Offshore Recruitment of Postlarval Spiny Lobster *(Panulirus argus)* at Looe Key Reef, Florida

DOUGLAS W. HEATWOLE, JOHN H. HUNT,
& BARBARA I. BLONDER
Florida Department of Natural Resources
Bureau of Marine Research, Marathon Field Lab
13365 Overseas Highway, Suite 103, Marathon, Florida 33050, U.S.A.

ABSTRACT

In an ongoing study of population dynamics of spiny lobster *Panulirus argus* at Looe Key Reef in the lower Florida Keys, postlarva (puerulus) collectors were placed in shallow (1-2 m) reef flat and nearshore zones to determine if pueruli are physiologically capable of settling in offshore reef habitats and, if so, how relative magnitude and timing of offshore settlement is related to settlement nearshore, 8 km from the reef. Collectors were also set in deep (30 m) water offshore of the reef in vertical arrays (0, 15, and 27 m) to monitor timing and stratification of incoming pueruli. During March-October 1987, maximum monthly recruitment of pueruli occurred simultaneously at reef flat and nearshore areas and was centered around new moon and first quarter lunar phases. Settlement peaks on offshore collectors occurred at first and third quarter phases. Combined numbers of pueruli and first stage juveniles on reef flat collectors averaged 42% that of nearshore collectors. Catch rates of pueruli and first stage juveniles on deep-water collectors were only 5% of those on reef flat collectors; 66% of all pueruli settled on bottom collectors, whereas 28 and 6% settled on middle and surface collectors, respectively.

INTRODUCTION

Research on postlarval recruitment presented here is part of a broader study of population dynamics of spiny lobster (*Panulirus argus*) being conducted by the Florida Department of Natural Resources at Looe Key National Marine Sanctuary off the lower Florida Keys. Looe Key, a classical spur and groove coral reef with a protected shallow reef flat, is located about 8 km from the island chain along the western edge of the Florida Current.

Palinurid larvae are transported to Florida year-round (Ingle *et al.*, 1963; Sims and Ingle, 1966), and recruitment of pueruli, or postlarvae, occurs throughout the year in nearshore waters of the Florida Keys (Sweat, 1968; Little, 1977; Little and Milano, 1980). However, circumstances regarding recruitment from offshore to inshore waters have not been determined, nor has the possibility that shallow offshore environments such as reef flats may provide habitat suitable for recruitment. The investigation now in progress monitors puerulus recruitment with artificial habitats to address the following questions:

1. At what depths are incoming pueruli transported?
2. Are pueruli physiologically capable of settling in offshore waters?

3. Does settlement offshore differ in lunar periodicty and magnitude from that near shore?
4. Is there a substantial transit time for pueruli between offshore and nearshore waters?

Preliminary results obtained during the first eight months of sampling are presented here.

METHODS

Puerulus collectors were constructed of a rectangular PVC frame and 6 sheets of air conditioning filter material, each measuring 40 x 61 cm. Each sheet was folded over a crossbar to form a total of 12 pages or leaves. A styrofoam buoy was tied to each corner of the frame for flotation. Each collector was attached to a buoyed line anchored to the bottom.

Three collectors were set approximately 50 m apart on the reef flat at Looe Key. Three nearshore collectors were set approximately 500 m apart, 100 m offshore of Big Munson Island, 8 km inshore of Looe Key. Water depth at both locations was 1-2 m. Two vertical arrays of collectors were set seaward of the Looe Key fore reef in 30 m depth. Each array consisted of one collector at the surface, one at 15 m, and one at 27 m. A third surface collector was also anchored offshore in 30 m depth. These deep-water arrays were located about 1 km apart.

Collectors were sampled weekly from March to October 1987. Collectors were lifted from the water in a mesh bag to catch pueruli that washed out of the filter material. Submerged collectors were retrieved by divers, who encircled them with mesh bags and brought them to the surface.

Collectors were thoroughly searched on board the boat and pueruli and juveniles counted. Pueruli were staged as follows: transparent with yellow eyes, semipigmented, and pigmented. First stage juveniles were distinguished from pueruli by their rounded carapace and erect supraorbital spines. Transparent pueruli with black eyes, as reported by Lewis *et al.* (1952) and Calinski and Lyons (1983), were not found. Pueruli were released at least 0.5 km from any collector.

Catch per unit effort (CPUE) was calculated as the number of pueruli caught per collector per week. Unless otherwise specified, calculations of CPUE include first stage juveniles.

RESULTS

Catch rates of pueruli were greatest near shore (Table 1). Catch rates of reef flat and deep-water collectors averaged 42% and 2%, respectively, of catch rates on nearshore collectors. Monthly recruitment peaks occurred in May and August at the nearshore location. Recruitment also peaked in May on the reef flat,

Table 1. Catch rates of all puerulus stages and juveniles on collectors at three locations during each lunar phase, March—October 1987. Trans = # of transparent pueruli, Semi = # of semipigmented pueruli, Pig = # of pigmented pueruli, Juv = # of juveniles, Total = # of all pueruli and first stage juveniles.

	CPUE (Catch/Collector/Week)														
	Nearshore					Reef Flat					Deep Water				
Lunar Phase	**Trans**	**Semi**	**Pig**	**Juv**	**Total**	**Trans**	**Semi**	**Pig**	**Juv**	**Total**	**Trans**	**Semi**	**Pig**	**Juv**	**Total**
New Moon	3.00	1.65	1.47	0.71	6.83	2.22	0.83	0.28	0.17	3.50	0.08	0.00	0.04	0.02	0.14
First Quarter	3.42	3.46	7.96	5.67	20.51	1.32	1.44	3.28	1.52	7.56	0.08	0.04	0.14	0.08	0.34
Full Moon	0.10	0.05	1.33	2.90	4.38	0.05	0.00	0.76	1.90	2.71	0.04	0.00	0.00	0.02	0.06
Third Quarter	0.65	0.15	0.30	1.65	2.75	0.15	0.05	0.05	0.80	1.05	0.16	0.06	0.04	0.06	0.32

although there was no increase in late summer. CPUE in deep water increased slightly in May, but maximum catches occurred in August.

Catch rates were greatest during the first quarter moon phase at all three locations (Table 1). Nearshore and reef flat collectors had their second highest catch rates during new moon, whereas catch rates of deep water collectors were nearly equal during first and third quarters. Catches of transparent pueruli, a more accurate indicator of recent settlement, exhibited a different pattern with respect to lunar timing. Maximum CPUE of transparent pueruli occurred during third quarter in deep water, new moon on the reef flat, and first quarter near shore (Table 1). This data suggests that movement of pueruli from deep water to nearshore locations may require up to two weeks. An experiment is underway attempting to estimate relative age of pueruli captured at each location.

Distributions of puerulus stages at each lunar phase were similar between nearshore and reef flat locations (Table1). Transparent pueruli were the predominant stage during new moon, whereas pigmented pueruli were predominant during first quarter. Most lobsters found on nearshore and reef flat collectors during full moon and third quarter were first stage juveniles. On deep-water collectors, transparent pueruli were the most abundant postlarval stage during every lunar phase except first quarter, when the majority of pueruli were pigmented. Transparent pueruli were twice as abundant during third quarter as during new moon and first quarter.

The vertical arrays of collectors in 30 m depth revealed an obvious depth stratification of incoming pueruli. Sixty-six percent of pueruli were found on bottom collectors, whereas 28% and 6% were found on middle and surface collectors, respectively. Catches of pueruli on bottom and middle collectors exhibited the same lunar periodicity, with maxima at first and third quarters. Catch on surface collectors was low but nearly constant throughout the lunar month.

DISCUSSION

Our results demonstrate that lobster pueruli can settle in offshore waters. The lower densities of pueruli settling offshore may be due to differences in suitability of habitat or to consequences of hydrodynamics. Pueruli may be concentrated near shore by currents impinging on the islands and shallow banks.

The time necessary for pueruli to swim or be transported by currents across the reef tract to nearshore waters appears to be 1-2 weeks, beginning offshore near third quarter lunar phase and arriving near shore between new moon and first quarter. If lunar timing of recruitment is a predator avoidance pattern, then transit should be timed so that pueruli pass the area of greatest predation risk during new moon. The facts that transparent pueruli are most numerous on the reef flat during new moon and that planktivores are abundant on reefs (Bohnsack *et al.*, 1985) support the predator avoidance hypothesis.

The data demonstrate that *P. argus* pueruli move inshore near the ocean bottom. Depth stratification of incoming pueruli in deep shelf waters off Western Australia has also been suggested for *P. cygnus* (Phillips *et al.*, 1978). Transit near the bottom permits pueruli to test substrates for suitability of settlement as they proceed shoreward. Because pueruli are physiologically ready to settle offshore, some offshore recruitment on natural habitat is likely.

ACKNOWLEDGEMENTS

This research was funded by the Marine and Estuarine Management Division, Office of Ocean and Coastal Resources Management, National Oceanic and Atmospheric Administration, U.S. Department of Commerce (Contract # 50-DGNC-6-00093). Our thanks to B. Causey, Manager, Looe Key National Marine Sanctuary for logistical assistance.

REFERENCES

Bohnsack, J.A., D.E. Harper, D.B. McClellan, D.L. Sutherland, and M.W. White. 1985. Final Report: A resource survey of fishes within Looe Key National Marine Sanctuary. Prepared for Sanctuary Programs Division, Office of Ocean and Coastal Resource Management, National Oceanic and Atmospheric Administration, Department of Commerce.

Calinski, M.D. and W.G. Lyons. 1983. Swimming behavior of the puerulus of the spiny lobster *Panulirus argus* (Latreille, 1804) (Crustacea: Palinuridae). *J. Crust. Biol.* 3(3): 329-335.

Ingle, R.M., B. Eldred, H.W. Sims, Jr., and E. Eldred. 1963. On the possible Caribbean origin of Florida's spiny lobster populations. Fla. State Board Conserv. Tech. Ser. No. 40. 12 pp.

Lewis, J.B., H.B. Moore, and W. Babis. 1952. The postlarval stages of the spiny lobster, *Panulirus argus. Bull. Mar. Sci. Gulf Caribb.* 2: 324-337.

Little, E.J., Jr. 1977. Observations on recruitment of postlarval spiny lobsters, *Panulirus argus*, to the South Florida coast. Fla. Mar. Res. Publ. N. 29. 35pp.

Little, E.J., Jr. and G.R. Milano. 1980. Techniques to monitor recruitment of postlarval spiny lobsters, *Panulirus argus*, to the Florida Keys. Fla. Mar. Res. Publ. No. 37. 16 pp.

Phillips, B.F., D.W. Rimmer, and D.D. Reid. 1978. Ecological investigations of the late-stage phyllosoma and puerulus larvae of the western rock lobster *Panulirus longipes cygnus. Mar. Biol.* 45: 347-357.

Sims, H.W., and R.M. Ingle. 1966. Caribbean recruitment of Florida's spiny lobster population. *Q. J. Fla. Acad. Sci.* 29(3): 207-242.

Sweat, D.E. 1968. Growth and tagging studies on *Panulirus argus* (Latreille) in the Florida Keys. Fla. State Board Conserv. Tech. Ser. No. 57. 30 pp.