Biological Evidence of Diminished Nursery Capability in Discovery Bay, Jamaica

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ABSTRACT

The protected waters of mangrove lined estuaries are considered nursery grounds for many important fisheries species. In the US Virgin Islands settlement rates of *Panulirus argus* pueruli on Witham collectors are much higher in near shore estuarine habitats than those placed in off shore oceanic waters. In Discovery Bay, Jamaica, settlement of pueruli and recruitment of other organisms was higher on the exposed fore reef than in the estuarine waters. The lack of pueruli and the low recruitment of other organisms on collectors within the protected waters of the Discovery Bay estuary may be a function of habitat degradation. While much attention is given to over fishing around Discovery Bay, degradation of the near shore nursery habitat of Discovery Bay is seldom considered a major factor in the decline of local fisheries.

KEY WORDS: Nursery grounds, lobsters, recruitment, Discovery Bay, Jamaica

Evidencia Biológica de la Reducción en la Capacidad de Criadero en la Bajía Discovery en Jamaica

Las aguas protegidas y los estuarios delineadas con manglares son considerados como áreas de criadero de muchas especies importantes de peces. En las islas Vírgenes de los Estados Unidos la taza de sedimento de *Panulirus argus* pueruli en los colectores Witham son altas en los habitáculos estuarianos en aguas someras en comparación a los que son puestos en áreas mar afuera. Deposición de sedimentos en el área delantera y expuesta del arrecife en la Bajía Discovery era mas alta que en las aguas estuarinas de la Bajía Discovery. La ausencia de pueruli en los colectores dentro de las aguas protegidas del estuario en la Bajía Discovery pueden ser una función de la degradación de habitáculo. Mientras se le da mucha atención a la sobre pesca en los alrededores de la Bajía Discovery, a la degradación de los habitáculos en las áreas de criaderos en las aguas someras se le da poca consideración como un factor major en la reducción o decline en la pesca.

PALABRAS CLAVES: *Panulirus argus*, áreas de criadero, la Bajía Discovery, Jamaica

INTRODUCTION

The sea grass meadows, mangroves and protected waters of sheltered bays and lagoons are considered to be the nursery grounds for Caribbean fish (Ogden and Gladfelter 1982, Ogden and Quinn, 1984) and lobsters (Hunt et al 1990, Little 1997, Quinn and Kojis 1997, Quinn et al. 1998, Kojis et al. in press).

The western Atlantic lobster, *Panulirus argus* (Latreille 1804), is commonly caught by Discovery Bay, Jamaica fishermen in wire mesh traps (termed "pots") set on or adjacent to a coral reef. This study examined the abundance of lobster pueruli and other motile organisms recruiting to pueruli collectors placed in the fore reef of the Discovery Bay Barrier reef and on reefs within Discovery Bay. We hypothesized that there would be no difference in settlement at sites within Discovery Bay and at sites outside the bay.

METHODS

Site Description

Discovery Bay is located on the north coast of Jamaica. The middle of the bay is 55 m deep with shallow reefs on the western and along portions of the eastern side of the bay. In the northeast quadrant of the bay, there are sea grass meadows (Gayle and Woodley 1998). A shipping channel was dredged in 1964 to increase the entrance channel depth from 5 m to 12 m to allow for large bauxite bearing ships to leave Port Rhoades in Discovery Bay. Although there is no permanent river flowing into Discovery Bay, fresh groundwater does continuously enter the bay through deep cracks in the basement limestone. This reduces the salinity throughout the bay.

Sampling Design

Puerulus settlement of the western Atlantic spiny lobster, *Panulirus argus*, was sampled using modified Witham collectors identical to those used in Quinn and Kojis (1997) and Kojis et al (in press). Sites were chosen within the sheltered waters of Discovery Bay at Columbus Park (18°28.00'N.; 77°23.62' W.) and Blue Hole (18°28.04'N.; 77°23.64'W.) and outside the bay at Dairy Bull (18°28.07'N.; 77°23.63.00'W.) and M1 (18°28.12'N.; 77°25.00'W.) (Figure 1). The collection sites were inside a Marine Protected Area that existed from 1996 to 2000 (Woodley et al, in press). Collectors were set ~ 3 m above a sandy substrate in water 10 – 14 m deep near coral reefs. From April 2001 to November 2002, the collectors were sampled periodically. All motile animals were removed from the collector, identified and counted.

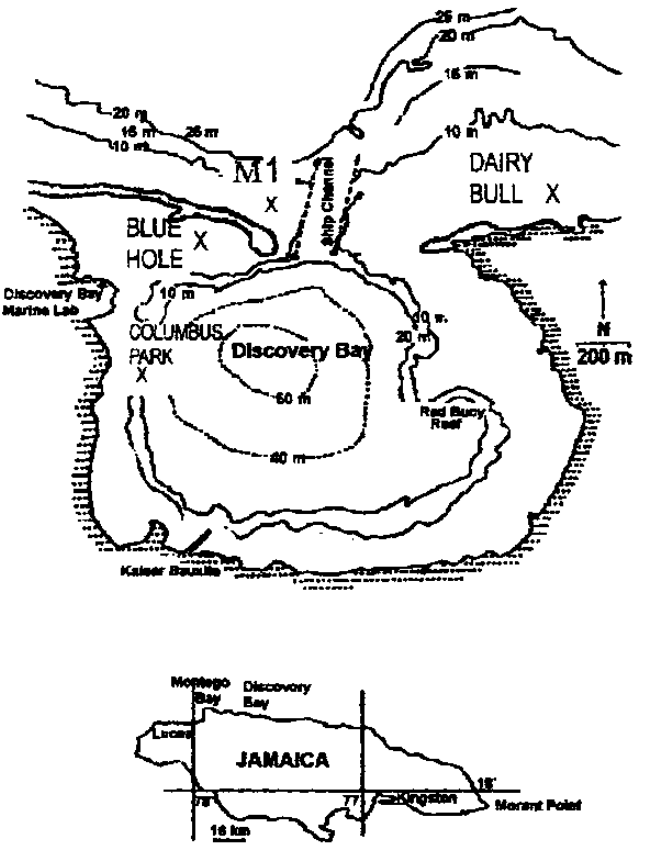

Figure 1. Map of Jamaica and sampling sites around Discovery Bay.

RESULTS

No pueruli were caught at the two sites inside the bay. Also, the abundance of other species recorded was low. The mean number of individuals of all species per sampling date (MID) (19.4 animals; n = 8; C.V. = 32 %) and total number of species caught (S) (11 species) was the lowest at the Columbus Park site inside Discovery Bay (Figure 2). The collector at this site was so laden with red muddy slit after a couple weeks that it could not be supported by the float. Visibility at this site was commonly < 4 m. Although the water is slightly clearer at the Blue Hole (~ 6 m visibility) and the muddy silt was not present, the number of animals was only slightly greater (45.3 animals; n = 10; C.V. = 24 %) and 24 species.

All pueruli were caught either at Dairy Bull (12 pueruli) or at M1 (17 pueruli), outside the bay. M1 also had the greatest species diversity with a MID of 61.4 animals (n = 12; C.V. = 41 %) and a total of 37 species (Figure 2). Dairy Bull had a MID of 52.1 individuals (n = 10; C.V. = 51 %) and 31 species.

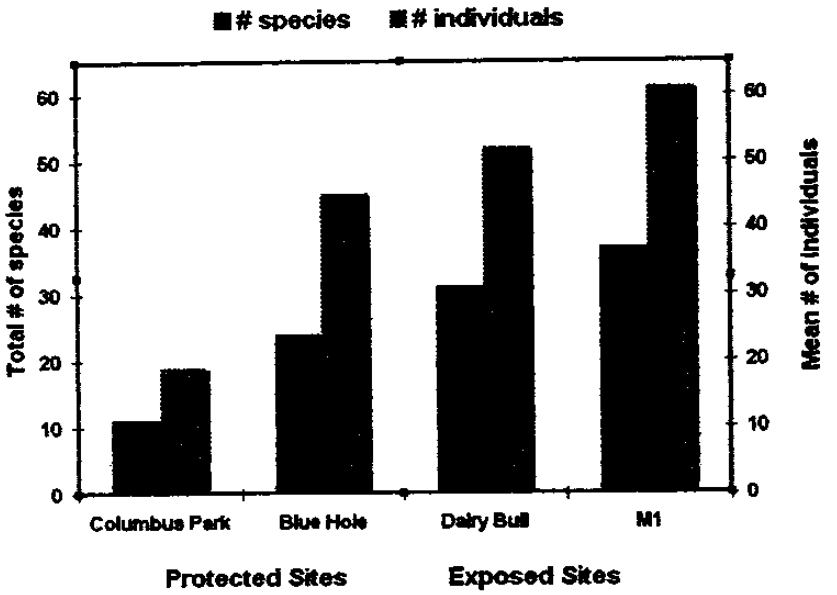

Figure 2. Comparison of mean number of individuals and total number of species settled in Discovery Bay sites.

DISCUSSION

The absence of pueruli within the bay was unexpected. In St. Thomas, US Virgin Islands 83% and 74% of the settled pueruli in 1993 and 1999, respectively, were caught in sheltered waters (Figure 3) (Quinn and Kojis, 1997; Kojis et al. in press). As pueruli have been shown to be more abundant in near shore Caribbean habitats (Olsen et al 1975, Heatwole et al. 1992, Little 1997) we suggest that the lack of pueruli settlement within Discovery Bay and the low abundance of other organisms on collectors is the result of increased sediment and nutrient loading resulting in degraded nursery habitat.

Birkeland (1997) observed that human activities have been affecting coral reefs and tropical coastal ecosystems much more than was generally recognized. Many studies have demonstrated that sediments and accompanying nutrients are one of the greatest threats to coral reefs (Johannes 1975, Hatcher et al. 1989, Rogers 1983,

1990, Hallock et al. 1993). In Queensland, the fluvial discharge rates from the coastal rivers is four times greater now than before humans began altering the drainage basins through deforestation and farming. Presently, approximately four times as much sediment, nitrogen, and phosphorus enter the Great Barrier Reef lagoon than before western agriculture began (Brodie 1995).

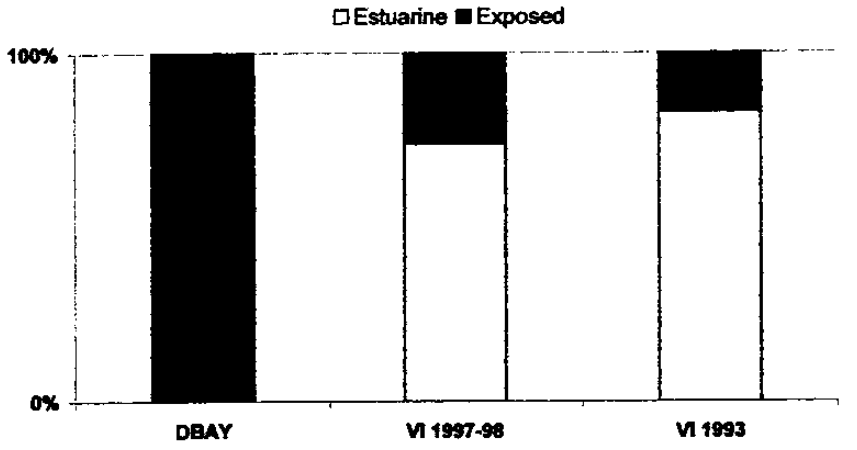

Figure 3. Comparison of percentage of pueruli caught in Discovery Bay with the US Virgin Islands (Quinn and Kojis 1997, Kojis et al. in press).

Many reefs near human population concentrations in the Caribbean (Rogers 1985), the Florida Keys (Jaap 1984), Bermuda (Dodge and Vaisnys 1977) and the U.S. Virgin Islands (Hubbard et al. 1987) have become degraded by sedimentation and nutrient input. No study makes that association with reefs near Discovery Bay. However, the ecological consequences of land based nutrient input to coral reefs communities in the Negril Marine Park have been studied (LaPointe and Thacher 2001). Negril and Ocho Rios have higher nitrogen and phosphorus concentrations than Discovery Bay (Greenaway pers. comm.)

The sea grass community (*Thallasia testudinum*) in the bay is not characteristic of a pristine oligotrophic bay and clearly shows signs of anthropogenic disturbance primarily through reduced light levels and increased nutrient levels (Bramwell 2000). Discovery Bay is impacted by sediment from the bauxite loading facility in the bay. During dry, windy periods bauxite is blown onto the bay waters and surrounding vegetation and ground. During heavy rains this is washed into the bay and impacts the sea grass community and coral reefs by direct contact and indirectly through reduced light levels.

Although Woodley et al (in press) reported that the reefs within Discovery Bay were in good condition until Hurricane Allen in 1980, Bonem (1975) reported in the early 1970s that the substrate at Red Buoy Reef was composed of carbonate sediment with varying amounts of skeletal debris – primarily *Halimeda* plates and

the reef was dominated by *Halicona* sponges. Hermatypic corals characteristic of shallow, clear Jamaican reefs such as *Dendrogyra cylindrus*, *Acropora plamata*, *Siderastrea radians* and *Diploria* spp. among others, were not present. The large amount of suspended sediment affected and limited coral diversity in the bay by reducing light penetration and by direct contact (Bonem 1975). Today a fine muddy substrate is characteristic of Bonem's Red Buoy reef site and the western shore of the bay by Columbus Park.

Wapnick et al. (2002) asserted that the branching stag horn coral, *Acropora cervicornis*, essentially dominated the Columbus Park reefs continuously prior to the 1980s similar to the present lagoonal reefs of Belize (MacIntyre et al. 2000). Wapnick et al. (2002) extracted cores from the Columbus Park reef, and are examining whether the transition from the acroporid coral to a macroalgal dominated community is unique on a centennial or millennial scale. They consider that it is likely that these reefs are currently exhibiting a community structure unique in the past several thousand years caused by extreme levels of both human and natural disturbance.

It has generally been accepted that the Jamaican north coast shallow coral reef fish stocks have been over-exploited (Roberts 1995, Woodley et al. in press). This recognition is largely due to the over three decades of research on the reefs of Discovery Bay and resulting numerous publications which have documented the fish stocks (Munro 1983, Aiken and Haughton 1987, Sary 2001, Sary et al. in press). The massive algal overgrowth of the coral reefs near Discovery Bay, which resulted in a severe loss of the biodiversity and disruption of the ecosystem, is considered "one of the worst cases known" (Munro 2001). This environmental change was initiated by the die off, thought to be caused by a virus, of the black long spined sea urchin (*Diadema antillarum*) in 1984 and exacerbated by the lack of herbivorous fish present to control the algal growth (Hughes 1994).

Watson and Munro (in press) found that the larval supply of commercially important fish species was far lower off the West Fore Reef of Discovery Bay than at any site in the British Virgin Islands. Together with the observations from the wire mesh traps set for juvenile fish, Watson and Munro (in press) observed that the larger high-valued species of snappers, grunts and jacks have almost disappeared from the Discovery Bay ecosystem.

Recruitment of juveniles is recognized as a major determinant of community structure in marine ecosystems (Doherty and Williams 1988, Harrison and Wallace 1990). We hypothesize that the low number of adults of many species is the result of low recruitment brought about by the degradation of nursery habitat on the north shore of Jamaica.

While much attention is given to over fishing around Discovery Bay, degradation of near shore nursery habitat may be an important contributing factor to the decline of fisheries (Rogers 1985, Nagelkerken 2000). We suggest monitoring water turbidity and sedimentation levels to document their contribution to habitat degradation and mitigating non-point source pollution are necessary steps to begin to improve the nursery habitat of Discovery Bay and increase spiny lobster

and fish populations.

ACKNOWLEDGEMENTS

We would like to acknowledge the assistance of staff and volunteers at the Discovery Bay Marine Lab and the staff of the US Virgin Islands Division of Fish and Wildlife. This is DBML publication number #661. Dr. K.R. Uwate kindly reviewed the manuscript.

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