

**FISH AND CORAL SPECIES LISTS COMPILED BY
CORAL CAY CONSERVATION:
BELIZE 1990-1998**



- Edited by -

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***This report is part of a series of working documents detailing CCC's
science programme on Turneffe Atoll (1994-1998).
The series is also available on CD-Rom.***

1. INTRODUCTION

Between 1986 and 1998, Coral Cay Conservation (CCC) provided data and technical assistance to the Belize Department of Fisheries, Coastal Zone Management Unit and Coastal Zone Management Project under the remit of a Memorandum of Understanding. This work has provided data for seven proposed or established marine protected areas at South Water Cay, Bacalar Chico, Sapodilla Cays, Snake Cays, Laughing Bird Cay, Caye Caulker and Turneffe Atoll (Figure 1). These projects have generally provided habitat maps, the associated databases and management recommendations to assist reserve planning.

In addition to the data collection, training, capacity building and environmental education undertaken by CCC, the expeditions have also provided opportunities for compiling presence / absence species lists of fish and corals in the different project areas. This document contains the fish list compiled by CCC staff and experienced volunteers and a reprint of Fenner (1999) detailing coral taxonomy in Belize and Cozumel, the Belize component of which was compiled while the author was working as a member of CCC's field science staff.

2. FISH SPECIES LIST

During baseline surveys (see Raines et al., 1993¹ for full details of the methodology) CCC science staff compiled lists of fish species encountered at each expedition site. Species are only added when CCC staff have either seen the fish themselves or trust the sighting of an experienced volunteer. 'Possible' sightings are not included in the lists given here. Any species that represents a range extension from published literature is only included if witnessed by CCC science staff.

2.1 Checklist notes

- ?? Shading highlights species recorded in only one study area.
- ?? Latin and common names taken from: Humann, P. 1996. *Reef fish identification*. New World Publications, Inc.
- ?? Abundances modified from the original 0-5 'DAFOR' used during standard CCC baseline surveys. Scale = **D**ominant, **A**bundant, **F**requent, **O**ccasional, **R**are. Abundance indicates the probability of seeing a given fish species during a survey dive. Abundances averaged across all habitat types and study areas.
- ?? *Hypoplectrus* spp. (hamlets) listed as separate species pending further research.
- ?? *Sanopus astrifer* (whitespotted toadfish), *Sanopus greenfieldorum* (whitelined toadfish), *Sanopus reticulatus* (reticulated toadfish), *Sanopus splendidus* (splendid toadfish) are listed as vulnerable, but also data deficient, within IUCN's Red List.
- ?? List is not intended as exhaustive for cryptic species such as Gobiidae and Blenniidae but those species that have been identified are included for completion.

¹ Raines, P.S., D. McCorry, P.J. Mumby and J.M. Ridley. 1992. Coral Cay Conservation – survey techniques and their application in Belize. *Proceedings of the 7th International Coral Reef Symposium* 1: 122-126.

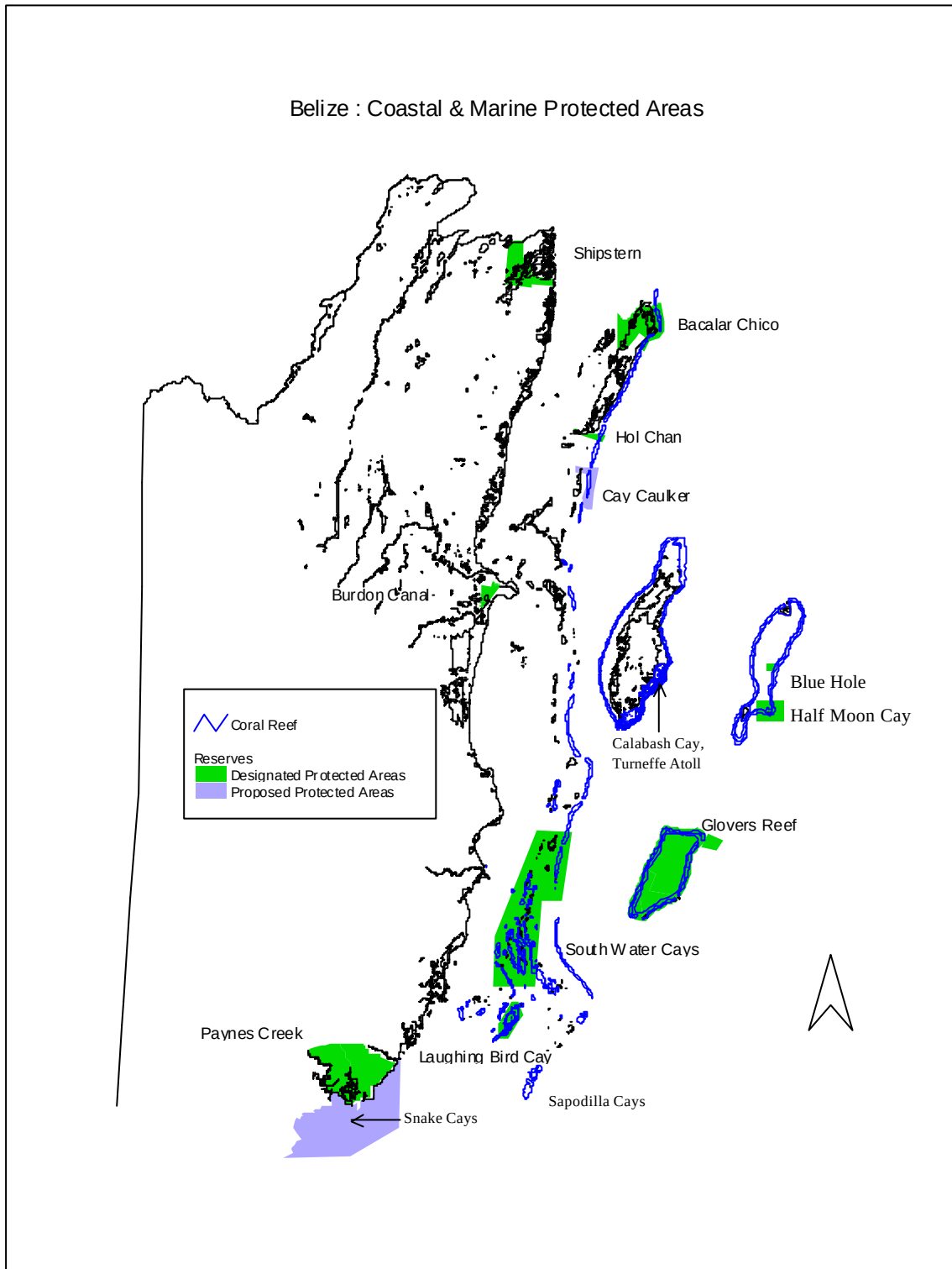


Figure 1. Designated and proposed marine and coastal protected areas of Belize, highlighting the location of CCC's expeditions sites since 1986. Source: Coastal Zone Management Project.

Latin Name	Common Name	Bacalar Chico Marine Reserve	Turneffe Atoll	South Water Cay Marine Reserve	Sapodilla Snake Cays	Unspecified Cays	Abundance
Acanthuridae							
<i>Acanthurus bahianus</i>	Ocean surgeon fish						Frequent
<i>Acanthurus chirurgus</i>	Doctorfish						Frequent
<i>Acanthurus coeruleus</i>	Blue tang						Common
Albulidae							
<i>Albula vulpes</i>	Bonefish						Occasional
Apogonidae							
<i>Apogon binotatus</i>	Barred cardinalfish						Occasional
<i>Apogon lachneri</i>	Whitestar cardinalfish						Rare
<i>Apogon maculatus</i>	Flamefish						Rare
<i>Apogon pseudomaculatus</i>	Twospot cardinalfish						Rare
<i>Apogon townsendi</i>	Belted cardinalfish						Rare
<i>Astrapogon stellatus</i>	Conchfish						Rare
Aulostomidae							
<i>Aulostomus maculatus</i>	Trumpetfish						Frequent
Balistidae							
<i>Aluterus schoepfi</i>	Orange filefish						Rare
<i>Aluterus scriptus</i>	Scrawled filefish						Occasional
<i>Balistes capriscus</i>	Gray triggerfish						Rare
<i>Balistes vetula</i>	Queen triggerfish						Frequent
<i>Cantherhines macroceros</i>	Whitespotted filefish						Rare
<i>Cantherhines pullus</i>	Orangespotted filefish						Occasional
<i>Canthidemis sufflamen</i>	Ocean triggerfish						Rare
<i>Melichthys niger</i>	Black durgon						Frequent
<i>Monacanthus tuckeri</i>	Slender filefish						Rare
<i>Xanthichthys ringens</i>	Sargassum triggerfish						Rare
Batrachoididae							
<i>Batrachoides gilberti</i>	Large eye toadfish						Rare
<i>Sanopus greenfieldorum</i>	Whitelined toadfish						Rare
<i>Sanopus splendidus</i>	Splendid toadfish						Rare
Belonidae							
<i>Ablennes hians</i>	Flat needlefish						Occasional
<i>Strongylura notata</i>	Redfin needlefish						Rare
<i>Tylosurus crocodilus</i>	Houndfish						Rare
Bothidae							
<i>Bothus lunatus</i>	Peacock flounder						Rare

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Carcharhinidae								
<i>Carcharhinus perezii</i>	Reef shark							Rare
<i>Negaprion brevirostris</i>	Lemon shark							Rare
Carangidae								
<i>Caranx batholomaei</i>	Yellow jack							Occasional
<i>Caranx crysos</i>	Blue runner							Rare
<i>Caranx hippos</i>	Crevalle jack							Rare
<i>Caranx latus</i>	Horse-eye jack							Occasional
<i>Caranx lugubris</i>	Black jack							Rare
<i>Caranx ruber</i>	Bar jack							Common
<i>Decapterus macarellus</i>	Mackerel scad							Rare
<i>Elagatis bipinnulata</i>	Rainbow Runner							Rare
<i>Trachinotus falcatus</i>	Permit							Occasional
<i>Trachinotus goodei</i>	Palometa							Rare
Centropomidae								
<i>Centropomus undecimalis</i>	Common snook							Rare
Chaetodontidae								
<i>Chaetodon aculeatus</i>	Longsnout butterflyfish							Occasional
<i>Chaetodon capistratus</i>	Four-eye butterflyfish							Frequent
<i>Chaetodon ocellatus</i>	Spotfin butterflyfish							Frequent
<i>Chaetodon sedentarius</i>	Reef butterflyfish							Rare
<i>Chaetodon striatus</i>	Banded butterflyfish							Frequent
Cirrhitidae								
<i>Amblycirrhitus pinos</i>	Redspotted hawkfish							Rare
Clinidae								
<i>Acanthemblemaria spinosa</i>	Spinyhead blenny							Rare
<i>Chaenopsis ocellata</i>	Bluethroat pikeblenny							Rare
<i>Emblemaria pandionis</i>	Sailfin blenny							Rare
<i>Lucayablennius zingaro</i>	Arrow blenny							Occasional
<i>Malacoctenus boehlkei</i>	Diamond blenny							Rare
<i>Malacoctenus macropus</i>	Rosy blenny							Rare
<i>Malacoctenus triangulatus</i>	Saddled blenny							Rare
<i>Ophioblennius atlanticus</i>	Redlip blenny							Rare
Congridae								
<i>Heteroconger halis</i>	Garden eel							Occasional

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Dasyatidae								
<i>Dasyatis americana</i>	Southern stingray							Occasional
Echeneidae								
<i>Echeneis naucrates</i>	Remora							Rare
Elopidae								
<i>Megalops atlanticus</i>	Tarpon							Occasional
Ephippidae								
<i>Chaetodipterus faber</i>	Atlantic spadefish							Rare
Exocoetidae								
<i>Hemiramphus brasiliensis</i> / <i>balao</i>	Ballyhoo / Balao							Rare
<i>Hirundichthys speculiger</i>	Mirrorwing flyingfish							Rare
Gerreidae								
<i>Eucinostomus lefroyi</i>	Mottled mojarra							Rare
<i>Gerres cinereus</i>	Yellowfin mojarra							Occasional
Gobiidae								
<i>Coryphopterus dicrus</i>	Colon goby							Rare
<i>Coryphopterus eidolon</i>	Pallid goby							Rare
<i>Coryphopterus glaucofraenum</i>	Bridled goby							Rare
<i>Coryphopterus lipernes</i>	Peppermint goby							Rare
<i>Coryphopterus personatus</i>	Masked goby							Rare
<i>Gnatholepis thompsoni</i>	Goldspot goby							Rare
<i>Gobionellus saepepallens</i>	Dash goby							Occasional
<i>Gobiosoma dilepsis</i>	Orangesided goby							Rare
<i>Gobiosoma evelynae</i>	Sharknose goby							Occasional
<i>Gobiosoma genie</i>	Cleaning goby							Occasional
<i>Gobiosoma horsti</i>	Yellowline goby							Rare
<i>Gobiosoma illecebrosus</i>	Barsnout goby							Rare
<i>Gobiosoma oceanops</i>	Neon goby							Frequent
<i>Gobiosoma prochilos</i>	Broadstripe goby							Rare
<i>Lophogobius cyprinoides</i>	Crested goby							Rare
Grammatidae								
<i>Gramma loreto</i>	Fairy basslet							Frequent
<i>Gramma melacara</i>	Blackcap basslet							Occasional
<i>Liopropoma rubre</i>	Peppermint bass							Rare

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Haemulidae							
<i>Anisotremus surinamensis</i>	Black margate						Occasional
<i>Anisotremus virginicus</i>	Porkfish						Frequent
<i>Haemulon album</i>	Margate						Occasional
<i>Haemulon aurolineatum</i>	Tomtate						Occasional
<i>Haemulon carbonarium</i>	Caesar grunt						Rare
<i>Haemulon chrysargyeum</i>	Smallmouth grunt						Rare
<i>Haemulon flavolineatum</i>	French grunt						Abundant
<i>Haemulon macrostomium</i>	Spanish grunt						Rare
<i>Haemulon melanurum</i>	Cottonwick						Rare
<i>Haemulon parrai</i>	Sailors choice						Occasional
<i>Haemulon plumieri</i>	White grunt						Frequent
<i>Haemulon sciurus</i>	Bluestriped grunt						Abundant
<i>Haemulon striatum</i>	Striped grunt						Rare
Holocentridae							
<i>Holocentrus adscensionis</i>	Squirrelfish						Frequent
<i>Holocentrus coruscus</i>	Reef squirrelfish						Occasional
<i>Holocentrus rufus</i>	Longspine squirrelfish						Frequent
<i>Holocentrus vexillarius</i>	Dusky squirrelfish						Occasional
<i>Myripristis jacobus</i>	Blackbar soldierfish						Occasional
<i>Neoniphon marianus</i>	Longjaw squirrelfish						Occasional
Inermiidae							
<i>Emmelichthyops atlanticus</i>	Bonnetmouth						Rare
<i>Inermia vittata</i>	Boga						Rare
Kyphosidae							
<i>Kyphosus sectatrix</i> / <i>incisor</i>	Bermuda chub						Occasional
Labridae							
<i>Bodianus pulchellus</i>	Spotfin hogfish						Rare
<i>Bodianus rufus</i>	Spanish hogfish						Occasional
<i>Clepticus parrai</i>	Creole wrasse						Frequent
<i>Doratonotus megalepis</i>	Dwarf wrasse						Rare
<i>Halichoeres bivittatus</i>	Slippery dick						Occasional
<i>Halichoeres cyanocephalus</i>	Yellowcheek wrasse						Rare
<i>Halichoeres garnoti</i>	Yellowhead wrasse						Frequent
<i>Halichoeres maculipinna</i>	Clown wrasse						Rare
<i>Halichoeres radiatus</i>	Puddingwife						Rare

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<i>Hemipteronotus novacula</i>	Pearly razorfish							Rare
<i>Lachnolaimus maximus</i>	Hogfish							Frequent
<i>Thalassoma bifasciatum</i>	Bluehead wrasse							Abundant
<i>Xyrichtys martinicensis</i>	Rosy razorfish							Rare
<i>Xyrichtys spendens</i>	Green razorfish							Rare
Lutjanidae								
<i>Lutjanus analis</i>	Mutton snapper							Frequent
<i>Lutjanus apodus</i>	Schoolmaster							Frequent
<i>Lutjanus cyanopterus</i>	Cubera snapper							Rare
<i>Lutjanus griseus</i>	Gray snapper							Frequent
<i>Lutjanus joco</i>	Dog snapper							Occasional
<i>Lutjanus mahogoni</i>	Mahogany snapper							Occasional
<i>Lutjanus synagris</i>	Lane snapper							Rare
<i>Ocyurus chrysurus</i>	Yellowtail snapper							Abundant
Malacanthidae								
<i>Malacanthus plumieri</i>	Sand tilefish							Occasional
Mobulidae								
<i>Manta birostris</i>	Atlantic manta							Rare
<i>Mobula hypostoma</i>	Devil ray							Rare
Mugilidae								
<i>Mugil curema</i>	White mullet							Rare
Mullidae								
<i>Mulloidichthys martinicus</i>	Yellow goatfish							Occasional
<i>Pseudupeneus maculatus</i>	Spotted goatfish							Rare
Muraenidae								
<i>Enchelycore carychroa</i>	Chestnut moray							Rare
<i>Gymnothorax funebris</i>	Green moray							Occasional
<i>Gymnothorax miliaris</i>	Goldentail moray							Rare
<i>Gymnothorax moringa</i>	Spotted moray							Rare
<i>Gymnothorax vicinus</i>	Purplemouth moray							Rare
Myliobatidae								
<i>Aetobatus narinari</i>	Spotted eagle ray							Occasional
Ogcocephalidae								
<i>Ogcocephalus nasutus</i>	Shortnose batfish							Rare
Ophichthidae								
<i>Myrichthys breviceps</i>	Sharptail eel							Rare

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Opistognathidae							
<i>Opistognathus aurifrons</i>	Yellowhead jawfish						Occasional
<i>Opistognathus macrognathus</i>	Banded jawfish						Rare
<i>Opistognathus whitehurstii</i>	Dusky jawfish						Rare
Ostraciidae							
<i>Lactophrys bicaudalis</i>	Spotted trunkfish						Occasional
<i>Lactophrys polygonia</i>	Honeycomb cowfish						Rare
<i>Lactophrys quadricornis</i>	Scrawled cowfish						Occasional
<i>Lactophrys trigonus</i>	Trunkfish						Rare
<i>Lactophrys triqueter</i>	Smooth trunkfish						Rare
Pempheridae							
<i>Pempheris schomburgki</i>	Glassy sweeper						Rare
Pomacanthidae							
<i>Holacanthus ciliaris</i>	Queen angelfish						Frequent
<i>Holacanthus tricolor</i>	Rock beauty						Frequent
<i>Pomacanthus arcuatus</i>	Gray angelfish						Frequent
<i>Pomacanthus paru</i>	French angelfish						Frequent
Pomacentridae							
<i>Abudefduf saxatilis</i>	Sergeant major						Frequent
<i>Abudefduf taurus</i>	Night sergeant						Rare
<i>Chromis cyanea</i>	Blue chromis						Frequent
<i>Chromis insolata</i>	Sunshinefish						Rare
<i>Chromis multilineata</i>	Brown chromis						Occasional
<i>Microspathodon chrysurus</i>	Yellowtail damselfish						Frequent
<i>Stegastes dienaecus</i>	Longfin damselfish						Occasional
<i>Stegastes fuscus</i>	Dusky damselfish						Occasional
<i>Stegastes leucostictus</i>	Beaugregory						Occasional
<i>Stegastes partitus</i>	Bicolor damselfish						Frequent
<i>Stegastes planifrons</i>	Threespot damselfish						Abundant
<i>Stegastes variabilis</i>	Cocoa damselfish						Occasional
Priacanthidae							
<i>Priacanthus arenatus</i>	Bigeye						Rare
<i>Priacanthus cruentatus</i>	Glasseye snapper						Rare
Rhincodontidae							
<i>Ginglymostoma cirratum</i>	Nurse shark						Rare

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<i>Rhincodon typus</i>	Whale shark						Occasional
Scaridae							
<i>Scarus coelestinus</i>	Midnight parrotfish						Rare
<i>Scarus coeruleus</i>	Blue parrotfish						Rare
<i>Scarus guacamaia</i>	Rainbow parrotfish						Rare
<i>Scarus iserti</i>	Striped parrotfish						Occasional
<i>Scarus taeniopterus</i>	Princess parrotfish						Frequent
<i>Scarus vetula</i>	Queen parrotfish						Occasional
<i>Sparisoma atomarium</i>	Greenblotch parrotfish						Rare
<i>Sparisoma aurofrenatum</i>	Redband parrotfish						Rare
<i>Sparisoma chrysotermum</i>	Redtail parrotfish						Occasional
<i>Sparisoma radians</i>	Bucktooth parrotfish						Rare
<i>Sparisoma rubripinne</i>	Yellowtail parrotfish						Occasional
<i>Sparisoma viride</i>	Stoplight parrotfish						Abundant
Sciaenidae							
<i>Equetus acuminatus</i>	Highhat						Rare
<i>Equetus punctatus</i>	Spotted drum						Rare
<i>Equetus umbrosus</i>	Cubby						Rare
<i>Odontoscion dentex</i>	Reef croaker						Occasional
Scombridae							
<i>Scomberomorus regalis</i>	Cero						Occasional
Scorpaenidae							
<i>Scorpaena plumieri</i>	Spotted scorpionfish						Rare
Serranidae							
<i>Hypoplectrus aberrans</i>	Yellowbelly hamlet						Rare
<i>Hypoplectrus chlorurus</i>	Yellowtail hamlet						Rare
<i>Hypoplectrus gemma</i>	Blue hamlet						Rare
<i>Hypoplectrus gummingatta</i>	Golden hamlet						Rare
<i>Hypoplectrus guttavarius</i>	Shy hamlet						Rare
<i>Hypoplectrus indigo</i>	Indigo hamlet						Occasional
<i>Hypoplectrus nigricans</i>	Black hamlet						Frequent
<i>Hypoplectrus puella</i>	Barred hamlet						Rare
<i>Hypoplectrus sp.</i>	Masked hamlet						Rare
<i>Hypoplectrus sp.</i>	Tan hamlet						Rare
<i>Hypoplectrus unicolor</i>	Butter hamlet						Rare
<i>Alphesthes afer</i>	Mutton hamlet						Rare
<i>Cephalopholis cruentata</i>	Graysby						Frequent

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<i>Cephalopholis fulvus</i>	Coney							Occasional
<i>Epinephelus adscensionis</i>	Rock hind							Occasional
<i>Epinephelus guttatus</i>	Red hind							Frequent
<i>Epinephelus inermis</i>	Marbled grouper							Rare
<i>Epinephelus itajara</i>	Jewfish							Rare
<i>Ephinephelus morio</i>	Red grouper							Rare
<i>Epinephelus striatus</i>	Nassau grouper							Frequent
<i>Mycteroperca bonaci</i>	Black grouper							Occasional
<i>Mycteroperca interstitialis</i>	Yellowmouth grouper							Rare
<i>Mycteroperca rubra</i>	Comb grouper							Rare
<i>Mycteroperca tigris</i>	Tiger grouper							Rare
<i>Mycteroperca venenosa</i>	Yellowfin grouper							Rare
<i>Paranthias furcifer</i>	Creole-fish							Rare
<i>Rypticus saponaceus</i>	Greater soapfish							Rare
<i>Serranus baldwini</i>	Lantern bass							Rare
<i>Serranus flaviventris</i>	Two-spot bass							Rare
<i>Serranus tabacarius</i>	Tobaccofish							Rare
<i>Serranus tigrinus</i>	Harlequin bass							Occasional
<i>Serranus tortugarium</i>	Chalk bass							Rare
Sparidae								
<i>Calamus bajonado</i>	Jolthead porgy							Occasional
<i>Calamus calamus</i>	Saucereye porgy							Frequent
Sphyraenidae								
<i>Sphyraeana barracuda</i>	Great barracuda							Common
<i>Sphyraeana picudilla</i>	Southern sennet							Rare
Sphyrnidae								
<i>Sphyrna mokarran</i>	Great hammerhead							Rare
Syngnathidae								
<i>Cosmocampus elucens</i>	Shortfin pipefish							Rare
<i>Hippocampus erectus</i>	Lined seahorse							Rare
Synodontidae								
<i>Synodus intermedius</i>	Sand diver							Rare
<i>Synodus saurus</i>	Bluestriped lizardfish							Occasional
Tetraodontidae								
<i>Canthigaster rostrata</i>	Sharpnose puffer							Frequent

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<i>Chilomycterus antennatus</i>	Bridled burrfish		<del><del></del></del>	<del><del></del></del>	<del><del></del></del>	<del><del></del></del>	<del><del></del></del>	Rare
<i>Chilomycterus antillarum</i>	Web burrfish	<del><del></del></del>	<del><del></del></del>	<del><del></del></del>	<del><del></del></del>	<del><del></del></del>	<del><del></del></del>	Rare
<i>Diodon holocanthus</i>	Balloonfish	<del><del></del></del>	<del><del></del></del>	<del><del></del></del>	<del><del></del></del>	<del><del></del></del>	<del><del></del></del>	Rare
<i>Diodon hystrix</i>	Porcupinefish	<del><del></del></del>	<del><del></del></del>	<del><del></del></del>	<del><del></del></del>	<del><del></del></del>	<del><del></del></del>	Rare
<i>Sphoeroides spengleri</i>	Bandtail puffer	<del><del></del></del>	<del><del></del></del>	<del><del></del></del>	<del><del></del></del>	<del><del></del></del>	<del><del></del></del>	Rare
<i>Sphoeroides testudineus</i>	Checkered puffer		<del><del></del></del>	<del><del></del></del>	<del><del></del></del>	<del><del></del></del>	<del><del></del></del>	Rare
Triglidae		<del><del></del></del>	<del><del></del></del>	<del><del></del></del>	<del><del></del></del>	<del><del></del></del>	<del><del></del></del>	
<i>Prionotus ophryas</i>	Bandtail searobin		<del><del></del></del>	<del><del></del></del>	<del><del></del></del>	<del><del></del></del>	<del><del></del></del>	Rare
Tripterygiidae		<del><del></del></del>	<del><del></del></del>	<del><del></del></del>	<del><del></del></del>	<del><del></del></del>	<del><del></del></del>	
<i>Enneanectes altivelis</i>	Lofty triplefin	<del><del></del></del>	<del><del></del></del>	<del><del></del></del>	<del><del></del></del>	<del><del></del></del>	<del><del></del></del>	Rare
<i>Enneanectes atrorus</i>	Blackedge triplefin		<del><del></del></del>	<del><del></del></del>	<del><del></del></del>	<del><del></del></del>	<del><del></del></del>	Rare
Urolophidae		<del><del></del></del>	<del><del></del></del>	<del><del></del></del>	<del><del></del></del>	<del><del></del></del>	<del><del></del></del>	
<i>Urolophus jamaicensis</i>	Yellow stingray	<del><del></del></del>	<del><del></del></del>	<del><del></del></del>	<del><del></del></del>	<del><del></del></del>	<del><del></del></del>	Rare

2.2 Conclusions

Figure 2 summarises results from the species checklist.

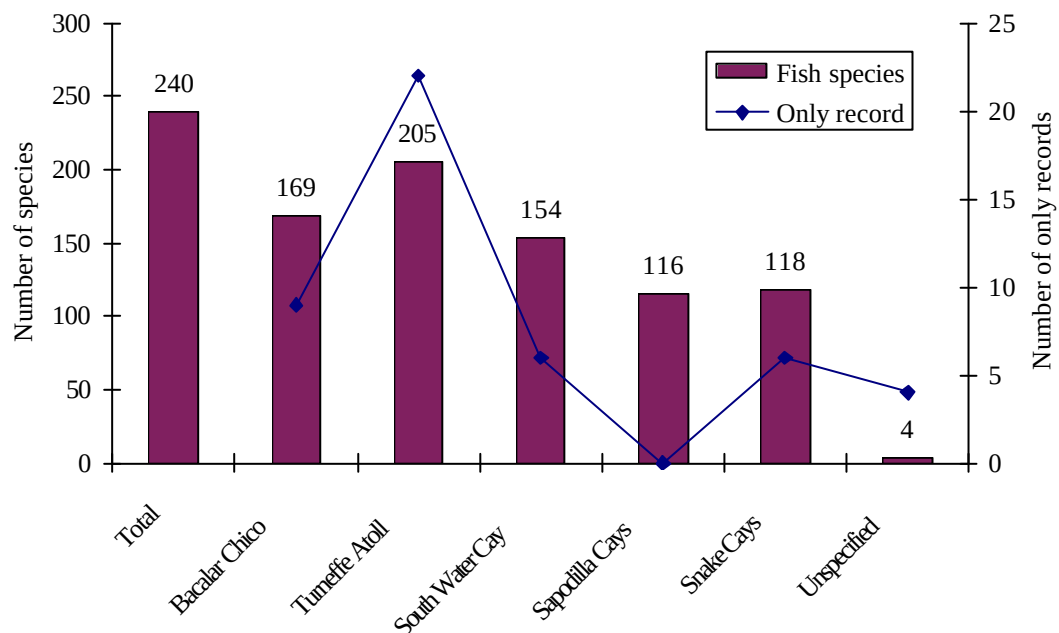


Figure 2. Summary of the number of species listed on the checklist for five areas surveyed by CCC in Belize. Total number of species also shown. ‘Only record’ refers to the number of species seen only at that location. ‘Unspecified’ represents confirmed sightings from Belize which cannot be allocated to one of the five areas.

Figure 2 shows that the five study areas, covering the whole geographical range of Belize, vary widely in fish species richness. While this almost certainly represents real differences comparisons must be made carefully since the areas differ considerably in size and survey effort. For example, Turneffe Atoll has the highest number of species (205) but is also the largest area (330 km²) and highest survey intensity. Conversely the diverse habitats within the Sapodilla Cays certainly supports more species than documented here.

There are, however, trends that can be seen within the data:

?? A high number of species seen only at Turneffe Atoll shows the importance of offshore atolls for conserving biodiversity. Both Bacalar Chico and South Water Cay (on the barrier reef itself) were surveyed reasonably extensively but 40-50 fewer species were recorded. Study of Belize's other atolls (Lighthouse Reef and Glovers Atoll) is, therefore, urgently required.

?? A relatively high number of species seen only in the Snake Cays (6 from 118) shows that reefs within the lagoon (i.e. between the mainland and barrier reef) are also important with respect to biodiversity. Habitats in these areas are often unique and more study is recommended.

?? A high total of fish species within the five study areas in evidence for an effective series of marine protected areas in Belize. South Water Cay, Bacalar Chico, the Sapodilla Cays and the Snake Cays are already subject to legislation and protection is planned for Turneffe Atoll. This study shows the importance of a series of complimentary marine reserves for effective conservation of biodiversity.

A paucity of detailed published literature for the fish species of Belize makes comparison with previous studies difficult. It is hoped, therefore, that this checklist will act as a basis for future work. However, it is believed that the following may be range extensions and new records for Belize:

?? <i>Sanopus splendidus</i>	-	Splendid toadfish
?? <i>Equetus acuminatus</i>	-	Highhat
?? <i>Equetus umbrosus</i>	-	Cubbyu
?? <i>Chromis insolatus</i>	-	Sunshinefish
?? <i>Bodianus pulchellus</i>	-	Spotfin hogfish
?? <i>Canthidermis sufflamen</i>	-	Ocean triggerfish
?? <i>Hypoplectrus aberrans</i>	-	Yellowbelly hamlet

The lists also confirms a range extension for *Hypoplectrus gemma* (Domeier, 1994)².

² Domeier, M.L. 1994. Speciation in the serranid fish *Hypoplectrus*. *Bulletin of Marine Science* **54**: 103-141

3. CORAL SPECIES LIST

CCC's coral species list has been compiled by Dr Doug Fenner, who worked as a field science staff member in 1994. His findings are summarised in the following paper. The paper is © Rosenstiel School of Marine and Atmospheric Science of the University of Miami.

NEW OBSERVATIONS ON THE STONY CORAL (SCLERACTINIA, MILLEPORIDAE, AND STYLASTERIDAE) SPECIES OF BELIZE (CENTRAL AMERICA) AND COZUMEL (MEXICO)

Douglas Fenner

ABSTRACT

A total of 61 species and eight forms of stony corals (Scleractinia, Milleporidae, and Stylasteridae) are known from the shallow waters (0–30 m) of Belize (Central America) and 63 species and eight forms from Cozumel (Mexico), including 11 new records from Belize and five new records from Cozumel. *Tubastraea coccinea* in Belize and Cozumel, and the hydrocoral *Millepora striata* in Belize represent biogeographic range extensions. A total of 94% of the species of zooxanthellate Scleractinia were found at both locations, but only 58% of the species of azooxanthellate Scleractinia were found at both locations. About 94% of the zooxanthellate Scleractinian species known from the Caribbean have been found at Belize and 91% found at Cozumel, and 25% and 43% of the known shallow-water (0–30 m) azooxanthellate Scleractinia have been found at the two sites, respectively, suggesting that the zooxanthellate Scleractinia may be better sampled than the azooxanthellate Scleractinia. Several zooxanthellates differed notably in abundance between the two sites, and some species showed greater within-species morphological variation at Belize than Cozumel. The appearance and ecology of *M. striata* and the field identification of four plate-forming *Agaricia* species are included.

Stony corals have been studied in both Belize, Central America (Thorpe and Bregazzi, 1960; Stoddart, 1962; Cairns, 1979, 1982) and Cozumel, Mexico (Fenner, 1988, 1991, 1993b; Jordan, 1988; Muckelbauer, 1990) in the northwest Caribbean, as well as at reefs located between these two locations (Jordan, 1979; Jordan, et al, 1981; Castaneros and Soto, 1982; Jordan and Martin, 1987; Jordan-Dahlgren et al. 1994). The relative proximity of Belize and Cozumel along with the presence of reefs at intermediate locations might suggest that their coral faunas would be quite similar, within the limits of the available habitats. In this study, expanded checklists for stony corals at Belize and Cozumel are reported, along with relative abundances, within-species morphological variation, and certain rarely reported and poorly known species.

METHODS

Belize and Cozumel are located in the northwestern Caribbean; Turneffe Atoll, Belize is about 400 km south of Cozumel. For descriptions of the reefs in these areas see Stoddart (1962), Rützler and Macintyre (1982), Fenner (1988, 1991), Jordan (1988), Muckelbauer (1990) and Macintyre and Aronson (1997). Observations in Belize were made by the author during September–December, 1994; observations at Cozumel were made during other studies (Fenner 1988, 1991, 1993a,b) and by Jose Castello (pers. comm.). Observations in Belize were centered on Calabash Cay (17°16.96'N, 87°48.69'W) in the southeastern part of Turneffe Atoll, with additional observations at Snake Cays (16°11.30'N, 88°34.00'W) in the southern Barrier Reef lagoon, where brief observations were limited to unusual corals. At each location, reef areas were observed using scuba equipment to a maximum depth of 40 m (usually to 30 m; only to 10 m at Snake Cays). Samples of three species of coral (*Agaricia grahamae* Wells, *Porites colonensis* Zlatarski, and *Thalamophyllia riisei* (Duchassaing and Michelotti)) were deposited in the collection of L. E. Dieckman, St. John's Col-

Table 1. Azooxanthellate Scleractinia found at 30 m depth or less in the Caribbean.

-
1. *Madracis myriaster* (Milne Edwards & Haime, 1849)
 2. *Madracis decactis* f. *pharensis* (Heller, 1868)
 3. *Astrangia poculata* (Ellis & Solander, 1786)
 4. *Astrangia solitaria* (Lesueur, 1817)
 5. *Phyllangia americana* Milne Edwards & Haime, 1849
 6. *Colangia immersa* (Pourtalès, 1871)
 7. *Coenocyathus goreau* (Wells, 1972)
 8. *Paracyathus pulchellus* (Philippi, 1842)
 9. *Polycyathus senegalensis* (Chevalier, 1966)
 10. *Thalamophyllia riisei* (Duchassaing & Michelotti, 1861)
 11. *Asterosmilia prolifera* (Pourtalès, 1871)
 12. *Rhizosmilia maculata* (Pourtalès, 1874)
 13. *Phacelocyathus flos* (Pourtalès, 1878)
 14. *Javania cailleti* (Duchassaing & Michelotti, 1864)
 15. *Gardineria minor* (Wells, 1973)
 16. *Gyneria annulata* (Duncan, 1872)
 17. *Balanophyllia pittieri* (Vaughan, 1919) (= *B. grandis*)
 18. *Balanophyllia dineta* (Cairns, 1977)
 19. *Balanophyllia floridana* (Pourtalès, 1860)
 20. *Rhizopsammia goesi* (Lindstrom, 1877) (= *Balanophyllia goesi*)
 21. *Leptopsammia trinitatis* (Hubbard & Wells, 1986)
 22. *Tubastraca coccinea* (Lesson, 1831)
 - 23–28. undescribed species (Cairns, pers. comm.)
-

lege, Belize City, and two species were in the personal collection of Jose Castello at Cozumel (*Mussa angulosa* f. *lacera* (Pallas) and *Oculina diffusa* Lamarck). Samples of *P. colonensis* and *Millepora striata* Duchassaing and Michelotti from Belize were deposited at the Smithsonian Institution (NMNH). Hermatypic corals (constructional, zooxanthellate: Schuhmacher and Zibrowius, 1985) were identified using the references given in Fenner (1993b) and ahermatypic (non-constructional, azooxanthellate) corals were identified by S. Cairns. The coral taxonomy used was that of Wells and Lang (1973) with modifications from Cairns (1982), van Moorsel (1983), de Weerd (1984), Zlatarski (1990), Weil (1992), Fenner (1993b), and Weil and Knowlton (1994). *Goreaugyra memorialis* Wells was considered a form of *Meandrina meandrites* (Linnaeus) as indicated in Zlatarski and Estrella (1982). Table 1 presents the species of azooxanthellate corals which have been found in the Caribbean in the 0–30 m depth range, and was derived from Tables 1 and 4 in Cairns (1979), and Cairns (pers. comm.). *Madracis formosa* Wells was excluded on the basis of its robust skeleton, colonies observed only in sunlit locations and as shallow as 10 m, and a dark green color. *Leptoseris cailleti* (Duchassaing and Michelotti) is light brown (P. Colin, pers. comm.), minimum 33 m depth (Dineson, 1980), and thus is probably zooxanthellate. *Oculina valenciennesi* was also considered to be zooxanthellate based on the observation that it is yellow and found at 2–20 m in Bermuda (Sterrer and Schoepfer-Sterrer, 1986). Two facultative zooxanthellates were excluded. *Oculina varicosa* Lesueur was excluded because it has not yet been reported to be azooxanthellate in less than 30 m depth in the Caribbean. *Madracis asperula* Milne-Edwards and Haime was also excluded, because it has been reported at depths as shallow as 21 m in the Caribbean (Cairns, pers. comm.) and in Texas it is a light brown (S. Gittings, pers. comm.). A recorded depth of 311 m (Cairns, pers. comm.) indicates it can also be azooxanthellate at greater depths. *Madracis pharensis* was considered a form of *Madracis decactis* (Fenner, 1993b). Coral species lists were compared using the Jaccard coefficient (Hubalek, 1982), $J_{12} = a / (a + b + c)$, where a = number of species

found at both sites, b = number of species at site 1 but not site 2, and c = number of species at site 2 but not site 1. The coefficient was converted to a percentage. Coral abundance ratings were derived from quantitative transect data reported by Fenner (1988, 1991) for Cozumel, and from 1579 team dives on transects from around the entire Turneffe Atoll by volunteers trained by Coral Cay Conservation and analyzed by A. Harborn. Methods of training and the testing of volunteers was described by Mumby et al. (1995). Briefly, training consisted of a week of instruction using the guidebook by Humann (1993). Surveying was carried out by teams of four volunteers surveying a 5-m wide transect from 30 m to 5 m depth; several team-dives were required to finish most transects. One member of each team recorded coral abundance on a 0 to 5 abundance scale for each species present, with 0 representing species not seen in the transect and 5 a dominant species. Quantitative data from Cozumel were supplemented by observations by the author outside transects, especially for rare species. The same was true for Belize with increased reliance on the author's observations for species which volunteers were not able to accurately identify (Mumby et al., 1995).

OBSERVATIONS

SPECIES RICHNESS.—Coral species richness appeared quite similar at the two locations, although some differences were notable. Sixty-one species and eight forms of stony corals (Scleractinia, Milleporidae, and Stylasteridae) have been found at Belize, and 63 species and eight forms at Cozumel (Table 2). *Madrepora carolina* (Pourtales) was excluded from the Cozumel list and *Caryophyllia ambrosia* Alcock, *Deltocyathus agassizii* Pourtales, *D. moseleyi* Cairns, and *Javania cailleti* (Duchassaing and Michelotti) were excluded from the Belize list as they were not found above 40 m depth, the maximum depth of this study, and represent deep water azooxanthellate Scleractinia. A total of 67 species and nine forms of stony coral were found at the two locations, with nine species and two forms found at only one of the two locations. Ninety-four percent of the zooxanthellate Scleractinian species were found at both locations, while only 58% of the azooxanthellate Scleractinian species were found at both locations. Similar overlap occurs between these locations and Jamaica, the currently best-studied site in the Caribbean: Belize and Jamaica share 98% of their zooxanthellate Scleractinia but only 63% of their azooxanthellate Scleractinia, and Cozumel and Jamaica share 96% of their zooxanthellates but 77% of their azooxanthellates. The 51 species of zooxanthellate Scleractinia known from Belize represent 94% of the approximately 54 zooxanthellate Scleractinia species known from the Caribbean, and the 49 species known from Cozumel represent 91% of the Caribbean fauna. The 12 species of azooxanthellate Scleractinia found at Cozumel represent 43% of the 28 shallow-water (0–30 m) azooxanthellate species known from the Caribbean (Table 1), and the seven species found in Belize represent 25% of those 28 species.

Table 2. Numbers of stony coral species and forms at Cozumel and Belize.

		Cozumel	Belize
Scleractinia	Zooxanthellate species	49	51
	forms	8	8
	azooxanthellate	12	7
Hydrocorals	zooxanthellate	2	3
	azooxanthellate	1	1
Total species		63 *	61 *

**Madracis decactis* was counted both as zooxanthellate and azooxanthellate.

The present study is the first published record of 11 corals in Belize: *Madracis decactis* f. *luciphila* (Lyman), *Agaricia agaricites* f. *danai* (Linnaeus), *A. humilis* Verrill, *Montastraea franksi* (Gregory), *Solenastrea bournoni* Milne Edwards and Haime, *S. hyades* Dana, *Astrangia rathbuni* Vaughan, *O. varicosa* Lesueur, *T. riisei*, *Tubastraea coccinea* Lesson and *M. striata*. This is not a new record of *Mycetophyllia reesi* Wells as it had previously been reported by James and Ginsburg (1979) and Humann (1993). This is also the first record of five corals for Cozumel: *Acropora prolifera*, (Lamarck), *A. undata* (Ellis and Solander), *A. grahamae*, *M. reesi*, and *T. coccinea*.

ABUNDANCES.—*Agaricia agaricites* forma *purpurea* was more common in Cozumel than Belize (Table 3), being by far the most common platy agariciid in Cozumel, while *A. lamarcki* Milne Edwards and Haime was more common in Belize than in Cozumel, being at least as common in Belize as *A. agaricites* f. *purpurea*. *Agaricia tenuifolia* Dana was more common in Cozumel than in Belize. In Cozumel, it was one of the two most common corals on the tops of reefs at all depths. In Belize, it was one of the three or four most common corals at shallow depths, but decreased rapidly in abundance with increasing depth even on the tops of reefs, being quite rare below 15 m depth. *Porites furcata* Lamarck was one of the two most common corals in Cozumel, forming patches 1–3 m in diameter on the tops of all reefs. In Belize, it was less common, forming more variable size colonies. *Isophyllastrea rigida* (Dana) was much more common than *Isophyllia sinuosa* (Ellis and Solander) in Cozumel, while *I. sinuosa* was somewhat more common than *I. rigida* in Belize. *Madracis formosa* Wells was more common in Belize than Cozumel, as were *Acropora palmata* (Lamarck), *A. cervicornis* (Lamarck), *A. prolifera*, *A. grahamae*, *Siderastrea siderea* (Ellis and Solander), *Porites porites*, (Pallas) and *M. reesi*. The latter has been reported from only a few locations, and is apparently uncommon or rare at most locations. However, it was quite common on vertical drop-offs below 25 m in Belize. Nine colonies were found on a transect running 81 m horizontally and 5 m vertically, on a vertical drop-off at 30 m depth at Calabash Cay. *Millepora striata* was seen both at Turneffe and Snake Cays. This little-studied hydrocoral was not uncommon in Belize, but was not seen at Cozumel. At Snake Cays, *S. bournoni*, *O. diffusa*, and *Cladocora arbuscula* (Lesueur) were fairly common, though they were rare at Cozumel (*O. diffusa* seen only at Punta Morena) and not seen at Turneffe. *Cladocora arbuscula* is well represented in the collection of L. E. Dieckman, and thus may be fairly common in Belize. Two colonies of *T. coccinea* in the Dieckman collection indicate that this species is present in Belize, though the location of collection was not recorded; it was also seen on the reef on the east side of Turneffe Atoll, Belize (K. Sherwood, pers. comm.). *T. coccinea* was found inside the fuselage of a sunken airplane at about 10 m depth near the International Piers at Cozumel (J. Castello, pers. comm.).

MORPHOLOGICAL VARIATION.—Morphological differences between corals at Cozumel and Belize were observed in a few species. *Porites furcata* in Cozumel appeared more uniform in diameter and color than in Belize, with *P. porites* being quite uncommon. In Belize, *P. porites* appeared to be as common as *P. furcata*, and the two appeared to be part of a continuous range of branch diameters and shapes. *Agaricia tenuifolia* in Cozumel was quite uniform, with relatively small, parallel, brown blades. In one small area near the Galapago hotel, *A. tenuifolia* had larger green blades that occasionally formed boxwork. In Belize, however, *A. tenuifolia* had a very wide range of blade sizes and shapes from narrow to wide, short to tall, and thin to thick, including many combinations of these. Colors included brown, green, and rust with or without orange tentacles or mouths. Vari-

Table 3. Stony Corals (Scleractinia, Milleporidae, and Stylasteridae) of Cozumel and Belize. Cozumel: 1: Fenner, 1988; 2: Jordan, 1988; 3: Muckelbauer, 1990; 4: Fenner, 1993a; 5: Fenner, 1993b; 6: V. Zlatarski, unpubl.; 7: J. Castello (personal comm.) Belize: 8: Torpe & Bregazzi, 1960 and Stoddart, 1962; 9: Cairns, 1982 (including previous studies referred to); 10: Handle & Eiberle, 1992; 11: Turneffe Atoll, present report; 12: Snake Cays, present report; 13: Bacalar Chico, observations of Jorge Cortés; 14: Dieckman Collection; 15: Aronson & Precht, 1997 Abundance: 1=rare 5=abundant.

		Cozumel							Belize							
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	<i>Stephanocoenia michelinii</i>	2	*	*	*				3	*	*	*			*	*
2	<i>Madracis mirabilis</i>	3	*	*	*	*			2	*	*	*			*	*
3	<i>M. decactis</i>															
	f. <i>decactis</i>	3	*	*	*	*			2	*	*	*	*		*	*
	f. <i>luciphila</i>	2				*			2			*			*	
	f. <i>pharensis</i>	+	1	*		*			1	*		*			*	
4	<i>M. formosa</i>	1				*			2		*	*			*	
5	<i>Acropora palmata</i>	3	*	*	*				3	*	*	*	*		*	*
6	<i>A. cervicornis</i>	2	*	*	*				3	*	*	*	*		*	*
7	<i>A. prolifera</i>	1					*		1	*	*	*			*	
8	<i>Agaricia agaricites</i>															
	f. <i>agaricites</i>	3	*	*	*				4	*	*	*		*	*	
	f. <i>purpurea</i>	4		*	*				3	*		*			*	
	f. <i>carinata</i>	2		*	*				1	*		*			*	
	f. <i>danai</i>	1		*	*				1			*			*	
9	<i>Agaricia tenuifolia</i>	5	*	*	*				3	*		*		*	*	*
10	<i>A. humilis</i>	2	*	*					2			*		*		
11	<i>A. fragilis</i>			*					2	*		*			*	*
12	<i>A. lamarcki</i>	1				*			3	*		*			*	*
13	<i>A. undata</i>	1						*								
14	<i>A. grahamae</i>	1						*	1			*			*	*
15	<i>Leptoseris cuculata</i> (= <i>Helioseris</i>)	4		*	*				3	*	*	*	*		*	*
16	<i>Siderastrea radians</i>	3	*	*	*	*			2	*	*	*	*		*	*
17	<i>S. siderea</i>	3	*	*	*	*			4	*	*	*	*		*	*
18	<i>Porites porites</i> ¹	1	*	*	*				3	*	*	*	*		*	*
19	<i>P. furcata</i> ¹	5	*	*	*				3	*	*		*		*	
20	<i>P. divaricata</i> ¹	2	*		*				1	*	*		*		*	
21	<i>P. astreoides</i> ¹	4	*	*	*				4	*	*	*	*		*	*
22	<i>P. colonensis</i>	1				*			1			*			*	*
23	<i>P. cf. branneri</i> ²	2	*							*				*		
24	<i>Favia fragum</i>	3	*	*	*				3	*	*	*	*		*	
25	<i>Diploria strigosa</i>	3	*	*	*				4	*	*	*	*		*	*
26	<i>D. clivosa</i>	3	*	*	*				2	*	*	*	*		*	*
27	<i>D. labyrinthiformis</i>	3	*	*	*				3	*	*	*	*		*	*
28	<i>Manicina areolata</i>															
	f. <i>areolata</i>	3	*		*				3	*	*	*	*		*	
	f. <i>mayori</i>	2			*				1	*		*			*	
29	<i>Colpophyllia natans</i> (= <i>breviserialis</i>)	3	*	*	*	*			2	*	*	*	*		*	*

Table 3. Continued.

		Cozumel							Belize							
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
30	<i>Cladocora arbuscula</i>			*					2	*	*		*		*	
31	<i>Montastraea annularis</i>	2	*	*	*				3	*	*	*	*	*	*	*
32	<i>M. faveolata</i>	3				*			3		*		*		*	*
33	<i>M. franksi</i>	1				*			1			*		*		
34	<i>M. cavernosa</i>	2	*	*	*				4	*	*	*	*		*	*
35	<i>Solenastrea bournoni</i>	1			*				2	*			*		*	
36	<i>S. hyades</i>								1						*	
37	<i>Phylangia americana</i>	+	1		*						*				*	
38	<i>Astrangia solitaria</i>	+	1				*				*				*	
39	<i>Colangia immersa</i>	+	2	*							*					
40	<i>Rhizosmilia maculata</i>	+	2	*												
41	<i>Oculina diffusa</i>	1				*		*	2		*		*		*	
42	<i>O. varicosa</i>								1				*		*	
43	<i>O. valenciennesi</i>										*					
44	<i>Meandrina meandrites</i>															
	f. <i>meandrites</i>	3	*	*	*				3	*	*	*	*		*	*
	f. <i>memoralis</i>								1		*					
45	<i>Dichocoenia stokesi</i> (= <i>stellaris</i>)	3	*	*	*				3	*	*	*	*		*	*
46	<i>Dendrogyra cylindrus</i>	1	*	*	*				1	*	*	*	*		*	
47	<i>Mussa angulosa</i>															
	f. <i>angulosa</i>	2	*	*	*				2	*	*	*	*		*	
	f. <i>lacera</i>	1	*	*	*				1		*	*	*			
48	<i>Scolymia cubensis</i>	2	*						2		*	*	*		*	*
49	<i>Isophyllia sinuosa</i>	2	*	*	*				3	* ³	*	*	*		*	
50	<i>Isophyllastrea rigida</i>	3	*	*	*				2	*	*	*	*		*	*
51	<i>Mycetophyllia lamarckiana</i>	3	*	*	*				3	*	*	*	*		*	*
52	<i>M. danaana</i>	4	*	*					3		*	*	*		*	*
53	<i>M. aliciae</i>	2	*	*					2		*	*	*			*
54	<i>M. ferox</i>	2	*	*					2		*		*		*	*
55	<i>M. reesi</i>	1						*	2			*			*	
56	<i>Thalamophyllia riisei</i>	+	1	*					1			*			*	
57	<i>Eusmilia fastigiata</i>															
	f. <i>fastigiata</i>	4	*	*	*				2	*	*	*	*		*	*
	f. <i>flabelliformis</i>	1			*											
58	<i>Gardinaria minor</i>	+	1		*						*				*	
59	<i>Balanophyllia pittieri</i> (= <i>grandis</i>)	+	2	*												
60	<i>Leptopsammia trinitatis</i>	+	1	*												
61	<i>Phacelocyathus flos</i>	+	1	*												
62	<i>Paracyathus pulchellus</i>	+	1	*												
63	<i>Tubastraea coccinea</i>	+	1					*	1			* ⁴			*	
64	<i>Millepora alcicornis</i>	4	*	*	*				3	*	*		*	*	*	*
65	<i>M. complanata</i>	5	*		*				3	*	*		*	*	*	*

Table 3. Continued.

		Cozumel							Belize						
		1	2	3	4	5	6	7	8	9	10	11	12	13	14 15
66	<i>M. striata</i>								1	*		*	*		*
67	<i>Stylaster roseus</i>	+	3	*	*				1	*		*			*

+ ahermatypic (azooxanthellate)

1. Jameson (1997) presents evidence supporting *P. astreoides*, *P. porites*, *P. furcata*, and *P. divaricata* as valid species present in Belize. 2. Small, blue *Porites* colonies were found at Cozumel, Little Cayman, and Cayman Brac (Fenner, 1982, 1988) and upon skeletal examination reported as *Porites branneri*. Similar colonies were found at Grand Cayman (Fenner, unpublished), and Belize (McRae, internet "coralist" message, June 8, 1997). The species is described and figured in Roos (1971), Smith (1971), Humann (1993) and Budd et al. (1994). Weil (1992) and Budd et al. (1994) present evidence that these colonies are a species distinct from other Caribbean *Porites*. Although similar to *P. branneri* (described from Brazil), they may not be synonymous, and thus Weil (1992) refers to them as "*P. branneri*." Jameson (1997) considered the lack of columella tubercles in Weil's Panama specimens as confirmation of *P. branneri*. 3. Thorpe and Bregazzi (1960) report *Isophyllia multiflora*, which may or may not be synonymous with *I. sinuosa*. 4. K. Sherwood (pers. comm.).

ability in these characteristics was small within colonies and large between colonies, even when the colonies were side by side, indicating that the variation was probably genetic. In Belize, variation in shape of both *Agaricia tenuifolia* and *A. agaricites* are so great that it appears possible that they form one continuous range of variation. Although variation in *A. agaricites* at Cozumel is considerable, it is readily distinguishable from the only two morphs of *A. tenuifolia* present there. The only possible intermediates at Cozumel are large, thick, brown blades (shown in Humann, 1993:145 bottom, author's photograph), which correspond to *A. agaricites* forma *danai*, and are quite uncommon.

In *M. complanata* Lamarck there was again a wide range of variation between colony shapes in Belize, with little variation in shape within colonies. *Millepora alcicornis* also showed great inter-colony variation with small intra-colony variation in Belize, especially at Snake Cays, where a few colonies resembled *M. dichotoma* Ortmann or *M. intricata* Edwards in the western Pacific. The range of variation of these two species, however, was not continuous and they could always be distinguished.

Several observations supported the view that valley length, hydrophorid collines (Fenner, 1993), and ambulacral grooves (Zlatarski and Estallela, 1982) are not always good characters for distinguishing species of Caribbean meandroid Scleractinia. In Belize, one *Diploria clivosa* (Ellis and Solander) was observed with areas having short valleys with one or just a few centers, and other areas having long valleys with many centers. One *Colpophyllia natans* (Muller) was observed in Belize having areas containing typical long valleys and meandroid collines. In other areas on the same colony the collines were broken into short hydrophorid sections, similar to that seen in one complete colony in Cozumel (Fenner, 1993b) and one in Colombia (Pfaff, 1969) and referred to by Wells (1973). A few colonies of *M. meandrites* were observed in Belize that were thick columns with areas on their surface where an ambulacral groove separated the meandering valleys, the distinctive feature of *G. memorialis*.

MILLEPORA STRIATA.—This rarely reported species was found only in shallow water, 1–3 m deep. Colonies consisted of narrow blades with small vertical ridges near the upper end of the blades (Fig. 1), and in some colonies paddle-like extensions (sometimes out of the plane of the lower blade) as illustrated by de Weerd (1984). Blades were about 1.5–3 cm wide in many colonies, and about 10–20 cm tall. At Calabash Cay, Turneffe, colonies



Figure 1. *Millepora striata* specimens in the Dieckman collection. Note flattened branches with vertical buttressing ridges near branch tips.

were found in clusters which had little morphological variation within clusters and higher variation between clusters. One distinctive group of about eight large colonies had produced a series of loose fragments. Thus, fragmentation appeared to have produced three or four clones, each consisting of several colonies. The group of eight colonies was composed largely of vertical blades that appeared much like twisted straps, with little branching. Most blades had one or more vertical ridges on the sides running much of the length of the blade, making it triangular in cross section. Some colonies were seen to encrust coral substrate and others encrusted gorgonians as does *M. alcicornis*. Dactyloporos and gastropores were of the size and density reported by de Weerd (1984) for *M. striata*. Living colonies are yellow-brown and sting human skin. The Dieckman collection contains seven *M. striata* coralla. Several dozen colonies were also observed in the San Blas Islands of Panama, appearing to belong to one or two dozen clones. Morphology was similar to the Belize colonies, and included colonies intermediate between the morphologies described above for Belize.

PLATE-FORMING AGARICIA.—Observations of three clones of *A. grahamae* in Belize, one large clone at St. Lucia, along with specimens in the Dieckman collection and at NMNH (including the type), together with previous observations (Fenner, 1993b) support the view that *A. grahamae* is a valid species. It appears quite distinct from other *Agaricia* species, with no intermediates found. The following narrative indicates how four plate-forming species of *Agaricia* can be distinguished in the field. *A. agaricites* f. *purpurea* forms small to medium plates that do not form whorls, spirals, or rosettes. Colony colors are dark browns or greens, with no noticeable white edge on colonies. The collines are sharp, intersect, with many that are not parallel; valleys are discontinuous. It is found in a wide range of depths. *A. lamarcki* forms large whorls or spirals that are usually flat, without raised edges that form rosettes. They are usually dark brown, always with contrasting white stars at the polyp centers. The collines are large and rounded, parallel, and often taper at their ends; valleys are continuous. It also lives at a wide range of depths, but may be most common in deep water (Ghiold and Smith, 1990). *A. undata* forms medium-sized

plates, whorls, spirals or rosettes. The collines are low, rounded, and parallel. Colony colors are uniform and light, and the collines are hard to see. The edges of plates are often white. The polyp centers are at the base of the collines, on their distal edge. The collines are widely spaced, with a flat-bottomed valley between them, and the valleys are continuous. This is true not only at the edge of the colony, but all the way across the colony. It may be most common in deep water (Ghiold and Smith, 1990). *A. grahamae* forms medium to large whorls, spirals, and rosettes with raised plate edges. Colony color is uniform, light, with white plate edges. The collines are sharp and parallel, and easily visible. Collines are close together, with no flat area between collines- valleys between the collines are V-shaped and continuous. The edge zone of colonies may appear like *A. undata*. It is found in deep water (25–40+ m).

DISCUSSION

Most of the zooxanthellate Scleractinian corals known from the Caribbean have been found at both Belize and Cozumel; however, a much smaller portion of the Caribbean shallow-water azooxanthellate Scleractinia has been found at either location. The lists of zooxanthellate Scleractinia reported here are quite similar, with 94% of the species on both lists. Indeed, these lists are also quite similar to that for Jamaica, with total stony coral species the same or only slightly fewer (Cozumel: 63, Belize: 61, Jamaica: 63, including *M. faveolata* and *M. franksi* reported by Weil and Knowlton (1995), and *P. colonensis* collected (at Discovery Bay) and identified by D. Danaher (pers. comm.); identification confirmed by S. Cairns). The percentage overlap of the Belize and Cozumel corals with Jamaica was very similar to that between Belize and Cozumel. Similarly, Chiappone, Sullivan, and Lott (1996) reported high overlap in a comparison of several moderately well-studied sites in the Caribbean. For zooxanthellate Scleractinia, about 94% of the Caribbean fauna have been found at Belize and 91% at Cozumel. This is consistent with the view that most zooxanthellate Scleractinia range throughout the Caribbean (Liddel and Ohlhorst, 1988; de Weerd, 1990; Fenner, 1993; Johnson et al. 1995; Veron, 1995; Paulay, 1997) and thus are likely to be found after a thorough search at any location with reefs over a sufficient range of depths and habitat types. Only 58% of the azooxanthellate Scleractinia were found at both Cozumel and Belize; only 43% and 25% of the known Caribbean shallow-water azooxanthellate Scleractinia were found at Cozumel and Belize, respectively. These low percentages may result from limited habitat (cavern roof) availability; although caverns are very common in Cozumel, they are quite rare in the area studied in Belize. Only about half as many of these species are known from Belize as Cozumel. However, both of these locations had fairly low species overlap with Jamaica and low percentages of the known Caribbean fauna, suggesting that this may only be part of the source of the low overlap. Most searches for corals are conducted primarily in sunlit habitats, including the present study, so it is likely that caverns were insufficiently sampled to find many species. In addition, most shallow azooxanthellate Scleractinia are quite small and cryptic. Compounding this effect is the patchy distribution of some azooxanthellate Scleractinia in clusters produced by growth from stolons and/or brooded larvae that crawl short distances (Gerrodette, 1979; Fadallah and Pearse, 1982). Higher site overlaps than percentages of the Caribbean fauna suggest that most of the species found were relatively common or regional. Thorough sampling may reveal most species on most reefs much like zooxanthellates, or more restricted (or patchy)

ranges due to limited planular dispersal, though ahermatypes with larvae that crawl can have wide ranges (Gerrodette, 1979; Hellberg, 1994).

This is the first report of *T. coccinea* north of Panama and west of the Caymans, and thus represents a range extension. *Millepora striata* was found in Belize and Panama; de Weerdt (1984) indicated *M. striata* was known from Guadeloupe, San Blas (Panama), and Venezuela, but did not find it in Curacao or Bonaire. Other specimens identified by de Weerdt (NMNH 99482) are from Fuerte Island, Colombia; no other reports are known. Thus, this report represents a range extension for *M. striata* to Belize. *Millepora striata* may not occur in Florida, the Bahamas, and the Greater Antilles much as *M. squarrosa* is not found outside of the eastern Caribbean and Brazil (de Weerdt 1990), or more likely it may simply be an uncommon coral that is neither well-known nor easily recognized.

The greater range of morphological variation of *Agaricia tenuifolia* in Belize than Cozumel may obscure reproductive isolation from *Agaricia agaricites* in Belize, or it may reflect reduced or absent reproductive isolation of these morphospecies in Belize. Similar problems are presented by the greater morphological variation of *Porites porites*, *Porites furcata*, *Millepora complanata* and *M. alcicornis* in Belize than Cozumel. Several coral morphospecies have been found to be capable of interbreeding (e.g., Miller and Babcock, 1997; Szmant et al. 1997; Willis et al. 1997, Miller and Benzie, 1997), and others may be able to interbreed at one location but not at another (Knowlton et al 1997; Szmant et al. 1997). This along with patterns of partial isolation produced by large distances between islands and changing currents, may have produced a pattern of reticulate evolution (Veron, 1995).

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