Summer 8-2010

Patterns of Diversity, Zoogeography, and Ecological Gradients in Honduran Freshwater Fishes

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PATTERNS OF DIVERSITY, ZOOGEOGRAPHY, AND ECOLOGICAL GRADIENTS IN HONDURAN FRESHWATER FISHES

by

Wilfredo Antonio Matamoros

Abstract of a Dissertation
Submitted to the Graduate School
of The University of Southern Mississippi
in Partial Fulfillment of the Requirements
for the Degree of Doctor of Philosophy

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ABSTRACT

PATTERNS OF DIVERSITY, ZOOGEOGRAPHY, AND ECOLOGICAL GRADIENTS IN HONDURAN FRESHWATER FISHES

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Nineteen major river drainages across Honduras were sampled from 2005-2009 in order to understand Honduran geographical patterns of freshwater fish distribution, to delineate the Honduran freshwater fishes ichthyographical provinces, and to understand patterns of species assemblage at the drainage level. A total of 166 species of freshwater fishes were sampled, a 64% increase over previously published reports. Eight species belong to primary freshwater families, 47 to secondary, and 111 to peripherals. In order to understand the species-drainages relationships, a presence-absence matrix was built for the 19 major drainages and 55 primary and secondary freshwater fishes. Correspondence and cluster analysis clearly separated the Pacific and Atlantic drainages, corresponding to earlier ichthyographical provinces for the region. However, the Pacific slope of Honduras formed a single Ichthyographical province that includes the Lempa, Goascorán, Nacaome, Choluteca, and Negro River drainages. In contrast to earlier studies, the Honduran Atlantic slope was divided in three Ichthyographical provinces: 1) the Motagua-Chamelecón-Ulúa-Ichthyographical Province; 2) the Nombre de Dios and Bay Islands Ichthyographical Province; and 3) the Honduran Mosquitia Ichthyographical Province. In order to study patterns of fish assemblages, eleven sites in two rivers (the Cangrejal and Lancetilla) of the Nombre de Dios and Bay Island Ichthyographical Province were sampled repeatedly over the study period. Sampling localities included lowland (0-10 m above sea level) middle (10-100 m) and upper reaches (>100 m) of both reaches. At each station I used several fishing techniques and also measured physicochemical parameters of the streams. Fish assemblages between the two rivers were found to be significantly different. Significant differences in fish assemblages were also found among the rivers lower, middle, and upper reaches. However, relationships among assemblage structure and physicochemical variables were weak. Diversity and assemblage structure change most at higher altitude where species diversity is the lowest. Upper reaches habitat are dominated mostly by fishes with strong swimming capabilities (e.g. Mullet), and fishes with morphological adaptations to inhabit and swim through rapids and waterfalls (e.g. gobies).

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ACKNOWLEDGMENTS

I would like to acknowledge the following agencies for financial contribution to carry out this project: Critical Ecosystem Partnership Fund, the United States Agency for International Development/Project MIRA Honduras (USAID/Project MIRA Honduras), and the World Wildlife Foundation. This project was partially supported by the Northeastern Illinois University Foundation Dr. Bernard J. Brommel Doctoral Scholarship and The University of Southern Mississippi (USM) Alliance for Graduate Education in Mississippi. I am grateful to Jorge Iván Restrepo from the Instituto Regional para la Biodiversidad, Juan Carlos Carrasco from the Red Hondureña para la Ecología y el Desarrollo Sostenible, and Pepe Herrero from USAID/Project MIRA Honduras for their assistance with logistics while performing field work in Honduras. I thank Luigi Lodo for all the help he provided while sampling the Coco River. Thanks to Luis Morales from the Dirección General de Pesca and Claudia Cárcamo, Ivonne Oviedo, and Andrés Alegría from the Instituto de Conservación Forestal for their assistance in obtaining collection permits. I would like to thank Bob Jordan of United States Agency for USAID/Project MIRA Honduras for his initial financial support in 2005. I am very grateful to everyone who has contributed to this project since the beginning with their hard work, including: Julio Mérida, Maritza Montoya, Merci Barahona, Carlos O'Reilly, Juan Carlos Funes, Oqueli Banegas, Julio Ancheta, Marcela Matamoros, Alejandra Sánchez, Edis López, Héctor Portillo, Fausto Elvir, Jonathan Hernández, Hermes Vega, Tomás Manzanares, Bryant Bowen, James Kerfoot, Matthew Wittenrich, Joshua Ennen, Michi Tobler, Chris Jones, Gregg Thompson, Kevin Merwing and Hsin-Hsin Hsia. I thank Leonel Marineros and Mario Espinal for providing fish samples from Copán and Santa Bárbara

In addition, I would like to acknowledge my advisors Dr. Brian Kreiser and Dr. Jake Schaefer who were largely responsible for the success of this project. I also thank the members of my research committee: Dr. Todd Slack, Dr. Mac Alford, and Dr. Mark Peterson for their contributions to this project. The USM Department of Biological Sciences provided me with funds to attend scientific meetings where I presented the results of my research. Finally, I would like to thank my family for all the support they have given me over the years. To Sheri Glowinski, my wife, whose understanding and support goes beyond limits.

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER III

Table

CHAPTER IV

Table

APPENDIXES

Table

LIST OF ILLUSTRATIONS

CHAPTER II

Figure

CHAPTER III

Figure

CHAPTER IV

Figure

CHAPTER I

OVERVIEW

Honduras probably has the least known freshwater fish fauna among all Central American countries. Even though the need for freshwater fish exploratory work in Honduras was pointed out by Carr and Giovannoli (1950), and Miller (1966) the need of ichthyological work in Honduras and specifically knowledge about Honduran freshwater fishes diversity, geographical distribution, biology, and ecology remain very limited.

One goal of this dissertation is to address specific questions that can be formulated about Honduran freshwater fishes and will give a framework for future ichthyological work in Honduras. This dissertation is divided in three interconnected projects. Project number one deals with basic freshwater fishes species occurrence and their geographical distribution in Honduran. I compiled Honduran species distributional data at the drainage and political department level from records found in ichthyological collections from museums in the United States to successfully accomplish this project. Museum data were complemented with five years (2005-2009) of field work in Honduras. The combined data, allowed me to put together one of the largest known data sets for Honduran freshwater fishes and built the framework for the following projects encompassed in this dissertation.

Project number two followed a natural transition from project number one as it intends two determine faunistic relationships between Honduran river drainages and the delineation of Honduran freshwater ichthyographical provinces based on species distribution compiled in the first part of this project. Freshwater ichthyography for Honduras has been inferred in larger global studies (Abell *et al*. 2008), and regional studies (Miller 1966; Bussing 1976). These studies proposed for Honduras major ichthyographical differences between Honduran Pacific and Atlantic slopes, but not any subdivisions within the slopes. Prior to this study distributional data for Honduras has been very limited, I attribute the lower number of ichthyographical provinces found in Honduras to data limitations in former studies. Data was analyzed by means of correspondence and cluster analysis. Under the assumption that those analyses will group together drainages with closer related fauna and those drainages that are more different will be in different clusters. All clusters were tested by significance using an analysis of similitude (ANOSIM). My results confirm that as previously proposed there is one ichthyographical province on the Honduran Pacific slope. However, in the Atlantic slope three provinces were identified.

Finally, in project three I determined the relationship between fish assemblages along a longitudinal gradient and their relationship to environmental factors in the Cangrejal and Lancetilla Rivers of the Honduran Caribbean coast. In this section I intended to see the community assemblage differences between lower, middle, and upper reaches in the streams as well as how environmental factors influenced community assemblage. In order to assess differences along the river gradient, 11 sites were sampled along the rivers. Sites were divided in lower, middle, and upper reaches. Lower reach sites were those located 20 meters above sea level (m.a.s.l.), middle reach sites those between 20 -100 masl, and upper reach site were those sites located above 100 masl. A nonmetric multidimensional scaling found distinctive clusters of groups, clusters were tested for significance with the use an ANOSIM ($P < 0.05$). I also tested for changes in species richness among reaches using a two way analysis of variance ($P > 0.05$). The results suggest that there are significant differences between river reaches in community assemblage as well as in species richness. Rivers lower reaches presented higher number of species in comparison with the middle and upper reaches. Lower reaches showed a higher number of marine vagrants that do not reach the middle and upper reaches.

References

Abell, R., Thieme, M.L., Revenga, C., Bryer, M.T., Kottelat, M., Bogutskaya, N.G., Coad, B., Mandrak, N.E., Contreras Balderas, S., Bussing, W., Stiassny, M.L.J., Skelton, P.H., Allen, G.R., Unmack, P.J., Naseka, A.M., Ng, R., Sindorf, N., Robertson, J., Armijo, E., Higgins, J.V., Heibel, T.J., Wikramanayake, E.D., Olson, D.M., López, H.L., Reis, R.E., Lundberg, J.G., Sabaj Pérez, M.H. & Petry, P. (2008) Freshwater Ecoregions of the World: A New Map of biogeographic units for freshwater biodiversity conservation. *BioScience*, 58, 403-414.

Bussing, W. (1976) Geographic distribution of the San Juan ichthyofauna of Central America with remarks on its origin and ecology. *In:* Thorson, T.B. (Ed.) *Investigations of the Ichthyofauna of Nicaraguan Lakes*. University of Nebraska, Lincoln, Nebraska, pp. 157-175.

Carr, A.F. & Giovannoli, L. (1950) The fishes of the Choluteca drainage of southern Honduras. Occasional *Papers of the Museum Zoology*, University of Michigan, 523, 1-38.

Miller, R.R. (1966) Geographical distribution of Central American freshwater fishes. *Copeia*, 1966, 773-802.

CHAPTER II

ANNOTATED CHECKLIST OF THE FRESHWATER FISHES OF CONTINENTAL AND INSULAR HONDURAS

Abstract

The freshwater fishes of Honduras were surveyed for a period of four years (2005-2008). Surveys were supplemented with both literature and museum collection reviews. Our results show that there are at least 172 species of fishes inhabiting Honduran mainland and insular freshwater systems, 166 native and six exotic. Primary freshwater fish diversity was low, with only eigth species (4.8%). The remaining species were either secondary freshwater (47 species, 28.3%) or peripheral (111 species, 66.9%). This checklist includes 36 new records for Honduras, and 12 range expansions. Nine species were found to be endemic; however, just two of them (*Amphilophus hogaboomorum* and *Theraps wesseli*) are already described. The depauperate primary freshwater fishes fauna of Honduras (8) is congruent with low primary freshwater fishes diversity found in the region between the Usumacinta River and the Nicaraguan great lakes. Although many previously unsampled regions of Honduras were visited as part of this project, there are a variety of remote areas that remain unstudied. While this paper contributes much to the understanding of the distribution and diversity of Honduran freshwater fishes, it is likely that much diversity there remains undocumented.

Introduction

The diversity and distributional patterns of Honduran freshwater fishes are the product of recent geological events (Myers 1966). All primary and secondary freshwater species that inhabit Honduras are of South American origin (Miller 1966; Myers 1966), moving to the region during or after the raising and closure of the Isthmus of Panama during the Pliocene (Marshall *et al*. 1979; Stehli & Webb 1985). The proposed timing of the enclosure of the Panamanian isthmus varies from between 3.1 to 3.5 million years ago (Coates *et al*. 1992; Coates & Obando 1996) to as early as 1.8 million years ago (Keller *et al*. 1989). While the formation of this land bridge is often cited as the major event structuring Honduran freshwater fish diversity, local geologic, climatic and other factors have also certainly played a role (Savage 1982). Unfortunately, few attempts have been made at studying Honduran freshwater fish biodiversity on a scale adequate to assess the role of local vs. regional processes in structuring biogeographic patterns in the country. As a result, Honduras (Figure 1) has long represented a large gap in biogeographical knowledge of Central America fishes (Carr & Giovannoli 1950; Miller 1966; Lyons 2005).

Accordingly, as a baseline for future biogeographical studies, we present an updated checklist of the freshwater fishes of Honduras that has been compiled from: 1) field sampling of all major drainages, 2) data from published literature and 3) review of museum holdings from Honduras. Checklists like this are an important tool for researchers, governmental and non-governmental agencies with interest in documenting and conserving biodiversity. It will serve as a foundation for future research aimed at understanding the origin and status of Honduran fish diversity as well as effective management and conservation programs (McNeely *et al*. 1990).

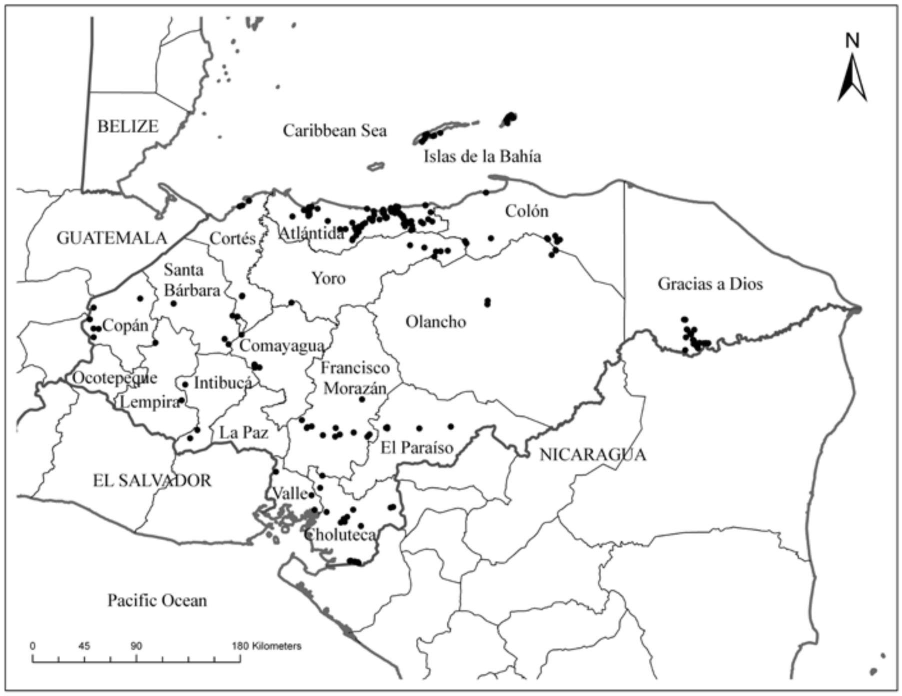

Figure 1. Map of Honduras showing the political divisions (Departments). Dots represent localities sampled during 2005-2008.

Review of Freshwater Ichthyographical Research in Honduras

Most of what is known about Honduran ichthyology is based on work done at a larger regional scale. Distributional ranges of freshwater fishes that included the territory of Honduras were mentioned in the works of Jordan and Evermann (1896-1900), Regan (1906-1908), and Jordan *et al.* (1930). These publications analyzed the freshwater ichthyofauna of Central America in general. However, sampling in Honduras was almost non-existent at the time. In his work with cyprinodonts, Hubbs (1924, 1926, 1931) mentioned a number of Honduran collections containing *Phallichthys amates*, *Belonesox belizanus*, and *Alfaro huberi*. Fowler (1932) reported collections in the Lancetilla and Choluteca Rivers. Rehn (1932) reported some collections in the Honduran Mosquitia region. Strong (1934) reported a bull shark (*Carcharhinus leucas*) in the Patuca River in La Mosquitia. Miller (1955) reported specimens of *Profundulus guatemalensis* collected in 1934 by A. Greenberg in western Honduras. Fowler (1943) reported collections made by G. Orr in Islas de la Bahía, and described *Poecilia orri* with specimens collected in the island of Bonnaca. The first detailed sampling of rivers in the country was carried out by A. Carr in the late 1940's. Carr focused on rivers of the Honduran Pacific slope, culminating with an analysis of the fishes of the Choluteca River and the description of *Amphilophus hogaboomorum* (Carr & Giovannoli 1950). Carr also published a second paper on the distribution and systematic relationships of some freshwater fishes of the Honduran and Nicaraguan Mosquitia region (Miller & Carr 1974).

The overall structure of Central American ichthyographical provinces was first proposed by Miller (1966). He proposed that Honduras was part of the Chiapas-Nicaraguan Province that extends from southern México to southern Nicaragua. Miller (1966) did not suggest separate provinces for the Honduran and Nicaraguan Atlantic slope, arguing there was not enough information available for that part of Central America. Ten years later, however, Bussing (1976), proposed a second additional ichthyographical province for Honduras: the Usumacinta province on the Honduran Atlantic slope. This province extends from the Usumacinta River in southern México to northern Nicaragua. From 1968 to 1970, Martin (1972) intensively sampled parts of Honduras as part of an unpublished thesis. For the next two decades, there were no major collections conducted on Honduran freshwaters fishes. In 1996, *Theraps wesseli* was described from individuals collected in the Bellaire River, close to the city of Jutiapa in the Department of Atlántida (Miller 1996).

Geological History

The region of Nuclear Central America that corresponds to Honduras has a complex geological history characterized by intensive faulting, orogeny, sea level change, sedimentation, and volcanism. The land connection between North and South America was lost in the early Jurassic as Pangaea broke apart (Dietz & Holden 1970). It is widely accepted that no land connection existed between North and South America from the early Cretaceous to the Pliocene (Holden & Dietz 1972; Malfait and Dinkelman 1972; Ladd 1976; Duellman 1979; Savage 1982). However, parts of Nuclear Central America, including the majority of Honduras, may have been above water since the Cretaceous (Savage 1982). A faunal exchange between México and Nuclear Central America through the Isthmus of Tehuantepec happened during the Tertiary (Olson & McGrew 1941). This faunal exchange was facilitated by a climatic filter barrier and a probable partial sea barrier across the Isthmus (Savage 1982). The Miocene was characterized by intensive faulting in the area, which produced several graben valleys, including the Honduras depression that is a corridor from the Caribbean to the Pacific slope (Roberts & Irving 1957). During the Miocene – Pliocene intense volcanism occurred in the area (Roberts & Irving 1957). Intense orogeny during late Pliocene or early Pleistocene formed the terrace systems of interior Honduras. Much of the Caribbean lowlands emerged during the Pleistocene as a result of extensive erosion and deposition in alluvial lowland depressions. There were also hypothesized fluctuations in sea level and climate during the Pleistocene glaciations (Roberts & Irving 1957). The uplifting of the Isthmus of Panama during the mid-Pliocene created the land bridge connecting North and South America (Beu 2001). This facilitated a massive faunal migration from both continents, referred to as the Great American Biotic Interchange (Marshall *et al*. 1979; Stehli & Webb 1985).

Although there are no currently active volcanoes in Honduras, volcanism has shaped the physiographic features of the country. Volcanic activity in Nuclear Central America was widespread during the Miocene and Pliocene, which resulted in the deposition of andesitic and rhyolitic ejecta over the majority of the southern half of Honduras (Roberts & Irving 1957). The rough terrain in this region was largely created during the Oligocene (the Sierras Madre in México), Miocene (highlands of Nuclear Central America) and Pliocene (highlands of Lower Central America including the Comayagua Graben) (Roberts & Irving 1957; Maldonado-Koerdell 1964; Savage 1982). The Gulf of Fonseca was formed by downfaulting at the Comayagua Graben and the Nicaraguan Graben (West 1964). Finally, Islas de la Bahía on the Honduran Caribbean coast (Figure 1) appear to be a northward extension of the Sierra de Omoa and were apparently connected to the mainland throughout most of the middle and late Tertiary (Vinson & Brineman 1963).

Physiography

A physiographical region is defined as a geographic area with similar geologic, topographic, and edaphic features (West 1964). Subdivisions of these physiographic regions are called sub-regions, in which there is a general uniformity of surface features (Martin 1972). There are three major physiographic regions proposed for Honduras (Bengston 1926; Carr 1950; Martin 1972): the Pacific Lowlands, the Caribbean Lowlands, and the Interior Serranía Region. The Pacific Lowlands region does not contain any sub-regions, but includes the river basins that drain into the Gulf of Fonseca

(Bengston 1926; Carr 1950). This includes the Goascorán, Nacaome, Choluteca, and Negro rivers (Figure 2). The Caribbean Lowlands extend from the delta of the Motagua River in western Honduras to the Coco River bordering Nicaragua. The Caribbean lowlands are divided into five sub-regions (Bengston 1926; Carr 1950); the Motagua River Delta, the Ulúa-Chamelecón River Valley, the Nombre de Dios Plain, the Aguán-Negro River Plain, and the Mosquitia Coast (Figure 2). The Interior Serrania Region is formed by the Northern Cordillera and the Southern Cordillera sub-regions. Detailed description of Honduran physiographic regions and sub-regions are found in Bengston (1926), Carr (1950), Martin (1972), Wilson and Meyer (1985), and McCranie and Wilson (2002).

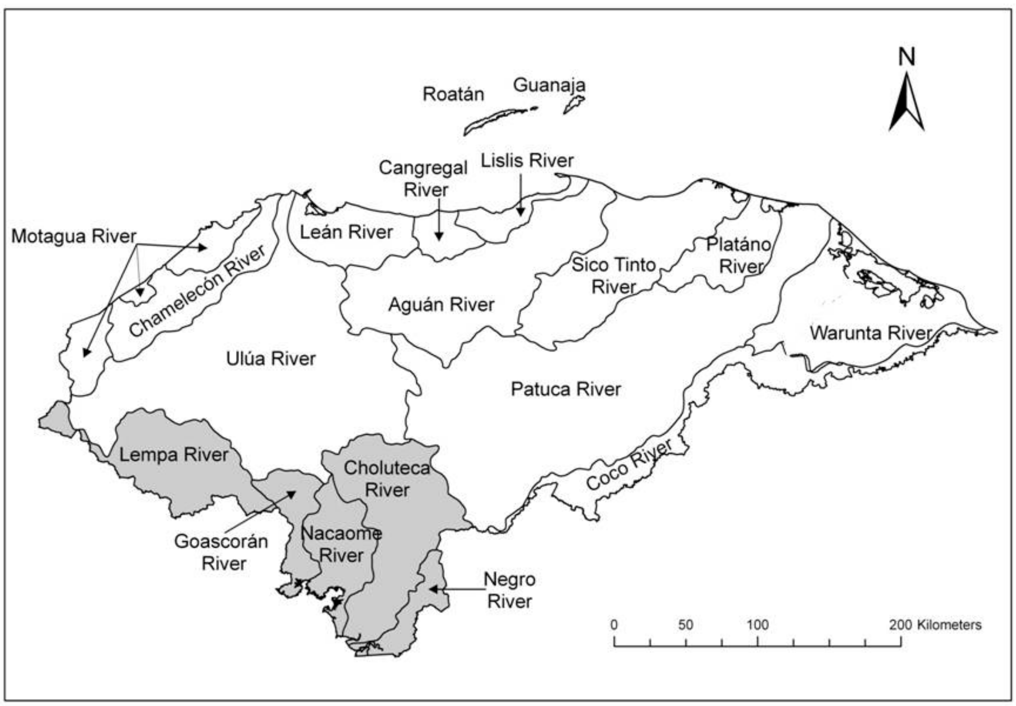

Figure 2. Map of Honduras showing 19 major Honduran river drainage basins. Shaded areas depict drainages located on the Pacific slope; unshaded areas are on the Atlantic Slope.

Materials and Methods

Institutional abbreviations are as follows: CAS = California Academy of Sciences; FLMNH = Florida Museum of Natural History; FMNH = Field Museum of Natural History; GCRL = Gulf Coast Research Laboratory; LACM = Los Angeles County Museum; UMMZ = University of Michigan Museum of Zoology; USM = University of Southern Mississippi Museum of Ichthyology; USNM = United States National Museum.

Field sampling at 278 localities in Honduras was performed in July 2005, November 2005, May-July 2006, May-August 2007, January-March 2008, and June-August 2008 (Figure 1). Sampling gear included seines (various sizes) with a mesh of 3.1 mm, cast nets, spear fishing, and backpack electrofishers. Captured fishes were fixed in 10% buffered formalin solution before being rinsed in water and preserved in 75% ethanol. Specimens were deposited at USM. To complement distribution and diversity data collected in our field surveys, we reviewed both the scientific and "grey" literature. We also queried the inter-institutional database NEODAT (http://www.neodat.org) and the online data bases of FLMNH, FMNH, GCRL, LACM, and UMMZ. The first author personally reviewed the Honduran freshwater fish holdings at the collections of the following museums: FLMNH, FMNH, GCRL, and parts of the Honduran holdings at UMMZ.

The annotated checklist is arranged by order and family following Eschmeyer and Fong (2008). Genera and species within a family are arranged in alphabetical order. The family tolerance to salinity is listed according to the classification by Myers (1949). Species valid name, authority, and year of description follow Eschmeyer and Fricke (2009), with the exception of *Rhamdia quelen* from which we follow Perdices *et al.*

(2002) in considering all Honduran *R. quelen* as belonging to the species *R. guatemalensis*. Honduran taxa included in the genus *Cichlasoma* is referred to here as '*Cichlasoma'* following Kullander (2003).

After the authority name, the common English name was provided followed by the common Spanish name. After the common name, we specify its origin as native, endemic or exotic. The exotic species included in the checklist are only those for which there is evidence of reproductive populations in Honduras.

The distribution of each species is given in two ways and is based on our own collections, literature reviews, online databases and museum specimens. First, we list the Honduran departments (alphabetical order) for which there are records for the species. Second, we list the major river drainage basins (Atlantic slope before Pacific slope drainages, all listed in west to east order) for which there are records for the species.

A considerable number of records on the checklist represent expansions of the known range or new reports of the species for Honduras. For range expansions and new country records (or both), we list the museum specimens that are associated with the individual specimens of interest. In the event that the museum specimen is not available, the field collection number is given. Finally, we considered a species new to Honduras as one that is not listed for Honduras either in FishBase (Froese & Pauly, 2009) or Reis *et al*. (2003).

Results

Annotated Checklist

CARCHARHINIFORMES

Carcharhinidae. Peripheral.

Carcharhinus leucas (Müller & Henle, 1839). Bull shark, tiburón toro. Native.

Department: Gracias a Dios. Drainage: Atlantic slope: Patuca.

Remarks: Martin (1972) listed *C. leucas* in Honduras based on a photograph taken by Strong (1934) in the Patuca River. This is the only documented report of *C. leucas* in Honduran freshwaters. Greenfield and Thomerson (1997) referred to a *C. leucas* in the "Patula River", which we assume is an error and they were in fact referring to the Patuca River.

Rhizoprionodon porosus (Poey, 1861). Caribbean sharpnose shark, cazón antillano. Native.

Department: Gracias a Dios. Drainages: Atlantic slope: Patuca and Coco.

PRISTIFORMES

Pristidae. Peripheral.

Pristis pectinata Latham, 1794. Smalltooth sawfish, pez sierra. Native.

Department: Gracias a Dios. Drainage: Atlantic slope: Patuca.

ELOPIFORMES

Megalopidae. Peripheral.

Megalops atlanticus Valenciennes, 1847. Tarpon, sábalo. Native.

Departments: Atlántida, Colón and Gracias a Dios. Drainages: Atlantic slope: Cangrejal, Aguán, Plátano and Patuca.

ANGUILLIFORMES

Anguillidae. Peripheral.

Anguilla rostrata (Lesueur, 1817). American eel, anguila americana. Native.

Departments: Atlántida, Colón, Cortés, Islas de la Bahía and Yoro. Drainages: Atlantic slope: Motagua, Chamelecón, Ulúa, Leán, Cangrejal, Lislis, Roatán and Guanaja.

Ophichthidae. Peripheral.

Myrophis punctatus Lütken, 1852. Speckled worm eel, tieso gusano. Native.

Departments: Cortés, Gracias a Dios and Islas de la Bahía. Drainages: Atlantic slope: Chamelecón, Patuca, Roatán and Guanaja..

CLUPEIFORMES

Clupeidae. Peripheral.

Harengula clupeola (Cuvier, 1829). False pilchard, sardinita carapachona. Native.

Department: Cortés. Drainage: Atlantic slope: Chamelecón.

Harengula humeralis (Cuvier, 1829). Redear sardine, sardinita de ley. Native.

Department: Islas de la Bahía. Drainage: Atlantic slope: Roatán.

Jenkinsia lamprotaenia (Gosse, 1851). Dwarf herring, sardinita flaca. Native.

Department: Islas de la Bahía. Drainage: Atlantic slope: Roatán.

Opisthonema oglinum (Lesueur, 1818). Atlantic thread herring, sardinita vivita de hebra. Native.

Department: Gracias a Dios. Drainage: Atlantic slope: Patuca.

Engraulidae. Peripheral.

Anchoa colonensis Hildebrand, 1943. Narrowstriped anchovy, anchoa rayita. Native.

Departments: Cortés and Gracias a Dios. Drainages: Atlantic slope: Chamelecón and Patuca.

Anchoa filifera (Fowler, 1915). Longfinger anchovy, anchoa dedolarga. Native.

Department: Gracias a Dios. Drainage: Atlantic slope: Patuca.

Anchoa parva (Meek & Hildebrand, 1923). Little anchovy, anchoa parva. Native.

Department: Gracias a Dios. Drainage: Atlantic slope: Patuca.

Anchovia clupeoides (Swainson, 1839). Zabaleta anchovy, anchoveta sardina. Native.

Department: Gracias a Dios. Drainage: Patuca.

Anchoviella elongata (Meek & Hildebrand, 1923). Elongate anchovy, anchoveta alargada. Native.

Department: Gracias a Dios. Drainage: Atlantic slope: Patuca.

CYPRINIFORMES

Cyprinidae. Primary.

Ctenopharyngodon idella (Valenciennes, 1844). Grass carp, carpa herbívora. Exotic.

Departments: Cortés and Santa Bárbara. Drainages: Atlantic slope: Chamelecón and Ulúa.

Remarks: Introduced by government agencies in an attempt to strengthen aquaculture activities and provide animal protein to rural communities (D. Meyer pers. comm.).

Hypophthalmichthys molitrix (Valenciennes, 1844). Silver carp, carpa plateada. Exotic.

Departments: Cortés and Santa Bárbara. Drainages: Atlantic slope: Chamelecón and Ulúa.

Remarks: Introduced by government agencies in an attempt to strengthen aquaculture activities and provide animal protein to rural communities (D. Meyer pers. comm.).

CHARACIFORMES

Characidae. Primary.

Astyanax aeneus (Günther, 1860). Banded tetra, sardina. Native.

Departments: Atlántida, Choluteca, Colón, Comayagua, Copán, Cortés, El Paraíso, Francisco Morazán, Gracias a Dios, Intibucá, La Paz, Olancho, Santa Bárbara, Valle and Yoro. Drainages: Atlantic slope: Motagua, Chamelecón, Ulúa, Leán, Cangrejal, Lislis, Aguán, Sico-Tinto, Plátano, Patuca, Warunta and Coco. Pacific slope: Lempa, Goascorán, Nacaome, Choluteca and Negro.

Brycon guatemalensis Regan, 1908. Macabi tetra, machaca. Native.

Departments: Choluteca, Comayagua, Copán, Cortés, El Paraíso, Francisco Morazán, La Paz, Lempira, Santa Bárbara and Yoro. Drainages: Atlantic slope: Motagua, Chamelecón, Ulúa, Leán and Choluteca.

Hyphessobrycon tortuguerae Böhlke, 1958. Tortuguero tetra, sardinita de Tortuguero. Native.

Departments: El Paraíso, Gracias a Dios and Olancho. Drainages: Atlantic slope: Patuca, Warunta and Coco. Pacific slope: Choluteca.

Roeboides bouchellei Fowler, 1923. Crystal tetra, sardinita plateada. Native.

Departments: Choluteca, El Paraíso, Francisco Morazán, Gracias a Dios, Olancho and Valle. Drainages: Atlantic slope: Sico-Tinto, Plátano, Patuca, Warunta and Coco. Pacific slope: Lempa, Goascorán, Nacaome, Choluteca and Negro.

Remarks: Bussing (2002) describes the distributional range for *R. bouchellei* as across the Atlantic slope of Central America from the Patuca River in Honduras to the Matina River in Costa Rica. Martin (1972) reported *R. bouchellei* (field numbers MMH 1969-14, MMH 1969-19, material deposited at LACM) in the Sico-Tinto o Negro River, which is located west of the Patuca River. We consider the distributional range of *R. bouchellei* to extend from the Sico-Tinto o Negro River in Honduras to the Matina River in Costa Rica, in the Atlantic slope of Central America.

SILURIFORMES

Ariidae. Peripheral.

Cathorops higuchii Marceniuk and Betancur-R., 2008. Higuchi's Sea Catfish, bagre de Higuchi. Native.

Department: Gracias a Dios. Drainage: Atlantic slope: Coco.

Remarks: Details about the distribution of this species in Honduras and Mesoamerica are given by Marceniuk and Betancur-R. (2008).

Cathorops melanopus (Günther, 1864). Dark sea catfish, bagre prieto. Native.

Departments: Cortés and Santa Bárbara. Drainages: Atlantic slope: Motagua and Ulúa.

Remarks: *C. melanopus* was thought to be endemic to the Motagua river basin in Guatemala and possibly occurring in Honduras (Marceniuk & Betancur-R. 2008). Vouchers LACM 32355-1 collected in the Río Ulúa in the department of Santa Bárbara, and LACM 32405-1 collected in the Río Blanco (tributary of the Ulúa River) represent the first records of *C. melanopus* in Honduras as well as a significant range extension. Furthermore, Vaux (1985) collected *C. melanopus* at the Yure River (at the confluence with the Quebrada de Chamo), which is a tributary of the Humuya River, Río Ulúa system.

Cathorops sp. Raredon's sea catfish, bagre de Raredon. Native.

Remarks: The distributional range of the Raredon's sea catfish as reported by Marceniuk *et al*. (in press), extends from Sinaloa México to the department of La Libertad to La Unión in El Salvador. In the description of the species, Marceniuk *et al*. (in press) included material collected in La Unión Bay. La Unión Bay is a small body of water located in the Gulf of Fonseca bordering Honduras and El Salvador. Based on the geographical location of the La Unión Bay, it is most likely that the Raredon's sea catfish also occurs in Honduras (R. Betancur-R. pers. comm.).

Cathorops steindachneri (Gilbert & Starks 1904). Steindachner's sea catfish, bagre de Steindachner. Native.

Remarks: The distributional range of *C. steindachneri* extends from El Salvador to Panama (Marceniuk *et al*. in press). This species has been reported from the Gulf of Fonseca in El Salvador, but is also potentially present on the Honduran side of the Gulf of Fonseca (R. Betancur-R. pers. comm.; Marceniuk *et al*. in press), since the Gulf of Fonseca is a shared body of water between these two countries.

Cathorops taylori (Hildebrand, 1925). Taylor's sea catfish, bagre de Taylor. Native.

Remarks: While no specimens of this species have been collected in Honduras, its occurrence in the country is very likely (R. Betancur-R. pers. comm.). Marceniuk *et al*. (in press) listed specimens collected in La Unión Bay, which is a small shared body of water at the Honduras – El Salvador border.

Sciades assimilis (Günther, 1864). Maya sea catfish, bagre maya. Native.

Department: Cortés. Drainage: Atlantic slope: Chamelecón.

Sciades guatemalensis (Günther, 1864). Widehead sea catfish, bagre guatemalense. Native.

Departments: Choluteca and Valle. Drainages: Pacific slope: Nacaome and Choluteca.

Sciades seemanni (Günther, 1864). Tete sea catfish, bagre tete. Native.

Departments: Choluteca and Valle. Drainages: Pacific slope: Lempa, Goascorán, Nacaome and Negro.

Ictaluridae. Primary.

Ictalurus punctatus (Rafinesque, 1818). Channel catfish, bagre de canal. Exotic.

Departments: Comayagua, Cortés and Santa Bárbara. Drainages: Atlantic slope: Chamelecón and Ulúa.

Remarks: *I. punctatus* was introduced in Honduras in the early 1960s for aquaculture purposes by technicians of the United Fruit Company. During Hurricane Fifi in 1975, many fish escaped into the Ulúa and Chamelecón Rivers. In the environmental impact study prior to building the El Cajón reservoir, Vaux (1985) reported *I. punctatus*. There is also evidence of at least one fish farmer in Comayagua that has been capable of reproducing catfish locally (D. Meyer pers. comm.).

Heptapteridae. Primary.

Rhamdia guatemalensis (Günther, 1864). Guatemalan chulin, barbudo de Guatemala. Native.

Departments: Atlántida, Choluteca, Colón, Comayagua, Copán, Cortés, El Paraíso, Francisco Morazán, Gracias a Dios, Intibucá, La Paz, Olancho, Santa Bárbara, Valle and Yoro. Drainages: Atlantic slope: Motagua, Chamelecón, Ulúa, Leán, Cangrejal, Lislis, Aguán, Sico-Tinto, Plátano, Patuca, Warunta and Coco. Pacific slope: Lempa, Goascorán, Nacaome, Choluteca and Negro.

Remarks: Silfvergrip's (1996) revision of the genus *Rhamdia* synonymized *R. guatemalensis* with *R. quelen*. Perdices *et al*. (2002) analyzed the evolutionary history of the genus in Central America and concluded that South American *R. quelen* are evolutionarily distinct from *R. guatemalensis* from Central America. Here we treat *R. guatemalensis* as a distinct species.

Rhamdia laticauda (Kner, 1858). Filespine Chulin, chulín. Native.

Departments: Atlántida, Comayagua, Copán, Cortés, El Paraíso, Francisco Morazán, Intibucá, Lempira, Olancho and Santa Bárbara. Drainages: Atlantic slope: Motagua, Ulúa, Chamelecón, Leán, Cangrejal, Lislis, Aguán, Sico-Tinto, Plátano, Patuca, Warunta and Coco. Pacific slope: Lempa and Choluteca.

GYMNOTIFORMES

Gymnotidae. Primary.

Gymnotus cylindricus La Monte, 1935. Knifefish, pez cuchillo. Native.

Departments: Atlántida, Choluteca, Colón, Comayagua, Cortés, Gracias a Dios, Santa Bárbara and Yoro. Drainages: Atlantic slope: Motagua, Chamelecón, Ulúa, Leán, Cangrejal, Lislis, Aguán, Sico-Tinto, Plátano, Patuca, Warunta and Coco. Pacific slope: Choluteca.

Remarks: Albert and Miller (1995) stated that *G. cylindricus* occurs only in drainages on the Atlantic slope of Central America. However, some of the material they examined in their paper came from localities in the Honduran Pacific slope, wrongly identified as Atlantic slope localities. This material includes: UMMZ 155831, UMMZ 188296, UMMZ 188297 (see Albert & Miller 1995; Albert *et al*. 1999; Albert 2001). Further, Bussing (2002) reported *G. cylindricus* from the Yeguare River, a tributary of the Choluteca River, which drains to the Gulf of Fonseca on the Honduran Pacific slope.

Gymnotus maculosus Albert and Miller, 1995. Spotted knifefish, cuchillo manchado. Native.

Departments: Choluteca and Valle. Drainages: Pacific slope: Lempa, Goascorán, Nacaome, Choluteca, and Negro.

Remarks: Albert and Miller (1995) did not include material from Honduras in the description of the species. However, Bussing (2002) and Miller *et al*. (2005) report a continuous distribution extending from southern México to Costa Rica, including the Honduran Pacific slope.

BATRACHOIDIFORMES

Batrachoididae. Peripheral.

Batrachoides gilberti Meek and Hildebrand, 1928. Large-eye toadfish, sapo ojón. Native.

Department: Gracias a Dios. Drainage: Atlantic slope: Patuca

Remarks: The following five vouchers collected in Brus Laguna represent the first report of *B. gilberti* in Honduras: FMNH 84545-84549.

GOBIESOCIFORMES

Gobiesocidae. Peripheral.

Gobiesox strumosus Cope, 1870. Skilletfish, cazoleta. Native.

Department: Cortés. Drainage: Atlantic slope: Chamelecón.

Remarks: The following two vouchers collected in the Cieneguita River (GCRL 4446) and the Tulián River (GCRL 4459) represents the first report of *G. strumosus* in Honduras.

ATHERINIFORMES

Atherinopsidae. Peripheral.

Atherinella argentea Chernoff, 1986. Moon silverside, plateadita de la luna. Native.

Departments: Choluteca and Valle. Drainages: Pacific slope: Lempa, Goascorán, Nacaome, Choluteca and Negro.

Atherinella blackburni (Schultz, 1949). Beach silverside, plateadita playera. Native. Departments: Colón and Islas de la Bahía. Drainages: Atlantic slope: Lislis and Roatán. Remarks: The following two vouchers collected in a stream in the island of Roatán; FMNH 84961, and UMMZ 199672 collected 5 km west of the city of Trujillo represent the first report of *A. blackburni*

in Honduras.

Atherinella guija (Hildebrand, 1925). Guija silverside, plateadita del Guija. Native. Departments: Choluteca and Valle. Drainages: Pacific slope: Lempa, Goascorán, Nacaome and Choluteca.

Atherinella meeki (Miller, 1907). Meek's silverside, plateadita de Meek. Native. Department: Cortés. Drainages: Atlantic slope: Motagua and Chamelecón. Remarks: *A. meeki* was described by Miller (1907) from material collected in the Motagua River. *A. meeki* has been considered endemic to the Motagua River in Guatemala since its description. Voucher GCRL 6004 identified as *A. meeki*, collected in the Chivana River which is a tributary of the Chamelecón River in Honduras, represents the first report of *A. meeki* in Honduras as well as an extension of its distributional range.

Atherinella milleri (Bussing, 1979). Miller's silverside, plateadita de Miller. Native. Departments: Atlántida, Colón and Gracias a Dios. Drainages: Atlantic slope: Cangrejal, Lislis, Aguán, Sico-Tinto, Plátano, Patuca, Warunta and Coco.

Atherinella pachylepis (Günther, 1864). Thickscale silverside, plateadita de escama gruesa. Native.

Departments: Choluteca and Valle. Drainages: Pacific slope: Lempa, Goascorán, Nacaome, Choluteca and Negro.

CYPRINODONTIFORMES

Rivulidae. Secondary.

Kryptolebias marmoratus (Poey, 1880). Mangrove rivulus, almirante de manglar. Native.

Departments: Atlántida and Islas de la Bahía. Drainages: Atlantic slope: Cangrejal, Roatán and Guanaja.

Remarks: Voucher FLMNH 116518 from the island of Guanaja and USM 31675 collected in the Río Cangrejal represent the first report of *K. marmoratus* in Honduras.

Rivulus tenuis (Meek, 1904). Maya rivulus, almirante maya. Native.

Departments: Atlántida and Cortés. Drainages: Atlantic slope: Motagua, Chamelecón, Ulúa, Leán and Cangrejal.

Profundulidae. Secondary.

Profundulus guatemalensis (Günther, 1866). Guatemalan killifish, escamudo de Guatemala. Native.

Departments: Copán, Intibucá and Lempira. Drainages: Atlantic slope: Motagua and Ulúa. Pacific slope: Lempa.

Profundulus portillorum Matamoros and Schaefer, 2010. Ulúan killifish, escamudo del Ulúa. Endemic.

Departments: Comayagua and Francisco Morazán. Drainages: Atlantic slope: Ulúa. Pacific slope: Nacaome..

Profundulus sp. 2. Santa Barbara killifish, escamudo de Santa Barbara. Endemic.

Department: Santa Bárbara. Drainage: Atlantic slope: Ulúa.

Remarks: This species is pending description.

Poeciliidae. Secondary.

Alfaro cultratus (Regan, 1908). Alfaro's livebearer, olomina de Alfaro. Native.

Departments: Gracias a Dios. Drainage: Atlantic slope: Coco.

Remarks: The known distributional range of *A. cultratus* extends from the Prinzapolka River in the Nicaraguan Mosquitia to the Cricamola River in Panama, in the Atlantic slope of Central America (Bussing 2002). USM collection field number WAM08-06 collected in the Rus Rus River which is a tributary of the Coco River in the Honduran Mosquitia, department of Gracias a Dios, represents the first report of *A. cultratus* in Honduras, as well as a range extension.

Alfaro huberi (Fowler, 1923). Huber's livebearer, olomina de Huber. Native.

Departments: Atlántida, Cortés, Comayagua, Copán, El Paraíso, Francisco Morazán, Gracias a Dios, Intibucá, La Paz, Lempira, Olancho, Santa Bárbara and Yoro. Drainages: Atlantic slope: Motagua, Chamelecón, Ulúa, Leán, Cangrejal, Lislis, Aguán, Sico-Tinto, Plátano, Patuca, Warunta and Coco. Pacific slope: Lempa and Choluteca.

Belonesox belizanus Kner, 1860. Pike killifish, picudito. Native.

Departments: Atlántida, Cortés, Colón, Gracias a Dios and Yoro. Drainages: Atlantic slope: Motagua, Chamelecón, Ulúa, Leán, Cangrejal, Lislis, Aguán, Sico-Tinto, Plátano, Patuca, Warunta and Coco.

Gambusia nicaraguensis Günther, 1866. Nicaraguan mosquitofish, bubuchita de Nicaragua. Native.

Departments: Atlántida, Colón, Cortés, Gracias a Dios, Islas de la Bahía and Yoro.

Drainages: Atlantic slope: Motagua, Chamelecón, Ulúa, Leán, Cangrejal, Lislis, Aguán, Sico-Tinto, Plátano, Patuca, Warunta, Coco, Roatán and Guanaja.

Heterandria anzuetoi Rosen and Bailey, 1979. Anzueto's killifish, olomina de Anzueto. Native.

Departments: Atlántida , Colón, Comayagua, Copán, Cortés, Francisco Morazán, Gracias a Dios, Olancho, Santa Bárbara and Yoro. Drainages: Atlantic slope: Motagua, Ulúa, Chamelecón, Leán, Cangrejal, Lislis, Aguán, Sico-Tinto, Plátano, Patuca, Warunta and Coco. Pacific slope: Lempa and Choluteca.

Heterandria bimaculata (Heckel, 1848). Spottail killifish, olomina de dos manchas. Native.

Departments: Atlántida and Cortés. Drainages: Atlantic slope: Motagua and Cangrejal.

Phallichthys amates (Miller, 1907). Merry widow, bubuchita de amates. Native.

Departments: Atlántida, Cortés, Colón, Gracias a Dios, Olancho and Yoro. Drainages: Atlantic slope: Motagua, Chamelecón, Ulúa, Leán, Cangrejal, Lislis, Aguán, Sico-Tinto, Plátano, Patuca, Warunta and Coco.

Poecilia gilli (Kner, 1863). Gill's Molly, olomina de Gill. Native.

Departments: Atlántida, Choluteca, Colón, Comayagua, Copán, Cortés, El Paraíso, Francisco Morazán, Gracias a Dios, Intibucá, La Paz, Lempira, Ocotepeque, Olancho and Santa Bárbara. Drainages: Atlantic slope: Motagua, Chamelecón, Ulúa, Leán, Cangrejal, Lislis, Aguán, Sico-Tinto, Plátano, Patuca, Warunta, Coco and Lempa. Pacific slope: Goascorán, Nacaome, Choluteca and Negro.

Remarks: The distribution of *P. gillii* presented here is based on Bussing (2002).

Poecilia marcellinoi Poeser, 1995. Marcellino's Molly, olomina de Marcellino. Native. Departments: Choluteca, Comayagua, Copán, Cortés, El Paraíso and Santa Bárbara. Drainages: Atlantic slope: Motagua and Ulúa. Pacific slope: Lempa and Choluteca. Remarks: Miller (1907) found *P. marcellinoi* in the Motagua River basin. In redescribing the species, Poeser (1995) listed a number of localities from the Lempa River in El Salvador. Because Salvadorian drainages all have headwaters in Honduras, it would not be surprising to find this species on the Honduran side of the Lempa River. Furthermore, Villa (1982) listed a *Poecilia* sp. from the Ulúa River in Honduras. This species is considered by Poeser (unpubl. data) to be *P. marcellinoi*. Finally, we collected *P. marcellinoi* in the Choluteca River drainage, meaning the Honduran distribution of *P. marcellinoi* may be broader than presented here.

Poecilia sp. 1. Miller's Molly, olomina de Miller. Endemic.

Departments: Atlántida, Cortés, Gracias a Dios and Olancho. Drainages: Atlantic slope: Chamelecón, Ulúa, Leán, Cangrejal, Lislis, Aguán and Sico-Tinto.

Poecilia sp. 2. Cangrejal Molly, olomina del Cangrejal. Endemic.

Department: Atlántida. Drainage: Atlantic slope: Cangrejal.

Poecilia sp. 3. Pacific Molly, olomina del Pacifico. Endemic.

Departments: Choluteca and Francisco Morazán. Drainage: Pacific slope: Choluteca.

Poecilia orri Fowler, 1943. Mangrove Molly, olomina de manglar. Native.

Departments: Atlántida, Colón, Cortés, Gracias a Dios, Islas de la Bahía and Yoro. Drainages: Atlantic slope: Motagua, Chamelecón, Ulúa, Leán, Cangrejal, Lislis, Aguán, Sico-Tinto, Plátano, Patuca, Roatán and Guanaja.

Poeciliopsis pleurospilus (Günther, 1866). Largespot livebearer, bubucha punteada. Native.

Departments: Choluteca, Comayagua, Copán, Cortés, Francisco Morazán, Intibucá, Lempira, Santa Bárbara and Valle. Drainages: Atlantic slope: Motagua, Chamelecón and Ulúa. Pacific slope: Lempa, Goascorán, Nacaome and Choluteca.

Remarks: *P. gracilis* and *P. pleurospilus* were placed in synonymy by Rosen and Bailey (1963). Miller *et al*. (2005) recognized *P. gracilis* as a distinct species with a range restricted to eastern México and *P. pleurospilus* as a second species occurring in México and Honduras.

Poeciliopsis turrubarensis (Meek, 1912). Barred livebearer, bubucha rayada. Native.

Departments: Choluteca, Francisco Morazán, and Valle. Drainages: Pacific slope: Lempa, Goascorán, Nacaome, Choluteca and Negro.

Xiphophorus helleri Heckel, 1848. Green swordtail, cola de espada. Native.

Departments: Copán and Santa Bárbara. Drainages: Atlantic slope: Motagua and Chamelecón.

Remarks: Miller *et al*. (2005) restricts the distributional range of *X. helleri* to the Nautla River in Mexico, south to the Usumacinta River in Guatemala, and also to the Sarstún River in Belize. In this research, we have collected *X. helleri* in the Motagua River drainage (vouchers USM 34171 from the Copan River and USM 31500 from the Blanco River, which is a tributary of the Copan River) and in the Chamelecón River (USM field number WAM09-31). Accordingly, the distributional range of *X. helleri* is larger than that proposed by Miller *et al*. (2005).

Xiphophorus mayae Meyer and Schartl, 2002. Mayan swordtail, cola de espada maya. Native.

Departments: Atlántida, Cortés and Santa Bárbara. Drainages: Atlantic slope: Chamelecón, Ulúa, Leán and Cangrejal.

Remarks: Meyer and Schartl (2002) suggest that *X. mayae* may occur in the Chamelecón and Lancetilla Rivers in Honduras. Voucher USM 31836 confirm the ocurrance of *X. mayae* in Lancetilla River. Vouchers USM 34338 collected in the Blanco River at Pulapanzack in the Ulúa River Drainage, USM 31076 from the Cuero River, USM 31144 from Las Camelias River, USM 31121 from Santiago River and USM 33993 from the Danto River represent a range expansion for *X. mayae*.

Anablepidae. Secondary.

Anableps dowei Gill, 1861. Northern four-eyed, cuatrojos. Native.

Departments: Choluteca, El Paraíso and Valle. Drainages: Pacific slope: Lempa, Goascorán, Nacaome, Choluteca and Negro.

BELONIFORMES

Belonidae. Peripheral.

Strongylura marina (Walbaum, 1792). Atlantic needlefish, agujón verde. Native.

Departments: Atlántida, Cortés, Gracias a Dios and Islas de la Bahía. Drainages: Atlantic slope: Chamelecón, Cangrejal, Patuca, Roatán and Guanaja.

Strongylura notata (Poey, 1860). Redfin needlefish, agujón negro. Native.

Department: Islas de la Bahía. Drainage: Atlantic slope: Roatán.

Remarks: USM field number WAM08-105 from a freshwater stream in the island of Roatán represents the first report of *S. notata* in Honduras.

Strongylura timucu (Walbaum, 1792). Timucu, agujón timucú. Native.

Departments: Cortés, Gracias a Dios and the Bay Island. Drainages: Atlantic slope: Chamelecón, Patuca and Roatán.

Hemiramphidae. Peripheral.

Hyporhamphus roberti hildebrandi Jordan and Evermann, 1927. Central American halfbeak, agujeta. Native.

Departments: Comayagua, Cortés, Gracias a Dios, Islas de la Bahía, Santa Bárbara and Yoro. Drainages: Atlantic slope: Ulúa, Patuca, Roatán and Guanaja.

Remarks: Matamoros *et al*. (2007) reported USM 31216 and USM 33917 as the first records of this species in Honduras. *H. roberti hildebrandi* was found to be common in Lake Yojoá and El Cajon reservoir.

Hyporhamphus unifasciatus (Ranzani, 1841). Atlantic silverstripe halfbeak, agujeta del Atlántico. Native.

Department: Cortés. Drainage: Atlantic slope: Chamelecón.

SYNGNATHIFORMES

Syngnathidae. Peripheral.

Microphis brachyurus lineatus (Kaup, 1856). Opossum pipefish, pez pipa culebra. Native.

Departments: Atlántida and Cortés. Drainages: Atlantic slope: Chamelecón, Leán, Cangrejal and Lislis.

Remarks: The following vouchers represent the first report of *M. brachiurus lineatus* in Honduras: Chamelecón River drainage - USM 31922 from Chivana River, USM 31902 from the Tulián River; Leán River drainage - USM 31804 and USM 31843 from

Lancentilla River; Cangrejal River drainage - USM 31685 from the Cangrejal River, USM 31751, and USM 31764 from Salado River; Lislis River drainage - USM 31465, USM 31723, USM 31734 from the Papaloteca River, and USM 34042 from the Mármol River west of the city of Trujillo.

Pseudophallus mindii (Meek & Hildebrand, 1923). Freshwater pipefish, pez pipa de agua dulce. Native.

Department: Atlántida. Drainages: Atlantic slope: Leán and Lislis.

Remarks: Voucher USM 31806 collected in Lancetilla River represents the first report of *P. mindii* in Honduras. *P. mindii* has also been collected in the Papaloteca River east of La Ceiba (C. Small pers. comm.).

Pseudophallus starksii (Jordan & Culver, 1895). Yellowbelly pipefish, pez pipa de río. Native.

Department: Valle. Drainage: Pacific slope: Nacaome.

Syngnathus pelagicus Linnaeus, 1758. Sargassum pipefish, pez pipa oceánico. Native.

Department: Gracias a Dios. Drainage: Atlantic slope: Patuca.

Remarks: Voucher FMNH 84369 collected in Brus Laguna represents the first report of *S. pelagicus* in Honduras.

Syngnathus scovelli (Evermann & Kendall, 1896). Gulf pipefish, pez pipa del Golfo. Native.

Department: Gracias a Dios. Drainage: Atlantic slope: Patuca.

SYNBRANCHIFORMES

Synbranchidae. Secondary.

Ophisternon aenigmaticum Rosen and Greenwood, 1976. Obscure swamp eel, anguila falsa. Native.

Departments: Atlántida, Copán and Cortés. Drainages: Atlantic slope: Motagua, Chamelecón, Ulúa, Leán and Cangrejal.

Synbranchus marmoratus Bloch, 1795. Marbled swamp eel, anguila de lodo. Native.

Departments: Atlántida, Choluteca, Colón, Comayagua, Copán, Cortés, El Paraíso, Francisco Morazán, Intibucá, La Paz, Olancho, Santa Bárbara, Gracias a Dios, Valle and Yoro. Drainages: Atlantic slope: Motagua, Chamelecón, Ulúa, Leán, Cangrejal, Lislis, Aguán, Sico-Tinto, Plátano, Patuca, Warunta and Coco. Pacific slope: Lempa, Goascorán, Nacaome, Choluteca and Negro.

PERCIFORMES

Centropomidae. Peripheral.

Centropomus ensiferus Poey, 1860. Swordspine snook, robalo de espolón. Native.

Departments: Cortés and Gracias a Dios. Drainage: Atlantic slope: Chamelecón, Patuca and Coco.

Centropomus nigrescens Günther, 1864. Black snook, robalo negro. Native.

Department: Choluteca. Drainage: Pacific slope: Choluteca.

Centropomus parallelus Poey, 1860. Smallscale fat snook, robalo escama pequeña. Native.

Departments: Cortés, Gracias a Dios and Santa Bárbara. Drainages: Atlantic slope: Chamelecón, Ulúa and Patuca.

Centropomus pectinatus Poey, 1860. Tarpon snook, robalo grande. Native.

Departments: Gracias a Dios and Islas de la Bahía. Drainages: Atlantic slope: Plátano, Patuca and Roatán.

Centropomus undecimalis (Bloch, 1792). Common snook, robalo blanco. Native.

Departments: Atlántida, Cortés, Gracias a Dios and Islas de la Bahía. Drainages: Atlantic slope: Motagua, Chamelecón, Ulúa, Leán, Cangrejal, Patuca and Roatán.

Centropomus unionensis Bocourt, 1868. Humpback snook, robalo serrano. Native.

Department: Choluteca. Drainage: Pacific slope: Choluteca.

Centrarchidae. Primary.

Micropterus salmoides (Lacepède, 1802). Largemouth bass, lobina negra. Exotic.

Remarks: *Micropterus salmoides* was introduced into Lake of Yojoá as a sport fish (Ostmark 1964; Cruz 1985). The literature suggests an introduction in the early 1950s (Ostmark 1964; Cruz 1985). However, an earlier arrival in Honduras is possible. Cruz (1985) studied the biology of *M. salmoides* in the Lake of Yojoá and provided a synopsis of the introduction. Vaux (1985) collected *M. salmoides* in the Laguna de Yure which is adjacent to the Lake of Yojoá. We have not collected *M. salmoides* outside of the previously mentioned localities.

Carangidae. Peripheral.

Caranx bartholomaei (Cuvier, 1833). Yellow jack, cojinuda amarilla. Native.

Department: Islas de la Bahía. Drainage: Atlantic slope: Roatán.

Remarks: USM field number WAM08-105 collected in freshwater streams in the island of Roatán represent the first report of *C. bartholomaei* in Honduras.

Caranx latus Agassiz,1831. Horse-eye jack, jurel blanco. Native.

Departments: Atlántida and Cortés. Drainages: Atlantic slope: Chamelecón, Leán and Cangrejal.

Oligoplites saurus (Bloch & Schneider, 1801). Leather jack, piña sietecueros. Native

Department: Cortés. Drainage: Atlantic slope: Chamelecón.

Remarks: Voucher USM 34351 collected in the Tulián River, a tributary of the Chamelecón River, represents the first report of *O. saurus* in Honduras.

Trachinotus goodei Jordan and Evermann, 1896. Palometa, pámpano listado. Native.

Department: Cortés. Drainage: Atlantic slope: Chamelecón.

Lutjanidae. Peripheral.

Lutjanus apodus (Walbaum, 1792). Schoolmaster, pargo amarillo. Native.

Departments: Atlántida, Cortés and Islas de la Bahía. Drainages: Atlantic slope: Chamelecón, Cangrejal and Roatán.

Lutjanus jocu (Bloch & Schneider, 1801). Dog snapper, pargo jocu. Native.

Departments: Cortés and Islas de la Bahía. Drainages: Atlantic slope: Chamelecón and Roatán.

Gerreidae. Peripheral.

Diapterus auratus Ranzani, 1842. Irish pompano, mojarra guacha. Native.

Departments: Cortés and Islas de la Bahía. Drainages. Atlantic slope: Chamelecón and Roatán.

Eucinostomus argenteus Baird and Girard, 1855. Spotfin mojarra, mojarra plateada. Native.

Departments: Colón, Cortés and Gracias a Dios. Drainages: Atlantic slope: Chamelecón, Lislis and Patuca.

Eucinostomus harengulus Goode and Bean, 1879. Tidewater mojarra, mojarra costera. Native.

Department: Islas de la Bahía. Drainage: Atlantic slope: Roatán.

Remarks: Vouchers collected in freshwater streams in the island of Roatán (USM field number WAM08-105) represent the first report *E. harengulus* in Honduras.

Eucinostomus jonesii (Günther, 1879). Slender mojarra, mojarra flaca. Native.

Department: Islas de la Bahía. Drainage: Atlantic slope: Roatán.

Remarks: Vouchers collected in freshwater streams in the island of Roatán (USM field number WAM08-106 and WAM08-114) represent the first report of *E. jonesii* in Honduras.

Eucinostomus melanopterus (Bleeker, 1863). Flagfin mojarra, mojarrita de ley. Native.

Departments: Colón, Cortés and Islas de la Bahía. Drainages: Chamelecón, Lislis and Guanaja.

Eugerres plumieri (Cuvier, 1830). Striped mojarra, mojarra rayada. Native.

Department: Gracias a Dios. Drainage: Atlantic slope: Coco.

Gerres cinereus (Walbaum, 1792). Yellow fin mojarra, mojarra plateada. Native.

Departments: Cortés and Islas de la Bahía. Drainages: Atlantic slope: Chamelecón, Roatán and Guanaja.

Haemulidae. Peripheral.

Pomadasys crocro (Cuvier, 1830). Burro grunt, corocoro crocro. Native.

Departments: Atlántida, Colón, Cortés, Islas de la Bahía and Santa Bárbara. Drainages: Atlantic slope: Chamelecón, Ulúa, Leán, Cangrejal, Lislis, Aguán, Roatán and Guanaja.

Sciaenidae. Peripheral.

Bairdiella ronchus (Cuvier, 1830). Ground croaker, ronco rayado. Native.

Department: Cortés. Drainage: Atlantic slope: Chamelecón.

Cynoscion praedatorius (Jordan & Gilbert, 1889). Boccone weakfish, corvina bocona. Native.

Department: Choluteca. Drainage: Pacific slope: Choluteca.

Remarks: The vouchers CAS 3206 and CAS 3207 collected in the Pedregal River, a tributary of the Choluteca River drainage, represent the first records of *C. praedatorius* in Honduras.

Menticirrhus americanus (Linnaeus, 1758). Southern kingfish, berrugato zorro. Native.

Department: Cortés. Drainage: Pacific slope: Chamelecón.

Paralonchurus dumerilii (Bocourt, 1869). Suco croaker, suco rayado. Native.

Department: Choluteca. Drainage: Pacific slope: Choluteca.

Umbrina broussonnetii Cuvier, 1830. Striped drum, corvina rayada. Native.

Department: Cortés. Drainage: Atlantic slope: Chamelecón.

Remarks: Voucher GCRL 21697 collected in the Omoa River, which is part of the Chamelecón River system, represents the first record of *U. broussonnetii* in Honduras.

Polynemidae. Peripheral.

Polydactylus virginicus (Linnaeus, 1758). Barbu, barbudo barbú. Native.

Department: Gracias a Dios. Drainage: Atlantic slope: Patuca.

Mugilidae. Peripheral.

Agonostomus monticola (Bancroft, 1834). Mountain mullet, tepemechín. Native.

Departments: Atlántida, Colón, Cortés, El Paraíso, Gracias a Dios, Islas de la Bahía, Santa Bárbara and Yoro. Drainages: Atlantic slope: Motagua, Chamelecón, Ulúa, Leán, Cangrejal, Lislis, Aguán, Sico-Tinto, Plátano, Patuca, Coco, Warunta, Guanaja and Roatán. Pacific slope: Choluteca.

Joturus pichardi Poey, 1860. Bobo mullet, cuyamel. Native.

Departments: Atlántida, Colón, Cortés, Gracias a Dios. Drainages: Atlantic slope: Motagua, Chamelecón, Ulúa, Leán, Cangrejal, Lislis, Aguán, Sico, Plátano, Patuca, Warunta and Coco.

Mugil curema Valenciennes, 1836. White mullet, lisa blanca. Native.

Departments: Cortés, Gracias a Dios, Islas de la Bahía and Choluteca. Drainages: Atlantic slope: Chamelecón, Patuca, Roatán and Guanaja. Pacific slope: Choluteca.

Mugil liza Valenciennes, 1836. Liza, lisa. Native.

Departments: Cortés. Drainage: Atlantic slope: Chamelecón.

Remarks: voucher UMMZ 173259 (originally identified as *M. brasiliensis*) collected in the Omoa River, which is part of the Chamelecón River system, represents the first record of *M. liza* in Honduras.

Cichlidae. Secondary.

Amatitlania nigrofasciata (Günther, 1867). Convict cichlid, conguito convicto. Native.

Departments: Choluteca, El Paraíso, Francisco Morazán, Gracias a Dios, Intibucá, Olancho, Valle and Yoro. Drainages: Atlantic slope: Lislis, Aguán, Sico-Tinto, Patuca, Warunta and Coco. Pacific slope: Lempa, Goascorán, Nacaome, Choluteca and Negro.

Amatitlania siquia Schmitter-Soto, 2007. Siquia cichlid, conguito del Siquia. Native.

Departments: El Paraíso, Francisco Morazán, and Gracias a Dios. Drainages: Atlantic slope: Coco. Pacific slope: Choluteca.

Remarks: The locality from the Yeguare River listed in Schmitter-Soto (2007) as an Atlantic locality is an error. The Yeguare River is a tributary of the Choluteca River which drains into the Gulf of Fonseca. Thus, in Honduras, *A. siquia* is found in both the Pacific and Atlantic slopes.

Amphilophus alfari (Meek, 1907). Pastel Cichlid, mojarra pastel. Native.

Departments: Gracias a Dios and Olancho. Drainages: Atlantic slope: Plátano, Patuca, Warunta and Coco.

Amphilophus hogaboomorum (Carr & Giovannoli, 1950). Cholutecan Mojarra, Mojarra de Choluteca. Endemic.

Departments: Choluteca. Drainages: Pacific slope: Choluteca and Negro.

Remarks: The distribution of this fish was limited to the lower reaches of the Choluteca River. We collected this species in the Negro River (USM field number WAM08-18) near the community El Ojo de Agua, and in a second locality in the lower reaches of the Choluteca River (USM 31935) near the community of El Mal Paso on the road to Orocuina. These two reports represent a range extension for *A. hogaboomorum*.

Amphilophus longimanus (Günther, 1867). Redbreast cichlid, mojarra pecho rojo. Native.

Departments: Choluteca, El Paraíso, Francisco Morazán, Gracias a Dios, Olancho, Valle and Yoro, Drainages: Atlantic slope: Aguán, Sico-Tinto, Plátano, Patuca, Warunta and Coco. Pacific slope: Nacaome, Choluteca and Negro.

Amphilophus robertsoni (Regan, 1905). Honduran cichlid, mojarra hondureña. Native.

Departments: Atlántida, Colón, Cortés, Gracias a Dios, Santa Bárbara and Yoro.

Drainages: Atlantic slope: Motagua, Chamelecón, Ulúa, Leán, Cangrejal, Lislis, Aguán, Sico-Tinto, Plátano and Patuca.

Remarks: Greenfield and Thomerson (1997) limited the southernmost range of this species to the department of Atlántida. However, Miller *et al*. (2005) listed UMMZ 188235 as *A. robertsoni* collected in the upper Patuca River in eastern Honduras.

Archocentrus centrarchus (Gill, 1877). Flier cichlid, mojarrita rayada. Native. Department: Choluteca. Drainages: Pacific slope: Choluteca and Negro.

Remarks: Schmitter-Soto (2007) states that *A. centrarchus* is found in drainages of the Gulf of Fonseca. *A. centrarchus* has been reported in Honduras only in two Gulf of Fonseca drainages, the Negro and Choluteca Rivers (Cruz & Espinal, 1989), but there is no evidence of its occurrence in the Nacaome and Goascorán Rivers.

Archocentrus multispinosus (Günther, 1867). Rainbow cichlid, mojarrita arcoiris. Native. Departments: Choluteca and Gracias a Dios. Drainages: Atlantic slope: Patuca, Warunta and Coco. Pacific slope: Choluteca and Negro.

Remarks: Schmitter-Soto (2007) found the northernmost limit of this species on the Pacific slope of Central America in the Guasaule River in Nicaragua. We collected this species in the Negro River (USM field number WAM08-20) and the Choluteca River (USM 31494). In addition, Cruz and Espinal (1989) also reported *A. multispinosus* in the Negro and Choluteca Rivers.

'Cichlasoma' trimaculatum (Günther, 1867). Threespot cichlid, mojarra prieta. Native. Department: Valle. Drainages: Pacific slope: Lempa and Goascorán.

'Cichlasoma' urophthalmus (Günther, 1862). Mayan cichlid, mojarra maya. Native. Departments: Atlántida and Cortés. Drainages: Atlantic slope: Motagua, Chamelecón, Ulúa, Leán and Lislis.

Cryptoheros cutteri (Fowler, 1932). Honduran congo, congo hondureño. Native.

Departments: Atlántida, Colón, Comayagua, Copán, Cortés, Francisco Morazán, Santa Bárbara and Yoro. Drainages: Atlantic slope: Motagua, Chamelecón, Ulúa, Leán, Cangrejal, Lislis, Aguán, Sico-Tinto and Patuca. Pacific slope: Choluteca.

Remarks: Schmitter-Soto (2007) restricts the distribution of this species to the Atlantic slope drainages of Honduras and Guatemala with its easternmost boundary at the Aguán River in Honduras. We collected *C. cutteri* in the Honduran Pacific slope (USM field number WAM08-43; Choluteca River basin, Valle de Zamorano). This collection represents a range extension for *C. cutteri*.

Hypsophrys nicaraguensis (Günther, 1864). Butterfly cichlid, moga amarilla. Native.

Department: Gracias a Dios. Drainage: Atlantic slope: Coco.

Remarks: The northern most reported boundary of *H. nicaraguensis* is a locality in the Nicaraguan side of the Coco River bordering Honduras (Schmitter-Soto, 2007). During this project *H. nicaraguensis* was colleted in the Rus Rus River on the Honduran side of the Coco River (USM field numbers WAM08-05 and WAM08-08). These records represent a range expansion for the species and a new species report for Honduras.

Oreochromis mossambicus (Peters, 1852). Mozambique tilapia, tilapia mozambiqueña. Exotic.

Departments: Intibucá, La Paz. Drainage: Pacific slope: Lempa.

Remarks: *O. mossambicus* was introduced to Honduras by a group of Taiwanese scientists on a mission to bring common carp and tilapia aquaculture to Central America (D. Meyer pers. comm.).

Oreochromis niloticus (Linnaeus, 1758). Nile tilapia, tilapia del Nilo. Exotic.

Departments: Atlántida, Choluteca, Colón, Comayagua, Copán, Cortés, El Paraíso, Francisco Morazán, Gracias a Dios, Intibucá, La Paz, Lempira, Ocotepeque, Olancho and Santa Bárbara. Drainages: Atlantic slope: Motagua, Chamelecón, Ulúa, Leán, Cangrejal, Lislis, Aguán, Sico-Tinto, Plátano, Patuca, Warunta and Coco. Pacific slope: Lempa, Goascorán, Nacaome, Choluteca and Negro.

Remarks: *O. niloticus* was brought to Honduras by governmental agencies in 1979 for stocking in the new ponds and facilities of the El Carao station (D. Meyer pers. comm.).

Parachromis dovii (Günther, 1864). Guapote, guapote blanco. Native.

Departments: Colón, El Paraíso, Gracias a Dios, Olancho and Yoro. Drainages: Atlantic slope: Aguán, Sico-Tinto, Plátano, Patuca, Warunta and Coco.

Parachromis friedrichsthalii (Heckel, 1840). Yellowjacket, guapote hondureño. Native.

Departments: Atlántida, Copán, Cortés and Yoro. Drainages: Atlantic slope: Motagua, Chamelecón, Ulúa, Leán, Cangrejal and Lislis.

Parachromis loisellei (Bussing, 1989). Yellow guapote, guapote amarillo. Native.

Departments: Atlántida, Cortés, Choluteca, Colón, Copán and Gracias a Dios. Drainages: Atlantic slope: Motagua, Chamelecón, Ulúa, Leán, Cangrejal, Lislis, Aguán, Sico-Tinto, Plátano, Patuca, Warunta and Coco.

Remarks: Bussing (2002) states that the range of *P. loisellei* extends from the Ulúa River in the Honduran Atlantic slope through the Cricamola River basin in Panama. Vouchers FMNH 50014 from the Chamelecón River and USM 31501 from the Blanco River (Motagua River drainage) represent a range expansion for the species. USM field number WAM08-138 from the upper reaches of the Coco River Close to San Marcos de Colón in the Department of Choluteca represents a new locality for Honduras.

Parachromis managuensis (Günther, 1867). Jaguar guapote, guapote jaguar. Native.

Departments: Comayagua, Cortés, El Paraíso, Gracias a Dios, Olancho, Santa Bárbara and Yoro. Drainages: Atlantic slope: Chamelecón, Ulúa, Sico-Tinto, Plátano, Patuca, Warunta and Coco.

Remarks: The natural distribution of *P. managuensis* includes most of the Atlantic slope of Honduras, from the Ulúa River (Martin 1972) to the drainage of the Matina River in Costa Rica (Bussing 2002). In Honduras, *P. managuensis* has been introduced in all Pacific slope drainages.

Parachromis motaguensis (Günther, 1867). Motagua cichlid, guapote del Motagua. Native.

Departments: Choluteca, Copán, Cortés, Francisco Morazán and Intibucá. Drainages: Atlantic slope: Motagua, Chamelecón and Ulúa. Pacific slope: Lempa, Goascorán, Nacaome and Choluteca.

Remarks: The distribution of *P. motaguensis* in Honduras was already recorded by Martin (1972). Carr and Giovannoli (1950) gave distributional details of the species in the drainage of the Choluteca River.

Rocio octofasciata (Regan, 1903). Jack Dempsey, mojarra castarrica. Native.

Departments: Cortés and Yoro. Drainages: Atlantic slope: Motagua, Chamelecón and Ulúa.

Theraps wesseli Miller, 1996. Cangrejal guapotillo, guapotillo del Cangrejal. Endemic.

Department: Atlántida. Drainages: Atlantic slope: Cangrejal and Lislis.

Remarks: *T. wesseli* was previously known only by the type locality in the drainage of the Papaloteca River. We collected *T. wesseli* in the Cangrejal River (USM 31003, USM

31009, USM 31017, USM 31022, USM 31552, USM 31561, USM 31574, USM 31582, USM 31774, USM 31780) and the Danto River (USM 31050) in La Ceiba, Department of Atlántida. Reports from the above mentioned rivers respresent a range extension for *T. wesseli*.

Thorichthys aureus (Günther, 1862). Blue flash, mojarrita dorada. Native.

Department: Copán. Drainage: Atlantic slope: Motagua.

Vieja maculicauda (Regan, 1905). Blackbelt cichlid, machaca. Native.

Departments: Atlántida, Colón, Cortés, Gracias a Dios, Santa Bárbara and Yoro.

Drainages: Atlantic slope: Motagua, Chamelecón, Ulúa, Leán, Cangrejal, Lislis, Aguán, Sico-Tinto, Plátano, Patuca, Warunta and Coco.

Vieja microphthalma (Günther, 1862). Motagua machaca, machaca del Motagua. Native.

Department: Copán. Drainage: Atlantic slope: Motagua.

Labrisomidae. Peripheral.

Labrisomus nuchipinnis (Quoy & Gaimard, 1824). Hairy blenny, trambollo peludo. Native.

Department: Cortés. Drainage: Atlantic slope: Chamelecón.

Dactyloscopidae. Peripheral.

Dactyloscopus tridigitatus Gill, 1859. Sand stargazer, miraestrellas ojilargo. Native.

Departments: Colón and Cortés. Drainages: Atlantic slope: Chamelecón and Aguán.

Blenniidae. Peripheral.

Lupinoblennius vinctus (Poey, 1867). Herre, 1942. Mangrove blenny, blenio de mangle. Native.

Department: Cortés. Drainage: Atlantic slope: Chamelecón.

Remarks: Specimen GCRL 4439 collected in the Cieneguita River, which is a tributary of the Chamelecón drainage, represents the first report of the species in the country.

Eleotridae. Peripheral.

Dormitator latifrons (Richardson, 1844). Pacific fat sleeper, dormilón del Pacifico. Native.

Departments: Choluteca and Valle. Drainages: Pacific slope: Lempa, Goascorán, Nacaome, Choluteca and Negro.

Dormitator maculatus (Bloch, 1792). Fat sleeper, dormilón del Atlantico. Native.

Departments: Atlántida, Colón, Cortés, Gracias a Dios and Islas de la Bahía. Drainages: Atlantic slope: Motagua, Chamelecón, Ulúa, Leán, Lislis, Cangrejal, Aguán, Sico-Tinto, Plátano, Patuca, Warunta, Coco and Roatán.

Eleotris amblyopsis (Cope, 1871). Largescaled spinycheek sleeper, Dormilon oscuro. Native.

Departments: Atlántida, Colón, Cortés, Gracias a Dios and Islas de la Bahía. Drainages: Atlantic slope: Motagua, Chamelecón, Ulúa, Leán, Cangrejal, Lislis, Aguán, Sico-Tinto, Plátano, Warunta, Coco, Roatán and Guanaja.

Eleotris perniger (Cope, 1871). Smallscaled spinycheek sleeper, Guavina espinosa. Native.

Departments: Atlántida, Colón, Cortés, Gracias a Dios and Islas de la Bahía. Drainages: Atlantic slope: Motagua, Chamelecón, Ulúa, Leán, Cangrejal, Lislis, Aguán, Sico-Tinto, Plátano, Patuca, Warunta, Coco, Roatán and Guanaja.

Remarks: Earlier collections in Honduras identified as *E. pisonis* actually refer to *E. perniger* (see Pezold & Cage, 2002). The distribution of *E. pisonis* extends from the delta of the Orinoco River in Venezuela to Brazil (Pezold & Cage, 2002).

Eleotris picta Kner,1863. Spotted sleeper, guavina manchada. Native.

Department: Choluteca and Valle Drainages: Pacific slope: Lempa, Goascorán, Nacaome, Choluteca and Negro.

Erotelis smaragdus (Valenciennes, 1837). Emerald sleeper, guavina de concha. Native.

Department: Islas de la Bahía. Drainage: Atlantic slope: Roatán

Remarks: Vouchers FMNH 84942, FMNH 95589 and UMMZ 199452 collected in creeks of Roatán represent the first record of *E. smaragdus* for Honduras.

Gobiomorus dormitor Lacepède, 1800. Bigmouth sleeper, guavina del Atlantico. Native.

Departments: Atlántida, Colón, Comayagua, Cortés, Gracias a Dios and Islas de la Bahía, Drainages: Atlantic slope: Motagua, Chamelecón, Ulúa, Leán, Cangrejal, Lislis, Aguán, Sico-Tinto, Plátano, Patuca, Warunta, Coco, Roatán and Guanaja.

Gobiomorus maculatus (Günther, 1859). Pacific sleeper, guavina del Pacifico. Native.

Departments: Choluteca and Valle. Drainages: Pacific slope: Goascoran, Nacaome, Choluteca and Negro.

Leptophilypnus fluviatilis (Meek and Hildebrand, 1916). Dwarf guavina, guavina enana. Native.

Department: Gracias a Dios. Drainage: Atlantic slope: Patuca.

Remarks: Thacker *et al*. (2006) redescribed the genus *Leptophilypnus* and included several specimens from the Patuca River (GCRL 7850, UMMZ 199575, UMMZ 199594, and UMMZ 199611).

Gobiidae. Peripheral.

Awaous banana (Valenciennes, 1837). River goby, gobio de río. Native.

Departments: Atlántida, Choluteca, Colón, Copán, Cortés, Francisco Morazán, Gracias a Dios, Islas de la Bahía and Valle. Drainages: Atlantic slope: Motagua, Chamelecón, Ulúa, Leán, Cangrejal, Lis-Lis, Aguán, Sico-Tinto, Plátano, Patuca, Warunta, Coco, Roatán and Guanaja. Pacific slope: Lempa, Goascorán, Nacaome, Choluteca and Negro.

Bathygobius soporator (Valenciennes, 1837). Frillfin goby, mapo aguado. Native.

Department: Cortés and Islas de la Bahía. Drainages: Atlantic slope: Chamelecón and Roatán.

Remarks: Vouchers USM 31766 and USM 31743 collected in the lower reaches of Salado River near La Ceiba, and USM field collection numbers WAM08-103 and WAM08-109 collected in creeks of the island of Roatán represent the first record of *B. soporator* in Honduras.

Ctenogobius boleosoma (Jordan and Gilbert, 1882). Darter goby, madrejuile. Native.

Departments: Cortés, Gracias a Dios and Islas de la Bahía. Drainages: Atlantic slope: Chamelecón, Patuca, and Roatán.

Ctenogobius fasciatus Gill, 1858. Blotchcheek goby, gobio caramarcada. Native.

Departments: Cortés. Drainage: Atlantic slope: Chamelecón.

Remarks: Voucher USM 34352 collected in the Tulián River, a tributary of the Chamelecón River, represents the first record of the species in Honduran freshwaters.

Ctenogobius sagittula (Günther, 1861). Longtail goby, gobio aguzado. Native.

Departments: Choluteca and Valle. Drainages: Pacific slope: Negro and Nacaome.

Ctenogobius stigmaticus (Poey, 1860). Marked goby, gobio marcado. Native.

Department: Gracias a Dios. Drainage: Atlantic slope: Patuca.

Evorthodus lyricus (Girard, 1858). Lyre goby, gobio lyra. Native.

Department: Atlántida, Cortés, Gracias a Dios and Islas de la Bahía. Drainages: Atlantic slope: Chamelecón, Cangrejal, Patuca and Roatán.

Remarks: Vouchers UMMZ 17385, UMMZ 17314, UMMZ 17302, UMMZ 173286, FMNH 98044, FMNH 84978, USM 31687, USM 31878, and USM 31912, as well as USM field collection numbers WAM08-103 and WAM08-109 represent the first reports of *E. lyricus* in Honduras.

Gobionellus oceanicus (Pallas, 1770). Highfin goby, madrejuile flecha. Native.

Departments: Cortés, Gracias a Dios and Islas de la Bahía. Drainages: Atlantic slope: Chamelecón, Patuca and Roatán.

Remarks: Vouchers FMNH 86679, FMNH 84944, and UMMZ 199456 collected in creeks of the island of Roatán, and FMNH 86861collected in Brus Laguna, represent the first formal report of *G. oceanicus* in Honduras.

Lophogobius cyprinoides (Pallas, 1770). Crested goby, gobio crestado. Native.

Department: Cortés. Drainage: Atlantic slope: Chamelecón.

Remarks: Voucher USM 31896 represents the first report of *L. cyprinoides* in Honduras.

Sicydium gymnogaster Ogilvie-Grant, 1884. Smoothbelly goby, chupa-piedras desnudo. Native.

Departments: Atlántida and Colón. Drainages: Atlantic slope: Leán, Cangrejal and Lislis.

Sicydium multipunctatum Regan, 1906. Multispotted goby, chupa-piedras pecoso. Native.

Department: El Paraíso. Drainage: Pacific slope: Choluteca.

Sicydium plumieri (Bloch, 1786). Sirajo. chupa-piedras de plumer. Native.

Departments: Atlántida, Colón and Islas de la Bahía. Drainages: Atlantic slope: Leán, Cangrejal, Lislis, Roatán and Guanaja.

Remarks: Vouchers FLMNH 16334 collected in a creek in the island of Rotan, USM 31858, USM 31866 from the Lancetilla River, USM 31540, USM31545, USM 31556, USM 31563 from the Cangrejal River, USM 31792 from the Coloradito River and USM 33996 from the Danto River represent the first report of *S. plumieri* in Honduras.

Sicydium punctatum Perugia, 1896. Spotted algae-eating goby, chupa-piedras punteado. Native.

Departments: Atlántida, Colón and Islas de la Bahía. Drainages: Atlantic slope: Leán, Cangrejal, Lislis and Guanaja.

Remarks: Vouchers USM 31860, USM 31868 and USM 31891 from the Lancetilla River, USM 31606, USM 31788 from the Coloradito River, USM 31544, USM 31555, USM 31562, USM 31580, USM31776 from the Cangrejal River, and USM 34047 from the Marmol River west of Trujillo on the Honduran Caribbean Coast, represet the first report of *S. punctatum* in Honduras as well as a expansion of its known distributional range.

Sicydium sp. 1. Native.

Departments: Atlántida, Colón and Islas de la Bahía. Drainages: Atlantic slope: Leán, Cangrejal, Lislis and Guanaja.

Sicydium sp. 2. Native.

Departments: Atlántida and Colón. Drainages: Atlantic slope: Leán, Cangrejal and Lislis.

Microdesmidae. Peripheral.

Microdesmus carri Gilbert, 1966. Stippled wormfish, pez lombriz punteado. Native.

Department: Cortés. Drainage: Atlantic slope: Chamelecón.

Remarks: Voucher GCRL 3704 collected in the Omoa River, which is part of the Chamelecón river system, represents the first record *M. carri* in Honduras.

Acanthuridae. Peripheral.

Acanthurus bahianus Castelnau, 1855. Ocean surgeon, cirujano pardo. Native.

Department: Gracias a Dios. Drainage: Atlantic slope: Patuca.

Sphyraenidae. Peripheral.

Sphyraena barracuda (Edwards, 1771). Great barracuda, barracuda. Native.

Department: Islas de la Bahía. Drainages: Atlantic slope: Roatán and Guanaja.

Sphyraena guachancho Cuvier, 1829. Guaguanche, tolete. Native.

Departments: Cortés and Islas de la Bahía. Drainages: Atlantic slope: Chamelecón, Roatán and Guanaja.

PLEURONECTIFORMES

Paralichthyidae. Peripheral.

Citharichthys abbotti Dawson, 1969. Veracruz whiff, lenguado veracruzano. Native.

Department: Cortés. Drainage: Atlantic slope: Chamelecón.

Remarks: Voucher GCRL 4470 collected in the Omoa River, which is part of the Chamelecón River system, represents the first record of *C. abbotti* in Honduras.

Citharichthys arenaceus Evermann and Marsh, 1900. Sand whiff, lenguado de arena. Native.

Department: Cortés. Drainage: Atlantic slope: Chamelecón.

Remarks: Vouchers GCRL 21631 and GCRL 21698 collected at the Omoa River, which is part of the Chamelecón River system, represent the first record of *C. arenaceus* in Honduras.

Citharichthys gilberti Jenkins and Evermann, 1889. Bigmouth sanddab, lenguado escondido. Native.

Department: Choluteca. Drainage: Pacific slope: Choluteca.

Citharichthys macrops Dresel, 1885. Spotted whiff, lenguado manchado. Native.

Departments: Cortés and Islas de la Bahía. Drainages: Atlantic slope: Chamelecón and Roatán.

Citharichthys spilopterus Günther, 1862. Bay whiff, lenguado pardo. Native.

Department: Cortés. Drainage: Atlantic slope: Chamelecón.

Remarks: the following two vouchers, GCRL 4487 and GCRL 4471, collected in the Omoa River, which is part of the Chamelecón River system, represents the first record of *C. spilopterus* in Honduras.

Achiridae. Peripheral.

Achirus lineatus (Linnaeus, 1758). Lined sole, suela listada. Native.

Departments: Cortés and Islas de la Bahía. Drainages: Atlantic slope: Chamelecón and Roatán.

Remarks: Vouchers GCRL 4478, GCRL 21693 from the Omoa River part of the Chamelecón River system, GCRL 4492, GCRL 6002, USM 31914 from the Chibana River, a tributary of the Chamelecón River, USM 31690 from the Cangrejal River, USM 31756 from the Salado River, USM 31805 from Lancetilla River USM 33991 from the Danto River, and FMNH 84968 from a small stream of the island of Roatán represent the first records of the *A. lineatus* in Honduras.

Trinectes fonsecensis (Günther, 1862). Spottedfin sole, suela rayada. Native.

Department: Valle. Drainage: Pacific slope: Goascorán.

Remarks: Voucher USM 33950 collected in the Goascorán River near the community of Caridad represents the first record *T. fonsecensis* in Honduras.

Trinectes maculatus (Bloch and Schneider, 1801). Hogchoker, suela tortilla. Native. Department: Islas de la Bahía. Drainages: Atlantic slope: Roatán and Guanaja. Remarks: USM field collection numbers WAM08-103 collected in creeks of the island of Roatán and WAM08-118 collected in creeks of the island of Guanaja represent the first records of *T. maculatus* in Honduras.

TETRAODONTIFORMES

Tetraodontidae. Peripheral.

Sphoeroides testudineus (Linnaeus, 1758). Checkered puffer, botete sapo. Native. Departments: Atlántida, Cortés, Gracias a Dios and Islas de la Bahía. Drainages: Atlantic slope: Chamelecón, Cangrejal, Ulúa, Patuca and Roatán.

Discussion

The native freshwater fish fauna of Honduras is composed of 166 species in 96 genera, 41 families, and 18 orders (Appendix A). In addition to the native species, six exotic species were found in the country. The most speciose families are Cichlidae (22 species), Poeciliidae (17 species), and Gobiidae (15 species). Based on published salinity tolerances (Myers 1949), just 4.8% (8 species) of the total freshwater native fish species are primary or obligate freshwater. These eight species are represented in just three families: Characidae (*A. aeneus*, *B. guatemalensis*, *H. tortuguerae* and *R. bouchellei*), Heptapteridae (*R. guatemalensis* and *R. laticauda.*) and Gymnotidae (*G. cylindricus* and *G. maculosus*). The secondary and peripheral freshwater species represent 28.3% and 66.9% of the freshwater fish fauna, respectively. The paucity of Honduran primary or obligate freshwater fishes found in this study is not surprising, given Myers' (1966) suggested history and composition of the Central American freshwater fish fauna.

A total of 36 species were new records for Honduras, and there were 12 species found to have expanded ranges. Nine species appear to be endemic to Honduras, of which only two have been formally described: the cichlids *A. hogaboomorun* and *T. wesseli*. Of the remaining six endemic species, descriptions of *Profundulus* sp.1 and *Poecilia* sp.1 are either in review or in preparation and four other species listed herein are awaiting description.

With the exception of El Salvador, most Central American countries now have fairly recent formal species lists. These lists include: México (Miller *et al*. 2005), Belize (Greenfield & Thomerson 1997), Guatemala (Kihn-Pineda *et al*. 2006), Nicaragua (Villa 1982), Costa Rica (Bussing 2002), Panama (Loftin 1965) and Honduras (this publication). The only formal list for El Salvador dates back to 1925 (Hildebrand 1925). In addition, large areas of some countries, such as the Mosquitia region of both Honduras and Nicaragua, are logistically difficult to sample and require more exploratory work which would likely yield additional diversity. Compared to other Central American countries, Honduras appears to have the smallest primary or obligate freshwater fish diversity (8 species). Given the geologic history and drainage patterns for the region, it is likely that El Salvador is similarly depauperate in these groups.

The primary freshwater fish composition of Nicaragua is very similar to that of Honduras and differs only for a few species in the family Characidae which are absent in Honduras. A number of species in the families Heptapteridae (See Villa 1982; Bussing 2002) and Gymnotidae are found in both countries (see Albert & Miller 1995; Albert *et* *al.* 1999; Albert 2001). Moving north of Honduras, major differences in fish assemblages appear to start in northern Guatemala near the Mexican border (see Kihn-Pineda *et al*. 2006; Valdez-Moreno *et al.* 2005), Belize (see Greenfield & Thomerson 1997) and Southern México (see Miller *et al*. 2005, Lozano-Vilano *et al*. 2007 and González-Díaz *et al.* 2008). A number of species of primary or obligate North American freshwater fishes families Ictaluridae and Catostomidae extend their ranges this far south. However, the central and southern portions of Guatemala bordering Honduras appears to have primary or obligate freshwater species assemblages very similar to that of Honduras.

Martin (1972) was struck by the apparent lack of endemism seen in Honduras. His surveys found just one endemic freshwater fish for the country (*A. hogaboomorum*). It was not until 1996 that *T. wesseli* was described (Miller 1996). Our samples appear to contain a number of putatively undescribed species (Appendix A), which are endemic to Honduras. We suspect that the perceived lack of endemism in Honduras is due to insufficient ichthyological research in the country. Further, of all putative new species reported here, none are primary freshwater fishes, and most are in the families Poeciliidae, Profundulidae, and Gobiidae.

As with most aspects of Honduran freshwater fish biogeography, the ecology and conservation impacts of exotic species are largely unknown. Most freshwater exotics were introduced for aquaculture purposes, with the notable exception of largemouth bass (*M. salmoides*) introduced in the early 1950's as a sport fish (Cruz 1985). All indications are that *M. salmoides* has not spread beyond the original site of introduction. Of the remaining five exotic species, the Nile and Mozambique tilapias (*O. niloticus* and *O. mossambicus,* respectively) have spread the most widely and potentially pose the greatest threat to native species. Three other species have been introduced to Honduras since the early 1980's for the purpose of aquaculture (*Colossoma macropomum*, *Oncorhynchus mykiss* and *Oreochromis urolepis hornorum*; D. Meyer pers. comm.), but there is no evidence that these species are reproducing in the wild.

One of the main goals of this project was to compile data from as much of Honduras as possible. Our broad approach was intended to be thorough, including museum material, published literature, and extensive direct sampling throughout the country. While our four-year sampling effort increased the number of Honduran freshwater fish on this checklist, substantial areas of the country remain unexplored. In particular, remote areas of the departments of Gracias a Dios and Olancho in the east, and Lempira, Intibucá and Ocotepeque in the west require further sampling (Figure 1). Given these gaps, this study is not the definitive work on Honduran freshwater fishes, but it is our hope that the data presented here will serve as the foundation for further study and conservation action.

References

Albert, J.S. (2001) Species diversity and phylogenetic systematics of American knifefishes (Gymnotiformes, Teleostei). *Miscellaneous Publications of the Museum of Zoology, University of Michigan*, 190, 1-127.

Albert, J.S., de Campos Fernandes-Matioli, F.M. & de Almeida-Toledo, L.F. (1999) New species of *Gymnotus* (Gymnotiformes, Teleostei) from Southeastern Brazil: toward the deconstruction of *Gymnotus carapo*. *Copeia*, 1999, 410-421.

Albert, J.S. & Miller, R.R. (1995) *Gymnotus maculosus*, a new species of electric fish (Chordata: Teleostei: Gymnotoidei) from Middle America, with a key to species of *Gymnotus*. *Proceedings of the Biological Society of Washington*, 108, 662-678.

Bengtson, N.A. (1926) Notes on the physiography of Honduras. *Geographical Review*, 16, 403-413.

Beu, A.G. (2001) Gradual Miocene to Pleistocene uplift of the Central American Isthmus: evidence from tropical American tonnoidean gastropods. *Journal of Paleontology*, 75, 706-720.

Bussing, W. (1976) Geographic distribution of the San Juan ichthyofauna of Central America with remarks on its origin and ecology. *In:* Thorson, T.B. (Ed.) *Investigations of the Ichthyofauna of Nicaraguan Lakes*. University of Nebraska, Lincoln, Nebraska, pp. 157-175.

Bussing, W.A. (2002) *Peces de las aguas continentales de Costa Rica/Freshwater fishes of Costa Rica*. Universidad de Costa Rica, San Jose, Costa Rica, 468 pp.

Carr, A.F. (1950) Outline for a classification of animal habitats in Honduras. *Bulletin of the American Museum of Natural History*, 94, 563-594.

Carr, A.F. & Giovannoli, L. (1950) The fishes of the Choluteca drainage of southern Honduras. *Occasional Papers of the Museum Zoology, University of Michigan*, 523, 1-38.

Coates, A.G., Jackson, J.B.C., Collins, L.S., Cronin, T.M., Dowsett, H.J., Bybell, L.M., Jung, P. & Obando, J.A. (1992) Closure of the Isthmus of Panama; the near-shore marine record of Costa Rica and western Panama. *Geological Society of America Bulletin*, 104, 814-828.

Coates, A.G. & Obando, J.A. (1996) The geologic evolution of the Central American Isthmus. *In:* Jackson, J.B.C., Budd, A.F. & Coates, A.G. (Eds.) *Evolution and Environment in Tropical America*. University of Chicago Press, Chicago, pp. 21-56.

Cruz, G.A. (1985) Biology of the black bass (*Micropterus salmoides*) in Yojoá Lake, Honduras. *Revista Latinoamericana de Acuicultura*, 23, 12-25.

Cruz, G.A. & Espinal, M. (1989) Six new records of freshwater fishes from the Pacific versant of Honduras. *Revista de Biología Tropical*, 37, 229-230.

Dietz, R.Z. & Holden, J.C. (1970) Reconstruction of Pangea: breakup and dispersion of continents, Permian to present. *Journal of Geophysical Research*, 75, 4939-4956.

Duellman, W.E. (1979) The South American herpetofauna: a panoramic view. *In:* Duellman, W.E. (Ed.) *The South American Herpetofauna: its Origin, Evolution, and Dispersal.* Monograph of the Museum of Natural History of the University of Kansas, Kansas, pp. 1-28.

Eschmeyer, W.N. & Fong, J.D. (2008) Species of Fishes by family/subfamily On-line version up dated 23/April/2008. California Academy of Sciences. Available from http://research.calacademy.org/research/ichthyology/catalog/SpeciesByFamily.html (acessed 22 August 2008)

Eschmeyer, W.N. & Fricke, R. (2009) Catalog of Fishes electronic version (updated 13 Mar. 2009). Eschmeyer, W.N. & Fricke, R. (eds.) Catalog of Fishes electronic version (updated 13 Mar. 2009). http://research.calacademy.org/ichthyology/catalog/fishcatsearch.html (accessed 20 April 2008)

Fowler, H.W. (1932) Notes on freshwater fishes from Central America. *Proceedings of the Academy of Natural Sciences of Philadelphia*, 84, 379-85.

Fowler, H.W. (1943) A new poeciliid fish from Honduras. *Notulae Naturae*, 117, 1-3.

Froese, R. & Pauly, D. (2009) FishBase. Available from http://www.fishbase.org (accesed 13 May 2009)

González-Díaz, A.A., Quiñones, R.M., Velásquez-Martínez, J. & Rodiles-Hernández, R. (2008) Fishes of La Venta River in Chiapas, México. *Zootaxa*, 1685, 47-54.

Greenfield, D.W. & Thomerson, J.E. (1997) *Fishes of the Continental Waters of Belize*. University Press of Florida, Gainesville, FL, 311 pp.

Hildebrand, S.F. (1925) Fishes of the Republic of El Salvador, Central America. *Bulletin of the Bureau of Fisheries*, 41, 237–287.

Holden, J.C. & Dietz, R.S. (1972) Galapagos Gore, NazCoPac triple junction and Carnegie/Cocos ridges. *Nature*, 235, 266–269.

Hubbs, C.L. (1924) Studies of the fishes of the order Cyprinodontes. I-IV. *Miscellaneous Publications of the Museum of Zoology, University of Michigan*, 13, 1-31.

Hubbs, C.L. (1926) Studies of the fishes of the order Cyprinodontes VI. Material for the revision of the American genera and species. *Miscellaneous Publications of the Museum of Zoology, University of Michigan*, 16, 1-87.

Hubbs, C.L. (1931) Studies of the fishes of the order Cyprinodontes, IX: A new and primitive genus of Poeciliidae from Central America. *Occasional Papers of the Museum Zoology, University of Michigan*, 230, 1-3.

Jordan, D.S. & Evermann, B.W. (1896-1900) The fishes of North and Middle America: a descriptive catalogue of the species of fish-like vertebrates found in the waters of North America, north of the isthmus of Panama. Part I (1896), II (1898), III (1898) and IV (1900). *Bulletin of the United States National Museum*, 47, 1-3313.

Jordan, D.S., Evermann, B.W. & Clark, H.W. (1930) *Check list of the fishes and fishlike vertebrates of North and Middle America north of the northern boundary of*

Venezuela and Colombia. Report 2 (for 1928). United States Commission of Fish and Fisheries, 670 pp.

Keller, G., Zenker, C.E. & Stone, S.M. (1989) Late Neogene history of the Pacific-Caribbean gateway. *Journal of South American Earth Science*, 2, 73–108.

Kihn-Pineda, P.H., Cano, E.B. & Morales, A. (2006) Peces de las aguas interiores de Guatemala. *In:* Cano, E.B. (Ed.) *Biodiversidad de Guatemala*. Universidad del Valle de Guatemala, Guatemala, pp. 457-486.

Kullander, S.O. (2003) Family Cichlidae. *In:* Reis, R.E., Kullander, S.O. & Ferraris Jr.., C.J. (Eds.) *Checklist of the Freshwater Fishes of South and Central America*. Edipucrs, Porto Alegre, pp. 605–654.

Ladd, J.W. (1976) Relative motion of South America with respect to North America and Caribbean tectonics. *Bulletin of the Geological Society of America*, 87, 967-976.

Loftin, H.G. (1965) *The Geographical Distribution of Freshwater Fishes in Panama*. Florida State University, Tallahassee, FL., 528 pp.

Lozano-Vilano, M.L., García-Ramírez, M.E., Contreras-Balderas, S. & Ramírez-Martínez, Y.C. (2007) Diversity and conservation status of the ichthyofauna of the Río Lacantún basin in the Biosphere Reserve Monte Azules, Chiapas, México. *Zootaxa*, 1410, 43-53.

Lyons, J. (2005) Distribution of *Sicydium* Valenciennes 1837 (Pisces: Gobiidae) in Mexico and Central America. *Hidrobiológica*, 15, 239-243.

Maldonado-Koerdell, M. (1964) Geohistory and paleogeography of Middle America. *In:* West, C. (Ed.) *Handbook of Middle American Indians*. The University of Texas Press, Austin, pp. 3-32.

Malfait, B.T. & Dinkelman, M.G. (1972) Circum-Caribbean tectonic and igneous activity and the evolution of the Caribbean Plate. *Bulletin of the Geological Society of America*, 83, 251-271.

Marceniuk, A.P. & Betancur-R, R. (2008) Revision of the species of the genus *Cathorops* (Siluriformes: Ariidae) from Mesoamerica and the Central American Caribbean, with description of three new species. *Neotropical Ichthyology*, 6, 25-44.

Marceniuk, A.P., Betancur-R., R. & Acero P., A. (in press.) A new species of *Cathorops* (Siluriformes; Ariidae) from Mesoamerica, with redescription of four species from the eastern Pacific. *Bulletin of Marine Science*.

Marshall, L., Buttler, R.F., Drake, R.E., Curtis, G.A. & Tedforth, R.H. (1979) Calibration of the Great American Interchange. *Science*, 204, 272-279.

Martin, M. (1972) *A biogeographic analysis of the freshwater fishes of Honduras*. Unpubl. Ph.D. Dissertation. University of Southern California. *Los Angeles*, pp.588.

Matamoros, W.A., Palmer, J. & Mérida, J. (2007) First record in Honduras of the Halfbeak *Hyporhamphus roberti hildebrandi* Jordan and Evermann 1927, (Hemiramphidae) collected in an inland reservoir. *Gulf and Caribbean Research*, 19, 1-3.

McCranie, J.R. & Wilson, L.D. (2002) The Amphibians of Honduras. *Society for the Study of Amphibians and Reptiles, Contributions to Herpetology*, 19, 1-625.

McNeely, J.A., Miller, K.R., Reid, W.V. & Mittermeier, R. (1990) *Conserving the world's biological diversity.* International Union for Conservation of Nature and Natural Resources, World Resources Institute, Conservation International, World Wildlife Fund, US. World Bank, Gland, Switzerland. 174 pp.

Meyer, M.K. & Schartl, M. (2002) *Xiphophorus mayae*, a new species of swordtail from Guatemala (Teleostei: Poeciliidae). *Ichthyological Explorations of Freshwaters*, 13, 59-66.

Miller, N. (1907) Fishes of the Motagua River, Guatemala. *Bulletin of the American Museum of Natural History*, 23, 95-123.

Miller, R.R. (1955) A systematic review of the Middle American fishes of the genus *Profundulus*. *Miscellaneous Publications of the Museum of Zoology, University of Michigan*, 92, 1-64.

Miller, R.R. (1966) Geographical distribution of Central American freshwater fishes. *Copeia*, 1966, 773-802.

Miller, R.R. (1996) *Theraps wesseli*, a new species of cichlid fish from the Caribbean slope of northern Honduras. *Tropical Fish Hobbyist*, 44, 179-183.

Miller, R.R. & Carr, A.F. (1974) Systematics and distribution of some freshwater fishes from Honduras and Nicaragua. *Copeia*, 1974, 120-125.

Miller, R.R., Minckley, W.L. & Norris, S.M. (2005) *Freshwater Fishes of México*. The University of Chicago Press, Chicago, 490 pp.

Myers, G.S. (1949) Salt-tolerance of fresh-water fish groups in relation to zoogeographical problems. *Bijdragen tot de Dierkunde*, 28, 315-322.

Myers, G.S. (1966) Derivation of the freshwater fish fauna of Central America. *Copeia*, 1966, 766-733.

Olson, E.C. & McGrew, P.O. (1941) Mammalian fauna from the Pliocene of Honduras. *Bulletin of the Geological Society of America*, 52, 1219-1244.

Ostmark, H.E. (1964) La introduccion reciente de la lobina boca ancha a los tropicos. *Apuntes Agricolas*, 6, 10-15.

Perdices, A., Bermingham, E., Montilla, A. & Doadrio, I. (2002) Evolutionary history of the genus *Rhamdia* (Teleostei: Pimelodidae) in Central America. *Molecular Phylogenetics and Evolution*, 25, 172-189.

Pezold, F. & Cage, B. (2002) A review of the spinycheek sleepers, genus *Eleotris* (Teleostei: Eleotridae), of the western hemisphere, with comparison to the West African species. *Tulane Studies in Zoology and Botany*, 31, 19-63.

Poeser, F.N. (1995) Nonrandon variation on *Poecilia marcellinoi* n. sp. and *P. salvatoris* Regan, 1907 in El Salvador (Pisces, Poeciliidae). *Bijdragen tot de Dierkunde*, 64, 239-252.

Regan, C.T. (1906-08) Pisces. *In:* Goldman, F.D. & Salvin, O. (Eds.) *Biologia Centrali-Americana*. Porter, R.H., London, pp. 1-203.

Rehn, J.A.G. (1932) A naturalist in Honduras. *Bulletin of the Panamerican Union*, 66, 390-400.

Reis, R.E., Kullander, S.O. & Ferraris Jr., C.J. (2003) *Check List of the Freshwater Fishes of South and Central America*. EDIPUCRS, Porto Alegre, Brazil, 742 pp.

Roberts, R.J. & Irving, E.M. (1957) *Mineral Deposits of Central America*. United States Goverment Printing Office, Washington, D.C., 205 pp.

Rosen, D.E. & Bailey, R.M. (1963) The poeciliid fishes (Cyprinidontiformes), their structure, zoogeography, and systematics. *Bulletin of the American Museum of Natural History*, 126, 1-176.

Savage, J.M. (1982) The enigma of the Central American herpetofauna: dispersal or vicariance? *Annals of the Missouri Botanical Garden*, 69, 464-547.

Schmitter-Soto, J.J. (2007) A systematic revision of the genus *Archocentrus* (Perciformes: Cichlidae), with the description of two new genera and six new species. *Zootaxa*, 1603, 1-78.

Silfvergrip, A.M.C. (1996) *A systematic revision of the neotropical catfish genus Rhamdia (Teleostei, Pimelodidae)*. Department of Zoology, Stockholm University and Department of Vertebrate Zoology, Swedish Museum of Natural History, Stockholm, 156 pp.

Stehli, F.G. & Webb, S.D. (1985) *The Great American Biotic Interchange*. Plenun Press, New York, 532 pp.

Strong, W.D. (1934) An archaeological cruise among the Islas de la Bahía of Honduras. *Smithsonian Institution Explorations and Fieldwork*, 1933–1934, 1-59.

Thacker, C.E., Pezold, F., Suttkus, R.D. & Buth, D. (2006) Redescription of the dwarf Neotropical eleotrid genus *Leptophilypnus* (Teleostei: Gobioidei), including a new species and comments on *Microphilypnus*. *Copeia*, 2006, 489-499.

Valdez-Moreno, M.E., Pool-Canul, J. & Contreras-Balderas, S. (2005) A checklist of the freshwater ichthyofauna from El Petén and Alta Verapaz, Guatemala, with notes for its conservation and management. *Zootaxa*, 1072, 43-70.

Vaux, P.D. (1985) *The ecology of the freshwater fishes of central Honduras*. Unpubl. Ph.D. Dissertation. *University of California, Davis. 258 pp.*

Villa, J. (1982) *Peces nicaragüenses de agua dulce*. Banco de America, Managua, Nicaragua, 253 pp.

Vinson, G.L. & Brineman, J.H. (1963) Nuclear Central America, hub of the Antillean transverse belt. *In:* Childs, O.E. & Beebe, B.W. (Eds.) *Backbone of the Americas: Tectonic History from Pole to Pole*. American Association of Petroleum Geologist, Tulsa, Oklahoma, pp. 101-112.

West, R.C. (1964) Surface configuration and associated geology of Middle America. *In:* Wauchope, R. & West, R.C. (Eds.) *Handbook of the Middle American Indians*. University of Texas Press, Austin, Texas, pp. 33-83.

Wilson, L.D. & Meyer, J.R. (1985) *The Snakes of Honduras. Second edition*. Milwaukee Public Museum, Milwaukee, 150 pp.

CHAPTER III

ZOOGEOGRAPHICAL PATTERNS OF HONDURAN OBLIGATE FRESHWATER FISHES

Abstract

I identified ichthyographical provinces for Honduras from correspondence analysis (CA) and unweighted pair group method with arithmetic mean (UPGMA) cluster analysis of a presence/absence matrix of 55 obligate freshwater fishes. Differences between provinces in species composition and species turnover between provinces were tested by analysis of similarities (ANOSIM) and the calculation of beta diversity indices. I further characterized each province using an Indicator Species Analysis (ISA). For each province I also included the number of endemics and species according to their salinity tolerance. Historically, two ichthyographical provinces have been assigned to Honduras. Our analyses supported the recognition of four ichthyographical provinces that correspond closely to the complex physiography of Honduras. The Atlantic slope of Honduras has been divided in three distinctive ichthyographical provinces: (1) the Motagua-Chamelecón-Ulúa Ichthyographical Province that is located in the Western Rifted Highlands Physiographic Sub-Regions and the western side of Central Chortis Plateau Physiographic Sub-Region; (2) the Honduran Mosquitia Ichthyographical Province that lies in the Mosquito Coast Lowlands Physiographic Province, the Eastern Dissected Plateau Physiographic Sub-Province, and the eastern side of the Central Chortis Plateau Physiographic Sub-Region: and (3) the Nombre de Dios-Bay Islands Ichthyographical Province that lies completely in the Honduran Borderlands Physiographic Sub-Province. The last province, the Honduran Pacific Ichthyographical

Province, includes the entire Honduran Pacific slope. Provinces were characterized by high beta-diversity and low endemicity. Freshwater fish communities were dominated by peripheral freshwater fishes, whereas primary freshwater fishes were poorly represented in each province (5.4 to 15.3 %). The most striking patterns of Honduran freshwater fish distribution are its paucity of primary freshwater fishes and limited numbers of endemics. While the four ichthyographical provinces are distinct as indicated by the ANOSIM analysis, the beta diversity values are low. These results suggest that regardless of the active geological history that characterized the region, there has been very little species isolation in any given province, and historical drainage connectivity has been high.

Introduction

Biogeographical provinces based on a region's species richness provide important information for understanding the effects of local and regional processes on contemporary patterns of species richness and distribution (Smith & Bermingham 2005; Heikinheimo *et al*. 2007; Reyjol *et al*. 2007; Bonada *et al*. 2009). This approach to understanding landscape-species relationships is not a new idea as work of this nature dates by over a century (e.g. Sclater 1858; Wallace 1876). The delineation of biogeographical provinces has become an important tool for natural resources management and conservation planning (Zogaris *et al*. 2009).

Miller (1966) and Bussing (1976) made the first attempts at defining Central American freshwater ichthyographical provinces. They identified four provinces: (1) the Chiapas-Nicaraguan Province (Pacific slope) extending from the Tehuantepec River in southern Mexico south to the Nicoya Peninsula in western Costa Rica; (2) the Usumacinta Province (Atlantic slope), which covers the area from the Papaloapan River in Southeastern Mexico to north of the San Juan River in Nicaragua; (3) the San Juan Province (Atlantic slope), that includes the Nicaraguan lakes, the San Juan River basin south to Tortuguero in Costa Rica; and (4) the Isthmian Province (Atlantic and Pacific slopes) that includes southeastern Nicaragua, Costa Rica (except for the small area occupied by the San Juan Province) and the entirety of Panama. More recent studies have taken a large-scale approach to studying the diversity and distribution of Central American freshwater fishes with either a global (e.g. Abell *et al*. 2008) or regional perspective (e.g. Smith & Bermingham 2005).

Currently, Honduras is partitioned into two regions whose delineations extend beyond Honduras: (1) the Honduran Atlantic slope, which extends from the Motagua River to the Coco River, and (2) the Pacific slope, which extends from the Lempa River to the Negro River (Figure 1). Abell *et al*. (2008), in a study aimed at classifying the freshwater ecoregions of the world, found that freshwater ichthyographical structure in Mesoamerica was more complex than previously thought. The four ichthyographical provinces proposed for Central America by Miller (1966) and Bussing (1976) were replaced by 16 smaller provinces (Abell *et al*. 2008). However, for Honduras they still identified just two ichthyographical provinces: (1) the Mosquitia Province in the Atlantic slope which extends from the Motagua River to the Nicaraguan Mosquitia and corresponds to Bussing's (1976) Usumacinta Province in Honduras, and (2) the Chiapas-Fonseca Province in the Pacific slope which corresponds to Bussing's (1976), Chiapas-Nicaraguensis Province in Honduras. However, the paucity of distributional information for freshwater fishes has forced researchers to exclude large areas of Honduras from biogeographical studies (e.g. Miller 1966), or to proceed in the delineation of ichthyographical provinces based on limited data (e.g. Bussing 1976; Abell *et al*. 2008).

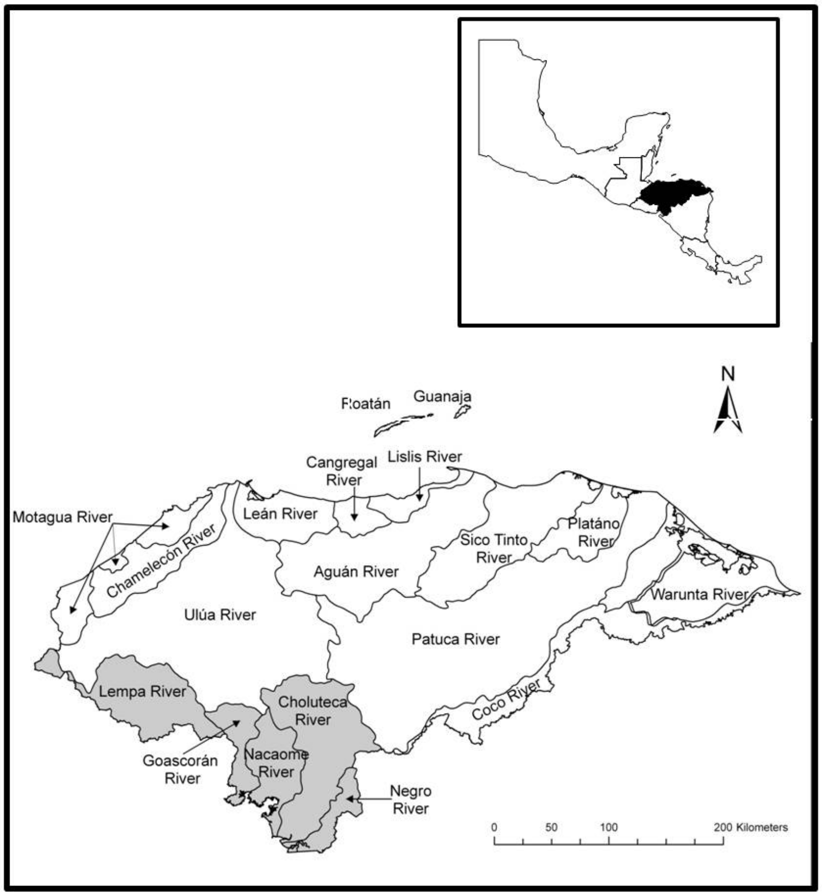

Figure 1. Map of Honduras showing the 19 major river drainages. Central American map insert.

A freshwater ichthyographical province (biogeographical province) as defined in the literature is a geographical region with a relatively homogeneous faunal composition (Smith & Bermingham 2005) formed by one or more freshwater systems from which there is less variability among them than is present between other such geographical regions (Abell *et al*. 2008). These groups, in addition to sharing faunistic similarities are expected to share a common ecological and evolutionary history and physiography. Given the complex topography, physiography, geologic history, and diverse ecosystems that characterize Central America that have presumably shaped its biological diversity (Coates & Obando, 1996; Matamoros *et al*. 2009), it is conceivable that two provinces do not adequately describe the Honduran ichthyography. For example, the Atlantic and Pacific slopes of Honduras are divided by the Central American Cordillera. Furthermore, the eastern Honduran Atlantic slope is characterized by lowland forest (e.g. Mosquitia lowlands) whereas the western Atlantic slope is characterized by mountainous terrain. More detailed distributional data for the country may consequently demonstrate more ichthyographical structure.

Traditionally, biogeographical provinces have been defined based on gestalt – a visual inspection of the geographic patterns of species distributions. Recent studies have pursued more quantitative approaches. Statistical analyses have been successfully used in ichthyographical studies at both continental (Unmack 2001; Reyjol *et al*. 2007) and regional levels (Smith & Bermingham 2005; Filipe *et al*. 2009). Some of the most common statistical procedures employed by biogeographers to delineate biogeographical provinces are ordinations (e.g. correspondence analysis [CA]) and cluster analysis (e.g. Unweighted Pair Group Method with Arithmetic Mean [UPGMA]). With these types of procedures it is expected that geographical operational units (GOUs; Crovello 1981) with more similar biota will cluster closer together rather than those GOUs with less similar biota.

Recently, Matamoros *et al.* (2009) provided a thorough checklist of the freshwater fishes of Honduras, but given the nature of the publication, there was no attempt to conduct a rigorous biogeographical analysis. The goal of this paper is to investigate the biogeographical patterns of obligate Honduran freshwater fishes using the detailed distributional data now available for Honduras. Using multivariate analyses, I quantify the ichthyographical provinces of Honduras with an emphasis on examining existing patterns of structure between eastern and western Honduras. In addition, the freshwater ichthyographical provinces were also described in the context of the physiographical features where they are placed based on Marshall (2007), who divided the country in the fallowing physiographical regions; the Mosquito Coast Lowlands Physiographic Province = MCL. The Chortis Highlands Physiographic Province is formed by the following physiographical sub-regions: WRH = Western Rifted Highlands, HBL = Honduran Borderlands, EDP = Eastern Dissected Plateau, CCP = Central Chortis Plateau (Figure 2).

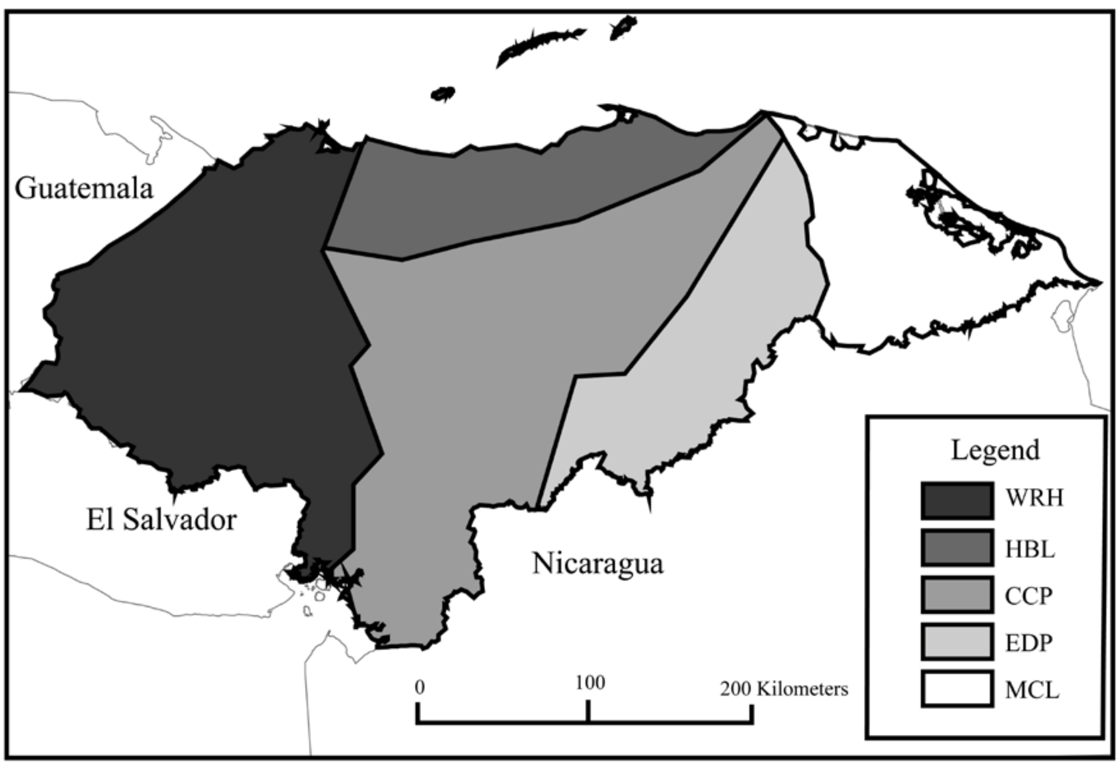

Figure 2. Map of the physiographic division of Honduras based on Marshal (2007).

Materials and Methods

Data Sources

Distributional data for 166 native freshwater fishes found in the 19 major Honduran river drainages (Figure 1, Appendix B) were obtained from Matamoros *et al*. (2009). The Honduran river drainages were used as our GOU as river drainages have been identified as one of the most important factors in freshwater fish biogeography (Gilbert 1980). We followed Myers (1949) for classification of species as primary, secondary or peripheral. Fifty-five species were found to belong to the primary and secondary freshwater species group (Appendix B). Peripheral freshwater fishes, which are more tolerant of high salinity conditions (Myers 1949), can easily disperse among drainages along the coastline and were excluded from analysis. The final data matrix consisted of the presence/absence of the 55 primary and secondary species across the 19 Honduran river drainages (Appendix B).

Taking a geographic perspective based on a set of political boundaries (i.e. Honduras) introduces some potential problems into my analysis. In particular, several drainages cross political boundaries so that the fish fauna may be undersampled. For instance this paper includes just the Honduran reports for the Motagua River drainage which largely drains into Guatemalan territory. In addition the lower reaches of the Lempa River drainage are found in El Salvador.

Data Analysis

First, I ran a CA based on the presence/absence data matrix. Because CA's use a chi-squared metric and as such are non-sensitive to zero matches (Hugueny & Lévêque 1994), they are appropriate for ecological and biogeographical multivariate analysis

(Legendre & Legendre 1998). I then used the first three axes of the CA and created a second data matrix upon which we ran an UPGMA using Euclidean distances as a distance measure. This type of data transformation reduces noise associated with the original data set (Gauch 1982; Jackson and Harvey 1989; Hugueny and Lévêque 1994), as noise is assumed to be uninformative from a biogeographical perspective (Hugueny & Lévêque 1994). Lastly, I ran an UPGMA on the original presence absence matrix using a Jaccard index as a distance measure. In order to test how accurately the dendrograms resulting from the UPGMA represented the original data set I performed a cophenetic correlation coefficient analysis (Farris 1969). Correlation results above 0.9 represent a very good fit; values between 0.8-0.9 depict a good fit; and results below 0.8 represent a poor fit to the data (Rohlf 1997). I used the statistical software package R 2.8.1 (R Development Core Team 2008) to perform all the procedures.

Subsequently, we compared the results of the three analyses for clusters that represented species-drainages relationships (i.e. ichthyographical provinces). I followed the criteria used by Smith and Bermingham (2005) to resolve cases of incongruence between the analyses. After we established these provinces, we tested for differences in species composition with a one-way analysis of similarity (ANOSIM) as implemented in PRIMER v.6 (Clarke and Gorley 2006). ANOSIM tests for differences between and within *a priori* grouping (Clarke and Warwick 1994). A test statistic (R) is computed, which reflects the observed differences between groupings, contrasted with differences within groupings. The R statistic ranges between 0 and 1: if $R = 1$ then all sites within a group are more similar to each other than any sites from different groups, and if $R = 0$

then the similarities between and within groups are the same on average (Clarke & Warwick 1994).

To estimate the rates of species turnover among ichthyographical provinces, I ran a beta diversity analysis (Whittaker 1960, 1972) using the Whittaker index (β_w) as in Koleff *et al.* (2003). Beta diversity measures the difference in species composition either between two or more local assemblages or between local and regional assemblages (Koleff *et al*. 2003). To identify the species that characterized each province I used an indicator species analysis (ISA) (Dufrene & Legendre 1997). A Monte Carlo test seeded with 1000 random permutations was used to test the significance of the indicator value of each species within a group. The Beta diversity analysis and ISA were implemented with the statistical software package R 2.8.1 (R Development Core Team 2008).

Results

Fish Community Composition

Matamoros *et al.* (2009) reported one hundred and sixty-six native species within 41 families in 19 major Honduran drainages (Appendix B). The family Cichlidae was the most speciose contributing 22 species (13.2% of total). The next most speciose families were the Poeciliidae (17 species - 10.2% of total), Gobiidae (16 species - 9.6% of total), Eleotridae (9 species - 5.4 % of total) and Ariidae (8 species - 4.8 % of total) (Figure 3). Twenty-two families with 2-7 species each represented approximately 50% of the total species present (Achiridae, Atherinopsidae, Belonidae, Carangidae, Carcharhinidae, Centropomidae, Characidae, Clupeidae, Engraulidae, Gerreidae, Gymnotidae, Hemiramphidae, Heptapteridae, Lutjanidae, Mugilidae, Paralichthyidae, Profundulidae, Rivulidae, Sciaenidae, Sphyraenidae, Synbranchidae, and Syngnathidae). Finally, 14 families (8.4% of total number of species) were represented only by one species: Anablepidae, Acanthuridae , Anguillidae , Batrachoididae , Dactyloscopidae , Gobiesocidae , Haemulidae, Labrisomidae, Megalopidae, Microdesmidae, Ophictidae, Polynemidae, Pristidae, and Tetraodontidae (Figure 3, Appendix B).

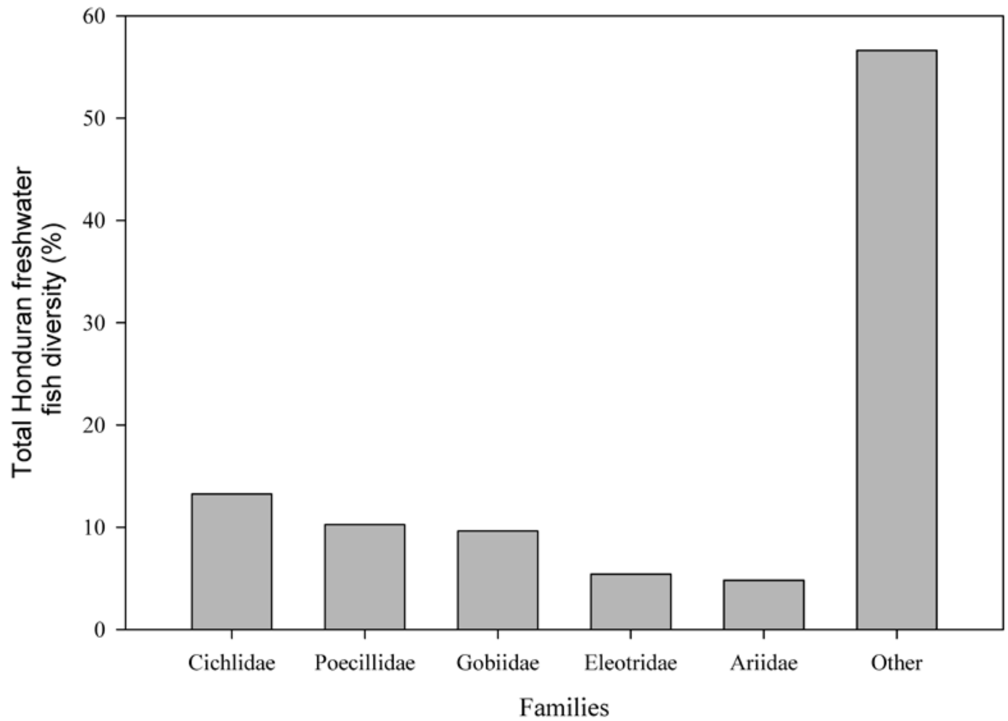

Figure 3. Bar plot showing the percent of contribution of the 5 most speciose Honduran freshwater fish families. Other represents 36 families that contain between 1 to 7 species.

Primary freshwater fish species made up a very small percentage of the total number of species (4.8%). There were only 8 species of primary freshwater fish found in 3 families (Appendix B): Characidae with four species (*Astyanax aeneus, Brycon guatemalensis, Hyphessobrycon tortuguerae,* and *Roeboides bouchellei*), Heptapteridae with two species (*Rhamdia guatemalensis*, and *R. laticauda*), and Gymnotidae with two species (*Gymnotus cylindricus*, and *G. maculosus*) (Appendix B). In any given province, these primary freshwater fish species only contributed between 5.5%-15.4% of the species (Figure 4). Secondary freshwater fish species were better represented in each province accounting for 25.0% to 38.5% of the species. The vast majority of species in a province were peripheral freshwater species contributing between 61.6%-69.7% of the total for Atlantic slope provinces and 46.1% of the total for the Pacific slope province (Figure 4).

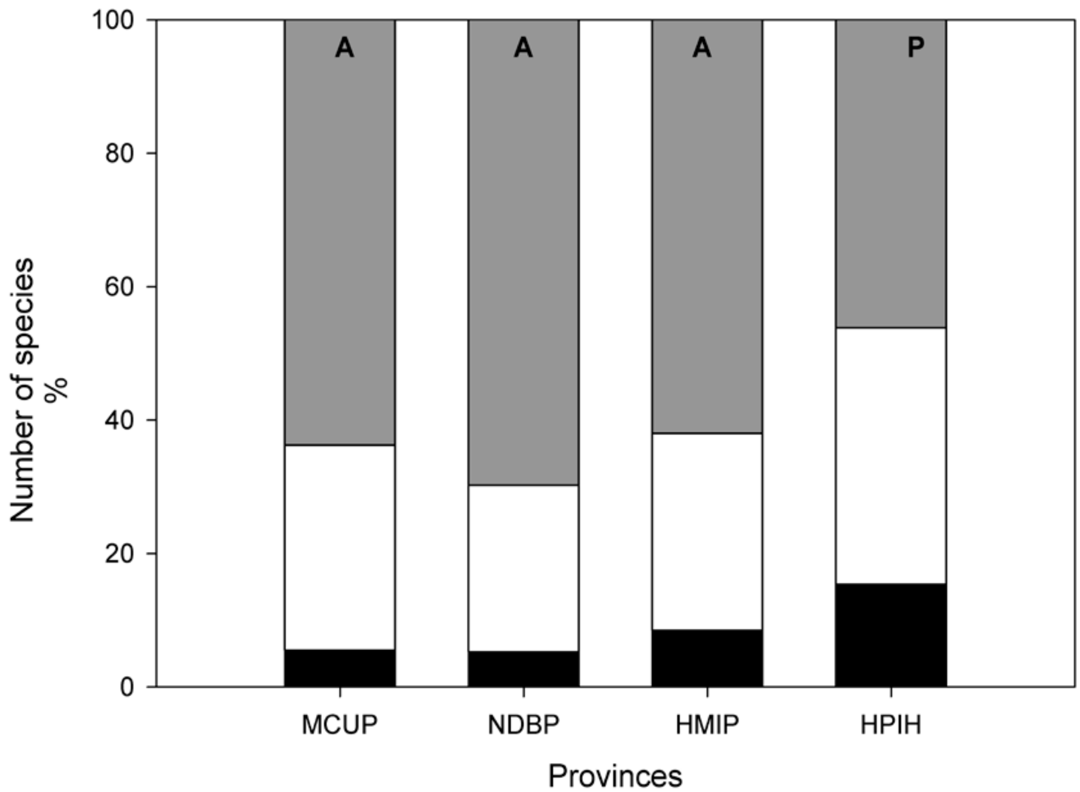

Figure 4. Stack bars showing the percentage of species contributions per province by species tolerance to salinity. Black represents primary freshwater fishes. White represents secondary freshwater fishes. Gray represents peripheral freshwater fishes. MCUP = Motagua-Chamelecón-Ulúa Ichthyographical Province, NDBP = Nombre de Dios-Bay Islands Ichthyographical Province, HMIP = Honduras Mosquitia Ichthyographical Province, HPIH = Honduras Pacific Ichthyographical Province. A = Atlantic Slope, P = Pacific Slope.

Endemism

Of the 166 species in Honduras, only six were endemic, with three yet to be formally described. One species is restricted to the Pacific slope, four are only on Atlantic slope and one is found in both. Two endemics are found in the Pacific slope drainages; *Amphilophus hogaboomorun* in the Negro and Choluteca River drainages, and *Profundulus portillorum* in the Nacaome River drainage. Five endemics are found in the Atlantic slope drainages; *Profundulus portillorum* in the Ulúa River drainage, *Profundulus* sp.1 in the Ulúa and Chamelecón River drainages. *Poecilia* sp.#1 is widely distributed along the Honduran Caribbean coast. *Poecilia* sp. #2 is found in the Motagua, Chamelecón, Ulúa and Lean River drainages. *Theraps wesseli* is restricted to the Cangrejal and Lislis river basins.

Correspondence and Cluster Analysis

The CA (Figure 5) shows four distinctive clusters which the ANOSIM indicate were significantly different ($p = 0.002$, R = 0.753). CA1 accounted for 43.7% of the variability and represented a north to south gradient while CA2 accounted for 29.9% of the variation and represented an east to west gradient. Except for the Lean River drainage, the dendrogram recovered by the Euclidean distances based UPGMA (Figure 6A) (cophenetic correlation coefficient = 0.858) matched the results of the clustering patterns in ordination space of the CA (Figure 5). The dendrogram produced by the Jaccard-based UPGMA (cophenetic correlation coefficient = 0.887) (Figure 6B) failed to cluster the Bay Islands and the Lislis River drainages in the same clusters recovered by the CA and UPGMA Euclidean's distance bases.

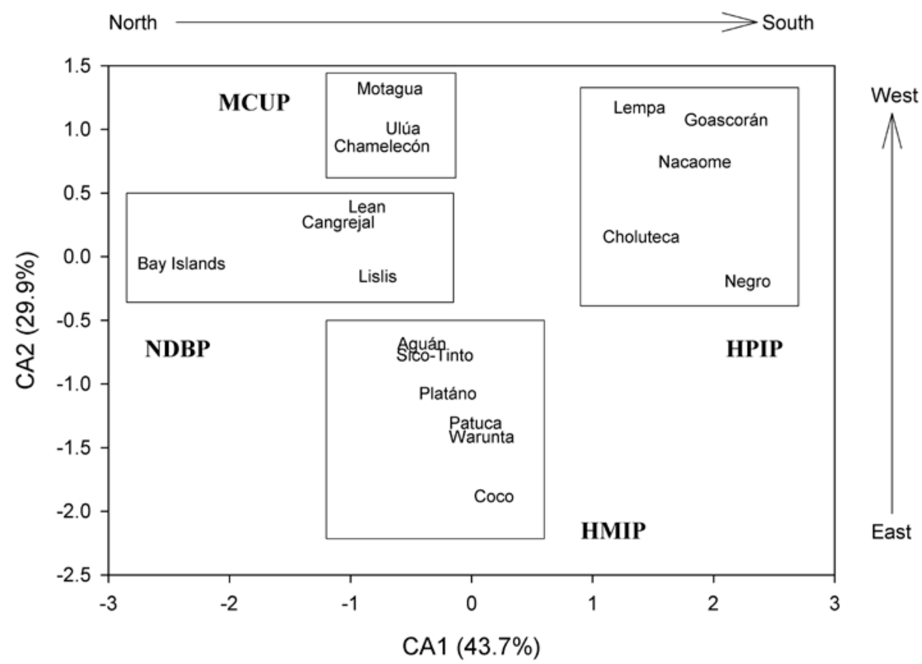

Figure 5. Correspondence analysis ordination of 19 Honduran drainages and presence/absence data of 55 species. The amount of variance explained by each axis is shown in parentheses. MCUP = Motagua-Chamelecón-Ulúa Ichthyographical Province, NDBP = Nombre de Dios-Bay Islands Ichthyographical Province, HMIP = Honduras Mosquitia Ichthyographical Province, HPIH = Honduras Pacific Ichthyographical Province.

Provinces were defined by identifying groups of drainages congruent between the CA and UPGMA dendrogram, and then using pairwise ANOSIM to determine if there are significant differences between them. testing for significance values the different clustering patterns found in the three results. For instance, in both UPGMA dendrograms (Figure 6) the cluster with the Coco, Warunta and Patuca Rivers were adjacent to the cluster with the Sico-Tinto, Aguán and Plátano Rivers. However, the pairwise ANOSIM between the two groups was not significant suggesting that the two groups form a single cluster just as reflected in the CA ordination (Figure 5). Based on the above criterion, I identified four ichthyographical provinces (Figure 7). These provinces are described in detail below along with the results of the beta diversity and indicator species analyses.

All pairwise comparisons between clusters (i.e. ichthyographical provinces) where significant ($p \leq 0.05$), except for one that was marginally significant ($p = 0.057$; Table 1). Marginal significance between those two provinces may be due to smaller sample size. Notably, the drainages belonging to these two provinces did not overlap in ordination space (Figure 5).

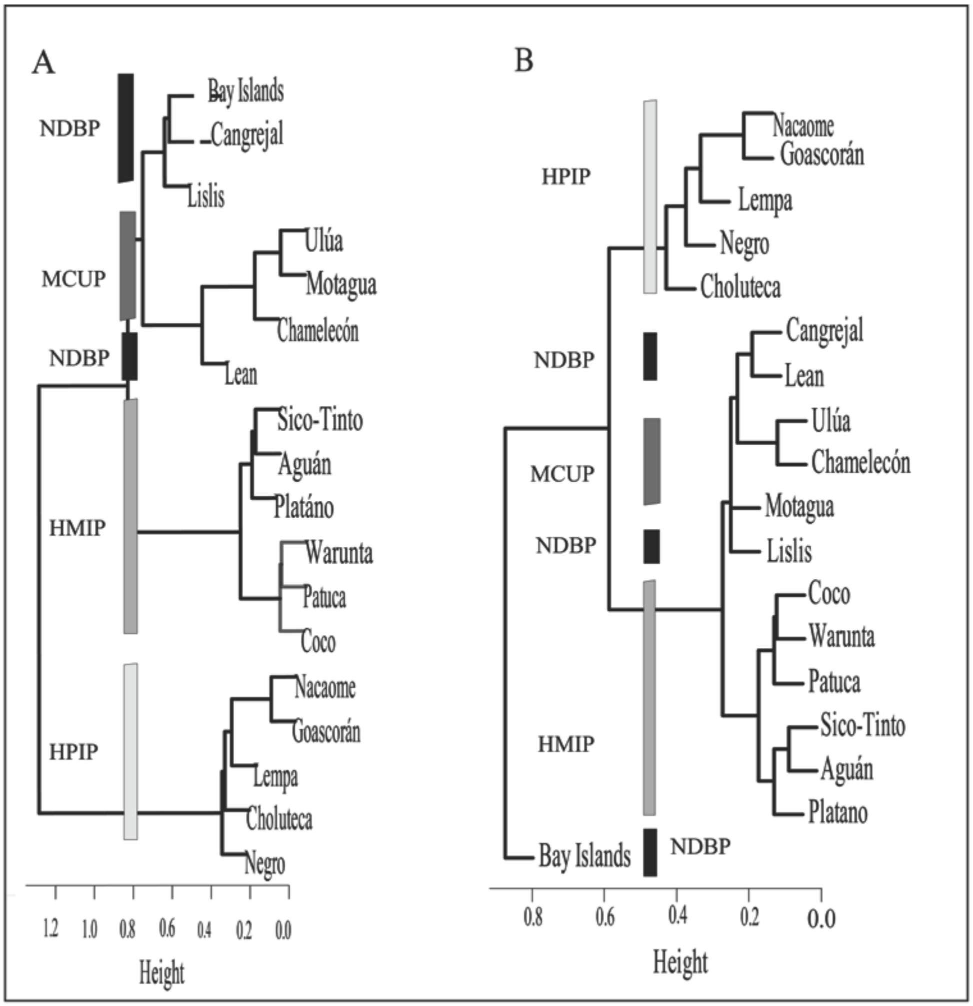

Figure 6. Dendrograms representing faunistic relationships among 19 Honduran major river drainages and 55 obligated freshwater fishes. (A)= UPGMA cluster analysis based on the measure of Euclidean distances. (B) = UPGMA cluster analysis based on Jaccard's similarity coefficient. NDBP = Nombre de Dios-Bay Islands Ichthyographical Province (black bars), MCUP = Motagua-Chamelecón-Ulúa Ichthyographical Province (dark gray bars), HMIP = Honduras Mosquitia Ichthyographical Province (light gray bars), HPIH = Honduras Pacific Ichthyographical Province (white bars).

Table 1

Results of ANOSIM Pairwise Comparisons

Provinces	MCUP	NDBP	HMIP	HPIP
MCUP	0	0.2	0.44	0.51
NDBP	**0.057** (0.407)	0	0.37	0.59
HMIP	**0.012** (1.00)	**0.005** (0.714)	0	0.47
HPIP	**0.018** (1.00)	**0.008** (0.741)	**0.002** (0.995)	0

Note. Results of ANOSIM pairwise comparisons below diagonal. R statistic in parentheses and *p* values in bold. Whittaker beta diversity index (β_w) as in (Koleff *et al*., 2003), above the diagonal line, a β_w value = 0 means that there are not differences in species composition between provinces, and 1 = there are not share taxa between provinces, provinces are 100% different. MCUP = Motagua-Chamelecón-Ulúa Ichthyographical Province, NDBP = Nombre de Dios-Bay Islands Ichthyographical Province, HOIP = Honduras Mosquitia Ichthyographical Province, HPIH = Honduras Pacific Ichthyographical Province.

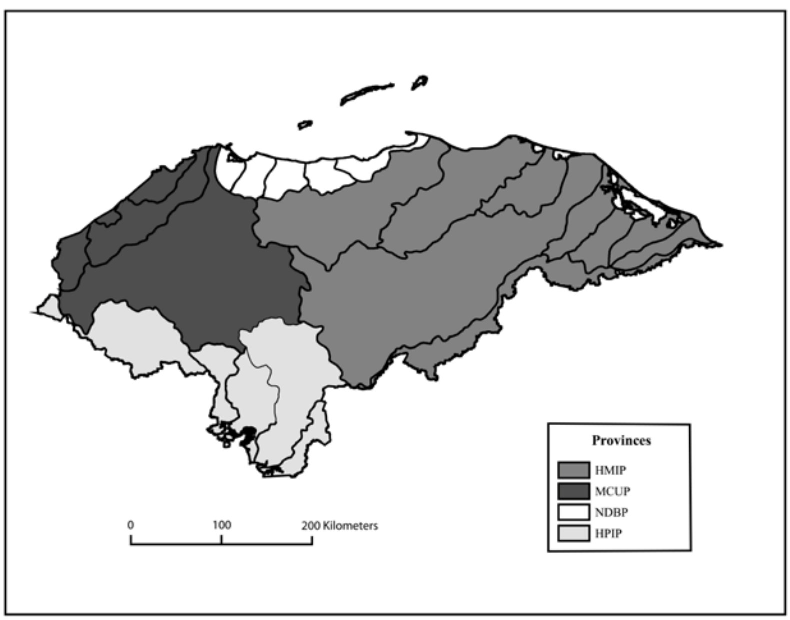

Figure 7. Map of Honduras depicting 4 resolved ichthyographical provinces. HMIP = Honduras Mosquitia Ichthyographical Province, MCUP = Motagua-Chamelecón-Ulúa Ichthyographical Province, NDBP = Nombre de Dios-Bay Islands Ichthyographical Province, HPIH = Honduras Pacific Ichthyographical Province.

Honduran Ichthyographical Provinces

Honduran Pacific Ichthyographical Province (HPIP). This province is formed by all rivers found in the Honduran Pacific slope, including the Lempa, Goascorán, Nacaome, Choluteca and Negro River drainages (Figures 1 and 2). The HPIP spans the Western Rifted Highlands Physiographical Sub-Region (WRH) and the Central Chortis Plateau (CCP) (Figure 2). Both the correspondence and cluster analysis grouped the Honduran Pacific slope river drainages into a single ichthyographical province (Figures 5 and 6 A-B) that was strongly supported by the ANOSIM. The pairwise R values ranged from 0.741 to 1.00. Similarly, beta diversity values between HPIP and the rest of the provinces were the highest in Honduras (Table 1) ranging from 0.47 to 0.51 indicating that there is a fairly high amount of species turnover. The ISA detected five species with significant indicator values in the HPIP; *Roeboides bouchellei*, *Gymnotus maculosus*, *Poecilliopsis turrubarensis*, *Anableps dowei*, and *Amatitlania nigrofasciata* (Table 2). Species endemic of this province are: *Amphilophus hogaboomorum*, *Poecilia* sp. #2 and *Profundulus portillorum*. (Appendix B).

Motagua-Chamelecón-Ulúa Ichthyographical Province (MCUP). This province is formed by the Motagua, Chamelecón, and Ulúa River drainages (Figures 1 and 7). The MCUP includes the WRH and the Atlantic drainages of the CCP physiographic provinces (Figure 2). CA (Figure 5) and UPGMA with transformed data (Figure 6A) clearly grouped the drainages that form the MCUP with the exception of the Lean River which clustered in the NDBP in the CA.

Table 2

Indicator Species Analysis of Four Honduras Ichthyographical Provinces Classified by a Combination of Cluster Analysis, and CA.

Species	MCUP	NDBP	HMIP	HPIP	*p*.val
Rocio octofasciata	**1.000**	0.000	0.000	0.000	0.001
Rivulus tenius	**0.714**	0.114	0.000	0.000	0.009
Ophysternon aenigmaticum	**0.714**	0.114	0.000	0.000	0.013
Brycon guatemalensis	**0.714**	0.029	0.000	0.029	0.008
Profundulus sp2	**0.667**	0.000	0.000	0.000	0.001
Xiphophorus helleri	**0.667**	0.000	0.000	0.000	0.001
Cichlasoma urophthalmus	**0.625**	0.225	0.000	0.000	0.026
Parachromis friedrichsthali	**0.625**	0.225	0.000	0.000	0.027
Profundulus guatemalensis	**0.513**	0.000	0.000	0.046	0.031
Thorichthys aureus	**0.333**	0.000	0.000	0.000	0.001
Vieja microphthalma	**0.333**	0.000	0.000	0.000	0.001
Kryptolebias marmoratus	0.000	**0.600**	0.000	0.000	0.002
Amatitlania nigrofasciata	0.000	0.018	**0.455**	**0.455**	0.006
Parachromis dovii	0.000	0.000	**1.000**	0.000	0.001
Amphilophus alfari	0.000	0.000	**0.833**	0.000	0.004
Amphilophus longimanus	0.000	0.000	**0.625**	0.225	0.001
Roeboides bouchellei	0.000	0.000	0.379	**0.545**	0.003
Gymnotus maculosus	0.000	0.000	0.000	**1.000**	0.001
Poeciliopsis turrubarensis	0.000	0.000	0.000	**1.000**	0.001
Anableps dowei	0.000	0.000	0.000	**1.000**	0.002

The pairwise comparison in the ANOSIM between the MCUP and the NDBP was marginally significant (Table 1). Beta diversity comparisons between MCUP and NDBP resulted in low scores indicating a high rate of species turnover (Table 1). The MCUP has the largest number of significant indicator species of all the provinces: *Brycon guatemalensis*, *Rivulus tenius*, *Profundulus guatemalensis*, *Profundulus sp* #2, *Xiphophorus helleri*, *Ophysternon aenigmaticum*, *Cichlasoma urophthalmus*, *Parachromis friedrichsthali*, *Parachromis motaguensis*, *Rocio octofasciata*, *Thoricthys* *aureus* and *Vieja michrophthalma* (Table 2). *Profundulus sp. #2* is the only endemic found in the MCUP.

Nombre de Dios-Bay Islands Ichthyographical Province (NDBP). The NDBP includes the Lean, Cangrejal, Lislis and the Islands of Roatán and Guanaja (Figure 1). The continental drainages that form this province coincide with the HBL and tend to be small with high altitudinal relief, making them unique from the other Honduran river systems. All mainland rivers in this province are on the north side of the Cordillera de Nombre de Dios. Roatán and Guanaja are located in the Caribbean Sea between 43 to 50 km off the Honduran Caribbean Coast (Martin 1972). Geologically the Bay Islands are associated with the Sierra de Omoa in western Honduras (Martin 1972). The Bay Islands separated from the mainland during the Miocene-Pliocene (Maldonado-Koerdell 1964), and it appears that were connected to the mainland for most of the early and middle Tertiary (Vinson & Brineman 1963). *Kryptolebias marmoratus* was the only species detected by the ISA with a significant indicator value (Table 2). *Theraps wesseli* is the only endemic of this province (Appendix B).

Honduran Mosquitia Ichthyographical Province (HMIP). This is the largest province which includes the Aguán, Sico-Tinto, Plátano, Patuca, Warunta, and Coco River drainages (Figures 1 and 7). The HMIP covers the Mosquito Coast lowlands physiographical sub-province (MCL), the Eastern dissected plateau (EDP), and the CCP (Figure 2). Beta diversity values ranged from 0.37 to 0.47 indicating fairly high rates of species turnover among provinces (Table 1). *Amatitlania nigrofasciata*, *Amphilophus alfari*, *Amphilophus longimanus*, and *Parachromis dovii* are species found with significant indicator species values. No endemic species were found in the HMIP.

Conclusions

The division of the Honduran landscape into four ichthyographical provinces (Figure 7) disagrees with previous findings (e.g. Bussing 1976; Abell *et al*. 2008), which suggested only two ichthyographical provinces. My work retained the Pacific slope of Honduras as one ichthyographical provinces, but divided the Honduran Atlantic slope into three distinctive provinces (Figure 7). These Honduran Atlantic slope provinces closely corresponded with the Honduran physiography (Figures 2 and 7). The HMIP occupies the totality of the MCL, the EDP and the eastern side of the CCP (Figures 2 and 7). Although there was marginal significance in the pairwise comparison between the NDBP and the MCUP as well as high rates of species turnover, I consider the NDBP to be distinct from the MCUP due to the distinctive characteristics of the rivers in the NDBP as well as the fact that this province is located completely within the Honduran Borderlands Physiographic sub-region (HBL; Figure 2). The MCUP covers the Atlantic side of the WRH and the CCP physiographical sub-regions (Figures 2 and 7). In addition to being characterized by their physiographical features, each province has unique species assemblages. I hypothesize that the larger number of indicator species in the MCUP may reflect the Motagua River's position as a biogeographical transition between regions of higher species richness to the north and the depauperate species richness to the south of that zone. Further research should be conducted to test this hypothesis. Identifying finer levels of biogeographic structure is consistent with other recent studies in the region. Smith and Bermingham (2005) split the three historically known lower Mesoamerican ichthyographical provinces in seven smaller provinces and Abell *et al.* (2008) split the Central American region in 16 smaller ichthyographical provinces.

Low levels of endemism and consistently moderate to high rates of species turnover are among the most striking patterns of Honduran freshwater fish distribution (Appendix B, Table 1). Honduras rests in a region characterized by an active geological history that includes faulting, volcanism, orogeny, and sea level change (Martin 1972), which traditionally is thought to promote speciation (Coates & Obando 1996). However, this active geological history does not seem to have produced the same extensive evolutionary diversification of fishes as it has for other vertebrate taxa in the country (e.g. amphibians and reptiles; McCranie and Wilson 2002; Wilson and McCranie 2003). For freshwater fishes, I found high beta diversity among ichthyographical provinces which may be explained by historical geological events that promoted drainage connectivity, not just between rivers belonging to the same slope, but also between drainage basins in the Atlantic and Pacific slopes (Sapper 1902; Olson and McGrew 1941; Martin 1972). Pleistocene stream capture is reported between the Patuca and the Coco Rivers (Rogers 1998; Marshall 2007), and historical connections may have existed during the Miocene between Pacific and Atlantic drainages via the Honduran depression (Comayagua graben; Sapper 1902).

Another puzzling feature of the Honduran ichthyofauna is the extreme paucity of primary freshwater fishes. Myers (1966) discussed the overall scarcity of primary freshwater fishes in Central America, which is most prominent in the area of Nuclear Central America of which Honduras occupies a large portion. Myers (1966) states that the most feasible theory to explain the lack of primary freshwater fishes in this region is that the invasion of these taxa in the region coincided with the lifting of the Panamanian isthmus (3.3 Mya). Consequently, there has been insufficient time for extensive speciation. This theory, however, is not congruent with recent molecular data that date the arrival of several primary freshwater fishes in Central America as occurring about 4-7 Mya (Bermingham & Martin 1998; Perdices *et al*. 2002; Perdices *et al*. 2005; Concheiro Perez *et al*. 2007; Ornelas-Garcia *et al*. 2008). To date, the timing of the arrival of primary freshwater fishes in Central American remains unresolved. Perhaps more interesting is the question as to why the primary freshwater families (i.e. catfishes, characids and gymnotids) in Nuclear Central America are distinctly depauperate in species richness compared to southern Central America (Angermeier & Karr 1984) and South America (Ouboter & Mol 1993; Hardman *et al.* 2002) where these three are among the most speciose groups.

Molecular systematic and phylogeographic studies may provide additional insight into the biogeography of Honduran freshwater fishes. For example, Perdices *et al*. (2002) in a phylogenetic analysis of the genus *Rhamdia* in Central America found that *R. guatemalensis* from the Lempa River in the Pacific slope of Honduras was most closely related to individuals from the Patuca and Aguán Rivers, which are located in the Atlantic slope of the country. Similarly, they also found that *R. laticauda* from the Choluteca River (Pacific Slope) was most closely related to individuals from the Ulúa and Patuca Rivers (Atlantic Slope). At least for the genus *Rhamdia*, a variety of historical drainage connections between the Atlantic and Pacific slopes appears to have facilitated the dispersal of these freshwater fishes across Honduras. Additional studies on other wide-ranging taxa may further characterize these sorts of geologic events that have shaped the distribution of freshwater fishes in Honduras.

The splitting of the Honduran Atlantic slope into three distinctive ichthyographical provinces is congruent with modern biogeographical inference in which an analytical approach is applied and physical factors of the environment are taken into account. Previous research has demonstrated that freshwater fish provincialism is highly related to physiographic, ecological and geological features of landscape (Unmack 2001; Smith & Bermingham 2005). Although physical factors were used as guides in the delineation of the provinces in this research, they were not explicitly tested. Accordingly, further research in Honduras should explicitly take into consideration these factors in the delineation of biogeographical provinces.

The Honduran landscape was presented as being mostly homogeneous with ichthyographical differences existing between the Pacific and Caribbean slopes only and consequently disregarded the complexity of the country's landscape from east to west. This research filled in the previous gaps in species distribution data resulting in analyses capable of producing new river drainage-species relationships at a finer scale and, as such, revealed a country much more ichthyographically complex than previously demonstrated. From a conservation perspective, ichthyographical provinces derived from a more finely scaled approach can provide NGOs and other agencies a more useful framework for prioritizing conservation planning efforts in a region (Higgins 2003).

References

Abell, R., Thieme, M.L., Revenga, C., Bryer, M.T., Kottelat, M., Bogutskaya, N.G., Coad, B., Mandrak, N.E., Contreras Balderas, S., Bussing, W., Stiassny, M.L.J., Skelton, P.H., Allen, G.R., Unmack, P.J., Naseka, A.M., Ng, R., Sindorf, N., Robertson, J., Armijo, E., Higgins, J.V., Heibel, T.J., Wikramanayake, E.D., Olson, D.M., López, H.L., Reis, R.E., Lundberg, J.G., Sabaj Pérez, M.H. and Petry, P. (2008) Freshwater Ecoregions of the World: A New Map of biogeographic units for freshwater biodiversity conservation. *BioScience*, 58**,** 403-414.

Angermeier, P.L. and Karr, J.R. (1984) Fish communities along environmental gradients in a system of tropical streams. *Environmental Biology of Fishes*, 9, 117-135.

Bermingham, E. & Martin, A.P. (1998) Comparative mtDNA phylogeography of Neotropical freshwaterfishes: testing share history to infer the evolutionary landscape of lower Central America. *Molecular Ecology*, 7, 499-517.

Bonada, N., Múrria, C., Zamora-Muñoz, C., El Alami, M., Poquet, J.M., Puntí, T., Moreno, J.L., Bennas, N., Alba-Tercedor, J., Ribera, C. & Prat, N. (2009) Using community and population approaches to understand how contemporaty and historical factors have shaped species distribution in river ecosystems. *Global Ecology and Biogeography*, 18**,** 202-213.

Bussing, W. (1976) Geographic distribution of the San Juan ichthyofauna of Central America with remarks on its origin and ecology. *In:* Thorson, T.B. (Ed.) *Investigations of the Ichthyofauna of Nicaraguan Lakes*. University of Nebraska, Lincoln, Nebraska, pp. 157-175.

Clarke, K. & Gorley, R. (2006) *PRIMER v6*. Primer-E. Plymouth.

Clarke, K.R. & Warwick, R.M. (1994) *Change in marine communities: an approach to statistical analysis and interpretation*. Natural Environment Research Council, Plymouth.

Coates, A.G. & Obando, J.A. (1996) The geologic evolution of the Central American Isthmus. *In:* Jackson, J.B.C., Budd, A.F. & Coates, A.G. (Eds.) *Evolution and Environment in Tropical America*. University of Chicago Press, Chicago, pp. 21-56.

Concheiro Perez, G.A., Rican, O., Orti, G., Bermingham, E., Doadrio, I. & Zardoya, R. (2007) Phylogeny and biogeography of 91 species of heroine cichlids (Teleostei: Cichlidae) based on sequences of the cytochrome b gene. *Molecular Phylogenetics and Evolution*, 43, 91-110.

Crovello, T.J. (1981) Quantitative biogeography. *Taxon*, 30**,** 563-575.

Dufrene, M. & Legendre, P. (1997) Species assemblages and indicator species: the need for a flexible asymmetrical approach. *Ecological Monographs*, 67**,** 345-366.

Farris, J.S. (1969) On the Cophenetic Correlation Coefficient. *Systematic Biology*, 18, 279-285.

Filipe, A.F., Araújo, M.B., Doadrio, I., Angermeier, P.L. & Collares-Pereira, M.J. (2009) Biogeography of Iberian freshwater fishes revisited: the roles of historical versus contemporary constraints. *Journal of Biogeography*, 36, 2096-2110.

Gauch, H.G., Jr. (1982) Noise reduction by eigenvector ordinations. *Ecology*, 63, 1643-1649.

Gilbert, C.R. (1980) Zoogeographic factors in relation to biological monitoring of fish. *In:* Hocutt C.H. & Stouffer J.R. Jr. (Eds.) *Biological monitoring of fish*.. D.C. Heath and Company, Lexington, Massachusetts. pp. 309-356

Hardman, M., Page, L., Sabaj, M., Armbruster, J. & Knouft, J. (2002) A comparison of fish surveys made in 1908 and 1998 of the Potaro, Essequibo, Demerara, and coastal river drainages of Guyana. *Ichthyological Exploration of Freshwaters*, 13, 225-238.

Heikinheimo, H., Fortelius, M., Eronen, J. & Mannila, H. (2007) Biogeography of European land mammals shows environmentally distinct and spatially coherent clusters. *Journal of Biogeography*, 34, 1053–1064.

Higgins JV. (2003) Maintaining the ebbs and flows of the landscape: Conservation planning for freshwater ecosystems. *In*: (Groves C. ed.) *Drafting a Conservation Blueprint: A Practitioner's Guide to Planning for Biodiversity.* Nature Conservancy and Island Press. Washington D.C. pp. 291–318.

Hugueny, B. & Lévêque, C. (1994) Freshwater fish zoogeography in West Africa: faunal similarities between river basins. *Environmental Biology of Fishes*, 39, 365-380.

Jackson, D.A. & Harvey, H.H. (1989) Biogeographic associations in fish assemblages: local vs. regional processes. *Ecology*, 70, 1472-1484.

Koleff, P., Gaston, K.J. & Lennon, J.J. (2003) Measuring beta diversity for presence-absence data. *Journal of Animal Ecology*, 72*,* 367-382.

Legendre, P. & Legendre, L. (1998) *Numerical ecology*, 2nd English edition, Elsevier Science, Amsterdam. pp. 853.

Maldonado-Koerdell, M. (1964) Geohistory and paleogeography of Middle America. *In:* West, C. (Ed.) *Handbook of Middle American Indians*. The University of Texas Press, Austin, pp. 3-32.

Marshall, J.S. (2007) Geomorphology and physiographic provinces of Central America. *In*: Bundschuh J. & Alvarado G. Eds.) *Central America: Geology, Resources, and Natural Hazards.* Balkema, Leiden, The Netherlands. pp. 75–122.

Martin, M. (1972) *A biogeographic analysis of the freshwater fishes of Honduras*. Unpubl. Ph.D. Dissertation. University of Southern California*. Los Angeles*, pp. 588.

Matamoros, W.A., Schaefer, J. & Kreiser, B. (2009) Annotated checklist of the freshwater fishes of continental and insular Honduras. *Zootaxa*, 2307, 1–38.

McCranie, J. & Wilson, L. (2002) The amphibians of Honduras. Contributions to Herpetology, 19, 1–625.

Miller, R.R. (1966) Geographical distribution of Central American freshwater fishes. *Copeia*, 4, 773-802.

Myers, G.S. (1949) Salt-tolerance of fresh-water fish groups in relation to zoogeographical problems. *Bijdragen tot de Dierkunde*, 28, 315-322.

Myers, G.S. (1966) Derivation of the freshwater fish fauna of Central America. *Copeia*, 1966, 766-733.

Olson, E.C. & McGrew, P.O. (1941) Mammalian fauna from the Pliocene of Honduras. *Geological Society of America Bulletin*, 52, 1219-1244.

Ornelas-Garcia, C.P., Dominguez-Dominguez, O. & Doadrio, I. (2008) Evolutionary history of the fish genus Astyanax Baird and Girard (1854) (Actynopterigii, Characidae) in Mesoamerica reveals multiple morphological homoplasies. *BMC Evolutionary Biology*, 8, 340.

Ouboter, P.E. & Mol, J.H.A. (1993) The fish fauna of Suriname. *In*: (Ouboter P.E. (Ed.), *Freshwater ecosystems of Suriname.* Kluwer Academic Publisher, Dordrecht, Netherlands, pp. 133-154.

Perdices, A., Bermingham, E., Montilla, A. & Doadrio, I. (2002) Evolutionary history of the genus Rhamdia (Teleostei: Pimelodidae) in Central America. Molecular *Phylogenetics and Evolution*, 25, 172-189.

Perdices, A., Doadrio, I. & Bermingham, E. (2005) Evolutionary history of the synbranchid eels (Teleostei: Synbranchidae) in Central America and the Caribbean Islands inferred from their molecular phylogeny. *Molecular Phylogenetics and Evolution*, 37, 460-473.

R Development Core Team (2008) *R 2.8.1.: A language and environment for statistical computing*. R Foundation for Statistical Computing, Vienna, Austria.

Reyjol, Y., Hugueny, B., Pont, D., Bianco, P.G., Beier, U., Caiola, N., Casals, F., Cowx, I., Economou, A., Ferreira, T., Haidvogl, G., Noble, R., de Sostoa, A., Vigneron, T. & Virbickas, T. (2007) Patterns in species richness and endemism of European freshwater fish. *Global Ecology and Biogeography*, 16, 65-75.

Rohlf, F.J. (1997) *NTSYS-pc, Version 2.02*. Exeter Software: Applied Biostatistics Inc.

Rogers, R.D. (1998) Incised meanders of the Río Patuca, stream piracy and landform development of the La Mosquitia, Central America. *Proceedings of the Fifteenth Caribbean Geological Conference,* Kingston, Jamaica, 3, 92.

Sapper, K. (1902) Beitrage zur physichen geographie von Honduras. *Zeit. der Gesellschaft fur Erdkunde zu Berlin*, 1902, 512-536.

Sclater, P. L. (1858) On the general geographical distribution of the members of the class Aves. *J. Proc. Lin. Soc. (London) Zool.*, 2, 130–145.

Smith, S.A. & Bermingham, E. (2005) The biogeography of lower Mesoamerican freshwater fishes. *Journal of Biogeography*, 32, 1835–1854.

Unmack, J. (2001) Biogeography of Australian freshwater fishes. *Journal of Biogeography*, 28, 1053-1089.

Vinson, G.L. & Brineman, J.H. (1963) Nuclear Central America, hub of the Antillean transverse belt. *Backbone of the Americas: Tectonic History from Pole to Pole*. (ed. by O.E. Childs & B.W.) Beebe), pp. 101-112. American Association of Petroleum Geologist, Tulsa, Oklahoma.

Wallace, A. R. (1876) *The geographical distribution of animals, with a study of the relations of living and extinct faunas as elucidating the past changes of the earth's surface*, (2 Vols). Macmillan, London. pp. 607.

Whittaker, R.H. (1960) Vegetation of the Siskiyou Mountains, Oregon and California. *Ecological Monographs*, 30, 279–338.

Whittaker, R.H. (1972) Evolution and measurement of species diversity. *Taxon*, 21, 213-251.

Wilson L.D., & McCranie, J.R. (2003) The conservation status of the herpetofauna of Honduras. Amphibian and Reptile Conservation, 3, 7–32.

Zogaris, S., Economou, A.N. & Dimopoulos, P. (2009) Ecoregions in the Southern Balkans: Should their boundaries be revised? *Environmental Management*, 43, 682-697.

CHAPTER IV

FISH ASSEMBLAGE STRUCTURE ALONG A LONGITUDINAL GRADIENT IN TWO SMALL HONDURAN CARIBBEAN STREAMS

Abstract

The relationship between structure of fish assemblages and environmental variables along a longitudinal gradient in two small Honduran drainages was studied from 2005-2009 at 11 sites in each drainage. Nonmetric multidimensional scaling separated the drainages as well as the lower, middle and upper reaches of the drainages distinctively ($P < 0.05$). Canonical correspondence analysis revealed that relationships between local environmental variables and community structure were generally weak but were better defined in the smaller Lancetilla River drainage and species richness declined with altitude. The lower reaches were dominated by mostly marine vagrants, whereas middle and upper reaches were dominated by species with morphological adaptations to thrive in rapid waters, large substrates, and small and high waterfalls. Decline in species richness in the upper reaches can be partially attributed to a general paucity of secondary and primary fishes in the region.

Introduction

A central topic in stream ecology has been to determine how river assemblages are influenced by interacting biotic (Werner & Gilliam 1984; Ross 1986; Gilliam *et al*. 1993; Taylor & Warren 2001) and abiotic (Rahel & Hubert 1991) factors. At the local level, biotic factors such as immigration, extinction, predation and competition have all been shown to be influential (Taylor & Warren 2001). The influence of abiotic factors has been widely investigated by freshwater fish ecologists (reviewed in Matthews 1998).

It is largely accepted that a stream's environmental gradients are highly correlated with changes in a stream's biotic communities (Schlosser 1982; Oberdorff *et al.* 1993; Lyons 1996; Angermeier & Winston 1998; Marsh-Matthews & Matthews 2000; Moyle *et al*. 2003). Stream size (Schlosser 1982; Lyons 1996), altitude (Jaramillo-Villa *et al*. 2010), geomorphology (Walters *et al*. 2003), water chemistry, temperature (Buisson *et al*. 2008; Pires *et al*. 2010), and landscape features (Angermeier & Winston 1998) are among the factors that influence fish community structure.

Although it is intuitive that changes in the river continuum will affect assemblage dynamics, one or several factors may be more paramount and an understanding of the fundamental mechanisms at work in this process is necessary. Tejerina-Garro *et al*. (2005) proposed two mechanisms to explain such longitudinal changes. The first (biotic zonation) states abrupt changes and discontinuities in abiotic gradients along a river course results in distinct assemblage structure (Huet 1959; Schlosser 1982; Rahel & Hubert 1991; Oberdorff *et al*. 1993; Belliard *et al*. 1997). If biotic zonation is the controlling mechanism in these systems, one would expect to see abrupt changes in species composition associated with changes in river width, substrate type, and predominant habitat types. For example, Rahel and Hubert (1991) found in a Rocky Mountain stream that drastic changes in assemblage composition were associated with stream temperature. The second mechanism (continual addition of species) states that nested patterns of assemblage structure result from gradual addition of species from upstream to downstream are related to gradual environmental gradients (Sheldon 1968; Rahel & Hubert 1991). If the continual addition of species is the mechanism at work in these systems, I would expect to see subtle additions of species from the upper to the lower reaches of the drainages. For example, Sheldon (1968) found in a New York creek that species continually were added from the upper reaches to lower reaches of the creek, with replacement of species generally not occurring along the continuum.

Considerable work has been devoted to understanding the effect of environmental gradients in the structuring of freshwater fish assemblages. Most of this work, however, has been performed in temperate North American and European streams (see Matthews 1998), with research in South America only recently being conducted (e.g. Mazzoni & Lobón-Cervía 2000; Mendonça *et al.,* 2005, Tejerina-Garro *et al*., 2005; Pouilly *et al.*, 2006; Jaramillo-Villa *et al*., 2010). A smaller number of studies have been conducted in southern Central America (e.g. Bussing & Lopez, 1977; Angermeier & Karr, 1983; Wootton & Oemke, 1992; Espinoza Mendiola, 2008), and northern Central America (Esselman *et al*. 2006). However, in Middle Central America (e.g. Honduras) no studies that address the relationship between environmental characteristics and the configuration of fish assemblages have been performed.

Among Central American countries, Honduras is characterized by an extreme paucity of primary freshwater fishes (as defined by Myers 1949). Primary groups such as characids, catfishes and knifefishes, in particular, that are very diverse in streams of South America (Ouboter & Mol 1993; Hardman *et al.* 2002) and Southern Central American (Myers 1966) are underrepresented in Honduras (Matamoros *et al*. 2009). The mechanisms that have produced this phenomenon have yet to be sufficiently explained (Myers 1966). Myers (1966) suggested that primary freshwater fishes have not yet had the time to speciate or colonize these areas since their relatively recent arrival in Central America in conjunction with the final lifting of the Isthmus of Panama (3.5 Mya). This theory is contested by molecular data that suggests that primary freshwater fishes arrived prior to the final lifting of the isthmus (~4-7 Mya; Bermingham & Martin 1998; Perdices *et al*. 2002; Perdices *et al*. 2005; Concheiro Perez *et al*. 2007).

In addition to the lack of primary freshwater fishes, Honduras also possesses a unique complex of stream systems in the Nombre de Dios and Bay Islands Ichthyographical Province along the Caribbean Coast. These drainages are small, with steep altitudinal profiles, and short flood plains of just a few kilometers or a complete lack of a flood plain. This combination of low primary freshwater fish diversity and the unique physical characteristics of streams within this province provide an opportunity to study some mechanisms controlling local diversity and community dynamics in freshwater fishes. The overall objectives of this study are as follows: 1) to characterize the species composition of two small Honduran Caribbean drainages, and 2) to test the following hypotheses:

Hypothesis 1: Two neighboring drainages located in the same ichthyographical province and in close proximity but differing in size and altitudinal profile will host differing fish assemblage structure.

Prediction 1: Drainage size and slope will influence assemblage composition as these are expected to relate directly to immigration and extinction rates. Specifically, a smaller and less steep drainage will host less species than a larger drainage with a more pronounced slope.

Hypothesis 2: Species richness will be highest at the lower reaches, decreasing dramatically in the headwaters.

Prediction 2: Headwaters will contain very few species due to extreme barriers to headwater colonization (waterfalls) and a general lack of primary freshwater fishes to serve as potential colonizers (biotic zonation). Downstream reaches will be most diverse near the mouth of the river with diversity decreasing as slope increases. These patterns should be more pronounced in shorter drainages with greater slopes.

Hypothesis 3: Local environmental factors will change along longitudinal gradients in each drainage, influencing fish assemblage structure.

Prediction 3: Fish assemblage structure will be correlated with local environmental variables in each drainage in similar ways.

Study Area

Fish communities were sampled at 22 sites (11 sites/river) in the Cangrejal (CGR) and Lancetilla (LCR) Rivers (Figure 1). The CGR is located on the Honduran Caribbean coast near the city of La Ceiba in the department of Atlántida (Figure 1). The entire stream measures ~ 45 km in length, and reaches the Caribbean Sea as a 3rd order stream. The CGR altitudinal profile changes from 0 meters above sea level (m.a.s.l.) at the river mouth to 402 m.a.s.l. at the highest sampling point at 35.75 river km upstream (mean slope of 11.2 m per river km; Figure 1A). For this study I classified lower reaches all sampling localities below 20 m.a.s.l., middle reaches were localities between 20-100 m.a.s.l. and upper reaches all localities found above the 100 m.a.s.l. mark (Figure 2). Two sampling stations were located at the lower reaches, two at the middle reaches and the remaining seven sampling stations were located at the upper reaches (Figure1A).

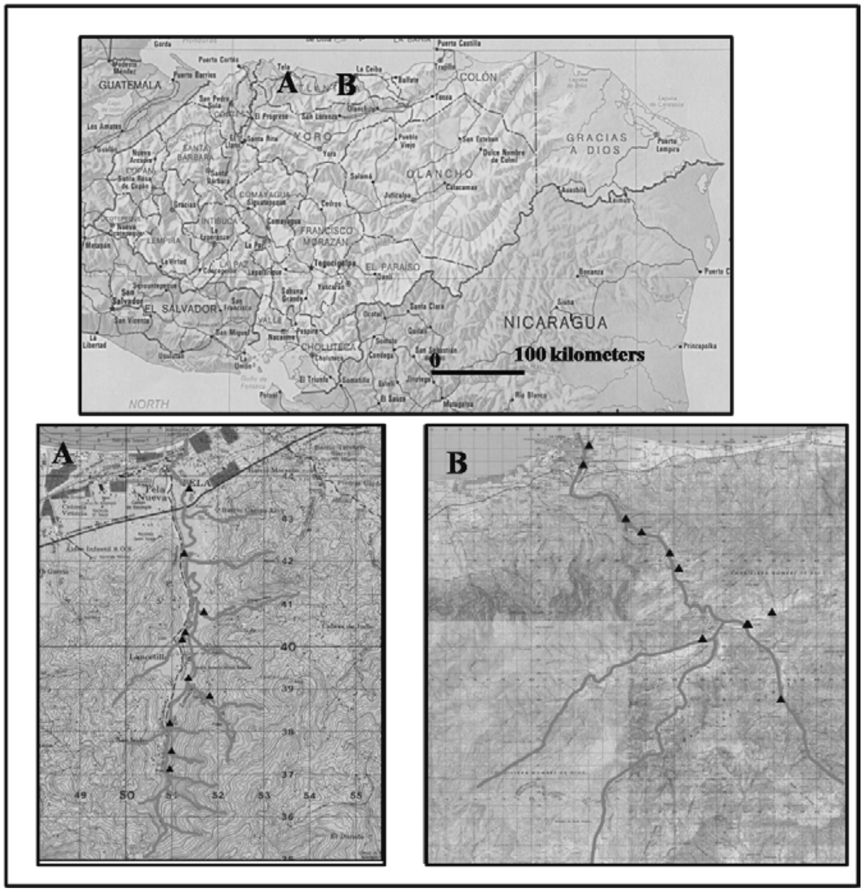

Figure 1. Map of Honduras showing sampling stations. A = Lancetilla River and B = Cangrejal River.

The lower reaches of the stream close to the river mouth are characterized by sandy muddy bottoms which rapidly changes upstream (~1.5 river km) to cobble and small boulder dominated substrate. This area of the stream is heavily disturbed by rock mining for construction purposes. In the middle and upper reaches of the drainage, rocks and boulders are common substrates while rapids, riffles and waterfalls are dominant habitat types. The LCR, 75 km west of the CGR, is located near the city of Tela in the department of Atlántida (Figure 1). The Lancetilla River is ~10 km long and reaches the Caribbean Sea as a 3rd order stream. It changes in relief from 11 m.a.s.l. at our lowest sampling locality 1.6 km from the mouth to 139 m.a.s.l. at the highest sampling point 10 river km upstream (mean slope of 13.9 m per river km, Figure 1B). The majority of the LCR is located within the limits of the Lancetilla Botanical Garden protected area. The LCR provides more than 50% of the potable water needs for the city of Tela.

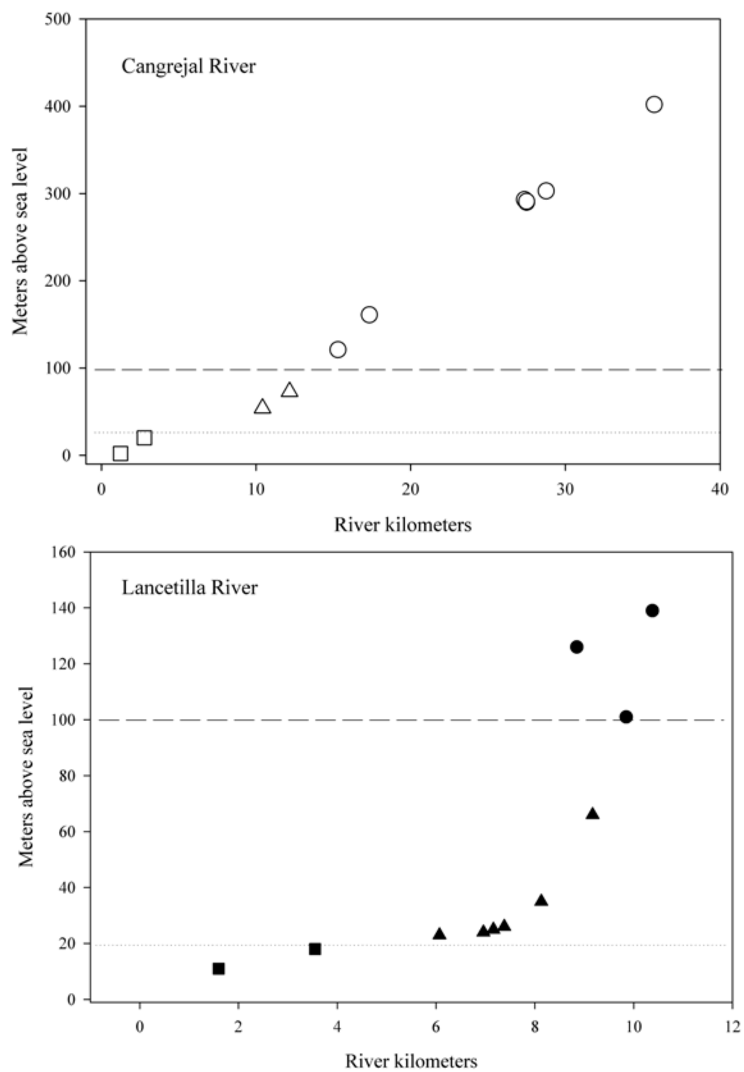

Figure 2. River kilometers and elevation (meters above sea level) from the Cangrejal River (○) and Lancetilla River (●). Dotted line at 20 m.a.s.l., and dashed line at 100 m.a.s.l.

Methods

Fish communities were sampled in November 2005, June 2006, June 2007, January – February 2008, and June 2009. Due to the high flows and extreme variability in substrate size, I utilized a mix of four complementary sampling techniques: backpack electrofishing, seining, cast-netting, and when possible spearfishing. At each sampling locality, all available habitats (run, pools, riffles, and rapids) over 75-150 m of stream were sampled. All fishes were fixed in 10% formalin and later transferred to 70% alcohol, identified to species and deposited in the USM Ichthyological Collection.

In June of 2009, I measured an array of water chemistry and physical parameters at each site. Three transects were established perpendicular to flow at upstream, middle and downstream portions of the sampled area, and water physicochemical variables were measured (YSI Professional Plus) at three points along each transect (25, 50 and 75% of stream width). Dissolved oxygen (DO (mg/L)), temperature (^{o}C), conductivity (microSiemens/cm (µS/cm)), salinity (PPT), pH, and total dissolved solids (TDS (mg/L)), depth (cm), current velocity (m/s), dominant substrate type (modified Wentworth scale), presence of physical cover ("cover"), presence of litter and the presence of emergent vegetation in the stream ("vegetation"). For each of the three transects I estimated percent canopy cover ("canopy"), erosion observed on both river banks ("bank") and habitat type (presence/absence of riffles, runs, rapids and pools) and measured stream wetted width with a meter stick. Turbidity (NTU) was measured once per site with a Hach 2100 turbidity meter. River slope ("slope") at each sampling locality was calculated as Slope = ((A1-A2)/1000) x 100, where A1 = altitude at 500 river m above sampling point, A2 = altitude recorded 500 river m below sampling point. Within each site, habitat heterogeneity was quantified as the coefficient of variation (CV) in habitat variables measured once per transect (river width) or three times per transect (depth and dominant substrate).

Data Analysis

Overall species composition and differences among systems. To assess how well the sampling regime detected the number of species present, I examined species accumulation curves for each system. Patterns in assemblage structure were assessed by nonmetric multidimensional scaling analysis (NMDS) performed on Bray-Curtis similarities of log (x + 1) transformed abundance data. Species that occurred less than five times during the study were considered rare and removed from ordination analyses. A one-way analysis of similarity (ANOSIM; Clarke and Warwick 1994) was performed to test for differences in species composition ($P < 0.05$) between the two drainages as well as differences in species composition among established lower, middle, and upper reaches sites. The ANOSIM procedure tests for differences within and between *a priori* groupings and computes a test statistic (R) which reflects the observed differences between groupings contrasted with differences within groupings. R ranges from 0 to 1 where an R of 1 indicates all sites within a group are more similar to each other than to those in other groups. An R of 0 indicates the similarities between and within groups are similar (Clarke & Warwick 1994). The above procedure was implemented in PRIMER v.6 (Clarke & Gorley 2006).

Species richness changes along the longitudinal gradient. A two-way analysis of variance (ANOVA) was used to test for differences in species richness between drainages and differences among reaches in the two drainages.

Environmental factors and their relationship with assemblage composition. To summarize the physical and water chemistry characteristics of the drainages I used a principal component analysis (PCA) on all local environmental variables. A canonical correspondence analysis (CCA) was used to directly relate species assemblage data to the measured environmental variables (ter Braak 1986). Because localities could not be sampled equally over the five year study period, I averaged the total abundance of species captured by site over the five year period for CCA analysis only. To select the best CCA model, all environmental variables were subjected to a correlation analysis and highly correlated variables were eliminated. The retained variables were: cover, DO, bank, slope, current, vegetation, and CV width. I then ran a forward selection procedure using Akaike's Information Criterion to identify the variable or suite of variables that most efficiently explained assemblage variability (ter Braak & Smilauer 2002). The final CCA model was performed using these Akaike's Information Criterion selected variables. In the final CCA model all variance inflation factors were < 0.4 indicating little redundancy among variables. I used a permutational analysis of variance (permutational ANOVA), based on 1000 permutations to test for significance (defined as $p < 0.05$) among individual variables, CCA axes and the overall CCA analysis. One of the main goals of this study was to detect differences in assemblage structure assemblage along the longitudinal gradient. Accordingly, I used an indicator species analysis (ISA; Dufrene & Legendre 1997) to identify species that significantly define the lower, middle and upper reaches of both drainages. All above described statistical procedures except for ANOSIM were performed with the statistical software package R. 2.8.1 (R Development Core Team 2008).

Results

Overall Species Composition and Assemblage Differences between the Cangrejal River and Lancetilla River

A total of 7,620 fishes representing 41 species were captured in both drainages (Appendix C). Twenty-nine species were recorded in the CGR of which seven were unique to the LCR. Thirty-four species were collected in the LCR of which 12 were unique to the CGR. *Poecilia* sp. “hondurensis” was the most abundant species in both streams (40. 6 % and 20.7% of total abundance in CGR and LCR, respectively). *Alfaro huberi* was the second most abundant fish in the CGR (23% total abundance) while *Poecilia* cf. *mexicana* was the second most abundant fish in the LCR (19.2 % total abundance). Five species in the CGR accounted for 81.3% of all individuals captured (*Poecilia sp*. “hondurensis”, *Alfaro huberi*, *Atherinella milleri*, *Cryptoheros cutteri*, and *Dormitator maculatus*), whereas in LCR, 71.2% of individuals were attributed to the five most abundant species (*Poecilia* sp. “hondurensis”, *Poecilia* cf. *mexicana*, *Atherinella milleri*, *Poecilia* cf. *nelsoni*, *Sicydium punctatum*).

The NMDS analysis (0.1976 stress) separated the CGR and the LCR drainages (Figure 3). Significant differences were found when comparing the overall assemblage composition between the two drainages (ANOSIM, $P = 0.001$; Global R = 0.33). Most localities from the LCR loaded negatively in NMDS2, whereas most localities from CGR loaded positively in NMDS2. The NMDS1 shows a clear longitudinal pattern of assemblage change from lower to middle and upper reaches in the LCR. However, this pattern is not as clear for the CGR. Pairwise comparisons from ANOSIM among zones based on species composition showed significant differences (*P* = 0.05; Table 1, Figure 3).

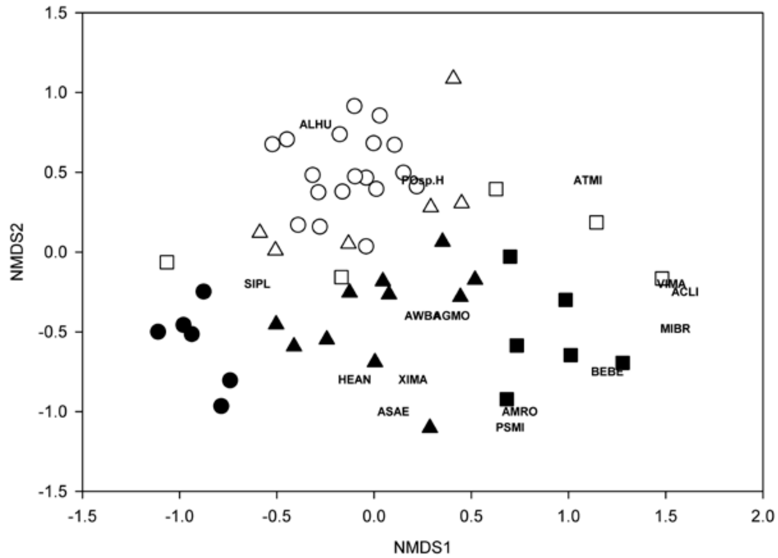

Figure 3. Nonmetric multidimensional scaling ordination (stress = 0.1976) of sites based on log (x+ 1) transformed abundance of fish species. The Cangrejal River (□ = lower reaches, Δ = middle reaches, ○ = upper reaches) and the Lancetilla River (■ = lower reaches, ▲ = middle reaches, and ● = upper reaches). Species abbreviations as follow: ALHU = *Alfaro huberi*, ACLI = *Achirus lineatus*, VIMA = *Vieja maculicauda*, MIBR = *Microphis brachyurus*, BEBE = *Belonesox belizanus*, ATMI = *Atherinella milleri*, AMRO = *Amphilophus robertsoni*, PSMI = *Pseudophallus mindii*, ASAE = *Astyanax aeneus*, XIMA = *Xiphophorus mayae*, HEAN = *Heterandria anzuetoi*, AWBA = *Awaous banana*, AGMO = *Agonostomus monticola*, ATMI = *Atherinella milleri*, SIPL = *Sicydium plumieri*, POSP.h = *Poecilia sp.* "hondurensis".

Table 1

Results of ANOSIM Pairwise Comparisons

Reaches	Lower	Middle	Upper
Lower	-	**0.017** (0.336)	**0.001** (0.87)
Middle	**0.001** (0.668)	-	**0.001** (0.626)
Upper	**0.002** (1.0)	**0.001** (0.643)	-

Note. Results of ANOSIM pairwise comparisons with *P* values in bold font and R statistic values in parentheses.

Cangrejal River results above dashed line. Lancetilla River results below dashed line.

Fish Diversity Zonation along The Longitudinal Gradient

The two-way ANOVA indicated a significant difference in species richness between drainages ($F_{1,2}$= 6.01, *P*>.013) and among zones ($F_{2,3}$= 10.99, *P* >.001). However, there was a significant interaction drainage X zone effect ($F_{2,1}$= 6.88, *P* >.002). The LCR showed similar mean species richness in the lower and middle reaches and a sharp decrease from the middle to upper reaches (Figure 4). In contrast, the CGR showed higher richness values in the lower reaches and similar richness for the middle and upper reaches (Figure 4).

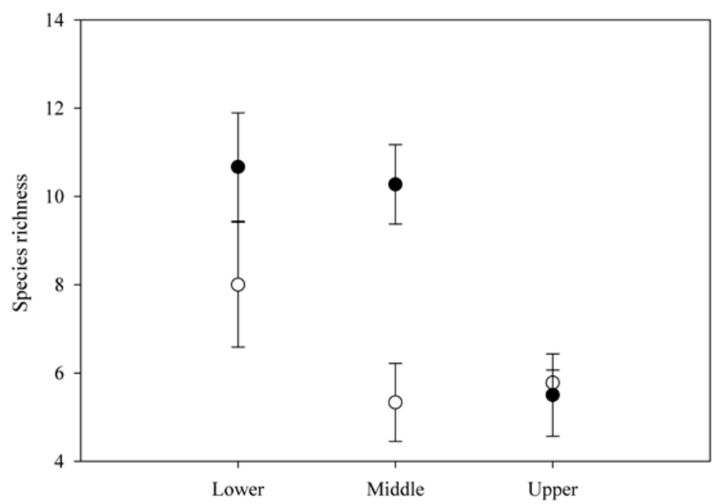

Figure 4. Mean species richness + standard errors of three different zones of the river continuum in the Cangrejal River (○) and Lancetilla River (●) on the Honduran Caribbean coast.

In the CGR, ISA identified six species that were significant indicators for the lower reaches (*Achirus lineatus*, *Caranx latus, Atherinella milleri, Amphilophus robertsoni, Anchoa sp., and Citharichthys macrops*). Two species were found to be good indicators of the middle reaches (*Awaous banana* and *Agonostomus monticola*), and the upper reaches (*Astyanax aeneus* and *Alfaro huberi*). In contrast, the LCR had seven indicator species in the lower reaches (*A. milleri*, *Belonesox belizanus*, *Microphis brachyurus*, *A. lineatus*, *Pseudophallus mindii*, and *Parachromis friedrichsthalii*), six in the middle reaches (*A. aeneus*, *Poecilia sp. "hondurensis", A. banana*, *Xiphophorus mayae*, *Heterandria anzuetoi*, *Ophisternon aenigmaticum*) and one in the upper reaches (*Sicydium plumieri*; Table 2).

Table 2

Results from Indicator Species Analysis

Cangrejal River				Lancetilla River			
Species	Lower	Middle	Upper	Species	Lower	Middle	Upper
*Achirus lineatus****	**0.400**	0.000	0.000	*Atherinella milleri****	**0.987**	0.003	0.000
*Caranx latus**	**0.400**	0.000	0.000	*Belonesox belizanus****	**0.808**	0.003	0.000
*Atherinella milleri**	**0.376**	0.010	0.000	*Microphis brachyurus***	**0.642**	0.004	0.000
*Amphilophus robertsoni***	**0.200**	0.000	0.000	*Achirus lineatus****	**0.500**	0.000	0.000
*Anchoa. sp**	**0.200**	0.000	0.000	*Vieja maculicauda**	**0.500**	0.000	0.000
*Citharichthys macrops**	**0.200**	0.000	0.000	*Pseudophallus mindii****	**0.333**	0.000	0.000
*Awaous banana**	0.167	**0.279**	0.031	*Parachromis friedrichsthalii****	**0.167**	0.000	0.000
*Agonostomus monticola***	0.000	**0.459**	0.121	*Astyanax aeneus***	0.204	**0.653**	0.010
*Astyanax aeneus***	0.000	0.006	**0.696**	*Poecilia sp. "Hondurensis"**	0.075	**0.603**	0.000
*Alfaro huberi***	0.000	0.002	**0.718**	*Awaous banana**	0.062	**0.543**	0.000
				*Xiphophorus mayae***	0.015	**0.691**	0.003
				*Heterandria anzuetoi***	0.005	**0.658**	0.087
				*Ophisternon aenigmaticum**	0.000	**0.444**	0.000
				*Sicydium plumieri**	0.000	0.131	**0.574**

Note: Only species with significant values are included. * indicates significance of Monte Carlo permutation test (* = p <0.05; ** = P < 0.01; *** = < 0.001). Significant indicator species were used to describe groups from ordination analysis.

Environmental Characteristics of the Streams

Results from the PCA show that 38.1% of the variation in environmental variables is explained by the first two PCA axes (22.4% and 15.7% on the first two axes, respectively; Figure 5). Variables that loaded heavily on the first components included substrate, depth, CV substrate, vegetation, and litter. Variables that loaded heavily on the second component were primarily related to stream size including cover, canopy, width and CV depth. Sites in the CGR were generally wider, deeper, and with less canopy cover whereas localities at LCR were characterized by higher cover, vegetation and canopy. Sites in the lower and middle reaches of both drainages clustered separately while sites from the upper reaches of both drainages tended to be similar physically. In general, upper reaches of both drainages had the same type substrates (i.e. boulders, large rocks), narrower canals, and a higher canopy cover.

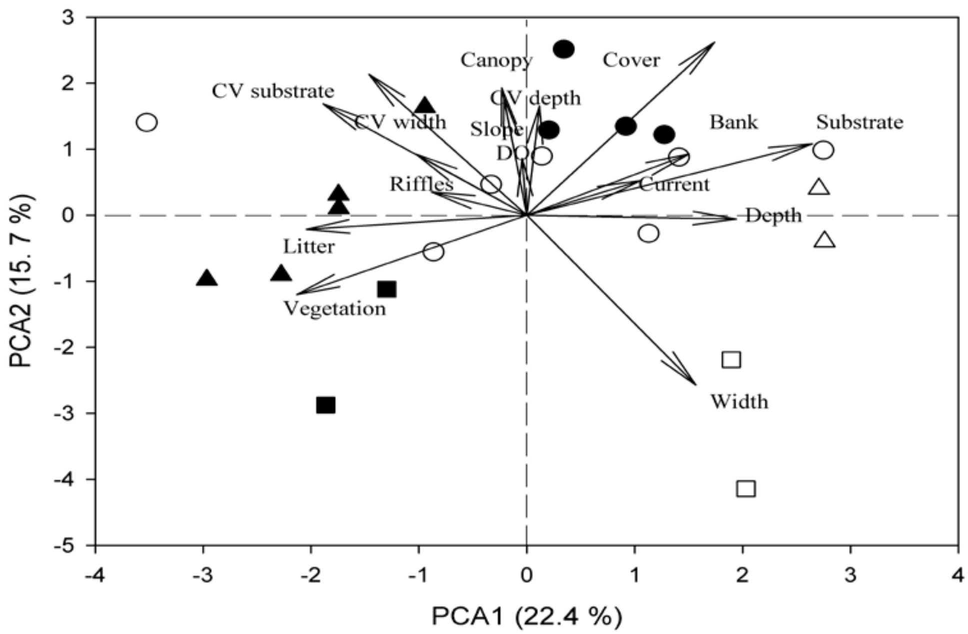

Figure 5. Ordination diagram of the PCA analysis of 16 environmental variables of 11 localities each from the Cangrejal River (□ = lower reaches, Δ = middle reaches, ○ = upper reaches) and the Lancetilla River (■ = lower reaches, ▲ = middle reaches, and ● = upper reaches).

Association between Environmental Parameters and Fish Assemblage Structure

The final CCA model for the CGR included three environmental variables: DO, CV width, vegetation. The CCA produced three axes that together accounted for 42.56 % of the total variance (30.79% on axis 1 and 8.16% on axis 2, Figure 6A). Dissolved oxygen loaded heavily on CCA axis 1, whereas vegetation and CV width were positively correlated with CCA axis 2. Permutation tests showed none of the variables or CCA axes explained a significant amount of variation in assemblage structure.

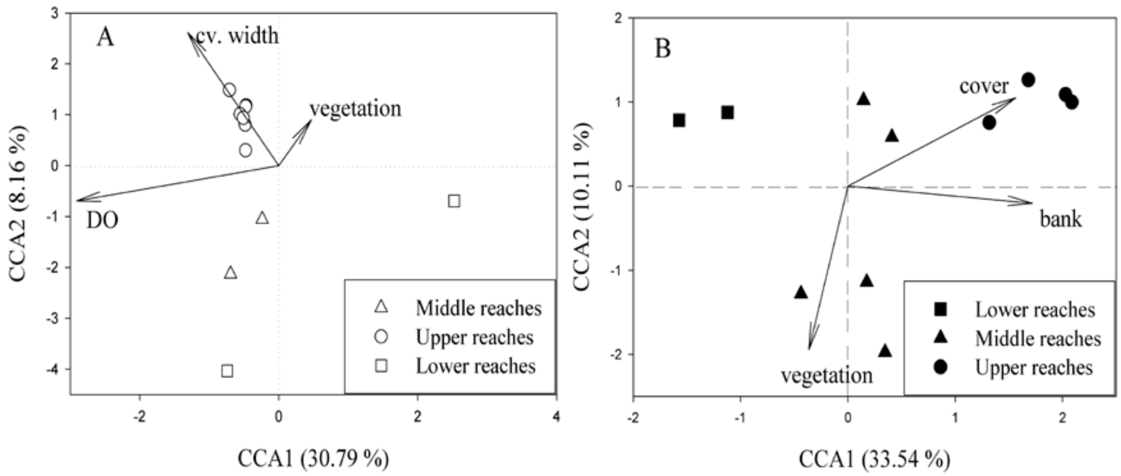

Figure 6. Canonical correspondence analysis diagram for 11 localities each in the Cangrejal River (A) and the Lancetilla River (B) from which three different environmental variables were examined.

The final CCA model for the LCR included three environmental variables: cover, vegetation, and bank. The CCA produced three axes that together accounted for 49.8% of the total variance (33.5% on axis 1 and 10.11% on axis 2; Figure 6B). Bank and cover loaded strongly in CCA axis 2, whereas vegetation loaded on CCA axis 2. Significant results were found by the permutational ANOVA ($P < 0.01$; 1000 permutations), indicating that the entire ordination accounted for more variation than expected by chance alone. Among the three CCA axis, axis 1 was significant (CCA axis one = $P < 0.005$) with cover loading significantly in that axis ($P < 0.01$).

Discussion

Fish assemblages differed between the Cangrejal and Lancetilla River drainages on the Honduran Caribbean coast. Samples from the two drainages clustered separately in NMDS space, there were differences in overall richness and different indicator species characteristic of lower, middle and upper reaches. Pairwise comparisons among reaches within each drainage revealed different patterns of assemblage change along longitudinal gradients for the two drainages. The two drainages are most similar in assemblage structure in the lower reaches that are composed largely of peripheral and secondary freshwater fishes that are salt tolerant and are not as likely to reach middle or upper reaches. The depauperate upper reaches are dominated by fishes with adaptations for strong swimming abilities (e.g. mullet), upstream movement (e.g. pelvic fins in gobies), or that allow them to thrive in habitats with high currents and waterfalls (e.g. some livebearers, gobies and mullet). Despite being smaller in size and higher in mean slope, the LCR drainage had higher species richness. Upper reaches of both drainages were similar in richness while the LCR middle and lower reaches were significantly more diverse. This may be due to a smoother transition in slope, and bottom types in the LCR, whereas the CGR transitions rapidly from run, muddy, and sandy bottoms close to the river mouth to rapids, rocks and boulder dominated bottoms in the middle reaches.

Differences in assemblage composition between the two rivers may be attributed to differences in river size (e.g. river length; Tejerina-Garro *et al*. 2005) or physicochemical properties of the environment (Angermeier & Karr 1983; Mendonca *et al*. 2005; Tejerina-Garro *et al*. 2005). The two drainages were different in many ways with the CGR sites generally being wider, deeper and with reduced canopy cover compared to LCR. As with assemblage structure, longitudinal gradients in habitat variables were more clearly defined in LCR than GCR. In LCR upper, middle and lower sites were clearly separated in PCA space. Within each drainage, relationships between environmental variables and assemblage structure were generally weak. CCA analysis for the CGR did not explain any more variation in assemblage structure than random. The final CCA model included DO, CV width and vegetation for which upper reach samples were very similar but differed from middle and lower reaches. It has been demonstrated that in Neotropical streams DO affects fish distribution (Gonzalez 1996; Rincón 1999). However, DO was not one of the final variables in the CCA model for the LCR. The LCR was generally smaller, shallower and with more heterogeneous canal conditions that may result in oxygen saturation (Mendonça *et al*. 2005), even in the lower reaches of the drainage. The results of the CCA suggest that amount of habitat available (cover) is the driving factor that influences fish assemblage in this system. The percentage of vegetation was another important factor in determining fish assemblages in the lower reaches of the LCR; vegetation was negatively correlated with CCA axis 2. These results are in congruence with Huston (1994) who states that reduction in biodiversity will be related to reduction in primary productivity.

Even though the two drainages show differences in assemblage composition, patterns of species turnover along the continuum were similar. Peripheral (e.g. *A. lineatus*, *A. milleri*, *Eleotris Perniger*, *E. lyricus*, *M. brachyurus*, and *P. mindii*) and secondary species (e.g. *B. belizanus*, *P. friedrichthalii*, *V. maculicauda*, and *P. cf. nelsoni)* that may be tolerant to marine water (Myers 1949) were important indicator species in lower reaches of both drainages. Most of these species rarely reached the middle and upper reaches of those systems. The ISA also detected important species in the middle and upper reaches of the drainages, primarily species with strong swimming abilities (e.g. *A. monticola*, *A. aeneus*, *A. huberi*) or with morphological adaptations (e.g. *A. banana*, *S. plumieri*) that allow them to thrive in fast currents, rapids, and waterfalls, which are common features in these areas of the river continuum.

Jaramillo-Villa *et al*. (2010) found a strong negative correlation between increasing altitude and species richness in streams of the central Andes in Colombia. In agreement with that study, my results also show that in Honduran Caribbean streams there is a decline in species richness from the lower to the upper reaches of the drainages. The explanatory mechanism for this pattern among disparate systems is still to be determined (Nogues-Bravo *et al*. 2008). Huston (1994) proposed that changes in diversity associated with altitude may be due to: 1) encroaching surface area and habitat complexity, 2) the effect of reduction of primary productivity with altitude, 3) more severe climatic conditions, and 4) less resource availability in higher altitudes. One or a combination of factors may be playing an important role in shaping assemblage structure. I propose that one of the most important factors in species decline in these streams is the inherent paucity of primary and secondary freshwater fishes in the region (Matamoros *et al*. 2009). Most taxa present in the drainages are of the peripheral type (Matamoros *et al*. 2009) with many of them restricted to the drainages' lower reaches. This, and the fact that there is a limited number of secondary and primary freshwater fishes in these drainages, results in a paucity of taxa in the middle and upper reaches of the drainages. This is contrasted with Southern Central America (e.g. Costa Rica and Panama) and South American streams that have higher primary and secondary freshwater fish diversity (Angermeier & Karr 1983; Ouboter & Mol 1993; Hardman *et al*. 2002).

References

Angermeier, P. & Karr, J. (1983) Fish communities along environmental gradients in a system of tropical streams. *Environmental Biology of Fishes,* 9, 117-135.

Angermeier, P. & Winston, M. (1998) Local vs. regional influences on local diversity in stream fish communities of Virginia. *Ecology*, 79, 911-927.

Belliard, J., Boët, P. & Tales, E. (1997) Regional and longitudinal patterns of fish community structure in the Seine River basin, France. *Environmental Biology of Fishes*, 50, 133-147.

Bermingham, E. & Martin, A.P. (1998) Comparative mtDNA phylogeography of Neotropical freshwaterfishes: testing share history to infer the evolutionary landscape of lower Central America. *Molecular Ecology*, 7, 499-517.

Buisson, L., Blanc, L. & Grenouillet, G. (2008) Modelling stream fish species distribution in a river network: the relative effects of temperature versus physical factors. *Ecology of Freshwater Fish*, 17, 244-257.

Bussing, W. & López, M. (1977) Distribución y aspectos ecológicos de los peces de las cuencas hidrográficas de Arenal, Bebedero y Tempisque, Costa Rica. *Revista de Biología Tropical*, 25, 13-37.

Clarke, K. & Gorley, R (2006) PRIMER v6. Plymouth Marine Laboratory

Clarke, K. & Warwick, R. (1994) Change in marine communities: an approach to statistical analysis and interpretation. UK: Natural Environment Research Council.

Concheiro Perez, G.A., Rican, O., Orti, G., Bermingham, E., Doadrio, I. & Zardoya, R. (2007) Phylogeny and biogeography of 91 species of heroine cichlids (Teleostei: Cichlidae) based on sequences of the cytochrome b gene. *Molecular Phylogenetics and Evolution*, 43, 91-110.

Dufrene, M. & Legendre, P. (1997) Species assemblages and indicator species: the need for a flexible asymmetrical approach. *Ecological Monographs,* 67, 345-366.

Espinoza-Mendiola, M. (2008) Sondeo ecológico rápido de las comunidades de peces tropicales en un área de explotación minera en Costa Rica. *Revista de Biología Tropical*, 56, 1971-1990.

Esselman, P.C., Freeman, M.C. & Pringle, C.M. (2006) Fish-assemblage variation between geologically defined regions and across a longitudinal gradient in the Monkey River basin, Belize. *Journal of the North American Benthological Society*, 25, 142-156.

Gilliam, J., Fraser, D. & Alkins-Koo, M. (1993) Structure of a tropical stream fish community: a role for biotic interactions. *Ecology*, 74, 1856-1870.

Gonzalez, R. (1996) Ion regulation in ion poor waters of low pH. *In*: Val, A.L., Almeida-Val, V.M. & Randall, D.J. (Eds). *Physiology and Biochemistry of the Fishes of the Amazon.* Instituto Nacional de Pesquisas da Amazonia, Manaus, Brazil, pp. 111-121.

Hardman, M., Page, L., Sabaj, M., Armbruster, J. & Knouft, J. (2002) A comparison of fish surveys made in 1908 and 1998 of the Potaro, Essequibo, Demerara, and coastal river drainages of Guyana. *Ichthyological Exploration of Freshwaters*, 13, 225-238.

Huet, M. (1959) Profiles and biology of Western European streams as related to fish management. *Transactions of the American Fisheries Society*, 88, 155-163.

Huston, M. (1994) *Biological diversity: the coexistence of species on changing landscapes*. Cambridge: Cambridge University Press, 681 pp.

Jaramillo-Villa, U., Maldonado-Ocampo, J. & Escobar, F. (2010) Altitudinal variation in fish assemblage diversity in streams of the central Andes of Colombia. *Journal of Fish Biology*, 76, 2401-2417.

Lyons, J. (1996) Patterns in the species composition of fish assemblages among Wisconsin streams. *Environmental Biology of Fishes*, 45, 329-341.

Matamoros, W., Schaefer, J. & Kreiser, B. (2009) Annotated checklist of the freshwater fishes of continental and insular Honduras. *Zootaxa*, 2307, 1-38.

Marsh-Matthews, E. & Matthews, W. (2000) Spatial variation in relative abundance of a widespread, numerically dominant fish species and its effect on fish assemblage structure. *Oecologia*, 125, 283-292.

Matthews, W.J. (1998) *Patterns in freshwater fish ecology*. New York: Chapman and Hall, pp.756 .

Mazzoni, R. & Lobón-Cerviá, J. (2000) Longitudinal structure, density and production rates of a neotropical stream fish assemblage: the river Ubatiba in the Serra do Mar, southeast Brazil. *Ecography*, 23, 588-602.

Mendonça, F.P., Magnusson, W. & Zuanon, J. (2005) Relationships between habitat characteristics and fish assemblages in small streams of Central Amazonia. *Copeia*, 2005, 751-764.

Moyle, P., Crain, P., Whitener, K. & Mount, J. (2003) Alien fishes in natural streams: fish distribution, assemblage structure, and conservation in the Cosumnes River, California, USA. *Environmental Biology of Fishes*, 68, 143-162.

Myers, G.S. (1949) Salt-tolerance of fresh-water fish groups in relation to zoogeographical problems. *Bijdragen tot de Dierkunde*, 28**,** 315-322.

Myers, G.S. (1966) Derivation of the freshwater fish fauna of Central America. *Copeia*, 1966, 766-733.

Nogues-Bravo, D., Araujo, M.B., Romdal, T. & Rahbek, C. (2008) Scale effects and human impact on the elevational species richness gradients. *Nature* , 453, 216-219.

Oberdorff, T., Guilbert, E. & Lucchetta, J. (1993) Patterns of fish species richness in the Seine River basin, France. *Hydrobiologia*, 259, 157-167.

Ouboter, P.E. & Mol, J.H.A. (1993) The fish fauna of Suriname. *In*: Ouboter, P.E. (Ed). *Freshwater ecosystems of Suriname.* Dordrecht, Netherlands: Kluwer Academic Publisher, pp. 133-154.

Perdices, A., Bermingham, E., Montilla, A. & Doadrio, I. (2002) Evolutionary history of the genus Rhamdia (Teleostei: Pimelodidae) in Central America. *Molecular Phylogenetics and Evolution*, 25**,** 172-189.

Perdices, A., Doadrio, I. & Bermingham, E. (2005) Evolutionary history of the synbranchid eels (Teleostei: Synbranchidae) in Central America and the Caribbean Islands inferred from their molecular phylogeny. *Molecular Phylogenetics and Evolution*, 37, 460-473.

Pires, D., Pires, A., Collares-Pereira, M. & Magalhães, M. (2010) Variation in fish assemblages across dry-season pools in a Mediterranean stream: effects of pool morphology, physicochemical factors and spatial context. *Ecology of Freshwater Fis*h, 19, 74-86.

Pouilly, M., Barrera, S. & Rosales, C. (2006) Changes of taxonomic and trophic structure of fish assemblages along an environmental gradient in the Upper Beni watershed (Bolivia). *Journal of Fish Biology*, 68, 137-156.

R Development Core Team. (2008) R 2.8.1. *A language and environment for statistical computing*. R Foundation for Statistical Computing. Vienna, Austria.

Rahel, F. & Hubert, W. (1991) Fish assemblages and habitat gradients in a Rocky Mountain-Great Plains stream: biotic zonation and additive patterns of community change. *Transactions of the American Fisheries Society*, 120, 319-332.

Rincón, P. (1999) Uso do micro-hábitat em peixes de riachos: métodos e perspectivas. *In*: Caramaschi, E.P., Mazzoni, R., & Perez-Neto, P.R., (Eds). *Ecologia de peixes de riachos*. Série Oecologia Brasiliensis, v. 6. Rio de Janeiro: Programa de pós-graduação em Ecologia-Universidade Federal do Rio de Janeiro, pp. 23-90.

Ross, D.T. (1986) Resource partitioning in fihs assemblages: A review of field studies. *Copeia*, 1986, 352-388.

Schlosser, I. (1982) Fish community structure and function along two habitat gradients in a headwater stream. *Ecological Monographs*, 52, 395-414.

Sheldon, A. (1968) Species diversity and longitudinal succession in stream fishes. *Ecology*, 49, 193-198.

Taylor, C. & Warren Jr, M. (2001) Dynamics in species composition of stream fish assemblages: environmental variability and nested subsets. *Ecology*, 82, 2320-2330.

ter Braak, C.J.F. (1986) Canonical correspondence analysis: a new eigenvector technique for multivariate direct gradient analysis. *Ecology*, 67, 1167-1179.

ter Braak, C. & Smilauer, P. (2002) CANOCO reference manual and CanoDraw for Windows user's guide: software for canonical community ordination (version 4.5). Ithaca: Microcomputer Power, pp. 500.

Tejerina-Garro, F., Maldonado, M., Ibañez, C., Pont, D., Roset, N. & Oberdorff, T. (2005) Effects of natural and anthropogenic environmental changes on riverine fish assemblages: a framework for ecological assessment of rivers. *Brazilian Archives of Biology and Technology*, 48, 91-108.

Walters, D., Leigh, D., Freeman, M., Freeman, B. & Pringle, C. (2003) Geomorphology and fish assemblages in a Piedmont river basin, USA. *Freshwater Biology*, 48, 1950-1970.

Werner, E. & Gilliam, J. (1984) The ontogenetic niche and species interactions in size-structured populations. *Annual Review of Ecology and Systematics*, 15, 393-425.

Wootton, J. & Oemke, M. (1992) Latitudinal differences in fish community trophic structure, and the role of fish herbivory in a Costa Rican stream. *Environmental Biology of Fishes*, 35, 311-319.

APPENDIX A

HONDURAN FRESHWATER FISH SPECIES BY POLITICAL DEPARTMENT

Table A1

Honduran Freshwater Fish Species by Political Department

FAMILY / Species	**Atlántida**	**Choluteca**	**Colón**	**Comayagua**	**Copán**	**Cortés**	**El Paraíso**	**Francisco Morazán**	**Gracias a Dios**	**Intibucá**	**Isl. Bahía**	**La Paz**
Carcharhinidae												
Carcharhinus leucas	0	0	0	0	0	0	0	0	1	0	0	0
Rhizoprionodon porosus	0	0	0	0	0	0	0	0	1	0	0	0
Pristidae												
Pristis pectinata	0	0	0	0	0	0	0	0	1	0	0	0
Megalopidae												
Megalops atlanticus	1	0	1	0	0	0	0	0	1	0	0	0
Anguillidae												
Anguilla rostrata	1	0	1	0	0	1	0	0	0	0	1	0
Ophicthidae												
Myrophis punctatus	0	0	0	0	0	1	0	0	1	0	1	0
Clupeidae												
Harengula clupeola	0	0	0	0	0	1	0	0	0	0	0	0
Harengula humeralis	0	0	0	0	0	0	0	0	0	0	1	0
Jenkinsia lamprotaenia	0	0	0	0	0	0	0	0	0	0	1	0
Ophistonema oglinum	0	0	0	0	0	0	0	0	1	0	0	0
Engraulidae												
Anchoa colonensis	0	0	0	0	0	1	0	0	1	0	0	0
Anchoa filifera	0	0	0	0	0	0	0	0	1	0	0	0
Anchoa parva	0	0	0	0	0	0	0	0	1	0	0	0
Anchovia clupeoides	0	0	0	0	0	0	0	0	1	0	0	0
Anchoviella elongata	0	0	0	0	0	0	0	0	1	0	0	0
Cyprinidae												
Ctenopharyngodon idella	0	0	0	0	0	1	0	0	0	0	0	0
Hypophthalmichthys molitrix	0	0	0	0	0	1	0	0	1	0	0	0
Characidae												
Astyanax aeneus	1	1	1	1	1	1	1	1	1	1	0	1
Brycon guatemalensis	0	1	0	1	1	1	1	1	0	0	0	1
Hyphessobrycon tortuguerae	0	0	0	0	0	0	1	0	1	0	0	0
Roeboides bouchellei	0	1	0	0	0	0	1	1	1	0	0	0

Table A1 (continued).

FAMILY / Species	Atlántida	Choluteca	Colón	Comayagua	Copán	Cortés	El Paraíso	Francisco Morazán	Gracias a Dios	Intibucá	Isl. Bahía	La Paz
Ariidae												
Cathorops higuchii	0	0	0	0	0	0	0	0	1	0	0	0
Cathorops sp	0	0	0	0	0	0	0	0	0	0	0	0
Cathorops melanopus	0	0	0	0	0	1	0	0	0	0	0	0
Cathorops steindachneri	0	0	0	0	0	0	0	0	0	0	0	0
Cathorops taylori	0	0	0	0	0	0	0	0	0	0	0	0
Sciades assimilis	0	0	0	0	0	1	0	0	0	0	0	0
Sciades guatemalensis	0	1	0	0	0	0	0	0	0	0	0	0
sciades seemanni	0	1	0	0	0	0	0	0	0	0	0	0
Ictaluridae												
Ictalurus punctatus	0	0	0	1	0	1	0	0	0	0	0	0
Heptapteridae												
Rhamdia guatemalensis	1	1	1	1	1	1	1	1	1	1	0	1
Rhamdia laticauda	1	0	0	1	1	1	1	1	0	1	0	0
Gymnotidae												
Gymnotus cylindricus	1	1	1	1	0	1	0	0	1	0	0	0
Gymnotus maculosus	0	1	0	0	0	0	0	0	0	0	0	0
Batrachoididae												
Batrachoides gilberti	0	0	0	0	0	0	0	0	1	0	0	0
Gobiesocidae												
Gobiesox strumosus	0	0	0	0	0	1	0	0	0	0	0	0
Atherinopsidae												
Atherinella argentea	0	1	0	0	0	0	0	0	0	0	0	0
Atherinella blackburni	0	0	1	0	0	0	0	0	0	0	1	0
Atherinella guija	0	1	0	0	0	0	0	0	0	0	1	0
Atherinella meeki	0	0	0	0	0	1	0	0	0	0	0	0
Atherinella milleri	1	0	1	0	0	0	0	0	1	0	0	0
Atherinella pachylepis	0	1	0	0	0	0	0	0	0	0	0	0
Rivulidae												
Kryptolebias marmoratus	1	0	0	0	0	0	0	0	0	0	1	0
Rivulus tenius	1	0	0	0	0	1	0	0	0	0	0	0
Profundulidae												
Profundulus guatemalensis	0	0	0	0	1	0	0	0	0	1	0	0
Profundulus sp.1	0	0	0	1	0	0	0	1	0	0	0	0
Profundulus sp.2	0	0	0	0	0	0	0	0	0	0	0	0

Table A1 (continued).

FAMILY / Species	**Atlántida**	**Choluteca**	**Colón**	**Comayagua**	**Copán**	**Cortés**	**El Paraíso**	**Francisco Morazán**	**Gracias a Dios**	**Intibucá**	**Isl. Bahía**	**La Paz**
Poeciliidae												
Alfaro cultratus	0	0	0	0	0	0	0	0	1	0	0	0
Alfaro huberi	1	0	0	1	1	1	1	1	1	1	0	1
Heterandria anzuetoi	1	0	1	1	1	1	0	1	1	0	0	0
Belonesox belizanus	1	0	1	0	0	1	0	0	1	0	0	0
Gambusia nicaraguensis	1	0	1	0	0	1	0	0	1	0	1	0
Heterandria bimaculata	1	0	0	0	0	1	0	0	0	0	0	0
Phallichthys amates	1	0	1	0	0	1	0	0	1	0	0	0
Poecilia gillii	1	1	1	1	1	1	1	1	1	1	1	1
Poecilia marcellinoi	0	1	0	1	1	1	1	0	0	0	0	0
Poecilia sp.1	1	0	0	0	0	1	0	0	1	0	0	0
Poecilia sp.2	1	0	0	0	0	0	0	0	0	0	0	0
Poecilia sp.3	0	1	0	0	0	0	0	1	0	0	0	0
Poecilia orri	1	0	1	0	0	1	0	0	1	0	1	0
Poeciliopsis pleurospilus	0	1	0	1	1	1	0	1	0	1	0	0
Poeciliopsis turrubarensis	0	1	0	0	0	0	0	1	0	0	0	0
Xiphophorus helleri	0	0	0	0	1	0	0	0	0	0	0	0
Xiphophorus mayae	1	0	0	0	0	1	0	0	0	0	0	0
Anablepidae												
Anableps dowei	0	1	0	0	0	0	1	0	0	0	0	0
Belonidae												
Strongylura marina	1	0	0	0	0	1	0	0	1	0	1	0
Strongylura notata	0	0	0	0	0	0	0	0	0	0	1	0
Strongylura timucu	0	0	0	0	0	1	0	0	1	0	1	0
Hemyrhamphidae												
Hyporhamphus roberti hildebrandi	0	0	0	1	0	1	0	0	1	0	1	0
Hyporhamphus unifasciatus	0	0	0	0	0	1	0	0	0	0	0	0
Sygnathidae												
Microphis brachyurus lineatus	1	0	0	0	0	1	0	0	0	0	0	0
Pseudophallus mindii	1	0	0	0	0	0	0	0	0	0	0	0
Pseudophallus starksi	0	0	0	0	0	0	0	0	0	0	0	0
Syngnathus pelagicus	0	0	0	0	0	0	0	0	1	0	0	0
Syngnathus scovelli	0	0	0	0	0	0	0	0	1	0	0	0
Synbranchidae												

Table A1 (continued).

FAMILY / Species	Atlántida	Choluteca	Colón	Comayagua	Copán	Cortés	El Paraíso	Francisco Morazán	Gracias a Dios	Intibucá	Isl. Bahía	La Paz
Ophisternon aenigmaticum	1	0	0	0	1	1	0	0	0	0	0	0
Synbranchus marmoratus	1	1	1	1	1	1	1	1	1	1	0	1
Centropomidae												
Centropomus ensiferus	0	0	0	0	0	1	0	0	1	0	0	0
Centropomus nigrescens	0	1	0	0	0	0	0	0	0	0	0	0
Centropomus parallelus	0	0	0	0	0	1	0	0	1	0	0	0
Centropomus pectinatus	0	0	0	0	0	0	0	0	1	0	1	0
Centropomus undecimalis	1	0	0	0	0	1	0	0	1	0	1	0
Centropomus unionensis	0	1	0	0	0	0	0	0	0	0	0	0
Centrarchidae												
Micropterus salmoides	0	0	0	1	0	1	0	0	0	0	0	0
Carangidae												
Caranx bartholomaei	0	0	0	0	0	0	0	0	0	0	1	0
Caranx latus	1	0	0	0	0	1	0	0	0	0	0	0
Olygoplites saurus	0	0	0	0	0	1	0	0	0	0	0	0
Trachinotus goodei	0	0	0	0	0	1	0	0	0	0	0	0
Lutjanidae												
Lutjanus apodus	1	0	0	0	0	1	0	0	0	0	1	0
Lutjanus jocu	0	0	0	0	0	1	0	0	0	0	1	0
Gerreidae												
Diapterus auratus	0	0	0	0	0	1	0	0	0	0	1	0
Eucinostomus argenteus	0	0	1	0	0	1	0	0	1	0	0	0
Eucinostomus harengulus	0	0	0	0	0	0	0	0	0	0		
Eucinostomus jonesi	0	0	0	0	0	0	0	0	0	0	1	0
Eucinostomus melanopterus	0	0	1	0	0	1	0	0	0	0	1	0
Eugerres plumieri	0	0	0	0	0	0	0	0	1	0	0	0
Gerres cinereus	0	0	0	0	0	1	0	0	0	0	1	0
Haemulidae												
Pomadasys crocro	1	0	1	0	0	1	0	0	0	0	1	0
Sciaenidae												
Bairdiella ronchus	0	0	0	0	0	1	0	0	0	0	0	0
Cynoscion praedatorius	0	1	0	0	0	0	0	0	0	0	0	0
Menticirrhus americanus	0	0	0	0	0	1	0	0	0	0	0	0
Paralonchurus dumerilii	0	1	0	0	0	0	0	0	0	0	0	0
Umbrina broussonnetii	0	0	0	0	0	1	0	0	0	0	0	0
Polynemidae												

Table A1 (continued).

FAMILY / Species	Atlántida	Choluteca	Colón	Comayagua	Copán	Cortés	El Paraíso	Francisco Morazán	Gracias a Dios	Intibucá	Isl. Bahía	La Paz
Polydactylus virginicus	0	0	0	0	0	0	0	0	1	0	0	0
Mugilidae												
Agonostomus monticola	1	0	1	0	0	1	1	0	1	0	1	0
Joturus pichardi	1	0	1	0	0	1	0	0	1	0	0	0
Mugil curema	0	1	0	0	0	1	0	0	1	0	1	0
Mugil liza	0	0	0	0	0	1	0	0	0	0	0	0
Cichlidae												
Amatitlania nigrofasciata	0	1	0	0	0	0	1	1	1	1	0	0
Amatitlania siquia	0	0	0	0	0	0	1	1	1	0	0	0
Amphilophus alfari	0	0	0	0	0	0	0	0	1	0	0	0
Amphilophus hogaboomorum	0	1	0	0	0	0	0	0	0	0	0	0
Amphilophus longimanus	0	1	0	0	0	0	1	1	1	0	0	0
Amphilophus robertsoni	1	0	1	0	0	1	0	0	1	0	0	0
Archocentrus centrarchus	0	1	0	0	0	0	0	0	0	0	0	0
Archocentrus multispinosus	0	1	0	0	0	0	0	0	1	0	0	0
"Cichlasoma" trimaculatum	0	0	0	0	0	0	0	0	0	0	0	0
"Cichlasoma" urophthalmus	1	0	0	0	0	1	0	0	0	0	0	0
Criptoheros cutteri	1	0	1	1	1	1	0	1	0	0	0	0
Hypsophrys nicaraguensis	0	0	0	0	0	0	0	0	1	0	0	0
Oreochromis mossambicus	0	0	0	0	0	0	0	0	0	1	0	1
Oreochromis niloticu	1	1	1	1	1	1	1	1	1	1	0	1
Parachromis dovii	0	0	1	0	0	0	1	0	1	0	0	0
Parachromis friedrichsthalii	1	0	0	0	1	1	0	0	0	0	0	0
Parachromis loisellei	1	1	1	0	1	1	0	0	1	0	0	0
Parachromis managuensis	0	0	0	1	0	1	1	0	1	0	0	0
Parachromis motaguensis	0	1	0	0	1	1	0	1	0	1	0	0
Rocio octofasciata	0	0	0	0	0	1	0	0	0	0	0	0
Theraps wesseli	1	0	0	0	0	0	0	0	0	0	0	0
Thorichthys aureus	0	0	0	0	1	0	0	0	0	0	0	0
Vieja maculicauda	1	0	1	0	0	1	0	0	1	0	0	0
Vieja microphthalma	0	0	0	0	1	0	0	0	0	0	0	0
Labrisomidae												
Labrisomus nuchipinnis	0	0	0	0	0	1	0	0	0	0	0	0
Dactyloscopidae												
Dactyloscopus tridigitatus	0	0	1	0	0	1	0	0	0	0	0	0

Table A1 (continued).

FAMILY / Species	**Atlántida**	**Choluteca**	**Colón**	**Comayagua**	**Copán**	**Cortés**	**El Paraíso**	**Francisco Morazán**	**Gracias a Dios**	**Intibucá**	**Isl. Bahía**	**La Paz**
Blenniidae												
Lupinoblennius vinctus	0	0	0	0	0	1	0	0	0	0	0	0
Eleotridae												
Dormitator latifrons	0	1	0	0	0	0	0	0	0	0	0	0
Dormitator maculatus	1	0	1	0	0	1	0	0	1	0	1	0
Eleotris amblyopsis	1	0	1	0	0	1	0	0	1	0	1	0
Eleotris perniger	1	0	1	0	0	1	0	0	1	0	1	0
Eleotris picta	0	1	0	0	0	0	0	0	0	0	0	0
Erotelis smaragdus	0	0	0	0	0	0	0	0	0	0	1	0
Gobiomorus dormitor	1	0	1	1	0	1	0	0	1	0	1	0
Gobiomorus maculatus	0	1	0	0	0	0	0	0	0	0	0	0
Leptophilypnus fluviatilis	0	0	0	0	0	0	0	0	1	0	0	0
Gobiidae												
Awous banana	1	1	1	0	1	1	0	1	1	0	1	0
Bathygobius soporator	0	0	0	0	0	1	0	0	0	0	1	0
Ctenogobius boleosoma	0	0	0	0	0	1	0	0	1	0	1	0
Ctenogobius fasciatus	0	0	0	0	0	1	0	0	0	0	0	0
Ctenogobius sagitulla	0	1	0	0	0	0	0	0	0	0	0	0
Ctenogobius stigmaticus	0	0	0	0	0	0	0	0	1	0	0	0
Evorthodus lyricus	1	0	0	0	0	1	0	0	1	0	1	0
Gobionellus oceanicus	0	0	0	0	0	1	0	0	1	0	1	0
Lophogobius cyprinoides	0	0	0	0	0	1	0	0	0	0	0	0
Sicydium gymnogaster	1	0	1	0	0	0	0	0	0	0	0	0
Sicydium multipunctatum	0	1	0	0	0	0	0	0	0	0	0	0
Sicydium plumieri	1	0	1	0	0	0	0	0	0	0	1	0
Sicydium punctatum	1	0	1	0	0	0	0	0	0	0	1	0
Sicydium sp1	1	0	1	0	0	0	0	0	0	0	1	0
Sicydium sp2	1	0	1	0	0	0	0	0	0	0	1	0
Microdesmidae												
Microdesmus carri	0	0	0	0	0	1	0	0	0	0	0	0
Acanthuridae												
Acanthurus bahianus castelnau	0	0	0	0	0	0	0	0	1	0	0	0
Sphyraenidae												
Sphyraena barracuda	0	0	0	0	0	0	0	0	0	0	1	0
Sphyraena guachancho	0	0	0	0	0	1	0	0	0	0	1	0

Table A1 (continued).

FAMILY / Species	**Atlántida**	**Choluteca**	**Colón**	**Comayagua**	**Copán**	**Cortés**	**El Paraíso**	**Francisco Morazán**	**Gracias a Dios**	**Intibucá**	**Isl. Bahía**	**La Paz**
Paralichthyidae												
Citharichthys abbotti	0	0	0	0	0	1	0	0	0	0	0	0
Citharichthys arenaceus	0	0	0	0	0	1	0	0	0	0	0	0
Citharichthys gilberti	0	1	0	0	0	0	0	0	0	0	0	0
Citharichthys macrops	0	0	0	0	0	1	0	0	0	0	1	0
Citharichthys spilopterus	0	0	0	0	0	1	0	0	0	0	0	0
Achiridae												
Achirus lineatus	0	0	0	0	0	1	0	0	0	0	1	0
Trinectes fonsecensis	0	0	0	0	0	0	0	0	0	0	0	0
Trinectes maculatus	0	0	0	0	0	0	0	0	0	0	1	0
Tetraodontidae												
Sphoeroides testudineus	1	0	0	0	0	1	0	0	1	0	1	0

Table A1 (continued).

FAMILY / Species	Lempira	Ocotepeque	Olancho	Santa Bárbara	Valle	Yoro	Sal.	Con. Sta.	NR	RE
Carcharhinidae										
Carcharhinus leucas	0	0	0	0	0	0	PE	Nat		
Rhizoprionodon porosus	0	0	0	0	0	0	PE	Nat		
Pristidae										
Pristis pectinata	0	0	0	0	0	0	PE	Nat		
Megalopidae										
Megalops atlanticus	0	0	0	0	0	0	PE	Nat		
Anguillidae										
Anguilla rostrata	0	0	0	0	0	1	PE	Nat		
Ophicthidae										
Myrophis punctatus	0	0	0	0	0	0	PE	Nat		
Clupeidae										
Harengula clupeola	0	0	0	0	0	0	PE	Nat		
Harengula humeralis	0	0	0	0	0	0	PE	Nat		
Jenkinsia lamprotaenia	0	0	0	0	0	0	PE	Nat		
Ophistonema oglinum	0	0	0	0	0	0	PE	Nat		
Engraulidae										
Anchoa colonensis	0	0	0	0	0	0	PE	Nat		
Anchoa filifera	0	0	0	0	0	0	PE	Nat		
Anchoa parva	0	0	0	0	0	0	PE	Nat		
Anchovia clupeoides	0	0	0	0	0	0	PE	Nat		
Anchoviella elongata	0	0	0	0	0	0	PE	Nat		
Cyprinidae										
Ctenopharyngodon idella	0	0	0	1	0	0	PR	Exo		
Hypophthalmichthys molitrix	0	0	0	0	0	0	PR	Exo		
Characidae										
Astyanax aeneus	1	1	1	1	1	1	PR	Nat		
Brycon guatemalensis	1	0	0	1	0	1	PR	Nat		
Hyphessobrycon tortuguerae	0	0	1	0	0	0	PR	Nat		
Roeboides bouchellei	0	0	1	0	1	0	PR	Nat		X
Ariidae										
Cathorops higuchii	0	0	0	0	0	0	PE	Nat		
Cathorops melanopus	0	0	0	1	0	0	PE	Nat	X	X

Table A1 (continued).

FAMILY / Species	Lempira	Ocotepeque	Olancho	Santa Bárbara	Valle	Yoro	Sal.	Con. Sta.	NR	RE
Cathorops sp	0	0	0	0	1	0	PE	Nat		
Cathorops steindachneri	0	0	0	0	1	0	PE	Nat		
Cathorops taylori	0	0	0	0	1	0	PE	Nat		
Sciades assimilis	0	0	0	0	0	0	PE	Nat		
Sciades guatemalensis	0	0	0	0	1	0	PE	Nat		
sciades seemanni	0	0	0	0	1	0	PE	Nat		
Ictaluridae										
Ictalurus punctatus	0	0	0	1	0	0	PR	Exo		
Heptapteridae										
Rhamdia guatemalensis	1	1	1	1	1	1	PR	Nat		
Rhamdia laticauda	1	0	1	1	0	0	PR	Nat		
Gymnotidae										
Gymnotus cylindricus	0	0	0	1	0	1	PR	Nat		
Gymnotus maculosus	0	0	0	0	1	0	PR	Nat		
Batrachoididae										
Batrachoides gilberti	0	0	0	0	0	0	PE	Nat	X	
Gobiesocidae										
Gobiesox strumosus	0	0	0	0	0	0	PE	Nat	X	
Atherinopsidae										
Atherinella argentea	0	0	0	0	1	0	PE	Nat		
Atherinella blackburni	0	0	0	0	0	0	PE	Nat	X	
Atherinella guija	0	0	0	0	0	0	PE	Nat		
Atherinella meeki	0	0	0	0	0	0	PE	Nat	X	X
Atherinella milleri	0	0	0	0	0	0	PE	Nat		
Atherinella pachylepis	0	0	0	0	1	0	PE	Nat		
Rivulidae										
Kryptolebias marmoratus	0	0	0	0	0	0	SE	Nat	X	
Rivulus tenius	0	0	0	0	0	0	SE	Nat		
Profundulidae										
Profundulus guatemalensis	1	0	0	0	0	0	SE	Nat		
Profundulus sp.1	0	0	0	0	0	0	SE	End		
Profundulus sp.2	0	0	0	1	0	0	SE	End		
Poeciliidae										

Table A1 (continued).

FAMILY / Species	Lempira	Ocotepeque	Olancho	Santa Bárbara	Valle	Yoro	Sal.	Con. Sta.	NR	RE
Alfaro cultratus	0	0	0	0	0	0	SE	Nat	X	X
Alfaro huberi	1	0	1	1	0	1	SE	Nat		
Belonesox belizanus	0	0	0	0	0	1	SE	Nat		
Gambusia nicaraguensis	0	0	0	0	0	1	SE	Nat		
Heterandria anzuetoi	0	0	1	1	0	1	SE	Nat		
Heterandria bimaculata	0	0	0	0	0	0	SE	Nat		
Phallichthys amates	0	0	1	0	0	1	SE	Nat		
Poecilia gillii	1	1	1	1	0	0	SE	Nat		
Poecilia marcellinoi	0	0	0	1	0	0	SE	Nat		
Poecilia sp.1	0	0	1	0	0	0	SE	End		
Poecilia sp.2	0	0	0	0	0	0	SE	End		
Poecilia sp.3	0	0	0	0	0	0	SE	End		
Poecilia orri	0	0	0	0	0	1	SE	Nat		
Poeciliopsis pleurospilus	1	0	0	1	1	0	SE	Nat		
Poeciliopsis turrubarensis	0	0	0	0	1	0	SE	Nat		
Xiphophorus helleri	0	0	0	1	0	0	SE	Nat		
Xiphophorus mayae	0	0	0	1	0	0	SE	Nat	X	X
Anablepidae										
Anableps dowei	0	0	0	0	1	0	SE	Nat		
Belonidae										
Strongylura marina	0	0	0	0	0	0	PE	Nat		
Strongylura notata	0	0	0	0	0	0	PE	Nat	X	
Strongylura timucu	0	0	0	0	0	0	PE	Nat		
Hemyrhamphidae										
Hyporhamphus roberti hildebrandi	0	0	0	1	0	1	PE	Nat		
Hyporhamphus unifasciatus	0	0	0	0	0	0	PE	Nat		
Sygnathidae										
Microphis brachyurus lineatus	0	0	0	0	0	0	PE	Nat	X	
Pseudophallus mindii	0	0	0	0	0	0	PE	Nat	X	
Pseudophallus starksi	0	0	0	0	1	0	PE	Nat		
Syngnathus pelagicus	0	0	0	0	0	0	PE	Nat	X	
Syngnathus scovelli	0	0	0	0	0	0	PE	Nat		
Synbranchidae										

Table A1 (continued).

FAMILY / Species	Lempira	Ocotepeque	Olancho	Santa Bárbara	Valle	Yoro	Sal.	Con. Sta.	NR	RE
Ophisternon aenigmaticum	0	0	0	0	0	0	SE	Nat		
Synbranchus marmoratus	0	0	1	1	1	1	SE	Nat		
Centropomidae										
Centropomus ensiferus	0	0	0	0	0	0	PE	Nat		
Centropomus nigrescens	0	0	0	0	0	0	PE	Nat		
Centropomus parallelus	0	0	0	0	0	0	PE	Nat		
Centropomus pectinatus	0	0	0	0	0	0	PE	Nat		
Centropomus undecimalis	0	0	0	0	0	0	PE	Nat		
Centropomus unionensis	0	0	0	0	0	0	PE	Nat		
Centrarchidae										
Micropterus salmoides	0	0	0	1	0	0	PR	Exo		
Carangidae										
Caranx bartholomaei	0	0	0	0	0	0	PE	Nat	X	
Caranx latus	0	0	0	0	0	0	PE	Nat		
Olygoplites saurus	0	0	0	0	0	0	PE	Nat	X	
Trachinotus goodie	0	0	0	0	0	0	PE	Nat		
Lutjanidae										
Lutjanus apodus	0	0	0	0	0	0	PE	Nat		
Lutjanus jocu	0	0	0	0	0	0	PE	Nat		
Gerreidae										
Diapterus auratus	0	0	0	0	0	0	PE	Nat		
Eucinostomus argenteus	0	0	0	0	0	0	PE	Nat		
Eucinostomus harengulus	0	0	0	0	0	0	PE	Nat	X	
Eucinostomus jonesi	0	0	0	0	0	0	PE	Nat	X	
Eucinostomus melanopterus	0	0	0	0	0	0	PE	Nat		
Eugerres plumier	0	0	0	0	0	0	PE	Nat		
Gerres cinereus	0	0	0	0	0	0	PE	Nat		
Haemulidae										
Pomadasys crocro	0	0	0	1	0	0	PE	Nat		
Sciaenidae										
Bairdiella ronchus	0	0	0	0	0	0	PE	Nat	X	
Cynoscion praedatorius	0	0	0	0	0	0	PE	Nat	X	
Menticirrhus americanus	0	0	0	0	0	0	PE	Nat		

Table A1 (continued).

FAMILY / Species	**Lempira**	**Ocotepeque**	**Olancho**	**Santa Bárbara**	**Valle**	**Yoro**	**Sal.**	**Con. Sta.**	**NR**	**RE**
Paralonchurus dumerilii	0	0	0	0	0	0	PE	Nat		
Umbrina broussonnetii	0	0	0	0	0	0	PE	Nat	X	
Polynemidae										
Polydactylus virginicus	0	0	0	0	0	0	PE	Nat		
Mugilidae										
Agonostomus monticola	0	0	0	1	0	1	PE	Nat		
Joturus pichardi	0	0	0	0	0	0	PE	Nat		
Mugil curema	0	0	0	0	0	0	PE	Nat		
Mugil liza	0	0	0	0	0	0	PE	Nat	X	
Cichlidae										
Amatitlania nigrofasciata	0	0	1	0	1	1	SE	Nat		
Amatitlania siquia	0	0	0	0	0	0	SE	Nat		
Amphilophus alfari	0	0	1	0	0	0	SE	Nat		
Amphilophus hogaboomorum	0	0	0	0	0	0	SE	End		X
Amphilophus longimanus	0	0	1	0	1	1	SE	Nat		
Amphilophus robertsoni	0	0	0	1	0	1	SE	Nat		
Archocentrus centrarchus	0	0	0	0	0	0	SE	Nat		
Archocentrus multispinosus	0	0	0	0	0	0	SE	Nat		
"Cichlasoma" trimaculatum	0	0	0	0	1	0	SE	Nat		
"Cichlasoma" urophthalmus	0	0	0	0	0	0	SE	Nat		
Criptoheros cutteri	0	0	0	1	0	1	SE	Nat		X
Hypsophrys nicaraguensis	0	0	0	0	0	0	SE	Nat	X	X
Oreochromis mossambicus	0	0	0	0	0	0	SE	Exo		
Oreochromis niloticu	1	1	1	1	1	1	SE	Exo		
Parachromis dovii	0	0	1	0	0	1	SE	Nat		
Parachromis friedrichsthalii	0	0	0	0	0	1	SE	Nat		
Parachromis loisellei	0	0	0	0	0	0	SE	Nat		X
Parachromis managuensis	0	0	1	1	0	1	SE	Nat		
Parachromis motaguensis	0	0	0	0	0	0	SE	Nat		
Rocio octofasciata	0	0	0	0	0	1	SE	Nat		
Theraps wesseli	0	0	0	0	0	0	SE	End		X
Thorichthys aureus	0	0	0	0	0	0	SE	Nat		
Vieja maculicauda	0	0	0	1	0	1	SE	Nat		
Vieja microphthalma	0	0	0	0	0	0	SE	Nat		

Table A1 (continued).

FAMILY / Species	Lempira	Ocotepeque	Olancho	Santa Bárbara	Valle	Yoro	Sal.	Con. Sta.	NR	RE
Labrisomidae										
Labrisomus nuchipinnis	0	0	0	0	0	0	PE	Nat		
Dactyloscopidae										
Dactyloscopus tridigitatus	0	0	0	0	0	0	PE	Nat		
Blenniidae										
Lupinoblennius vinctus	0	0	0	0	0	0	PE	Nat	X	
Eleotridae										
Dormitator latifrons	0	0	0	0	1	0	PE	Nat		
Dormitator maculatus	0	0	0	0	0	0	PE	Nat		
Eleotris amblyopsis	0	0	0	0	0	0	PE	Nat		
Eleotris perniger	0	0	0	0	0	0	PE	Nat		
Eleotris picta	0	0	0	0	1	0	PE	Nat		
Erotelis smaragdus	0	0	0	0	0	0	PE	Nat	X	
Gobiomorus dormitory	0	0	0	0	0	0	PE	Nat		
Gobiomorus maculatus	0	0	0	0	1	0	PE	Nat		
Leptophilypnus fluviatilis	0	0	0	0	0	0	PE	Nat		
Gobiidae										
Awous banana	0	0	0	0	1	0	PE	Nat		
Bathygobius soporator	0	0	0	0	0	0	PE	Nat	X	
Ctenogobius boleosoma	0	0	0	0	0	0	PE	Nat		
Ctenogobius fasciatus	0	0	0	0	0	0	PE	Nat	X	
Ctenogobius sagitulla	0	0	0	0	1	0	PE	Nat		
Ctenogobius stigmaticus	0	0	0	0	0	0	PE	Nat		
Evorthodus lyricus	0	0	0	0	0	0	PE	Nat	X	
Gobionellus oceanicus	0	0	0	0	0	0	PE	Nat	X	
Lophogobius cyprinoides	0	0	0	0	0	0	PE	Nat	X	
Sicydium gymnogaster	0	0	0	0	0	0	PE	Nat		
Sicydium multipunctatum	0	0	0	0	0	0	PE	Nat		
Sicydium plumieri	0	0	0	0	0	0	PE	Nat	X	X
Sicydium punctatum	0	0	0	0	0	0	PE	Nat	X	X
Sicydium sp1	0	0	0	0	0	0	PE	Nat		
Sicydium sp2	0	0	0	0	0	0	PE	Nat		
Microdesmidae										

Table A1 (continued).

FAMILY / Species	**Lempira**	**Ocotepeque**	**Olancho**	**Santa Bárbara**	**Valle**	**Yoro**	**Sal.**	**Con. Sta.**	**NR**	**RE**
Microdesmus carri	0	0	0	0	0	0	PE	Nat	X	
Acanthuridae										
Acanthurus bahianus castelnau	0	0	0	0	0	0	PE	Nat		
Sphyraenidae										
Sphyraena barracuda	0	0	0	0	0	0	PE	Nat		
Sphyraena guachancho	0	0	0	0	0	0	PE	Nat		
Paralichthyidae										
Citharichthys abbotti	0	0	0	0	0	0	PE	Nat	X	
Citharichthys arenaceus	0	0	0	0	0	0	PE	Nat	X	
Citharichthys gilberti	0	0	0	0	0	0	PE	Nat		
Citharichthys macrops	0	0	0	0	0	0	PE	Nat		
Citharichthys spilopterus	0	0	0	0	0	0	PE	Nat	X	
Achiridae										
Achirus lineatus	0	0	0	0	0	0	PE	Nat	X	
Trinectes fonsecensis	0	0	0	0	1	0	PE	Nat	X	
Trinectes maculatus	0	0	0	0	0	0	PE	Nat	X	
Tetraodontidae										
Sphoeroides testudineus	0	0	0	0	0	0	PE	Nat		

Note. Sal. refers to tolerance to salinity based on Meyers (1949); primary = Pri; secondary = Se; and peripheral = Pe. Con. Sta. Stands for conservation status, and species were classified as native, endemic and exotic. NR stands for New Records. These are fishes that are reported for the first time in Honduras. RE stands for Range Extension. These are fishes whose natural range has been expanded based on the findings of this study.

APPENDIX B

LIST OF FRESHWATER FISHES FOUND IN HONDURAN RIVER DRAINAGE SYSTEM

Table B1

Species by River Drainage and Ichthyographical Province

		Ichthyographical provinces	MCUP			NDBP					HMIP						HPIP				
Sal.	Family	Species \ Drainages	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
I	Characidae	*Astyanax aeneus*	+	+	+	+	+	+	-	-	+	+	+	+	+	+	+	+	+	+	+
I	Characidae	*Brycon guatemalensis*	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-
I	Characidae	*Hyphessobrycon tortuguerae*	-	-	-	-	-	-	-	-	-	-	-	+	+	+	-	-	-	+	-
I	Characidae	*Roeboides bouchellei*	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
I	Gymnotidae	*Gymnotus cylindricus*	+	+	+	+	+	+	-	-	+	+	+	+	+	+	-	-	-	+	-
I	Gymnotidae	*Gymnotus maculosus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+
I	Heptapteridae	*Rhamdia guatemalensis*	+	+	+	+	+	+	-	-	+	+	+	+	+	+	+	+	+	+	+
I	Heptapteridae	*Rhamdia laticauda*	+	+	+	+	+	+	-	-	+	+	+	+	+	+	+	-	-	+	-
II	Anablepidae	*Anableps dowei*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+
II	Cichlidae	*Amatitlania nigrofasciata*	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+	+
II	Cichlidae	*Amatitlania siquia*	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	+	-
II	Cichlidae	*Amphilophus alfari*	-	-	-	-	-	-	-	-	-	-	+	+	+	+	-	-	-	-	-
II	Cichlidae	*Amphilophus hogaboomorum*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
II	Cichlidae	*Amphilophus longimanus*	-	-	-	-	-	-	-	-	+	+	+	+	+	+	-	-	+	+	+
II	Cichlidae	*Amphilophus robertsoni*	+	+	+	+	+	+	-	-	+	+	+	+	-	-	-	-	-	-	-
II	Cichlidae	*Archocentrus centrarchus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
II	Cichlidae	*Archocentrus multispinosus*	-	-	-	-	-	-	-	-	-	-	-	+	+	+	-	-	-	+	+
II	Cichlidae	*Cichlasoma' trimaculatum*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-
II	Cichlidae	*Cichlasoma' urophthalmus*	+	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
II	Cichlidae	*Criptoheros cutteri*	+	+	+	+	+	+	-	-	+	+	-	+	-	-	-	-	-	+	-
II	Cichlidae	*Hypsophrys nicaraguensis*	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-

Table B1 (continued).

		Ichthyographical provinces	MCUP			NDBP					HMIP						HPIP				
Sal.	Family	Species \ Drainages	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
II	Cichlidae	*Parachromis dovii*	-	-	-	-	-	-	-	-	+	+	+	+	+	+	-	-	-	-	-
II	Cichlidae	*Parachromis friedrichsthalii*	+	+	+	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-
II	Cichlidae	*Parachromis loisellei*	+	+	+	+	+	-	-	-	+	+	+	+	+	+	-	-	-	-	-
II	Cichlidae	*Parachromis managuensis*	-	+	+	-	-	-	-	-	-	+	+	+	+	+	-	-	-	-	-
II	Cichlidae	*Parachromis motaguensis*	+	+	+	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	-
II	Cichlidae	*Rocio octofasciata*	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
II	Cichlidae	*Theraps wesseli**	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-
II	Cichlidae	*Thorichthys aureus*	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
II	Cichlidae	*Vieja maculicauda*	+	+	+	+	+	+	-	-	+	+	+	+	+	+	-	-	-	-	-
II	Cichlidae	*Vieja microphthalma*	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
II	Poeciliidae	*Alfaro cultratus*	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-
II	Poeciliidae	*Alfaro huberi*	+	+	+	+	+	+	-	-	+	+	+	+	+	+	+	-	-	+	-
II	Poeciliidae	*Belonesox belizanus*	+	+	+	+	+	+	-	-	+	+	+	+	+	+	-	-	-	-	-
II	Poeciliidae	*Gambusia nicaraguensis*	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	-	-	-	-
II	Poeciliidae	*Heterandria anzuetoi*	+	+	+	+	+	+	-	-	+	+	+	+	+	+	+	-	-	+	-
II	Poeciliidae	*Heterandria bimaculata*	+	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
II	Poeciliidae	*Phallichthys amates*	+	+	+	+	+	+	-	-	+	+	+	-	+	+	-	-	-	-	-
II	Poeciliidae	*Poecilia gillii*	+	+	+	+	+	+	-	-	+	+	+	+	+	+	+	+	+	+	+
II	Poeciliidae	*Poecilia marcellinoi*	+	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	-	+	-
II	Poeciliidae	*Poecilia orri*	+	+	+	+	+	+	+	+	+	+	+	-	-	-	-	-	-	-	-
II	Poeciliidae	*Poecilia sp.1(hondurensis)**	-	+	+	+	+	+	-	-	+	+	-	-	-	-	-	-	-	-	-
II	Poeciliidae	*Poecilia sp.2**	+	+	+	+	-	-	-	-	-	-	-	-	-	-	+	-	-	+	-
II	Poeciliidae	*Poecilia sp.3*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-
II	Poeciliidae	*Poeciliopsis pleurospilus*	+	+	+	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	-
II	Poeciliidae	*Poeciliopsis turrubarensis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+
II	Poeciliidae	*Xiphophorus helleri*	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table B1 (continued).

		Ichthyographical provinces	MCUP			NDBP					HMIP						HPIP				
Sal.	Family	Species \ Drainages	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
II	Poeciliidae	*Xiphophorus mayae*	-	+	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
II	Profundulidae	*Profundulus guatemalensis*	+	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-
II	Profundulidae	*Profundulus portillorum**	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-
II	Profundulidae	*Profundulus sp.2**	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
II	Rivulidae	*Kryptolebias marmoratus*	-	-	-	-	+	-	+	+	-	-	-	-	-	-	-	-	-	-	-
II	Rivulidae	*Rivulus tenius*	+	+	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
II	Synbranchidae	*Ophisternon aenigmaticum*	+	+	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
II	Synbranchidae	*Synbranchus marmoratus*	+	+	+	+	+	+	-	-	+	+	+	+	+	+	+	+	+	+	+
III	Acanthuridae	*Acanthurus bahianus castelnau*	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
III	Achiridae	*Achirus lineatus*	-	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
III	Achiridae	*Trinectes fonsecensis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-
III	Achiridae	*Trinectes maculatus*	-	-	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-
III	Anguillidae	*Anguilla rostrata*	+	+	+	+	+	+	+	+	-	-	-	-	-	-	-	-	-	-	-
III	Ariidae	*Sciades assimilis*	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
III	Ariidae	*Sciades guatemalensis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-
III	Ariidae	*sciades seemanni*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+
III	Ariidae	*Cathorops higuchii*	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-
III	Ariidae	*Cathorops melanopus*	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
III	Ariidae	*Cathorops raredone*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-
III	Ariidae	*Cathorops steindachneri*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-
III	Ariidae	*Cathorops taylori*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-
III	Atherinopsidae	*Atherinella argentea*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+
III	Atherinopsidae	*Atherinella blackburni*	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-
III	Atherinopsidae	*Atherinella guija*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	-
III	Atherinopsidae	*Atherinella meeki*	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
III	Atherinopsidae	*Atherinella milleri*	-	-	-	-	+	+	-	-	+	+	+	+	+	+	-	-	-	-	-
III	Atherinopsidae	*Atherinella pachylepis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+
III	Batrachoididae	*Batrachoides gilberti*	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-

Table B1 (continued).

		Ichthyographical provinces	MCUP			NDBP					HMIP						HPIP				
Sal.	Family	Species \ Drainages	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
III	Belonidae	*Strongylura marina*	-	+	-	-	+	-	+	+	-	-	-	+	-	-	-	-	-	-	-
III	Belonidae	*Strongylura notata*	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-
III	Belonidae	*Strongylura timucu*	-	+	-	-	-	-	+	-	-	-	-	+	-	-	-	-	-	-	-
III	Blenniidae	*Lupinoblennius vinctus*	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
III	Carangidae	*Caranx latus*	-	+	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
III	Carangidae	*Olygoplites saurus*	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
III	Carangidae	*Trachinotus goodei*	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
III	Carcharhinidae	*Carcharhinus leucas*	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
III	Carcharhinidae	*Rhizoprionodon porosus*	-	-	-	-	-	-	-	-	-	-	-	+	-	+	-	-	-	-	-
III	Centropomidae	*Centropomus ensiferus*	-	+	-	-	-	-	-	-	-	-	-	+	-	+	-	-	-	-	-
III	Centropomidae	*Centropomus nigrescens*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-
III	Centropomidae	*Centropomus parallelus*	-	+	+	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
III	Centropomidae	*Centropomus pectinatus*	-	-	-	-	-	-	+	-	-	-	+	+	-	-	-	-	-	-	-
III	Centropomidae	*Centropomus undecimalis*	+	+	+	+	+	-	+	-	-	-	-	+	-	-	-	-	-	-	-
III	Centropomidae	*Centropomus unionensis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-
III	Clupeidae	*Harengula clupeola*	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
III	Clupeidae	*Harengula humeralis*	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-
III	Clupeidae	*Jenkinsia lamprotaenia*	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-
III	Clupeidae	*Ophistonema oglinum*	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
III	Dactyloscopidae	*Dactyloscopus tridigitatus*	-	+	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-
III	Eleotridae	*Dormitator maculatus*	+	+	+	+	+	+	+	-	+	+	+	+	+	+	-	-	-	-	-
III	Eleotridae	*Dormitator latifrons*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+
III	Eleotridae	*Eleotris amblyopsis*	+	+	+	+	+	+	+	+	+	+	+	-	+	+	-	-	-	-	-
III	Eleotridae	*Eleotris perniger*	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	-	-	-	-
III	Eleotridae	*Eleotris picta*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+
III	Eleotridae	*Erotelis smaragdus*	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-

Table B1 (continued).

Sal.	Family	Ichthyographical provinces Species \ Drainages	MCUP 1	 2	 3	NDBP 4	 5	 6	 7	 8	HMIP 9	 10	 11	 12	 13	 14	HPIP 15	 16	 17	 18	 19
III	Eleotridae	*Gobiomorus dormitor*	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	-	-	-	-
III	Eleotridae	*Gobiomorus maculatus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+
III	Eleotridae	*Leptophilypnus fluviatilis*	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
III	Engraulidae	*Anchoa colonensis*	-	+	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
III	Engraulidae	*Anchoa filifera*	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
III	Engraulidae	*Anchoa parva*	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
III	Engraulidae	*Anchovia clupeoides*	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
III	Engraulidae	*Anchoviella elongata*	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
III	Gerreidae	*Diapterus auratus*	-	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-
III	Gerreidae	*Eucinostomus argenteus*	-	+	-	-	-	+	-	-	-	-	-	+	-	-	-	-	-	-	-
III	Gerreidae	*Eucinostomus harengulus*	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-
III	Gerreidae	*Eucinostomus jonesi*	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-
III	Gerreidae	*Eucinostomus melanopterus*	-	+	-	-	-	+	-	+	-	-	-	-	-	-	-	-	-	-	-
III	Gerreidae	*Eugerres plumieri*	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-
III	Gerreidae	*Gerres cinereus*	-	+	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-
III	Gobiesocidae	*Gobiesox strumosus*	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
III	Gobiidae	*Awous banana*	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
III	Gobiidae	*Bathygobius soporator*	-	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-
III	Gobiidae	*Ctenogobius boleosoma*	-	+	-	-	-	-	+	-	-	-	-	+	-	-	-	-	-	-	-
III	Gobiidae	*Ctenogobius fasciatus*	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
III	Gobiidae	*Ctenogobius sagitulla*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+
III	Gobiidae	*Ctenogobius stigmaticus*	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
III	Gobiidae	*Evorthodus lyricus*	-	+	-	-	+	-	+	-	-	-	-	+	-	-	-	-	-	-	-
III	Gobiidae	*Gobionellus oceanicus*	-	+	-	-	-	-	+	-	-	-	-	+	-	-	-	-	-	-	-
III	Gobiidae	*Lophogobius cyprinoides*	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
III	Gobiidae	*Sicydium gymnogaster*	-	-	-	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-
III	Gobiidae	*Sicydium multipunctatum*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-
III	Gobiidae	*Sicydium plumieri*	-	-	-	+	+	+	+	+	-	-	-	-	-	-	-	-	-	-	-

Tabla B1 (continued).

		Ichthyographical provinces	MCUP			NDBP					HMIP						HPIP				
Sal.	Family	Species \ Drainages	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
III	Gobiidae	*Sicydium punctatum*	-	-	-	+	+	+	-	+	-	-	-	-	-	-	-	-	-	-	-
III	Gobiidae	*Sicydium sp2*	-	-	-	+	+	+	-	+	-	-	-	-	-	-	-	-	-	-	-
III	Gobiidae	*Sicydium sp3*	-	-	-	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-
III	Haemulidae	*Pomadasys crocro*	-	+	+	+	+	+	+	+	+	-	-	-	-	-	-	-	-	-	-
III	Hemiramphidae	*Hyporhamphus roberti*	-	-	+	-	-	-	+	+	-	-	-	+	-	-	-	-	-	-	-
III	Hemiramphidae	*Hyporhamphus unifasciatus*	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
III	Labrisomidae	*Labrisomus nuchipinnis*	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
III	Lutjanidae	*Lutjanus apodus*	-	+	-	-	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-
III	Lutjanidae	*Lutjanus jocu*	-	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-
III	Megalopidae	*Megalops atlanticus*	-	-	-	-	+	-	-	-	+	-	+	+	-	-	-	-	-	-	-
III	Microdesmidae	*Microdesmus carri*	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
III	Mugilidae	*Agonostomus monticola*	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	-	-	+	-
III	Mugilidae	*Joturus pichardi*	+	+	+	+	+	+	-	-	+	+	+	+	+	+	-	-	-	-	-
III	Mugilidae	*Mugil curema*	-	+	-	-	-	-	+	+	-	-	-	+	-	-	-	-	-	+	-
III	Mugilidae	*Mugil liza*	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
III	Ophictidae	*Myrophis punctatus*	-	+	-	-	-	-	+	+	-	-	-	+	-	-	-	-	-	-	-
III	Paralichthyidae	*Citharichthys abbotti*	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
III	Paralichthyidae	*Citharichthys arenaceus*	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
III	Paralichthyidae	*Citharichthys gilberti*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-
III	Paralichthyidae	*Citharichthys macrops*	-	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-
III	Paralichthyidae	*Citharichthys spilopterus*	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
III	Polynemidae	*Polydactylus virginicus*	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
III	Pristidae	*Pristis pectinata*	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
III	Sciaenidae	*Bairdiella ronchus*	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
III	Sciaenidae	*Cynoscion praedatorius*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-
III	Sciaenidae	*Menticirrhus americanus*	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Tabla B1 (continued).

Sal.	Family	Ichthyographical provinces Species \ Drainages	MCUP 1	2	3	NDBP 4	5	6	7	8	HMIP 9	10	11	12	13	14	HPIP 15	16	17	18	19
III	Sciaenidae	*Paralonchurus dumerilii*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-
III	Sciaenidae	*Umbrina broussonnetii*	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
III	Sphyraenidae	*Sphyraena barracuda*	-	-	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-
III	Sphyraenidae	*Sphyraena guachancho*	-	+	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-
III	Syngnathidae	*Microphis brachyurus*	-	+	-	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-
III	Syngnathidae	*Pseudophallus mindii*	-	-	-	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-
III	Syngnathidae	*Pseudophallus starksi*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-
III	Syngnathidae	*Syngnathus pelagicus*	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
III	Syngnathidae	*Syngnathus scovelli*	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
III	Tetraodontidae	*Sphoeroides testudineus*	-	+	+	-	+	+	-	+	-	-	-	+	-	-	-	-	-	-	-

Note. Roman numbers represent the families salinity tolerance (Sal.) based on Myers (1949). Ichthyographical provinces abbreviated as follow: MCUP = Motagua-Chamelecón- Ulúa- Ichthyographical Province, NDDP = Nombre de Dios Ichthyographical Province, BAIP = Bay Islands Ichthyographical Province, ESHP = El Salvador-Honduras Ichthyographical Province and GUFP = Gulf of Fonseca Ichthyographical Province. Arabic numbers represent the river drainages: 1 = Motagua, 2 = Chamelecón, 3 = Ulúa, 4 = Lean, 5 = Cangrejal, 6 = Lislis, 7 = Roatán, 8 = Guanaja, 9 = Aguán, 10 = Sico – Tinto, 11 = Plátano, 12 = Patuca, 13 = Warunta, 14 = Coco, 15 = Lempa, 16 = Goascorán, 17 = Nacaome, 18 = Choluteca, and 19 = Negro. Presence of a species in is a drainage represented by a + sign and its absence with – sign. Endemic species of Honduras are marked with an asterisk.

APPENDIX C

CANGREJAL AND LANCETILLA RIVERS SPECIES

Table C1

Cangrejal and Lancetilla Rivers Species Arranged by Rank Based on Abundance (ABD) and Percentage Abundance (%ABD).

Cangrejal River					Lancetilla River				
Species	Rank	ABD	% ABD	CP	Species	Rank	ABD	% ABD	CP
Poecilia sp. "Hondurensis"	1	1718	40.6	40.6	*Poecilia sp.* "Hondurensis"	1	703	20.7	20.7
Alfaro huberi	2	973	23	63.6	*Poecilia cf. mexicana*	2	652	19.2	40
Atherinella milleri	3	283	6.7	70.3	*Atherinella milleri*	3	470	13.9	53.9
Cryptoheros cutteri	4	249	5.9	76.2	*Poecila cf. Nelsoni*	4	347	10.2	64.1
Dormitator maculatus	5	218	5.2	81.3	*Sicydium punctatum*	5	241	7.1	71.2
Astyanax aeneus	6	185	4.4	85.7	*Astyanax aeneus*	6	197	5.8	77
Rhamdia laticauda	7	152	3.6	89.3	*Cryptoheros cutteri*	7	130	3.8	80.9
Sicydium punctatum	8	134	3.2	92.4	*Heterandria anzuetoi*	8	103	3	83.9
Theraps wesseli	9	49	1.2	93.6	*Agonostomus monticola*	9	88	2.6	86.5
Microphis brachyurus	10	47	1.1	94.7	*Gobiomorus dormitor*	10	74	2.2	88.7
Agonostomus monticola	11	39	0.9	95.6	*Sicydium plumieri*	11	74	2.2	90.9
Poecila cf. Nelsoni	12	34	0.8	96.4	*Awaous banana*	12	53	1.6	92.4
Achirus lineatus	13	32	0.8	97.2	*Xiphophorus mayae*	13	49	1.4	93.9
Gambusia nicaraguensis	14	27	0.6	97.8	*Belonesox belizanus*	14	22	0.6	94.5
Vieja maculicauda	15	19	0.4	98.3	*Vieja maculicauda*	15	20	0.6	95.1
Sicydium plumieri	16	12	0.3	98.6	*Amphilophus robertsoni*	16	18	0.5	95.7
Awaous banana	17	11	0.3	98.8	*Microphis brachyurus*	17	18	0.5	96.2
Eleotris perniger	18	10	0.2	99.1	*Brycon guatemalensis*	18	17	0.5	96.7
Gobiomorus dormitor	19	10	0.2	99.3	*Eleotris perniger*	19	15	0.4	97.1
Heterandria anzuetoi	20	9	0.2	99.5	*Carlhubbsia stuarti*	20	14	0.4	97.6
Ctenogobius pseudofasciatus	21	7	0.2	99.7	*Poecilia orri*	21	14	0.4	98
Evorthodus lyricus	22	4	0.1	99.8	*Rhamdia laticauda*	22	13	0.4	98.3
Caranx latus	23	2	< 0.1	99.8	*Pseudophallus mindii*	23	11	0.3	98.7

Table C1 (continued).

Cangrejal River					Lancetilla River				
Species	Rank	ABD	% ABD	CP	Species	Rank	ABD	% ABD	CP
Gymnotus cylindricus	24	2	< 0.1	99.9	*Poecilia sp.1*	24	10	0.3	99.5
Poecilia cf. mexicana	25	2	< 0.1	99.9	*Gambusia nicaraguensis*	25	8	0.2	99.2
Amphilophus robertsoni	26	1	< 0.1	99.9	*Joturus pichardi*	26	5	0.1	99.4
Anchoa. sp	27	1	< 0.1	100	*Achirus lineatus*	27	4	0.1	99.5
Citharichthys macrops	28	1	< 0.1	100	*Anguilla rostrata*	28	4	0.1	99.6
Pseudophallus mindii	29	1	< 0.1	100	*Ophisternon aenigmaticum*	29	4	0.1	99.7
					Alfaro huberi	30	3	0.1	99.8
					Anchoa. sp	31	3	0.1	99.9
					Gymnotus cylindricus	32	2	0.1	99.9
					Parachromis friedrichsthalii	33	1	< 0.1	100
					Pomadasys crocro	34	1	< 0.1	100

Note. CP = cumulative percentage. Total number of individuals captured in the Cangrejal River was 4,232 representing 29 species. In Lancetilla River 3,388 individuals were captured representing 34 species. Together, both rivers contribute 7,620 individuals within 41 species.