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SHORT COMMUNICATION

OCCURRENCE OF LARVAL AND JUVENILE FISH IN MANGROVE HABITATS IN THE SIAN KA'AN BIOSPHERE RESERVE, QUINTANA ROO, MEXICO

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Introduction

Mangrove forests are ubiquitous in low lying coastal areas of tropical and subtropical zones of the world, including the lagoons of the Sian Ka'an Biosphere Reserve, Quintana Roo, Mexico. Mangroves are habitat for juvenile fish of both oceanic and estuarine origin (Vásquez-Yoemans 1992, Vásquez-Yoemans et al. 1992, Laegdsgaard and Johnson 1995). Development of the Caribbean coast of Mexico north and south of the Sian Ka'an Reserve is in large part focused on tourism-related endeavors such as destination resorts, scuba diving and fishing. While some of the development is innocuous, land acquisition for development of resorts has fragmented mangrove habitats in the region and likely altered their function. It has been shown in other mangrove estuaries that habitat fragmentation negatively impacts fish assemblages (Layman et al. 2004). Because of the importance of mangrove estuaries as juvenile fish habitat, loss of mangrove habitat may result in noticeable effects on adult recruitment to fisheries in tropical regions. Very little is known about the composition of larval and juvenile fish communities within the reserve.

Ichthyofaunal surveys of mangrove-lined estuaries worldwide have shown broadly similar taxonomic composition, including Eleotridae (sleepers), Gerreidae (mojarras), Mugilidae (mullets), Poeciliidae (livebearers), Gobiidae (gobies), Clupeidae (herrings) and Belonidae (needlefish) (Austin 1971, Blaber et al. 1989, Wright 1986, Thayer et al. 1987, Yáñez-Arancibia et al. 1988, Chong et al. 1990, Vásquez-Yoemans 1992; Vásquez-Yoemans and González 1992). In this research, we describe the juvenile fish community of two connected mangrove lagoons within the Sian Ka'an Biosphere Reserve at the end of the dry season (May).

Study Area

The Sian Ka'an Biosphere Reserve includes two bays, Bahía de la Ascensión and Bahía Espiritu Santo, and two shallow lagoons, Laguna Campechén, and Laguna Boca Paila (Figure 1). All sampling in this study took place in the shallow lagoon system. The two shallow water lagoons are created by a long narrow sand bar, are separated from the bay systems, and are connected to the Caribbean Sea through Boca Paila inlet. The lagoon system is about 1 m deep with deeper (2 – 3 m) channels, with fringing red mangrove (Rhizophora mangle), algal flats and seagrass beds. Shoal grass (Halodule sp.) was dense in the ocean pass (Boca Paila) and became sparse past the bridge and as the lagoon system extended inland.

Materials and Methods

Light trap sampling was conducted nightly from 7-20 May 1999, excluding 16 May 1999. Neuston net sampling was conducted during daylight hours on 9, 16 and 21 May 1999. Sampling included parts of two lunar cycles but not an entire cycle due to time constraints.

Three light trap sampling (LTS) stations were selected at increasing distances from Boca Paila inlet (Figure 1), but could not be spread too far due to the difficulties of navigating the lagoons at night. Microhabitats were red mangrove adjacent to seagrass beds (LTS 1), red mangrove adjacent to sandy bottom (LTS 2), and fringing red mangrove in a secondary channel (LTS 3). Light trap design followed that of Mueller et al. (1993). Electric diving lights (similar to cyalume sticks) were used as a light source. Two light traps were set at each site at sunset and retrieved about 1 h later. One trap was set within the red mangrove prop root complex and the second was located in the channel, about 1 m from the interior trap to ensure no overlap of illuminated areas. Upon retrieval, LTS samples were washed into 0.5 mm mesh biobags and fixed in 10% formalin overnight .

Four neuston net sampling sites were also selected at increasing distances from Boca Paila inlet and could be spread out further into the system since sampling occurred during the day (Figure 1). Microhabitats sampled were a secondary channel with sandy bottom fringed by red mangrove (NNS 1) rocky/sandy bottom adjacent to red mangrove, near a cenote (NNS 2), sandy bottom adjacent to red mangrove (NNS 3), and a seagrass bed adjacent to red mangrove (NNS 4). These sites were located in sufficient water depths (at least 1 m) to prevent the net from dragging the bottom. Neuston sampling was conducted with a 3:1 aspect ratio 60 cm net of 0.33

mm mesh. On each sampling day three net tows were conducted at each site and in haphazard directions for varying lengths of time. A high speed flowmeter was secured inside the neuston ring to calculate linear distance from the flowmeter coefficient. After each sampling effort, samples were washed down the net into the cod end (0.33 mm mesh) with buckets of seawater, and fixed in 10% formalin overnight.

Formalin-preserved samples from both gear types were transferred to 45% isopropyl alcohol for transportation and storage. Fish were identified to the lowest possible taxon and counted using keys in Ditty et al. (1994), Farooqi et al. (1995), Fritzsche (1978), Johnson (1978), Jones et al. (1978), Martin and Drewry (1978), Moser et al. (1984), Powles (1977), and Richards et al. (1994).

Raw data was standardized for both light trap and neuston net data. Mean set time was calculated for LTS samples, and total numbers of fish were then standardized to this unit of time for each sample (total fish/total minutes x mean minutes = standardized fish). NNS sampling was standardized to 100 m^3 (total fish/total volume x 100 m^3). Volume was calculated using the area of the neuston net ring multiplied by the distance sampled (volume = area x linear distance).

Results and Discussion

A total of 2,457 individuals representing 26 families and 50 species were collected during the sampling period. Light trap sampling captured 1,977 individuals from 42 species and 23 families (Table 1). The most commonly captured species in light traps were *Eucinostomus* spp., *Harengula jaguana, Cyprinodon variegatus* and an unidentified Gobiid. Neuston net sampling collected 480 individuals from 20 species and 13 families (Table 2), with the most commonly captured species including 2 unidentified goby species and an unidentified atherinid. Family dominance was similar between gears with Gobiidae, Atherinidae (silversides), and Gerreidae representing nearly 70% of the total catch in both. Other important families included Clupeidae and Cyprinodontidae (killifish) in light trap collections and Belonidae and Syngnathidae (pipefish) in the neuston net collections. Families exclusive to light trap collections were Balistidae (triggerfish), Lambrisomidae (lambrisomid blennies), Clupeidae, Eleotridae, Elopidae (ladyfish), Megalopidae (tarpon), Mugilidae, Ophichthidae (snake eels), Opistognathidae (jawfish), Pomacentridae (damselfish), Scaridae (parrotfish), Scorpaenidae (scorpionfish), Sparidae

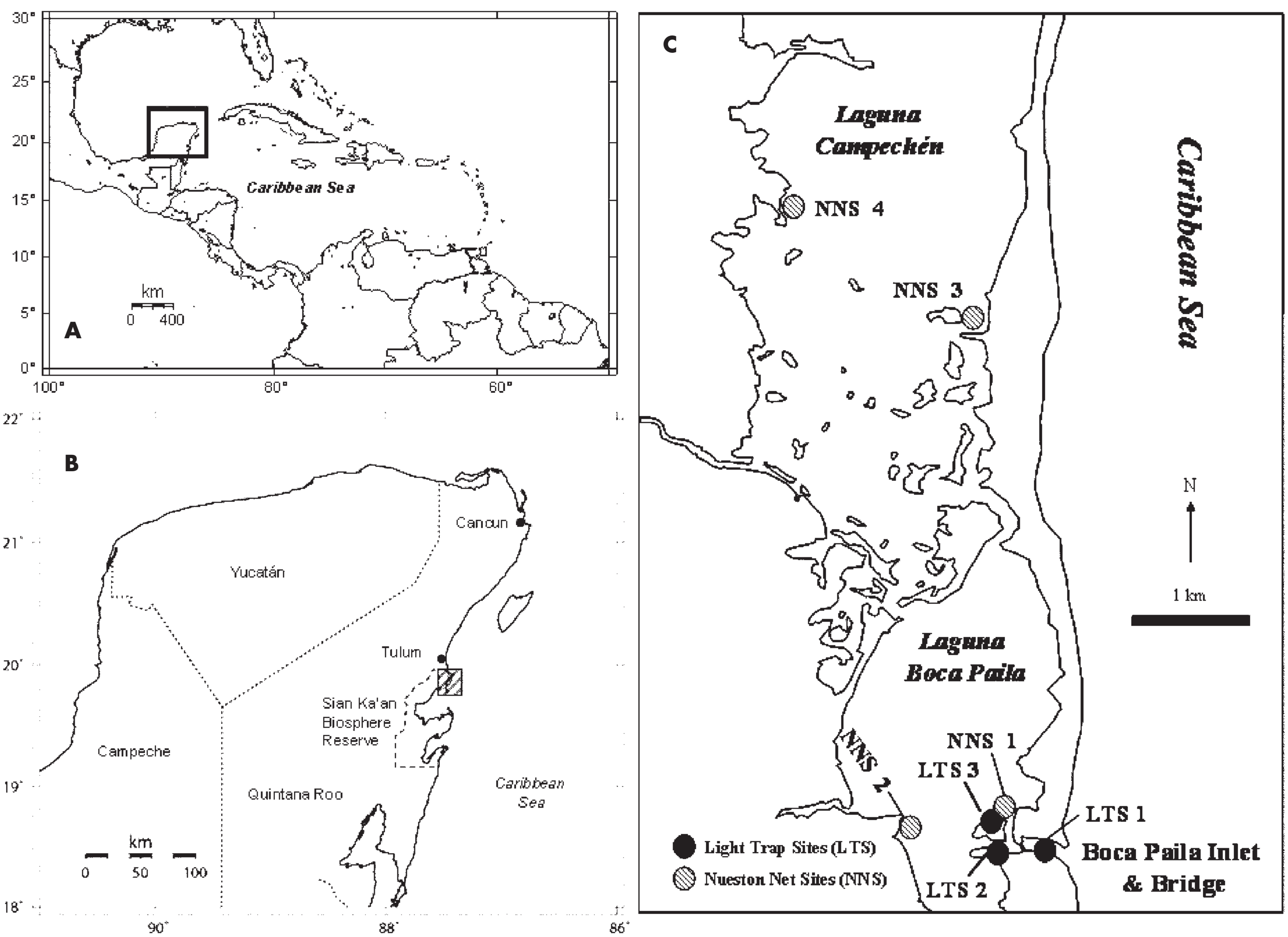

Figure 1. *Maps showing the location of the Sian Ka'an Biosphere Reserve on the Yucatán Peninsula, in Quintana Roo, Mexico (A), with detail of the study area (denoted by the hatched square; B) and location of sampling sites (C).*

TABLE 1. *Mean catch per unit effort (CPUE; fish/minute) of species in light trap stations, with standard error in parenthesis. Phylogenetic order, family and species names follow McEachran and Flechhelm (1998) and McEachran and Flechhelm (2005).*

	LTS 1	LTS 2	LTS 3		LTS 1	LTS 2	LTS 3
Elopidae				Carangidae			
Elops saurus	0.04 (0.06)	0.00	0.06 (0.06)	*Trachinotus falcatus*	0.04 (0.06)	0.00	0.00
Megalopidae				Gerreidae			
Megalops atlanticus	0.04 (0.06)	0.00	0.00	*Eucinostomus* spp.	17.21 (6.41)	10.12 (3.91)	9.64 (4.06)
Ophichthidiae				Sparidae			
Myrophis punctatus	0.04 (0.06)	0.03 (0.05)	0.00	Sparidae species A	0.00	0.2 (0.2)	0.00
Clupeidae				Pomacentridae			
Harengula jaguana	0.04 (0.06)	10.87 (10.22)	2.57 (1.98)	*Stegastes* spp.	0.00	0.03 (0.05)	0.00
Jenkinsia lamprotaenia	0.00	0.59 (0.49)	0.16 (0.22)	Scaridae			
Clupeidae species A	0.00	0.1 (0.1)	0.00	*Scarus vetula*	0.00	0.03 (0.05)	0.00
Engraulidae				Lambrisomidae			
Anchoa lamprotaenia	0.00	0.1 (0.11)	0.00	*Starksia lepicoelia*	0.18 (0.25)	0.00	0.00
Belonidae				Gobiesocideae			
Strongylura notata	0.44 (0.26)	0.14 (0.11)	0.06 (0.06)	*Gobiesox* spp.	0.49 (0.58)	0.00	0.00
Strongylura spp.	0.27 (0.16)	0.15 (0.1)	0.03 (0.04)	Gobiesocidae species A	0.09 (0.13)	0.03 (0.05)	0.00
Belonidae species A	0.09 (0.09)	0.00	0.00	Eleotridae			
Hemiramphidae				*Dormitator maculatus*	0.87(0.50)	0.13 (0.15)	0.06 (0.06)
Hyporhamphus unifasciatus	0.49 (0.35)	0.00	0.00	Gobiidae			
Mugilidae				Species A	5.85 (2.23	1.02 (0.78)	0.56 (0.67)
Mugil curema	0.00	0.00	0.03 (0.04)	Species B	0.9 (0.54)	0.14 (0.15)	0.03 (0.04)
Atherinidae				Species C	0.05 (0.07)	0.00	0.00
Atherinimorus sp.	0.18 (0.25)	0.11 (0.15)	0.00	Species D	1.42 (1.18)	0.2 (0.16)	0.00
Atherinomorus stipes	0.00	0.33 (0.18)	0.23 (0.23)	Species E	0.08 (0.08)	0.07 (0.07)	0.00
Atherinidae species A	1.29 (0.97)	1.4 (0.74)	0.21 (0.13)	Species F	0.36 (0.36)	0.00	0.00
Cyprinodontidae				Species G	0.04 (0.06)	0.00	0.00
Cyprinodon variegatus	3.84 (1.98)	0.32 (0.2)	0.04 (0.05)	Balistidae			
Syngnathidae				Balistidae species A	0.04 (0.06)	0.00	0.00
Syngnathus dunckeri	0.23 (0.13)	0.00	0.00	Monacathidae			
Syngnathus spp.	1.12 (1.20)	0.00	0.00	*Stephanolepis setifer*	0.04 (0.06)	0.00	0.00
Syngnathidae species A	0.00	0.23 (0.33)	0.00	Tetraodontidae			
Scorpaenidae				*Sphoeroides parvus*	0.09 (0.08)	0.00	0.00
Scorpaena plumieri	0.04 (0.06)	0.00	0.00	*Sphoeroides* spp.	0.04 (0.06)	0.00	0.00
Scorpaena spp.	0.09 (0.09)	0.00	0.00	Unidentified	0.00	0.03 (0.05)	0.00
Opistognathidae				**Overall**	**36.16 (7.9)**	**26.43 (12.95)**	**13.68 (5.0)**
Opistognathus spp.	0.00	0.05 (0.07)	0.00	**Species Richness**	**32**	**23**	**13**

(porgies) and Tetraodontidae (puffers). Families exclusive to neuston net collections were Blenniidae (combtooth blennies), Fistulariidae (cornetfish) and Haemulidae (grunts).

In light traps, both fish CPUE and species richness decreased as distance from the Boca Paila inlet increased (Table 1). Gerreids (*Eucinostomus* spp.) dominated the catch at all sites, and represented 48% of total catch. Gerreids are typically abundant along sandy shorelines, bays, and estuaries, a few species are found in freshwater, and they are important components of fish communities in many estuaries (Böhlke and Chaplin 1993). *Eucinostomus* spp. comprised the largest year-round population of juvenile fishes in saline mangroves bordered by coral reefs in Puerto Rico (Austin 1971). Gerreids were also the dominant species in mangrove-lined bays in the Ten Thousand Islands, Florida (Tabb and Manning 1961, Carter et al. 1973, Colby et al. 1985).

Clupeids represented 20% of the total light trap collection and were the second most abundant family. However, of the total clupeids collected at light trap sites, 77% were captured on 10 May 1999, and were either *Harengula jaguana*

TABLE 2. *Mean density (fish/100 m³) of species in neuston net stations, with standard error in parenthesis. Phylogenetic order, family and species names follow McEachran and Flechhelm (1998) and McEachran and Flechhelm (2005).*

	NNS 1	NNS 2	NNS 3	NNS 4
Engraulidae				
Engraulidae species A	0.00	0.23 (0.23)	0.00	0.75 (0.75)
Belonidae				
Strongylura spp.	0.29 (0.10)	0.00	0.00	0.15 (0.15)
Hemiramphidae				
Hyporhamphus unifasciatus	0.27 (0.09)	0.76 (0.40)	0.14 (0.14)	0.00
Fistulariidae				
Fistulariidae species A	0.00	0.00	0.00	0.10 (0.10)
Atherinidae				
Atherinomorus stipes	0.00	0.16 (0.16)	0.00	0.00
Atherinidae species A	1.76 (0.59)	7.71 (3.08)	1.06 (0.48)	1.95 (1.00)
Cyprinodontidae				
Cyprinodon variegatus	0.00	0.37 (0.37)	0.00	0.00
Syngnathidae				
Syngnathus spp.	0.21 (0.07)	0.25 (0.25)	0.80 (0.48)	1.59 (0.63)
Syngnathidae species A	0.00	0.00	0.00	1.58 (1.58)
Carangidae				
Oligoplites saurus	0.00	0.00	0.29 (0.19)	0.57 (0.45)
Gerreidae				
Eucinostomus spp.	0.21 (0.07)	0.16 (0.16)	0.00	1.8 (1.35)
Haemulidae				
Haemulon spp.	0.00	0.00	0.28 (0.28)	0.00
Blenniidae				
Blennius spp.	0.00	0.00	0.00	0.23 (0.23)
Blenniidae species A	0.00	0.28 (0.19)	0.37 (0.25)	2.56 (1.70)
Gobiesocidae				
Gobiesox spp.	0.27 (0.09)	0.12 (0.12)	0.00	0.00
Gobiesocidae species A	0.00	0.50 (0.50)	0.21 (0.21)	0.00
Gobiidae				
Gobiidae species D	0.00	0.20 (0.20)	0.92 (0.70)	0.26 (0.26)
Gobiidae species H	0.00	0.00	0.43 (0.31)	0.00
Gobiidae species I	2.49 (0.83)	4.53 (1.75)	24.46 (15.96)	4.45 (2.54)
Gobiidae species J	0.29 (0.10)	1.10 (0.73)	4.06 (3.13)	3.13 (1.86)
Unidentified	2.84 (0.95)	1.35 (0.78)	4.45 (3.65)	2.49 (1.0)
Yolk sac larvae	0.00	0.00	0.00	0.12 (0.12)
Overall	**8.63 (2.09)**	**17.72 (4.74)**	**37.46 (19.6)**	**21.73 (6.88)**
Species Richness	**8**	**13**	**11**	**13**

or *Jenkinsia lamprotaenia. Jenkinsia* sp. and *Harengula* sp. also dominated mangrove estuaries in Puerto Rico (Rooker et al. 1996) and Bahía de la Ascension (Vásquez-Yoemans 1992).

Gobiids were dominant in this study and are generally important components of shallow water communities. In this study, Gobiidae represented one-half of the abundance in neuston net collections, with 73% of individuals collected on the same day at NNS 1 and NNS 2. Elsewhere, gobiids dominated catch from shallow coral reef habitat at One Tree Island, Great Barrier Reef (Kingsford and Finn 1997), and in a lagoon reef at Moorea Island, French Polynesia (Dufour and Galzin 1993). In Florida (USA) estuaries, gobiids are important components of fish communities (Odum and Heald 1972). Gobiids were abundant and widely distributed in Bahía de la Ascension (Vásquez-Yeomans 1992) and represented 8.5% of the Bahaman shore-fish fauna. Worldwide, they form a significant element of the tropical fish faunas (Böhlke and Chaplin 1993).

Due to the spatial and temporal limitations of the study the role of microhabitats in the lagoons could not be easily examined. However, larval and juvenile fish diversity and abundance within the mangrove estuary may have been enhanced by habitat contiguity. For example, species richness and CPUE were greater at LTS 1, where mangroves grew adjacent to dense seagrass beds, than it was in other LTS sites where mangroves were adjacent to bare bottoms. In contrast, the greatest density of fishes at neuston net sites was collected where the bottom was sandy (NNS 3), but species richness was greatest where there was a sandy/rocky bottom and a cenote (NNS 2) and seagrasses (NNS 4).

Mangrove estuaries are significant in supporting local and global species diversity, and tropical fisheries are highly dependent on their continued healthy functioning. Maintaining the productivity of the mangrove estuaries within the Sian Ka'an Biosphere Reserve should be considered a high priority. Further analysis of fish recruitment in Laguna Boca Paila and Laguna Campechén is recommended with amendments to the spatial and temporal components of experimental design. Future studies should correct sampling design shortfalls from this study: for example, sample all sites with both gears and on the same days. Effects of lunar periodicity, currents, tides, and on-shore wind on recruitment of larval fish also need to be investigated.

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