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Shore Fishes from Islands of the Mona Passage, Greater Antilles with Comments on Their Zoogeography

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ABSTRACT.—The geology, physical conditions, size, and position within the Caribbean may all play a role in shaping the fauna of islands in the Mona Passage. This paper describes the ichthyofauna of Mona, Monito, and Desecheo by habitat, compares it to surrounding island faunas, and discusses the zoogeography of its shore fishes. We used ichthyocides and diver visual survey during several expeditions to collect and identify the shore fishes from the islands. Islands in the Mona Passage have a diverse though perhaps impoverished marine ichthyofauna consisting of 261 known species, compared to nearby Puerto Rico that has more than twice as many species. The narrow shelf area of these islands compresses reef zones that are typically distinct and spread over a much broader shelf. Species typical of the same reef zones in Puerto Rico also occur at Mona, but shelf-edge species can be found nearshore. The limited habitat diversity, including restricted mangrove and seagrass areas, may have an effect on the marine fishes by excluding some species and reducing the abundance of others. These islands fall within a major faunal break between Hispaniola and Puerto Rico. This biogeographical barrier is an imperfect filter for marine fishes as some are found east of the Mona Passage, but are absent from the Puerto Rican Plateau and Lesser Antilles. While several sampling methods were used, ichthyocide collections accounted for the largest number of species. The true diversity of the ichthyofauna would be hidden without the use of ichthyocides to sample the cryptic fish assemblage.

KEYWORDS.—zoogeography, ichthyocide, marine fauna, reef fishes

INTRODUCTION

Europeans first sighted the islands of the Mona Passage on 22 November 1493 during the second voyage of Columbus (Morison 1942). Bartolomé de las Casas (1971), Columbus' chronicler, thought the name was derived from the classical name from Anglesea off Wales known as the Isle of Mona, though Ferdinand Columbus indicates its origin is from the Indian name Amona. The islands are not only of historical importance, but also zoogeographic stepping stones between Hispaniola and Puerto Rico (Fig. 1).

Under island biogeographic theory, the fauna composition of islands, such as those in the Mona Passage, are strongly influenced by island size and habitat heterogeneity (MacArthur and Wilson 1967). Larger islands provide a greater number of habitats allowing more ways to exploit environmental resources that contribute to species diversity. The lack or reduced size of important habitats should have a noticeable effect on faunal diversity or abundance.

The physical setting of an island also has a profound influence on the local fauna. Islands of the Mona Passage are positioned in a deep (>500 m) water gap between Hispaniola and Puerto Rico in the eastern Greater Antilles. There is a major faunal break here with primary freshwater fishes

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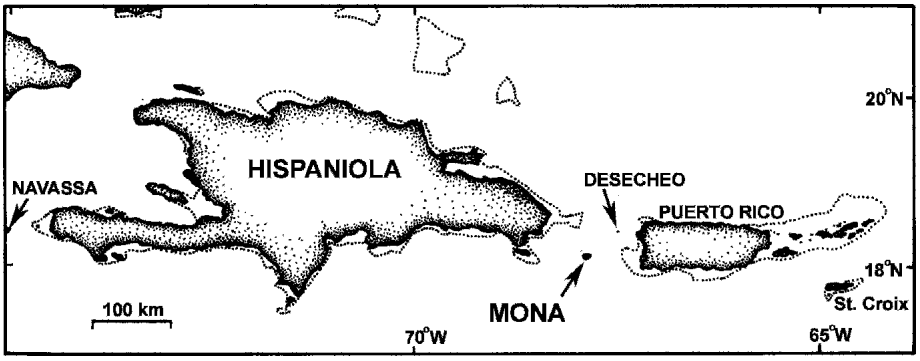

FIG. 1. Location of Mona and Desecheo between Hispaniola and Puerto Rico in the eastern Greater Antilles. Monito is located off the northwest corner of Mona. Dotted line indicates 200 m depth contour.

absent from islands east of Hispaniola (Myers 1938). The geology of the region is complex, with numerous blocks of various age and origin comprising the islands (Donnelly 1988). The Mona Passage is one of the main channels between the Caribbean Sea and Atlantic Ocean (Johns et al. 2002). Both the geology and oceanographic conditions play a role in shaping the fauna of these islands.

While the terrestrial biology of these unique islands has been studied (e.g., Rolle et al. 1964; Terborgh and Faaborg 1973; Kelper 1978; Meier et al. 1989), little has been reported on the shore fishes (Fowler 1943). The Caribbean is considered the center of marine fish diversity in the western Atlantic (Brigg 1995; Floeter and Gaspanni 2000). While there have been recent updates on the ichthyofauna of Bermuda (Smith-Vaniz et al. 1999), Bahamas (Böhlke and Smith-Vaniz 1993), Cuba (Claro and Parenti 2001), and Puerto Rico (Dennis et al. 2004), the literature on the eastern Greater Antilles is still limited. Little has been published on Hispaniola (Williams et al. 1983) though a recent summary of the Puerto Rico Plateau found 693 shallow-water species (Dennis 2000). A recent study of the ichthyofauna at Navassa Island is highly relevant as it is of similar size to Mona and comparably situated between larger islands in the Windward Passage between Jamaica and Hispaniola (Collette et al. 2003). The geology, physical conditions, size, and position within the Caribbean may all play a role in shaping the ichthyofauna of the islands in the Mona Passage. This paper describes the ichthyofauna of the islands of the Mona Passage by habitat, compares it to surrounding island faunas, and discusses the zoogeography of its shore fishes. These islands fall at a major biogeographical break between Hispaniola and Puerto Rico. This barrier is an imperfect filter for marine fishes as some occur only east of the barrier and many others on both sides. Ichthyocide collections were essential in obtaining an estimate of the true diversity of the ichthyofauna and making comparisons across the barrier.

MATERIALS AND METHODS

Study area

Mona, the largest island (587 ha), is composed of uplifted marine limestone forming a plateau edged with steep cliffs (45-60 m) extending to at least a 30 m depth on the north coast (Rodriguez et al. 1977) (Fig. 2). The southern coast consists of reef limestone overlaid by sand. The climate is semiarid, and there is little freshwater runoff (Picó 1950). Mona (18.08°N, 67.89°W) is 65 km east of Hispaniola and 72 km west of Puerto Rico (Fig. 1).

Mona is accompanied by Monito (18.16°N, 67.95°W), a small (16 ha) sliver of dolomite off the northwest corner of Mona (Figs. 2d and e). Desecheo (18.38°N, 67.48°W) is found to the east, 49 km northeast of Mona and only 21 km from Puerto Rico, along a seaward projection of the

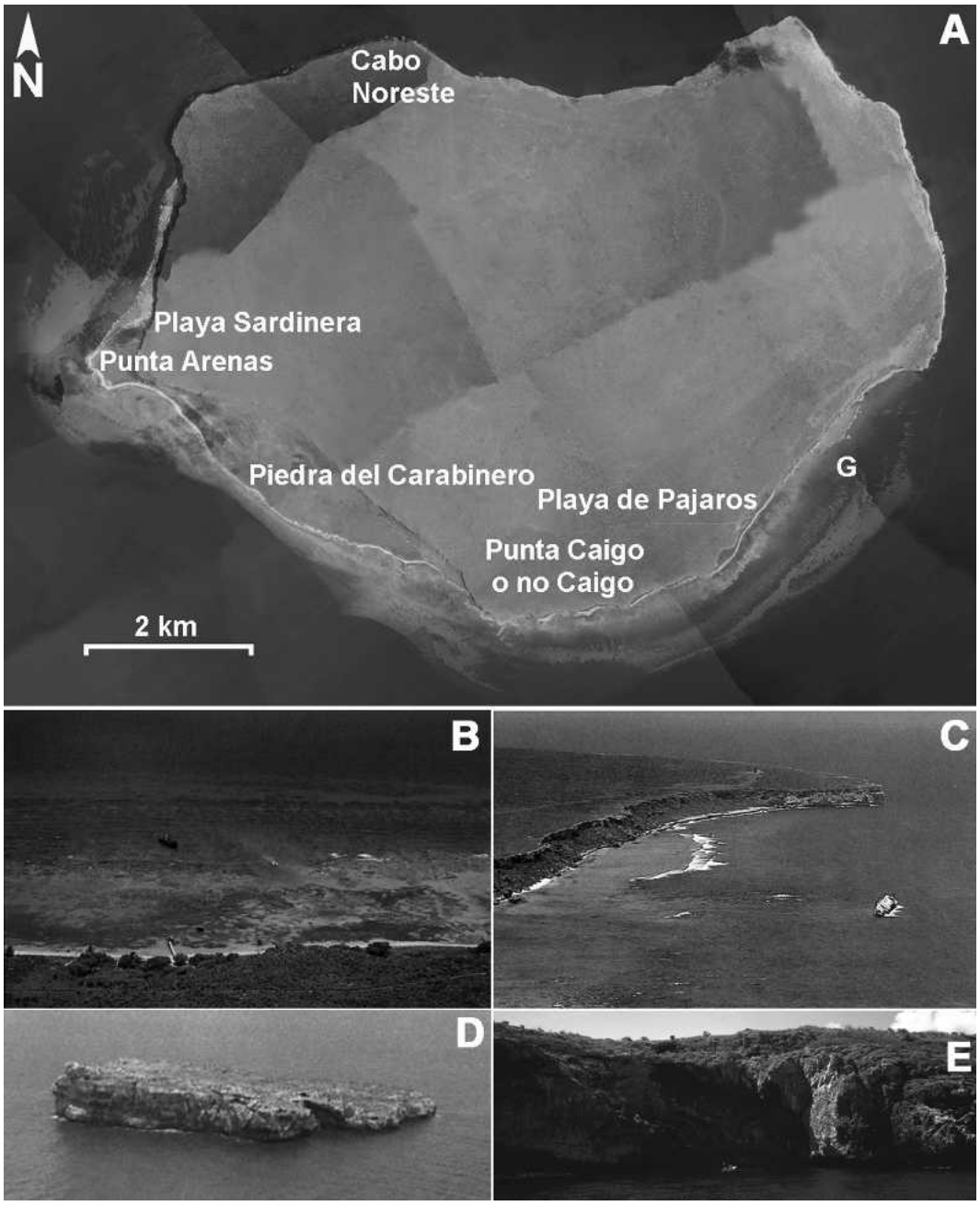

FIG. 2. A. Aerial image of Mona with sampling locations. B. Oblique view of Playa Sardinera fringing reef and anchorage. C. Oblique view of M/V A. REGINA grounding (G) off Playa de Pajaros. D. Oblique view of Monito. E. Closeup view of cove on west coast of Monito. 2A modified from Kendall et al. (2001) and 2B, 2C, and 2D, from Cerame-Vivas (1988; with permission of the author).

southern Puerto Rico fault zone (Figs. 3a and b). It is intermediate in size (121 ha) and composed of Eocene volcanic rocks with marine terrace deposits (Seiders et al. 1972). On three sides there are abrupt sea cliffs from a wave-cut terrace to ridge crests 30-60 m above sea level. Several narrow inlets indent the rocky shoreline and give access to small beaches (Fig. 3c).

The Mona Passage is an important wintering ground for humpback whales (*Megaptera novaeangliae* (Borowski)) (Mattila and Clapham 1989). Mona is one of the largest nesting sites for hawksbill turtles (*Eretmochelys imbricata* (Linnaeus)) in the Caribbean and the waters around Mona and Monito are important juvenile hawksbill feeding areas (Pares-Jordan et al. 1994, Diez and van Dam 2002). All three islands are part of the Commonwealth of Puerto Rico. Since 1975, Mona and Monito have been managed by Puerto Rico Department of Natural Resources. In 1976 Desecheo was incorporated into the U.S. Fish and Wildlife Service National Wildlife Refuge system to restore and protect historical seabird colonies and the natural island ecosystems (Service 2003). Breckon (2000) summarizes the history of Desecho.

Surface currents in the Mona Passage are

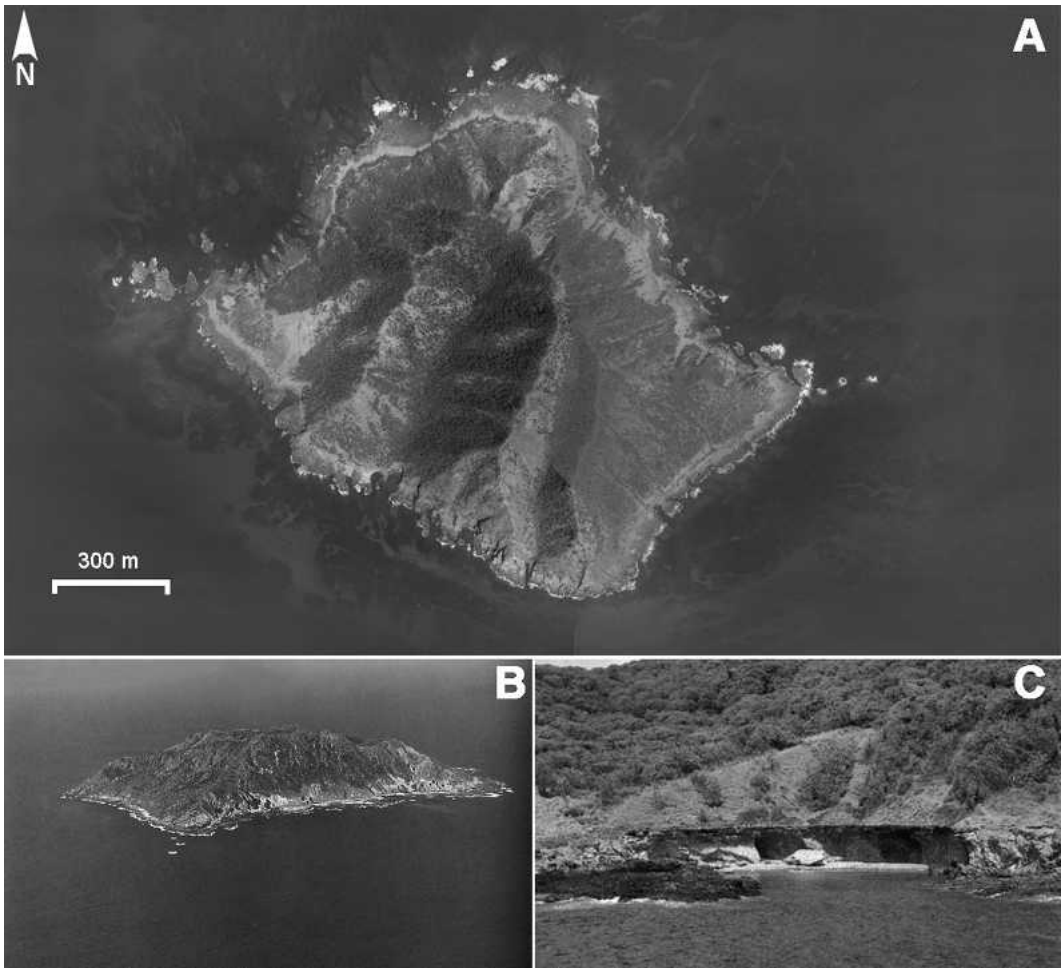

FIG. 3. A. Aerial image of Desecheo. B. Oblique view of Desecheo. C. Closeup view of Puerto de los Botes cove with beach on Desecheo. 3A modified from Kendall et al. (2001), and 3B and 3C from Cerame-Vivas (1988; with permission of the author).

complex with upper water column flow predominately southward west of Mona and a persistent countercurrent to the north along the Puerto Rican coast, though flow is highly variable (Metcalf et al. 1977; Johns et al. 1999). Water temperature at Mona reaches a maximum of 29.9°C in August to September and a minimum of 25.3°C in February to March (Diez and van Dam 2002). The arid conditions and limited freshwater make these islands oceanic in character. In May 1988 salinities of 37 to 38 ppt were recorded off Playa Sardinera. Benthic habitat around Mona and Desecheo has been mapped by Kendall et al. (2001). Here we give a brief description of the habitats relevant to this paper.

Rocky Shore.—Most of the island shorelines are composed of rocky shore. Tidal pools are numerous where there is a wave-cut platform near sea level. Rocky shores were sampled along the west coast of Mona and Monito.

Beaches.—The largest sandy beaches are found at Playa de Pájaros and Playa Sardinera on Mona (Fig. 2a). Desecheo has cobble beaches (Fig. 3c) and Monito lacks them (Fig. 2e).

Backreef.—The backreef area behind the fringing reef off Playa Sardinera was a major sampling area. This area is composed of scattered coral heads interspersed with sand patches. Depths ranged from 1-5 m.

Reef Crest-Buttress zone.—The main anchorage (Anclaje Sardinera) of Mona is off Playa Sardinera on the west (leeward) side of the island (Fig. 2b). The seaward side of the Playa Sardinera fringing reef from 2-15 m depth was another main sampling site. It has the most diverse coral community with numerous corals, gorgonians, and sponges. Scleractinian species diversity is low compared to the Puerto Rican mainland (Almy and Carrión-Torres 1963). The dominant species in this zone, in order of decreasing abundance, are: *Diploria strigosa*, *Siderastrea radians*, *Agaricia agaricites*, *Porites astereoides*, and *Montastraea annularis* (D. Matos Carabello, pers. comm.).

Forereef.—The bottom gently slopes downward from 15-30 m to the shelf edge. The greatest epifaunal diversity occurs in this zone. The forereef was sampled off Playa Sardinera and Piedra del Carabinero (Fig. 2a).

Forereef Slope and Deep Forereef.—At the shelf edge the bottom increases in slope forming an escarpment or wall below 30 m. This habitat is easily reached at Piedra del Carabinero where the shelf edge comes close to shore (Fig. 2a). The epifauna changes from a hermatypic coral and algae dominated system to a gorgonian and sponge dominated assemblage. At Desecheo, the escarpment extends down to at least 335 m (Nelson and Appeldoorn 1985). Notches in the escarpment provide shelves that collect sediments and make convenient sampling locations.

Ferry Grounding Site.—The ferry M/V A. REGINA ran aground at Mona on 15 February 1985 (Fig. 2c). The hull came to rest in the reef crest-buttress zone off Playa de Pájaros. There was extensive damage to large *Acropora palmata* colonies and some head corals. The hull was removed from the reef in February 1990.

Sampling

Various scientific expeditions to the islands of the Mona Passage have been carried out from the University of Puerto Rico-Mayagüez marine laboratory in La Parguera, Puerto Rico. Many cataloged and uncataloged fish lots from the islands are housed in the ichthyological collection (UPRM) located there. These were examined and are summarized here. A search of other computerized museum collections was also made to identify new records from the area (Fish Net 2004; NEODAT 2004). Specimens housed at the Academy of Natural Sciences of Philadelphia (ANSP) were especially important. An Academy scientific expedition from 4-9 October 1978 provided data from 12 ichthyocide collection sites. Approximately 2 liters of liquid emulisified rotenone were dispensed at each location during this expedition. At some locations quinaldine, an anesthetic or fish narcotizing agent, was used along with rotenone. Information on collections with multiple specimens is listed in Table 1. A list of specimens examined can be obtained from the first author.

TABLE 1. Collection locations and associated data for ichthyocide stations from islands in the Mona Passage.

Collection	Island	Location	Habitat	Method	Depth (m)	Collector	Date
1978 Expedition							
MON-1	Mona	Piedra del Carabinero	vertical wall with sandy ledge	quinal./rotenone	55	Colin & Smith-Vaniz	4-Oct-78
MON-2	Mona	Anclaje Sardinera	sand with some exposed rock outcrop	rotenone	0-1	Smith-Vaniz et al.	4-Oct-78
MON-3	Monito	west side	large boulder, cave, and deep crevice	rotenone	30.5	Smith-Vaniz	5-Oct-78
MON-4	Monito	west side	undercut cliff wall	rotenone	15	Colin	5-Oct-78
MON-5	Mona	Anclaje Sardinera	cave under large coral	rotenone	9	Smith-Vaniz & Colin	5-Oct-78
MON-6	Mona	Piedra del Carabinero	vertical wall with undercut ledges	quinal./rotenone	45.5-53	Smith-Vaniz & Colin	6-Oct-78
MON-7	Mona	Anclaje Sardinera	nearshore, shallow caves, sand/rock	rotenone	1	Smith-Vaniz & Colin	6-Oct-78
MON-8	Mona	Piedra del Carabinero	same as Stat. 1	quinaldine	58	Colin	7-Oct-78
MON-9	Mona	Piedra del Carabinero	crest of reef near vertical wall	quinaldine	7.5-9	Smith-Vaniz	7-Oct-78
MON-10	Mona	Punta Arenas	shoreline, rocky with sandy patches	rotenone	0.3-1	Smith-Vaniz et al.	7-Oct-78
MON-11	Mona	Piedra del Carabinero	shelf-edge dropoff	rotenone	30.5	Smith-Vaniz et al.	8-Oct-78
MON-12	Desecheo	southwest side	shoreline, large cave, sandy bottom	rotenone	7.5	Smith-Vaniz & Colin	9-Oct-78
Miscellaneous Collections							
M1-66	Mona	Punta Caigo o No Caigo	reef	rotenone	1.5	Ramsey, J	21-Mar-66
M3-67	Mona	west side	shoreline	rotenone	3.3	Eger, W	4-Oct-67
M1-69	Mona	Carabinero	tidal pool	rotenone	0		13-Oct-69
M3-71	Mona	Playa Sardinera, at pier	rocky shore	rotenone	3.3	Rolon, M et al.	2-Oct-71
M8-71	Mona	Sardinera, south channel edge	reef	rotenone	11		4-Oct-71
M9-71	Mona	Anclaje Sardinera	rocky shore	rotenone	1.3	Eger, W et al.	4-Oct-71
M1-72	Mona	Punta Oeste, 1.1 km south	reef	rotenone	21	Prentice, J	2-Sep-72
D3-73	Desecheo	Puerto de los Botas, east side	rocky shore with coral	rotenone	7	Eger, W et al.	9-Feb-73
D4-73	Desecheo	Puerto de los Botes, 75 m offshore	rock with coral	rotenone	15	Eger, W et al.	9-Feb-73
D5A-73	Desecheo	western point, 90 m north	beach rock tidepool	rotenone	0	Eger, W et al.	9-Feb-73
M4-73	Mona	Playa La Pasita, 180 m offshore	reef	rotenone	14	Prentice, J et al.	10-Feb-73
M5-73	Mona	Playa La Pasita, southeast corner	seagrass bed	seine	2	MacDonald, C et al.	10-Feb-73
M6-73	Mona	Playa La Pasita, 25 m west	rocky shore with sandy bottom	rotenone	1	Eger, W et al.	10-Feb-73
M9-73	Mona	Cabo Noroeste, 360 m west	rocky cliff	rotenone	15	Eger, W et al.	11-Feb-73
M11-73	Mona	Playa Sardinera, 180 m north	fringing reef	rotenone	1.5	Wallace, R et al.	11-Feb-73

Diver visual survey was carried out at Mona and Monito in four habitats: rocky shore, backreef, reef crest-buttress, forereef, and the grounding site from 15-20 May 1988. During the 1988 surveys the ferry was still aground. Diver surveys were repeated in the backreef, reef crest-buttress, forereef, and the ferry grounding site on 9-10 March 1991. The ferry had been salvaged by the 1991 sampling period. Surveys were conducted by scuba divers using the point-count census method to quantify reef fishes (Bohnsack and Bannerot 1986). These surveys were supplemented by discrete diver observations in these habitats and on the forereef slope. Literature records, personal logs, and personal communication with colleagues supplemented the above records. We follow Eschmeyer (2005) for scientific nomenclature.

RESULTS

Two hundred sixty taxa of marine shore fishes are reported from islands in the Mona Passage (Table 2). Of these, 84 percent (218) are hard-bottom associated taxa. Twenty-three species were associated with soft bottom and 19 were found in the water column. Diver visual surveys recorded 111 taxa and ichthyocide collections added 110 species (Table 2). Miscellaneous gears accounted for nine taxa and literature records added 29 records. The number of taxa found at each island reflected the sampling effort with Mona (238) having the most species followed by Desecheo (74) and Monito (33). Monito provided one additional species, *Liopropoma carmabi*, and collections at Desecheo added ten species not recorded from Mona (Table 2). The data were not adequate to make comparisons among islands, but fish assemblages at Mona are described by habitat.

Sampling

Diver Visual Survey.—Approximately 32 hours of underwater observations, including 112 point-count surveys, yielded 111 taxa (Table 3). As true of most Caribbean locations, common species included *Thalassoma bifasciatum*, *Chromis multilineata*, *Acanthurus bahianus*, *Stegastes partitus*, and *Acanthurus coeruleus*. The top 20 species are a mixture of inshore and offshore species found in Puerto Rico (Table 4). The oceanic island character of the fauna is evident in the widespread occurrence of *Melichthys niger* (Lubbock 1980; Lubbock and Edwards 1981; Smith-Vaniz et al. 1999).

Ichthyocide Collections.—One hundred sixty species were sampled using ichthyocides, 125 of which were taken in 12 collections during the 1978 expedition (Table 3). An additional 35 species were collected during visits by various expeditions from the University of Puerto Rico La Parguera Marine Laboratory to the islands. Of these collections 52 taxa were also observed. The remaining 69 species were not sampled by other methods. Only two of the top 20 species taken by ichthyocides were observed (Table 3). In particular, cryptic members of the families Apogonidae, Chaenopsidae, Gobiidae, Gobiesocidae, Labrisomidae, and Muraenidae were important in these collections with 8, 8, 15, 12, 19, and 9 species, respectively. Eels, such as juvenile *Gymnothorax vicinus* and *Moringua edwardsi*, were common as in other ichthyocide studies (Smith 1973; Collette et al. 2003). Five new species, *Starksia melasma*, *Starksia smithvanizi*, *Tomicodon cryptus*, *Tomicodon rupestris* and *Ogilbichthys puertoricoensis* (Williams and Mounts 2003; Williams and Tyler 2003; Møller et al. 2004) have been described from these collections and at least one species of *Ogilbia* sp. remains to be described.

Other Gears.—Six species were taken at night under light including adult *Hypoatherina harringtonensis* and *Moringua edwardsi*, and juvenile *Aulostomus maculatus*, *Entomacrodus nigricans*, and *Mycteropera bonaci*. Two species, *Canthidermis maculata* and *Hemiramphus balao*, were collected by dip net during the day, and *Ahlia egmontis* and *Caulolatilus williamsi*, were taken by hook and line. The later species is not known from the Puerto Rican Plateau. Several seine hauls were made on beaches along the shores of Mona, but only three species (*Albula vulpes*, *Polydactylus oligodon*, and *Polydactylus virginicus*) were collected. Three species, *Centropyge argi*, *Prognathodes*

TABLE 2. List of shore fishes from islands in the Mona Passage in alphabetical order by family, genus and species. Biotopes include R – reef, WC – water column, and SB – soft bottom. Record types are listed by island include DN – dip net, HL – hook and line, I – ichthyocide, L – literature, NL – night light, RD – rock dredge, S – seine, and V – visual. Museum location of specimens examined are A – ANSP, F – FMNH, and U – UPRM.

Family	Taxon	Biotope	Mona	Monito	Desecheo	Museum	Notes and previous citations
Acanthuridae	*Acanthurus bahianus*	R	I, V, L			A	Fowler (1943); Siddiqi and Cable (1960); Williams and Williams (1981); McGehee (1991)
	Acanthurus chirurgus	R	L		L		Dyer et al. (1985); McGehee (1991)
	Acanthurus coeruleus	R	I, V, L	V		A	Fowler (1943); Siddiqi and Cable (1960); McGehee (1991)
Achiridae	*Achirus lineatus*	SB	I			U	
Albulidae	*Albula vulpes*	SB	S			U	
Anguillidae	*Anguilla rostrata*	SB	I			F	
Antennariidae	*Antennarius bermudensis*	R	I			U	
	Antennarius multiocellatus	R			I	A	
Apogonidae	*Apogon binotatus*	R	I			A	
	Apogon lachneri	R	I	I		A	
	Apogon maculatus	R	I, V, L	I	I	A	Fowler (1943); Williams and Williams (1980)
	Apogon robinsi	R	I			A	
	Apogon townsendi	R	I, L	I	I	A	Williams and Williams (1980)
	Astrapogon alutus	R	I			U	
	Phaeoptyx conklini	R	I	I	I	A	
	Phaeoptyx pigmentaria	R	I			A	
Atherinidae	*Atherinomorus stipes*	WC	L				Fowler (1943)
	Hypoatherina harringtonensis	WC	NL			U	
Aulostomidae	*Aulostomus maculatus*	R	NL			U	
Balistidae	*Balistes vetula*	R	V, L				Turingan et al. (1995)
	Canthidermis maculata	WC			DN	A	
	Canthidermis sufflamen	R	V				
	Melichthys niger	R	V, L				Turingan et al. (1995)
	Xanthichthys ringens	R	I, V, L			U	Turingan et al. (1995)
Belonidae	*Platybelone argula*	R	I, L			A	Fowler (1943)
Blenniidae	*Entomacrodus nigricans*	R	I, NL, L		I	A, U	Springer (1967)
	Hypsoblennius exstochilus	R	L				Smith-Vaniz (1980)
	Ophioblennius macclurei	R	I, V, L		I	A	McGehee (1991)
	Scartella cristata	R	I			A	
Bothidae	*Bothus lunatus*	R	I, V, L			A	Dyer et al. (1985); McGehee (1991)
	Bothus maculiferus	R	I			A	

TABLE 2. Continued.

Family	Taxon	Biotope	Mona	Monito	Desecheo	Museum	Notes and previous citations
Bythitidae	*Grammonus claudei*	R			I	A	
	Ogilbia sp.	R	I		I	A, U	
	Ogilbichthys puertoricoensis	R	I				Møller et al. (2004)
Carangidae	*Caranx crysos*	WC	V				
	Caranx latus	WC	I, V	V		A	
	Caranx lugubris	WC	V, L	V	L		Dyer et al. (1985); Nelson and Appeldoorn (1985)
	Caranx ruber	R	V				
	Trachinotus goodei	SB	I, L			A	Dyer et al. (1985); also as *glaucus*
Carcharhinidae	*Carcharhinus falciformis*	WC	L				Bane (1964)
	Galeocerdo cuvier	R	L				Randall (1963)
Chaenopsidae	*Acanthemblemaria chaplini*	R	I			A	
	Acanthemblemaria maria	R	I		I	A, U	Only reported from Anegada on the Puerto Rican Plateau.
	Acanthemblemaria spinosa	R	I			A	
	Emblemaria pandionis	R	I			A	
	Emblemariopsis bottomei	R	I			U	
	Lucayablennius zingaro	R	I			A	
	Stathmonotus gymnodermis	R			I, L		Hastings and Springer (1994)
	Stathmonotus stahli tekla	R	I, L				Hastings and Springer (1994)
Chaetodontidae	*Chaetodon capistratus*	R	V, L				Fowler (1943); Williams and Williams (1981); McGehee (1991)
	Chaetodon sedentarius	R			L		Nelson and Appeldoorn (1985)
	Chaetodon striatus	R	V, L				Fowler (1943); Williams and Williams (1981)
	Prognathodes aculeatus	R	I, V, RD		L	A, U	Nelson and Appeldoorn (1985)
Chlopsidae	*Kaupichthys hyoproroides*	R	I	L	I	U	Smith (1989b)
	Kaupichthys nuchalis	R	I		I	U	
Cirrhitidae	*Amblycirrhitus pinos*	R	V				
Clupeidae	*Jenkinsia lamprotaenia*	WC	I, L			A	Fowler (1943)
Coryphaenidae	*Coryphaena hippurus*	WC	L				Siddiqi and Cable (1960)
Dactyloscopidae	*Dactyloscopus crossotus*	SB	I			A	
	Dactyloscopus tridigitatus	SB	I, L			A, U	Dawson (1982b)
	Gillellus greyae	SB	I, L			A	Dawson (1982b)
	Platygillellus rubrocinctus	SB	I			A	
Dasyatidae	*Dasyatis americana*	SB	V				
Diodontidae	*Diodon hystrix*	R	V				
Gerreidae	*Gerres cinereus*	SB	L				Siddiqi and Cable (1960)

TABLE 2. Continued.

Family	Taxon	Biotope	Mona	Monito	Desecheo	Museum	Notes and previous citations
Ginglymostomatidae	*Ginglymostoma cirratum*	R	V				
Gobiesocidae	*Acyrtops beryllinus*	R	I			A	
	Acyrtus artius	R			I	A	
	Acyrtus rubiginosus	R	I, L			A	Johnson and Greenfield (1983)
	Arcos nudus	R	I			A	previously *macrophthalmus*
	Derilissus altifrons	R	I			A	Not reported from Puerto Rican Plateau
	Gobiesox lucayanus	R	I			A	Not reported from Puerto Rican Plateau
	Gobiesox nigripinnis	R	I		I	A, U	
	Gobiesox punctulatus	R	I, L		I	A, U	as *cephalus*, Fowler (1943)
	Tomicodon cryptus	R	I, L				Williams and Tyler (2003)
	Tomicodon reitzae	R	I, L				Williams and Tyler (2003)
	Tomicodon rupestris	R	I, L				Williams and Tyler (2003)
Gobiidae	*Bathygobius soporator*	R	I, L			A	Fowler (1943)
	Coryphopterus eidolon	R	I			A	
	Coryphopterus glaucofraenum	R	I, V			U	including *C. tortugae* after Smith-Vaniz and Böhlke (1991).
	Coryphopterus hyalinus	R	I			A	juvenile individuals may include *C. personatus.*
	Coryphopterus personatus	R	I			A	
	Coryphopterus thrix	R			I	U	
	Elacatinus chancei	R	V		I	A	in sponge
	Elacatinus evelynae	R	I, V		I, L	A	Taylor and Hellberg (2003)
	Elacatinus gemmatus	R	I			A	
	Ginsburgellus novemlineatus	R			I	A, U	
	Gnatholepis thompsoni	R	I, V, L		I	A, U	McGehee (1991)
	Lythrypnus crocodilus	R	I, L				Greenfield (1988)
	Lythrypnus elasson	R	I			A	
	Priolepis hipoliti	R	I	I	I, L	A, U	Greenfield (1989)
	Psilotris celsus	R	I, L				Greenfield et al. (1993)
	Risor ruber	R	I		I	A	
	Vomerogobius sp.	R	I			U	Specimens in poor condition generic assignment questionable.
Grammatidae	*Gramma linki*	R	I			A, U	
	Gramma loreto	R	I, V		I	A	
	Lipogramma regium	R	I			A	

TABLE 2. Continued.

Family	Taxon	Biotope	Mona	Monito	Desecheo	Museum	Notes and previous citations
Haemulidae	*Anisotremus surinamensis*	R	I, V	V		U	
	Haemulon album	R	V				
	Haemulon carbonarium	R	V				
	Haemulon chrysargyreum	R	V				
	Haemulon flavolineatum	R	I, V, L			U	Siddiqi and Cable (1960); McGehee (1991)
	Haemulon parra	R	L				Dyer et al. (1985)
	Haemulon sciurus	R	V				
Hemiramphidae	*Hemiramphus balao*	WC	DN			A	
Holocentridae	*Holocentrus adscensionis*	R	V, L		L		Fowler (1943); Siddiqi and Cable (1960); Nelson and Appeldoorn (1985).
	Holocentrus rufus	R	V, L	V			McGehee (1991)
	Myripristis jacobus	R	I, V, L			A	Williams and Williams (1981); McGehee (1991)
	Neoniphon marianus	R	I, V		L	A	Nelson and Appeldoorn (1985)
	Plectrypops retrospinis	R	I	I	I	A	
	Sargocentron coruscus	R	I, L			A	Fowler (1943), as *Holocentrus siccifer.*
	Sargocentron vexillarium	R	I, V, L			A, U	Siddiqi and Cable (1960)
Istiophoridae	*Makaira nigricans*	WC			L		Dyer et al. (1992)
Kyphosidae	*Kyphosus sectatrix*	WC	L				Dyer et al. (1985)
	Kyphosus spp.	WC	V	V			Species undetermined.
Labridae	*Bodianus rufus*	R	V	V			
	Clepticus parrae	R	I, V		L	A	Nelson and Appeldoorn (1985)
	Doratonotus megalepis	R	I			A	
	Halichoeres bivittatus	R	I, V, L			A	Fowler (1943); McGehee (1991)
	Halichoeres garnoti	R	V	I		U	
	Halichoeres maculipinna	R	I, V, L			A	Randall and Böhlke (1965); McGehee (1991)
	Halichoeres radiatus	R	I, V, L			A	McGehee (1991)
	Thalassoma bifasciatum	R	I, V, L	V		A	McGehee (1991)
	Xyrichthys splendens	R	V				
Labrisomidae	*Labrisomus bucciferus*	R	I			A	
	Labrisomus gobio	R	I			A, U	
	Labrisomus guppyi	R	I, V, L		I	A	McGehee (1991)
	Labrisomus kalisherae	R	I			U	In poor condition; identification questionable.
	Labrisomus nigricinctus	R	I, L			A, U	Springer (1959)
	Labrisomus nuchipinnis	R	I, L			A	Fowler (1943); Siddiqi and Cable (1960)
	Malacoctenus aurolineatus	R	I, V, L			A	McGehee (1991)
	Malacoctenus erdmani	R	I			A	

TABLE 2. Continued.

Family	Taxon	Biotope	Mona	Monito	Desecheo	Museum	Notes and previous citations
Labrisomide (continued)	*Malacoctenus gilli*	R	I			A	
	Malacoctenus macropus	R	V, L				McGehee (1991)
	Malacoctenus triangulatus	R	I, V, L	I	I	A, U	McGehee (1991)
	Malacoctenus versicolor	R	I			A	
	Paraclinus cingulatus	R	I, L			A	McGehee (1991)
	Paraclinus fasciatus	R	I			A	
	Paraclinus nigripinnis	R	I, L			A, U	Springer (1955)
	Starksia atlantica	R	I			U	
	Starksia hassi	R	I			A	
	Starksia melasma	R			I, L	A	Williams and Mount (2003); not reported from the Puerto Rican Plateau.
	Starksia smithvanizi	R	I			A	
Lutjanidae	*Lutjanus apodus*	R	V, L	V			Fowler (1943)
	Lutjanus buccanella	R	V		L		Nelson and Appeldoorn (1985)
	Lutjanus griseus	R	V				
	Lutjanus mahogoni	R	V				
	Lutjanus vivanus	R			L		Nelson and Appeldoorn (1985)
	Ocyurus chrysurus	R	V, L	V			Fowler (1943)
Malacanthidae	*Caulolatilus williamsi*	R	HL				Not reported from the Puerto Rican Plateau.
	Malacanthus plumieri	R	V, L				Siddiqi and Cable (1960)
Monacanthidae	*Aluterus scriptus*	R	V				
	Cantherhines macrocerus	R	V, L				Turingan et al. (1995)
	Cantherhines pullus	R	V				
	Monacanthus tuckeri	R	I			U	
	Stephanolepis hispidus	R			DN	U	Footnote 1
Moringuidae	*Moringua edwardsi*	R	I, NL		I	A, U	Smith (1989a)
Mugilidae	*Mugil curema*	WC	L				Fowler (1943)
	Mugil liza	WC	I			U	
	Mugil trichodon	WC	L				Fowler (1943)
Mullidae	*Mulloidichthys martinicus*	R	I, V			A	
	Pseudupeneus maculatus	R	I, V, L			U	McGehee (1991)
Muraenidae	*Channomuraena vittata*	R	L				Böhlke et al. (1989)
	Echidna catenata	R	I, L		I, L	U	Fowler (1943); Böhlke et al. (1989)
	Enchelycore carychroa	R	I, L	I	I	U	Böhlke et al. (1989)
	Enchelycore nigricans	R	I, L	L	I, L	U	Böhlke et al. (1989)
	Gymnothorax funebris	R			L		Dyer et al. (1985)

TABLE 2. Continued.

Family	Taxon	Biotope	Mona	Monito	Desecheo	Museum	Notes and previous citations
Muraenidae (continued)	*Gymnothorax miliaris*	R	I, L		I	U	Böhlke et al. (1989)
	Gymnothorax moringa	R	I, V, L		L	U	Böhlke et al. (1989)
	Gymnothorax vicinus	R	I, L			U	Böhlke et al. (1989)
	Uropterygius macularis	R	I, L			U	Böhlke et al. (1989)
Ophichthidae	*Ahlia egmontis*	SB	I, HL, L			U	McCosker et al. (1989)
	Myrichthys breviceps	SB	I, L		I	U	McCosker et al. (1989)
	Myrichthys ocellatus	SB	I, L		L	U	Dyer et al. (1985); McCosker et al. (1989)
	Myrophis platyrhynchus	SB	I			U	
Ophidiidae	*Ophidion lagochila*	SB	I	I		A, U	
	Petrotyx sanguineus	R	I			A	
Opistognathidae	*Opistognathus aurifrons*	SB			I	A	
	Opistognathus gilberti	R	I			A	
	Opistognathus macrognathus	SB	I			U	
	Opistognathus maxillosus	SB	L				Smith-Vaniz (1997)
Ostraciidae	*Acanthostracion polygonius*	R	V	V			
	Acanthostracion quadricornis	R	L				Siddiqi and Cable (1960)
	Lactophrys bicaudalis	R	V				
	Lactophrys triqueter	R	V, L				McGehee (1991)
Polynemidae	*Polydactylus oligodon*	SB	I, S		I	U	
	Polydactylus virginicus	SB	I, S			U	
Pomacanthidae	*Centropyge argi*	R	RD		L	U	Nelson and Appeldoorn (1985)
	Holacanthus bermudensis	R	V				Not reported from the Puerto Rican Plateau.
	Holacanthus ciliaris	R	V		L		Nelson and Appeldoorn (1985)
	Holacanthus tricolor	R	V, L	V, L	L		Williams and Williams (1981); Nelson and Appeldoorn (1985)
	Pomacanthus arcuatus	R	L				Williams and Williams (1994)
	Pomacanthus paru	R	I, V, L			A	Dyer et al. (1985)
Pomacentridae	*Abudefduf saxatilis*	R	I, V, L			A	Fowler (1943), as *A. marginatus*.
	Abudefduf taurus	R			I	A	
	Chromis cyanea	R	I, V			U	
	Chromis enchrysura	R			L		Nelson and Appeldoorn (1985)
	Chromis insolata	R	I, V		L	A	Nelson and Appeldoorn (1985)
	Chromis multilineata	R	I, V, L	I, V		A	Williams and Williams (1981)
	Microspathodon chrysurus	R	I, V, L			A	McGehee (1991)
	Stegastes adustus	R	I, V, L			A	Fowler (1943) as *Pomacentrus fuscus*; Robertson and Allen (1981), as *S. dorsopunicans*.

TABLE 2. Continued.

Family	Taxon	Biotope	Mona	Monito	Desecheo	Museum	Notes and previous citations
Pomacentridae (continued)	*Stegastes diencaeus*	R	I, V, L			A	Robertson and Allen (1981); McGehee (1991)
	Stegastes leucostictus	R	I, V, L			A	Fowler (1943); McGehee (1991), as *Pomacentrus.*
	Stegastes partitus	R	I, V, L	V	L	A	Williams et al. (1984); Nelson and Appeldoorn (1985); McGehee (1991)
	Stegastes planifrons	R	I, V, L			A	McGehee (1991)
	Stegastes variabilis	R	I, V, L			A	McGehee (1991)
Priacanthidae	*Heteropriacanthus cruentatus*	R	I, V, L			A	McGehee (1991)
Scaridae	*Scarus iseri*	R	V				
	Scarus taeniopterus	R	V				
	Scarus vetula	R	V				
	Sparisoma atomarium	R	RD			U	
	Sparisoma aurofrenatum	R	I, V, L			A	Fowler (1943), as *Sp. pachycephalum.*
	Sparisoma chrysopterum	R	V				
	Sparisoma radians	R	I, V			A	
	Sparisoma rubripinne	R	V		L		Randall (1968)
	Sparisoma viride	R	I, V, L			A	Siddiqi and Cable (1960)
Sciaenidae	*Equetus lanceolatus*	R			I	A	
	Equetus punctatus	R	I, V		I	A	
Scombridae	*Acanthocybium solandri*	WC	L		L		Siddiqi and Cable (1960); Dyer et al. (1985)
	Katsuwonus pelamis	WC			L		Bane (1964)
	Thunnus atlanticus	WC			L		Bane (1964)
Scorpaenidae	*Scorpaena plumieri*	R	I, V			A	
	Scorpaenodes caribbaeus	R	I			U	
	Scorpaenodes trecimspinosus	R	I			U	
Serranidae	*Cephalopholis cruentata*	R	I, V, L			A	McGehee (1991)
	Cephalopholis fulva	R	V, L	V	L		Siddiqi and Cable (1960); Williams and Williams (1981); Nelson and Appeldoorn (1985)
	Epinephelus adscensionis	R	V, L				Dyer et al. (1985)
	Epinephelus guttatus	R	V, L				Dyer et al. (1994)
	Epinephelus striatus	R	V, L				Siddiqi and Cable (1960); Dyer et al. (1985)
	Gonioplectrus hispanus	R	L		L		Kendall and Fahay (1979); Nelson and Appeldoorn (1985)
	Hypoplectrus chlorurus	R	V, L				McGehee (1991)
	Hypoplectrus unicolor	R	V				
	Liopropoma carmabi	R		I		A	

TABLE 2. Continued.

Family	Taxon	Biotope	Mona	Monito	Desecheo	Museum	Notes and previous citations
Serranidae (continued)	*Liopropoma mowbrayi*	R	I, V			A	
	Liopropoma rubre	R	I, V	I		A	
	Mycteroperca bonaci	R	NL			U	
	Mycteroperca interstitialis	R	V		L		Nelson and Appeldoorn (1985)
	Mycteroperca tigris	R	V	V			
	Mycteroperca venenosa	R	V				
	Paranthias furcifer	R	V, L	V, L	L		Williams and Williams (1981); Nelson and Appeldoorn (1985)
	Parasphyraenops incisus	R	L				Colin (1978), as *Serranus*
	Protonogrammus martinicensis	R			L		Nelson and Appeldoorn (1985)
	Rypticus saponaceus	R	I, V, L			A	Fowler (1943); Guimarães (1999)
	Rypticus subbifrenatus	R	I, L			A, U	Guimarães (1999)
	Serranus luciopercanus	R	I		L	A	Nelson and Appeldoorn (1985)
	Serranus tabacarius	R	V				
	Serranus tigrinus	R	V				
Sparidae	*Archosargus rhomboidalis*	SB	I			U	
	Calamus bajonado	R	V				
Sphyraenidae	*Sphyraena barracuda*	R	V, L	V			Siddiqi and Cable (1960)
Syngnathidae	*Bryx dunckeri*	R	I, L			A	Dawson (1982a)
	Cosmocampus albirostris	R	L				Dawson (1982a)
Synodontidae	*Synodus intermedius*	R	V				
	Synodus saurus	SB			I	U	
	Synodus synodus	R	I		I	A, U	
Tetraodontidae	*Canthigaster rostrata*	R	I, V	V	I	A, U	
Tripterygiidae	*Enneanectes altivelis*	R	I		I	A, U	
	Enneanectes atrorus	R	I		I	A, U	
	Enneanectes boehlkei	R	I		I	A, U	
	Enneanectes pectoralis	R	I			A, U	
Urolophidae	*Urobatis jamaicensis*	SB	V				Not reported from Puerto Rican Plateau.

Footnote 1—These specimens have dorsal and anal fin rays counts that overlap with *S. setifer* yet with dermal spines similar to *hispidus*. Berry and Vogele (1961) did not report *S. hispidus* this far south. The numerous reports for Puerto Rico summarized under *S. setifer* by Dennis (2000) may actually be *S. hispidus*.

TABLE 3. List of shore fishes observed by diver visual survey at Mona and Monito and collected by ichthyocide at Mona, Monito, and Desecheo. Species names are in alphabetical order. Total refers to the number of individuals observed or collected. Frequency refers to occurrence by habitat/year (n = 11) for visual survey and sample (n = 11) for ichthyocide, and Rank represents order by gear type. P indicates presence outside of the survey areas.

	Visual survey Mona/Monito			Ichthyocide Mona/Monito/Desecheo		
Taxa	Total	Freq.	Rank	Total	Freq.	Rank
Abudefduf saxatilis	3	5			4	1
Acanthemblemaria chaplini				5	1	
Acanthemblemaria maria				12	2	
Acanthemblemaria spinosa				25	2	
Acanthostracion polygonius	P	3				
Acanthurus bahianus	302	9	**3**	39	3	**13**
Acanthurus coeruleus	235	10	**5**	13	2	
Acyrtops beryllinus				3	1	
Acyrtus rubiginosus				14	2	
Ahlia egmontis				6	1	
Aluterus scriptus	P	1				
Amblycirrhitus pinos	4	2				
Anisotremus surinamensis	P	2				
Antennarius multiocellatus				1	1	
Apogon binotatus				4	2	
Apogon lachneri				16	7	
Apogon maculatus	P	1		16	6	
Apogon townsendi				23	3	
Arcos nudus				2	1	
Balistes vetula	3	5				
Bathygobius soporator				2	1	
Bodianus rufus	50	8	**17**			
Bothus lunatus	1	1		4	2	
Bothus maculiferus				2	2	
Bryx dunckeri				1	1	
Calamus bajonado	3	2				
Cantherhines macrocerus	3	2				
Cantherhines pullus	P	1				
Canthidermis sufflamen	P	1				
Canthigaster rostrata	1	2		11	5	
Caranx crysos	P	1				
Caranx latus	1	3		1	1	
Caranx lugubris	7	4				
Caranx ruber	11	8				
Cephalopholis cruentata	2	4		1	1	
Cephalopholis fulva	132	10	**8**			
Chaetodon capistratus	16	6				
Chaetodon striatus	20	7				
Chromis cyanea	130	6	**10**			
Chromis insolata	P	1		5	1	
Chromis multilineata	503	8	**2**	5	2	
Clepticus parrae	39	3		1	1	
Coryphopterus eidolon				3	2	
Coryphopterus glaucofraenum	5	2				
Coryphopterus hyalinus				61	3	**5**
Dactyloscopus crossotus				18	1	
Dactyloscopus tridigitatus				52	3	**6**
Dasyatis americana	1	3				

TABLE 3. Continued.

Taxa	Visual survey Mona/Monito			Ichthyocide Mona/Monito/Desecheo		
	Total	Freq.	Rank	Total	Freq.	Rank
Derilissus altifrons				1	1	
Diodon hystrix	P	3				
Doratonotus megalepis				2	1	
Echidna catenata				19	1	
Elacatinus chancei	P	2				
Elacatinus evelynae	5	3		1	1	
Elacatinus gemmatus				2	1	
Emblemaria pandionis				34	1	**15**
Enchelycore carychroa				7	4	
Enchelycore nigricans				39	5	**13**
Enneanectes altivelis				16	3	
Enneanectes atrorus				6	3	
Enneanectes boehlkei				43	4	**11**
Enneanectes pectoralis				9	1	
Entomacrodus nigricans				76	4	**4**
Epinephelus adscensionis	4	4				
Epinephelus guttatus	P	4				
Epinephelus striatus	P	1				
Equetus punctatus	1	1		2	1	
Gillellus greyae				6	2	
Ginglymostoma cirratum	P	2				
Ginsburgellus novemlineatus				1	1	
Gnatholepis thompsoni	8	1		4	2	
Gobiesox lucayanus				1	1	
Gobiesox nigripinnis				117	1	**2**
Gobiesox punctulatus				12	1	
Gramma linki				41	4	**12**
Gramma loreto	64	8	**14**	126	7	**1**
Grammonus claudei				1	1	
Gymnothorax miliaris				1	1	
Gymnothorax moringa	1	1		33	2	**17**
Gymnothorax vicinus				49	2	**7**
Haemulon album	1	2				
Haemulon carbonarium	2	3				
Haemulon chrysargyreum	P	1				
Haemulon flavolineatum	8	3				
Haemulon sciurus	2	1				
Halichoeres bivittatus	231	8	**6**	4	2	
Halichoeres garnoti	121	8	**11**			
Halichoeres maculipinna	131	9	**9**	19	2	
Halichoeres radiatus	48	8	**19**	7	3	
Heteropriacanthus cruentatus	P	1		11	2	
Holacanthus bermudensis	P	1				
Holacanthus ciliaris	2	1				
Holacanthus tricolor	28	7				
Holocentrus adscensionis	3	5				
Holocentrus rufus	30	9				
Hypoplectrus chlorurus	P	1				
Hypoplectrus unicolor	P	1				
Kaupichthys hyoproroides				7	3	
Kyphosus spp.	42	5	**20**			
Labrisomus bucciferus				44	3	**10**

TABLE 3. Continued.

Taxa	Visual survey Mona/Monito			Ichthyocide Mona/Monito/Desecheo		
	Total	Freq.	Rank	Total	Freq.	Rank
Labrisomus gobio				23	2	
Labrisomus guppyi	2	1		29	3	**20**
Labrisomus nigricinctus				3	1	
Labrisomus nuchipinnis				5	2	
Lactophrys bicaudalis	P	1				
Lactophrys triqueter	9	7				
Liopropoma carmabi				1	1	
Liopropoma mowbrayi	P	1		2	1	
Liopropoma rubre	P	1		3	2	
Lucayablennius zingaro				2	2	
Lutjanus apodus	1	5				
Lutjanus buccanella	P	1				
Lutjanus griseus	P	1				
Lutjanus mahogoni	3	4				
Lythrypnus crocodilus				1	1	
Lythrypnus elasson				6	1	
Malacanthus plumieri	5	8				
Malacoctenus aurolineatus	1	1		22	3	
Malacoctenus erdmani				1	1	
Malacoctenus gilli				7	2	
Malacoctenus macropus	1	1				
Malacoctenus triangulatus	28	5		6	3	
Malacoctenus versicolor				33	2	**17**
Melichthys niger	98	10	**12**			
Microspathodon chrysurus	60	9	**15**	1	1	
Moringua edwardsi				48	3	**9**
Mulloidichthys martinicus	16	5		1	1	
Mycteroperca interstitialis	2	2				
Mycteroperca tigris	P	3				
Mycteroperca venenosa	P	2				
Myrichthys breviceps				2	1	
Myrichthys ocellatus				1	1	
Myripristis jacobus	8	4		3	2	
Neoniphon marianus	3	2		1	1	
Ocyurus chrysurus	P	2				
Ogilbia sp.				17	2	
Ogilbichthys puertoricoensis				1	1	
Ophidion lagochila				1	1	
Ophioblennius macclurei	81	7	**13**	34	4	**15**
Paraclinus cingulatus				2	1	
Paraclinus fasciatus				15	1	
Paraclinus nigripinnis				33	2	**17**
Paranthias furcifer	10	3				
Petrotyx sanguineus				1	1	
Phaeoptyx conklini				94	7	**3**
Phaeoptyx pigmentaria				2	2	
Platybelone argula				3	1	
Platygillellus rubrocinctus				28	3	
Plectrypops retrospinis				11	5	
Pomacanthus paru	1	3		2	1	
Priolepis hipoliti				49	4	**7**
Prognathodes aculeatus	P	1		2	1	

TABLE 3. Continued.

Taxa	Visual survey Mona/Monito			Ichthyocide Mona/Monito/Desecheo		
	Total	Freq.	Rank	Total	Freq.	Rank
Pseudupeneus maculatus	14	5				
Psilotris celsus				2	1	
Risor ruber				1	1	
Rypticus saponaceus	P	1		10	1	
Rypticus subbifrenatus				5	2	
Sargocentron coruscus				3	1	
Sargocentron vexillarium	P	2		17	3	
Scartella cristata				9	1	
Scarus iseri	41	5				
Scarus taeniopterus	18	7				
Scarus vetula	16	5				
Scorpaena plumieri	1	1		5	2	
Serranus tabacarius	P	1				
Serranus tigrinus	6	4				
Sparisoma aurofrenatum	52	9	**16**	4	1	
Sparisoma chrysopterum	10	3				
Sparisoma radians	2	2		1	1	
Sparisoma rubripinne	21	3				
Sparisoma viride	49	8	**18**	3	1	
Sphyraena barracuda	P	3				
Starksia hassi				2	2	
Starksia melasma				13	1	
Starksia smithvanizi				6	2	
Stathmonotus gymnodermis				2	1	
Stathmonotus stahli				10	1	
Stegastes adustus	171	7	**7**	3	1	
Stegastes diencaeus	29	6		22	1	
Stegastes leucostictus	17	2		4	1	
Stegastes partitus	300	8	**4**	2	2	
Stegastes planifrons	28	2		3	1	
Stegastes variabilis	3	2				
Synodus intermedius	1	1				
Synodus synodus				1	1	
Thalassoma bifasciatum	1999	11	**1**	18	3	
Tomicodon cryptus				2	1	
Tomicodon reitzae				4	1	
Tomicodon rupestris				10	2	
Trachinotus goodei				2	1	
Urobatis jamaicensis	1	3				
Xanthichthys ringens	P	1				
Xyrichthys splendens	6	3				

aculeatus, *Sparisoma atomarium*, were collected by rock dredge off Mona.

Habitats

Pelagic.—Although no large schools of forage fishes were observed, the Mona Passage is a very productive area based on the number of nesting seabirds (Erdman 1967; Kepler 1978) and the dominance of the reef fish fauna by planktivores. Nearshore pelagics, such as *Caranx* spp., were not common during our visits, but oceanic pelagics, such as *Katsuwonus pelamis*, *Thunnus atlanticus* and *Makaira nigricans* are commonly taken in the area (Bane 1964; Dyer et al.

1992). The second most common pelagic observed was *Caranx lugubris,* a typical oceanic island species (Lubbock and Edwards 1981; Edwards and Glass 1987; Collette et al. 2003).

Sandy Beaches.—The only typically sandy bottom species found in collections were *P. oligodon* and *P. virginicus*. *Polydactylus oligodon* was most common and found at several sites around Mona and at Desecheo. Both species are common in Puerto Rico, but very rare in the Virgin Islands (Dennis 2000). Both species are found throughout the Caribbean with *P. oligodon* only rarely reported, perhaps due to misidentification (Randall 1966).

Rocky Shore.—*Enchelycore carychroa*, *Gymnothorax miliaris*, and *Gymnothorax moringa* were taken by ichthyocide in tidal pools in this study. Fowler (1943) also reported *Mugil curema* and *Mugil trichodon* from this habitat. Diver visual surveys recorded the greatest diversity along the rocky shore (Table 5). Seventy species were observed in this habitat. Five species, *Aluterus scriptus*, *Equetus punctatus*, *Haemulon chrysargyreum*, *Holacanthus ciliaris*, and *Lactophrys bicaudalis*, were only observed here. The compressed nature of the habitat due to the narrow shelf allows typically forereef species, such as *C. multilineata* and *G. loreto*, to be common along the shore, and even typically shelf-edge species, such as *Melichthys niger* and *Xanthichthys ringens*, also occur there.

Backreef.—The backreef zone off Playa Sardinera shows a typical reef assemblage dominated by *Halichoeres bivittatus*, *Stegastes adustus*, *Stegastes planifrons*, and *Scarus iseri.* Fifty-two species were observed in this habitat (Table 5). Three species, *Cantherhines pullus*, *Haemulon sciurus*, *Synodus intermedius*, were observed only in this zone. Of the common species, *Acanthurus coeruleus* and *Sparisoma viride* were most conspicuously abundant in the backreef. These species are typical of the backreef habitat in Puerto Rico (Kimmel 1985).

Reef Crest-Buttress.—The reef crest-buttress zone has a similar level of species diversity to the backreef, although *S. adustus* and *S. planifrons* were absent. Fifty species were observed in this zone (Table 5). *Thalassoma bifasciatum* was the dominant wrasse and *Halichoeres bivittatus* and *H. maculipinna* were also common. *Chromis multilineata* and *Chromis cyanea* were common here as typical at other Caribbean

TABLE 4. Comparison of top 20 taxa observed at Mona with habitat use of the same taxa at La Parguera on the southwest coast of Puerto Rico (based on Kimmel 1985).

Rank	Taxa	Common habitat in La Parguera
1	*Thalassoma bifasciatum*	Offshore reefs (high relief)
2	*Chromis multilineata*	Inshore reefs
3	*Acanthurus bahianus*	Offshore reefs (low relief)
4	*Stegastes partitus*	Offshore reefs (high relief and rubble)
5	*Acanthurus coeruleus*	Inshore reefs
6	*Halichoeres bivittatus*	Inshore reefs
7	*Stegastes adustus*	Inshore reefs
8	*Cephalopholis fulva*	Offshore reefs (low relief)
9	*Halichoeres maculipinna*	Inshore reefs (rubble)
10	*Chromis cyanea*	Offshore reefs (high relief)
11	*Halichoeres garnoti*	Offshore reefs (high relief)
12	*Melichthys niger*	Shelf edge only
13	*Ophioblennius macclurei*	Inshore reefs
14	*Gramma loreto*	Offshore reefs (high relief)
15	*Microspathodon chrysurus*	Inshore reefs
16	*Sparisoma aurofrenatum*	Offshore reefs (high relief)
17	*Bodianus rufus*	Offshore reefs (high relief)
18	*Sparisoma viride*	Inshore reefs (but widespread)
19	*Halichoeres radiatus*	Inshore reefs
20	*Kyphosus* spp.	Not observed

TABLE 5. Summary of diver visual survey data by habitat at Mona. Forereef slope represents only presence data.

	1988/89 Rocky shore	1988/89 Back reef	1988/89 Buttress zone	1988/89 Fore reef	1988 Ferry grounding	1991 Ferry grounding	1988 Forereef slope
Reef fish taxa inside survey	44	44	38	39	26	28	—
Reef fish taxa outside survey	26	8	12	18	7	4	32
Total taxa observed	70	52	50	57	33	32	32
No. individuals	1435	745	1095	1152	457	434	
No. samples	20	24	24	20	12	12	—

sites. *Halichoeres radiatus* is most abundant here compared to other habitats.

Ferry Grounding Site.—In 1988, while the ferry was still aground, the ichthyofauna shared many taxa with the reef crest-buttress zone off Playa Sardinera. Three species, *C. multilineata*, *S. partitus*, and *C. fulva*, were more common at the grounding site than the reef crest-buttress zone. Similar dominance of these species has been reported at other grounding sites and may be due to the relief provided by the hull (Dennis and Bright 1988a). These species were not recorded in the 1991 survey following the removal of the hull, but there was an increase in abundance of *Stegastes adustus*, *Sparisoma rubripinne* and *Sparisoma viride*. All three species are herbivorous. Forty-six species were observed at the ferry grounding site. Overall diversity and abundance of reef fishes differed little after removal of the vessel (Table 5).

Forereef.—Fifty-seven species were observed on the forereef (Table 5). This habitat had moderate diversity with a higher than average abundance. *Halichoeres garnoti* replaced *H. bivittatus* from the reef crest-buttress zone as the second most common wrasse after *T. bifasciatum*. Two species, *Holacanthus bermundensis* and *Serranus tabacarius*, were only observed in this zone. Six species were taken by ichthyocide only in this zone: *Acanthemblemaria spinosa*, *Emblemaria pandionis*, *Neoniphon marianus*, *Phaeoptyx pigmentaria*, and *P. aculeatus.*

Forereef Slope.—No quantitative surveys were made on the forereef slope, but 32 species were observed, five of which, *C. insolata*, *H. chlorurus*, *H. unicolor*, *L. mowbrayi*, and *C. rostrata*, were found only there (Table 5). Two species (*P. aculeatus* and *L. rubre*) collected on the deep forereef were only observed on the forereef slope. Two ichthyocide collections in this habitat at Mona and Monito yielded three species, *Liopropoma carmabi*, *Ophidion lagochila*, and *Risor ruber*, not found in other habitats.

Deep Forereef.—Three ichthyocide collections were made in deep forereef habitat below 30 m. Three species were unique to these collections: *Derilissus altifrons*, *Lythrypnus elasson*, and *Starksia hassi*. The deepwater parrotfish, *Sparisoma atomarium* was also collected by dredge in this habitat. On the wall at Desecheo typical members of the Caribbean deep reef fish assemblage have been reported from submersible observations, including *Centropyge argi*, *Gonioplectrus hispanus*, *Pronotogrammus martinicensis*, *Serranus luciopercanus*, and an unidentified candy-striped labrid (Nelson and Appeldoorn 1985).

DISCUSSION

The ichthyofauna of the islands of the Mona Passage, represented by 261 known species, appears somewhat impoverished compared to the 693 species known from the Puerto Rican Plateau (Dennis 2000). The number of taxa reported from any location is a function of the amount of sampling effort, the variety of sampling methods, and the range of habitats available. It has been estimated that approximately 85 hours of diver visual survey time are required to observe 90 percent of the non-cryptic reef-fish taxa present on a Caribbean coral reef (Jeffrey et al. 2001). We did not approach this effort so additional visual surveys will likely add to the list of species. Sampling

effort was limited to a narrow range of habitats, and thus also may have affected the reported ichthyofaunal composition. Robins (1971) noted that islands with reduced shallow-water environments should have impoverished fish faunas and the lack of specialized habitats, such as seagrass beds and mangroves, can result in absence or scarcity of some faunal components. The limited area of seagrass and mangrove fringe habitat at islands of the Mona Passage is apparently reflected in the low abundance and number of *Haemulon* species. Although only five species occur at Mona, 12 species are known from Puerto Rico (Dennis 2000). No *Haemulon* species was common at Mona whereas all species reported from Mona are common on the nearby southwest coast of Puerto Rico (Kimmel 1985; Dennis 1992). Another common grassbed species in Puerto Rico, *Ocyurus chrysurus*, with a high degree of dependence as a subadult on seagrass beds and mangroves in Curaçao (Nagelkerken et al. 2001; Nagelkerken et al. 2002), was rarely observed at Mona (Kimmel 1985). In diver visual surveys at Navassa, that also lacks seagrass and fringing mangroves, *Haemulon* spp. were absent and *O. chrysurus* was in low abundance (Miller and Gerstner 2002).

Ichthyocide collections in seagrass beds in Puerto Rico yielded numerous juvenile parrotfishes, *Sparisoma chrysopterum* and *S. rubripinne*, and the grassbed resident *S. radians* (Martin and Cooper 1981). Only adults of these parrotfishes were observed at Mona and very few juveniles were collected. Three goby species, *Bathygobius curacao*, *Gobionellus bolesoma*, and *Gobionellus saepapellens*, commonly collected by ichthyocides in Puerto Rican seagrass beds (Martin and Cooper 1981), were absent from the Mona collections. There are seagrass beds off Playa de Pajeros at Mona (Kendall et al. 2001) that should be surveyed to better characterize the ichthyofauna of this inadequately sampled habitat.

The lack of a red mangrove fringe may also pose limitations on the ichthyofauna. Two species, *H. sciurus* and *Lutjanus apodus*, have been shown to have a high level of dependence on mangroves (Nagelekerken et al. 2002). The rarity of *H. sciurus*, one of the most common grunts in Puerto Rico, perhaps best demonstrates this effect. It is a typical mangrove fringe species as a subadult (Rooker and Dennis 1991). *Lutjanus apodus* is another species rarely observed at Mona that is typically found in mangroves of southwestern Puerto Rico (Kimmel 1985; Rooker and Dennis 1991). The rarity of *A. chirurgus* also may be related to the lack of mangrove fringe habitat as it is the only surgeonfish typically found in this habitat in Puerto Rico and Curaçao (Kimmel 1985, Moriniere et al. 2002), though Nagelkerken et al. (2002) did not find any dependence on mangroves. Neither *L. apodus* nor *A. chirurgus* were reported in diver visual surveys from Navassa (Miller and Gerstner 2002). The lack of grassbeds and fringing mangroves at Monito and Desecheo and their limited area at Mona may be important contributors to an impoverished ichthyofauna of the Mona Passage islands.

Several rare species were taken that deserve comment. A juvenile *Canthidermis maculata* was collected at Desecheo; it has not been reported from the Puerto Rican Plateau (Dennis 2000). It is a pelagic species, typically found at the surface, but apparently rare in the Caribbean (Moore 1967; Alevizon 1976). The occurrence at Desecheo may be adventitious, though it shows up at many oceanic islands such as St. Helena, Bermuda, and Navassa (Edwards 1993; Smith-Vaniz et al. 1999; Collette et al. 2003). We have also examined a juvenile specimen from Isla de Aves, an oceanic island in the central Caribbean. Another unique observation is the collection of *Sparisoma atomarium* off Mona at 84 m. This species is the deepest dwelling parrotfish in the western Atlantic and this specimen represents a depth record for the species (Randall 1965; Williams and Shipp 1980; Dennis and Bright 1988b).

Mona shares many characteristics, such as a small shelf area and limited habitat diversity, with Navassa off the west coast of Hispaniola, which has been recently well sampled (Collette et al. 2003). Although almost twice as many stations were sampled with ichthyocides at Navassa only 20% more species (33) were taken. There is only

a 48% overlap in the species collected at the two sites. At Navassa, significantly more species per collection were taken (Mann-Whitney test, P = 0.01), and the number of individuals per collection was also higher. Major differences in species composition were particularly notable in the Labrisomidae: *Labrisomus* (5 species Mona, 1 species Navassa), *Malacoctenus* (5 species Mona, 1 species Navassa), *Starksia* (3 species Mona, 7 species Navassa), and *Paraclinus* (3 species Mona, 0 species Navassa). Overall, Navassa appears more diverse in its cryptic fish assemblage, but this may be due in part to differences in sampling effort.

Zoogeography

Islands in the Mona Passage are situated at a faunal break between Hispaniola and Puerto Rico. There is an abrupt discontinuity in the freshwater fish fauna of the Greater Antilles, with primary freshwater fishes absent from Puerto Rico (Myers 1938). This faunal break has been referred to as the Wallace Line for freshwater fishes in the region (Rivas 1986). The cause of this faunal break has been ascribed to vicariant events (Rosen 1975), filtering via overseas dispersal (Briggs 1984), or overland dispersal (Rivas 1986). Although many species of marine fishes have a planktonic larval stage that provides potential for broad dispersal (Leis 1991), neither reproductive type nor length of larval stage is a good predictor of geographic distribution (Shulman and Bermingham 1995; Rocha 2004). The Mona Passage does not provide much of a dispersal distance barrier for marine fishes yet there are substantial differences across this gap. Examples of visually obvious fishes that are found only in or west of the Mona Passage include: *Hypoplectrus gummigutta*, *Elacatinus xanthiprora*, *Gramma melacara*, *Holacanthus bermudensis*, and *Urobatis jamaicensis*.

Domeier (1994) examined the distributions of nine nominal species of hamlets and found what he termed population centers for the various species. *Hypoplectrus gummigutta* is reported to occur in the northern Caribbean as far east as the eastern end of Hispaniola. Only a single *H. gummigutta* has been reported from the Puerto Rico Plateau (Colin and Clavijo 1988). This serranid is rare at most insular sites, but the single individual observed during many years of field work in Puerto Rico suggests it may be a stray or waif.

The white form of the sponge dwelling goby, *E. xanthiprora*, is known east to Isla Catalina off the southeastern coast of Hispaniola (PLC, pers. obs.); it is absent from the Puerto Rican Plateau and eastern Caribbean islands (Colin 1975; Dennis 2000). It is found at relatively isolated islands, such as Serranilla Bank and Isla de Providencia, suggesting good dispersal abilities (Colin 1975).

Starck and Colin (1978) noted that *G. melacara* is not known east of Hispaniola and Randall (1963a) indicated that it is absent from eastern Caribbean islands. Twenty-five years of additional observations have not refuted this pattern. No individuals were observed at Mona although special effort was made to find the species. This species lays benthic eggs, but has free-swimming larvae that required 21-35 days in aquarium to reach metamorphosis (Addison 1994). It is able to disperse across considerable water gaps as it is found in Jamaica (Colin 1974), but has not been able the cross the Mona Passage.

Holacanthus bermudensis and *U. jamaicensis* are found from the Bahamas to Hispaniola, but not known from the Puerto Rican Plateau or the Lesser Antilles (Böhlke and Chaplin 1968; Williams et al. 1983; Dennis 2000). These taxa do not fit into any specialized category of poor dispersers and *U. jamaicensis* occurs in Jamaica (Colin 1974).

Small cryptic species that have limited dispersal abilities show a mixed pattern of distribution. In the genus *Starksia* two newly described species, *S. melasa* and *S. smithvanizi*, are known from the Mona Passage and St. Croix, but not the Puerto Rican Plateau (Williams and Mounts 2003). This is probably not a sampling artifact as the fauna of Puerto Rico and St. John have been well sampled with ichthyocides. In contrast, *Starksia culebrae*, an insular species, is found on Hispaniola and Puerto Rico (Greenfield 1979), but not reported from Mona. Subspecific differentiation occurs

across the Mona Passage in *Stathmonotus stahli*, with *S. stahli tekla* occurring on Mona and islands to the west and *S. stahli stahli* found on Puerto Rico and islands to the east (Hastings and Springer 1994). *Stathmonotus gymnodermis* also exhibits substantial geographic variation across the Mona Passage (Hastings and Springer 1994). Two rare clingfishes, *Derilissus altifrons* and *Gobiesox lucayanus*, are not known from the Puerto Rican Plateau, but *G. lucayanus* is known from Navassa and the Bahamas (Dennis 2000; Collette et al. 2003). The cryptic fish fauna is not well enough known from the Greater Antilles to judge the effectiveness of the barrier, but it certainly exists.

Taylor and Hellberg (2003) found genetic differentiation between the white and blue forms of the coral dwelling goby, *Elacatinus evelynae*. The blue form of *E. evelynae* occurs throughout the Lesser Antilles to the west coast of Puerto Rico, while the white form occurs from Desecheo west through the Caribbean to at least Jamaica. The fact that these broadly distributed forms separate across the short gap (14 km) between Desecheo and Puerto Rico implies some sort of isolating mechanism must exist. Taylor and Hellberg (2003) proposed larval retention as the mechanism, while Colin (2003) suggested that oceanographic factors might be more important in restricting larval transport.

The Mona Channel is basically a conduit between the Caribbean Sea and Atlantic Ocean, and cross channel transport is less likely than transit through the passage north and south. Oceanographic studies (Johns et al. 1999; Johns et al. 2002) indicate most water passes from the Atlantic Ocean into the Caribbean Sea through this passage, however, the direction of movement for satellite-tracked drifters indicated 3 of 4 transiting through the passage went from Caribbean to Atlantic (PLC, pers. obs.). Certainly water and fish larvae can easily move in both north and south directions, but not as easily east and west between Hispaniola and Puerto Rico. Factors other than dispersal ability shape the distributions of these species and make the Mona Passage a biogeographical barrier even to some marine fishes. This barrier provides an imperfect filter as some marine fishes are found east to the Mona Passage, but are absent from the Puerto Rican Plateau. Many are found throughout the Caribbean.

The importance of ichthyocide collections to the understanding of the diversity of the ichthyofauna can not be overemphasized. It is well known that diver visual survey samples only the observable species that make up the suprabenthic fish assemblage and thus underestimates the total diversity of the fish assemblage (Smith and Tyler 1973; Brock 1982). Only 18% of the species taken by ichthyocides at the Great Barrier Reef were observed prior to collection (Ackerman and Bellwood 2000). While the method is consumptive, the total biomass lost to the system is small compared to commercial fisheries, and cryptic fishes are short lived, recolonizing treated areas rapidly (Smith 1973). The cryptic fish assemblage recovers rapidly from the ichthyocide disturbance, but may be subject to the vagaries of stochastic processes that do not allow the reliable prediction of its composition (Sale and Douglas 1984). Application of an ichthyocide, such as rotenone, allows the collection of a suite of fishes that greatly increases our knowledge of the biodiversity of the system (Smith 1973; Collette et al. 2003). These small fishes may play a more important role in reef processes than previously assumed (Ackerman and Bellwood 2000). We reinforce this conclusion here where ichthyocide collections added an additional 70 species (27%) to our list. The true diversity of the ichthyofauna is hidden without employing such methods to sample the cryptic fish assemblage.

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