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The rich ichthyofaunal diversity within the mangal of the Belize offshore cays

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ABSTRACT

We assessed ichthyofaunal diversity within Belizean offshore cay mangroves during three sampling events (2003-2005). A variety of sampling gears (n=9 types nets/traps) were deployed in pre-defined habitats: fringe, transition, dwarf red, internal creek, pond, sinkhole. A total of 2,586 gear sets was completed and 8,131 individuals collected, comprising 75 species. Water quality data (temperature, salinity, DO) were taken during most collections. Minnow trap data from the various micro-habitats tested indicates some overlap in assemblages. Significant differences in water quality were also noted, with the fringe presenting the best conditions and sinkhole the worst. We also conducted extensive visual surveys around the fringe at a number of cays, tallying an additional 67 species. The fringe is the most diverse (128 species) and sinkhole least (12 species). An overall total of 142 species from 55 families has therefore been documented from the cays, and all but eight species were found on Twin Cays alone. This figure is among the highest reported for oceanic mangroves in this biogeographic realm. Our comprehensive approach with a variety of gear-types in a wide range of micro-habitats, combined with visual observation, lends credence to the conclusion that most ichthyological species accounts for the mangal are often perhaps underestimates.

KEYWORDS: fringing mangroves, visual survey, fish traps, community structure, mangrove associated fish, Twin Cays, biodiversity.

La Rica Diversidad de la Ictiofauna en los Manglares de los Cayos de Belice

Determinamos la diversidad de la ictiofauna en manglares en cayos de mar afuera en Belice durante tres eventos de muestreo (2003-2005). Varios tipos de equipos de muestreo (n=9 redes/trampas) fueron desplegados en habitáculos predeterminados: borde, transición, enano rojo, arroyo interno, charca, y fosa de derrumbe. Se completaron 2,586 despliegues de equipo y se atraparon 8,131 individuos de 75 especies. Datos sobre la calidad de las aguas (temperatura, salinidad, oxígeno en solución) fueron obtenidos durante la mayoría de las colecciones. Datos resultantes del uso de trampas de alambre para chipas en varios micro-habitáculos indican que existe cierto traslapo en las agrupaciones de peces. Se notaron también diferencias significativas en la calidad de las aguas, donde los bordes presentaron las mejores condiciones y la fosas las peores. También conducimos extensos reconocimientos visuales en derredor al borde en varios cayos y anotamos 67 especies adicionales. El borde es el habitáculo más diverso (128 especies) y la fosa el menos diverso (12 especies). Un total de 142 especies de 55 familias diferentes han sido documentadas en los cayos, y con excepción de ocho especies, todas se pueden encontrar en Twin Cays. Estos datos se encuentran entre los más altos reportados para manglares oceánicos en esta región biogeográfica. Nuestro enfoque comprensivo, el cual utilizó variedad de equipos en combinación con observaciones visuales en gran variedad de micro-habitáculos, da creencia a la conclusión de que la mayoría de las cuentas ictiológicas de especies en los manglares son subestimados.

PALABRAS CLAVES: manglar de borde, reconocimiento visual, estructura de la comunidad, peces asociados con man-

INTRODUCTION

There is a need to better understand the complex association between mangroves and adjacent ecosystems, although the biological connectivity between the mangal and adjacent seasgrasses and coral reefs has been well established. This linkage is of some concern, as the current extent of mangrove destruction is alarming, and estimates are that tropical shorelines were once 75% covered by mangroves and the rate of destruction may be increasing (World Resources Inst., 1996, Valiela *et al*. 2001). The implications of this loss rate to fisheries are sobering.

Mangroves have an established value as feeding and nursery habitat for many coral reef-dependent fish species (reviewed in Sheridan and Hays 2003, Manson et al. 2005; Verweij *et al*. 2006). A number of studies in the Caribbean and Florida mangroves have documented varying numbers of fish species. From Caribbean habitats, species counts vary from 17 in the Netherlands Antilles (Dorenbosch *et al*. 2004), 61 in Guadeloupe (in seagrasses adjacent to mangroves- Baelde 1960), 41 in Puerto Rico mangroves (Rooker and Dennis 1991) and 87 species in Cuban mangroves (Claro *et al.* 1993).

In Florida, where estuarine mangroves are more prevalent, Thayer et al. (1987) found 63 species, Gilmore (1995)

found 88 and Ley *et al.* (1999) recorded 76 species. However, in our review of the literature we find varying collection/observation techniques as well as confusion over whether surveys were completed in seagrass or strictly within mangroves.

Below, we report below on what we believe to be one of the more comprehensive surveys (wide variety of gears, range of micro-habitats sampled) of mangrove fishes from the Caribbean in a study completed in the cays of the Belize barrier reef. As a further distinction, our study documents species found only physically within mangroves.

METHODS

Study location

We assessed mangrove fish assemblages on the cays west of the Belize barrier reef, with a focus on Twin Cays, a 92 ha complex of mangrove islands with two main cays located 1.5 km west of the barrier reef. We also completed supplemental visual surveys on various cays spanning a 25 km range north and south of Twin Cays. Our surveys were completed during two week visits during Oct.-Nov. 2003, Sept. 2004 and April-May 2005. We conducted visual surveys, as well as utilizing the following nine primary gear-types: fyke net (5 hoops, 4.7 m wings/1.7 m high, 6 mm mesh bag and wings), 1 m^2 throw-trap, center bag seine (10 m long/6.7 mm mesh), Gee™wire minnow traps, 'cup' traps (Taylor 1990), Breder traps, oval mesh traps, 1 m^2 drop-trap, gill net (38 mm stretch mesh). In addition, we also made opportunistic collections with cast net, hook and line, hand spear, and hand nets. We identified the following micro-habitat types within Twin Cays for deployment of these gears, with some of the descriptions following those of Woodroffe (1995) and Feller *et al*. (2002): fringe (shoreline, *Rhizophora mangle* dominant), transition (landward of fringe, *Avicennia germinans/Laguncularia racemosa* /*R. mangle* mix), dwarf red (internal, stunted *R. mangle*), pond (internal, open shallow water bodies), internal creek (interior tidal channels), and sink hole (small, deep, infrequently tidally flushed, internal ponds).

The fyke and gill nets, minnow, cup and oval traps were deployed for 24 h. Minnow and oval traps were baited with cut fish. Cup traps were covered with debris/ leaf litter, with the intent of providing a refuge for small fishes in very shallow water. At most collections, water quality data were obtained with a YSI 6920 sonde, including temperature, DO and salinity. All collected fishes and crustaceans were identified, counted and released, except for needed specimens for laboratory identification or stable isotope studies.

The visual surveys were conducted by snorkelers swimming around the outside of the fringe or within internal tidal creeks, ponds and dwarf red mangrove. Observers compiled species lists with the strict criteria of a specimen being observed within the prop root zone, under the overhanging canopy or within internal creeks, ponds, or dwarf stands. Species within adjacent seagrass beds were never included.

An overall species list was compiled from gear collections and visual surveys. Water quality data were analyzed with a two-way ANOVA (with micro-habitat and year as main effects) and Tukey HSD post-hoc tests to identify differences in water quality between micro-habitats, using SPSS 12.0 software.

RESULTS

We completed 2,586 gear-sets of the nine primary gear types over the three collection cycles. We deployed 1,277 sets within the fringe, 321 in the transition (low water frequently prevented deployment of traps here, particularly in 2005 when this zone did not flood at all), 614 in dwarf red, 203 in sinkhole, 66 in internal creek, and 101 in pond. A total of 8,131 individual fishes was taken, comprising 75 species. Many gear-sets (38.2%), particularly with smaller traps, resulted in no catch. *Poecilia orri*, followed by *Gerres cinereus*, and *Gambusia yucatana* were the most common species taken. Fyke net sets within internal creeks produced the largest number of individuals (n=2,627), consisting mostly of gerreids, followed by dwarf and sinkhole, with high overall catches consisting mostly of two species, *P. orri* and *G. yucatana*. Catches from the fringe had 27 species unique to that micro-habitat, followed closely by internal creeks with 18 species.

We collected 1,154 macro-crustaceans in conjunction with the fish collections. These were dominated by mud crabs (genus *Panopeus* and *Eurytium*). They were common across most micro-habitats, but most common in the fringe, where many were taken in minnow traps. Second in abundance was a grass shrimp (*Palaemonetes* sp.), also found in abundance in the fringe. Two commercially important species, *Callinectes* sp. and an unidentified penaeid shrimp, were also taken, but in considerably fewer numbers. Both, however, were found well into the interior of the cay, in creeks and ponds, as well as in the fringe.

We completed 104 person-hours of visual surveys over the three collection periods, including some night-time surveys, and these surveys documented an additional 67 species. A heavy advection of *Sargassum* sp. algae into the windward *R. mangle* fringe in 2005 probably accounted for the collection of a few species that would not commonly be encountered in mangroves, including *Histrio histrio, Microphis brachyurus, Syngnathus pelagicus, Balistes capriscus,* and *Cantherhines pullus*. Between the gear collections and the visual surveys, the total number of species documented was 142.

We completed a total of 115 water quality samples in conjunction with collections. There were significant differences in water quality across all micro-habitats, and lowest temperatures were found in the fringe and highest in the transition. Salinity was highest in sinkhole and lowest in the transition, and dissolved oxygen was highest in pond and lowest in sinkhole.

DISCUSSION

Our documentation of 142 species from 55 different families from the mangal of the Belize cays represents perhaps the highest number of species reported from oceanic mangrove systems within this biogeographic realm. Most remarkable was that all but eight species were recorded from Twin Cays alone. Our two-week collections over three consecutive years and at two different seasons perhaps also allowed a wider range of opportunities to document new taxa. However, the gradually increasing species count over the three years illustrates the difficulty of collection/observation in the mangal. Our initial collection in 2003 documented 86 species, followed by 22 new species in 2004 and 34 in 2005.

The distribution of species across micro-habitats is interesting. We documented 128 species from the fringe, 30 each in creeks and ponds, 20 from the dwarf red, 18 from the transition and 12 from the sinkhole. The lower diversity from the sinkhole is probably indicative of poor water quality and infrequent connection to other micro-habitats. However, three species were unique to this micro-habitat, the two eleotrids *Guavina guavina* and *Dormitator maculatus* and *Megalops atlanticus*, all species known to be tolerant of low DO.

Only four species, *Lutjanus apodus, G. cinereus, G. yucatana* and *P. orri* were found across all micro-habitats. Four other gerreids were taken and were also notable for their presence in all but sinkhole.

We recorded 10 species of serranids, all but three by visual observation. All species were recorded as juveniles or sub-adults from the fringe only, and all were relatively rare. In addition, eight species of lutjanids were documented, all mostly juveniles and sub-adult and from the fringe, with only a few species in creeks/ponds. We commonly observed juvenile *Lutjanus cyanopterus*, ranging in size from 20-50 cm TL within the fringe, dwarf red, ponds and creeks. While information on the juvenile ecology of this very important commercial species is sparse (Lindeman and DeMaria, 2005), our observations reinforce the importance of mangroves as juvenile habitat. Haemulids were represented by eight species, and the most ubiquitous was *Haemulon sciurus*, observed/collected everywhere but sinkhole. With few exceptions, other species of grunt occurred only in the fringe. Other reef-associated species (e.g. Pomacentridae, Labridae, Scaridae, etc.) were observed/collected strictly in the fringe, and most records were visual, and with few exceptions, individuals of these families were sub-adult.

Our data from an oceanic/island mangrove system may reinforce the importance of the association between the mangal and adjacent seagrasses and coral reefs. The abundance and diversity of fishes and crustaceans that we have documented cannot but help and have obvious 'spillover' effects into seagrasses and coral reefs. Our comprehensive approach, over three different years and two seasons, with a variety of gear-types applied across a wide range of micro-habitats, combined with extensive visual observation, lends credence to the notion that most ichthyological species accounts for the mangal, mostly focused on the fringe, often perhaps underestimate diversity.

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