BULLETIN

of the
FLORIDA STATE MUSEUM
Biological Sciences

Volume 16 1971 Number 1

FISHES OF THE TORTUGUERO AREA, CARIBBEAN COSTA RICA

Carter R. Gilbert
Donald P. Kelso

UNIVERSITY OF FLORIDA GAINESVILLE

Numbers of the BULLETIN OF THE FLORIDA STATE MUSEUM, BIOLOGICAL SCIENCES, are published at irregular intervals. Volumes contain about 300 pages and are not necessarily completed in any one calendar year.

Communications concerning purchase or exchange of the publication and all manuscripts should be addressed to the Editor of the Bulletin, Florida State Museum, Museum Road, University of Florida, Gainesville, Florida 32601.

Publication date: 4 June, 1971

Price: $0.85

FISHES OF THE TORTUGUERO AREA, CARIBBEAN COSTA RICA

CARTER R. GILBERT and DONALD P. KELSO

SYNOPSIS: This paper summarizes fish collections taken from 1955 to 1969 in the vicinity of Tortuguero, Costa Rica. Most collections were made in the estuary during the summer rainy season, others in the tributary streams, ocean beach, and open ocean. The 111 species represented nearly double the total reported by Caldwell, Ogren, and Giovannoli (1959). Nine are additions to Miller's (1966) checklist of Central American freshwater fishes, and one species is described as new. Of the 80 freshwater species collected, six (7.5%) are primary division, 18 (22.5%) secondary division, and the remainder peripheral division forms, according to Myers' (1938) classification of freshwater fishes based on degree of salt tolerance.

A list of collection localities is included, with pertinent ecological data, together with an annotated list of species and a summary table. The paper also summarizes previous literature pertaining to Central American freshwater and Caribbean shore fishes, discusses the zoogeographic relationships of the Tortuguero fish fauna, describes the geographical and ecological characteristics of the Tortuguero area, and discusses the assemblage of larval fishes and invertebrates (*tismiche*) periodically observed in the estuary.

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Carter R. Gilbert is Assistant Curator in Ichthyology, Florida State Museum, and Assistant Professor, Department of Zoology, University of Florida, Gainesville, Florida 32601. Donald P. Kelso is Assistant Professor, Division of Biology, George Mason College, University of Virginia, Fairfax, Virginia 22030.

Gilbert, Carter R. and Donald P. Kelso. 1971. Fishes of the Tortuguero Area, Caribbean Costa Rica. Bull. Florida State Mus., Biol. Sci., Vol. 16, No. 1, pp. 1—54

INTRODUCTION

The Central American fish fauna, between the Isthmus of Tehuantepec and Colombia, remains inadequately known. Collections are uneven, and the literature consists mostly of descriptions and/or taxonomic reviews of the freshwater species and faunal reports. Meek (1903, 1904) discussed the zoogeography of Mexican freshwater fishes, and Regan (1906-08) expanded this to cover all of Central America. Miller (1966) updated the last work, and in addition presented a checklist, with ranges, of the Middle American freshwater species known from the Isthmus of Tehuantepec southward. Loftin's (1965) unpublished work on the zoogeography of Panamanian freshwater fishes represents the only intensive study of its type for a specific area of Central America, although similar studies, by William A. Bussing on Costa Rican fishes and Michael Martin on Honduran Fishes, are currently in progress. Finally Darlington (1957) and Myers (1966) presented contrasting theories on the derivation of the freshwater fish fauna. These are discussed in a subsequent section of this paper.

Some of the above papers treat marine fishes that enter fresh water, although little has been published on the strictly marine species occurring in the Caribbean that are closely restricted to beach or estuarine situations. The most comprehensive works dealing with western Caribbean marine fishes are those by Meek and Hildebrand (1923, 1925, 1928). Chickering (1930) and Hildebrand (1937, 1939) published on the possible effects of the Panama Canal on trans-isthmian movement of both marine and freshwater fishes. Other papers, more limited in scope, are by Bean (1890); Fowler (1903, 1916, 1923); Caldwell, Ogren, and Giovannoli (1959); Caldwell (1963); Caldwell and Caldwell (1964); and Birdsong and Emery (1968). Also pertinent to this discussion are several works dealing with the marine fishes from the adjacent coast of South America: Fowler (1953) on Colombia; and Schultz (1949), Mago (1965), and Cervigon (1966, 1968) on Venezuela.

Although many fish collections exist from Central America, these are by no means uniformly distributed. Certain areas have received inadequate attention, of which the "Mosquito coast" of Nicaragua and Honduras is the most extensive geographically. Obviously surveys of the freshwater and marine faunas of this and other critical regions are vital to our knowledge of the distribution and ecology of Middle American fishes. Unfortunately problems of transportation and communication make such areas difficult to reach, and the lack of adequate field facilities make long-term projects even more difficult.

The establishment of research and living facilities near the small Caribbean village of Tortuguero, Costa Rica, has resulted in an unusually favorable opportunity for studying and collecting the biota of a small section of the Central American coast. For the past 15 years this village has been the site of Archie F. Carr's extensive investigations on the ecology and life history of the green turtle, *Chelonia mydas*. During this time various individuals associated with the project have made a number of fish collections that have formed the basis for several papers (Böhlke, 1958; Caldwell, 1958, 1962; Böhlke and Caldwell, 1961; Gilbert, 1966a, 1966b, 1968; Gilbert and Caldwell, 1967; Collette, 1968). Other papers in preparation, in which Tortuguero specimens are involved, are by B. B. Collette (families Exo-

coetidae [subfamily Hemiramphinae] and Belonidae) and by C. R. Gilbert and J. E. Randall (genus *Gobionellus,* family Gobiidae). Caldwell, Ogren, and Giovannoli (1959) summarized the earlier Tortuguero fish collections, but as these collections were incidental to the main turtle work, with most of the specimens coming from the readily accessible lagoon, this checklist was incomplete, and the fishes were mostly typically brackish-water forms. Collections by the authors in 1963 and 1964, supplemented by a few in 1962, 1965, and 1969 from previously unsampled habitats, have more than doubled the number of species recorded from the area. Despite this, many forms remain to be discovered. Most of these probably will be marine species that seldom, if ever, venture into the estuary, whereas a lesser number may also be found in the interior streams. Nearly all previous work has been done during July, August, and September, at the height of the rainy season, when collecting success in the streams is generally poor. In addition, the lagoon at this time has a very low salinity (from 0 to 1.5 ppt at the surface), and many marine species that are present in the estuary during the dry season (when salinity is high) move out. The only dry-season collections from the Tortuguero area were made by the junior author in late April and early May 1964, and most of these were from the lagoon. Obviously additional collections during this time of year would be especially desirable. The need for more shore collecting along the entire Caribbean coast of Central America, regardless of season, is pointed up by the fact that two species (the dactyloscopid *Dactylagnus peratikos* Böhlke and Caldwell, 1961, and the microdesmid *Microdesmus carri* Gilbert, 1966) are still known only from Tortuguero material.

The present paper is an outgrowth of a section of a master's thesis by the junior author (Kelso, 1965). Its purpose is 1) to update the earlier checklist of Caldwell, Ogren, and Giovannoli (1959); 2) to provide additional taxonomic, ecological, and distributional data for the included fish species; and 3) to indicate the availability of this material in the Florida State Museum fish collection. All these factors assume added importance with the proposal to build a sea-level canal in southern Panama. Because of the gene interchange that will presumably occur between many geminate species presently confined to the opposite coasts of Middle America, comparisons of these closely related forms are especially desirable. In this regard three papers, in which the Atlantic material has been largely or entirely collected at Tortuguero, have so far been published (Böhlke and Caldwell, 1961; Gilbert, 1966a; Gilbert and Caldwell, 1967).

ACKNOWLEDGMENTS

Many individuals have aided in this study. We particularly wish to thank Archie F. Carr, University of Florida, without whom this work would not have been possible, and who provided financial assistance from grants by the National Science Foundation (G-1684, G-5479, G-10717, and GB-86), the Office of Naval Research (ONR 580 (12)), and the Caribbean Conservation Corporation. Sr. Guillermo Cruz, San José, Costa Rica, was of invaluable help in various logistical matters. Larry Ogren, Key Eoff, Lenton O. Rowland, Harry F. Hirth, and Leonard Giovannoli made a number of collections from 1955-1962; Gene Holmes made several collections in 1969; and Archie F.

(Chuck) Carr III, Randy Kaufman, David Flack, Emory Pierce, Stephen Carr, J. Richard Moore, and Leo Martinez aided during the collections from 1963-1965. Thomas H. Fraser, Rosenstiel School of Marine and Atmospheric Sciences, University of Miami, provided information on the present status of the genus *Centropomus* in the western Atlantic. Robert R. Miller and Reeve M. Bailey, Museum of Zoology, University of Michigan; Roy Irwin, Tulane University; and William A. Bussing, Departamento de Biología, Universidad de Costa Rica, San José, provided information on the systematic status of several Costa Rican freshwater fishes. Russell Parks, Florida State Museum, took the photographs, and Margaret Estey, Florida State Museum, drew the map. We extend our sincere appreciation to all.

Materials And Methods

Fishes were collected by various methods. Most collections from the lagoon and tributary streams were made with rotenone-based toxicants (Chem Fish), although some were taken with a 15' x 4' ¼" bag seine and/or an 8' x 4' ¼" non-bag seine. All collections from the ocean beach were made with the bag seine, to which a metal chain was attached to the lead line. Experimental gill nets were also used, mostly at night, both in the lagoon and the streams. Collections from the open ocean were made, during the day, with a small try net pulled by a catamaran at a maximum depth of 25-30 feet. Finally some specimens were caught by hook and line.

All specimens were preserved in 10% formalin and later transferred to 40% isopropyl alcohol. These are deposited in the fish collections of the Florida State Museum, University of Florida, and (1969 collections only) Florida State University. Synoptic series of some of the more common species and some paratypes of *Hyphessobrycon tortuguerae*, *Gobionellus pseudofasciatus*, and *Microdesmus carri* have been distributed to certain other museums.

All measurements are expressed in standard length (SL), except for the chondrichthyans (Carcharhinidae and Dasyatidae), which are given in total length (TL). Species in the annotated list that were collected only in the ocean are indicated by an asterisk (*). Primary, secondary, and peripheral freshwater fishes (Myers, 1938, 1951) are indicated by roman numerals I, II, or III, respectively. Peripheral freshwater fishes were so designated if they were ever taken in Tortuguero lagoon or farther upstream during the rainy season (when the water was either fresh or of very low salinity), even though in some cases (as with *Larimus breviceps* and *Echeneis naucrates*) it is obvious that these fish stray into fresh water only occasionally. Species not reported in the earlier list (Caldwell et al., 1959) are indicated by the words "new record." Vernacular names are listed when known. Both "official" names (those included in Bailey et al., 1970) and local names are included, the latter indicated by quotation marks.

The procedures followed in listing collections and in the individual species' accounts generally follow those of Caldwell et al. (1959) except that 1) catalogue numbers are not used; and 2) certain collection stations are lumped together (see below). For each station the geographical locality is followed by the date of collection, pertinent ecological data, time of day, method of collection, names of collectors, field number, and species obtained. Under each species account is listed the station where collected and the number of specimens and their ranges in length from each locality. All collections made from the ocean or ocean beach are given separate station numbers, as are those from the tributary steams. Also all estuarine collections the junior author made during April and May 1964 are listed separately, inasmuch as these are the only ones made from Tortuguero lagoon during the dry season. The numerous

collections made in the estuary during July, August, and September (various years) have been combined for the following reasons: 1) Some from the lagoon were made incidentally, comprise one or a few specimens, and have no precise locality data; 2) many were made from the same or closely adjacent localities and thus are largely repetitious; and 3) estimated distances from the village or from the lagoon entrance vary individually and different collections might record the same locality differently. Estimates of exact distances were particularly difficult for stream collections, although in view of the relatively few stream collections made and the large expanse from which they could have come, that any two were from precisely the same spot is unlikely. For these reasons no attempt was made to pinpoint exact collection localities on the drainage map (Fig. 1). Because of pronounced ecological differences (see subsequent discussion), estuarine collections made from July to September were separated into the following categories: 1) Those made on the far (west) side of the lagoon (all combined as station 1); 2) from the near (east) side (station 2); and 3) gill-net and hook-and-line collections away from shore (station 3).

Table 2 shows, in a general way, habitat preferences among the various fish species. Six major habitats are recognized: The streams, ocean beach, and open ocean, in addition to the three habitats within the lagoon itself (see preceding paragraph). The preparation and composition of this table is discussed in greater detail in a later section of this paper (pp. 17-20).

A problem has arisen regarding material collected in the boca (inlet) area. Collections made on the two sides of the sand spit that separates the estuary from the ocean were usually combined. Fortunately field notes taken for the two 1963 collections so involved (field nos. G 63-16 and G 63-21) show where each species was encountered, and these collections have thus been divided into "A and B" subcollections; but this is not true for other years. Consequently the remarks on ecological separation of the species occurring in this general area are based entirely on data from the 1963 collections.

Observations and discussion of the *tismiche* are largely by the junior author. All fish identifications are by the senior author, unless otherwise noted. Various papers, too numerous to mention, were used for this purpose, with those by Meek and Hildebrand (1923, 1925, 1928) being especially useful for the marine species, and those by Meek (1914) and López-Sánchez (1968) being primarily used for the freshwater forms. Only the ariid catfishes proved troublesome, the available keys either being outdated, inaccurate, or incomplete. Specific determinations of the two species of Ariidae found at Tortuguero are therefore based entirely on the geographical distributions of the species included in Miller's (1966) checklist of Central American freshwater fishes. Nomenclature used in this paper follows Miller (1966). All nonfish identifications and stomach analyses are by the junior author.

The spelling of patronymics has recently been the subject of considerable debate among ichthyologists. If the present (post-1963) rules of zoological nomenclature are followed, patronymics must be spelled according to the original orthography, both with regard to the body of the word and the endings (e.g., i, ii, or with no ending in the case of masculine patronymic, though this does not apply in those occasional cases that call for a change in gender). The rationale for this is that it is not always possible to determine if a person's name is spelled correctly, particularly for species described during the early days of binomial nomenclature. In earlier papers Gilbert (1966b, 1967a, 1967b) followed current rules, which many others, including Miller (1966), have chosen not to follow. In the present paper, we have not followed current rules, primarily to avoid confusing the reader with patronymics in Miller's (1966) checklist, but in all cases where the spelling of a name is so corrected the original spelling is also given.

To facilitate identification of the small fishes collected in the *tismiche*, a number of specimens were cleared and stained by the enzyme technique Taylor described (1967). As identification of the various species of Cichlidae (particularly small specimens) can present problems, Table 4 was prepared, in which dorsal, anal, and pectoral fin-ray counts are given (except for *Cichlasoma dowi*) for a maximum of 15 specimens (all from Tortuguero) of each species. Photographs are included of small specimens of all species of *Cichlasoma* found at Tortuguero (Figs. 2-4). In addition, photographs of large specimens of *Cichlasoma spilurum* from Costa Rica and Guatemala (Figs. 5a-b) illustrate differences between populations from the two areas.

The drainage map (Fig. 1) was drawn from topographic maps prepared by the Instituto Geográfico Nacional, San José, Costa Rica.

List Of Collection Stations

Station 1. — (C.O.G. stas. 5, 7, 9, 14). Tortuguero lagoon, west (far) side. A total of 17 collections made on the following dates: 28 July 1956; 12, 24 July 1957; 11 July 1958; 19 August 1958; 3 September 1958; 12-14, 18-21, 24-25 August 1963; 26 August 1964; 13, 16 August 1969. Extensive shallow bays of 4 ft. or less in depth, some areas with open bottom and others with some submerged aquatic vegetation and heavy growths of filamentous algae. Rotenone, seines, and cast nets. Various collectors. Field nos. Ogren 48, 225, 422-424, 461, 475; G 63-17A, G 63-19, G 63-26, G 63-27, G 63-35, G 63-36, G 63-39; H 6902, H 6903, H 6904. Species: 3, 13, 14, 18, 19, 20, 28, 30, 31, 32, 33, 34, 35, 36, 37, 38, 40, 41, 42, 43, 49, 50, 52, 56, 57, 58, 60, 61, 64, 65, 66, 67, 69, 70, 74, 82, 83, 85, 86, 93, 94, 95, 96, 98, 99, 100, 101, 102, 103, 106, 107, 111.

Station 2. — (C.O.G. stas. 3, 4, 6, 8). Tortugero lagoon, east (near) side. A total of 40 collections made on the following dates: 25, 27 July 1955; 22 August 1955; 13, 15, 17, 24 July 1956; 25, 28 August 1956; 1-3, 9 September 1956; 31 August-1 September 1957; 9, 16-18, 24, 27, 30 July 1958; 2, 30 August 1958; 10, 13-14, 16-20, 24 August 1963; 18, 25 August 1964; 24 July 1969; 2, 16 August 1969. Mostly narrow shoreline with bottom usually sloping sharply into deeper water and with shallow, open areas lacking in all but a few places; heavy submergent, emergent, and floating vegetation lining much of shore. Rotenone, seines, cast nets. Various collectors, Field nos. Ogren 1-5, 7, 25, 131, 141, 152, 155, 157, 175, 233, 277, 420, 430-431, 434, 441-442, 448, 452, 455; G 63-14, G 63-16B, G 63-20, G 63-21B, G 63-34; H 6901, H 6905, H 6906. Species: 14, 19, 21, 25, 28, 30, 31, 33, 35, 37, 38, 40, 43, 44, 45, 49, 50, 52, 56, 57, 61, 64, 65, 67, 68, 69, 82, 83, 85, 86, 91, 92, 93, 94, 95, 96, 98, 99, 100, 101, 103, 104, 111.

Station 3. — Tortuguero lagoon, nonshoreline areas. A total of 10 collections made on 12 July 1957, from 11-20 August 1963; and ? July 1965. Bottom uniformly flat, from 12-15 ft. deep, with mud and detritus, no submergent vegetation. Experimental gill nets, hook and line. All but 1957 collection by C. R. Gilbert, D. P. Kelso, A. F. Carr III, D. Flack and R. Kaufman. Field nos. Ogren 205, G 63-15, G 63-17B, G 63-18A & B, G 63-22, G 63-25, G 63-29, G 63-30. Species: 1, 5, 6, 24, 25, 57, 58, 66, 70, 73, 76, 103, 108.

Station 4. — (C.O.G. sta. 1). Caribbean Sea, open beach near Tortuguero village, Beach consisting of black volcanic sand sloping sharply into water; heavy surf almost always present.

Station 4A. — 14 August 1955. Fish driven onto beach by predators. Giovannoli. Species: 8, 10, 12, 15, 42, 46.

Station 4B — 15 July 1956. Fish found dead on beach. Ogren, Species: 77.

Station 4C. — 30 July 1958. Fish scooped up as it buried itself in sand at surf line as wave receded. Ogren. Ogren no. 451. Species: 105.

Station 5. — (C.O.G. sta. 2). Just inside inlet, where Tortuguero lagoon enters sea.

Station 5A — 26 August 1955. Water almost fresh from recent rains. Hook and line. Giovannoli and A. F. Carr. Species: 1, 104.

Station 5B. — 29 July 1958. Jigs and baited hooks. Ogren and Eoff. Ogren no. 449. Species: 1, 49, 52, 104.

Station 6. — (C.O.G. sta. 10). Near confluence of Río Tortuguero, Lagunas, Penitencia, and lagoon. Silty bottom, water hyacinths present.

Station 6A. — 13 July 1957. Night. Fish shaken from hyacinth roots. Ogren. Ogren no. 208. Species: 92.

Station 6B. — 10 August 1957. Night. Hook and line, with shrimp bait. Ogren. Ogren nos. 247-248. Species: 83, 85.

Station 7. — (C.O.G. sta. 11). Caño Mora, ca. 5 miles from inlet. 9 September 1956. Creek steep-banked; water deep, fresh. Afternoon. Hook and line. Ogren. Ogren no. 176. Species: 85.

Station 8. — (C.O.G. sta. 12). Caño Palacio, ca. 6 miles from inlet and just above junction with Lagunas Penitencia. 26 August 1956. Fish found dead near river. Ogren. Ogren no. 136. Species: 16.

Station 9. — (C.O.G. sta. 13). Caño Palacio, ca. 8 miles from inlet and ca. 1½ miles above junction of Río Palacio. 26 August 1956. Water fresh, highly turbid, brown-stained; river in flood, current 2-3 mph; river running through a river-swamp forest (no hardwoods), ca. 30-40 yds wide at point of collection; spiny palm most abundant shore vegetation. Fish collected near shore, cichlids under hyacinths taken with hook and line and shrimp bait, *Eleotris* shaken from hyacinth roots. Mid-afternoon. Ogren. Ogren no. 134. Species: 83, 86, 93.

Station 10. — Caribbean Sea, open beach SE of Tortuguero village at "Mile 2½." 1 August 1962. Black sand beach. Fish found alive at water's edge. Kelso. Species: 109.

Station 11. — Río Tortuguero, ca. 2-3 miles from Tortuguero village.

Station 11A. — 10 August 1963. Sidewater tributary, a short distance off main stream. Bottom of very soft mud, with some submerged branches and logs; no aquatic vegetation where collection made, but much emergent vegetation and water hyacinths close by; water turbid (ca. 1 ft. visibility), depth 4 ft. maximum where collection made; no current where collection made, but a good current present a short distance away. 3:00-4:00 P.M. Rotenone. Gilbert, Kelso, Carr, Flack, Kaufman. Field no. G 63-13A. Species: 19, 22, 23, 35, 85, 86, 87, 88, 90.

Station 11B. — 10 August 1963. Same locality as above, but in main stream. Sand bottom grading to mud near shore; heavy emergent and overhanging vegetation; current swift in center of stream, slower near shore; water 3 ft maximum where collected. 4:00-5:00 PM. Bag and nonbag seines. Gilbert, Kelso, Carr, Flack, Kaufman. Field no. G 63-13B. Species: 19, 20, 27, 29, 35, 40, 84, 94.

Station 12. — Mouth of Tortuguero lagoon, on seaward side of sand spit. 12, 13, 24 August 1963. Bottom consisting entirely of shifting sand; many small floating

rafts of water hyacinths; collection made at maximum depth of about 4 ft. Specimens of *Phallichthys amates pittieri* and *Cichlasoma nigrofasciatum* found among hyacinth roots. 10:30-12:00 AM. Bag seine with chain attached to lead line. Gilbert and Kelso. Field no. G 63-16A. Species: 30, 42, 87, 105.

Station 13. — Caribbean Sea, open beach just south of Tortuguero lagoon inlet. 15 August 1963. Black sand beach, heavy surf. Collection made at maximum depth of about 4 ft. 4:00-5:00 P.M. Bag seine with chain attached. Gilbert and Pierce. Field no. G 63-21A. Species: 34, 42, 64.

Station 14. — Benjamin Creek, sidewater area, a short distance above mouth in Río Tortuguero, ca. 2½ miles above Tortuguero village. 17 August 1963. Mud and silt bottom with many submerged logs and limbs, no aquatic vegetation. Maximum depth of collection 3 ft. 10:00-11:00 AM. Rotenone. Gilbert, Kelso, Carr, Flack, Kaufman. Field no. G 63-23. Species: 19, 21, 27, 28, 30, 40, 81, 82, 85, 86, 87, 88, 93, 99, 101.

Station 15. — Deadwater, just above mouth in Caño Mora, ca. 1½-2 miles from Tortuguero village. 17-18 August and 1 September 1963; September 1964. Stagnant backwater, with very soft mud bottom, many limbs and logs and heavy mats of water hyacinths; water darkly stained. Rotenone collection made at maximum depth of ca. 4 ft, gill net and spear collections made in 6-7 ft. 11:00-11:45 AM (poison collection), overnight (gill-net). A specimen of *Lepisosteus tropicus* speared in September 1964. Gilbert, Kelso, Carr, Flack, Kaufman, Martinez. Field no. G 63-24. Species: 4, 14, 27, 40, 43, 57, 82, 83, 85, 87, 93, 111.

Station 16. — Caribbean Sea, up to a mile up and out from Tortuguero inlet. 19-21, 23, 25, 31 August 1963. Black sand and silt bottom. Small (12 ft. wide) try net, pulled by a catamaran, fishing at a maximum depth of 25-30 ft. Specimen of *Scomberomorus maculatus* caught with hook and line. Gilbert et al. Field no. G 63-28. Species: 2, 7, 9, 11, 39, 46, 47, 48, 55, 62, 63, 71, 72, 73, 78, 79, 80.

Station 17. — Caño Servulo, ca. 10 stream miles from Tortuguero village, ca. 1-2 miles above mouth in Lagunas del Tortuguero. 22 August 1963. Soft mud bottom with much leafy detritus and many limbs and branches. Afternoon. Rotenone. Gilbert. Field no. G 63-31. Species: 27, 28, 40, 57, 82, 83, 85, 86, 87, 88, 92, 93, 95, 101.

Station 18. — Caribbean Sea, shore in front of turtle camp, ca. 2 miles SE of Tortuguero inlet. 22 August 1963. Open black sand beach with heavy surf. Late afternoon. Bag seine with chain attached. Specimen of *Porichthys plectrodon* found, partially eaten, on beach at night. Gilbert and Carr. Field no. G 63-32. Species: 8, 13, 14, 33, 34, 42, 45, 46, 49, 52, 53, 54, 62, 63, 64, 69, 73, 75, 80, 110.

Station 19 — Río Palacio, ca. 2 miles above in Caño Palacio. 23 August 1963. Mud bottom with a number of limbs and logs; no vegetation; water white, not stained. Collection made in a tiny side tributary, the only place found where collecting was feasible. 11:30-3:00 PM. Nonbag seine. Gilbert and Kelso. Field no. G 63-33. Species: 19, 20, 27, 28, 29, 30, 31, 35, 38, 40, 41, 66, 81, 84, 85, 88, 89, 97, 101, 102.

Station 20. — Río Tortuguero, ca. 3½ miles upstream from Tortuguero village. 26 August 1963. Sand bottom with mud near banks; water white, turbid, with good current present; dense, low, submergent vegetation in shallow areas near shore; width of stream ca. 10-15 ft; depth ca. 4 ft maximum. 11:00-11:30 AM. Nonbag seine. Gilbert, Carr, Flack, Kaufman, Field no. G 63-37. Species: 19, 20, 22, 27, 28, 30, 69, 81, 84, 85, 87, 90, 93, 95, 101.

Station 21. — Río Tortuguero, ca. 4 miles upstream from Tortuguero village. 26 August 1963. Sand bottom, with some mud near bank; water white, rather turbid, with strong current; no aquatic vegetation; width of stream ca. 25-30 ft; depth of capture up to 1 ft, with some deeper spots where current funneled into a chute. 1:00-3:00 PM. Nonbag seine; hook and line. Gilbert, Carr, Flack, Kaufman. Field no. G 63-38. Species: 19, 20, 22, 27, 29, 35, 40, 41, 43, 44, 64, 84, 85, 93, 94, 95.

Station 22. — Tortuguero lagoon, west side, shore ca. 2 miles from inlet, "across from Leo's." 28 April 1964. 7:00 PM. Dipnet. Kelso. Species: 35, 43, 57, 86, 92, 93.

Station 23. — Tortuguero lagoon, at turtle camp, ca. 2 miles above inlet. 28 April 1964. Kelso. Species: 43,45.

Station 24. — Tortuguero lagoon, at turtle camp, ca. 2 miles above inlet. 2 May 1964. Kelso. Species: 51.

Station 25. — Tortuguero lagoon, bay across from airstrip, ca. ¾ mile above inlet. 5 May 1964. 5:00-6:00 PM. Rotenone. Kelso *et al.* Species: 17, 18, 34, 35, 36, 37, 40, 45, 50, 52, 56, 57, 61, 64, 69, 82, 86, 93, 94, 95, 98, 100, 101, 106, 107.

Station 26. — Flats across from Tortuguero village. 6 May 1964. 5:00 PM. Bottom dredge. Kelso. Species: 16.

Station 27. — Caribbean Sea, beach in front of turtle camp. 6 May 1964. 7:00 PM. Fish driven ashore by predators. Kelso *et al.* Species: 8.

Station 28. — Tortuguero lagoon, shore across from village, ca. 3 miles from inlet. 7 May 1964. 4:00-5:00 PM. Rotenone. Kelso *et al.* Species: 35, 43, 50, 56, 57, 58, 64, 65, 70.

Station 29 — Tortuguero lagoon, inlet area. 7 May 1964. Kelso. Species: 36, 42, 45, 46, 50, 54, 62, 69, 105.

Station 30 — Inlet of Tortuguero lagoon (*tismiche* collection). 7 August 1964. 10:00-11:00 PM. Plankton net. Kelso *et al.* Species: 36, 40, 93, 94, 97, 101, 106.

Station 31. — Creek off Río Aqua Fría, ca. 8 miles from Tortuguero village. 25 August 1964. Rotenone. Kelso *et al.* Species: 16, 19, 20, 21, 26, 27, 28, 29, 30, 35, 36, 38, 56, 64, 69, 81, 83, 87, 88, 89, 93, 94, 95, 98, 100, 101, 102, 103.

Station 32. — Canal off Río Aqua Fría, ca. 8 miles from Tortuguero village. 25 August 1964. Rotenone. Kelso *et al.* Species: 22, 23, 26, 84, 88.

Station 33. — Benjamin Creek, 1 mile from mouth. 17 August 1969. 11:00-12:00 AM. Rotenone and seine. Gene Holmes and Rudolfo Martinez. Field no. H 6907. Species: 14, 19, 22, 27, 30, 31, 40, 43, 81, 83, 84, 85, 86, 87, 92, 93, 94, 95, 101, 102.

Station 34. — Benjamin Creek, 2 miles from mouth. 18 August 1969. 10:30-12:00 AM. Rotenone and seine. Holmes, Martinez, and A. F. Carr III. Field no. H 6908. Species: 20, 22, 28, 56, 82, 83, 85, 86, 87.

Station 35. — Benjamin Creek, 1¾ miles from mouth. 18 August 1969. 12:30-2:00 PM. Seine. Holmes and Martinez. Field no. H 6909. Species: 19, 20, 22, 26, 27, 28, 30, 31, 35, 43, 44, 69, 70, 81, 82, 85, 86, 88, 93, 95, 98, 101, 111.

ZOOGEOGRAPHIC IMPLICATIONS

Darlington (1957) and Myers (1966) presented contrasting theories regarding

the derivation of the Central American freshwater fish fauna. The latter tendered convincing evidence to refute previous ideas that Central America served as an avenue by which the characins, catfishes, cichlids, and possibly other groups moved down from North to South America during the late Mesozoic. Myers thus believes that the bulk of the South American freshwater fauna came directly from Africa, presumably before these continents separated and began to drift apart during mid-Mesozoic. The Central American freshwater fauna is characterized by the dominance of certain autochthonous secondary families or genera (primarily the Poeciliidae and the cichlid genus *Cichlasoma*), relatively large numbers of species of marine affinities, and a paucity of species and lack of diversity in the few primary families (Characidae, Gymnotidae, and Pimelodidae) occurring north of central Panamá. Penetration by the North American freshwater fauna has been very limited, only one species of Ictaluridae and one species of Catostomidae having reached the Isthmus of Tehuantepec. Penetration by the South American fauna has been more extensive, two species (a characin and a cichlid) having moved north to southern Texas. Geological studies indicate that 1) a sizeable core of middle Central America, comprising Honduras, El Salvador, and large adjacent parts of Guatemala and Nicaragua, has remained above the sea since the Paleozoic; 2) to the north, especially in the Tehuantepec region, considerable marine transgression occurred during the Cenozoic; 3) an oceanic connection existed across southern Nicaragua during the Oligocene and Miocene, and perhaps at other times; and 4) if the Panama interocean passage (i.e., the area now occupied by eastern Panama) was ever bridged by dry land prior to the Pliocene, that bridging was far back in the Mesozoic (Myers, 1966: 771). Thus no nondisjunct Central American landmass is believed to have existed between the Jurassic (if then) and late Pliocene. It should be noted that Savage (1966), in discussing the zoogeography of the Central American herpetofauna, hypothesized an Isthmian connection of Central and South America during the Paleocene. Finally, as yet no paleontological evidence documents the presence of catfishes (of South American type), characins, or cichlids in North or Middle America during the Mesozoic or throughout most of the Cenozoic. Considering all the above, it seems highly unlikely that Central America ever harbored a primary freshwater fish fauna till after the final (Pliocene) emergence of the Panamian isthmus.

The freshwater fish fauna of the Tortuguero area Miller (1966: 782) considered to belong to the San Juan faunal province, as defined by Regan (1906-08). This province encompasses lakes Managua and Nicaragua, their outlet the Río San Juan, and closely adjacent river systems to the south. Of the 42 species of primary and secondary freshwater fishes found there, 17 (2 Poeciliidae, 4 Characidae, and 11 Cichlidae) are endemic or nearly so, although only one endemic genus (the monotypic cichlid *Herotilapia multispinosa*) apprently is present. In addition one species each of the peripheral freshwater families Clupeidae and Atherinidae appears to be so restricted.

Of the 19 endemic fish species occurring in the San Juan faunal province, only 6 (the cichlids *Cichlasoma centrarchus, C. citrinellum, C. dowi, C. rostratum* and *Herotilapia multispinosa;* and the characid *Hyphessobrycon tortuguerae)* were taken at Tortuguero. Although further collecting undoubtedly will increase this list, the comparatively small percentage of provincial endemics found there indicates that the freshwater fishes of Tortuguero constitute a somewhat diluted outpost of the main

San Juan fauna. The presence of certain other species, which apparently do not range north to the Great Lakes-San Juan drainage (e.g., the cichlids *Cichlasoma alfaroi* and *C. spilotum*, the poeciliid *Brachyrhaphis parismina*, and the pimelodid *Rhamdia wagneri*), suggests that the Tortuguero area might best be considered a region of transition between the San Juan and Isthmian provinces (Miller, 1966: 778).

The marine fishes found at Tortuguero belong almost entirely to the southern Continental fauna, as defined by Robins (in press) and Gilbert (in press). This fauna occurs along the South and Central American coasts northward to the tip of Yucatan, where an abrupt transition occurs between it and the northern Continental fauna. The amount of overlap between these faunas is apparently small, although more inshore collections along the coasts of Nicaragua, Honduras, and the eastern Yucatán peninsula are needed to determine to just what degree this occurs. That some overlap does exist is shown by the presence at Tortuguero of the northern sciaenids *Menticirrhus americanus* and *M. littoralis*, and by the recent collection of a southern sciaenid (*Bairdiella sanctaeluciae*) on the southeast Florida coast (specimens in University of Florida and Cornell University collections).

No species belonging to the Insular fauna (see Robins (in press) and Gilbert (in press)) were taken at Tortuguero and probably none occurs there, inasmuch as the conditions these forms require (clear water and a stable environment) are absent. Yet it should be noted that a diluted Insular fauna does occur in the Limón area, about 50 miles to the south (Caldwell, 1963).

Description And Characteristics Of The Tortuguero Area

Tortuguero is a small sawmill and turtle-fishing village approximately 52 miles (84 km) northwest of Puerto Limón and 17 miles (27 km) southeast of Barra de Colorado, on the Caribbean coast of Costa Rica (Carr and Giovannoli, 1957). The village is on a barrier island separated from the mainland by the brackish Lagunas del Tortuguero (Fig. 1), formed by the confluence of three streams: Río Suerte (Caño Palacio), Río Tortuguero, and Río Sierpe. Río Suerte has three main tributaries, Desenredo, Penitencia, and Palacio, and Río Tortuguero has two, Río Agua Fría and Caño Chiquera. Lagunas del Tortuguero extends along the coast south of Tortuguero for several miles, and connects with Río Reventazón via the Caño Negro. The Suerte-Tortuguero-Sierpe watershed extends inland for about 25 miles (40 km), and is separated from the drainage of the foothills of the Cordillera Central by Río Toro Amarillo, a tributary of Río San Juan. The watershed is bounded on the north by tributaries of Río Colorado and on the south by tributaries of Río Reventazón. Almost the entire area is swamp and rain forest, with many interlacing distributaries connecting the various streams. The main channel of Río Reventazón enters the ocean at Parismina, 21 miles (34 km) southeast of Tortuguero. Río Suerte is connected to Río Colorado by Caño Palmas and Laguna Simón, which parallels the coast north of Tortuguero. The main channel of Río Colorado enters the ocean at Barra de Colorado. No direct confluence of the Colorado system exists with Río San Juan, the major river in this part of Central America, although temporary connections may exist during periods of high water.

In the lower part of the Suerte-Tortuguero-Sierpe system the rain runoff water

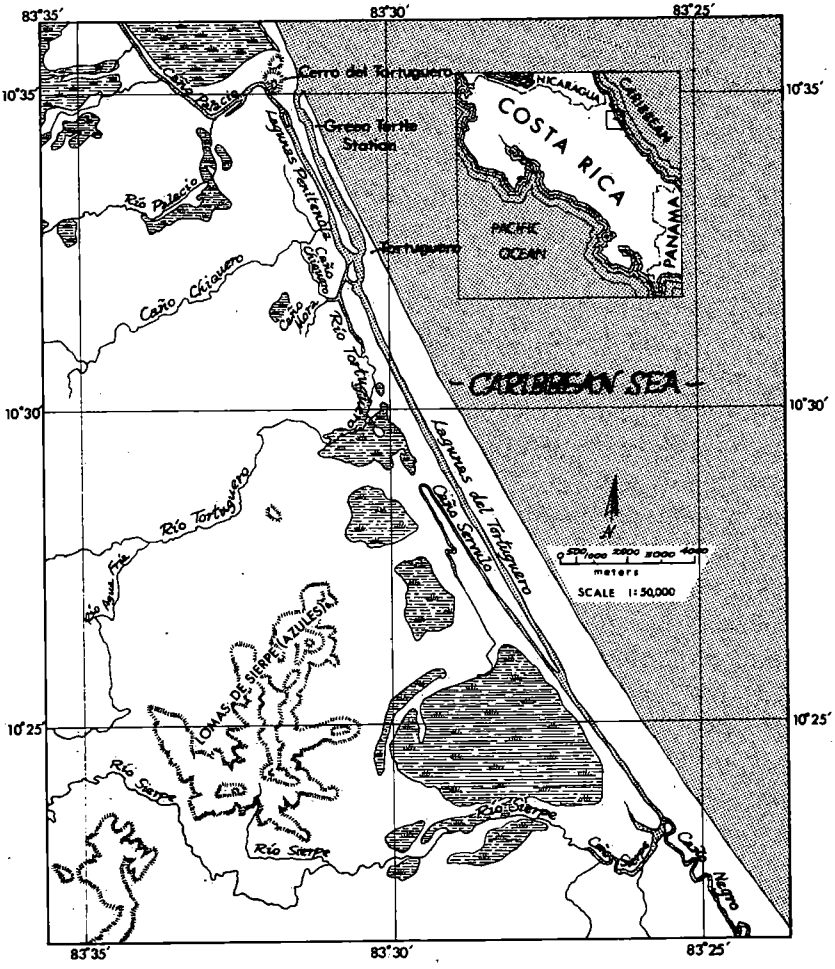

FIGURE 1. Drainage map of Tortuguero area. Two streams from which collections were made, Deadwater and Benjamin Creek, are not shown. The former is a backwater of Caño Mora and is located a short distance above the junction of that stream with Caño Chiquero. Benjamin Creek flows into Río Tortuguero from the west and is located just south of Deadwater.

collects first in shallow, mud-bottom pools. These are fairly clear and quiet and, because they are heavily shaded by palms or hardwoods, are devoid of aquatic plants. They drain into deep flood-channels, which are more turbid, but are likewise still and without vegetation, with the bottom ranging from solid to soft mud, sand and sticks. From these the water moves into narrow, deep, swift-flowing streams, such as Río Tortuguero and Río Palacio. Along the woodland streams patches of rooted aquatic grasses and water hyacinths (*Eichhornia crassipes*) sometimes completely cover the

surface. To what extent the drainage has been modified by logging is not known, although logs 3 to 4 feet in diameter are floated down the streams during timbering operations, and the loggers keep the waterways fairly clear of obstructions at these times.

Lagunas Penitencia, Lagunas del Tortuguero, and Río Tortuguero join slightly over a quarter of a mile inland near Tortuguero village. From here the estuary extends northward parallel to the coast for 3 miles, then turns sharply and enters the ocean. The estuary is from 400 to 1200 feet wide and width of the peninsula separating the estuarine basin from the ocean varies from 300 to 1000 feet.

The coast, which extends generally north-northwestward and south-southeastward in a broad concave arc, is one of the last two major nesting sites in the western Atlantic for the Green turtle, *Chelonia mydas*. The beach of black volcanic-sand is completely open, without offshore bars or coral reefs. Topographically the area is generally a flat coastal plain, with a few low hills 4 miles inland from the coast south of the estuary and with one lone prominence, Cerro Tortuguero, rising close to the beach at the northwest side of the estuarine pass. The foothills of the Cordillera Central begin 30 to 40 miles inland.

The yearly climatic cycle of the region has two dry and two wet seasons (Hirth, 1963). September through November and February through June are dry; July-August and December-January are rainy, but as Hirth points out, no month has less than 50 mm of rain. Portig (1965) placed Tortuguero in a higher rainfall class than Hirth's data indicate. Hirth measured 3882.5 mm from June 1960 through May 1961, whereas Portig estimated 5000-6000 mm as the average annual rainfall. Inland in the Tortuguero watershed area, lower rainfalls (4000-5000 mm) can be expected. The watershed is unaffected by rainfall in the mountains. The summer rainy season appears to begin earlier in the inland watershed area; when the junior author was at Tortuguero in late April 1964, the rains had already started, whereas on the coast it was still dry.

The Atlantic coast of Costa Rica was generally classed a "hot zone" by Sapper (1932). This zone is characterized by an annual mean temperature of 23-26°C.

The Tismiche

An important phenomenon in Tortuguero estuary is the arrival of the *tismiche*, a diverse assemblage of post-larval fishes and crustaceans that appear in the lagoon at intervals not yet determined. The name *tismiche* was suggested by Sr. Dilio Fuentes, Director of the Estación de Biología Pesquera of Campeche, México, who saw the phenomenon at Tortuguero in October 1964, and was struck by its similarity to mixed larval aggregations that occur regularly in the basin of the Río Papaloápam, Veracruz, México. The name is evidently of Indian origin, suggesting that the phenomenon is of regular occurrence in that region. According to Sr. Fuentes, *tismiches* occur in Veracruz twice a year, usually in May and December, at which time the local inhabitants exploit them for food. They appear to consist of several species of shrimp and fishes, some of which are probably the same as those found at Tortuguero. Similar assemblages are called *seti* in Puerto Rico where they consist primarily of larval gobiids (mostly of the genus *Sicydium*) and are caught commercially.

Tismiches are not restricted to the New World tropics. Herre (1927: 15-19)

discusses a similar phenomenon in the Philippines, in which the fry of various gobies and eleotrids (six species predominantly) that have hatched in the sea move into the estuaries and streams. The natives call these fry *ipon*; and they form the basis for an important commercial fishery at certain times of the year. Herre says nothing about invertebrates in these schools, although some presumably are present. *Ipon* migrations occur between October and March, and, though of general occurrence throughout the islands, seem to be particularly common along the north and northwest coasts of Luzon. They are commonest for about 3 days after the full moon each month, when tides are highest.

Although *tismiches* have been seen off and on since work began at the Tortuguero turtle camp in 1955 and are well known to local fishermen, their polyspecific character was not realized until recently. Because all larval aggregations at Tortuguero are not of mixed composition, it has been impossible to determine the seasonality of the event from old records or from conversations with fishermen.

Large concentrations of larval to post-larval shrimp were seen near the inlet by Larry Ogren on 3 September 1958 and by the junior author at the tagging camp on 21 August 1963. Individuals from the 1963 *tismiche* were about 10 mm in length and were identified as a species of the palaemonid shrimp genus *Macrobrachium*. The latter concentration was observed for the next 9 days, during which time the shrimp exhibited a definite pattern of activity, resting by day on the bottom along shaded sections of the bank, and at night swimming in the upper half of the water column close to shore. The onset of a strong tidal current would cause the shrimp to disappear, only to return the following night. The stomach of a *Centropomus pectinatus*, taken at the camp on 31 August 1963, was packed with these shrimp and nothing else.

Other aggregations of young shrimp, seen on 4 May and 19 July 1964 at the tagging camp, consisted mostly of atyid shrimp (genera *Jonga, Potimirim,* and *Micratya*) about 5 mm long, with many 10 mm *Macrobrachium* also present. On 7 August 1964 collections were made from a *tismiche* near the inlet. In addition to the above shrimp, which formed the bulk of the collection, many crab megalops (ca. 2 mm across the carapace) and post-larval fishes were also present, including small numbers of *Microdesmus carri* (Microdesmidae) and *Awaous tajasica* (Gobiidae), and larger numbers of *Gobionellus fasciatus* (Gobiidae) and *Eleotris* sp. (probably both *E. amblyopsis* and *E. pisonis*) (Eleotridae). Very likely other species of fish were also present, though in smaller numbers. In addition, many small (67-85 mm) pipefish *(Oostethus lineatus)* were scattered throughout the concentration. These were swimming upstream against the current, the only indication of orientation by any component of the *tismiche*. Many fish-eating bats (*Noctilio*) were seen fishing at the surface. Large numbers of adult mullet (genus *Mugil*) were also present, although their stomachs proved to be empty when examined, but the stomachs of four large *Pomadasys crocro* were packed with small shrimp and fish. This *tismiche* was observed both at the inlet and the turtle camp for nearly 3 weeks (till 26 August), during which time it fluctuated considerably in abundance. Much larger concentrations of fishes and crab megalops were seen at the pass than at the turtle camp, and on the eight nights collections were made at the camp only five fishes and no crabs were taken.

Obviously more study is needed to determine what correlation, if any, exists

between the *tismiche* and various environmental phenomena (such as lunar or tidal changes), and whether the appearance of the *tismiche* follows a predictable pattern.

Discussion Of The Tortuguero Fish Fauna

Of the 111 fish species collected at Tortuguero, 80 were taken at least once in fresh, or nearly fresh water. Of these, 56 species (in 25 families) may be classed as peripheral, of which 9 (*Citharichthys uhleri, Coleotropis blackburni, Oligoplites palometa, Larimus breviceps, Menticirrhus americanus, Bathygobius soporator, Gobionellus pseudofasciatus, Echeneis naucrates,* and *Microdesmus carri*) are additions to Miller's (1966) checklist. Eighteen species, belonging to 4 families (22.5%), are secondary freshwater fishes, and only 6 species (3 families) are primary freshwater fishes. The percentage of fishes belonging to the last group (7.5%) is thus considerably less than the percentage (22.8%) of primary species Miller lists for Central America as a whole, although the latter figure includes a large number of South American species not recorded beyond eastern Panama.

The 111 species represents an increase of 56 over the number Caldwell, Ogren, and Giovannoli (1959) recorded from Tortuguero. As one of the species reported in the 1959 paper (*Centropomus ensiferus*) was misidentified, this number should really be 57, but the increase actually should only be 54, for three species reported as new in the present paper (*Strongylura timucu, Centropomus undecimalis,* and *Gobionellus boleosoma*) were present in the 1955-1959 collections, but were not distinguished from *S. marina, C. parallelus, and G. fasciatus*, respectively.

In addition to the above, the 1959 record of *Anchoa lamprotaenia* merits comment.

Table 1. Proposed Nomenclatural Changes

Caldwell, Ogren, & Giovannoli, 1959	Present paper	Reference or source
Subspecies name deleted:		
Harengula p. caribbaea	*H. pensacolae*	Rivas, 1963
Subspecies name added:		
Phallichthys pittieri	*P. amates pittieri*	Rosen & Bailey, 1959
Hyporhamphus roberti	*H. r. hildebrandi*	B. B. Collette, *pers. comm.*
Specific name changes:		
Gobionellus claytonii	*G. fasciatus* (Tortuguero material only)	Robins & Lachner, 1966
Trinectes maculatus fasciatus	*T. paulistanus* (Tortuguero material only)	G. C. Miller (*fide* C. L. Hubbs), *pers. comm.*
Generic name changes:		
Thryinops chagresi	*Melaniris chagresi*	Miller, 1966
Garmannia spes	*Gobiosoma spes*	Böhlke & Robins, 1968
Generic and specific name changes:		
Molliensia sphenops	*Poecilia mexicana* (Tortuguero material only)	Miller, 1966; and *in litt.*
Microeleotris mindii	*Leptophilypnis fluviatilis*	Miller, 1966

Table 1. *Continued*

Generic name changes and/or specific name additions:		
Carcharhinus sp.	*Carcharhinus leucas*	Specimens examined by authors
Anchoviella sp.	*Cetengraulis edentulus*	Specimen reexamined by Gilbert
Coleotropis sp.	*Coleotropis blackburni*	Gilbert & Caldwell, 1967
Eugerres sp.	*Diapterus plumieri*	Miller, 1966; specimens examined by authors
Dactylagnus sp.	*Dactylagnus peratikos*	Böhlke & Caldwell, 1961
Species to be deleted from list:		
Centropomus ensiferus	*C. parallelus*	Specimen reexamined by Gilbert
Complexes of species:		
Strongylura marina	*S. marina* and *S. timucu*	Collette, 1968
Centropomus parallelus	*C. parallelus* and *C. undecimalis*	Specimens reexamined by Gilbert
Gobionellus claytonii	*G. fasciatus* (see above) and *G. boleosoma*	Specimens reexamined by Gilbert

The senior author reexamined the 290 specimens on which this record was based, and Robert R. Miller a lesser number; all proved to be *Anchoviella elongata*. As a few (10) specimens of *Anchoa lamprotaenia* were collected in 1962 and 1963, Caldwell, Ogren, and Giovannoli's (1959) record for this species is valid, though based on misidentified material. The present paper includes, in addition to the new species resulting from recent collections, a number of name changes, both at the genus and species levels. Some of these are of a nomenclatural nature, whereas others are taxonomic. These are listed in Table 1.

Table 2 is intended to show the general ecological distribution of fishes around Tortuguero by listing the actual number of specimens collected from each of the six major habitats (ocean, offshore; ocean beach; estuary, west side; estuary, east side; estuary, center; streams). While habitat preference might be indicated better by listing the species as rare, common or abundant in each, only for the shore areas of the lagoon are sufficient collections available to provide a reasonably objective idea of relative abundance. Obviously the abundance of a particular stream species cannot be determined accurately from a dozen widely scattered collections, most of which were made in quiet sidewaters during periods of high water at one season of the year.

Another problem arises regarding the distinction between collections made during the wet and dry seasons. Increased penetrance of salt water into the estuary during the wet season allows certain marine species to move into the estuary that otherwise would be unable to do so. Because the number of dry-season collections are too few to permit accurate comparison, both Table 2 and the following discussion are based solely on material taken during the wet season.

The table also does not take into account 1) size of the specimens tabulated;

2) differences in numbers of collections made from the different habitats; 3) different collecting methods (which vary in effectiveness for different species); 4) unusually large concentrations of specimens in one collection (e.g., *Pomadasys crocro* and *Microdesmus carri*); or 5) that many specimens of the larger and commoner species such as *Cichlasoma friedrichsthali, C. maculicauda,* and *Sphoeroides testudineus* were discarded in the field.

Despite these shortcomings the table does provide some useful information, particularly with regard to differences in species composition between the ocean and estuary, and between the estuary and tributary streams. For example, the atherinids *Coleotropis blackburni* and *Melaniris chagresi* were collected together only once, although they occur commonly within 100 feet of one another at the mouth of the lagoon (*Coleotropis* on the ocean side, *Melaniris* on the estuary side). The pomadasyids *Conodon nobilis* and *Pomadasys corvinaeformis* were never encountered in the estuary, whereas *P. crocro* was found in the ocean, the lagoon, and also in the tributary streams. The sciaenids *Bairdiella ronchus* and *Micropogon furnieri* were found only in fresh and/or brackish water, whereas all other sciaenids were taken only in the ocean, with the exception of one specimen of *Larimus breviceps* gill-netted in the estuary. Differences in salinity tolerance offer one explanation for the above, although undoubtedly other factors are also involved. Certainly the fact that such species as *Citharichthys spilopterus, C. uhleri, Achirus lineatus, Trinectes paulistanus* and *Sphoeroides testudineus* were found only in the lagoon has no relationship to their ability to live in salt water. Much more needs to be known regarding the ecology of these species before such problems can be answered.

TABLE 2. NUMBER OF SPECIMENS FROM THE SIX MAJOR HABITATS, TAKEN IN TORTUGUERO WET-SEASON COLLECTIONS

	OO	OB	EW	EE	EC	S
1. *Carcharhinus leucas*					6	
2. *Carcharhinus limbatus*	1					
3. *Himantura schmardae*			1			
4. *Lepisosteus tropicus*						1
5. *Elops saurus*					6	
6. *Megalops atlantica*					5	
7. *Chirocentrodon bleekerianus*	1					
8. *Harengula pensacolae*		19				
9. *Odontognathus compressus*	67					
10. *Opisthonema oglinum*		14				
11. *Pellona harroweri*	13					
12. *Sardinella anchovia*		9				
13. *Anchoa lamprotaenia*		2	1			
14. *Anchoviella elongata*		1	345	2		39
15. *Cetengraulis edentulus*		1				
16. *Synbranchus marmoratus*						2
17. *Anguilla rostrata*	—	—	—	—	—	—
18. *Myrophis punctatus*			178			
19. *Astyanax fasciatus*			32	59		164
20. *Brycon guatemalensis*			1			41
21. *Hyphessobrycon tortuguerae*				7		11

Table 2. *Continued*

	OO	OB	EW	EE	EC	S
22. *Roeboides guatemalensis*						56
23. *Gymnotus cylindricus*						3
24. *Arius melanopus*					1	
25. *Bagre filamentosus*				1	5	
26. *Rhamdia wagneri*						7
27. *Alfaro cultratus*						165
28. *Belonesox belizanus*			7	1		15
29. *Brachyrhaphis parismina*						17
30. *Phallichthys amates pittieri*			1	6		35
31. *Poecilia mexicana*			23	136		5
32. *Strongylura marina*			2			
33. *Strongylura timucu*		4	26	3		
34. *Hyporhamphus roberti hildebrandi*		5	18			
35. *Citharichthys spilopterus*			46	8		26
36. *Citharichthys uhleri*			5		1	13
37. *Achirus lineatus*			42	1		
38. *Trinectes paulistanus*			9	2		4
39. *Symphurus plagusia*	1					
40. *Oostethus lineatus*			5	9	20	9
41. *Pseudophallus mindii*			4			2
42. *Coleotropis blackburni*		154	2			
43. *Melaniris chagresi*			125	147		12
44. *Agonostomus monticola*				2		7
45. *Mugil curema*		34		8		
46. *Polydactylus virginicus*	93	80				
47. *Sphyraena guachancho*	3					
48. *Scomberomorus maculatus*	1					
49. *Caranx hippos*		1	7	5	2	
50. *Caranx latus*			5	6		
51. *Chloroscombrus chrysurus*	—	—	—	—	—	—
52. *Oligoplites palometa*		32	8	1	3	
53. *Trachinotus carolinus*		2				
54. *Trachinotus goodei*		7				
55. *Vomer setapinnis*	9					
56. *Centropomus parallelus*			10	4		4
57. *Centropomus pectinatus*			41	16	6	3
58. *Centropomus undecimalis*			9		2	
59. *Epinephelus* (?) sp.					1	
60. *Lutjanus griseus*			7			
61. *Lutjanus jocu*			30	5		
62. *Conodon nobilis*	10	6				
63. *Pomadasys corvinaeformis*	4	39				
64. *Pomadasys crocro*		51	30	2689		3
65. *Diapterus olisthostomus*			2	2		
66. *Diapterus plumieri*			3		1	1
67. *Diapterus rhombeus*			12	20		
68. *Eucinostomus argenteus*				1		
69. *Eucinostomus pseudogula*		15	98	16		6

Table 2. *Continued*

	OO	OB	EW	EE	EC	S
70. *Bairdiella ronchus*			20		14	3
71. *Bairdiella sanctaeluciae*	1					
72. *Cynoscion jamaicensis*	1					
73. *Larimus breviceps*	242	34			1	
74. *Menticirrhus americanus*			1			
75. *Menticirrhus littoralis*		5				
76. *Micropogon furnieri*					7	
77. *Ophioscion costaricensis*		2				
78. *Ophioscion panamensis*	14					
79. *Stellifer colonensis*	12					
80. *Umbrina broussoneti*	6	1				
81. *Cichlasoma alfaroi*						14
82. *Cichlasoma centrarchus*			6	20		11
83. *Cichlasoma citrinellum*			120	30		15
84. *Cichlasoma dowi*						32
85. *Cichlasoma friedrichsthali*			24	36		105
86. *Cichlasoma maculicauda*			251	9		26
87. *Cichlasoma nigrofasciatum*		1				70
88. *Cichlasoma rostratum*						16
89. *Cichlasoma spilotum*						3
90. *Cichlasoma* cf *spilurum*						3
91. *Herotilapia multispinosa*				2		
92. *Dormitator maculatus*				35		4
93. *Eleotris amblyopsis*			116	74	many	70
94. *Eleotris pisonis*			1	2	many	7
95. *Gobiomorus dormitor*			11	18		12
96. *Leptophilypnus fluviatilis*			2	4		
97. *Awaous tajasica*					7	2
98. *Bathygobius soporator*			13	2		1
99. *Evorthodus lyricus*			11	1		1
100. *Gobionellus boleosoma*			16	1		15
101. *Gobionellus fasciatus*			55	23	many	61
102. *Gobionellus pseudofasciatus*			6			4
103. *Gobiosoma spes*			216	9		3
104. *Echeneis naucrates*				1	8	
105. *Dactylagnus peratikos*		7				
106. *Microdesmus carri*			3		34	
107. *Batrachoides gilberti*			1			
108. *Batrachoides surinamensis*					1	
109. *Porichthys pauciradiatus*		1				
110. *Porichthys plectrodon*		1				
111. *Sphoeroides testudineus*			81	17		2

The six habitats are: Ocean, offshore (OO); Ocean beach (OB); estuary, west side (EW); estuary, east side (EE); estuary, center (EC); streams (S).
Two species (*Anguilla rostrata and Chloroscombrus chrysurus*) were not collected during the wet season, but are included for the sake of completeness.

Table 2 also shows that not all species were collected in equal numbers on both sides of the estuary. For example the predominance of shallow, open mud-sand flats

on the west side apparently offers a more favorable habitat for a burrowing species such as *Myrophis punctatus*; this is reflected by the fact that all 199 specimens of this species were taken there, although it probably occurs along the east shore in the relatively few places where open flats exist. A comparison of the relative numbers of the cichlids *Cichlasoma centrarchus, C. citrinellum, and C. maculicauda* taken on the two sides shows that most individuals of the first species were collected along the east bank, whereas the other two were encountered in much greater numbers on the opposite shore. This appears to be related to a preference by *C. centrarchus* for heavy submergent vegetation (not including filamentous algae), such as one finds along much of the east bank, as opposed to a preference by *C. citrinellum* and *C. maculicauda* for more open situations. *Gobiosoma spes* was encountered in greatest numbers where heavy growths of filamentous algae were present; the number of specimens of this species collected along the west shore, where algae was very abundant in certain places, outnumbered those taken elsewhere by over 20 to 1. All but two specimens of *Dormitator maculatus* collected in the estuary were taken on the east side. This species was found exclusively among water hyacinth roots, and the differential collecting success is related to the much heavier concentrations of hyacinths along the east shore.

A number of species found in the tributary streams were never taken in the estuary, and other more or less common stream inhabitants were collected in the estuary only once or twice. Although a substantial percentage of the total specimens (7 (the types) out of 25) of *Hyphessobrycon tortuguerae* and the only two individuals of *Herotilapia multispinosa* taken during this study were found in the estuary (in 1955 and 1956 respectively), both are probably stream inhabitants, as evidenced by their absence from the many subsequent estuarine collections. These and other species occasionally appearing in the lagoon probably are carried down, in most cases, under floating mats of water hyacinths. The only specimen of *Cichlasoma nigrofasciatum* taken in the lagoon was found under such a mat.

Of the four species of characins collected during this study, one (*Astyanax fasciatus*) appears to be more or less ubiquitous, a second (*Hyphessobrycon tortuguerae*) is thought to be basically a stream inhabitant (see above), and the other two (*Brycon guatemalensis* and *Roeboides guatemalensis*) obviously prefer a stream environment. The various cichlid species collected only in streams were nearly always found in sidewaters where current was completely lacking. On the basis of this admittedly incomplete evidence, it appears that some other factor, or factors, are involved in the distribution of the various cichlid species. Of the cichlids found at Tortuguero, two (*C. citrinellum* and *C. maculicauda*) were more common in the estuary, six (*C. alfaroi, C. dowi, C. nigrofasciatum, C. rostratum, C. spilotum,* and *C. cf spilurum*) were taken only in streams (with the exception of the one specimen of *C. nigrofasciatum* mentioned earlier), and two (*C. centrarchus* and *C. friedrichsthali*) were equally common in both areas. The ecological status of *Herotilapia multispinosa* has been discussed previously.

Finally, of the five species of Poeciliidae encountered during this study, *Poecilia mexicana* was found much more commonly in the estuary, whereas the other four were either taken exclusively in the tributaries (*Alfaro cultratus* and *Brachyrhaphis parismina*) or were much more common there (*Belonesox belizanus* and *Phallichthys amates pittieri*).

ANNOTATED LIST OF SPECIES[1]

Family CARCHARHINIDAE

1. *Carcharhinus leucas* (Valenciennes). Bull shark. (III)
Stations 2, 3, 5A, 5B (teeth only saved).

The bull shark is common in Tortuguero lagoon. Many have been caught in the area, mostly by hook and line, a few in gill nets. The 13 individuals (6 females and 7 males) collected in 1963-1964 ranged from 1016 to 1930 mm total length, and weighed from 42 to 110 pounds.

Age-length data given by Clark and von Schmidt (1965) indicate the above specimens are all of subadult size, but as Springer (1960: 27) notes, the average size of adult *C. leucas* from Trinidad is appreciably less than for adults from the Gulf of Mexico. Inasmuch as the pelvic claspers on male *C. leucas* taken in Tortuguero lagoon were well developed, it appears likely that the Tortuguero and Trinidad individuals belong to the same population.

The stomachs of several bull sharks from Tortuguero contained crabs (*Callinectes bocourti*); numerous fishes of various sizes, including one 350 mm *Centropomus* sp. (probably *undecimalis*); bird remains; a small trunkback turtle (*Dermochelys*); and the remains of a butchered Hawksbill turtle (*Eretmochelys*).

Local residents occasionally remove and dry the fins of *C. leucas*, and then sell them for soup ingredients.

It is not known how far this shark moves up the tributaries in the Tortuguero area, although judging from the distances the species travels up the neighboring Río San Juan (Thorson, 1966) it probably is considerable. Its ability to migrate upstream is probably limited more by its size than by its physiology.

2. *Carcharhinus limbatus* (Valenciennes). Blacktip shark. (*)
Station 16 (1, 867); new record.

The above specimen, a subadult male, was caught by hook and line 23 August 1963, about a half-mile offshore in about 30 feet of water. This species is probably fairly common in the area, although it seldom, if ever, enters the lagoon.

Family DASYATIDAE

3. *Himantura schmardae* (Werner). (III)
Station 1 (1, 535); new record.

The specimen is an immature male, caught on the flats across from the village 25 August 1963 (field no. G 63-36). No other rays were seen or collected, although local residents say they sometimes are fairly common.

Family LEPISOSTEIDAE

4. *Lepisosteus tropicus* (Gill). Tropical gar; "alligator fish." (II)
Station 15 (1, 695); new record.

Several individuals were seen in Deadwater; the specimen was collected in September 1964. Deadwater, as the name implies, is a stagnant, darkly stained, weed-choked

[1] For explanation of symbols see page 4.

backwater, one of the few such places in the immediate vicinity of Tortuguero; it is the only place where *Lepisosteus* is definitely known to occur.

Family ELOPIDAE

5. *Elops saurus* Linnaeus. Ladyfish; "bone fish." (III)
   Station 3 (2, 365-430); new record.

A number of specimens were caught by hook and line at the inlet during July and August of 1963-64, and two other individuals (432-508 mm) were taken at the tagging camp in early May 1964, during the dry season. The stomachs of the last two specimens contained six 15-25 mm crabs, three 25-mm river shrimp, and four small clupeiform fishes. The 508-mm specimen contained an undetermined number of eggs in its ovaries, averaging about 0.75 mm in diameter.

6. *Megalops atlantica* Valenciennes. Tarpon; "sabalo." (III)
   Station 3 (1 skeleton saved); new record.

Only mature tarpon were caught in Tortuguero lagoon, ranging in length from about 1000 to 1300 mm and in weight from 30 to 46 pounds. All specimens examined were males, and all of the seven caught during the summer of 1964 were ripe. The stomachs of the latter individuals were examined, but all were empty. The apparent absence of young stages of tarpon at Tortuguero may perhaps be related to the lack of small brackish and freshwater ponds, which elsewhere have been found to be a favored habitat of the young (Wade, 1962: 591).

Some workers (Greenwood, 1970) place this species in a separate genus, *Tarpon*.

Family CHIROCENTRIDAE

7. *Chirocentrodon bleekerianus* (Poey). (*)
   Station 16 (1, 41.5); new record.

Family CLUPEIDAE

8. *Harengula pensacolae* Goode and Bean. Scaled sardine; "sprat." (*)
   Stations 4A (14, 69-102), 18 (3, 95-100), 27 (2, 79-94.5).
9. *Odontognathus compressus* Meek and Hildebrand. (*)
   Station 16 (67, 48-65); new record.

This collection represents the northernmost record for this species along the Central American coast (Berry, 1964: 730).

10. *Opisthonema oglinum* (Lesueur). Atlantic thread herring. (*)
    Station 4A (14, 66-98).
    This species has not been collected at Tortuguero since 1955.
11. *Pellona harroweri* (Fowler). (*)
    Station 16 (13, 29-45); new record.

This represents the northernmost record for this species along the Central American coast (Berry, 1964: 729).

12. *Sardinella anchovia* Valenciennes. Spanish sardine. (*)
    Station 4A (9, 67-83).
    This species has not been collected at Tortuguero since 1955.

Family ENGRAULIDAE

13. *Anchoa lamprotaenia* Hildebrand. Longnose anchovy . (III)
Stations 1 (1, 41), 18 (2, 40-44).

In addition to the above, seven other individuals (34-37 mm) were collected in an unspecified area of the lagoon in August 1962. Gill-raker and anal-ray counts for three specimens were 16 + 19, 17 + 19, and 18 + 20; and 21, 22, and 22, respectively. As mentioned previously, all individuals identified by Caldwell, Ogren, and Giovannoli (1959) as this species have proved, upon reexamination, to be *Anchoviella elongata.*

14. *Anchoviella elongata* (Meek and Hildebrand). (III)
Stations 1 (345, 39-77), 2 (2, 58-65), 15 (6, 44-45), 18 (1, 49), 33 (43, 33-45); new record.

In addition to the various morphological and meristic characters by which this species can be distinguished from *Anchoa lamprotaenia,* it also apparently reaches a larger size.

15. *Cetengraulis edentulus* (Cuvier). (*)
Station 4A (1, 72.5).

Caldwell, Ogren, and Giovannoli (1959: 15) list this specimen as *Anchoviella* sp. Reexamination shows their gill-raker count (37 + 45 = 82) to be in error, the apparent result of breakage of the upper limb of the outer gill arch; the corrected count should be 49 + 45 = 94. This count, together with the number of dorsal and anal-fin rays (14 and 24, respectively), agrees closely with counts given by Hildebrand (1963: 245) for *Cetengraulis edentulus.* Identification of the Tortuguero specimen as this species is further confirmed by a careful comparison with Hildebrand's (1963: fig. 59) illustration and by other morphological features appearing in his diagnosis. The only apparent character of importance he does not mention are the sheaths of large scales covering the basal half to two-thirds of the anal fin and the lowermost part of the dorsal fin. The thin membrane connecting the gill covers across the isthmus (a key generic character) is torn, but can be seen by careful scrutiny.

A second specimen of this species, 88 mm SL, from Cayenne, French Guiana, has 47 + 51 = 98 gill rakers, 13 dorsal rays, and 25 anal rays. The gill membrane in this specimen also is no longer intact.

Family SYNBRANCHIDAE

16. *Synbranchus marmoratus* Bloch. (II)
Stations 8 (1, 150), 26 (1, 152), 31 (1, 265).

This is a burrowing species that has the ability to live for long periods of time in habitats of low oxygen concentration. In addition it sometimes moves overland (as does *Anguilla rostrata*) after rains. Carr and Giovannoli (1950) found individuals in Honduras several feet from water, both under rocks and buried in the mud. Sterba (1962: 839) reports the maximum total length of this species as 1500 mm.

Family ANGUILLIDAE

17. *Anguilla rostrata* (Lesueur). American eel. (III)
Station 25 (1, 460); new record.

Family OPHICHTHIDAE

18. *Myrophis punctatus* Lütken. Speckled worm eel. (III)
Stations 1 (178, 61-115), 25 (23, 67-160).

As mentioned previously, this species was taken only on the mud flats on the far (west) side of the estuary. It apparently does not grow as large at Tortuguero as it does elsewhere. Florida individuals are known to reach lengths of at least 285 mm.

Family CHARACIDAE

19. *Astyanax fasciatus aeneus* (Günther). (I)
Stations 1(32, 17-76), 2 (59, 21-78), 11A (1, 54.5), 11B (8, 23-31.5), 14 (9, 16.5-73), 19 (31, 18-100), 20 (20, 20.5-67.5), 21 (37, 18-79), 31 (39, 23-72.5), 33 (6, 22.5-35.5), 35 (13, 17-72).

This species was extremely common during the wet season in both the streams and estuary, but was not taken in the latter area during the dry season. Anal-ray counts recorded by Caldwell, Ogren, and Giovannoli (1959: 16) for 59 specimens are as follows: iv, 24 (3); iv, 25 (17); iv, 26 (16); iv, 27 (17); iv, 28 (3); iv, 29 (3). The following color notes are taken from the same paper: "the caudal, anal, and pelvic fins were brick red, with the upper and lower portions of the first and the leading edges of the latter two fins even brighter (and darker) than the rest of the fin. The dorsal and pectoral fins, while red, were much less intensely so. The dorsal portion of the body was metallic black, and the dark stripe on the caudal peduncle very conspicuous."

20. *Brycon guatemalensis* Regan. "Guapote." (I)
Stations 1 (1, 146), 11B (6, 30-37), 19 (1, 34.5), 20 (1, 23.5), 21 (20, 23-290), 31 (2, 26-38.5), 34 (6, 79-152), 35 (3, 89-225); new record.

This large characin is common above Cuatro Esquinas, and a few stray into the estuary during the wet season. A 146-mm specimen was seined on the flats across from the village, and a 390-mm, 2.2-pound individual was gill-netted at the tagging camp, both in August 1964; neither was saved. This species seems to prefer more rapidly-flowing water than any of the other species of Characidae found in the area.

21. *Hyphessobrycon tortuguerae* Böhlke. (I)
Stations 2 (7, 24-39), 14 (2, 21-22.5), 31 (9, 18-19).

Although the seven type specimens of this species were taken in the lagoon, the absence of subsequent material from there indicates that *H. tortuguerae* is basically a stream inhabitant. Since its original description, the known range of this species has been extended outside the Tortuguero area (Miller, 1966: 785; W. A. Bussing, *in litt.*).

22. *Roeboides guatemalensis* (Günther). (I)
Stations 11A (5, 20-74), 20 (6, 25-49), 21 (2, 61-83), 32 (38, 27.5-87.5), 33 (1, 33), 34 (2, 72.5-87), 35 (2, 66.5-70); new record.

This species was never found in the main channel of the streams, as was *Brycon guatemalensis*. It was the only characin never taken in the lagoon proper.

Family GYMNOTIDAE

23. *Gymnotus cylindricus* LaMonte. (I)
Stations 11A (1, 140), 32 (2, 238-240); new record.

Miller (1966:786) gives the range of *Gymnotus cylindricus* as "Atlantic slope from Río Motagua, Guatemala, to northwestern Honduras," and the range of *G. carapo?* as "Both slopes of Costa Rica and Nicaragua (Myers) and the Atlantic slope of extreme western Panama (Behre, 1928: 310); northern limit of range of this South American species very uncertain." Despite this, the Tortuguero specimens are identified as *G. cylindricus* on the basis of both morphological characters (see below) and the authority of Bussing (1967), who referred all his Costa Rican material to this species. In so doing, Bussing (1967: 221) said, "Dr. Robert M. (*sic*) Miller (*in litt.*) states that specimens of *Gymnotus* from the Atlantic slope of Costa Rica are definitely not *G. carapo*."

In the original description (LaMonte, 1935), *G. cylindricus* was said to differ from the closely related *G. carapo* in having a shorter head (9.4 (vs. 6.9) in body length), shorter snout (3.8 (vs 3.1) in head), deeper head (1.4 (vs. 1.9) in body depth), and three rows of teeth instead of one. No differences in body coloration were noted. Nevertheless, R. R. Miller informs me (Gilbert) that color pattern provides the best means for separating the two species, *carapo* being marked by oblique stripes and *cylindricus* having a uniformly dark coloration. Tortuguero specimens are uniformly pigmented. Proportional measurements for these individuals (140, 238, and 240 mm) are as follows (shortest to longest specimens, respectively): body length/head length 8.2, 8.8, and 9.6; head length/snout length 4.3, 4.4, and 3.8; body depth/head depth 1.2, 1.9, and 1.6. These ratios, on the whole, agree more closely with those given by LaMonte (1935) for *G. cylindricus* than for G. *carapo*. Only one row of teeth can be seen in both the upper and lower jaws of each specimen.

Family ARIIDAE

24. *Arius melanopus* (Günther). (III)

Station 3 (1, 173); new record.

The identifications of this and the next species are based solely on range statements given in Miller's (1966: 795) checklist. This specimen was collected by gill net on the night of 19-20 August 1963, and was the only one seen in Tortuguero lagoon.

25. *Bagre filamentosus* (Swainson). (III)

Stations 2 (1, 280), 3 (5, 218-360); new record.

Twenty-four additional specimens, ranging in length from 218 to 457 mm, and in weight from 0.5 to 4.6 pounds, were also collected in the estuary in 1963 and 1964, four of them during the dry season.

Of 19 stomachs examined, 11 contained food. The contents consisted mostly of small crabs, as well as river and burrowing shrimps, small fishes, vegetable matter, and some large tarpon scales. Darnell (1958) reports *Bagre marinus* to feed primarily on blue crabs and penaeid shrimp, although it also takes fishes and various invertebrates.

One 457-mm female collected 29 April 1964 contained well-developed ovaries, with eggs measuring from 1 to 17 mm in diameter. A 415-mm female, caught 29 July 1964, contained eggs up to 15 mm in diameter. McLane (1955) states that in the St. Johns River, Florida, *Bagre marinus* spawns in brackish water from July through September. Gunter (1945) says *B. marinus* in Texas breeds in early May and carries the eggs and young orally until July.

Family PIMELODIDAE

26. *Rhamdia wagneri* (Günther). (I)

Stations 31 (1, 41), 32 (3, 170.5-187), 35 (3, 30.5-66); new record.

The genus *Rhamdia* is badly in need of revision. Tortuguero specimens were identified with López-Sánchez' (1968) key as *R. wagneri* on the basis of the relatively long adipose fin (less than 4.3 times in standard length), deeply bifurcated caudal fin, long occipital process (measuring twice in distance from occipital base to dorsal origin), and long maxillary barbel (extending past origin of anal fin). R. M. Bailey (*pers. comm.*) informs me that this species may not be specifically distinct from *R. guatemalensis* (Günther).

Family POECILIIDAE

27. *Alfaro cultratus* (Regan). (II)

Stations 11B (2, 24-28), 14 (6, 21.5-49), 15 (2, 33-39), 17 (2, 15-27.5), 19 (89, 15.5-63.5), 20 (11, 14-52.5), 21 (3, 24-50), 31 (33, 24.5-60.5), 33 (11, 29.5-64), 35 (6, 20.5-48); new record.

All specimens were collected in quiet sidewaters of tributary streams. Most were taken in open water, and none were found in thick mats of vegetation. Females attained a maximum length of 63.5 mm, whereas males were no more that 46.5 mm; females outnumbered males by about five to one.

28. *Belonesox belizanus* Kner. Pike killifish. (II)

Stations 1 (7, 45-77.5), 2 (1, 32), 14 (2, 48-75.5), 17 (2, 45.5-64), 19 (4, 26-63), 20 (1, 98.5), 31 (2, 39.5-64), 34 (1, 99.5), 35 (3, 37.5-79).

According to R. R. Miller (*pers. comm.*), Sterba's (1962: 558) statement that females of this species reach a maximum total length of 200 mm is in error. The largest specimen present in the University of Michigan collection is about 140 mm, and females at least as small as 73 mm have been found with embryos.

29. *Brachyrhaphis parismina* (Meek). (II)

Stations 11B (5, 21-23.5), 19 (6, 13.5-22), 21 (1, 36), 31 (5, 15-42.5); new record.

All but three of the above specimens were females. The three males (one from station 11B and two from station 31) all measured between 18 and 20 mm. In general *Brachyrhaphis* seemed to prefer somewhat weedier situations than *Alfaro* wherever the two coexisted.

30. *Phallichthys amates pittieri* (Meek). (II)

Stations 1 (1, 34.5), 2 (6, 27-43), 12 (1, 28.5), 14 (3, 44.5-51), 19 (4, 17-45), 20 (3, 16.5-18), 31 (14, 14-48), 33 (8, 34-48), 35 (2, 24-26).

Several of the specimens collected in the lagoon came from under floating rafts of water hyacinths. Although all specimens from the tributaries were taken in quiet water, Meek (1914) gives the habitat of this species as small rocky streams, and Alfaro collected specimens at Tiribi and Descampos, Costa Rica, at altitudes of 1200 m. Apparently this species is able to live in a variety of habitats.

31. *Poecilia mexicana* Steindachner. (II)

Stations 1 (23, 21.5-82.5), 2 (136, 14-78), 19 (3, 27-45), 33 (1, 40), 35 (1, 46).

This is the only poeciliid that occurs regularly throughout the estuary, and in fact

it appears to be rather scarce in the tributary streams (only three collections (five specimens) coming from the latter). It was present in the lagoon during both seasons, 42 specimens (not listed above) being taken in one dry-season collection near the lagoon mouth. This fish is often seen foraging along the shore in company with *Sphoeroides testudineus*.

Caldwell, Ogren, and Giovannoli (1959) listed this species as *Mollienesia sphenops*, but R. R. Miller, who is studying mollies, has reidentified the Tortuguero material as *P. mexicana*. *Poecilia mexicana* and *P. sphenops* superficially are virtually identical, but differ consistently in the nature of the inner tooth rows; these teeth are unicuspid in *mexicana*, multicuspid in *sphenops* (Schultz and Miller, 1971).

Family BELONIDAE

32. *Strongylura marina* (Walbaum). Atlantic needlefish. (III)
Station 1 (2, 129-141).

Of the 14 specimens of this species Caldwell, Ogren, and Giovannoli (1959) list, only two are actually *S. marina;* the remainder are *S. timucu*. These two individuals were collected 11 July 1958 over the flats across from the village, together with seven *S. timucu*. All subsequent collections of needlefish from the Tortuguero area have proved to be *timucu*. Neither species was encountered in the tributary streams, although both probably occur there.

Studies by Darnell (1958) indicate that small fishes and shrimp form the bulk of the diet of *S. marina*.

33. *Strongylura timucu* (Walbaum). Timucu; "long guard." (III)
Stations 1 (26, 64-275), 2 (3, 168-204), 18 (4, 53-76); new record.

Although Berry and Rivas (1962) synonymized *Strongylura timucu* with *S. marina*, Collette (1968) has shown *timucu* to be a valid species, differing from *marina* in having 1) both left and right gonads developed instead of only the right one, and 2) fewer predorsal scales (120-185 vs. 213-304). In addition *timucu* typically is darker than *marina:* Melanophores usually extend to the ventral margin of the orbit in *timucu* but not past the middle of the orbit in *marina;* the preorbital bone is densely pigmented in *timucu* but only slightly so in *marina;* and melanophores are present along the lateral line in *timucu* but are usually absent in *marina*.

As indicated above, *timucu* is much the commoner of the two species at Tortuguero.

Family EXOCOETIDAE

34. *Hyporhamphus roberti hildebrandi* Jordan and Evermann. (III)
Stations 1 (18, 70-186), 13 (1, 38), 18 (4, 44-62), 25 (5, 114-119).

This species shows a distribution at Tortuguero similar to that of *Strongylura timucu*.

Family BOTHIDAE

35. *Citharichthys spilopterus* Günther. Bay whiff; "sandfish." (III)
Stations 1 (46, 135-95), 2 (8, 30-91), 11A (1, 76), 11B (2, 44.5-57), 19 (12, 36-39),

21 (3, 37.5-45), 22 (1, 64.5), 25 (19, 30-68.5), 28 (4, 46.5-63.5), 31 (6, 34.5-60.5), 35 (2, 62-103).

This flatfish was extremely common in the estuary and tributary streams during both wet and dry seasons. Reid (1955) found the food of *C. spilopterus* in Texas to consist primarily of copepods.

36. *Citharichthys uhleri* Jordan. (III)

Stations 1 (5, 11-33.5), 25 (4, 26.5-32.5), 29 (1, 12), 30 (1, 13), 31 (13, 14-30); new record.

Citharichthys uhleri has, in the past, frequently been confused with *C. spilopterus* (Erdman, 1967: unnumbered pl. 27), but may be distinguished from that species by a number of characters. Adult *uhleri* have numerous diffuse whitish blotches on the pigmented side of the body that are absent in *spilopterus*. Very small specimens of *uhleri* (ca. 20 mm or less) are characterized by 6 dark, broad, irregular, interrupted lines on the ocular side; 6 well defined, regularly-situated dark spots on both dorsal and ventral parts of the blind side, with a 7th spot situated on the mid-side between the posteriormost spots; and 5 dark spots on the middle of both the dorsal and anal fins; *spilopterus* specimens of comparable size lack such markings. Finally, the two species differ in both dorsal and anal-ray counts (Table 3).

TABLE 3. DORSAL AND ANAL FIN-RAY COUNTS IN *Citharichthys spilopterus* AND *C. uhleri*

Dorsal rays

	70	71	72	73	74	75	76	77	78	79	80	81	82	83	N	$\bar{x}$
C. spilopterus							4	7	7	9	5	2	—	1	35	78.4
C. uhleri	2	3	7	4	1										17	71.9

Anal rays

	50	51	52	53	54	55	56	57	58	59	60	61	62	N	$\bar{x}$
C. spilopterus								1	7	10	8	5	4	35	59.6
C. uhleri	2	5	6	2	1	1								17	51.9

The failure of workers to differentiate between *uhleri* and *spilopterus* probably accounts in large part for the presumed rarity of the former in collections ("known only from the type," according to Gutherz (1967: 35). *C. uhleri* is very close to, and perhaps not specifically distinct from *C. arenaceus,* which is also rare in collections. Should these two prove to be the same, the name *uhleri* would have priority.

C. uhleri is an addition to Miller's (1966) checklist of Central American freshwater fishes.

Family SOLEIDAE

37. *Achirus lineatus* (Linnaeus). Lined sole. (III)

Stations 1 (42, 12-56.5), 2 (1, 38.5), 25 (2, 38.5-88).

38. *Trinectes paulistanus* Miranda-Ribeiro. Southern hogchoker. (III)

Stations 1 (9, 17-27), 2 (2, 13-18), 19 (2, 43-53), 31 (2, 15.5-16).

This species appears to be less common than *Achirus lineatus* at Tortuguero. Based on present collections, as well as overall knowledge of their comparative

ecologies, *T. paulistanus* occurs in completely fresh water much more frequently than does *A. lineatus*. This species is found from southeastern Yucatán to Brazil, where it is the allopatric replacement of the more northern *T. maculatus*. *T. paulistanus* differs primarily from *maculatus* in usually having five instead of four pelvic rays on each side.

Family CYNOGLOSSIDAE

39. *Symphurus plagusia* (Bloch and Schneider). (*)
Station 16 (1, 79); new record.

Family SYNGNATHIDAE

40. *Oostethus lineatus* (Valenciennes). Opossum pipefish. (III)
Stations 1 (5, 48-119), 2 (9, 67.5-90), 11B (2, 127), 14 (1, 120), 15 (1, 109), 17 (1, 126), 19 (1, 166.5), 21 (2, 122-145), 25 (2, 110-130), 30 (20, 67-85, 33 (1, 130).

The authorship of this specific name has been questioned. Jordan and Evermann (1896: 773) credit it to Valenciennes, based on the listing by Kaup (1856: 59) in the original description of the species as "*Dorichthys lineatus* (Valenciennes MS)." Caldwell, Ogren, and Giovannoli (1959:18) followed this decision; others (Hubbs, 1929; Bailey *et al*, 1970: 23) attribute the species to Kaup. We follow Jordan and Evermann for reasons Gilbert (1964: 129-130) has previously discussed.

O. lineatus, which ranges from Panama through the Greater Antilles to South Carolina (Miller, 1966: 796), is more closely restricted to fresh and/or brackish water than most species of northern-ranging pipefish (i.e., those occurring north of the Yucatán Straits). Males with well-developed embryos were found both in Tortuguero estuary and well up the tributary streams, indicating that the young probably hatch in fresh water. However, the capture on the night of 7 August 1964 (sta. 30) of 20 small individuals swimming against the current at the mouth of the lagoon suggests that early development of the species may occur in the ocean. McLane (1955) found *O. lineatus* only in the lower reaches of the St. Johns River, Florida, and reported gravid females (males?) from there during the months of July and August.

Several small (65-80 mm) individuals of *O. lineatus* were found in the stomach of a 254-mm jack (*Caranx* sp.) that had been feeding on the mass of small fishes and invertebrates concentrated at the mouth of Tortuguero lagoon the night of 13 August 1964.

Caldwell, Ogren and Giovannoli (1959:18) report one specimen of this species from Tortuguero (UF 5833), collected in 1957, to have only 18 tail rings, whereas the other five individuals examined had 22 or 23. Subsequent counts on a total of 34 Tortuguero specimens, plus four other specimens from Florida and Cuba, are as follows: 22(8), 23(24), 24(6). Close examination of the single atypical specimen shows no obvious malformation, and no other morphological characters could be found to separate the two types. Additional material must be examined to clarify this situation.

41. *Pseudophallus mindii* (Meek and Hildebrand). (III)
Stations 1 (4, 62-91), 19 (1, 90), 21 (1, 96).

Family ATHERINIDAE

42. *Coleotropis blackburni* Schultz. (III)

Stations 1 (2, 48-66.5), 4A (1, 76), 12 (1, 68.5), 13 (23, 31-65), 18 (94, 19-94.5), 29 (35, 15.5-25).

All but two specimens of this species were taken in the surf in water not over 1 or 2 feet deep. It was encountered only once in the estuary, at a spot not far from the lagoon entrance. Two specimens were collected 13 August 1969 (during the wet season) together with six individuals of *Melaniris chagresi,* the only time these two species were found sympatrically.

Coleotropis colecanos, which Caldwell (1962) described from a single Tortuguero specimen, has recently been synonymized with the present species (Gilbert and Caldwell, 1967).

43. *Melaniris chagresi* (Meek and Hildebrand). (III)

Stations 1 (125, 28-109), 2 (147, 25-103), 15 (1, 19), 21 (3, 53-58), 22 (1, 80), 23 (1, 89.5), 28 (4, 48-62), 33 (2, 29-30.5), 35, (6, 46.5-64.5).

This is one of the commonest species in the estuary and was also collected several times in the tributary streams. One of the largest specimens, a female taken in late April 1964, contained eggs averaging 1 mm in diameter. Individuals were commonly seen swimming slowly at the surface along the shore both at night and during the day. Ogren saw fish-eating bats (*Noctilio*) preying on it (Caldwell, Ogren, and Giovannoli, 1959:23).

Family MUGILIDAE

44. *Agonostomus monticola* (Bancroft). Mountain mullet; "califavor." (III)

Stations 2 (2, 28-31), 21 (2, 45-60), 35 (5, 30.5-37.5); new record.

Adult *A. monticola* characteristically occur in mountain torrents. Only small individuals were found in Tortuguero lagoon, thus indicating that this species spawns in the ocean, with the young later moving into fresh water, where they stay until sexually mature. Anderson (1957) suggested a similar mode of reproduction, also based on indirect evidence. Although this seems likely, it is also possible that the species spawns in fresh water and the eggs are carried into the ocean, where they hatch.

45. *Mugil curema* Valenciennes. White mullet, "lisa." (III)

Stations 2 (8, 16-27), 18 (34, 22-36). 23 (4, 71-83), 25 (3, 23.5-95), 29 (1, 16).

This species is common in Tortuguero estuary throughout the year. Both young and adults were present, the largest specimen seen (but not saved) measuring 369 mm. One large female (length not recorded) caught in May contained well developed ovaries 150 × 20 mm. An unusually large number of mullet were seen at the pass during the *tismiche,* but the stomachs of the several specimens examined were empty. Darnell (1958) states that most *Mugil* species feed upon plankton, filamentous algae, diatoms, and other minute vegetable matter, or upon organic detritus and other such nutritive material as can be filtered from the bottom mud.

Family POLYNEMIDAE

46. *Polydactylus virginicus* (Linnaeus). "Barbu;" "gourd fish." (III)

Stations 4A (1, 45), 16 (93, 50-122.5), 18 (79, 46-76.5), 29 (3, 45.5-48).

In addition to the above, three specimens (145-159 mm SL) were caught in the estuary at the tagging camp in July 1963, a 178-mm female was taken at the camp in May 1964, and three specimens 120-230 mm SL were taken at the boca, also in May 1964. The 178-mm female contained tiny eggs. Stomachs of five of the large specimens were examined, of which three were empty and the other two contained a small unidentified fish and three small river shrimp. Reid (1955) found the food of *Polydactylus octonemus* in Texas to consist primarily of penaeid shrimps.

Family SPHYRAENIDAE

47. *Sphyraena guachancho* Cuvier. Guachanche. (*)

Station 16 (3, 56-62.5); new record.

Chuck Carr caught a 25-pound barracuda, possibly this species, in the lagoon on 23 April 1965.

Family SCOMBRIDAE

48. *Scomberomorus maculatus* (Mitchill). Spanish mackerel. (*)

Station 16 (none saved); new record.

One specimen was caught by hook and line in the ocean in August 1963. Many others were seen in the area.

Family CARANGIDAE

49. *Caranx hippos* (Linnaeus). Crevalle jack; "jurel." (III)

Stations 1 (7, 31-48), 2 (5, 255-310), 5B (2, 260-297), 18 (1, 39.5).

This species and the next are common in the estuary, where they seem to be concentrated near the mouth. The stomach of a large (590 mm SL; 9.6 pounds) individual contained some large fish vetebrae, sticks, and several large *Macrobrachium* shrimp. A 20-pound individual caught in the ocean in front of the tagging camp contained a 254-mm *Centropomus* sp. Previous studies (Darnell, 1958) list the food of *C. hippos* as mostly fishes and crabs, with some squid, shrimp, and other invertebrates.

50. *Caranx latus* Agassiz. Horse-eye jack; "jurel." (III)

Stations 1 (5, 43.5-51), 2 (6, 45-190), 25 (1, 110), 28 (2, 47.5-56.5), 29 (1, 94).

This was the only species of *Caranx* taken in the estuary during the wet season.

51. *Chloroscombrus chrysurus* (Linnaeus). Bumper. (III)

Station 24 (5, 170-191); new record.

The largest specimen contained eggs averaging 0.5 mm in diameter.

52. *Oligoplites palometa* (Cuvier). "Leathercoat." (III)

Stations 1 (8, 18-38.5), 2 (1, 27), 5B (3, 284-323), 18 (32, 15-29), 25 (1, 70).

Stomachs of seven specimens, ranging from 284 to 385 mm SL, were examined. Four of these were empty, one contained a large crab (probably *Callinectes*), another a 50-mm *Sphoeroides testudineus*, and the other nine small shrimp. Females caught in July 1964 contained eggs measuring from 0.5 to 1.0 mm in diameter.

O. palometa is an addition to Miller's (1966) checklist of Central American freshwater fishes.

53. *Trachinotus carolinus* (Linnaeus). Pompano. (*)
Station 18 (2, 75-92); new record.

54. *Trachinotus goodei* Jordan and Evermann. Palometa. (*)
Stations 18 (7, 73-144), 29 (1, 111); new record.
This species was called *Trachinotus glaucus* (Bloch) until recently.

55. *Vomer setapinnis* (Mitchill). Atlantic moonfish. (*)
Station 16 (9, 27.5-36); new record.

Family CENTROPOMIDAE

56. *Centropomus parallelus* Poey. Fat snook; "robalo."
Stations 1, (10, 65-104), 2 (4, 19-103), 25 (29, 41-69.5), 28 (1, 66.5), 31 (1, 60.5), 34 (1, 89).

Neither *C. parallelus* nor *C. undecimalis* seems to be quite so common at Tortuguero as *C. pectinatus*, although neither is rare. The young (up to 100 mm) of all three species occur over the estuarine flats (from July to September anyway), and they have been taken in the same collection at least once (field no. G 63-26); young of *parallelus* and *pectinatus* also have been collected well up the tributaries. In contrast to the above, adults of these species show distinct ecological preferences. Adult *pectinatus* were found throughout the estuary as well as in the streams, and many were taken with gill nets; the species seemed to become increasingly more common away from the inlet. Neither *parallelus* nor *undecimalis* were caught in gill nets, nor were large specimens seen or collected outside the boca area. Of the last two species, all positively identified individuals caught by hook and line were *undecimalis*, and as all other specimens so collected were substantially longer than the largest individual (580 mm) of *parallelus* recorded by Rivas (1962: 60), it is likely that these were *undecimalis* also.

Tagging studies on *undecimalis* in Florida (Volpe, 1959) indicate that the species is nonmigratory, and one may assume that this is true of other kinds of *Centropomus* as well. If so, however, it is surprising that no intermediate-sized individuals of any of the three species were seen at Tortuguero. Local Tortuguero residents say that large numbers of mature snook move into the pass at certain times, and Archie F. Carr (*pers. comm.*) observed such an "arrival" at the beginning of the dry season in September 1964. This was concurrent with the arrival of schools of clupeids upon which the snook were feeding. The specimen of *C. ensiferus* reported by Caldwell, Ogren, and Giovannoli (1959: 24) proves, upon reexamination, to be *C. parallelus*.

57. *Centropomus pectinatus* Poey. Tarpon snook; "big bone." (III)
Stations 1 (41, 21.5-100), 2 (16, 37.5-148), 3 (6, 240-390), 15 (2, adults; not saved), 17 (1, 93), 22 (1, 57.5), 25 (27, 38.5-78), 28 (1, 76).

Stomachs of 71 specimens gill-netted at night were examined, of which 36 contained food. This consisted (in order of abundance) of river shrimp, small fish (up to 80 mm SL), and crabs. Large numbers of parasites were found in the coeloms of most large specimens of *C. pectinatus*. Dr. G. W. Hunter, III, identified these as the larval stage of a tapeworm of the genus *Gymnorhynca*. An earlier stage lives in crustaceans, and the adults parasitize elasmobranchs. What appeared to be the same parasite was also found in *Bairdiella ronchus*.

58. *Centropomus undecimalis* (Bloch). Snook; "robalo." (III)
Stations 1 (9, 34.5-61), 3 (2, 385-485), 28 (5, 123.5-202.5); new record.

Caldwell, Ogren, and Giovannoli (1959) did not distinguish *undecimalis* from *parallelus* although they had both species in their collections. The two superficially are very similar, but are readily distinguished by the presence, in *undecimalis*, of fewer total gill rakers (12 or 13 vs. 16 to 18, excluding rudiments), and fewer scales in the first row above the lateral line (69 to 71 vs. 80 to 92) (above counts based on Tortuguero specimens only). In addition, *C. undecimalis* grows substantially larger.

Volpe (1959) says that Florida *undecimalis* spawn in saline passes during late spring and early summer, an observation confirmed by Marshall (1958), who adds that not all the eggs may ripen simultaneously. Females of *undecimalis* with well-developed ovaries containing eggs 0.5 mm in diameter were caught at Tortuguero on 19 July 1964, 8 August 1964, 12 August 1963, and 2 September 1963. Adult males and females taken in the estuary in September 1964 were all in breeding condition.

Family SERRANIDAE

59. *Epinephelus* (?) sp. (*)
New record.

A large grouper, 1340 mm SL and weighing 170 pounds, was caught at the pass on 31 July 1964. The specimen was tentatively identified by Kelso as *Epinephelus itajara* (Lichtenstein), but was not preserved and was not seen by the senior author.

The stomach contained several blue crabs *(Callinectes)*, measuring 100 mm across the carapace.

Family LUTJANIDAE

60. *Lutjanus griseus* (Linnaeus). Gray snapper. (III)
Station 1 (7, 26.5-119); new record.

61. *Lutjanus jocu* (Bloch and Schneider). Dog snapper. (III)
Stations 1 (30, 18-150), 2 (5, 18.5-138), 25 (1, 67.5).

In addition to the small specimens present in most rotenone collections, large individuals are commonly caught by hook and line in deeper water. Stomachs of three specimens (560-620 mm SL and weighing from 9.5 to 12.4 pounds) caught in July 1964 were examined, of which one was empty and two contained small crabs. Stomachs of five smaller specimens (140-210 mm SL) poisoned near the airstrip on 26 August 1964 contained many small *Macrobrachium*, one 25-mm river shrimp, and several different species of fishes *(Citharichthys spilopterus, Eucinostomus pseudogula, Strongylura timucu*, and small specimens of an unidentified goby). Mature ovaries containing eggs 0.5 mm in diameter were found in a 380-mm female collected 26 August 1964.

Family POMADASYIDAE

62. *Conodon nobilis* (Linnaeus). Barred grunt. (*)
Stations 16 (10, 55-143), 18 (6, 48.5-50.5), 29 (1, 58.5); new record.

63. *Pomadasys corvinaeformis* (Steindachner). (*)
Stations 16 (4, 48-76), 18 (39, 65-91); new record.

This species, unlike *P. crocro,* does not appear to enter brackish or fresh water around Tortuguero.

64. *Pomadasys crocro* (Cuvier). Burro grunt. (III)
Stations 1 (30, 32-50), 2 (2689, 13.5-154.5), 13 (50, 18-21.5), 18 (1, 19), 21 (3, 33-310), 25 (1, 54), 28 (2, 59-59.5), 31 (2, 7-12).

This is a very common species, both in the estuary and tributary streams. *P. crocro* appears to spawn from July to September in the Tortuguero area, probably in the estuary. Tremendous numbers of young encountered in the lagoon near the airfield on 15 August 1963 probably had hatched from 2 to 4 weeks previously. Four ripe females (275-380 mm SL) were collected between 17 and 26 August 1964 at the pass and at the tagging camp. Stomach contents of four large specimens collected at the pass 8 August 1964 included mostly post-larval shrimp, as well as some small fish and crabs.

Family GERREIDAE

65. *Diapterus olisthostomus* (Goode and Bean). Irish pompano. (III)
Stations 1 (2, 25-89), 2 (49-56), 28 (1, 54.5).

This and the following four species have previously been referred to the family Gerridae. Inasmuch as that family name is preoccupied in the class Insecta (order Coleoptera), emendation of the name to Gerreidae is necessary (Bailey and Moore, 1963).

66. *Diapterus plumieri* (Cuvier). Striped mojarra. (III)
Stations 1 (3, 210-265), 3 (1, not saved), 19 (1, 53).
Caldwell, Ogren, and Giovannoli (1959: 25) list this species as *Eugerres* sp.

67. *Diapterus rhombeus* (Cuvier). (III)
Stations 1 (12, 38-60), 2 (20, 29-62).

68. *Eucinostomus argenteus* Baird and Girard. Spotfin mojarra. (III)
Station 2 (1, 56): new record.

The only specimen was collected in the estuary near the airstrip 15 July 1962. *E. argenteus* lacks the large black blotch found at the tip of the dorsal fin in *E. pseudogula,* and has only seven (instead of eight) gill rakers on the lower limb of the outer arch.

69. *Eucinostomus pseudogula* Poey. Slender mojarra. (III)
Stations 1 (98, 11.5-71.5), 2 (16, 22-62), 18 (15, 14.5-19), 20 (1, 14.5), 25 (3, 20.5-49.5), 29 (6, 14-57), 31 (4, 18-25.5), 35 (1, 53.5).

This species may not be specifically distinct from *E. melanopterus* (Bleeker), which was described from the eastern Atlantic (Miller, 1966: 797). If the two are the same, the name *melanopterus* would have priority.

Family SCIAENIDAE

70. *Bairdiella ronchus* (Cuvier). "Pis-pis." (III)
Stations 1 (20, 79-118.5), 3 (14, 89.5-230), 28 (1, 122), 35 (3, 92.5-119).

The absence of young individuals from Tortuguero collections may indicate that

this species either spawns outside the estuary and the young do not enter until they have attained a certain size, or else it spawns in late fall or winter when no collections were made. Of 37 stomachs examined, 14 were empty and the others contained small fishes and river shrimp.

71. *Bairdiella sanctaeluciae* (Jordan). Striped croaker. (*)
Station 16 (1, 104.5); new record.

This essentially Caribbean species has recently been found along the southeastern coast of Florida (UF 12031, CU 43321), and thus is one of the few southern continental fishes known north of the Yucatán Straits (Robins, in press; Gilbert, in press).

72. *Cynoscion jamaicensis* (Vaillant and Boucourt). (*)
Station 16 (1, 65.5); new record.

Counts on this specimen are as follows: Dorsal rays, X-I, 26; anal rays, II-9; gill rakers (not including rudiments), 2 + 8 = 10; pectoral rays, 17-16; lateral-line scales not countable, but apparently relatively few in number (70-80).

73. *Larimus breviceps* Cuvier. (III)
Stations 3 (1, 115), 16 (242, 49-132), 18 (34, 22-43.5); new record.

This species was the one most commonly collected in offshore trawling, but was taken only once in the estuary. *L. breviceps* is another addition to Miller's (1966) Central American freshwater fish checklist.

74. *Menticirrhus americanus* (Linnaeus). Southern kingfish. (III)
Station 1 (1, 40); new record.

This species, collected a short distance from the lagoon entrance, is an addition to Miller's (1966) freshwater checklist.

75. *Menticirrhus littoralis* (Holbrook). Gulf kingfish. (*)
Station 18 (5, 19.5-135); new record.

These specimens were identified by Roy Irwin, who is revising the genus. *M. littoralis* and *M. americanus* are two of the few northern continental species (Robins, in press; Gilbert, in press) found south of the Yucatán Straits.

76. *Micropogon furnieri* (Desmarest). (III)
Station 3 (7, 189-285).

The absence of young individuals from collections may indicate that spawning occurs outside the estuary.

77. *Ophioscion costaricensis* Caldwell. (*)
Station 4B (2, 110-117).

This species, which was described from the above specimens, is very close to *O. brasiliensis* Schultz, and may not be specifically distinct. Nevertheless a cursory comparison by the senior author of the two types of *O. costaricensis* with specimens of *O. brasiliensis* from South America seems to confirm Caldwell's (1958) observation of a significantly smaller eye and wider interorbital space in *costaricensis*.

78. *Ophioscion panamensis* Schultz. (*)
Station 16 (14, 31-90.5); new record.

79. *Stellifer colonensis* Meek and Hildebrand. (*)
Station 16 (12, 42-130.5); new record.

80. *Umbrina broussoneti*[1] Cuvier. (*)

Stations 16 (6, 86.5-129.5), 18 (1, 95); new record.

Gilbert (1966b) recently removed this species from the synonymy of *U. coroides* Cuvier.

Family CICHLIDAE

81. *Cichlasoma alfaroi*[2] Meek. (II) Figure 2a

Stations 14 (1, 48), 19 (2, 24.5-28.5), 20 (1, 28), 31 (5, 26-80.5); new record.

This species has been referred to in most publications as *C. lethrinus* Regan (see Miller, 1966: 792). It was found only in the tributary streams, as were *C. dowi, C. rostratum, C. spilotum,* and *C.* cf *spilurum.*

C. alfaroi is easily confused with *rostratum,* the two having very similar fin-ray counts (Table 4) and pigmentation patterns (Figure 2a-b). They are most readily distinguished by caudal-fin shape (emarginate in *alfaroi,* rounded in *rostratum),* maximum size (*alfaroi* is smaller), and (in smaller specimens) by distribution of pigment at the base of the caudal fin. In *alfaroi* the pigment is concentrated on the upper half of the peduncle, whereas *rostratum* has it more diffuse and evenly distributed along the entire caudal base.

82. *Cichlasoma centrarchus* (Gill and Bransford). (II) Figure 3a

Stations 1 (6, 19-68), 2 (20, 14-80), 14 (2, 56-104), 15 (2, 54-99), 17 (3, 45-52.5), 25 (1, 36), 34 (1, 51.5), 35 (3, 68-93).

C. centrarchus appears to be the least common of the four cichlid species regularly found in the estuary.

83. *Cichlasoma citrinellum* (Günther). "Crana;" "mountain tuba." (II) Figure 2c

Stations 1 (120, 20-220), 2 (30, 21.5-92), 6B (1, 139), 9 (1, 111), 15 (1, 29), 17 (4, 38.5-105), 31 (1, 57), 33 (6, 24-52), 34 (1, 89).

Although collected in the tributaries, *citrinellum* appears to be much more common in the estuary. Of the cichlids it ranked second only to *maculicauda* in abundance. Stomach contents of 19 specimens caught in May 1964 near the airstrip included "orange slime," well-mascerated plant material, mud, sand, and one small eel.

84. *Cichlasoma dowi*[3] (Günther). "Guapote." (II) Figures 4a-c

Stations 11B (2, 20-48), 14 (1, 14) (?), 19 (1, 30), 20 (4, 17-27.5), 21 (5, 21-85), 32 (1, 190), 33 (18, 22-29.5); new record.

The small (14 mm) specimen from station 14 (Figure 4c) is questionably identi-

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[1] New emendation; originally spelled *broussonnetii* but named for Pierre M. A. Broussonet, French ichthyologist.

[2] New emendation; originally spelled *alfari* but named for Dr. A. Alfaro, formerly director of the National Museum of Costa Rica.

[3] New emendation; originally spelled *dovii* but named for Capt. John M. Dow.

TABLE 4. FIN-RAY COUNTS IN TORTUGUERO SPECIMENS OF THE CICHLID FISH GENERA *Cichlasoma* AND *Herotilapia*

Anal rays

	Spines							Soft rays					
	V	VI	VII	VIII	IX	X	XI	6	7	8	9	10	N
C. alfaroi		1	11						5	7			12
C. centrarchus					1	11	3		1	11	3		15
C. citrinellum			15							14	1		15
C. dowi	1	21	9							12	19		31
C. cf *dowi*					1					1			1
C. friedrichsthali				4	11			1	11	3			15
C. maculicauda		15								12	3		15
C. nigrofasciatum					1	12	2	6	6	3			15
C. rostratum			12	1					6	7			13
C. spilotum				3				1	2				3
C. cf *spilurum*					3				1	2			3
H. multispinosa							2		2				2

Dorsal rays

	Spines					Soft rays							
	XVI	XVII	XVIII	XIX	XX	7	8	9	10	11	12	13	N
C. alfaroi		5	7						12				12
C. centrarchus	8	7					5	10					15
C. citrinellum	4	9	2						2	10	3		15
C. dowi		3	26	2					5	23	3		31
C. cf *dowi*		1							1				1
C. friedrichsthali	1	8	6				5	9	1				15
C. maculicauda	1	13	1							8	6	1	15
C. nigrofasciatum			10	5		1	10	4					15
C. rostratum	8	3	2						5	8			13
C. spilotum			1	1	1			1	2				3
C. cf *spilurum*			2	1				1	2				3
H. multispinosa			2				2						2

Pectoral rays (both sides)

	12	13	14	15	16	N
C. alfaroi			8	16		24
C. centrarchus		29	1			30
C. citrinellum			13	17		30
C. dowi		1	40	21		62
C. cf *dowi*		2				2
C. friedrichsthali			29	1		30
C. maculicauda				19	11	30
C. nigrofasciatum	1	20	9			30
C. rostratum			7	17	2	26
C. spilotum			3	3		6
C. cf *spilurum*		1	5			6
H. multispinosa	1	3				4

fied as *C. dowi*. It agrees closely in color pattern with *C. dowi* specimens of comparable, or larger, size (Figures 4a-b), but differs in several meristic characters (Table 3). The most notable of these is number of anal spines, which is two higher (IX) than found in any of the other specimens examined (range V-VII). Both spinous and soft dorsal-ray counts are low, but are within the range of variation for the species. The number of pectoral rays is also low, but because of the difficulty in obtaining accurate pectoral counts for very small cichlids, the values may actually be higher than listed. All meristic data are within the range of the closely related *C. friedrichsthali*, thus suggesting that the specimen may be that species. The smallest individual of *friedrichsthali* examined (19 mm SL) has a color pattern very similar to that of the 30 mm specimen illustrated in figure 4d, and markedly different from that of the specimen in question. In *friedrichsthali* the bar at the base of the caudal fin is narrower and more diffuse, the bars along the sides of the body are much narrower and extend uninterrupted between the bases of the dorsal and anal fins, and the dark lateral blotch just posterior to the middle of the body is much less prominent. Nevertheless it is possible that *C. friedrichsthali* may initially have a color pattern very similar to that of *C. dowi*, but which (unlike *dowi*) undergoes a marked change early in life (i.e., between 14 and 19 mm SL).

85. *Cichlasoma friedrichsthali* (Heckel). "Viejita." (II) Figure 4d

Stations 1 (24, 28-128), 2 (36, 21-153), 6B (1, 107), 7 (2, 124.5-168.5), 11A (6, 95-175), 14 (20, 40-160), 15 (4, 60-111.5), 17 (11, 19-135), 19 (1, 19, 20 (5, 20-24), 21 (3, 54.5-96), 33 (28, 20-52.5), 34 (13, 70.5-146.5), 35 (11, 33-140.5).

This species appears to be equally common in the tributary streams and the estuary during both dry and wet seasons. The stomachs of 18 individuals caught near the airstrip in May 1964 were examined, of which 17 were empty and the other contained a small unidentified fish.

The species name has frequently been misspelled *friedrichstahli* (R. R. Miller, *pers. comm.*) For further remarks concerning this species, see above.

86. *Cichlasoma maculicauda* Regan. "Tuba." (II) Figure 3c

Stations 1 (251, 10-208), 2 (9, 27-191), 9 (2, 180-182), 11A (14, 21-195), 14 (1, 102), 17 (3, 45-205), 22 (10, 10-11), 25 (5, 24.5-39.5), 33 (1, 26), 34 (2, 65.5-139.5), 35 (3, 44-102.5).

C. maculicauda is the most abundant cichlid in the estuary, and is also very common in the streams. The stomachs of several individuals collected in May 1964 contained plant material, mud, and sand. Concentrations of large individuals were frequently seen beneath the outhouses bordering the lagoon, where they presumably were feeding on fecal matter.

Numerous small (10-12 mm) individuals were collected in the estuary, and on three separate occasions fish of this size were observed being accompanied or guarded by large adults. This indicates that the species probably spawns in the estuary.

87. *Cichlasoma nigrofasciatum* (Günther). (II) Figure 3b

Stations 11A (7, 14.5-61.5), 12 (1, 14.5), 14 (13, 36.5-76), 15 (5, 42-73), 17 (32, 11.5-63), 20 (1, 16.5), 31 (4, 50-69), 33 (3, 38.5-50.5), 34 (5, 45.5-68.5); new record.

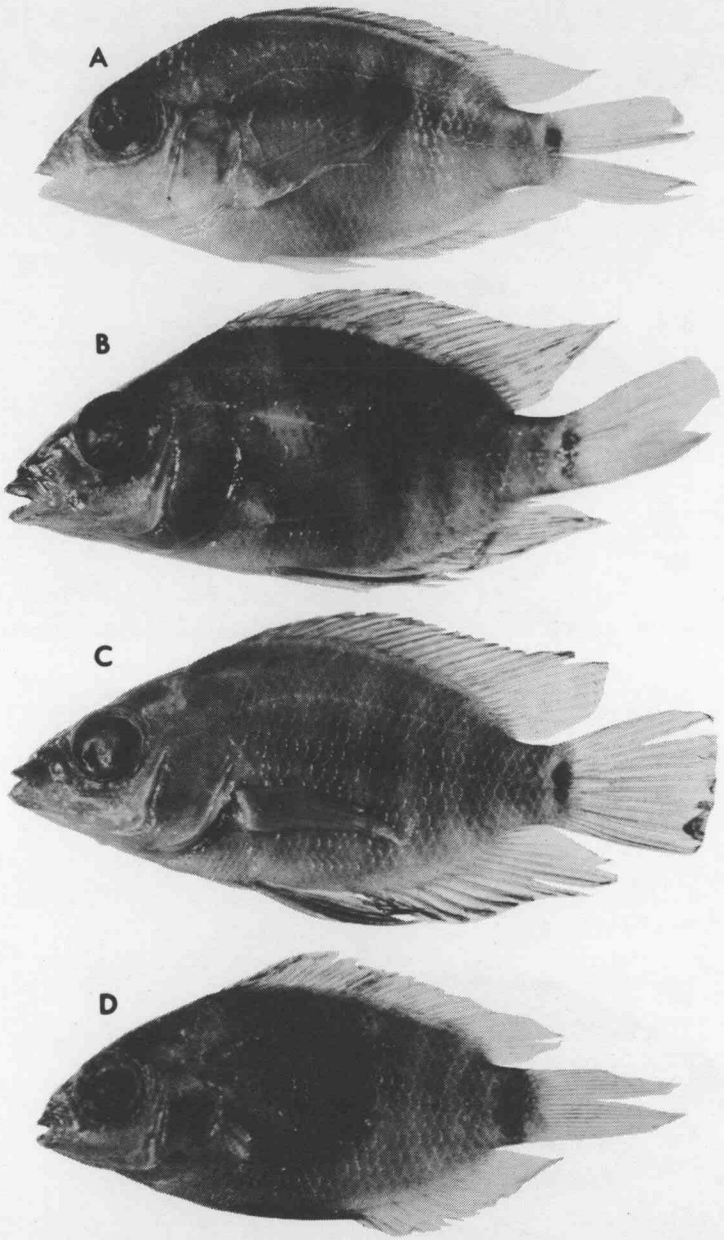

FIGURE 2. A.—*Cichlasoma alfaroi*, UF 16392, 27.8 mm SL. B.—*C. rostratum*, UF 11232, 32 mm SL. C.—*C. citrinellum*, UF 11088, 29 mm SL. D.—*C.* cf *spilurum*, UF 16396, 18.4 mm SL. All specimens from Tortuguero area.

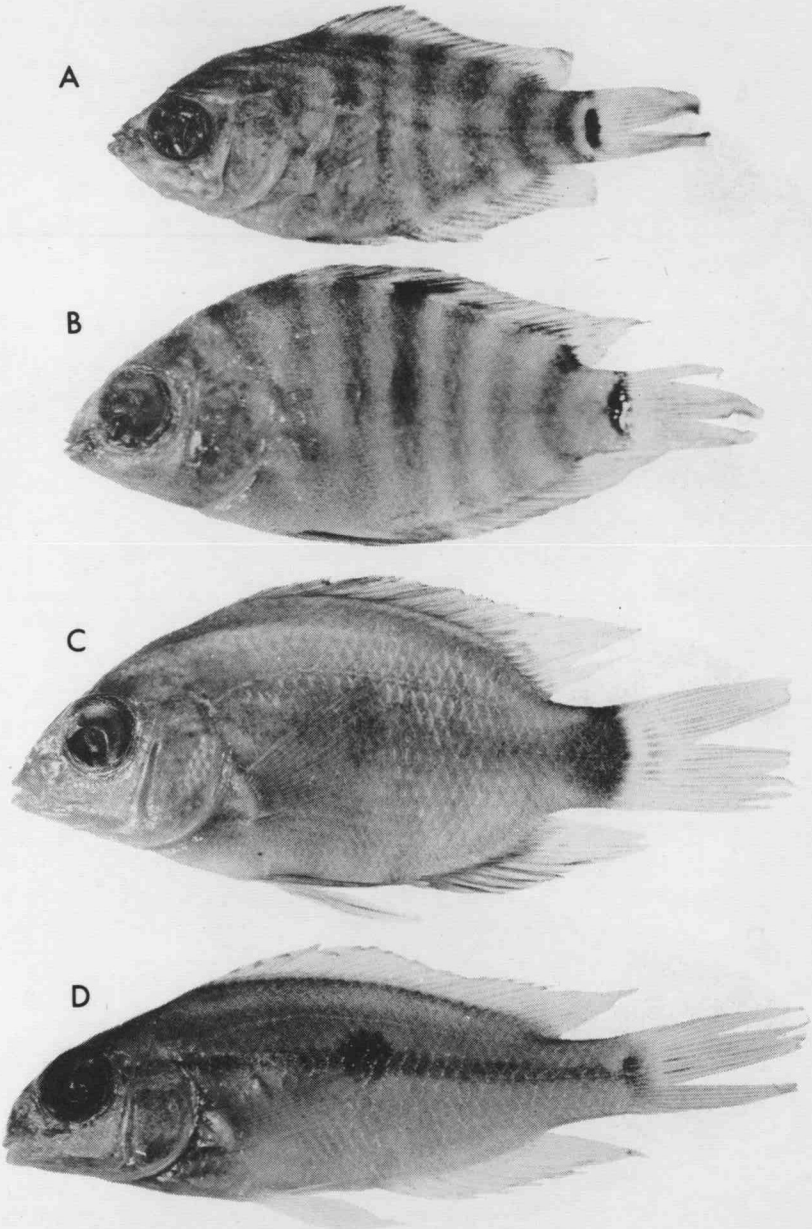

FIGURE 3. A.—*Cichlasoma centrarchus*, UF 11060, 14 mm SL. B.—*C. nigrofasciatum*, UF 16395, 16.5 mm SL. C.—*C. maculicauda*, UF 7170, 29 mm SL. D.—*C. spilotum*, UF 11173, 30 mm SL. All specimens from Tortuguero area.

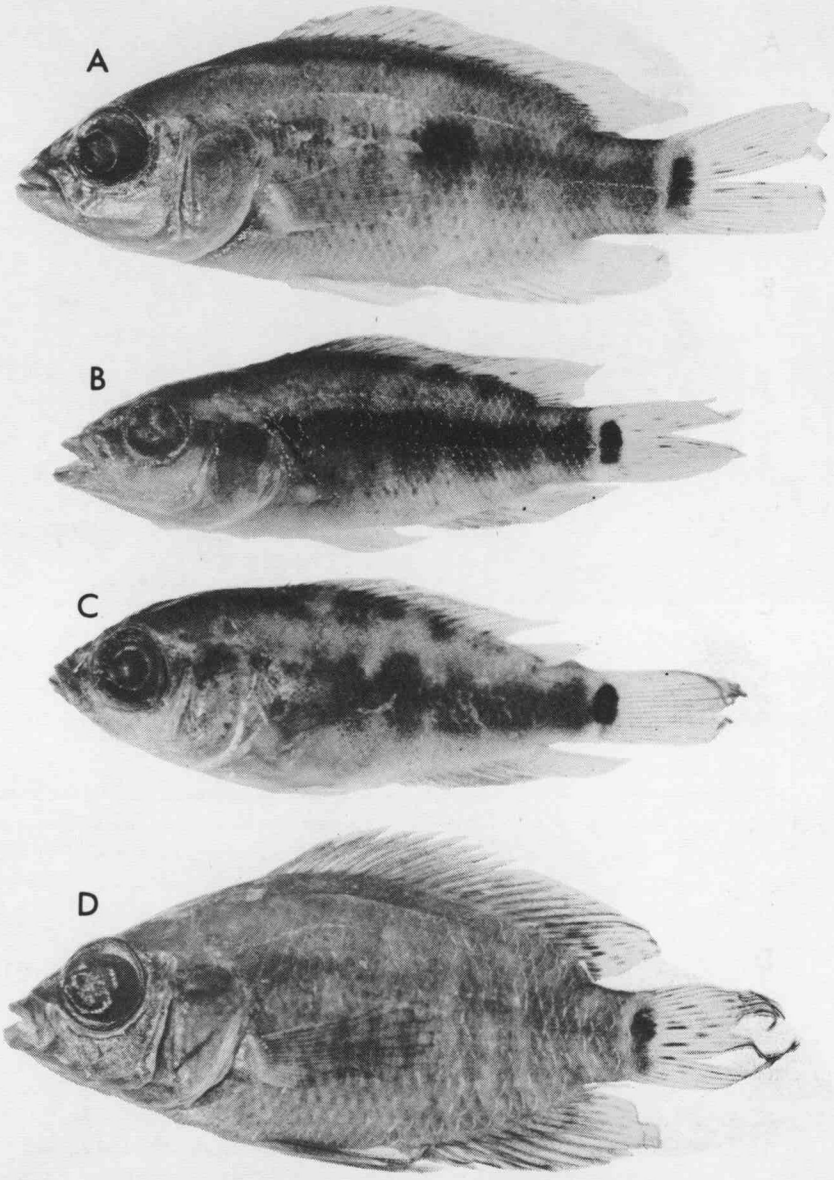

FIGURE 4. A.—*Cichlasoma dowi*, UF 11171, 30 mm SL. B.—*C. dowi*, UF 17304, 23.5 mm SL. C.—*C.* cf *dowi*, UF 11227, 14 mm SL. D.—*C. friedrichsthali*, UF 11059, 30 mm SL. All specimens from Tortuguero area.

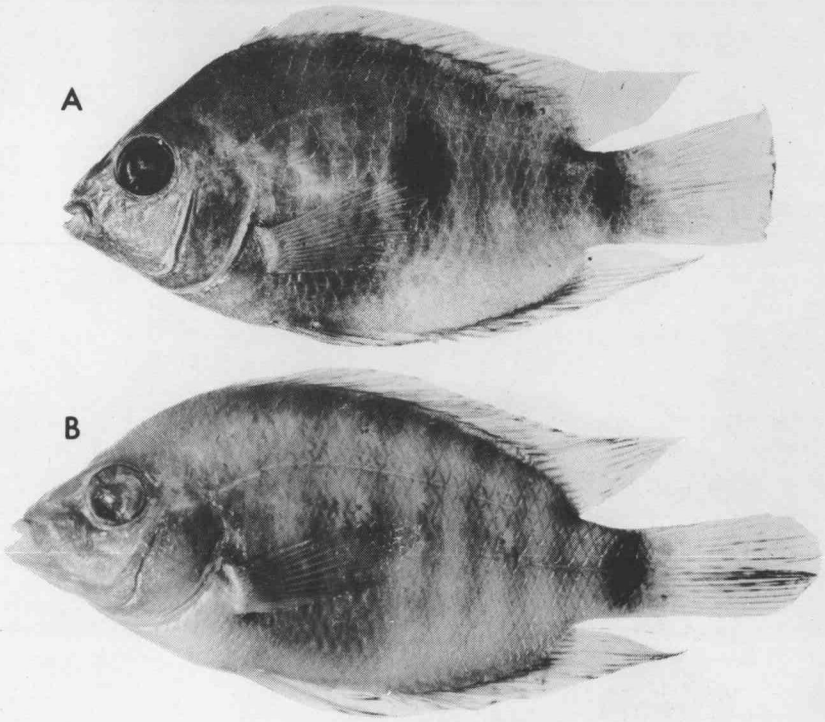

FIGURE 5. A.—*Cichlasoma* cf *spilurum*, UF 11032, 57.5 mm SL, Tortuguero area. B.—*C. spilurum*, UF 13984, 50.5 mm SL, Lake Izabal, Guatemala.

This species appears to be the commonest stream-inhabiting cichlid in the area, and might well be included in the list of Tortuguero Cichlidae that are exclusively confined to this habitat (see account of *C. alfaroi*). The one specimen found in the estuary (station 12) was obviously a stray that had drifted down under a clump of water hyacinths.

88. *Cichlasoma rostratum* (Gill and Bransford). (II) Figure 2b
Stations 11A (4, 17.5-208), 14 (1, 32), 17 (4, 31.5-159), 19 (1, 173), 31 (1, 51), 32 (2, 155.5-173.5), 35 (3, 127-142); new record.

89. *Cichlasoma spilotum* Meek. (II) Figure 3d
Stations 19 (2, 27.5-30), 31 (1, 59); new record.

90. *Cichlasoma* cf *spilurum* (Günther). (II) Figures 2d, 5a
Stations 11A (1, 57), 20 (2, 14.5-18.5); new record.

These individuals differ from specimens of *C. spilurum* from Lake Izabal, Guatemala (the type locality), in having less distinct bars on the side of the body; a single large vertically oblong blotch on the mid-side of the body (blotch indistinct or absent in *C. spilurum*); and a small well-defined caudal spot (spot larger, lighter, and more diffuse in *C. spilurum*) (Figures 5a-b). Fin-ray counts are very similar or identical, as the following data demonstrate:

Dorsal spines - Costa Rica, XVII (2), XVIII (1); Guatemala, XVII (1), XVIII (3), XIX (1).

Dorsal soft rays - Costa Rica, 9 (1), 10 (2); Guatemala, 9 (3), 10 (2).

Anal spines - Costa Rica, IX (3); Guatemala IX (5).

Anal soft rays - Costa Rica, 7 (1), 8 (2); Guatemala, 7 (4), 8 (1).

Pectoral rays - Costa Rica, 13 (1), 14 (5); Guatemala 13 (6), 14 (4).

Either *C. spilurum* is a variable species with regard to color pattern, or the Tortuguero specimens represent an undescribed sibling form.

91. *Herotilapia multispinosa* (Günther). (II)

Station 2 (2, 80-91).

This species has not been taken at Tortuguero since 1955, despite many collections from presumably favorable habitats.

Family ELEOTRIDAE

92. *Dormitator maculatus* (Bloch). Fat sleeper. (III)

Stations 2 (35, 10-65), 6A (1, 75), 17 (2, 26.5-36), 22 (2, 11.5-22.5), 33 (1, 38.5).

D. maculatus was much less common in the 1962-1965 collections than in earlier ones. This probably was the result of less intense collecting among water hyacinth roots, where this species seems to be largely confined.

According to Sterba (1962: 750), *D. maculatus* reaches 250 mm TL. This may be an exaggeration, for the largest specimen seen by us (from Volusia County, Florida) was 146 mm TL (107 mm SL), and the largest (of 179 specimens) reported by Meek and Hildebrand (1916: 355) was only 115 mm SL. Sterba (*op. cit.*) also reported small fishes to be the main item of diet, but McLane (1955) found the stomachs of Florida specimens to contain mostly plant material.

93. *Eleotris amblyopsis* (Cope). (III)

Stations 1 (116, 11.5-67), 2 (74, 19-67), 9 (1, 62), 14 (2, 38-46), 15 (13, 14-26.5), 17 (3, 13-27), 20 (6, 28-41.5), 21 (3, 26.5-34), 22 (1, 38), 25 (33, 8-63), 30 (many, ca. 9; see below), 31 (4, 43-51), 33 (28, 22-60), 35 (10, 25.5-54.5).

The young of both *E. amblyopsis* and *E. pisonis* were frequently found among water hyacinth roots. Unlike *Dormitator maculatus*, these species were taken in other habitats as well. Larval specimens of *Eleotris* were the commonest fish component of the *tismiche*. Although specific identifications could not be made at this size, both *amblyopsis* and *pisonis* were probably present.

E. amblyopsis was called *E. isthmensis* by Meek and Hildebrand (1916: 357-360). It is readily distinguished from *E. pisonis* by its larger scales (44 to 54 versus 59 to 68 scales in lateral series and 12 versus 18 rows between bases of second dorsal and anal fins).

94. *Eleotris pisonis* (Gmelin). Spinycheek sleeper. (III)

Stations 1 (1, 29), 2 (2, 87-280), 11B (1, 30.5), 20 (1, 36), 21 (3, 29-108), 25 (1, 110), 30 (many, ca. 9; see above), 31 (1, 73.5), 33 (1, 93).

95. *Gobiomorus dormitor* Lacépède. Bigmouth sleeper; "mudfish."

Stations 1 (11, 34-222.5), 2 (18, 21-101), 17 (1, 140), 20 (1, 185), 21 (4, 82-104), 25 (3, 35.5-55.5), 31 (2, 171-187.5), 33 (1, 101), 35 (3, 57.5-190).

The stomachs of three specimens collected in May 1964 contained river shrimp 10 to 25 mm long. Gravid females were collected in the estuary the same month.

96. *Leptophilypnus fluviatilis* Meek and Hildebrand. (III)
Stations 1 (2, 31-35), 2 (4, 34-42).

Family GOBIIDAE

97. *Awaous tajasica* (Lichtenstein). River goby. (III)
Stations 19 (2, 59.5-137), 30 (7, 12.5); new record.

Although larval individuals of this species were not one of the more common components of the *tismiche,* many more probably were present than the above collections indicate (Sta. 30).

98. *Bathygobius soporator* (Valenciennes). Frillfin goby. (III)
Stations 1 (13, 22-70), 2 (2, 48-58), 25 (7, 16.5-47.5), 35 (1, 37.5); new record.

This species is an addition to Miller's (1966) Central American freshwater fish checklist.

99. *Evorthodus lyricus* (Girard). Lyre goby. (III)
Stations 1 (11, 9-35), 2 (1, 37), 14 (1, 28).

100. *Gobionellus boleosoma* (Jordan and Gilbert). Darter goby. (III)
Stations 1 (16, 16.5-33), 2 (1, 15.5), 25 (5, 15.5-19.5), 31 (15, 17.5-28); new record.

This species was present in pre-1959 collections, but was not distinguished from *Gobionellus fasciatus* (= *claytonii*) by Caldwell, Ogren, and Giovannoli (1959: 28).

101. *Gobionellus fasciatus* (Gill). (III)
Figure 6b
Stations 1 (55, 11-69), 2 (23, 19.5-49), 14 (7, 25.5-42.5), 17 (2, 23.5-25), 19 (5, 46.5-62.5), 20 (1, 12.5), 25 (6, 32.5-60), 30 (many, ca. 10), 31 (42, 18-46.5), 33 (3, 33-48), 35 (1, 25.5).

G. fasciatus was called *G. claytonii* (Meek) by Caldwell, Ogren, and Giovannoli (1959: 28). Unpublished studies by the senior author and John E. Randall indicate that the two are valid, though very closely related, species, apparently differing only by the presence in *fasciatus* of a well-defined cheek blotch and more completely scaled belly. *G. claytoni* is restricted to the southwestern Gulf of Mexico, whereas *G. fasciatus* occurs throughout the southern Caribbean, having been recorded from Costa Rica to Dominica. Although future collecting may decrease this distributional hiatus, there seems little doubt that the ranges of the two species are widely separated.

102. ***Gobionellus pseudofasciatus* Gilbert and Randall, new species.** (III)
Figure 6a
Stations 1 (6, 17-35), 19 (1, 44), 31 (2, 27-31.5), 33 (1, 34.5); new record.

A diagnosis is presented here to establish the scientific name of this species. A more detailed description will appear in a later paper by the senior author and John E. Randall.

DIAGNOSIS. — A species of *Gobionellus* with large scales (31 to 33 in lateral series), usually 17 pectoral-fin rays (occasionally 16 or 18), and the combination of 12 total second dorsal and 13 total anal elements. Differs from *G. fasciatus,* which it most closely resembles, in having 1) a dark blotch of pigment extending from lower posterior corner of cheek anteriorly at about a 45° angle and which, if

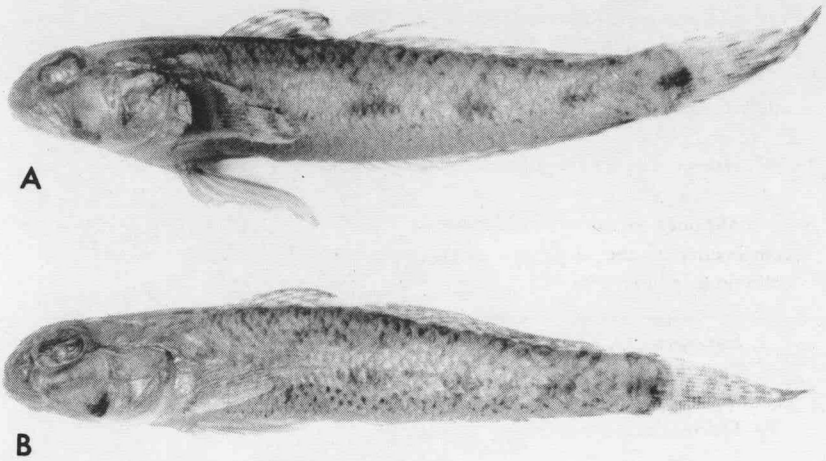

FIGURE 6. A.—*Gobionellus pseudofasciatus*, female, holotype, UF 13516, 34.7 mm SL, Tortuguero area. B.—*G. fasciatus*, female, UF 5804, 36.3 mm SL, Tortuguero area.

continued, would pass just anterior to eye (blotch confined to posterior corner of cheek in *fasciatus*); 2) small, dark discrete spots in the proximal part of most anal-fin membranes of males (spots larger and more diffuse in male *fasciatus*); 3) no spots in anal-fin membranes of females (diffuse spots present in female *fasciatus*); 4) no diagonal line extending from postero-dorsal margin of maxillary to below and behind eye; 5) the pectoral fins with four or five narrow, slightly diagonal bars (bars absent in *fasciatus*); 6) the upper half of the body lighter; and 7) a small (in females) to moderately large (in males) posteriorly-directed canine tooth in anterior part of each lower jaw (absent in *fasciatus*).

HOLOTYPE. — University of Florida (UF) 13516 (subadult female, 35.0 mm SL, illustrated), west side of Tortuguero lagoon, just below point across from Tortuguero village, Limón Province, Costa Rica (station 1), 25 August 1963, C. R. Gilbert and R. Kaufman (field no. G 63-36).

PARATYPES — (Costa Rica-Tortuguero) UF 13517 (1), University of Miami, Institute of Marine Science (UMML) 23117 (1), U.S. National Museum (USNM) 201589 (1) (3, 17.0-25.3), same data as for holotype. UF 13518 (2, 17.2-24.5), same locality as for holotype, 18 August 1963, C. R. Gilbert et al (field no. G 63-27). UF 13519 (1, 44.2), station 19. UF 13520 (1), Academy of Natural Sciences of Philadelphia (ANSP) 109179 (1) (2, 27.1-31.6), station 31. Florida State University (FSU) 17695 (1, 34.5), station 33. (Guatemala) USNM 114338 (10, 29.2-53.0), Jicotea Creek, tributary of Río Sarstoon, ca. ¼ mi. above mouth, 30 April 1947, Midence, Miller, and Holloway (field no. M 47-51). (Canal Zone-Mindi Cut) USNM 81824 (1), USNM 205202 (1) (32.3-35.3), 14 Jan. 1911, Meek and Hildebrand. USNM 105109 (1), USNM 123264 (1) (29.7-32.2), 28 Jan. 1911, Meek and Hildebrand. (Trinidad) University of Puerto Rico (UPR) 2225 (1, 28.5), first irrigation ditch on hwy. south of Caroni River, 9 May 1964, J. E. Randall.

103. *Gobiosoma spes* (Ginsburg). (III)
Stations 1 (216, 14-34), 2 (9, 16.5-25), 31 (3, 18.5-23.5).

G. spes was taken in Tortuguero estuary only during the wet season, with nearly all specimens coming from the west shore. Except for several individuals taken in shipworm holes in a piling at the tagging camp, all individuals were found living in mats of filamentous algae or other submergent aquatic vegetation.

Family ECHENEIDAE

104. *Echeneis naucrates* Linnaeus. Sharksucker. (III)
Stations 2 (1, 174), 3 (5, 110-370), 5A (1, 155), 5B (2, 111-170).

The presence of *E. naucrates* in fresh water is undoubtedly related to the ability of *Carcharhinus leucas* (to which the sharksucker commonly attaches itself) to move back and forth between fresh and salt water. This species is an addition to Miller's (1966) Central American freshwater fish checklist.

Family DACTYLOSCOPIDAE

105. *Dactylagnus peratikos* Böhlke and Caldwell. (*)
Stations 4C (1, 44), 12 (5, 48.5-53.5), 29 (1, 49).
This species is still known only from the above Tortuguero specimens.

Family MICRODESMIDAE

106. *Microdesmus carri* Gilbert. (III)
Stations 1 (2, 36.5-72), 25 (1, 54.5), 30 (34, 28-33.5); new record.

M. carri, like the preceding species, is known only from Tortuguero material. The fact that both forms are burrowers, and thus not readily collected by conventional means, probably accounts in large part for their apparent rarity.

All specimens of *carri* collected during the *tismiche* (Station 30) are postlarvae; the other three are adults, or at least show adult characteristics. As the postlarvae presumably were moving into the estuary at the time of capture, spawning and early development are hypothesized to have occurred in the ocean (Gilbert, 1966a: 331). *M. carri* is an addition to Miller's (1966) Central American freshwater fish checklist.

Family BATRACHOIDIDAE

107. *Batrachoides gilberti* Meek and Hildebrand. (III)
Stations 1 (1, 122.5), 25 (4, 31-151); new record.

B. gilberti is readily distinguished from the other two species of *Batrachoides* occurring in the southwestern Caribbean (*B. surinamensis* (Bloch and Schneider) and *B. manglae* Cervigon) by number of dorsal and anal rays. Counts for the above six specimens of *B. gilberti* are dorsal soft rays 24 (3), 25 (1), and 26 (2); and anal rays 22 (2) and 23 (4). For *B. surinamensis* and *B. manglae,* respectively, dorsal counts are 28 or 29 and 22 or 23, and anal counts 25 to 27 and 20 (data from Meek and Hildebrand, 1928: 914-915; and Cervigon, 1966: 858 respectively).

108. *Batrachoides surinamensis* (Bloch and Schneider). (III)

Stations 3 (1, 285); new record.

This specimen was caught by hook and line just inside the lagoon in July 1965. Dorsal and anal ray counts are 29 and 27 respectively.

109. *Porichthys pauciradiatus* Caldwell and Caldwell. (*)

Station 10 (1, 65.5); new record.

This species, recently described from Panama (Caldwell and Caldwell, 1963), is known from Costa Rica, Panama, and Brazil. The single Brazilian specimen differs in several pigmentary features from other known specimens (Gilbert, 1968: 717-719), and may prove to be a nameworthy form.

110. *Porichthys plectrodon* Goode and Bean. Atlantic midshipman. (*)

Station 18 (1, —); new record.

This specimen was found dead on the beach, the posterior part of the body partially eaten by crabs.

Until now this species has been called *Porichthys porosissimus* (Valenciennes). It has recently been found that *P. porosissimus* is confined to the southwestern Atlantic from southern Brazil to Argentina, and that populations occurring from central Brazil northward are *P. plectrodon*. The two species are very similar in color pattern, but differ trenchantly in shape of the sagitta (otolith). In *porosissimus* this structure is identical to that shown by Gilbert (1968: 679, fig. 2d) for the eastern Pacific *P. myriaster*, whereas the sagitta indicated as belonging to "*P. porosissimus*" (*op. cit.*, fig. 2a) is actually from *P. plectrodon*. In addition *porosissimus* has a significantly higher average gill-raker count (ca. 15 to 13) (*op. cit.*, p. 700, Table 4), although there is considerable overlap. Finray counts are very close, with the range of counts for *plectrodon* completely overlapping those given for *porosissimus* (*op. cit.*, Tables 1-3).

Family TETRAODONTIDAE

111. *Sphoeroides testudineus* (Linnaeus). Checkered puffer; "mutros;" "pesisapos." (III)

Stations 1 (81, 5-115.5), 2 (17, 70-124), 15 (1, 83), 35 (1, 100).

This species was most abundant over the mud flats along the west shore. It was common during both wet and dry seasons, although no specimens taken during the dry period were saved. *S. testudineus* is primarily a scavenger, and was observed feeding on a wide variety of detritus and garbage. Despite its relative abundance, only one individual was found in the stomach of a predator (*Oligoplites palometa*).

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