beyond the flats and algal ridge, the groove and spur region of the outer reef supports a fish fauna that becomes increasingly diverse with depth. Observations at two locations along the forereef (water depth, 3–20 m) revealed the presence of an outer reef terrace (shown diagrammatically and by inset photograph in Fig. 39). This terrace supports a diverse coral and fish fauna.

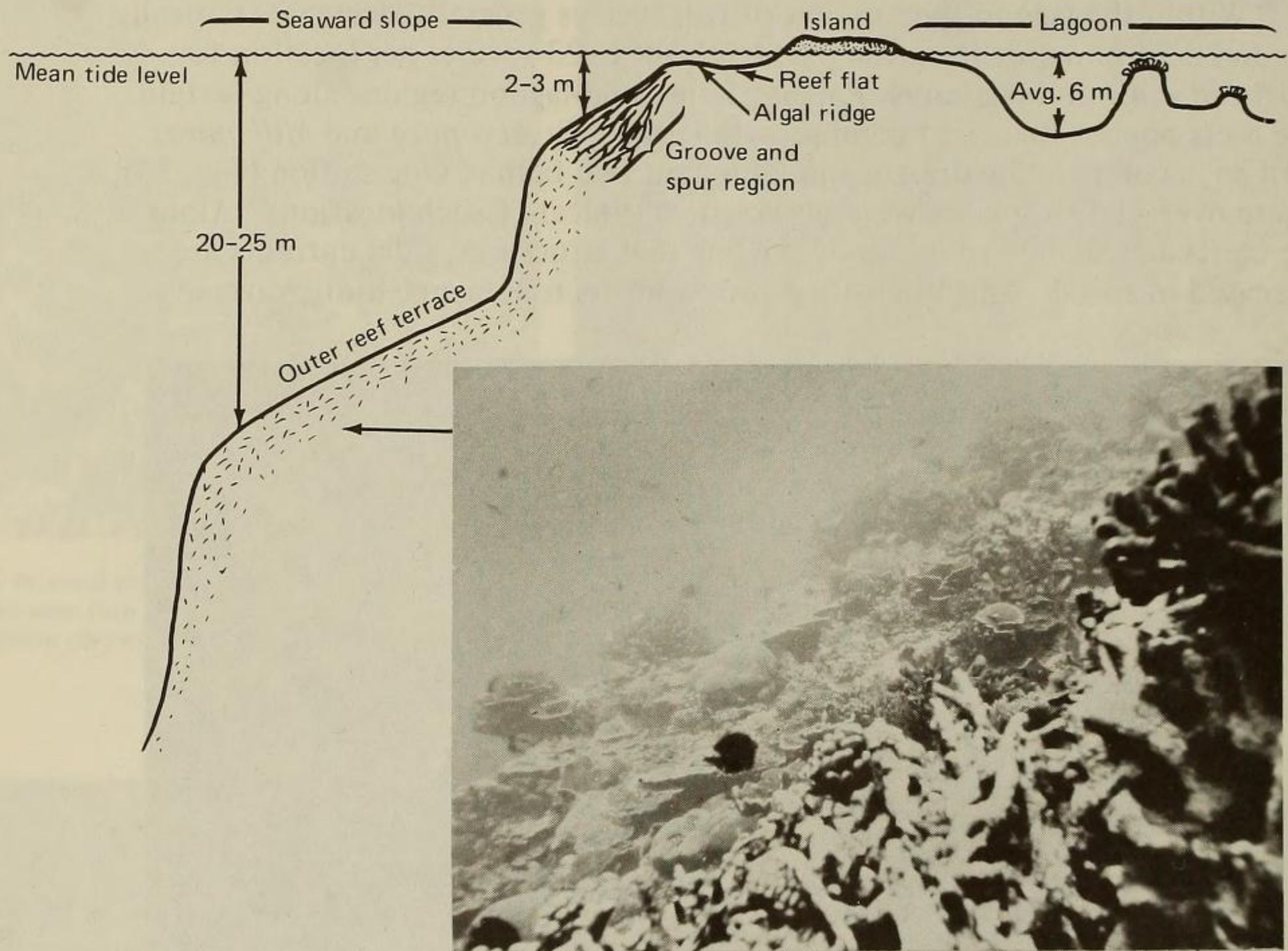


Figure 39. Schematic cross-section of Canton Atoll reef structure (western side). Inset photo was taken at 15 m depth along seaward edge of outer reef terrace.

Distribution of Selected Species

Data on the distribution of fishes were recorded at the 24 transect and observation stations and were also examined for meaningful patterns or trends by taxa. Twenty fish species have been selected (see Table 21) to illustrate the observed patterns in fish distribution at Canton Atoll. Nineteen of these selected species were recorded at 25% or more of the sampling stations. The remaining species, *Arothron hispidus*, was recorded at 20% of the stations; its occurrence is also considered significant to the distributional discussion.

Table 21. Alphabetical listing of selected fish species with remarks on behavior, habitat, and distribution.

Species	Total no. individuals recorded ^a	Behavioral characteristics	Feeding type ^c	General habitat ^d	Possible factors limiting distribution
		Aggregating type ^b			
<i>Acanthurus triostegus</i>	491	schooling	herbivore	P,R,s,Lc	food availability, seasonal movement?
<i>Acanthurus xanthopterus</i>	524	schooling	herbivore	U	algal substrata, vertical relief
<i>Arothron hispidus</i>	54	solitary	carnivore (omni.)	Lt	food availability
<i>Centropyge flavissimus</i>	97	solitary/tr	herbivore	P,O	clean water algal forms
<i>Cephalopholis argus</i>	45	solitary/tr	carnivore	P,O	prey abundance, protective cover
<i>Chaetodon auriga</i>	80	grouping	carnivore (omni.)	U	protective cover
<i>Chaetodon lunula</i>	60	pairing	carnivore (omni.)	O,P,Lc	food availability (proximity to live coral), protective cover
<i>Cheilodipterus quinquelineata</i>	36	grouping	carnivore	U	protective cover, water motion
<i>Chromis margaritifer</i>	525+	schooling	planktivore	O,P	oceanic plankton, protective cover
<i>Dascyllus aruanus</i>	306	schooling	planktivore	P,Lc	abundance of plankton, competition with other pomacentrids
<i>Epinephelus merra</i>	57	solitary/tr	carnivore	U	prey abundance, protective cover with high relief
<i>Gomphosus varius</i>	31	solitary	carnivore	P	prey abundance
<i>Lutjanus fulvus</i>	523	schooling	carnivore	Lt	competition with other carnivores, prey abundance
<i>Monotaxis grandoculis</i>	85	solitary/tr	carnivore	P,Lc	protective cover, competition with lutjanids?
<i>Pomacentrus coelestis</i>	261	schooling	herbivore (omni.)	P,O,Lc	clean water algal forms, protective cover
<i>Pomacentrus nigricans</i>	737	solitary/tr	herbivore (omni.)	U	high relief substratum, territorial competition
<i>Rhinecanthus aculeatus</i>	22	solitary/tr	omnivore	Lc,Lt	protective cover, proximity to sand bottom habitat
<i>Scarus sordidus</i>	231+	schooling	herbivore	U	food availability
<i>Thalassoma amblycephalus</i>	1200+	schooling	planktivore	O,P,Lc	proximity to live coral, abundance of plankton
<i>Zebrasoma scopas</i>	23	solitary/tr	herbivore	O,P	clean water algal forms

^aThese data are conservative because they represent minimum counts of individuals, that is, data recorded greater than (>) were treated as number listed only (see Appendix); + indicates that numbers of individuals were recorded as TNTC (too numerous to count) at some stations.

^btr = territorial; grouping = occurring in small aggregations (3-10 individuals); solitary, pairing, and schooling are self-explanatory.

^cFeeding type information was obtained from Hiatt and Strasburg (1960) and Hobson (1974).

^dHabitat types: P=pass; Rs=outer reef shelf; Lc=clear lagoon; Lt=turbid lagoon; O=ocean (along outer reef slope); U=ubiquitous (observed at nearly all habitat types).

Six species show a nearly ubiquitous distribution at Canton Island: *Chaetodon auriga*, *Pomacentrus nigricans*, *Acanthurus xanthopterus*, *Epinephelus merra*, *Scarus sordidus*, and *Cheilodipterus quinquelineata* (Fig. 40a–40f). These species appear well-adapted to inhabit nearly any available habitat with sufficient bottom relief.

Another group of species is confined to the pass region and at the outside ocean stations. The five species in this group are *Chromis margaritifer*, *Centropyge flavissimus*, *Zebrasoma scopas*, *Cephalopholis argus*, and *Gomphosus varius* (Fig. 40g–40k).

One species, *Dascyllus aruanus*, is restricted to the pass and clear lagoon regions (Fig. 40l). Possible factors which might limit the distribution of this and other selected species are presented in the last column of Table 21.

Three species occur at ocean, pass, and lagoon stations, but are not ubiquitous: *Thalassoma amblycephalus*, *Pomacentrus coelestis*, and *Chaetodon lunula* (Fig. 40m–40o). The distribution observed for these species suggests a mild preference for clear-water, moderate live-coral-coverage environments. As seen by the distribution for *P. coelestis*, a possible remnant population at a lagoon station north of the present pass is suggested; this station is near ocean passes closed about 30 years before this survey (see Henderson *et al.*, this volume).

Rhinecanthus aculeatus and *Monotaxis grandoculis* occur primarily at lagoon patch reef stations (Fig. 40p and 40q). Both species exhibit solitary behavior patterns (see Table 21).

Two other species which have been recorded as abundant in turbid lagoon environments are *Lutjanus fulvus* and *Arothron hispidus* (Fig. 40r and 40s). *A. hispidus* was observed almost exclusively at shallow, turbid-water stations.

One remaining species, *Acanthurus triostegus*, shows a curious distributional pattern at Canton (Fig. 40t). Hiatt and Strasburg (1960) consider the species as being ubiquitous in the Marshall Islands; Chave and Eckert (1974) found a similar distribution at Fanning Atoll. However, at Canton *A. triostegus* was recorded only from the pass, ocean, outside reef shelf, and southern lagoon stations. Possibly some specific food or habitat preference is reflected in the limited lagoon distribution of this species.

Juveniles and young adults of certain selected species were observed predominantly inside the lagoon, while adult forms were seen at outside stations. *Scarus sordidus*, *Monotaxis grandoculis*, and *Lutjanus fulvus* are representative species which exhibit this pattern.

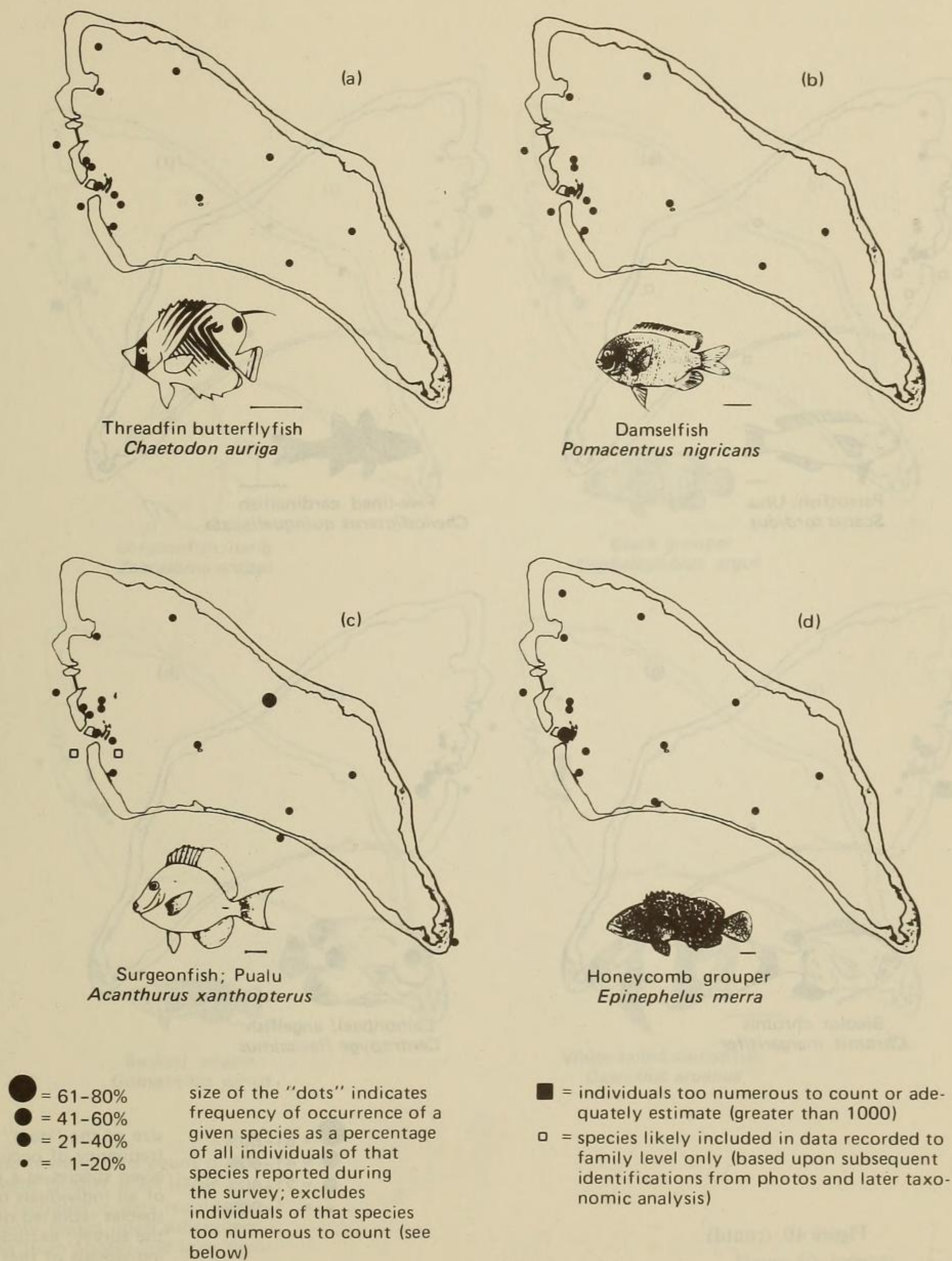
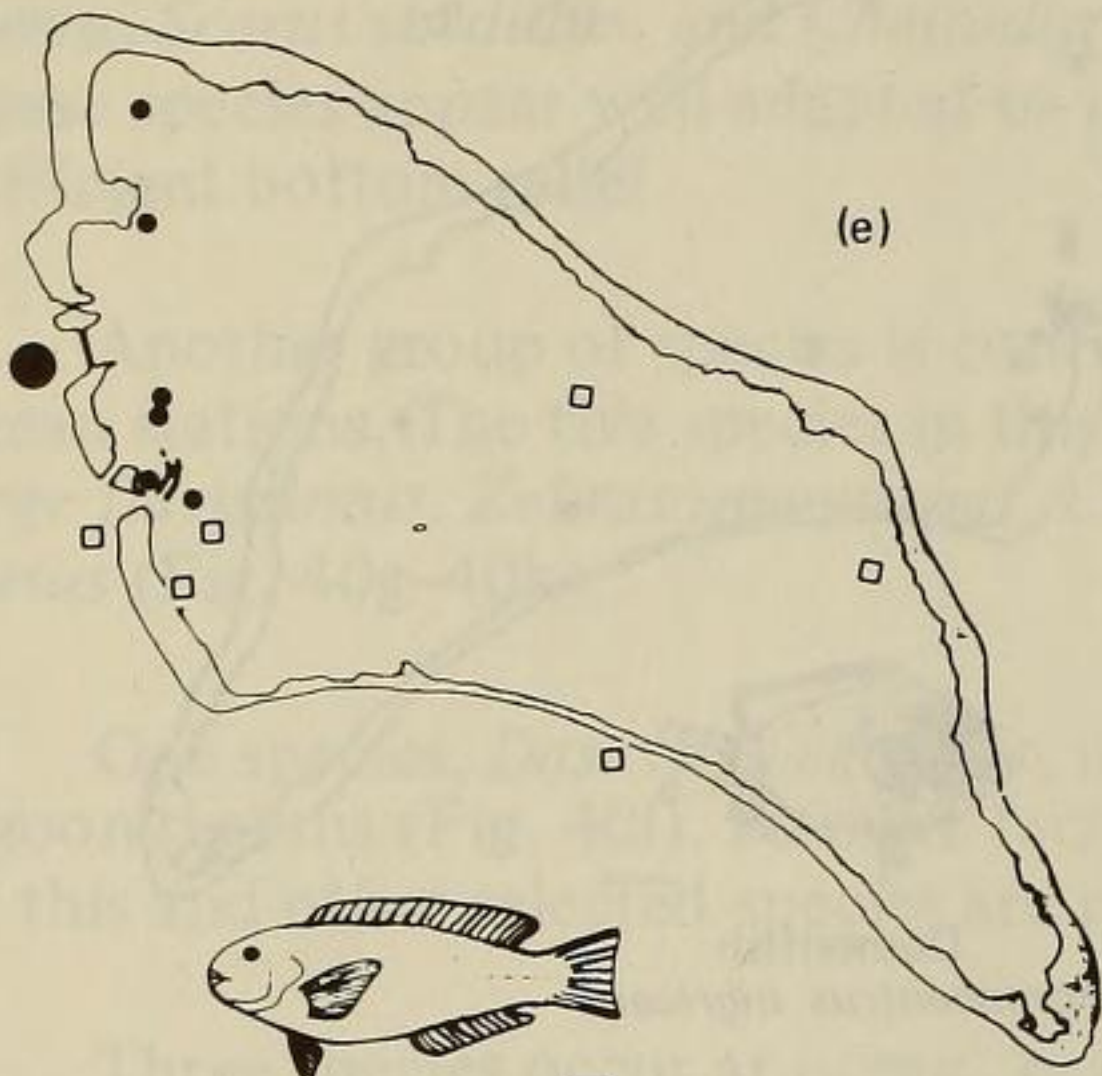
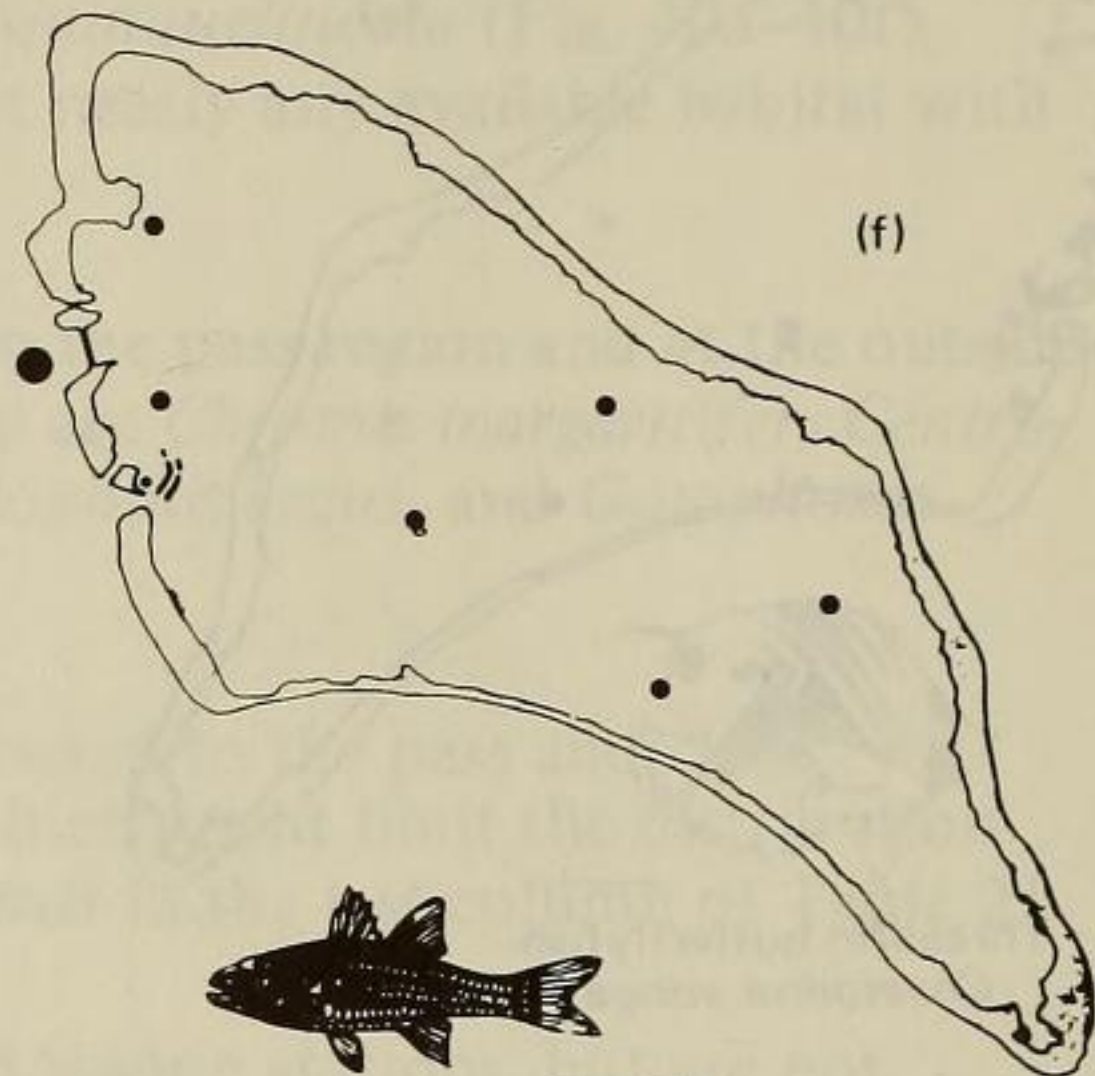


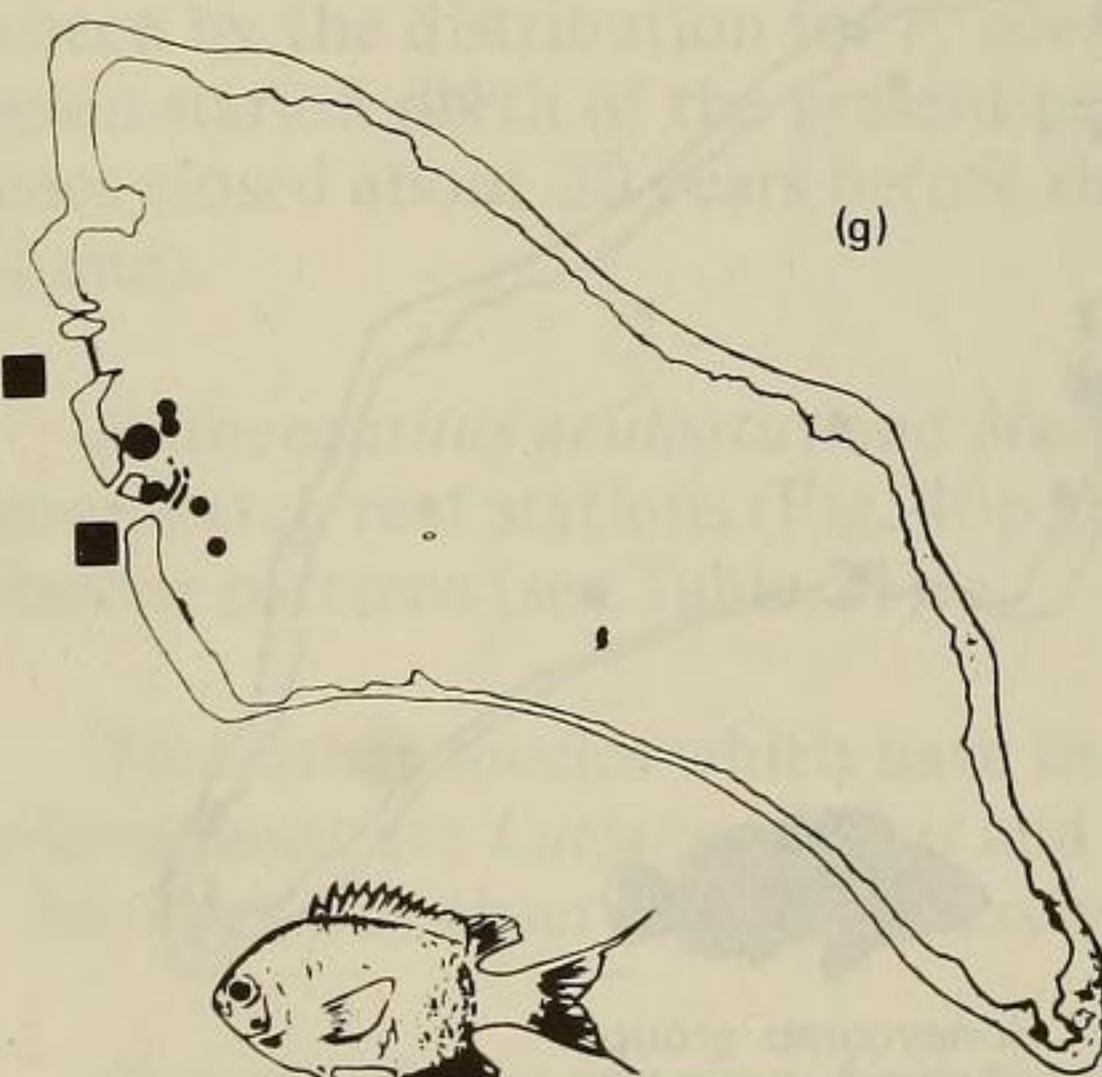
Figure 40. Distribution pattern of 20 representative reef fish species.



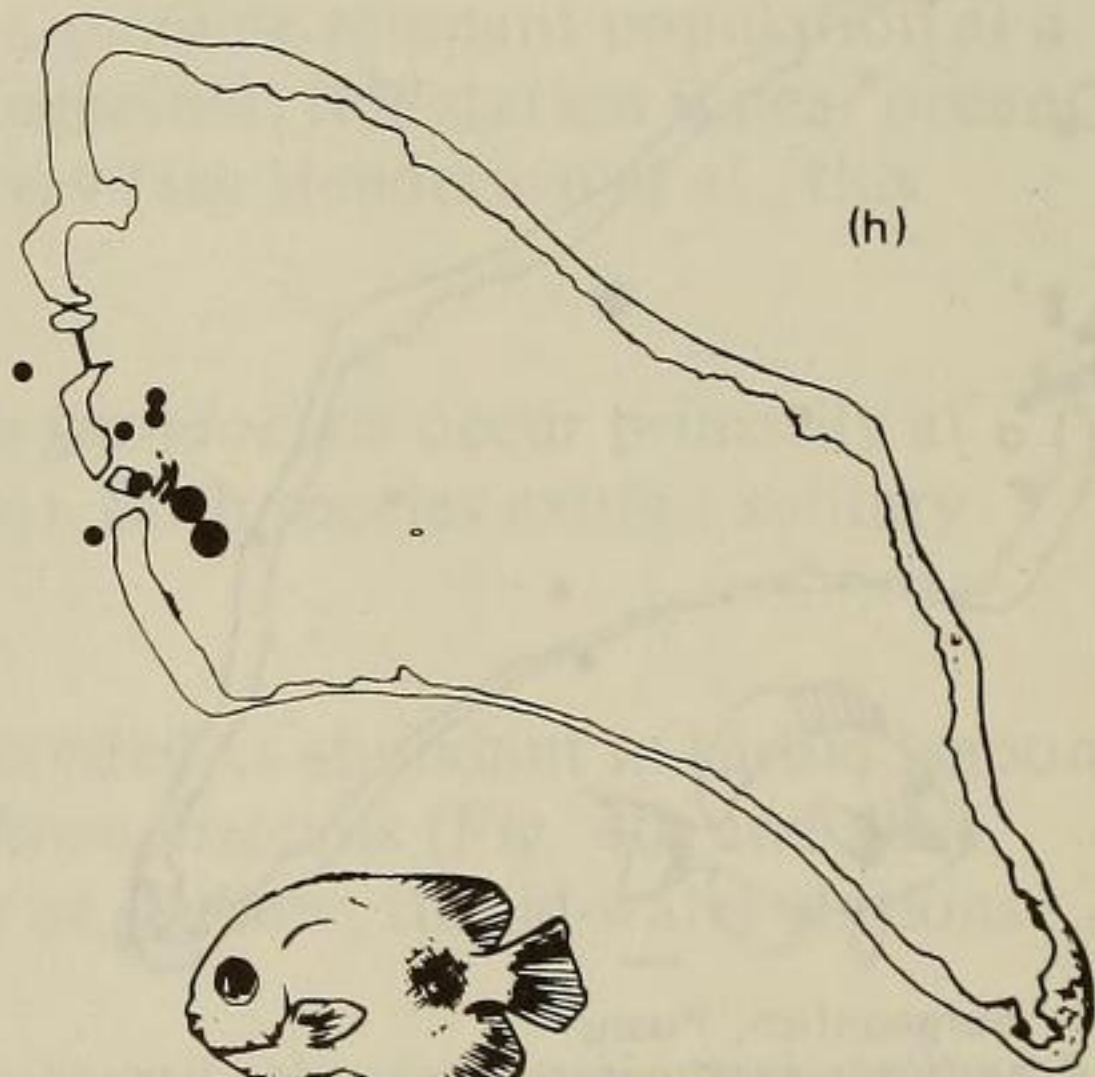
Parrotfish; Uhu
Scarus sordidus



Five-lined cardinalfish
Cheilodipterus quinquelineata



Bicolor chromis
Chromis margaritifer

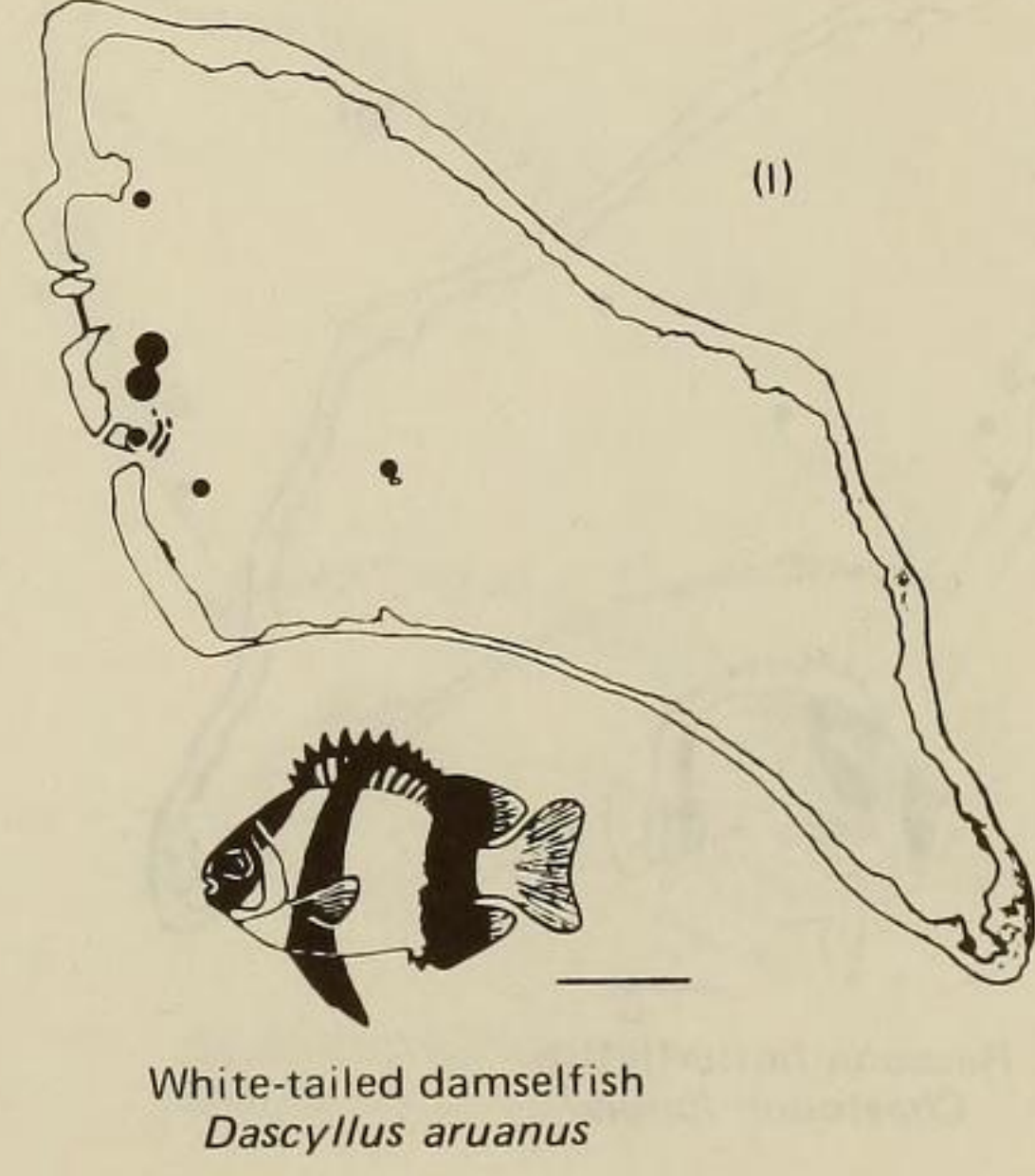
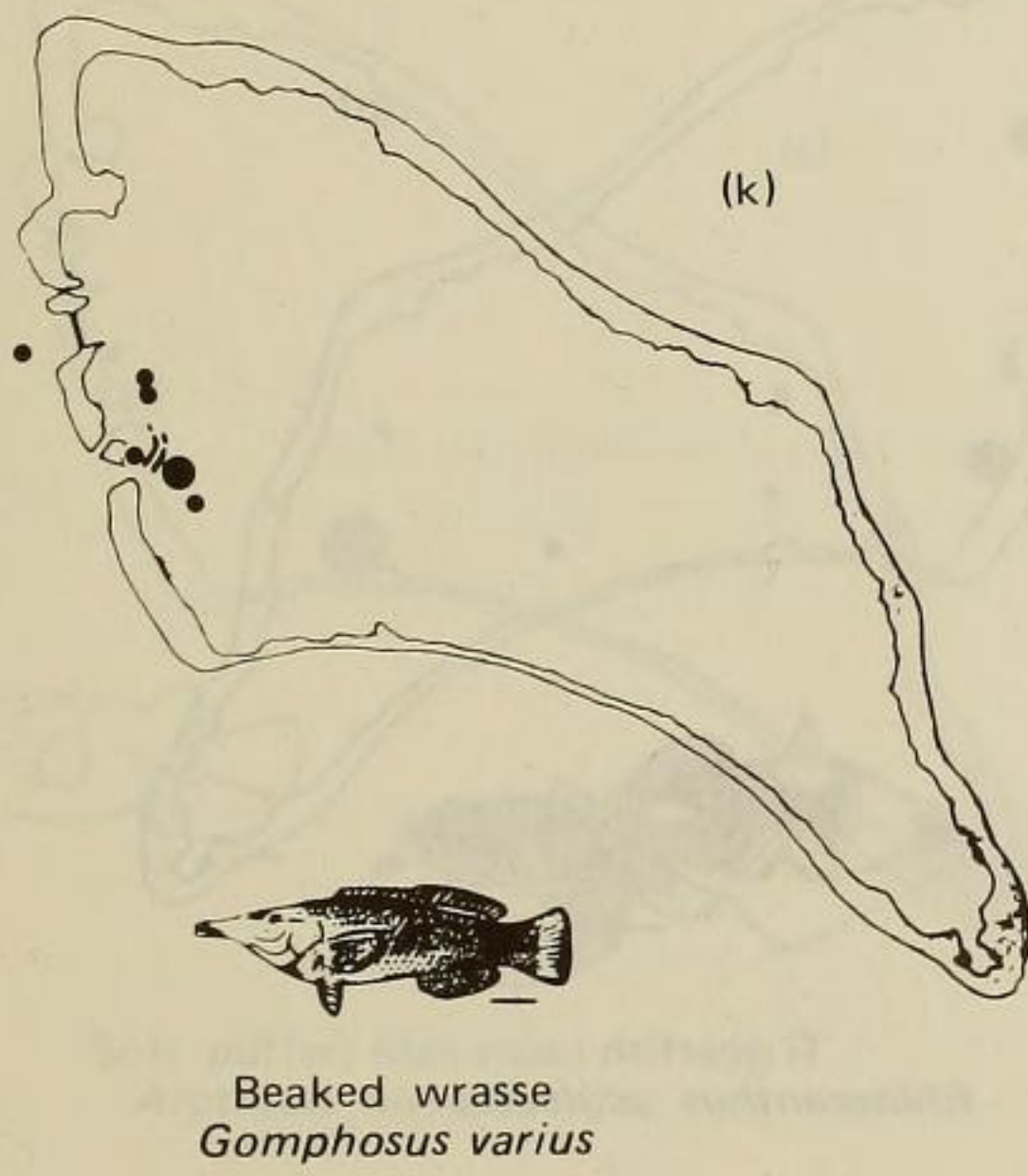
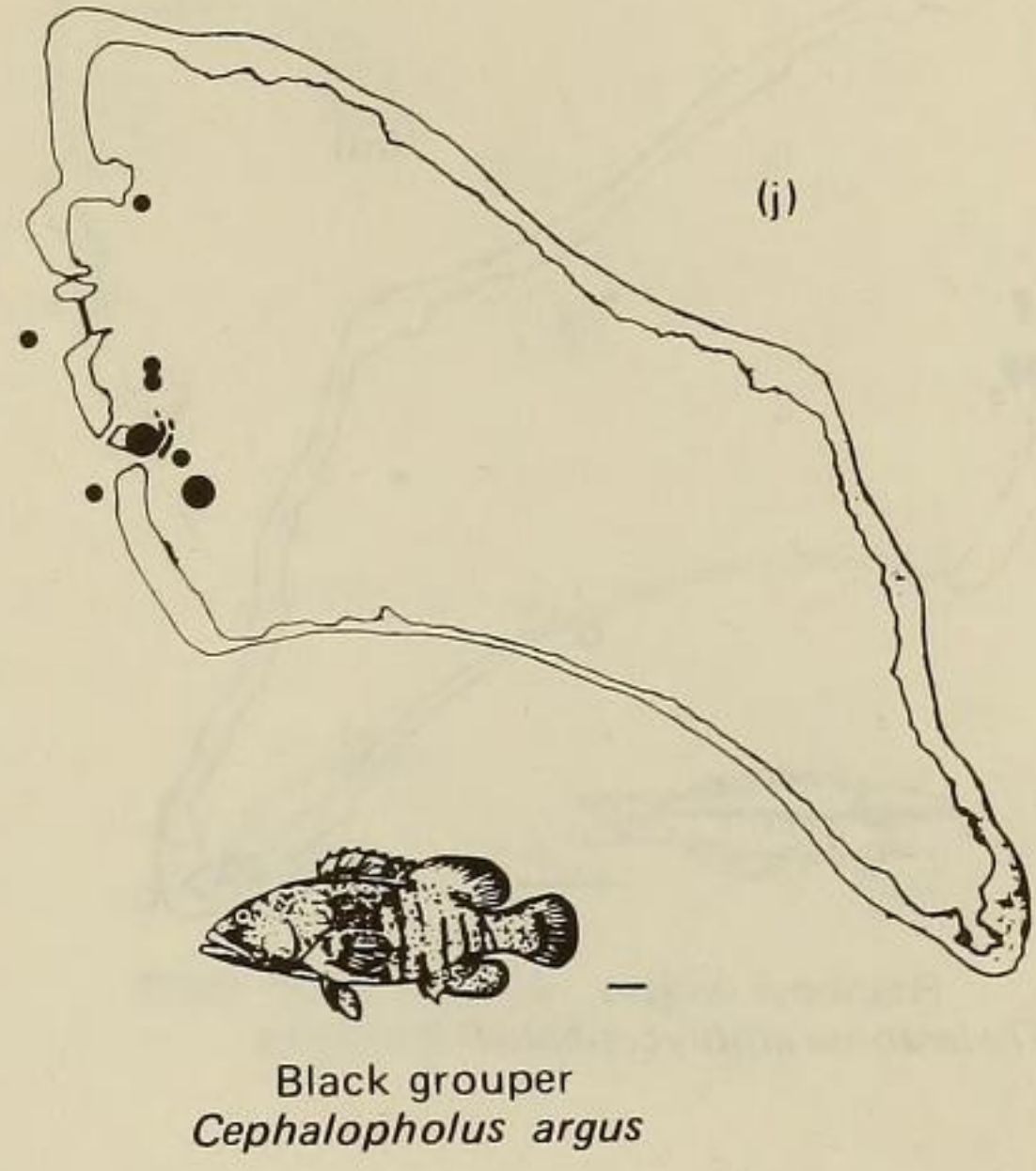
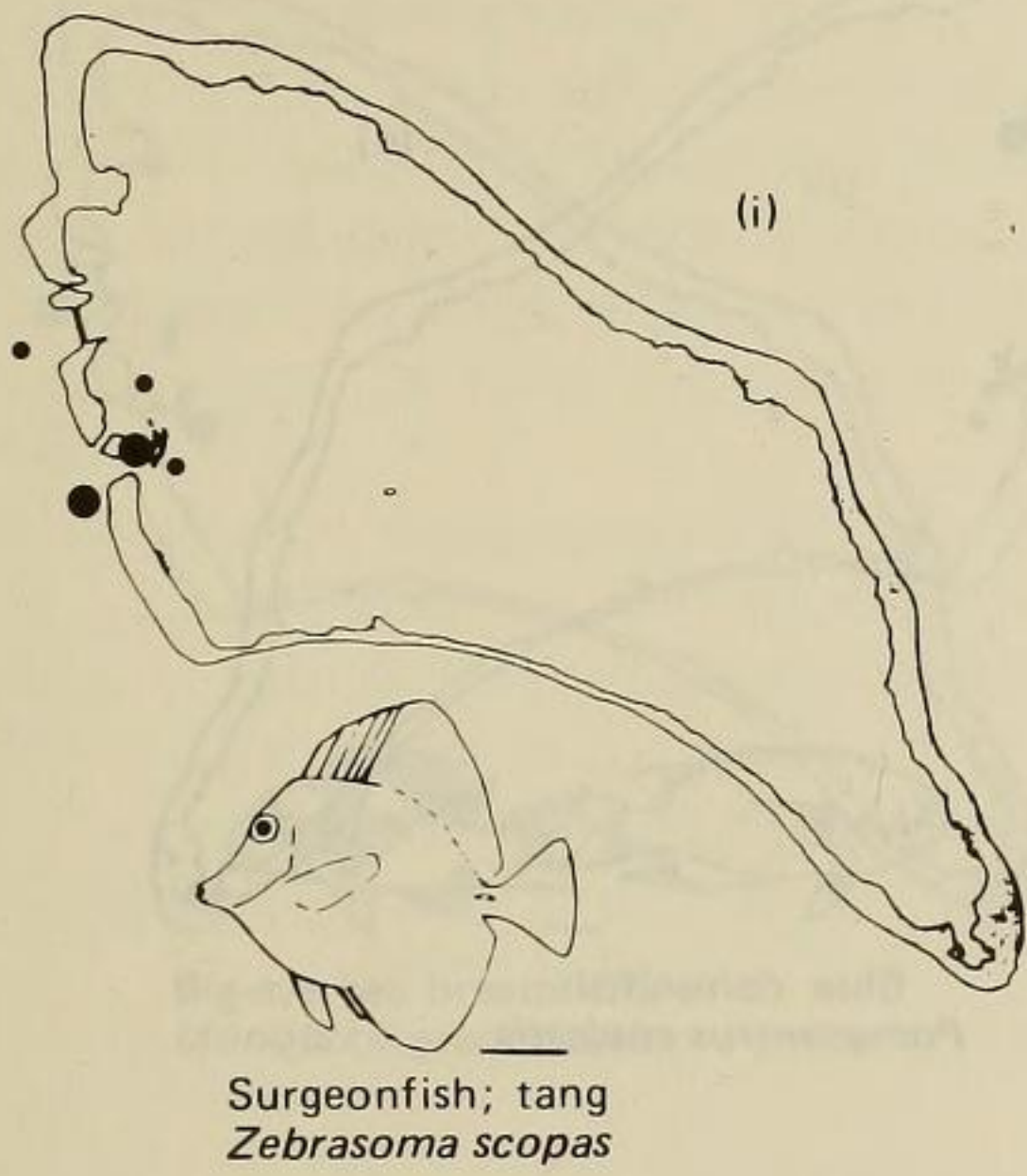


Lemonpeel; angelfish
Centropyge flavissimus

- = 61-80%
- = 41-60%
- = 21-40%
- = 1-20%

size of the "dots" indicates frequency of occurrence of a given species as a percentage of all individuals of that species reported during the survey; excludes individuals of that species too numerous to count (see below)

Figure 40. (contd)



■ = individuals too numerous to count or adequately estimate (greater than 1000)
 □ = species likely included in data recorded to family level only (based upon subsequent identifications from photos and later taxonomic analysis)

Figure 40. (contd)

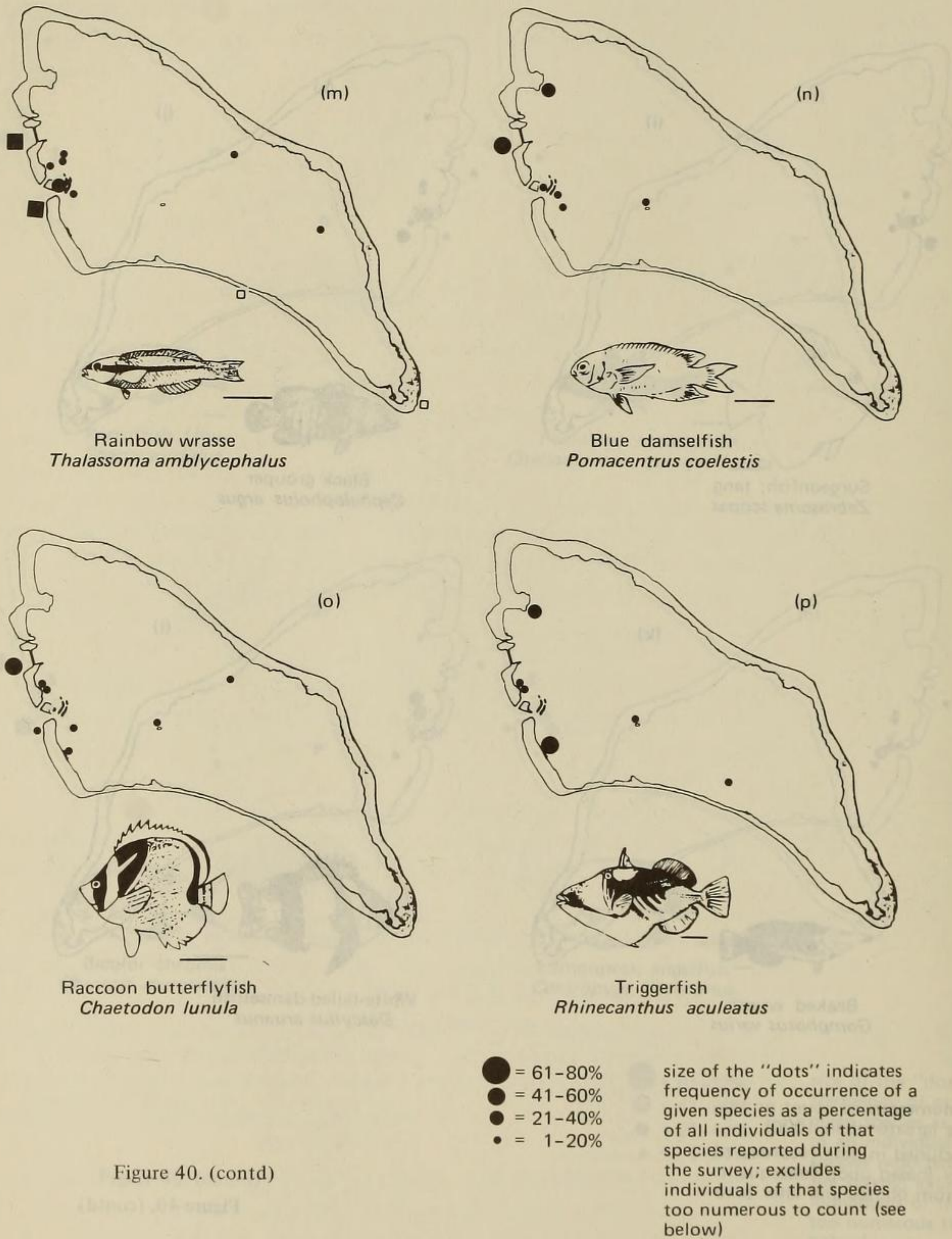
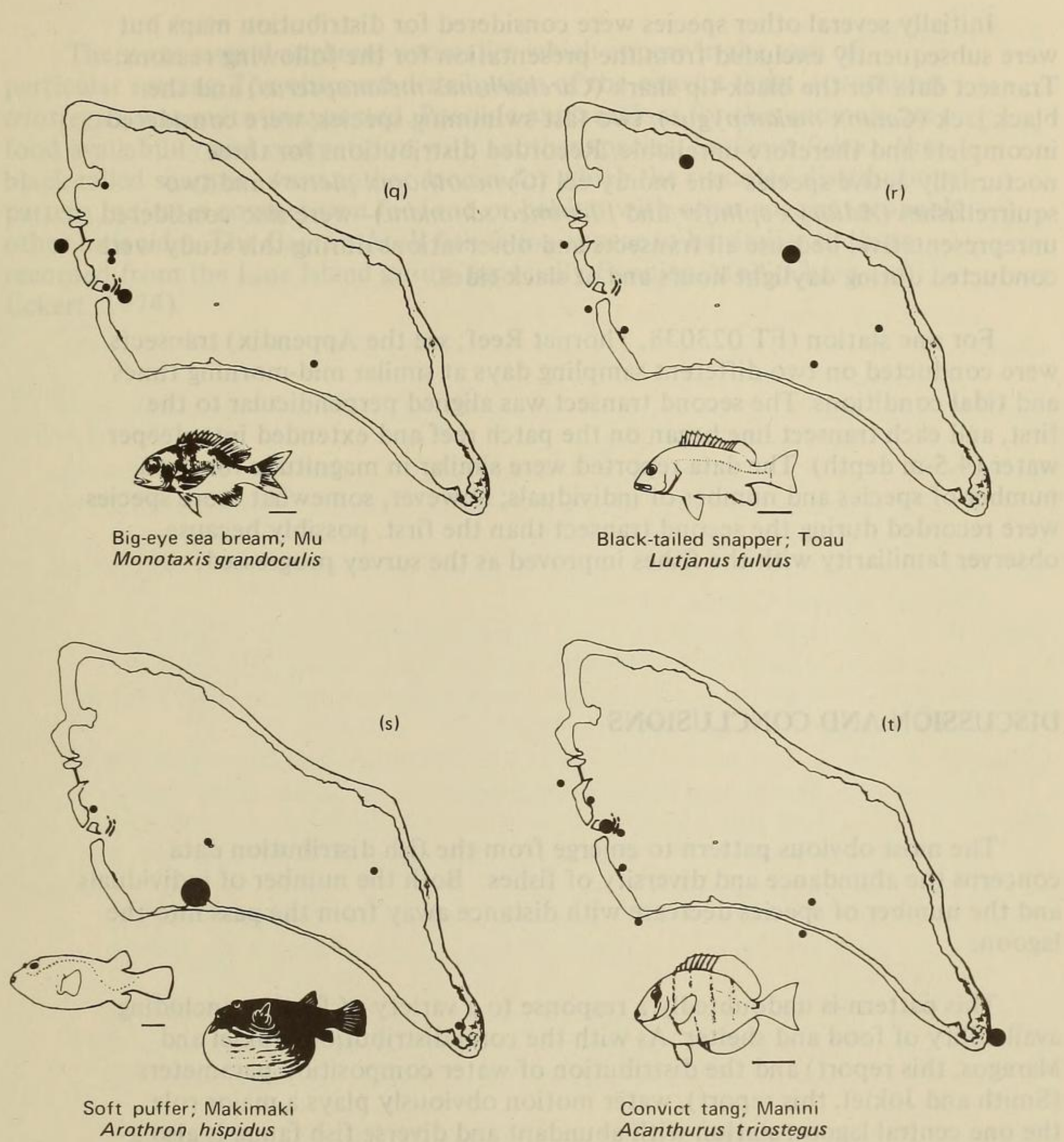


Figure 40. (contd)



- = individuals too numerous to count or adequately estimate (greater than 1000)
- = species likely included in data recorded to family level only (based upon subsequent identifications from photos and later taxonomic analysis)

Figure 40. (contd)

Initially several other species were considered for distribution maps but were subsequently excluded from the presentation for the following reasons: Transect data for the black-tip shark (*Carcharhinus melanopterus*) and the black jack (*Caranx melampygus*), two fast-swimming species, were considered incomplete and therefore unreliable. Recorded distributions for three nocturnally active species—the moray eel (*Gymnothorax pictus*) and two squirrelfishes (*Adioryx spinifer* and *Flammeo sammara*)—were also considered unrepresentative, because all transects and observations during this study were conducted during daylight hours and at slack tides.

For one station (FT 023038, Thornet Reef; see the Appendix) transects were conducted on two different sampling days at similar mid-morning times and tidal conditions. The second transect was aligned perpendicular to the first, and each transect line began on the patch reef and extended into deeper water (4.5-m depth). The data reported were similar in magnitude for both number of species and number of individuals; however, somewhat more species were recorded during the second transect than the first, possibly because observer familiarity with the fishes improved as the survey progressed.

DISCUSSION AND CONCLUSIONS

The most obvious pattern to emerge from the fish distribution data concerns the abundance and diversity of fishes. Both the number of individuals and the number of species decrease with distance away from the pass into the lagoon.

This pattern is undoubtedly a response to a variety of factors, including availability of food and shelter. As with the coral distribution (Jokiel and Maragos, this report) and the distribution of water composition parameters (Smith and Jokiel, this report), water motion obviously plays a major role; the one central lagoon station with abundant and diverse fish fauna is also a site of locally accelerated water flow.

A second and more subtle pattern also emerges from the data when the fish species are examined individually. There is the suggestion that remnant populations of fishes commonly found to inhabit more oceanic conditions may still exist in the lagoon, particularly along the western side of the lagoon north of the present pass. Passes in this area have been closed for about 30 years (Henderson *et al.*, this report), a timespan far beyond the life expectancy of the fishes observed during this survey.

There are several apparent anomalies which appear in the case of particular species. The observed distribution of the convict tang, *Acanthurus triostegus*, was quite unexpected. Possible explanations for this anomaly are food availability and competition with another species. *Lutjanus fulvus*, the black-tailed snapper, was another species for which the recorded distributional pattern indicates competition for food or habitat with other species (probably other lutjanids). The Canton Atoll fish fauna appear to be similar to those recorded from the Line Island group, especially Fanning Atoll (Chave and Eckert, 1974).

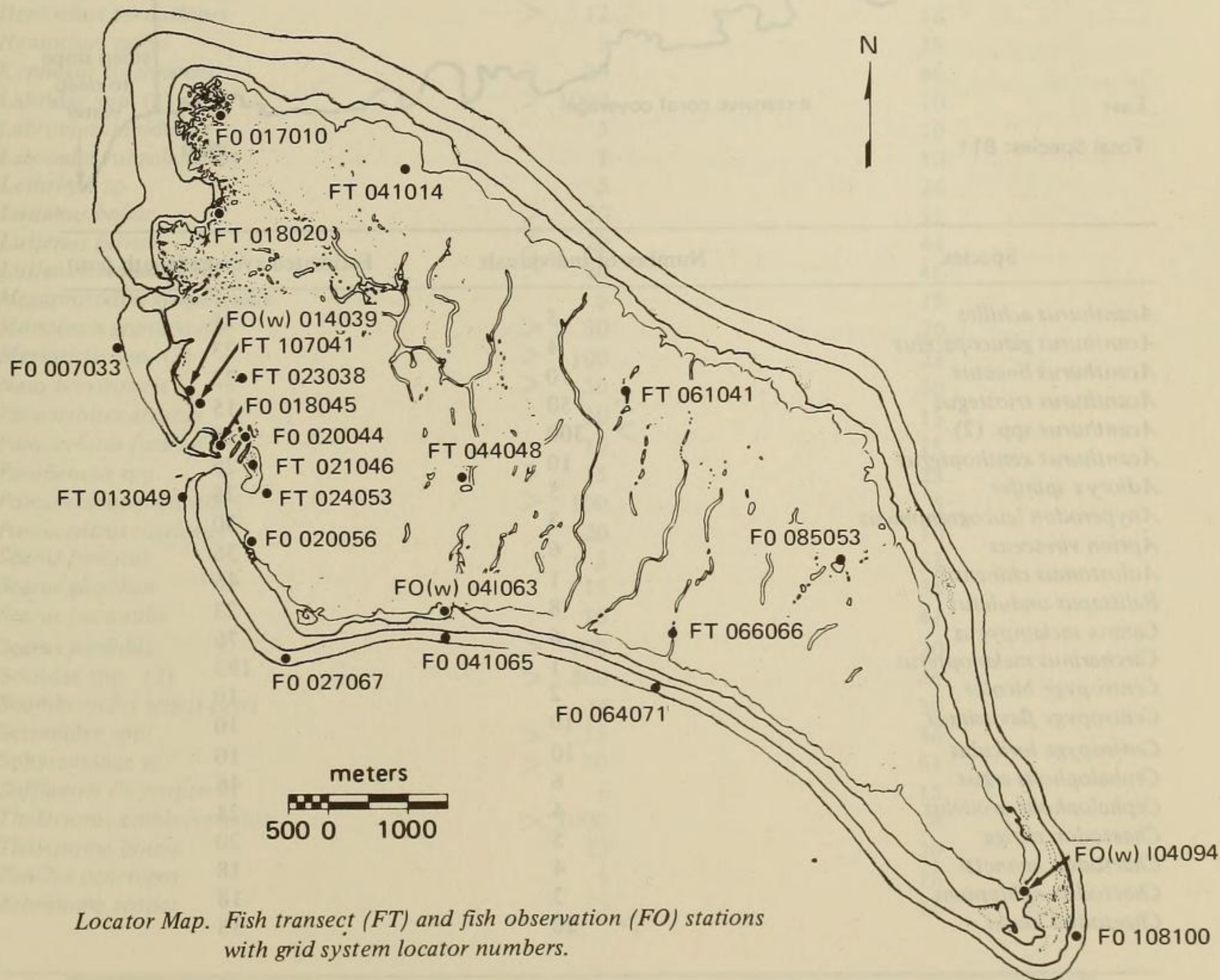
Undersea Center Tech Note 1128, 5 volumes
 Gosline, W. A. 1971. The zoogeographic relationships of Fanning Island fishes. *Fishes Pac.* 25: 281-289.
 Gosline, W. A., and V. E. Brock. 1960. Handbook of Hawaiian fishes. Univ. of Hawaii Press, Honolulu. 372 pp.
 Greenwood, P. H., D. E. Rosen, S. H. Weitzman, and G. S. Myers. 1966. Phylogenetic studies of teleost fishes, with a provisional classification of living forms. *Am. Mus. Nat. History* 131: 339-456.
 Halstead, B. W., and N. C. Bonker. 1954. A survey of the poisonous fishes of the Phoenix Islands. *Copeia* 1: 1-11.
 Platt, R. W., and D. W. Schroeder. 1960. Ecological relationships of the fish fauna on coral reefs of the Marshall Islands. *Biol. Monographs* 30: 1-21.
 Hopson, E. Z. 1974. Feeding relationships of teleostean fishes on coral reefs in Kona, Hawaii. *Fish. Bull.* 74: 915-1017.
 Jones, R. S., and H. K. Larson. 1972. A key to the families of fishes recorded from Guam. The Marine Laboratory, University of Guam, Tech. Rep. 1.
 Keen, C. S. 1973. Reef fishes of the line, in Atlas of the Pacific Islands, vol. 1, western Pacific states. J. Smith, K. B. Chaves, and D. J. O'Connell, eds. *UNEP Regional Report* 12-01, 128 pp.
 Lacey, C. S., Jr. 1973. Study of environmental impact for development of a Range Report prepared for the U.S. Army Corps of Engineers, HONOLULU, HI. 132 pp.
 Randall, J. E. 1955. Fishes of the Gilbert Islands. *Atoll Research Bulletin* 4: 289 pp.
 Schultz, L. P. 1945. Fishes of the Phoenix and Sulu Islands collected in 1939 during the expedition of the USF Buwalda, Smithsonian Inst. Bull. 180: 316 pp.
 Steadman, D. W. 1973. Fishes of the southern Marshall Islands. Manuscripted Office of Naval Research Report 357, 247 pp.

REFERENCES

- Brock, V. E., R. S. Jones, and P. Helfrich. 1965. An ecological reconnaissance of Johnston Island and the effects of dredging. Hawaii Marine Laboratory Tech. Rept. 5, 90 pp.
- Chave, E. A., and D. E. Eckert. 1974. Ecological aspects of the distributions of fishes at Fanning Island. *Pac. Sci.* 28:297-317.
- Evans, E. C. III (ed.). 1973. Pearl Harbor biological survey—final report. Naval Undersea Center Tech. Note 1128. 3 volumes.
- Gosline, W. A. 1971. The zoogeographic relationships of Fanning Island inshore fishes. *Pac. Sci.* 25:282-289.
- Gosline, W. A., and V. E. Brock. 1960. Handbook of Hawaiian fishes. Univ. of Hawaii Press, Honolulu. 372 pp.
- Greenwood, P. H., D. E. Rosen, S. H. Weitzman, and G. S. Myers. 1966. Phyletic studies of teleostean fishes, with a provisional classification of living forms. *Am. Mus. Nat. History.* 131:339-456.
- Halstead, B. W., and N. C. Bunker. 1954. A survey of the poisonous fishes of the Phoenix Islands. *Copeia.* 1:1-11.
- Hiatt, R. W., and D. W. Strasburg. 1960. Ecological relationships of the fish fauna on coral reefs of the Marshall Islands. *Ecol. Monogr.* 30:65-127.
- Hobson, E. S. 1974. Feeding relationships of teleostean fishes on coral reefs in Kona, Hawaii. *Fish. Bull.* 74:915-1031.
- Jones, R. S., and H. K. Larson. 1972. A key to the families of fishes as recorded from Guam. The Marine Laboratory, University of Guam, Tech. Rept.
- Key, G. S. 1973. Reef fishes in the bay, *in* Atlas of Kaneohe Bay: a reef ecosystem under stress (S. V. Smith, K. E. Chave, and D. T. O. Kam, eds.). UNIH Seagrant Rept. 72-01, 128 pp.
- Losey, G. S., Jr. 1973. Study of environmental impact for Kwajalein Missile Range. Report prepared for the U. S. Army Corps of Engineers, HONO. 152 pp.
- Randall, J. E. 1955. Fishes of the Gilbert Islands. *Atoll Res. Bull.* 47:243 pp.
- Schultz, L. P. 1943. Fishes of the Phoenix and Samoa Islands collected in 1939 during the expedition of the USS Bushnell. *Smithsonian Inst. Bull.* 180, 316 pp.
- Strasburg, D. W. 1953. Fishes of the southern Marshall Islands. Mimeographed Office of Naval Research Rept. 267 pp.

Appendix

FISH TRANSECT AND OBSERVATION DATA

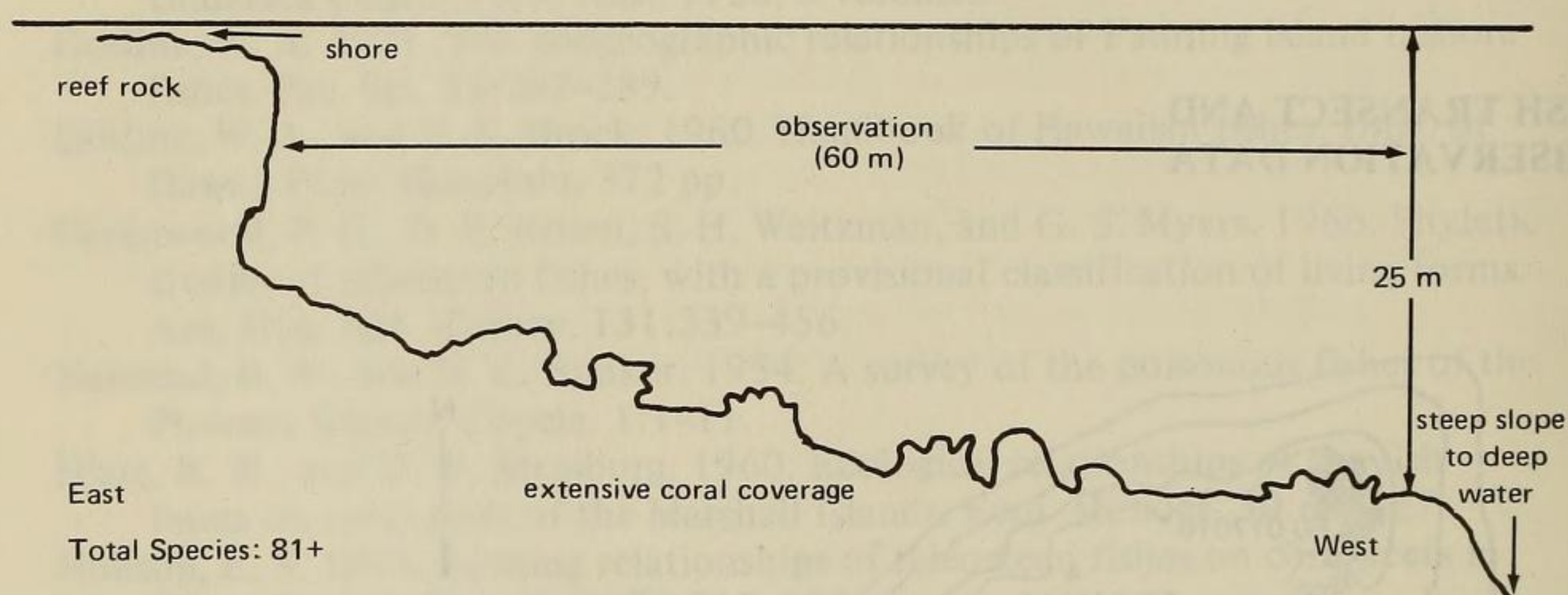


Locator Map. Fish transect (FT) and fish observation (FO) stations with grid system locator numbers.

Fish Observation, north of pass, ocean: FO 007033

Surveyed: 9 Dec 73, 1330-1400 hours. Tide: incoming from high-low (15 cm) at 1133 hours. HIV: 21 m. Observation track length: 60 m.

Observation area general description: 1600 m north of lagoon pass, immediately offshore of intertidal reef shelf. Depth 6 to 25 m. Bottom fairly irregular with greater than 50% live coral coverage. Coral types very numerous; most predominant: *Pocillopora*, *Montipora*, *Porites*, *Pavona*, *Halomitra*, *Herpolitha*.



Species	Number of individuals	Estimated average length (cm)
<i>Acanthurus achilles</i>	5	25
<i>Acanthurus glaucopareius</i>	4	23
<i>Acanthurus lineatus</i>	10	23
<i>Acanthurus triostegus</i>	> 50	15
<i>Acanthurus</i> spp. (2)	> 300	18
<i>Acanthurus xanthopterus</i>	10	25
<i>Adioryx spinifer</i>	5	25
<i>Anyperodon leucogrammicus</i>	3	30
<i>Aprion virescens</i>	6	36
<i>Aulostomus chinensis</i>	1	46
<i>Balistapus undulatus</i>	8	23
<i>Caranx melampygus</i>	6	76
<i>Carcharinus melanopterus</i>	1	183
<i>Centropyge bicolor</i>	2	10
<i>Centropyge flavissimus</i>	10	10
<i>Centropyge loriculus</i>	10	10
<i>Cephalopholis argus</i>	6	46
<i>Cephalopholis urodelus</i>	4	23
<i>Chaetodon auriga</i>	5	20
<i>Chaetodon bennetti</i>	4	18
<i>Chaetodon ephippium</i>	3	18
<i>Chaetodon kleini</i>	> 20	18

<i>Chaetodon lunula</i>	> 30	20
<i>Chaetodon meyeri</i>	6	20
<i>Chaetodon trifasciatus</i>	> 12	20
<i>Chaetodon ulietensis</i>	10	18
<i>Cheilodipterus quinquelineata</i>	8	8
<i>Cheilinus undulatus</i>	3	76
<i>Chromis caeruleus</i>	> 200	6
<i>Chromis margaritifer</i>	> 2000	5
<i>Chromis</i> sp.	> 3000	9
<i>Ctenochaetus striatus</i>	1	15
<i>Ctenochaetus strigosus</i>	> 50	18
<i>Dascyllus trimaculatus</i>	5	10
<i>Elagatis bipinnulatus</i>	> 30	30
<i>Epinephelus merra</i>	10	25
<i>Epinephelus microdon</i>	5	61
<i>Forcipiger longirostris</i>	3	15
<i>Gomphosus varius</i>	6	15
<i>Gracila albomarginatus</i>	1	25
<i>Gymnothorax flavimarginatus</i>	2	102
<i>Heniochus acuminatus</i>	10	18
<i>Heniochus permutatus</i>	> 12	18
<i>Heniochus varius</i>	3	15
<i>Kyphosus cinerascens</i>	> 20	46
Labridae spp. (3)	> 1000	10
<i>Labroides dimidiatus</i>	3	10
<i>Labroides rubrolabiatus</i>	2	10
<i>Lethrinus</i> sp.	5	36
<i>Lutjanus bohar</i>	> 20	51
<i>Lutjanus fulvus</i>	> 20	46
<i>Lutjanus monostigma</i>	> 20	46
<i>Megaprotodon strigangulus</i>	5	18
<i>Monotaxis grandoculis</i>	> 30	20
<i>Myripristis</i> spp. (3)	> 100	23
<i>Naso brevirostris</i>	> 50	30
<i>Paracirrhites arcatus</i>	10	15
<i>Paracirrhites forsteri</i>	10	15
<i>Parupeneus</i> spp.	> 15	23
<i>Pomacentrus coelestis</i>	> 100	8
<i>Pomacentrus nigricans</i>	20	10
<i>Scarus frenatus</i>	5	41
<i>Scarus ghobban</i>	15	36
<i>Scarus pectoralis</i>	10	41
<i>Scarus sordidus</i>	> 100	20
Scaridae spp. (3)	> 300	41
<i>Scomberoides sancti-petri</i>	4	30
Serranidae spp.	> 15	36
Sphyraenidae sp.	> 30	61
<i>Sufflamen chrysopterus</i>	6	15
<i>Thalassoma amblycephalus</i>	> 1000	8
<i>Thalassoma lunare</i>	12	20
<i>Zanclus canescens</i>	5	18
<i>Zebrasoma scopas</i>	3	15

Fish Observation, **small boat marina, lagoon**: FO(w) 014039

Shoreside observations, in marina (under and around floating docks)
on intertidal reef flats nearby.

6 Dec 73, 0900-0905 hours. Tide: slack at low-low (27 cm). HIV: 2.5 m.

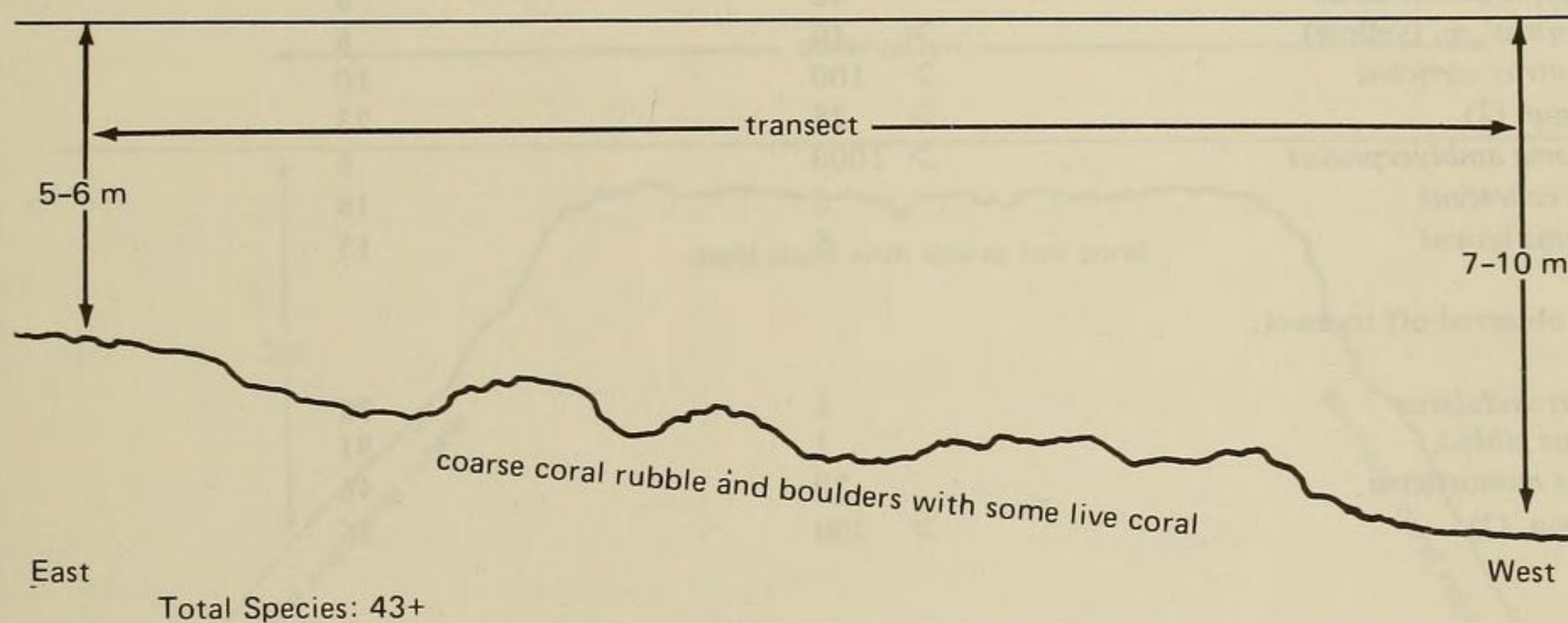
Total Species: 11+

Species	Number of individuals	Estimated average length (cm)
<i>Acanthurus triostegus</i>	1	13
<i>Acanthurus xanthopterus</i>	> 10	23
Balistidae sp.	5	76
<i>Caranx melampygus</i>	> 30	25
<i>Chaetodon auriga</i>	2	15
<i>Chaetodon lunula</i>	1	13
<i>Gymnothorax pictus</i>	> 12	64
Labridae spp. (2)	> 100	6
<i>Mulloidichthys samoensis</i>	8	25
<i>Rhinecanthus aculeatus</i>	1	18

Fish Transect, south of Taylor wreck, ocean: FT 013049

Surveyed: 4 Dec 73, 1355-1435 hours. Tide: slack, high-high (1 m) at 1415 hours. HIV: 21 m. Transect length: 30 m.

Transect general description: Approximately 60 m south of President Taylor wreck (at pass). Depth shoreward 5 to 6 m, increasing seaward to 8-9 m. Bottom mostly boulder and irregular formations of dead coral and rubble. Live coral covering approximately 5-10% of bottom; predominant coral types *Pocillopora* and *Porites*.



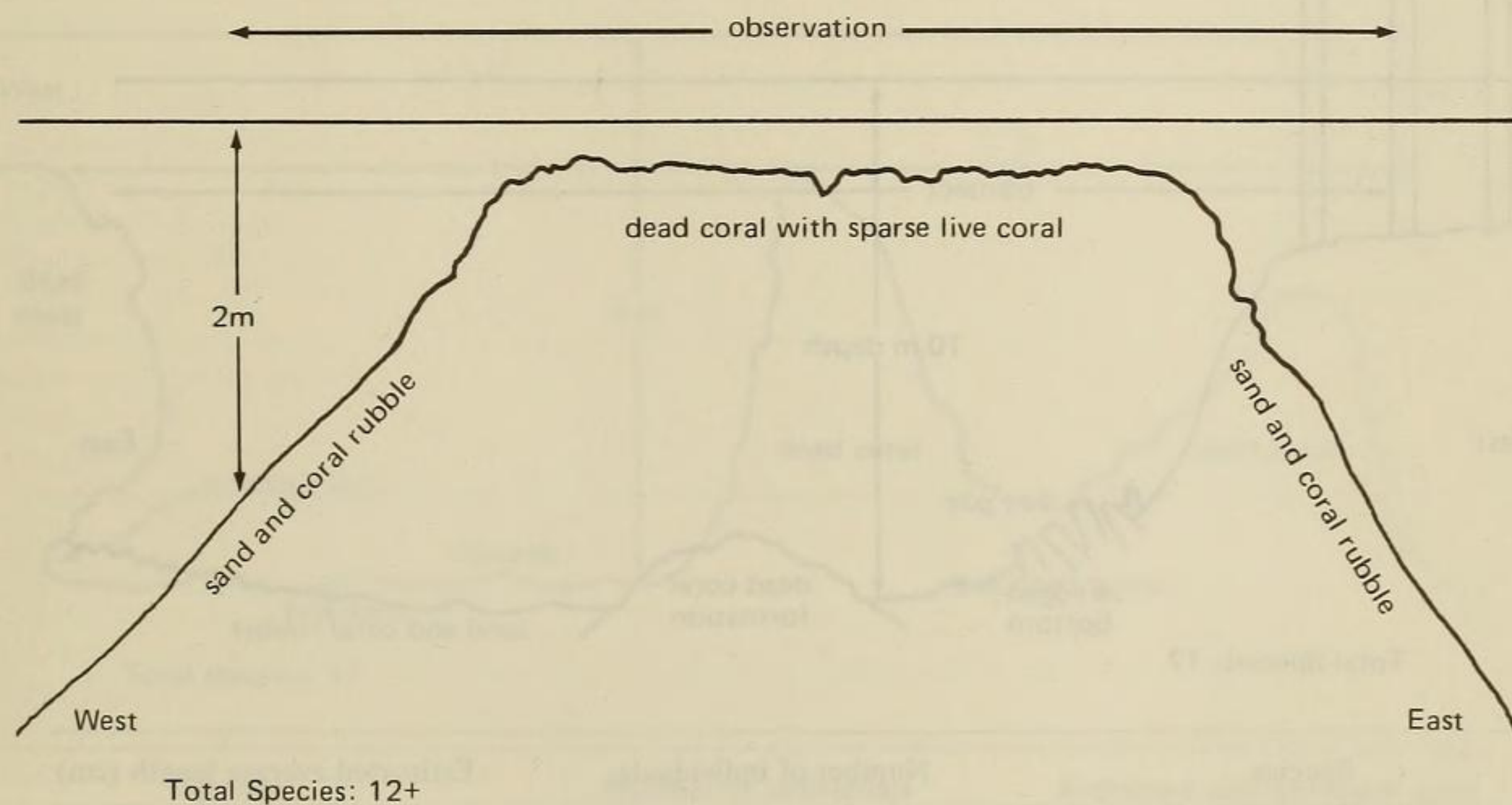
Species	Number of individuals	Estimated average length (cm)
<i>Acanthurus lineatus</i>	> 100	23
<i>Acanthurus olivaceus</i>	2	20
<i>Acanthurus</i> spp. (2)	> 150	18
<i>Carcharinus melanopterus</i>	1	183
<i>Centropyge flavissimus</i>	7	10
<i>Cephalopholis argus</i>	3	25
<i>Cephalopholis urodelis</i>	8	20
<i>Chaetodon auriga</i>	2	13
<i>Chaetodon ephippium</i>	1	20
<i>Chaetodon lunula</i>	1	15
<i>Chaetodon meyeri</i>	2	18
<i>Chaetodon ornatissimus</i>	3	18
<i>Chaetodon quadrimaculatus</i>	5	15
<i>Chaetodon ulietensis</i>	2	18
<i>Chromis caeruleus</i>	46	8
<i>Chromis margaritifer</i>	> 1000	5
<i>Coris gaimardi</i>	2	10
<i>Ctenochaetus strigosus</i>	> 500	18

Species	Number of individuals	Estimated average length (cm)
<i>Epibolus insidiator</i>	3	18
<i>Epinephelus microdon</i>	3	61
<i>Forcipiger longirostris</i>	1	13
Labridae spp. (2)	> 100	10
<i>Lutjanus bohar</i>	13	61
<i>Lutjanus fulvus</i>	20	46
<i>Melichthys vidua</i>	1	15
<i>Paracirrhites xanthus</i>	3	10
<i>Parupeneus barberinus</i>	3	41
<i>Parupeneus trifasciatus</i>	1	25
<i>Plectrogyphidodon dickii</i>	40	8
<i>Pomacentrus</i> sp. (yellow)	> 10	8
<i>Pomacentrus nigricans</i>	> 100	10
<i>Scarus</i> spp. (2)	> 25	23
<i>Thalassoma amblycephalus</i>	> 1000	6
<i>Zanclus canescens</i>	5	18
<i>Zebrasoma scopas</i>	8	15
Species observed off transect:		
<i>Cheilinus undulatus</i>	4	76
<i>Chlorurus gibbus</i>	1	91
<i>Lutjanus monostigma</i>	20	46
<i>Scarus</i> spp. (2)	> 200	36

Fish Observation, northwest corner, lagoon: FO 017010

Surveyed: 6 Dec 73, 1015–1035 hours. Tide: incoming from high–low 28 cm at 0907 hours. HIV: 1.2 m. Observation track length: 30 m.

Observation area general description: Patch reef area approximately 600 m off of cantonment area. Patch reef about 10 m in diameter. Gentle-slope sand and coral rubble apron around leeward (southwest) base of reef. Steeper apron around windward side. Reef mostly dead coral, approximately 10% coverage of live coral. Predominant corals: *Acropora*, *Porites*, *Pocillopora*, and *Favia*.

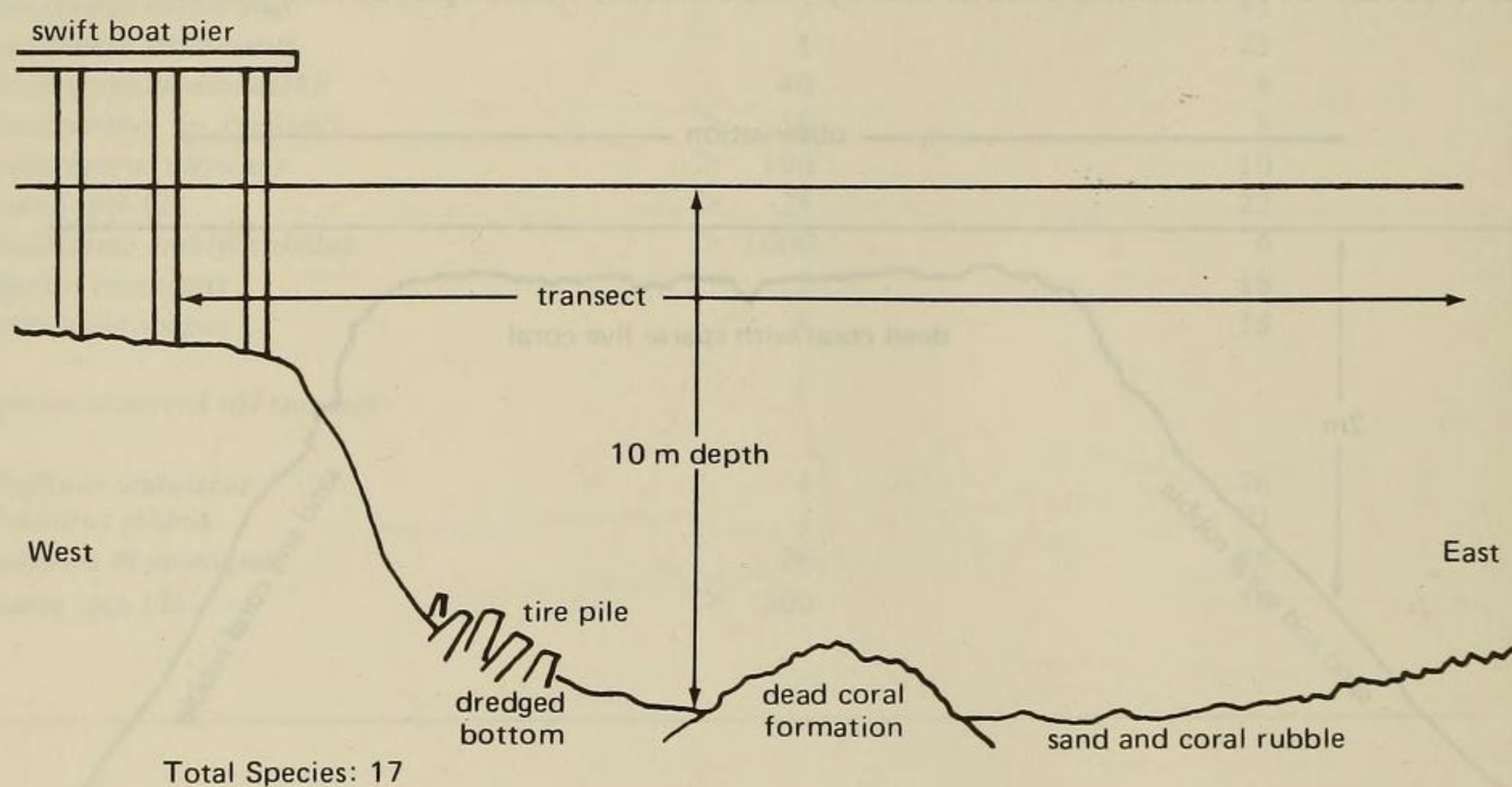


Species	Number of individuals	Estimated average length (cm)
<i>Chaetodon auriga</i>	2	18
<i>Chaetodon trifasciatus</i>	1	13
<i>Chaetodon ulietensis</i>	2	10
<i>Chromis caeruleus</i>	> 30	4
<i>Ctenochaetus striatus</i>	8	13
<i>Epinephelus merra</i>	1	13
<i>Flammeo sammara</i>	10	13
Labridae spp. (2)	> 30	5
<i>Lutjanus kasmira</i>	2	15
<i>Pomacentrus nigricans</i>	> 50	10
<i>Scarus sordidus</i>	4	15

Fish Transect, main wharf, lagoon: FT 017041

Surveyed: 1 Dec 73, 1330-1342 hours. Tide: outgoing to high-low (.5 m) at 1720 hours. HIV: 11 m. Transect length: 30 m.

Transect general description: Transect line extended from swift boat pier in offshore (east) direction. Bottom predominantly of sand and coral rubble. Most fish on and around a pile of discarded auto tires and a mound of dead coral. During the transect observation a tidal current of approximately 1 knot was present. No abundant live coral.

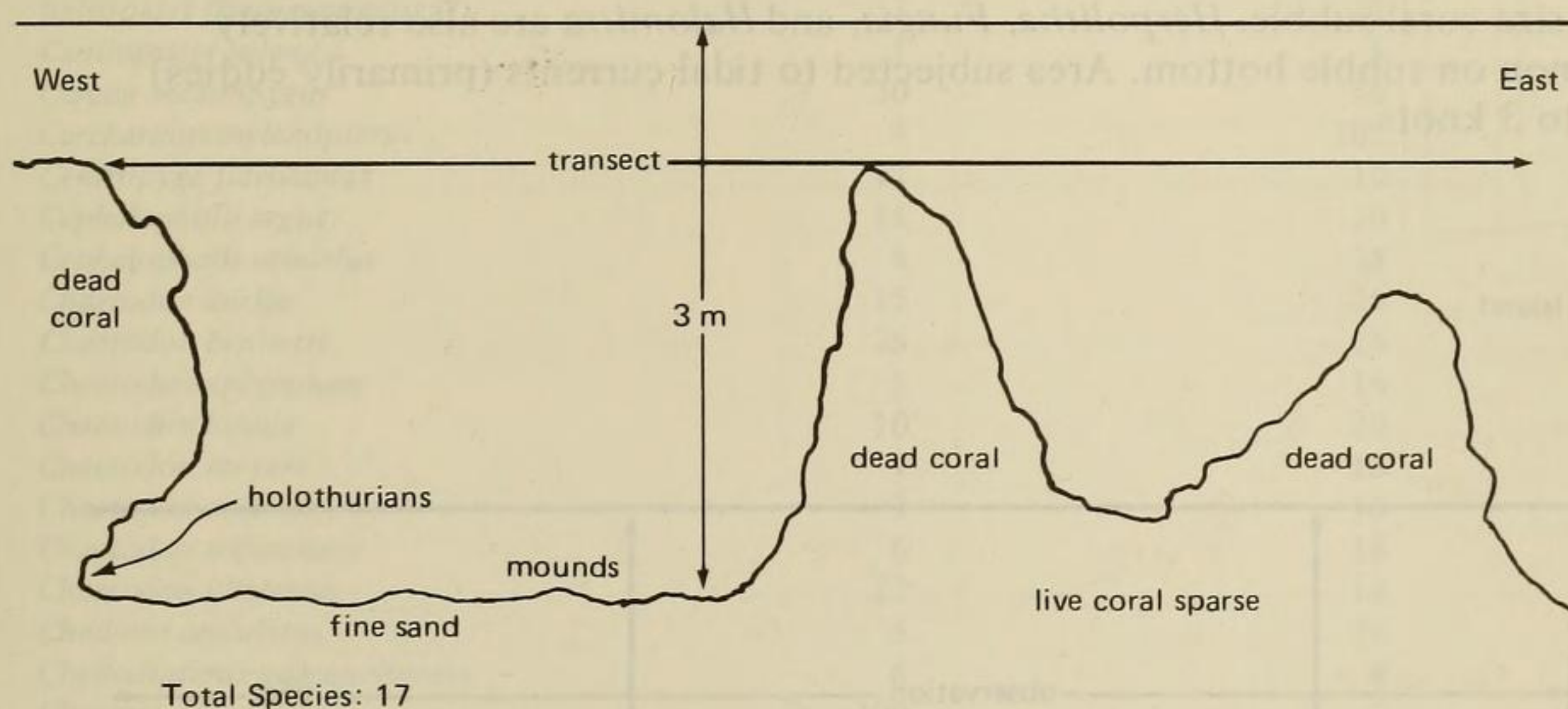


Species	Number of individuals	Estimated average length (cm)
<i>Arothron hispidus</i>	1	33
<i>Acanthurus xanthopterus</i>	5	23
<i>Caranx melampygus</i>	4	41
<i>Centropyge flavissimus</i>	1	8
<i>Cephalopholis urodelus</i>	3	20
<i>Chaetodon auriga</i>	7	15
<i>Chaetodon lunula</i>	2	13
<i>Chromis caeruleus</i>	37	8
<i>Chromis margaritifer</i>	> 200	5
Gobiidae sp.	50	4
<i>Heniochus acuminatus</i>	28	13
Labridae sp.	25	6
<i>Rhinecanthus aculeatus</i>	2	9
<i>Rhinecanthus rectangulatus</i>	1	15
<i>Sufflamen chrysopterus</i>	2	13
<i>Thalassoma amblycephalus</i>	30	8
<i>Thalassoma lunare</i>	4	13

Fish Transect, off swimming pool, lagoon: FT 018020

Surveyed: 1 Dec 73, 1155-1220 hours. Tide: outgoing to high-low (.5 m) at 1720 hours. HIV: 2.3 m. Transect length: 30 m.

Transect general description: About 175 m offshore (east of salt water swimming pool site). Many patch reefs, mostly of 10 to 70 m maximum dimension. Coral coverage less than 10% on solid surfaces. Most reef areas showing thin layers of silt. Holothurians at base of reef edge on sand. Dominant coral types: predominantly "lobate," rounded coral forms—*Porites*, *Leptastrea* (?), *Pocillopora*.

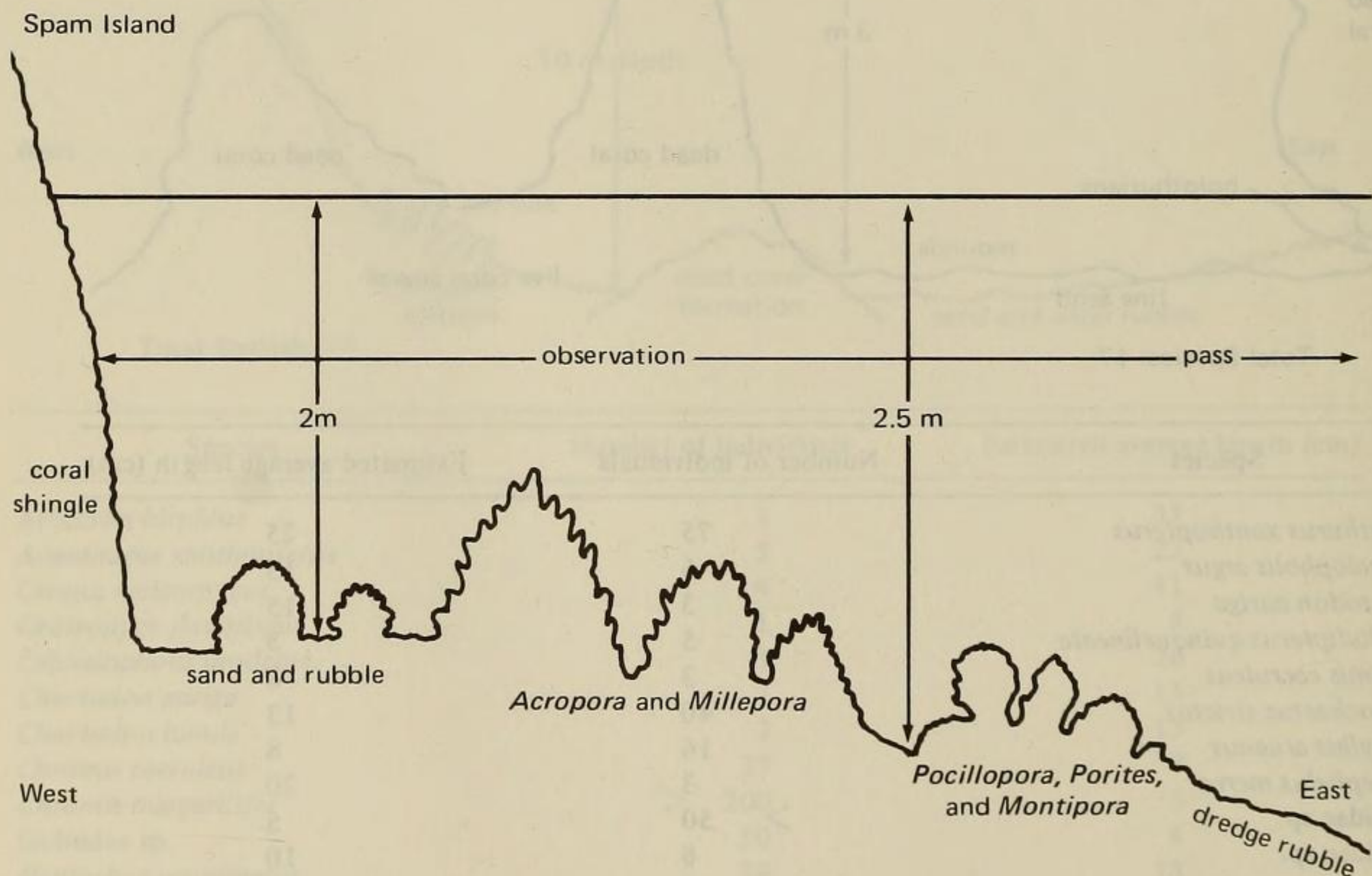


Species	Number of individuals	Estimated average length (cm)
<i>Acanthurus xanthopterus</i>	75	25
<i>Cephalopholis argus</i>	6	15
<i>Chaetodon auriga</i>	3	15
<i>Cheilodipterus quinquelineata</i>	5	8
<i>Chromis caeruleus</i>	3	6
<i>Ctenochaetus striatus</i>	40	13
<i>Dascyllus aruanus</i>	16	8
<i>Epinephelus merra</i>	3	20
Gobiidae sp.	> 50	5
Labridae sp.	8	10
<i>Monotaxis grandoculis</i>	2	13
<i>Pomacentrus albofasciatus</i>	25	10
<i>Pomacentrus coelestis</i>	60	8
<i>Pomacentrus nigricans</i>	20	10
<i>Rhinecanthus aculeatus</i>	5	13
<i>Scarus sordidus</i>	5	10
<i>Scarus</i> sp.	10	13

Fish Observation, Spam Island, lagoon: FO 018045

Surveyed: 9 Dec 73, 1430–1450 hours. Tide: incoming to high–high (1.3 m) at 1821 hours. HIV: 20 m. Observation track length: 40 m.

Observation area general description: Area immediately to east of lagoon shore of Spam Island. Varied bottom; at shoreline a slope of coral shingle extending down to 25 m depth where bottom is composed of sand, coral rubble, and scattered coral heads. Further north and east, *Acropora* and *Millepora* are very abundant, covering up to 30% of bottom. Further east *Pocillopora*, *Porites*, *Montipora*, and *Favia* become dominant although covering less than 10% of bottom. Bottom area without live coral is primarily of medium to large size coral rubble. *Herpolitha*, *Fungia*, and *Halomitra* are also relatively common on rubble bottom. Area subjected to tidal currents (primarily eddies) of 1 to 3 knots.



Total Species: 77+

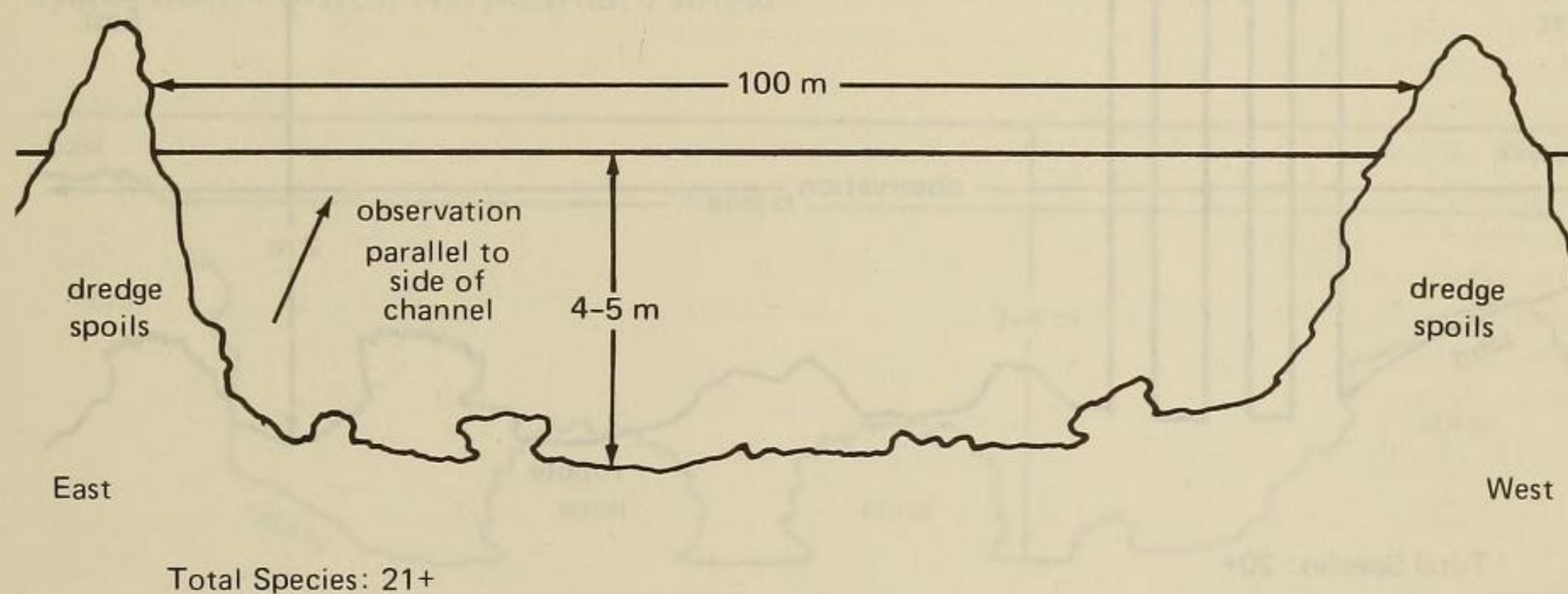
Species	Number of individuals	Estimated average length (cm)
<i>Acanthurus glaucopareius</i>	10	23
<i>Acanthurus lineatus</i>	25	23
<i>Acanthurus triostegus</i>	> 100	15
<i>Acanthurus xanthopterus</i>	> 100	25
<i>Acanthurus</i> spp. (2)	> 200	18
<i>Adioryx spinifer</i>	5	20
<i>Amphiprion chrysopterus</i>	10	10
<i>Anampses caeruleo punctatus</i>	3	10
<i>Anyperodon leucogrammicus</i>	7	28
<i>Aprion virescens</i>	2	25
<i>Balistapus undulatus</i>	6	20
<i>Balistoides flavimarginatus</i> (?)	3	76
<i>Canthigaster solandri</i>	1	8
<i>Caranx melampygus</i>	> 30	36
<i>Carcharinus melanopterus</i>	4	102
<i>Centropyge flavissimus</i>	12	10
<i>Cephalopholis argus</i>	15	30
<i>Cephalopholis urodelus</i>	8	25
<i>Chaetodon auriga</i>	15	20
<i>Chaetodon bennetti</i>	25	18
<i>Chaetodon ephippium</i>	5	18
<i>Chaetodon lunula</i>	10	20
<i>Chaetodon meyeri</i>	4	18
<i>Chaetodon semeion</i>	2	18
<i>Chaetodon trifasciatus</i>	6	18
<i>Chaetodon ulietensis</i>	12	18
<i>Cheilinus undulatus</i>	5	76
<i>Cheilodipterus quinquelineata</i>	6	8
<i>Chromis caeruleus</i>	> 300	6
<i>Chromis margaritifer</i>	> 100	5
<i>Ctenochaetus strigosus</i>	> 100	18
<i>Dascyllus aruanus</i>	> 50	6
<i>Dascyllus trimaculatus</i>	6	10
<i>Epibolus insidiator</i>	10	20
<i>Epinephelus merra</i>	12	25
<i>Epinephelus microdon</i>	8	61
<i>Gnathanodon speciosus</i>	2	64
<i>Gomphosus varius</i>	6	10
<i>Gymnothorax flavimarginatus</i>	3	97
<i>Gymnothorax pictus</i>	2	89
<i>Hemigymnus melapterus</i>	3	18
Hemiramphidae sp.	50	30
<i>Heniochus permutatus</i>	10	18
<i>Heniochus varius</i>	12	15
Labridae spp. (3)	> 75	13
<i>Labroides bicolor</i>	1	9
<i>Labroides dimidiatus</i>	5	10
<i>Labroides rubrolabiatus</i>	2	10

Species	Number of individuals	Estimated average length (cm)
<i>Lethrinus</i> spp. (2)	6	36
<i>Lutjanus bohar</i>	8	41
<i>Lutjanus monostigma</i>	12	36
<i>Megaprotodon strigangulus</i>	8	18
<i>Monotaxis grandoculis</i>	15	23
<i>Naso brevirostris</i>	20	25
<i>Paracirrhites arcatus</i>	10	15
<i>Parupeneus bifasciatus</i>	3	20
<i>Plectroglyphidodon dickii</i>	> 25	8
<i>Pomacentrus coelestis</i>	> 30	8
<i>Pomacentrus nigricans</i>	> 100	10
<i>Pterois antennata</i>	8	18
<i>Pygoplites diacanthus</i>	1	20
<i>Scarus ghobban</i>	20	38
<i>Scarus frenatus</i>	15	23
<i>Scarus pectoralis</i>	30	36
<i>Scarus sordidus</i>	> 25	15
Scaridae spp. (2)	> 100	20
<i>Sufflamen chrysopterus</i>	8	13
<i>Thalassoma amblycephalus</i>	> 300	8
<i>Thalassoma hardwickei</i>	10	20
<i>Thalassoma lunare</i>	8	20
<i>Zanclus canescens</i>	12	18
<i>Zebrasoma scopas</i>	6	15

Fish Observation, dredge channel, lagoon: FO 020044

Surveyed: 7 Dec 73, 1135–1150 hours. Tide: near slack, high–low (21 cm) at 0955 hours. HIV: 10 m. Observation length: 30 m.

Observation area general description: Dredged channel approximately 100 m wide and 600 m long. Southwestern end 300 m from mouth of main lagoon pass. Subjected to tidal currents in excess of 5 knots. Average depth 5–6 m. Bottom primarily of dead coral rubble (to boulder size) with >10% live coral coverage. Predominant coral types: *Pocillopora*, *Montipora*, *Halomitra*. Elongate dredge spoil island along both sides of channel. Observation track parallel with western side of channel.

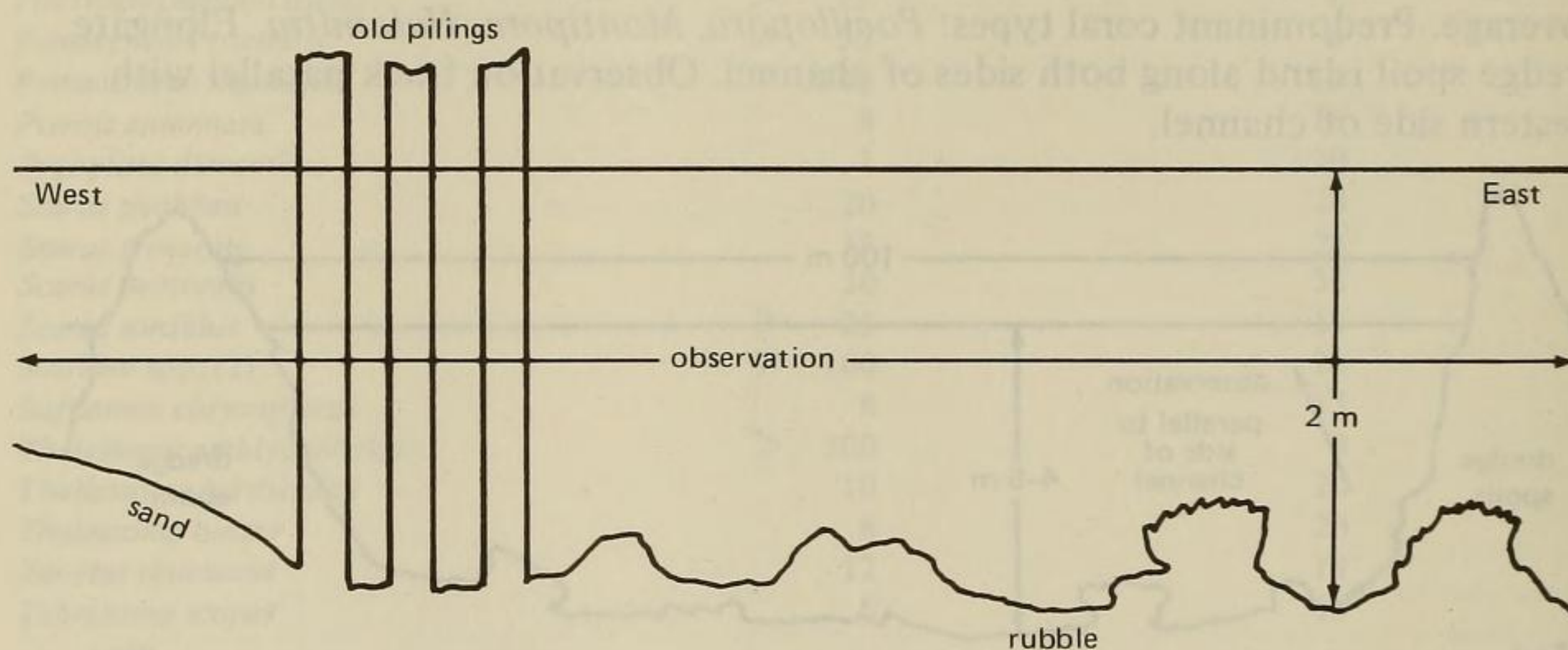


Species	Number of individuals	Estimated average length (cm)
<i>Acanthurus</i> sp.	> 500	15
<i>Adioryx spinifer</i>	2	20
<i>Balistes undulatus</i>	1	20
<i>Centropyge flavissimus</i>	10	9
<i>Chaetodon auriga</i>	2	20
<i>Chaetodon trifasciatis</i>	1	18
<i>Ctenochaetus striatus</i>	> 100	13
<i>Gymnothorax flavimarginatus</i>	1	114
Labridae spp. (3)	> 500	13
<i>Myripristis murdjan</i>	25	18
<i>Pomacentrus nigricans</i>	> 50	10
<i>Scarus frenatus</i>	25	18
<i>Scarus ghobban</i>	30	25
<i>Scarus sordidus</i>	40	13
<i>Scarus</i> spp. (2)	> 200	20
<i>Thalassoma amblycephalus</i>	> 150	8
<i>Zanclus canescens</i>	4	18
<i>Zebrasoma scopas</i>	2	20

Fish Observation, seaplane moorage, lagoon: FO 020056

Surveyed: 2 Dec 73, 1405-1415 hours. Tide: outgoing to high-low (0.5 m) at 1819 hours. HIV: 6.5 m. Observation track length: 50 m.

Observation area general description: Dredged bottom immediately offshore between two artificial rock groins (abandoned sea-plane docks). Bottom primarily of coral rubble and concrete block debris. Live coral sparse, predominantly *Pocillopora*.



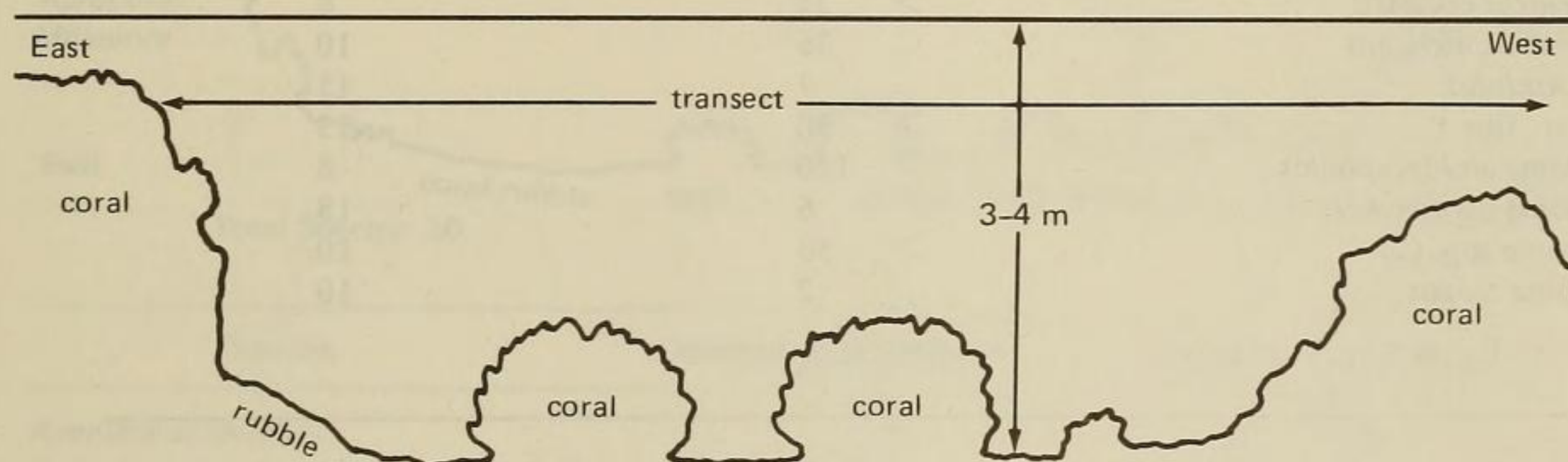
Total Species: 20+

Species	Number of individuals	Estimated average length (cm)
<i>Abudefduf glaucus</i>	10	10
<i>Abudefduf phoenixensis</i>	4	9
<i>Abudefduf sordidus</i>	> 50	13
<i>Acanthurus triostegus</i>	> 40	13
<i>Acanthurus xanthopterus</i>	12	23
<i>Caranx melampygus</i>	3	28
<i>Chaetodon auriga</i>	2	15
<i>Chaetodon lunula</i>	5	13
<i>Chelon vaigiensis</i>	2	23
<i>Epinephelus merra</i>	3	15
<i>Flammeo sammara</i>	1	15
<i>Lutjanus fulvus</i>	5	23
<i>Mulloidichthys samoensis</i>	> 40	25
<i>Pomacentrus albofasciatus</i>	> 50	6
<i>Pomacentrus nigricans</i>	> 30	10
<i>Rhinecanthus aculeatus</i>	10	14
<i>Scarus</i> spp. (3)	> 25	13
<i>Stethojulis balteat</i>	> 30	10

Fish Transect, Coral Gardens, lagoon: FT 021046

Surveyed: 30 Nov 73, 1135–1155 hours. Tide: outgoing to high–low (0.5 m) at 1619 hours. HIV: 15 m. Transect length: 30 m.

Transect general description: An area of abundant and large patch reefs approximately 500 m east of the south lagoon pass. From the edge of the patch reef area toward the pass the bottom becomes more uniform in depth (approximately 3–4 m) and coral rubble bottom becomes more prevalent as the pass is approached. The transect line follows the reef edge to coral rubble gradient and is an area subjected to tidal currents of >2 knots. Bottom generally of large dead coral masses covered with approximately 30% live coral and 20% coral rubble. One large anemone. Dominant coral types: *Pocillopora*, *Millepora*, *Halomitra*, *Porites*, *Herpolitha*, *Fungia*.



Total Species: 62+, also sighted: 2 turtles (76 cm and 100 cm carapace lengths)

Species	Number of individuals	Estimated average length (cm)
<i>Adioryx caudimaculata</i>	2	20
<i>Adioryx spinifer</i>	2	18
<i>Acanthurus xanthopterus</i>	6	20
<i>Acanthurus</i> sp.	40	15
<i>Amphiprion chrysopterus</i>	6	10
<i>Anyperodon leucogrammicus</i>	3	23
<i>Balistapus undulatus</i>	3	15
<i>Calotomus</i> sp.	9	18
<i>Caranx melampygus</i>	20	36
<i>Centropyge flavissimus</i>	28	9
<i>Cephalopholis argus</i>	2	20
<i>Chaetodon auriga</i>	2	15
<i>Chaetodon bennetti</i>	5	13
<i>Chaetodon trifasciatus</i>	4	15
<i>Chaetodon ulietensis</i>	3	15
<i>Chromis margaritifer</i>	> 100	6
<i>Chromis caeruleus</i>	> 200	6
<i>Ctenochaetus strigosus</i>	> 60	15

Species	Number of individuals	Estimated average length (cm)
<i>Gomphosus varius</i>	8	10
<i>Heniochus acuminatus</i>	1	15
Labridae spp. (>2 juv.)	40	10
<i>Labroides dimidiatus</i>	2	10
<i>Labroides rubrolabiatus</i>	3	9
<i>Lutjanus bohar</i>	2	46
<i>Megaprotodon strigangulus</i>	1	13
<i>Myripristis amaenus</i>	> 10	18
<i>Myripristis murdjan</i>	> 25	18
<i>Myripristis</i> sp.	2	18
<i>Naso brevirostris</i>	12	25
<i>Paracirrhites forsteri</i>	6	13
<i>Paracirrhites xanthus</i>	2	10
<i>Plectroglyphidodon dickii</i>	16	6
<i>Pomacentrus coelestis</i>	> 25	8
<i>Pomacentrus nigricans</i>	36	10
<i>Scarus sordidus</i>	7	15
<i>Scarus</i> sp. (juv.)	> 30	13
<i>Thalassoma amblycephalus</i>	> 120	8
<i>Thalassoma hardwickei</i>	6	18
<i>Thalassoma</i> spp. (2)	> 50	10
<i>Zebrasoma scopas</i>	2	10

Other species sighted in area adjacent to transect area on 20 Nov 73 observation:

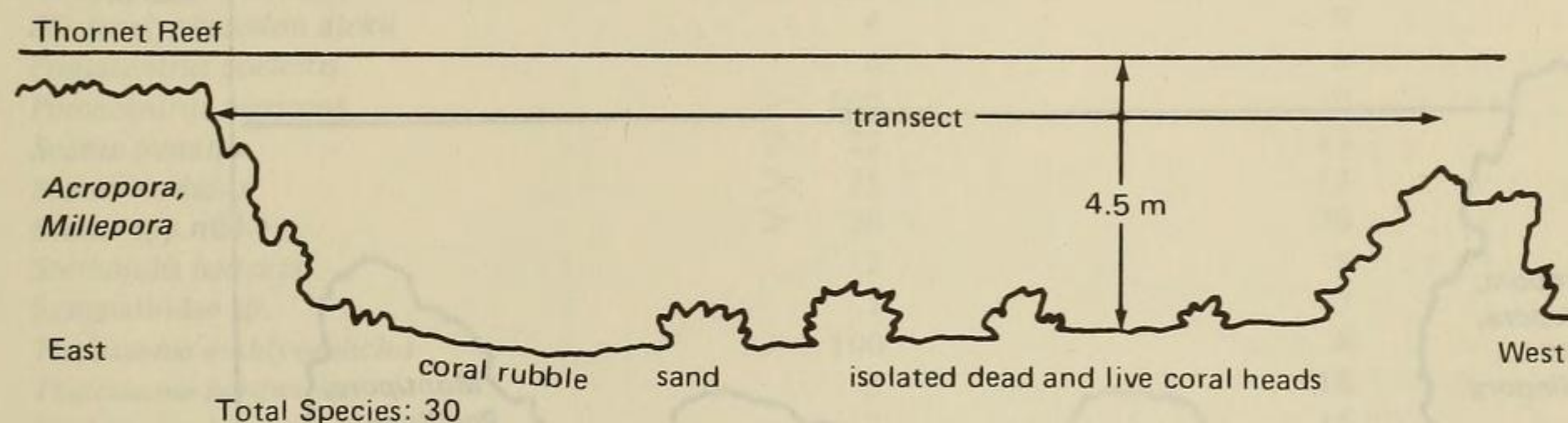
Acanthurus triostegus
Aprion virescens
 Balistidae sp. (>50 cm)
Chaetodon ephippium
Chaetodon lunula
Chaetodon meyeri
Chaetodon unimaculatus
Cheilinus undulatus
Epibulus insidiator
 Hemiramphidae sp.
Heniochus permutatus
Kyphosus cineracens
Lethrinus sp.
Lutjanus fulvus
Lutjanus monostigma
Monataxis grandolulis
Pygoplites diacanthus
Scarus spp. (adults)
Thalassoma lunare

Also sighted: 2 turtles (76 cm and 100 cm carapace lengths)

Fish Transect, Thornet Reef, lagoon: FT 023038

Surveyed: 30 Nov 73, 1012–1050 hours. Tide: incoming to low–high (0.9 m) at 1044 hours. HIV: 15–18 m. Transect length: 30 m.

Transect general description: Patch reef area approximately 800 m east of main wharf area and 300 m from dredged turning basin. Depths in surrounding area 4.5 to 9 m with coral pinnacles and patch reefs of 3 to 15 m diameter rising to within a few feet of the surface. Bottom generally of sand or sand and coral rubble. Dominant coral types: *Acropora*, *Pocillopora*, and *Millepora*. This area was subjected to tidal currents of approximately 1 knot during incoming tides.

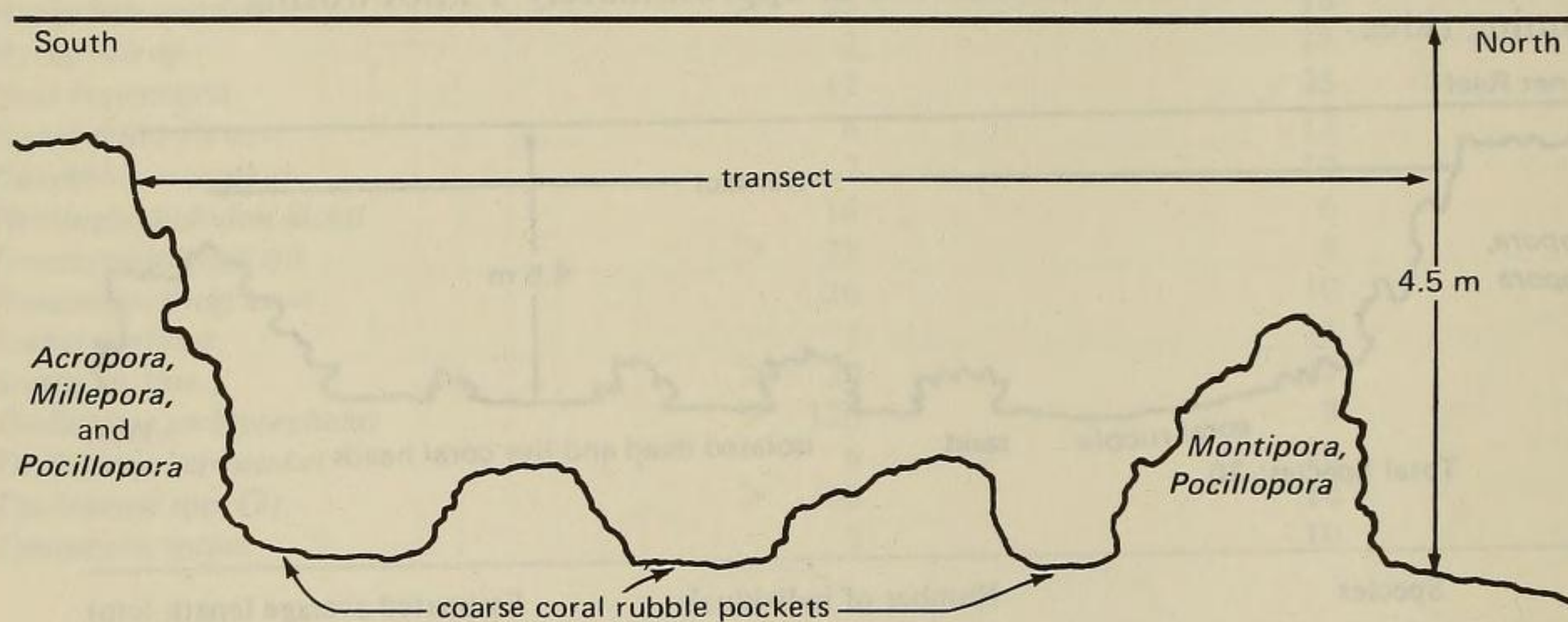


Species	Number of individuals	Estimated average length (cm)
<i>Acanthurus lineatus</i>	1	20
<i>Acanthurus</i> sp. (new species—Randall)	> 725	18
<i>Acanthurus xanthopterus</i>	10	25
<i>Centropyge bicolor</i>	2	9
<i>Centropyge flavissimus</i>	6	10
<i>Cephalopholis argus</i>	2	20
<i>Cephalopholis urodelus</i>	1	10
<i>Cheilodipterus quinquelineata</i>	5	6
<i>Chromis caeruleus</i>	> 100	5
<i>Chromis margaritifer</i>	> 50	6
<i>Dascyllus aruanus</i>	> 80	5
<i>Epinephelus merra</i>	1	15
Gobiidae spp. (3)	> 100	5
<i>Gomphosus varius</i>	4	9
Labridae spp. (3)	30	10
<i>Megaprotodon strigangulus</i>	1	13
<i>Monotaxis grandoculis</i>	5	13
<i>Paracirrhites forsteri</i>	3	13
<i>Parupeneus barberinus</i>	1	18
<i>Pomacentrus nigricans</i>	45	9
<i>Scarus frenatus</i>	> 40	10
<i>Scarus ghobban</i>	4	25
<i>Scarus sordidus</i>	> 25	13
<i>Scomberoides sancti-petri</i>	5	25
<i>Sufflamen chrysopterus</i>	3	11
<i>Thalassoma amblycephalus</i>	> 100	8

Fish Transect, **Thornet Reef II, lagoon**: FT 023038

Surveyed: 4 Dec 73, 0935–0950 hours. Tide: incoming to high–high (1 m) at 1415 hours. HIV: 10 m. Transect length: 30 m.

Transect general description: Same as 30 Nov 73, FT 023038, except this transect aligned on a north–south orientation. Dominant coral types: *Acropora*, *Pocillopora*, *Montipora*.



Total Species: 44

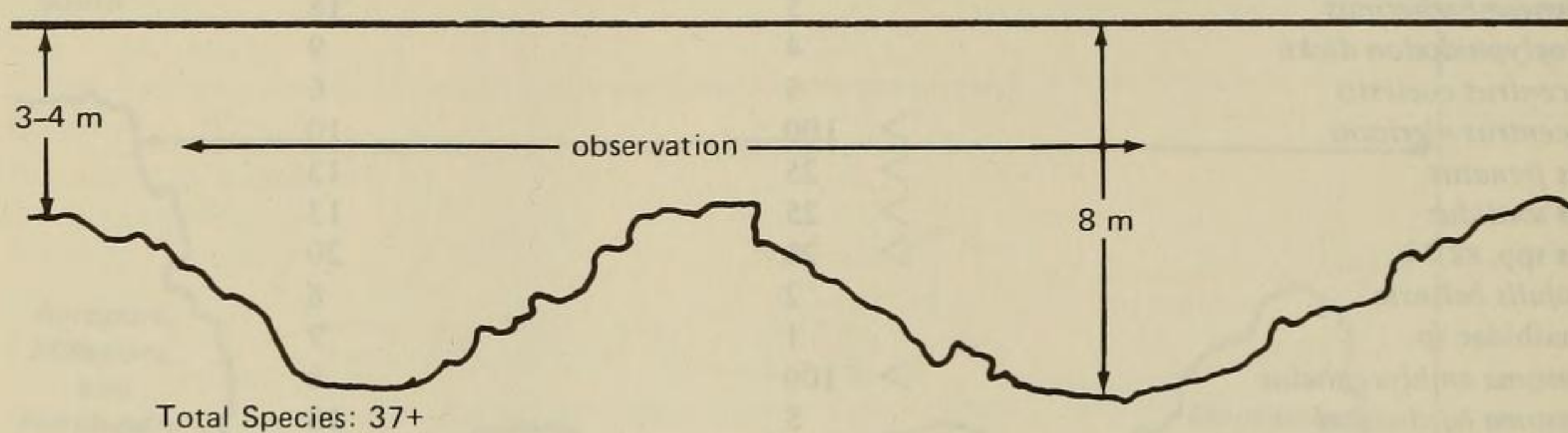
Species	Number of individuals	Estimated average length (cm)
<i>Acanthurus glaucopareius</i>	6	20
<i>Acanthurus xanthopterus</i>	3	20
<i>Amphiprion chrysopterus</i>	12	20
<i>Amphiprion</i> sp.	2	6
<i>Centropyge flavissimus</i>	6	9
<i>Cephalopholis argus</i>	1	20
<i>Cephalopholis urodelus</i>	2	20
<i>Chaetodon bennetti</i>	2	15
<i>Chaetodon kleini</i>	2	13
<i>Chaetodon trifasciatis</i>	3	13
<i>Chaetodon ulietensis</i>	4	13
<i>Cheilinus undulatus</i>	1	76
<i>Chromis caeruleus</i>	50	6
<i>Chromis margaritifer</i>	> 25	8
<i>Chromis</i> sp.	> 50	5
Cirrhitidae sp.	1	10
<i>Ctenochaetus</i> sp.	7	13
<i>Dascyllus aruanus</i>	> 100	5
<i>Dascyllus trimaculatus</i>	2	25

Species	Number of individuals	Estimated average length (cm)
<i>Epinephelus merra</i>	1	15
Gobiidae spp. (2)	> 50	5
<i>Gomphosus varius</i>	2	10
<i>Gymnothorax flavimarginatus</i>	1	122
<i>Labroides dimidiatus</i>	5	11
<i>Labroides rubrolabiatus</i>	2	13
Labridae sp. (juv.)	3	10
<i>Monotaxis grandoculis</i>	2	15
<i>Paracirrhites forsteri</i>	4	14
<i>Parupeneus barberinus</i>	5	18
<i>Plectroglyphidodon dickii</i>	4	9
<i>Pomacentrus coelestis</i>	6	6
<i>Pomacentrus nigricans</i>	> 100	10
<i>Scarus frenatus</i>	> 25	13
<i>Scarus sordidus</i>	> 25	13
Scarus spp. (2)	> 20	20
<i>Stethojulis balteata</i>	2	8
Syngnathidae sp.	1	9
<i>Thalassoma amblycephalus</i>	> 100	8
<i>Thalassoma hardwickei</i>	5	18
<i>Thalassoma lunare</i>	7	15
<i>Zanclus canescens</i>	4	15
<i>Zebrasoma scopas</i>	2	15

Fish Observation, southwest lagoon: FO 024053

Surveyed: 6 Dec 73, 1445–1500 hours. Tide: incoming to high–high (1.2 m) at 1641 hours. HIV: 15 m. Observation track length: 30 m.

Observation area general description: 600 m east of shoreline point between old Pan Am hotel and northernmost seaplane ramp. Water 3 to 8 m deep. Bottom with large ravines (3–5 m deep and 25–30 m across) with lengths running east–west. Extensive and diverse coral coverage (estimated >30% of bottom covered). Predominant coral types: *Pocillopora*, *Montipora*, *Porites*, *Pavona*, and *Acropora*.

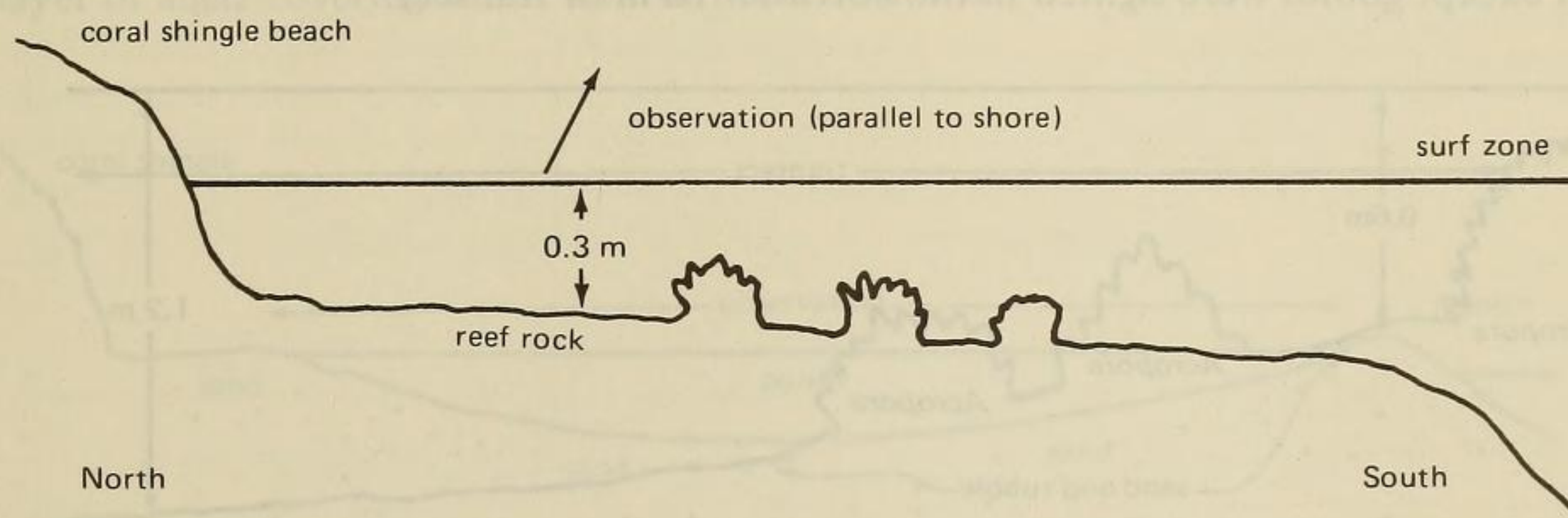


Species	Number of individuals	Estimated average length (cm)
<i>Acanthurus</i> spp. (2)	> 50	15
<i>Centropyge flavissimus</i>	20	10
<i>Cephalopholis argus</i>	10	36
<i>Chaetodon auriga</i>	10	18
<i>Chaetodon kleini</i>	2	15
<i>Chaetodon lunula</i>	3	15
<i>Chaetodon trifasciatus</i>	4	18
<i>Chaetodon ulietensis</i>	12	15
<i>Chanos chanos</i>	> 40	64
<i>Cheilinus undulatus</i>	5	64
<i>Chromis caeruleus</i>	> 300	5
<i>Chromis margaritifer</i>	> 50	5
<i>Ctenochaetus strigosus</i>	> 100	13
<i>Dascyllus aruanus</i>	30	5
<i>Epibolus insidiator</i>	5	25
<i>Epinephelus merra</i>	10	20
<i>Epinephelus microdon</i>	2	64
<i>Gomphosus varius</i>	5	10
<i>Gracila albomarginata</i>	1	18
<i>Gymnothorax flavimarginatus</i>	3	102
<i>Heniochus acuminatus</i>	> 40	18
Labridae spp. (2)	> 100	10
<i>Labroides dimidiatus</i>	5	10
<i>Labroides rubrolabiatus</i>	4	10
Lutjanidae spp. (2)	6	25
<i>Megaprotodon strigangulus</i>	2	18
<i>Myripristis</i> spp. (2)	> 20	18
<i>Plectroglyphidodon dickii</i>	30	8
<i>Pomacentrus nigricans</i>	> 50	10
<i>Scarus</i> spp. (2)	> 50	20
<i>Thalassoma amblycephalus</i>	> 200	8
<i>Zanclus canescens</i>	5	15

Fish Observation, southwest ocean reef: FO 027067

Surveyed: 2 Dec 73, 1500–1510 hours. Tide: outgoing to high–low (0.5 m) at 1819 hours. HIV: 9 m. Observation track length: 60 m.

Observation area general description: Ocean reef intertidal shallows, approximately 0.3 m deep. Bottom of shallow gullied reef rock; coral sparse, predominantly small, isolated *Pocillipora* heads. Observation track parallel to shoreline, about 12 m from shore.



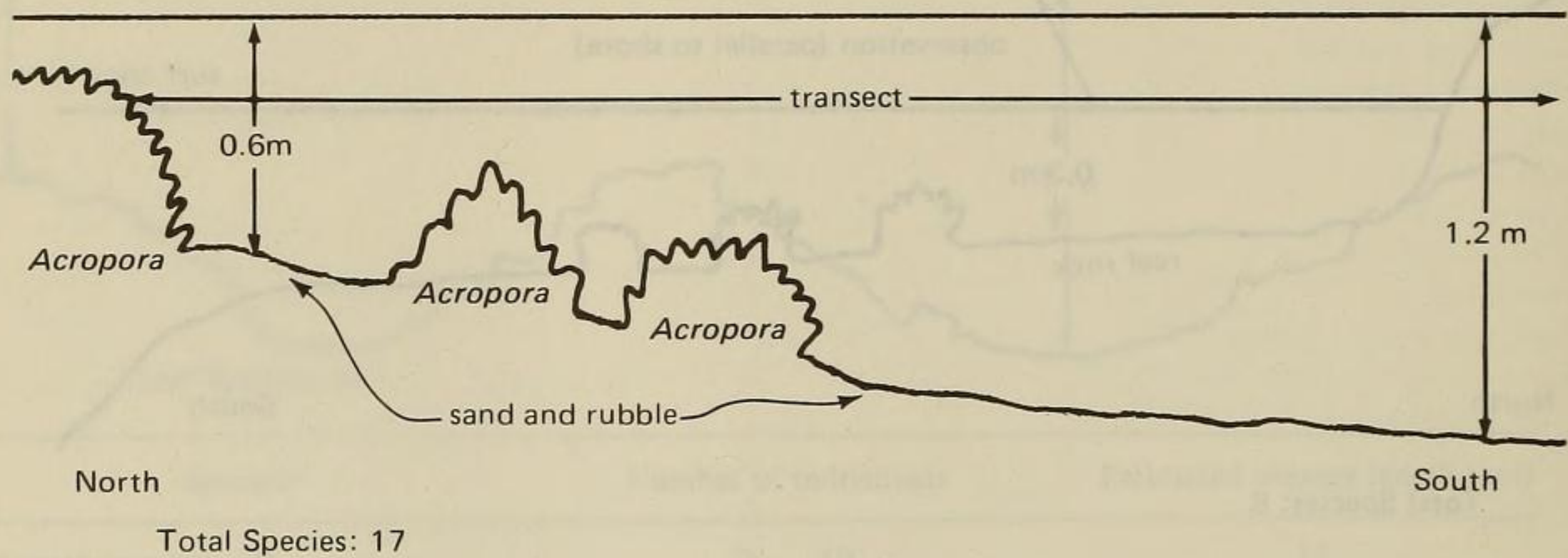
Total Species: 8

Species	Number of individuals	Estimated average length (cm)
<i>Abudefduf glaucus</i>	5	10
<i>Acanthurus triostegus</i>	> 30	13
Carangidae sp.	2	25
<i>Carcharinus melanopterus</i>	4	61
<i>Kuhlia</i> sp.	> 50	18
Lutjanidae sp.	> 100	8
<i>Lutjanus bohar</i>	2	25
<i>Thalassoma hardwickei</i>	3	13 [^]

Fish Transect, east runway end, lagoon: FT 041014

Surveyed: 1 Dec 73, 1505–1515 hours. Tide: outgoing to high–low (0.5 m) at 1720 hours. HIV: 2 m. Transect length: 30 m.

Transect general description: On sandy shelf approximately 200 m offshore and 1500 m southeast of east end of main runway. 30 m to the south the bottom begins to drop off steeply to the deeper lagoon water (4.5 m). North end of transect is in a shallow stand of *Acropora formosa* coral; the southern 250 m of the transect is over bottom of sand and shell and coral rubble. All fish except gobies were sighted in the northern 10 m of transect.



Species	Number of individuals	Estimated average length (cm)
<i>Acanthurus xanthopterus</i>	20	20
<i>Amblygobius phalaena</i>	1	6
<i>Chaetodon auriga</i>	1	18
<i>Chromis caeruleus</i>	40	5
<i>Ctenochaetus striatus</i>	1	13
<i>Epinephelus merra</i>	1	10
<i>Flammeo sammara</i>	4	11
Gobiidae sp.	2	6
Labridae sp.	5	3
<i>Lutjanus fulvus</i>	> 150	23
<i>Lutjanus kasmira</i>	12	18
<i>Pomacentrus nigricans</i>	3	10

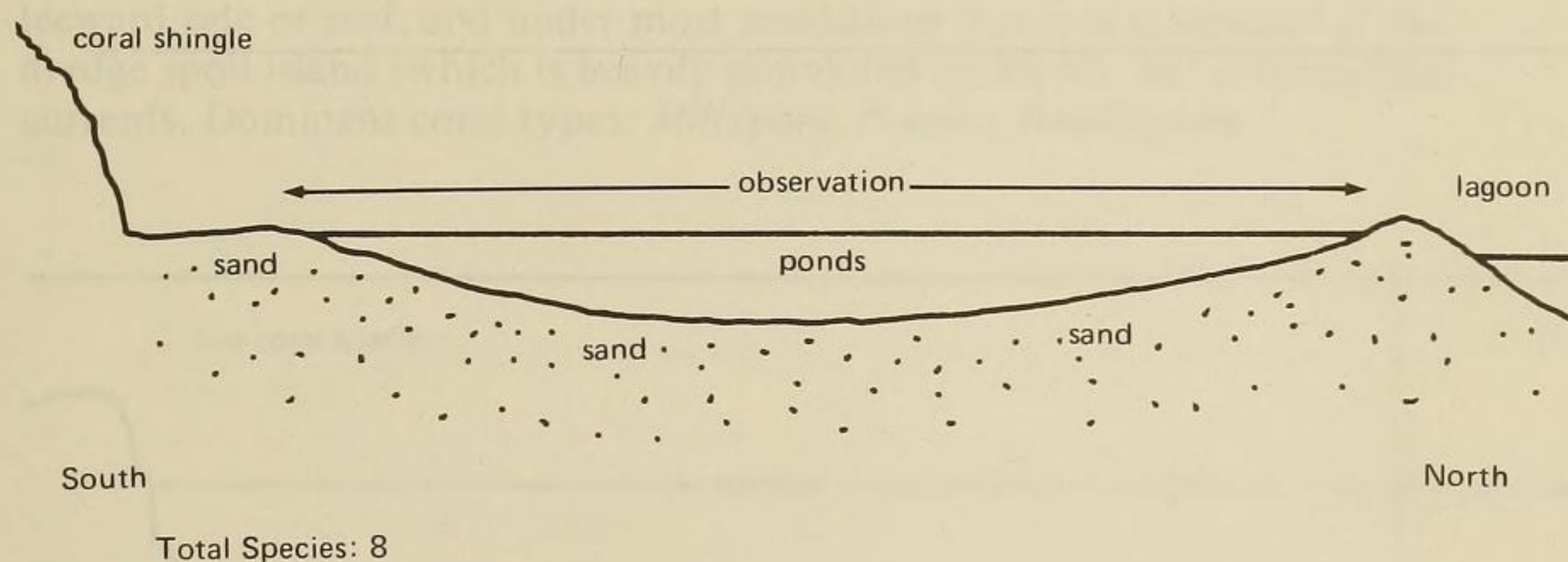
Other species sighted adjacent to area shoreward of transect site on 2 Dec 73 observations:

Albula vulpes
Arothron hispidus
 Balistidae sp.
Chelon vaigiensis
Crenimugil crenilabis

Fish Observation, palm tree row intertidal pond: FO(w) 041063

Surveyed: 2 Dec 73, 1515–1530 hours. Tide: outgoing to high–low (0.5 m) at 1819 hours. HIV: Not determined. Observation track length: 200 m (waded).

Observation area general description: An intertidal pond complex of approximately 300 m by 400 m. Average depth when surveyed was about 20–25 cm. All bottom of sand with sparse coral rubble; no live coral. Located on southwestern shore of lagoon-side slightly to west of “fisherman’s shack.” Thin layer of algae covering about 40% of pond bottoms.



Species	Number of individuals	Estimated average length (cm)
<i>Abudefduf sordidus</i>	2	13
<i>Arothron hispidus</i>	> 40	15
<i>Carcharinus melanopterus</i>	7	66
<i>Chelon vaigiensis</i>	> 300	18
<i>Crenimugil crenilabis</i>	> 300	20
<i>Epinephelis merra</i>	1	15
<i>Gymnothorax pictus</i>	1	61
<i>Lutjanus fulvus</i>	2	18

Also sighted *Calappa hepatica* (box crabs), about 6 individuals with a mean carapace width of 9 cm.

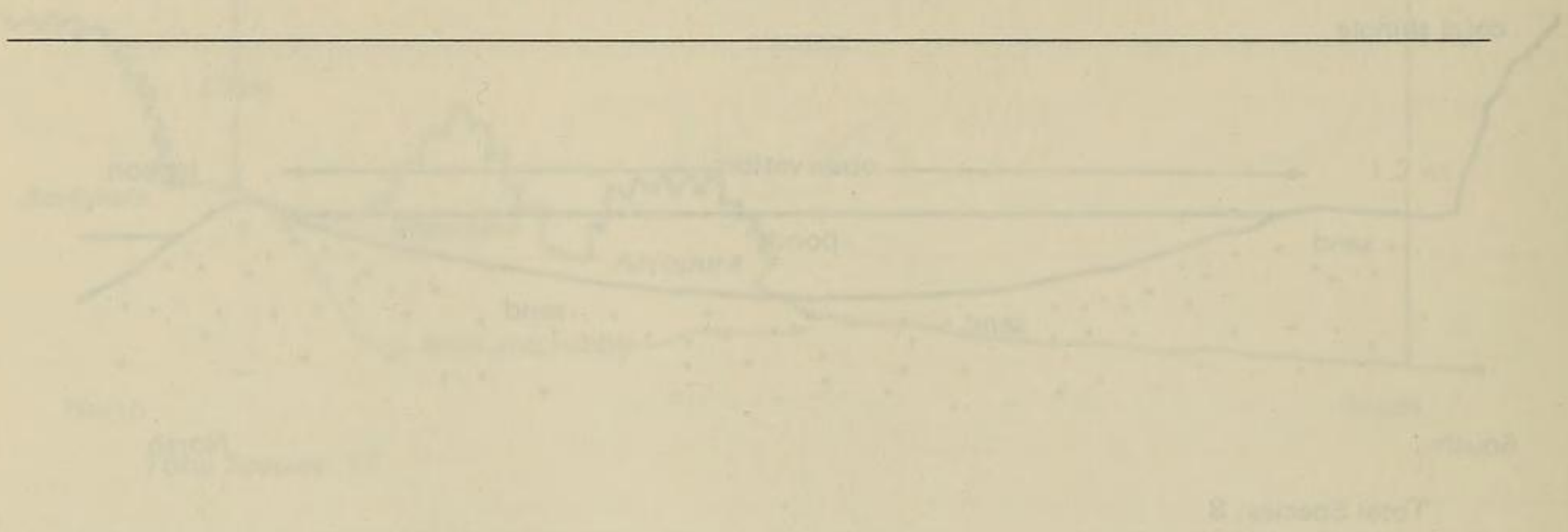
Fish Observation, palm tree row, ocean reef: FO 041065

Surveyed: 2 Dec 73, 1530-1540

All conditions similar to southwest ocean reef: FO 027067

Total species: 4+

Species	Number of individuals	Estimated average length (cm)
Carangidae sp.	4	69
<i>Carcharinus melanopterus</i>	3	25
Labridae spp. (2)	> 50	8

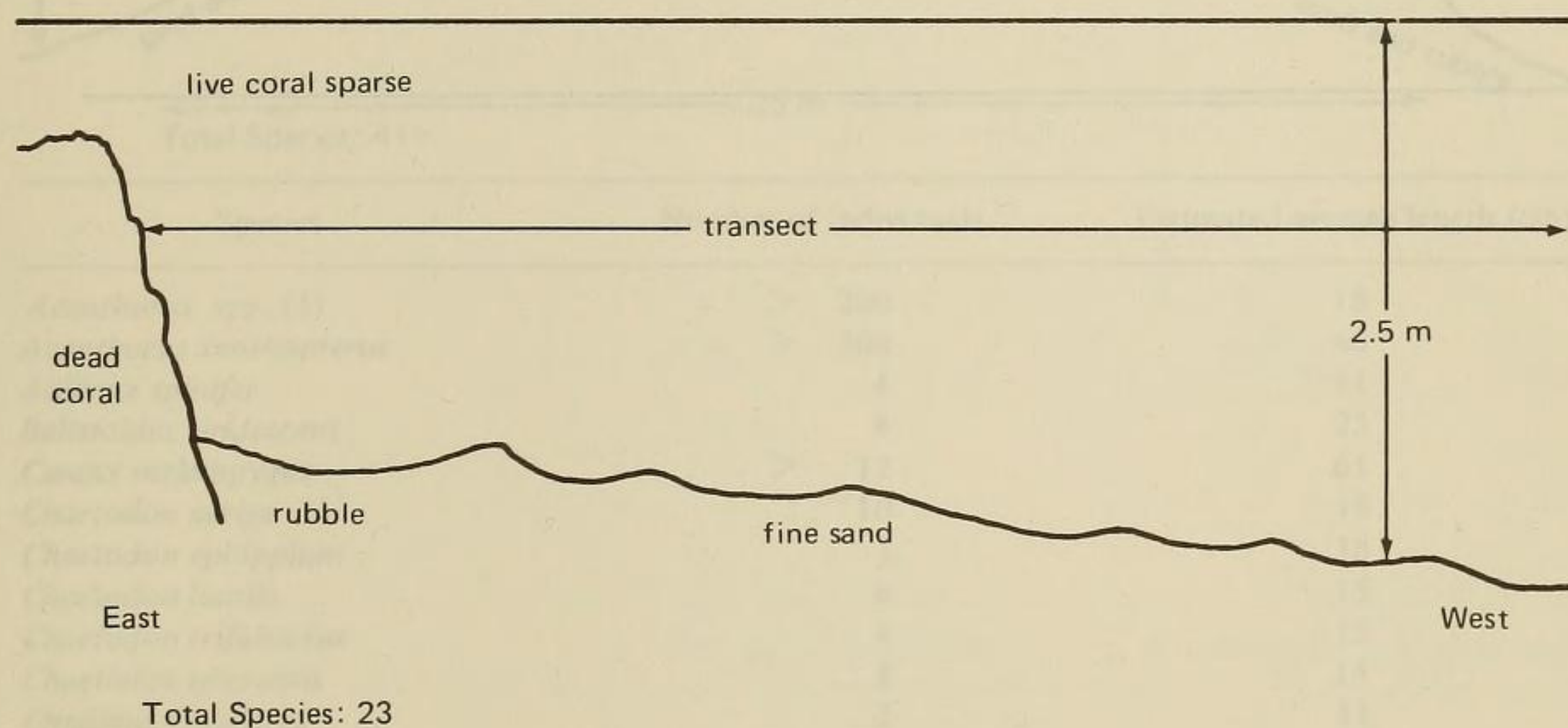


(This section contains a very faint, illegible table, likely a species list or detailed observation log, which is mirrored from the reverse side of the page.)

Fish Transect, dredge spoil island, central lagoon: FT 044048

Surveyed: 30 Nov 73, 1530-1600 hours. Tide: outgoing to high-low (0.5 m) at 1619 hours. HIV: 2-4 m. Transect length: 30 m.

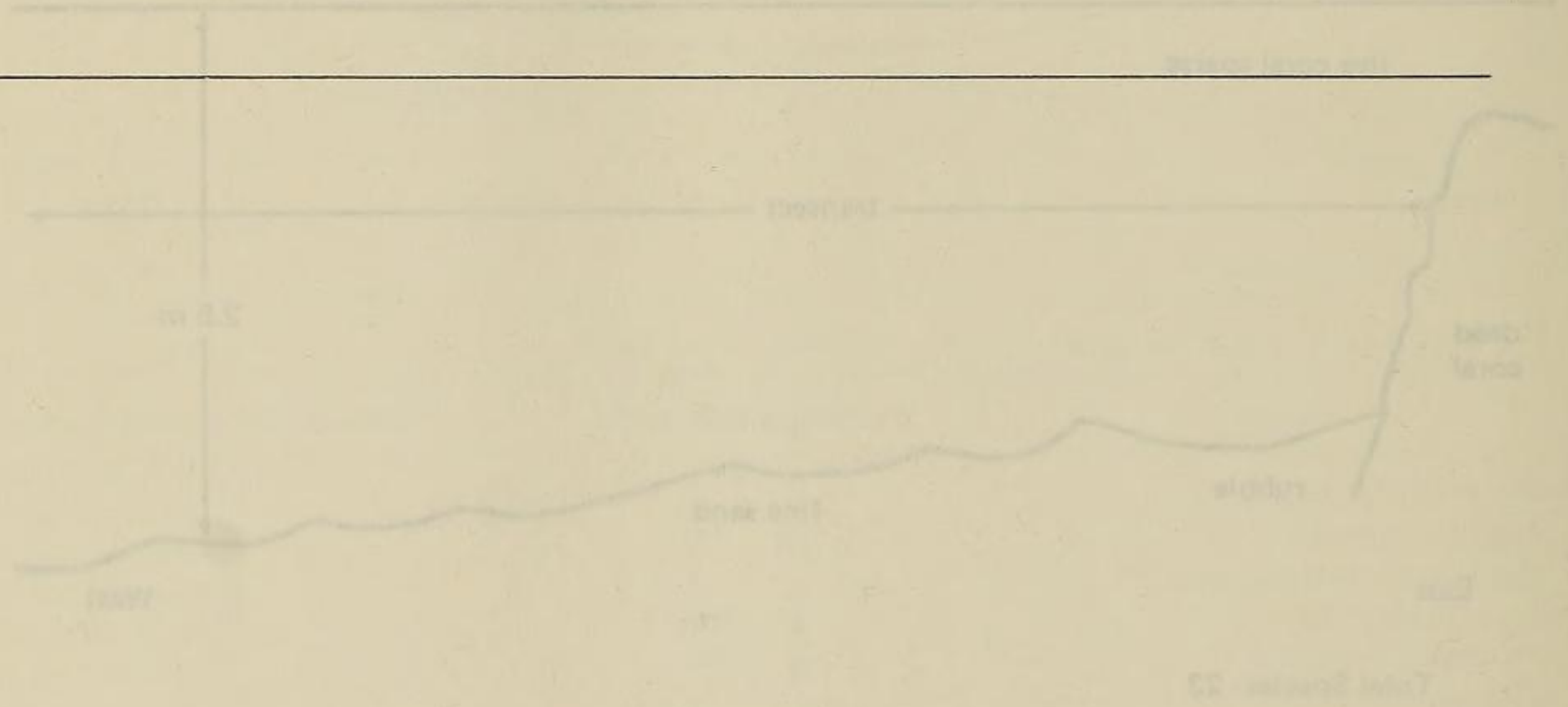
Transect general description: Southern tip of a linear reef which terminates at a dredge spoil island about 200 m to the south and extends approximately 3000 m to the north. Live coral is very sparse (covering less than an estimated 5% of hard surface), and a brownish (blue-green?) algae covered substantial areas of the reef flat shallows. A major portion of the reef appeared to be undergoing active siltation. Many holothurians on base of reef slope and on fine-sand bottom. 90% of fish limited to reef and rubble area. Transect on leeward side of reef, and under most conditions this area is upwind of the dredge spoil island (which is heavily populated by birds). No obvious tidal currents. Dominant coral types: *Millepora*, *Porites*, *Pocillopora*.



Species	Number of individuals	Estimated average length (cm)
<i>Acanthurus xanthopterus</i>	2	15
Balistidae sp.	3	46
<i>Chaetodon ephippium</i>	1	18
<i>Cheilodipterus quinquelineata</i>	4	5
<i>Chromis caeruleus</i>	6	6
<i>Epinephelus merra</i>	6	15
Gobiidae sp.	> 20	5
<i>Rhinecanthus aculeatus</i>	2	15

Fish observed off transect on adjacent reef flats (15 species):

Species	Number of individuals	Estimated average length (cm)
<i>Acanthuridae</i> sp.	> 30	20
<i>Amblygobius phalaena</i>	1	8
<i>Arothron hispidus</i>	1	46
<i>Balistoides viridescens</i> (?)	2	20
<i>Caranx melampyus</i>	1	51
<i>Chaetodon auriga</i>	3	18
<i>Chaetodon lunula</i>	2	18
<i>Cheilodipterus quinquelineata</i>	2	5
<i>Chromis caeruleus</i>	> 50	5
<i>Dascyllus aruanus</i>	30	5
<i>Kyphosus cinerascens</i>	2	25
<i>Myripristis</i> sp.	5	15
<i>Pomacentrus coelestis</i>	25	6
<i>Pomacentrus nigricans</i>	> 30	8
<i>Rhinecanthus aculeatus</i>	2	15

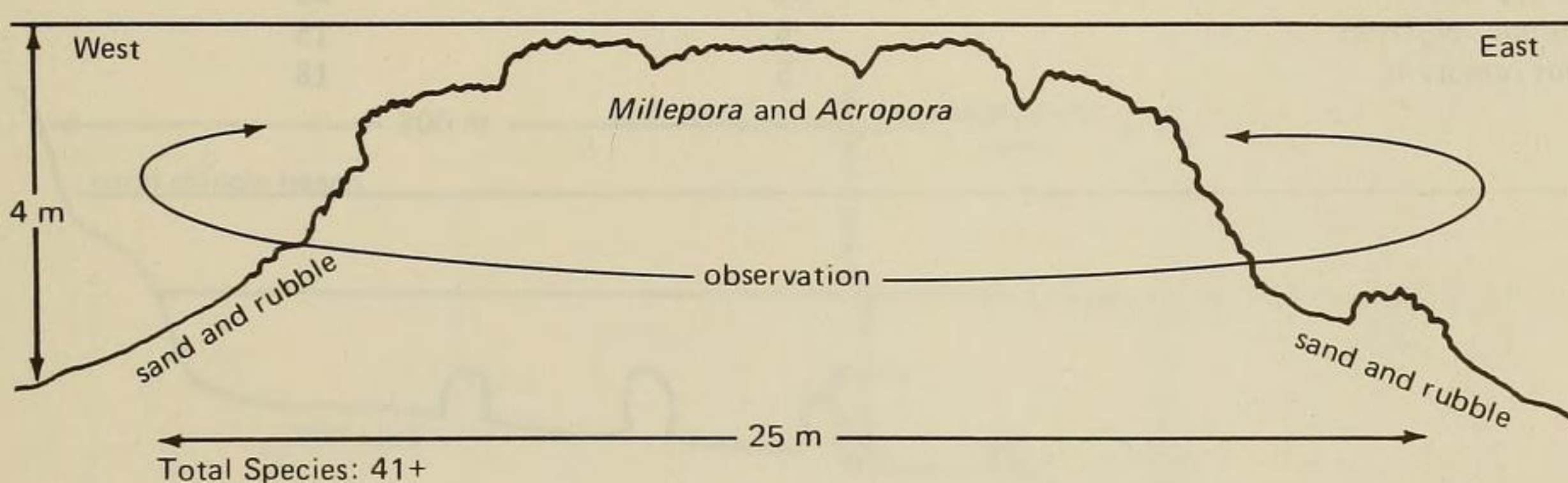


Species	Number of individuals	Estimated average length (cm)
<i>Rhinecanthus aculeatus</i>	2	15
<i>Pomacentrus nigricans</i>	> 30	8
<i>Pomacentrus coelestis</i>	25	6
<i>Myripristis</i> sp.	5	15
<i>Kyphosus cinerascens</i>	2	25
<i>Dascyllus aruanus</i>	30	5
<i>Chromis caeruleus</i>	> 50	5
<i>Cheilodipterus quinquelineata</i>	2	5
<i>Chaetodon lunula</i>	2	18
<i>Chaetodon auriga</i>	3	18
<i>Caranx melampyus</i>	1	51
<i>Balistoides viridescens</i> (?)	2	20
<i>Arothron hispidus</i>	1	46
<i>Amblygobius phalaena</i>	1	8
<i>Acanthuridae</i> sp.	> 30	20

Fish Observation, linear reef, central lagoon: FO 061041

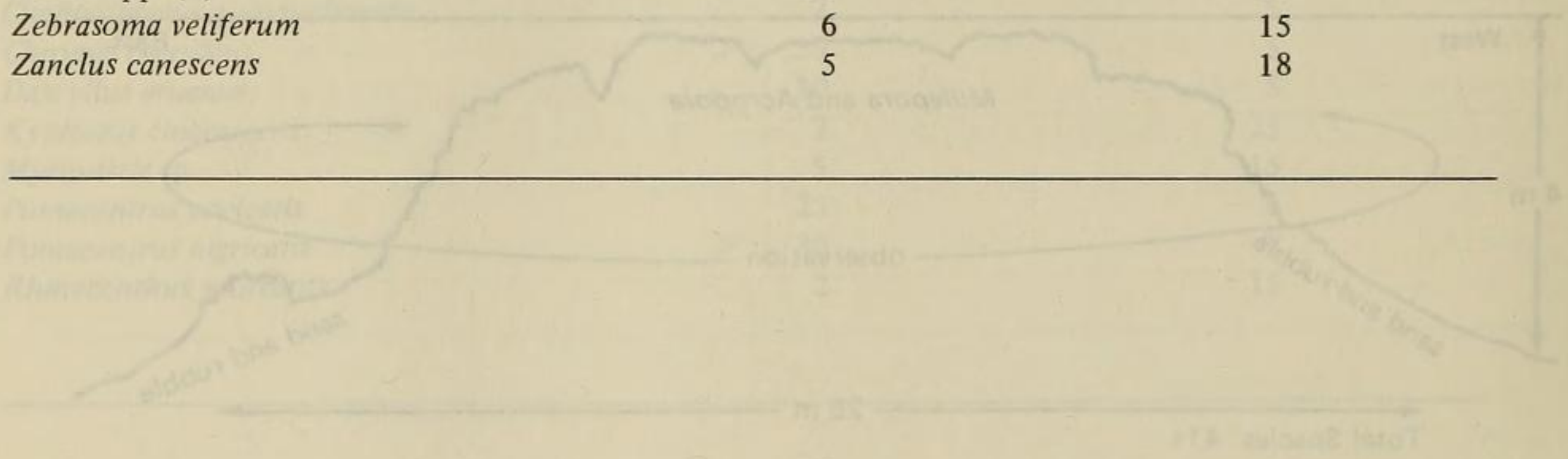
Surveyed: 6 Dec 73, 1234-1330 hours. Tide: incoming to high-high (1.1 m) at 1553 hours. HIV: 4.5-5.5 m. Observation track length: 30 m.

Observation area general description: Portion of one of the main line reef complexes. Area surveyed approximately 25 m wide by 20 m long. *Millepora* and *Acropora* extremely abundant, covering more than 80% of the bottom down to approximately 3 m. Sand and coral rubble mound on deeper bottom. Slight current ($\frac{1}{2}$ knot) heading east.



Species	Number of individuals	Estimated average length (cm)
<i>Acanthurus</i> spp. (3)	> 200	18
<i>Acanthurus xanthopterus</i>	> 200	46
<i>Adioryx spinifer</i>	4	41
<i>Balistoides viridescens</i>	4	25
<i>Caranx melampygus</i>	> 12	61
<i>Chaetodon auriga</i>	10	18
<i>Chaetodon ephippium</i>	2	18
<i>Chaetodon lunula</i>	6	15
<i>Chaetodon trifasciatus</i>	4	15
<i>Chaetodon ulietensis</i>	8	15
<i>Cheilinus undulatus</i>	2	41
<i>Cheilodipterus quinquelineata</i>	6	8
<i>Ctenochaetus strigosus</i>	> 150	13
<i>Epibulus insidiator</i>	12	18
<i>Epinephelus merra</i>	5	25
<i>Epinephelus microdon</i>	8	51
<i>Flammeo sammara</i>	25	15
<i>Gnathodentex aureolineatus</i>	> 200	18
<i>Heniochus acuminatus</i>	> 40	18
<i>Heniochus permutatus</i>	> 20	15
<i>Heniochus varius</i>	> 10	15
<i>Lethrinus</i> sp.	12	30
<i>Lutjanus bohar</i>	> 50	36
<i>Lutjanus fulvus</i>	> 300	23

Species	Number of individuals	Estimated average length (cm)
<i>Lutjanus kasmira</i>	> 200	23
<i>Lutjanus monostigma</i>	> 75	23
<i>Megaprotodon strigangulus</i>	6	18
<i>Monotaxis grandoculis</i>	30	18
<i>Mulloidichthys auriflamma</i>	> 200	30
<i>Mulloidichthys samoensis</i>	> 200	30
<i>Myripristis kuntee</i>	> 10	18
<i>Myripristis</i> spp. (2)	> 50	18
<i>Pomacentrus coelestis</i>	15	8
<i>Pomacentrus nigricans</i>	> 100	8
<i>Scarus</i> spp. (2)	> 30	25
<i>Zebrasoma veliferum</i>	6	15
<i>Zanclus canescens</i>	5	18

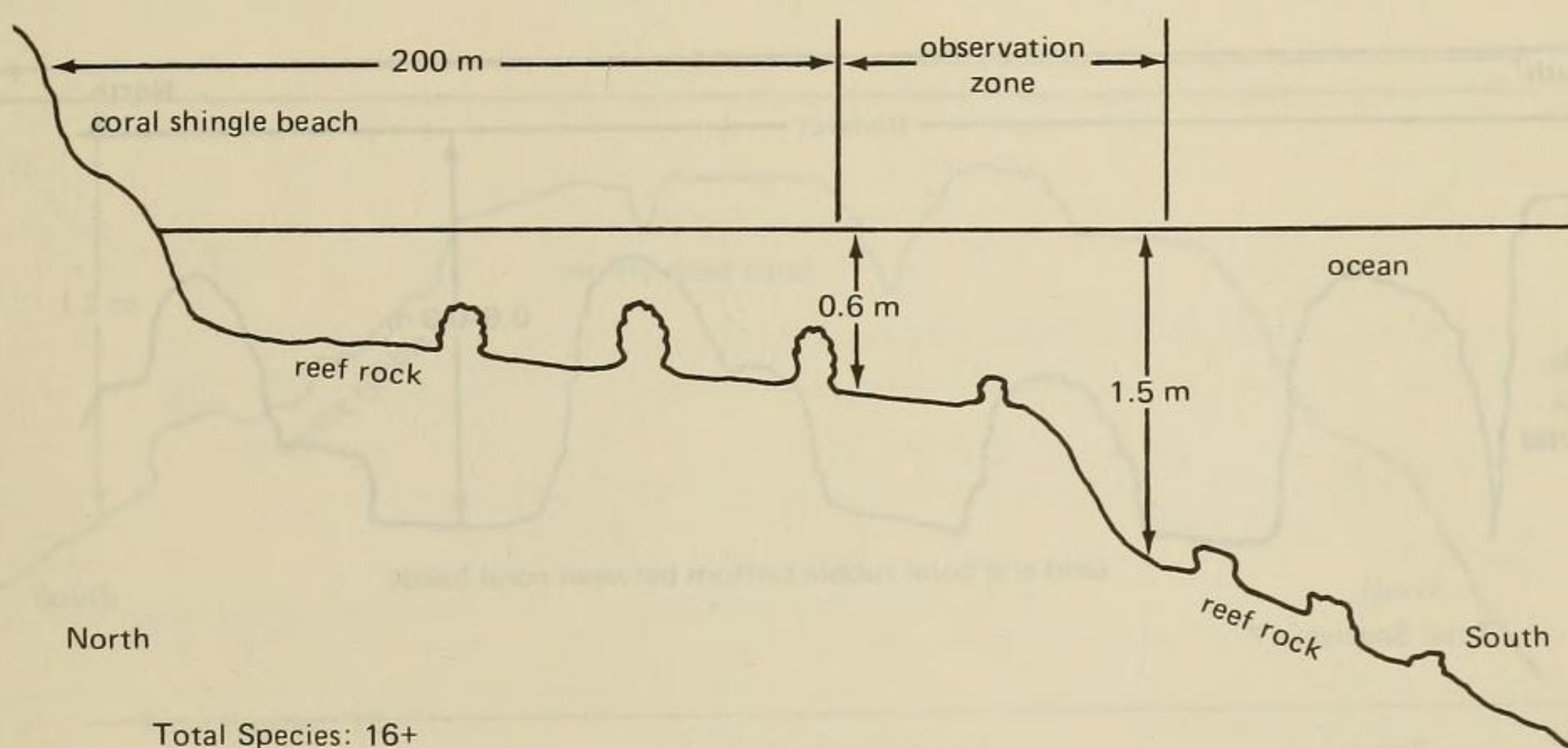


Species	Number of individuals	Estimated average length (cm)
<i>Lutjanus</i> spp. (2)	> 200	18
<i>Acropora</i> spp.	> 200	46
<i>Myripristis</i>	4	41
<i>Bombrus</i> spp.	4	33
<i>Chromis</i> spp.	> 12	61
<i>Chaetodon</i> spp.	10	18
<i>Chaetodon</i> spp.	7	18
<i>Chaetodon</i> spp.	6	17
<i>Chaetodon</i> spp.	4	12
<i>Chaetodon</i> spp.	4	12
<i>Chaetodon</i> spp.	3	12
<i>Chaetodon</i> spp.	1	41
<i>Chaetodon</i> spp.	6	8
<i>Chaetodon</i> spp.	> 150	17
<i>Chaetodon</i> spp.	12	18
<i>Chaetodon</i> spp.	7	22
<i>Chaetodon</i> spp.	7	21
<i>Chaetodon</i> spp.	21	15
<i>Chaetodon</i> spp.	200	18
<i>Chaetodon</i> spp.	40	18
<i>Chaetodon</i> spp.	30	12
<i>Chaetodon</i> spp.	30	12
<i>Chaetodon</i> spp.	12	20
<i>Chaetodon</i> spp.	20	36
<i>Chaetodon</i> spp.	200	22

Fish Observation, south central ocean reef: FO 064071

Surveyed: 2 Dec 73, 1630-1645 hours. Tide: outgoing to high-low (0.5 m) at 1819 hours. HIV: 15 m. Observation track length: 15 m.

Observation area general description: Seaward edge of 200-m-wide reef shelf (in surf zone). Depth increasing from intertidal zone (0.6 m) to about 1.5 m. Bottom of gullied beach rock with sparse live coral, mostly small, isolated *Pocillopora* heads. Observation track perpendicular to shoreline. Numerous sea urchins (*Echinometra* sp.) in surf zone.

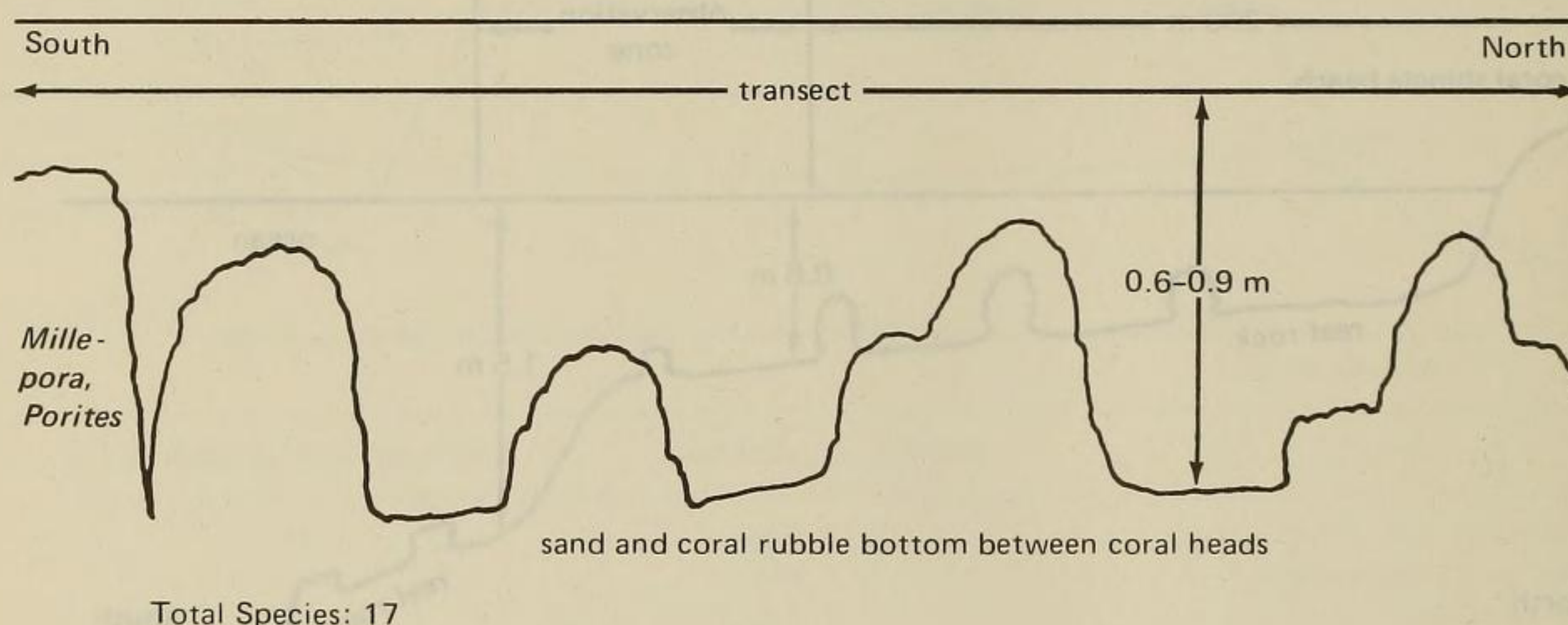


Species	Number of individuals	Estimated average length (cm)
<i>Abudefduf imparipennis</i>	10	5
<i>Abudefduf phoenixensis</i> (?)	1	8
<i>Abudefduf sordidus</i>	> 20	15
<i>Acanthurus achilles</i>	> 40	25
<i>Acanthurus glaucopareius</i>	> 12	23
<i>Acanthurus lineatus</i>	> 20	23
<i>Acanthurus triostegus</i>	> 30	13
<i>Acanthurus xanthopterus</i>	> 20	23
<i>Acanthurus</i> spp. (>2)	> 40	23
<i>Adioryx lacteoguttatus</i>	1	10
<i>Kyphosus cinerascens</i>	15	46
<i>Pomacentrus</i> sp. (yellow)	1	9
<i>Rhinecanthus rectangulatus</i>	10	10
<i>Scarus</i> spp. (2)	> 30	30

Fish Transect, south fisherman's shack, lagoon: FT 0660066

Surveyed: 3 Dec 73, 1345-1355 hours. Tide: outgoing from high-high (0.9 m) at 1322 hours. HIV: 3 m. Transect length: 30 m.

Transect general description: Patch of coral (about 30 m in diameter) on shallow sand shelf approximately 300 m offshore. *Millepora* covering estimated 30% of bottom; *Porites* (large rounded heads) covering estimated 10% of bottom. Sand bottom very shelly with some coral rubble. Average depth 0.6-0.9 m. More than 20 *Tridacna* sp. along transect, mostly in *Porites* heads, average size 15-20 cm.

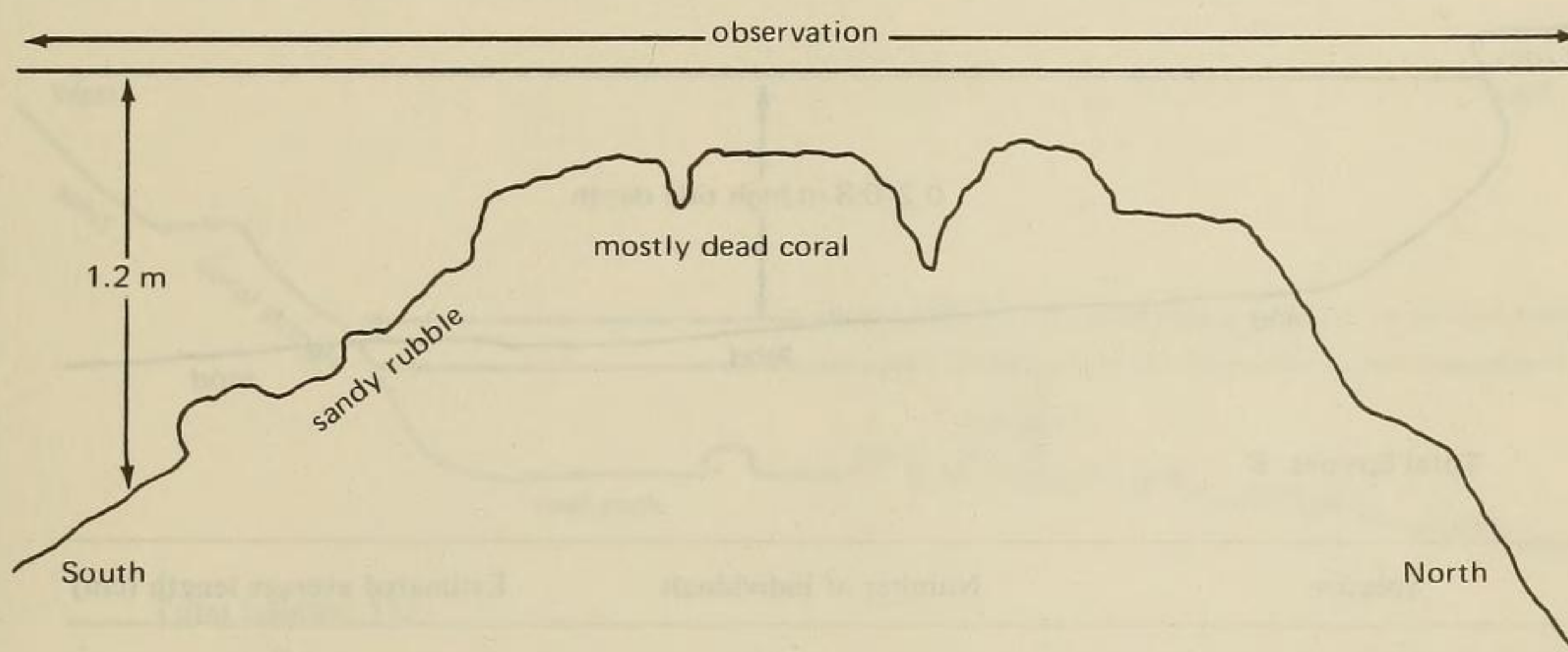


Species	Number of individuals	Estimated average length (cm)
<i>Acanthurus triostegus</i>	> 40	10
<i>Acanthurus xanthopterus</i>	> 25	30
<i>Balistoides viridescens</i>	1	25
<i>Chaetodon auriga</i>	> 12	15
<i>Chaetodon ephippium</i>	2	15
<i>Cheilodipterus quinquelineata</i>	3	8
<i>Ctenochaetus striatus</i>	> 30	13
<i>Epinephelus merra</i>	1	15
<i>Flammeo sammara</i>	1	10
Gobiidae sp.	6	8
Labridae sp. (juv.)	20	8
<i>Lutjanus fulvus</i>	> 14	20
<i>Lutjanus kasmira</i>	6	20
<i>Monotaxis grandoculis</i>	1	18
<i>Pomacentrus nigricans</i>	3	10
<i>Pomacentrus</i> sp. (yellow)	1	8
<i>Rhinecanthus aculeatus</i>	2	15

Fish Observation, east central lagoon: FO 085053

Surveyed: 6 Dec 73, 1134–1150 hours. Tide: incoming to high–high (1.2 m) at 1553 hours. HIV: 0.9–1.2 m. Observation track length: 30 m.

Observation area general description: 550 m southwest of shoreline point, half-way between north and south poles on southeast shore. Small patch reef (about 15 m in diameter) mostly of dead coral surrounded by sandy rubble. Live coral >5%. Predominant coral types: *Porites* and *Favia*; no *Acropora*. Many large holothurians; more than 20 *Tridacna maxima*.



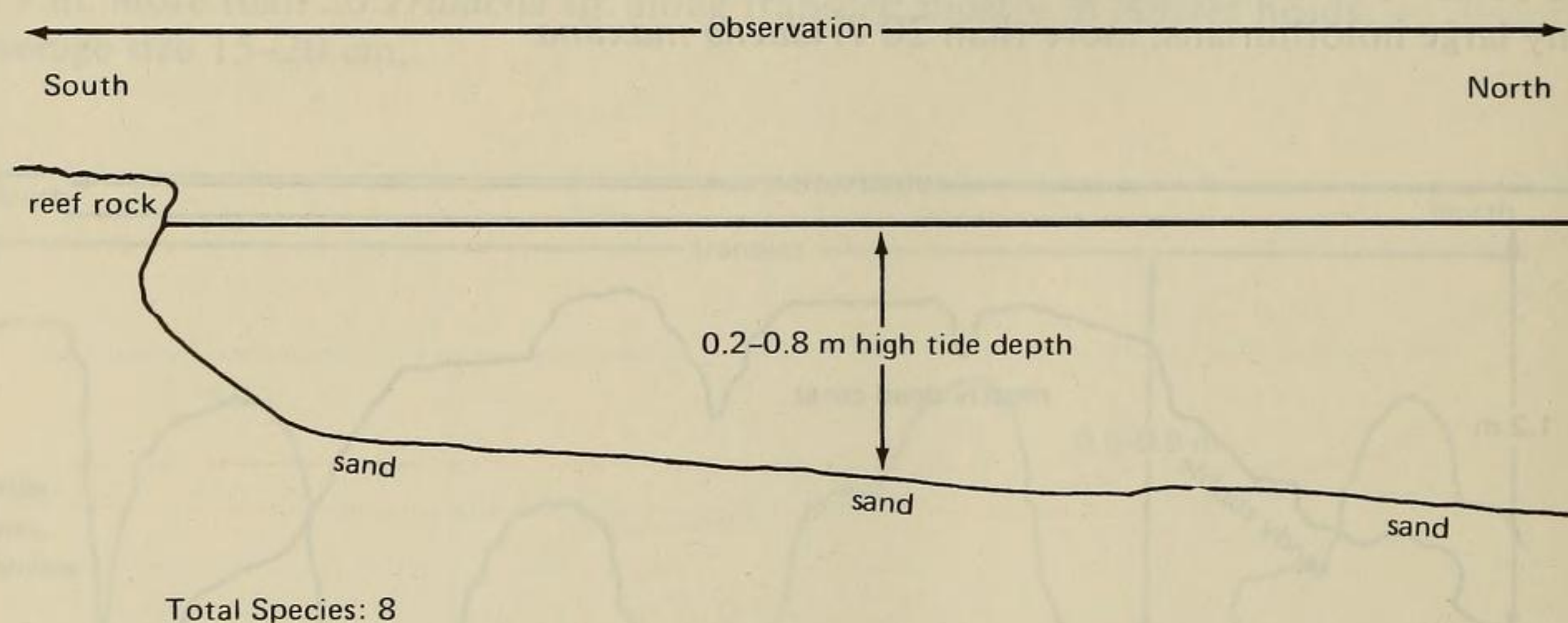
Total Species: 10

Species	Number of individuals	Estimated average length (cm)
<i>Acanthurus xanthopterus</i>	25	20
<i>Arothron hispidus</i>	2	46
<i>Chaetodon auriga</i>	8	13
<i>Chaetodon ephippium</i>	2	18
<i>Chaetodon ulietensis</i>	1	10
<i>Cheilodipterus quinquelineata</i>	1	10
<i>Ctenochaetus strigosus</i>	5	13
<i>Epinephelus merra</i>	2	15
Gobiidae sp.	6	8
<i>Lutjanus fulvus</i>	12	18

Fish Observation, south tide flats, lagoon: FO(w) 104094

Surveyed: 5 Dec 73, 1500-1515 hours. Tide: slack at high-high (1.1 m) at 1434 hours. HIV: not estimated. Observation track length: about 30 m.

Observation area general description: Sandy near-shore shallows; dry at low tide. No coral; many *Cerithium* shells (live and dead). Most distant station in site lagoon from main pass.

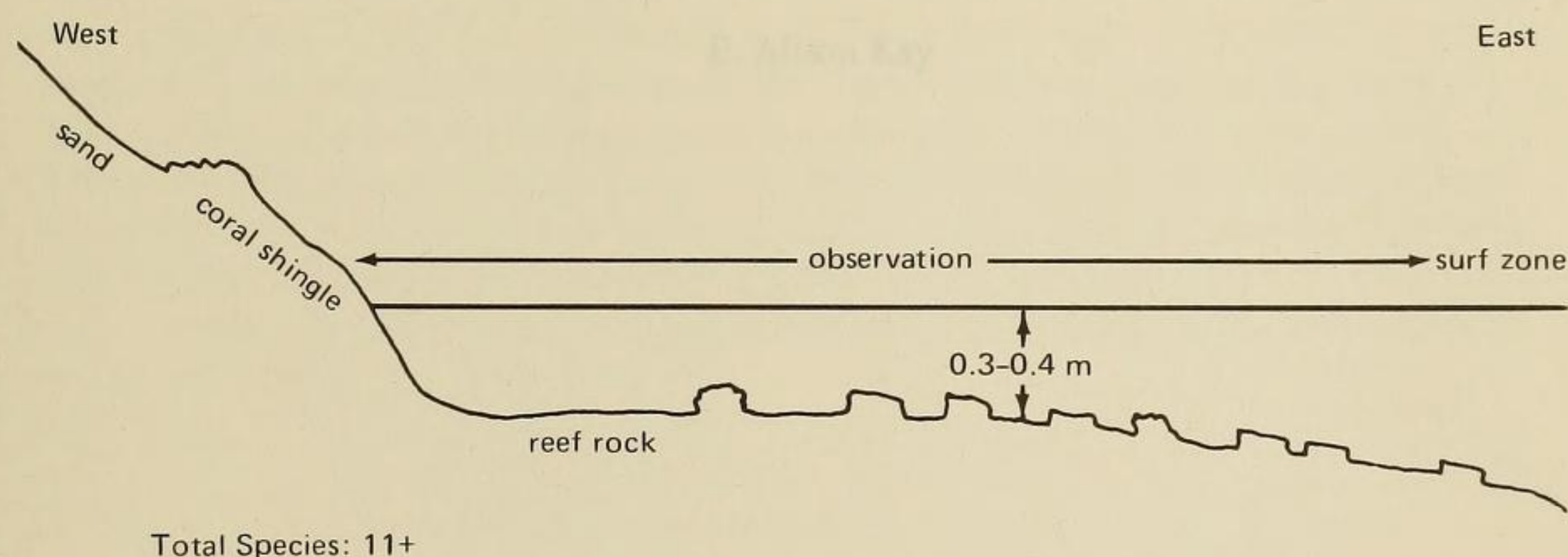


Species	Number of individuals	Estimated average length (cm)
<i>Arothron hispidus</i>	10	18
<i>Carcharinus melanopterus</i>	5	61
<i>Chelon vaigiensis</i>	> 20	15
<i>Crenimugil crenilabis</i>	> 15	18
Dasyatidae sp.	1	76
Mullidae spp. (2)	> 25	25
Gobiidae sp.	> 50	5

Fish Observation, **alpha site, ocean tide flats**: FO 108100

Surveyed: 2 Dec 73, 1720-1740 hours. Tide: outgoing to high-low (0.5 m) at 1819 hours. HIV: 15 m +. Observation track length: 100 m.

Observation area general description: A small embayment on the extreme southeastern tip of the island. Bounded to the south by a 100 m+ wide band of dead coral boulders and shingles, bounded to the north only by a slight seaward turn of the coast. Open seaward (east) to the reef shelf edge. Embayment area approximately 100 m by 150 m. Bottom of reef rock with shallow (15-20 cm) ravines. Approximately 10% of bottom covered with loose coral shingle. Coral (small, isolated *Pocillopora* heads) sparse. Average depth 30-40 cm.



Species	Number of individuals	Estimated average length (cm)
<i>Abudefduf amabilis</i>	1	5
<i>Abudefduf imparipennis</i>	12	5
<i>Acanthurus triostegus</i>	> 200	8
<i>Acanthurus xanthopterus</i>	3	41
<i>Carcharinus melanopterus</i>	1	61
<i>Crenimugil crenilabis</i>	> 100	36
<i>Gymnothorax pictus</i>	1	61
Labridae spp. (2)	> 100	6
<i>Rhinecanthus rectangulatus</i>	10	13
Synodontidae sp.	2	10