Efficacy of Two- and Three-Chamber Light-traps for Presettlement Fishes and Invertebrate Plankton from Mangrove and Coral Reef Habitats at Key Largo, Florida

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ABSTRACT

Light-traps have been used in ichthyo- and invertebrate plankton studies to sample the larval and juvenile stages of fishes and planktonic invertebrates that are often inadequately sampled with conventional nets. Light-traps can be used in shallow areas where the use of towed nets is difficult, such as in mangroves and over coral reefs. Our purpose was to field test and compare the efficacy of two- and three-chamber light-traps in these two habitats. Three-chamber traps significantly out-performed two-chamber traps in both the mangroves and over the reef, collecting 7 and 9.5 times the number of fish larvae per hour, respectively. The three-chamber traps also sampled a greater diversity and abundance of invertebrate plankton.

KEY WORDS: Ichthyoplankton, invertebrate plankton, light attraction, sampling gear

INTRODUCTION

Light-traps have been used recently in ichthyoplankton studies to sample the older, post-flexion pelagic stages and presettlement juveniles that are not sampled adequately with conventional net tows (Brogan 1994, Choat et al. 1993, Hernandez and Lindquist 1999). The traps have demonstrated certain biases, including being size and taxon selective (Doherty 1987), but they do offer several advantages as a sampling device. They can be used in shallow areas where the use of towed nets can be difficult (Brogan 1994). Larvae are collected live and can be placed in aquaria for further studies and identification purposes (Doherty 1987) or released by divers and tracked for behavioral analyses (Leis et al. 1998, 1999). Several designs, all modeled after Doherty's (1987) design, have been used extensively around different reef systems, particularly the Great Barrier Reef, and have demonstrated the ability to sample individuals from many different families. However, light-traps have not specifically been used to assess the relative abundance of all captured marine invertebrate plankton (see Thorrold 1992 and Moltschaniwskyj and Doherty 1994, 1995, and Kraemer 1996 for juvenile squid catches). In May, 1994, we were able to collect zooplankton using two different light-trap designs in Key Largo, Florida in a mangrove lagoon and above a coral reef. Our purpose was to field test and compare both designs in terms of their efficiency as presettlement larval fish and invertebrate plankton samplers.

METHODS and MATERIALS

Samples were collected from a shallow (< 2 m deep) mangrove lagoon channel located near an inlet on the southwest end of Largo Sound (25°6.5'N, 80°24.2'W) on May 9 - 11, 1994, and from Three Sisters, a reef (< 7 m deep) located approximately 7.5 km from shore (25°1.6'N, 80°23.7'W), on May 12, 1994 (Figure1).

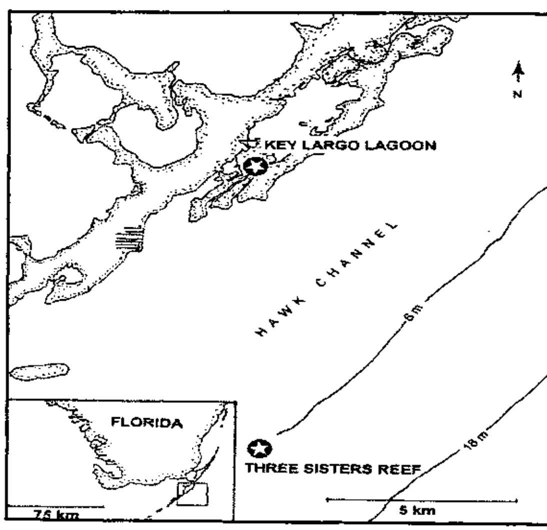

Figure 1. Chart of study area showing the two study sites. Depth contours shown are 6 and 18 m.

Two different light-trap designs were utilized to collect fish larvae and presettlement juveniles. One design, constructed by Progressive Technologies, Inc. (PTI) in Plantation, Florida, and modeled after Doherty (1987), had three chambers and a timer, which alternately turned the bulbs in the two upper chambers on and off, drawing organisms into the trap. The other, simpler design, constructed at UNCW's Center for Marine Science Research (CMSR), and modeled after Brogan (1994), had only two chambers with the two 8 watt florescent bulbs in each chamber remained on continuously. Traps were deployed on site beginning at sunset using a 7 m outboard (*R/V Tomtate*) from UNCW's National Undersea Research Center facilities in Key Largo, Florida. Each night in the lagoon, three sets of samples were completed using 3 three-chamber models (n = 27) and 1 two-chamber model (n = 9). Above the reef, three sets were completed using 2 three-chamber light traps (n = 6) and 1 two-chamber light trap (n = 3). In the mangrove, traps were moored to the bottom with anchors. Above the reef, the traps were linked together at 50 m intervals with line and attached to a mooring. Buoys were attached to each trap above the reef, allowing them to remain in the water column near the surface. Traps were allowed to fish for approximately 1 hour before being collected. The duration that each trap fished was recorded. Upon retrieval, the contents of each trap were rinsed with seawater into a sieve. Organisms were then rinsed into a collection jar and fixed with 95% ethanol. Samples were sorted in the laboratory for larval and juvenile fishes and zooplankton. Fish larvae were counted and measured to the nearest 0.5 mm. Fish identifications were made to the lowest possible taxon using many resources, primarily Fahay (1983), Leis and Rennis (1983), and reference materials provided by Drs. A.B. Powell and R.E. Robbins at a larval fish workshop conducted at the National Marine Fisheries Service laboratory in Beaufort, North Carolina. Invertebrate plankton were identified to the lowest possible taxon and enumerated, except in eight cases where high volumes were subsampled, using a volumetric technique to extrapolate total numbers in the sample.

RESULTS

The Doherty three-chamber model significantly out-performed the Brogan two-chamber model in both the mangrove and on the reef, collecting 7 and 9.5 times the number of fish larvae/hr, respectively (Table 1). A total of 11 Doherty samples and seven Brogan samples contained no fish larvae. A total of 60 individuals representing at least five families was sampled using the Doherty model in the mangrove, while the Brogan model sampled only four individuals representing two families. Above the reef, the Doherty model collected 29 fish from at least nine families, and the Brogan design collected two individuals from two families. Overall, individuals from at least 12 families were collected, and the combined capture rate was 1.9 fish/hr. Clupeids (primarily *Jenkinsia* spp.) were the most abundant larvae collected by the Doherty trap, dominating both the mangrove (72%) and reef (55%) samples (Table 2).

Table 1. Number of fish larvae and fish juveniles sampled per hour in the mangrove lagoon and above the reef.

Location	Trap Type	Number of Fish Sampled per Hour
Mangrove	Doherty	2.1
Mangrove	Brogan	0.3
Reef	Doherty	5.7
Reef	Brogan	0.6

Table 2. Total number, size range, and percent total of fish larvae and fish juveniles sampled with light-traps in the mangrove and above the reef. **=no data.

	MANGROVE						REEF					
	DOHERTY			BROGAN			DOHERTY			BROGAN		
Family	n	SL	%	n	SL	%	n	SL	%	n	SL	%
Atherinidae	7	19 - 49.5	12	1	5.0	25	0	**	0	0	**	0
Clupeidae	44	14.5 - 57	72	3	16 - 17	75	16	4.5 - 18	55	0	**	0
Cyprinodontidae	1	7.0	2	0	**	0	0	**	0	0	**	0
Engraulidae	4	24 - 38	7	0	**	0	0	**	0	0	**	0
Gobiidae	0	**	0	0	**	0	1	4.5	3	0	**	0
Haemulidae	0	**	0	0	**	0	2	5 - 5.5	7	1	5.0	50
Labrisomidae	0	**	0	0	**	0	1	7.5	3	0	**	0
Ophidiidae	0	**	0	0	**	0	1	5.0	3	0	**	0
Pomacentridae	0	**	0	0	**	0	1	8.0	3	0	**	0
Synodontidae	0	**	0	0	**	0	2	19 - 20	7	1	35.0	50
Tetraodontidae	0	**	0	0	**	0	1	3.5	3	0	**	0
Unidentified	4	2.5 - 3	7	0	**	0	4	5 - 7.5	14	0	**	0
Totals	60	2.5 - 57.0	100	4	5.0 - 17.0	100	29	3.5 - 20	100	2	5.0 - 35.0	100

The Doherty traps sampled individuals from a larger size range (2.5 mm-57.0 mm) than the Brogan traps (5.0 mm-35.0 mm), although the number of individuals sampled with the latter model was too low for comparison. The majority of individuals sampled with both trap designs on the reef and in the mangrove lagoon were post-flexion larvae and juveniles (Table 3).

Table 3. Summary of the different stages of fish larvae and juveniles sampled with light-traps.

Site/Trap	% Preflexion	% Flexion	%Postflexion/ juveniles
Mangrove			
Doherty	5	2	93
Brogan	25	0	75
Reef			
Doherty	17	17	66
Brogan	50	0	50

Both trap types sampled diverse invertebrate plankton, including holoplankters such as copepods, chaetognaths, and polychaetes as well as meroplankters such as stomatopods, zoea, and megalopae. The total number of individuals sampled varied for each trap type, but the three-chamber trap caught an average of four to seven times more invertebrate plankton than the two-chamber trap. Differences in total catches were observed at the two habitats. The mangrove lagoon had a mean of 768 individuals per two-camber trap and 5,842 per three-chamber trap while these numbers for the coral reef habitat were 188 and 809, respectively. The composition of invertebrate plankton also differed at the two habitats (Figure 3). Harpacticoid copepods comprised 68 percent of the mean total at the mangrove lagoon, but this is biased by a single three-chamber trap catch of 37,404 individuals. Cumaceans were the second most abundant taxon at the mangrove lagoon with nearly 19 percent of the mean total. Amphipods and calanoid copepods were the abundant taxa caught at the coral reef with 22 and 18 percent of the mean totals, respectively, for the two- and three-chamber traps.

DISCUSSION

The Brogan two-chamber model did not sample as well as the Doherty three-chamber model in terms of number of individual fish sampled, number of fish taxa sampled, and size-range of fish sampled. However, only one Brogan trap was available for use in the study, and did not get field tested as extensively as the Doherty model. Both traps appear to collect the "target" size-range they are designed to sample, the post-flexion larvae and juvenile stages. With the exception of family Cyprinodontidae, all families represented in our studies have been sampled in other light trap studies. The capture rate for the Doherty trap above the reef is slightly higher than that reported in Doherty's original study (1987), but lower than subsequent studies, which range from 11.8 - 313.5

larvae/hr. It must be noted, however, that our site was a small patch reef and not comparable to the Great Barrier Reef sites in terms of larval abundance and diversity.

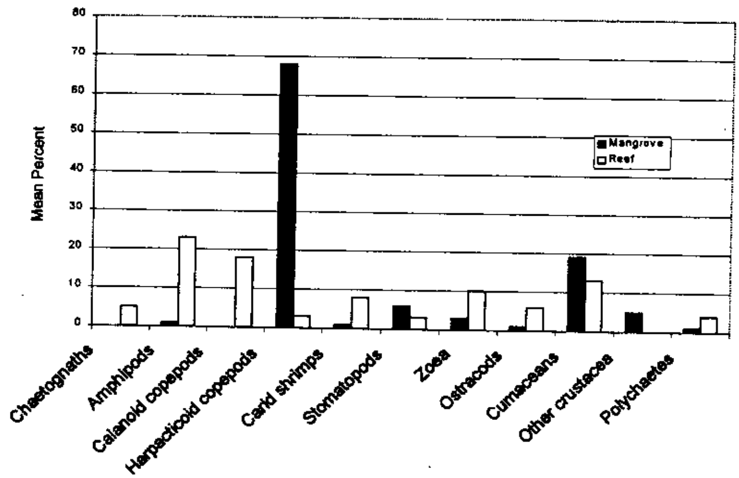

Figure 3. Comparison of major invertebrate zooplankton taxa at the two habitats captured in both two- and three-chamber light-traps.

Our results indicate that the three-chamber trap is much more efficient in the capture of invertebrate plankton than the two-chamber trap. The timer light system of the three-chamber trap helps attract and retain a greater number of individuals compared to the continuous light system of the two-chamber trap. Moreover, the three-chamber trap has twice the number of entry vents compared to the two-chamber trap (six vs. three) and thus allows a greater number of individuals to enter the upper collecting chamber. The main disadvantages of the three-chamber trap are cost ($3,000 in 1994) as well as greater bulk and weight. Both light-trap designs sampled the diversity of invertebrate plankters almost equally. Only cyclopoid copepods were entirely absent in the two-chamber trap but they were rare in the three chambered trap, as well.

Differences in the composition and abundance of invertebrate plankters at the two sites were observed in our study. These differences may be due to distributional patterns in planktonic taxa that may be controlled by prevailing current patterns at the two sites. Differences may also be due to biological factors since some organisms migrate at night from the soft substrates of the mangrove sediments to the water column (e.g., harpacticoid copepods) and are thus differentially available depending upon temporal and spatial activity patterns.

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LITERATURE CITED

Brogan, M.W. 1994. Two methods of sampling fish larvae over reefs: a comparison from the Gulf of California. *Mar. Biol.* **118**:33-44

Choat, J.H., Doherty, P.J., Kerrigan, B., Leis, J.M. 1993. A comparison of towed nets, purse seine, and light-aggregation devices for sampling larvae and pelagic juveniles of coral reef fishes. *Fish. Bull. U.S.* **91**:195-209

Doherty, P.J. 1987. Light-traps: selective but useful devices for quantifying the distributions and abundances of larval fishes. *Bull. Mar. Sci.* **41**:423-431

Fahay, M.P. 1983. Guide to the early stages of marine fishes occurring in the Western North Atlantic Ocean, Cape Hatteras to the Southern Scotian Shelf. *J. Northw. Atl. Fish. Sci.* **4**: 423 pp.

Hernandez, F.J., Jr. and D.G. Lindquist. 1999. A comparison of two light-trap designs for sampling larval and presettlement juvenile fish above a reef in southern Onslow Bay, North Carolina. *Bull. Mar. Sci.* **64**:173-184.

Kraemer, J.J. 1996. Size frequency and light trap catch efficiencies of the squid, *Loligo* sp., during the hatchling and juvenile stages in the coastal waters of Onslow Bay, North Carolina. Honors thesis, University of North Carolina at Wilmington, 30 pp.

Leis, J.M., Rennis, D.S. 1983. *The Larvae of Indo-Pacific Reef Fishes.* University of Hawaii Press, Honolulu. 371 pp.

Leis, J.M. and B.M. Carson-Ewart. 1998. Complex behaviour by coral-reef fish larvae in open-water and near-reef pelagic environments. *Env. Biol. Fish.* **53**:259-266.

Leis, J.M. and B.M. Carson-Ewart. 1999. *In situ* swimming and settlement behavior of larvae of an Indo-Pacific coral-reef fish, the coral trout *Plectropomus leopardus* (Pisces:Serranidae). *Mar. Biol.* **134**:51-64.

Moltschaniwskyj, N.A. and P.J. Doherty. 1994. Distribution and abundance of two juvenile tropical *Photololigo* species (Cephalopoda: Loliginidae) in the central Great Barrier Reef Lagoon. *Fish. Bull. U.S.* **92**:302-312.

Moltschaniwskyj, N.A. and P.J. Doherty. 1995. Cross-shelf distribution patterns of tropical juvenile cepahlopods sampled with light-traps. *Mar. Freshwater Res.* **46**:707-714.

Thorrold, S.R. 1992. Evaluating the performance of light-traps for sampling small fish and squid in open waters of the central Great Barrier Reef lagoon. *Mar. Ecol. Prog. Ser.* **89**:277-285