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PREDATORS AND THE DISTRIBUTION AND ABUNDANCE OF BLENNIES ON OFFSHORE PETROLEUM PLATFORMS

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ABSTRACT Predation may be important in structuring fish assemblages but studies of the intensity of predation on marine fish assemblages are uncommon. Predator avoidance behavior was used to identify the predators of an assemblage of blennies found on offshore petroleum platforms in the northern Gulf of Mexico. The distribution of predators was then compared with the distribution of 3 species of blennies to see if predation intensity was related to the vertical zonation of blennies. Predator approaches and blenniid activity were compared in low and high surface current events. Results did not support a hypothesis of predation controlling the distribution and abundance of blennies. Also, predators were less abundant and blennies increased their activity when a surface current was present. 'Enemy free space' created by surface currents may help explain why predation is not important in structuring these blenniid assemblages.

INTRODUCTION

In recent years the role of predation in assemblage regulation has received increased attention (reviewed by Sih et al. 1985, Ebeling and Hixon 1991). Although predation is recognized as an important assemblage structuring process, it has received little attention in marine fish systems (reviewed by Hixon 1991). Studies of predation effects in marine fish assemblages are constrained by design and implementation problems (Hixon 1991, Hixon and Beets 1993).

Blenniid assemblages (Family: Blenniidae) on offshore petroleum platforms in the northern Gulf of Mexico (GOM) are characterized by a distinct bathymetric zonation (Rauch 2003). *Scartella cristata* are found only in the upper few meters of the water column whereas *Parablennius marmoreus* are most abundant at 15 m and do not occur at depths < 5 m. *Hypsoblennius invemar* are found throughout the water column (to depths > 15 m) but are more abundant at shallower depths. The abundance of blennies (all species combined) decreases with increasing depth (at least to 30 m)(Rauch 2003). Although blennies are abundant on offshore platforms, their biomass is small compared to most northern GOM fishes (Gallaway and Lewbel 1982).

If predators are limiting *S. cristata* to depths < 5 m, I should find different predators and abundance at 5 m and 1 m depths. Likewise, if predators are limiting *P. marmoreus* abundance at 10 m, I should find one or more predators at 10 m depths, where the blenny is less abundant, and not find those predators (or find fewer of them) at 15 m depths, where the blenny is twice as abundant. Additionally, if predators reduce the abundance of blennies (all species combined) as depth increases, I should find a greater number of predators at deeper depths. Equal densities of predators at different depths would not be expected if predation were affecting this blenniid distribution.

Surface currents are common but not always present in the northern GOM (Gallaway and Lewbel 1982), and fishes around offshore petroleum platforms often congregate below surface currents (pers. obs.). Stanley and Wilson (1997), using hydroacoustics, noted that fishes ≤ 20 cm were uncommon around offshore platforms during current events. Fishes ≤ 20 cm are within the size range of fishes likely to prey upon blennies, which reach a maximum size of 8 cm (Hoese and Moore 1998). Lima and Dill (1990) suggested that animals assess the risk of predation and behave in a way that reduces this risk. Thus, a surface current may reduce the abundance of fishes likely to be predators of blennies and provide the blennies with 'enemy free space' (Jefferies and Lawton 1984).

Herein I classify fishes as predators/non-predators of blennies and compare the distribution of blenny predators with the distribution of blennies. Additionally, I relate blenniid activity with the abundance of blenniid predators when surface currents are present or absent.

MATERIALS AND METHODS

Observations of fishes (predator/visitors) and blenny behavior were collected between 0830 and 1300 hrs using SCUBA. Blennies chosen for detailed observations were spatially separated by > 5 m, and all focal blennies were located within 0.5 m of one of the depths listed. Observations at 10 and 15 m were conducted every day during the periods of 24–27 July 1996 and 16–24 July 1997 at East Breaks 165A, a platform located 158 km south of Galveston, Texas, in 116 m of water. One and 5 m observations were conducted on four days between 25 July and 29 August 1998 at or around 7 platforms (South Timbalier 134S, 128R, 151O, 135M, 128X, 151COMP, and 151I) located 50 km south of Fourchon, Louisiana. Platforms are numerous and concentrated within a small area at the Fourchon site (Kasprzak 1998). Depth of these platforms ranged from 30 m (the northernmost platform) to 43 m (the southernmost). Both East Breaks and Fourchon sites have similar blenniid abundance and distribution patterns (Rauch 2003, pers. obs.).

I conducted 10 observations (15 min each) at each of the four depths in 1997 and 1998. Due to logistical constraints, 2 observations in 1997 at the 15 m depth were shortened to 7.8 and 6.4 min. In 1996 a strong surface current limited me to eight observation periods between 10 and 15 m at EB165A.

I used the predator avoidance behavior of blennies, sheltering in barnacle cavities, to classify all fishes larger than adult blennies (those which approached within 1 m of a blenny) as 'predators' or 'non-predators' (Lima and Dill 1990, Hastings 1991). If a blenny retreated into a cavity when a fish approached, the approaching fish was classified as a predator. If a blenny did not retreat into its cavity, the approaching fish was classified as a non-predator. I also categorized the abundance of all fishes which approached within 3 m of the focal blenny as follows: fish species which approached at a rate of between one and four times in a 15 min observation were listed as 'present,' and those that approached at a rate of five or more times were 'numerous.' To avoid errors in identifying damselfishes, all species were grouped as *Stegastes* spp. (Rooker et al. 1997) except for *Abudefduf saxatilis* which could be easily identified by color pattern. Finally, for each depth in 1997 and 1998 I recorded the number of predators/visitors not recorded in a previous observation to ensure adequate sampling.

I used blenniid abundance data from Rauch (2003) for the Fourchon platforms. Blenniid abundance at 5, 10, and 15 m was determined using visual surveys (described in Rauch 2003) in 1997 at East Breaks 165A.

I also classified blenny behavior into one of the following categories: a) in cavity, b) moving outside the cavity, c) feeding, and d) interactions with other blennies. I recorded the activity that the focal blenny was engaged in every five sec throughout each 15 min observation period. I classified water current at the beginning of each observation as follows: a) no current, b) slight current—divers had no trouble swimming against this current, c) strong current—divers had trouble swimming against this current and limited dive time to less than 30 min, and d) very strong current—divers could only swim short distances (< 10 m) against this current and had to be put in the water up-current of the platform and leave the water down-current of the platform.

I used student-*t* tests to compare numbers of blennies at different depths when normality assumptions were satisfied. If the normality assumption was not satisfied, I used a Mann-Whitney (MW) U-test. I grouped blenniid predators by depth and compared their frequency of approach using Chi-square tests of independence (Siegel and Castellan 1988). McNemar's test was used to compare differences in proportions of predator approaches and blenniid behavior (sheltering in cavity or outside of cavity) (Siegel and Castellan 1988).

RESULTS

At the 1 and 5 m depths (Fourchon platforms), 10 species of fishes approached the focal blennies and 4 were considered blenniid predators (Table 1). Blenniid predators outnumbered non-predators in approaches (within 1 m) by 35 to 19.

In 1997, the 10 and 15 m depths (East Breaks platform) were visited by 20 species of fishes, of which 8 were classified as predators (Table 1). Visits (within 1 m) by non-predators of blennies at this site outnumbered predators by 126 to 14. In 1996, predators were so rare during the high current periods that their distribution could not be examined.

In the 1 and 5 m observations combined ($n = 20$), no new species of approaching fishes (both predators and non-predators) were recorded after the 11th observation. In the 10 and 15 m observations (in 1997), no new species of fishes (neither predators nor non-predators) were recorded after the 14th observation. Therefore, there were an adequate number of observation periods.

Blennies were very consistent in their avoidance of predators. In only 2 of 49 cases did a fish categorized as a predator approach within 1 m and not elicit a predator avoidance response by the blenny. In both cases, the predator veered off in another direction before it approached within 0.5 m of the focal blenny.

Species Distribution

No difference was found in the blenniid predator approaches at 1 and 5 m ($\chi^2 = 0.84$, $P = 0.84$) or at 10 and 15 m ($\chi^2 = 6.4$, $P = 0.49$). Because several of the less abundant predators were detected in fewer than five of the observations, these tests lack the desired power (Siegel and Castellan 1988). Therefore, I analyzed each species individually. *Scartella cristata* was more abundant at 1 m (6.75/m^2) than at 5 m (0.16/m^2)(MW U < 0.001, P =

TABLE 1

The number of fishes approaching within 1 m of a focal blenny and number of times the blenny displayed predator avoidance behavior in all observations at the depths listed. Number of 15 min observations (out of 10) that predators/visitors were recorded. Personal observations include observations at these platforms and others that were not part of this project's data collection. Predator/Non-predator classification determined by: *observations at other depths, **stomach content analysis (Randall 1967), ***personal observations.

			Number of times present (numerous in parenthesis)	
	Approaches	**Avoidances**	**Depth 1 m**	**Depth 5 m**
1 and 5 m observations				
(Predators of blennies)				
Lutjanus griseus	25	24	8 (4)	8 (2)
Bodianus rufus	5	4	2	1
Epinephelus adscensionis	2	2	3	5
Caranx fusus	2	2	4	5
(Non-predators of blennies)				
Stegastes sp.	8	0	3 (1)	3
Abudefduf saxatilis	3	0	5	2
Balistes capriscus	1	0	1	1
Kyphosus sectatrix	2	0	2 (10)	0
Chaetodipterus faber	6	0	6	6 (3)
**** Sphyraena barracuda*	0	0	1	1
10 and 15 m observations				
(Predators of blennies)				
Seriola dumerili	2	2	1	3
Seriola rivoliana	8	8	3 (1)	5 (3)
Bodianus rufus	2	2	3	1
Epinephelus adscensionis	1	1	3	2
Lutjanus griseus	1	1	0	1
** Caranx fusus*	0	0	5 (3)	6 (4)
*** Caranx latus*	0	0	1	0
*** Caranx lugubris*	0	0	0	2
(Non-predators of blennies)				
Acanthurus coeruleus	45	0	6	8
Stegastes spp.	13	0	4 (2)	2
Paranthias furcifer	52	0	6 (4)	5 (3)
Kyphosus sectatrix	7	0	4 (1)	2
Abudefduf saxatilis	3	0	2 (1)	0
Carcharhinus falciformis	1	0	4	5
Balistes capriscus	1	0	5	1
Thalassoma bifasciatum	2	0	1	1
Canthigaster rostrata	1	0	0	1
Cantherhines pullus	1	0	1	0
**** Sphyraena barracuda*	0	0	4	4
*** Pomacanthus paru*	0	0	1	0

< 0.0001). *Lutjanus griseus* and *Caranx fusus* had nearly the same abundance at both depths and *Bodianus rufus* was more abundant at the shallower depth. *Epinephelus adscensionis* was slightly more abundant at 5 m but was detected at both depths.

Parablennius marmoreus was more abundant at 15 m (0.63/m^2) than at 10 m (0.29/m^2)(U = 42.5, P = 0.029). Ten and 15 m observations revealed *Seriola dumerili*, *Seriola rivoliana*, *L. griseus*, *C. fusus*, and *Caranx lugubris* were more abundant at 15 m than at 10 m. This distribution is the opposite of that expected if these fishes were limiting the distribution of *P. marmoreus. Bodianus rufus* and *E. adscensionis* were present in nearly equal numbers at the two depths. Only *Caranx latus* was found (one time) at 10 m and not at 15 m. This was the only *C. latus* seen around this platform throughout the data collection period (9 days).

Blenniid Abundance

The abundance of blennies dropped from 12.54/m^2 at 1 m to 7.92/m^2 at 5 m (student-t = 5.96, P = < 0.0001). However, predators (all species combined) did not display an increased frequency of approaches (within 1 m) as depth increased from 1 m (4.88/hr) to 5 m (7.78/hr) (MW U = 29.0, P = 0.123).

The abundance of blennies was higher at 10 m (1.89/m^2) than at 15 m (1.32/m^2)(MW U = 32.0, P = 0.006). However, predators (all species combined) did not approach more frequently at 15 m (3.05/hr) than at 10 m (2.75/hr)(MW U = 48.0, P = 0.912).

"Enemy free space" and currents

All observation periods (n = 1089) in 1996 were classified as 'high current' while all observation periods in 1997 (n = 3488) were classified as 'low current.' The proportion of predator approaches (within 1 m) in the 'high current' year (0.18%) was significantly less than the proportion of predator approaches in the 'low current' year (0.40%) (McNemar's test; x^2 = 1043.8, P < 0.0001).

Blenniid behaviors outside the barnacle cavity included swimming, feeding, patrolling territorial borders, and intra- and interspecific interactions. The focal blennies were outside the barnacle cavity more often in the 'high current' (11.0%) than in the 'low current' (1.7%) events (x^2 = 3083.4, P < 0.0001). The proportion of observations where blennies were feeding was higher in 'high current' (1.6%) than in 'low current' (0.7%) events (x^2 = 1003.0, P < 0.0001).

DISCUSSION

Predator avoidance behavior of blennies was effective in classifying fishes as predators or non-predators, and my classifications were consistent with stomach content analysis (Randall 1967). Additionally, through this research I was able to add species considered blenny predators not recorded by Randall. Fishes recorded around platforms in this study were consistent with the species listed over the last 2 decades (Sonnier et al. 1976, Putt 1982) as well as recently (Bull and Kendall 1994, Rooker et al. 1997, Stanley and Wilson 1997).

The approaches of predators at 1 and 5 m is not consistent with a hypothesis of predators limiting the distribution of *S. cristata* to the upper few meters of the water column. No predators were found at 1 m or 5 m. Observations at 10 and 15 m failed to find any predators with a distribution that could limit the numbers of *P. marmoreus* found at 10 m. Only 2 predators were more common at 15 m, and one, *C. latus*, was observed only once in the 9 d of observations. This lone individual did approach within 3 m of a focal blenny, but rare species are not likely to limit or restrict the distribution of a prey species. Rooker et al. (1997) and Stanley and Wilson (1997, 2000) found that *C. latus* were rare or not present in their observations. *Bodianus rufus* was recorded in three observation periods at 10 m and one at 15 m. Rooker et al. (1997) found *B. rufus* less common at depths < 9 m, a distribution not consistent with the expected distribution if this predator was limiting the distribution of *P. marmoreus*. *Bodianus rufus* are territorial (Hoffman 1983) and additional observations indicated this species consistently frequented parts of the platform that offer some cover (where diagonal and vertical members meet). Such a territorial behavior would limit the potential for this predator to restrict a prey species on areas of the structure that are not a part of its territory. Overall, predation is apparently not important in limiting the distribution of *P. marmoreus*.

The abundance of blennies decreased with increasing depth in both 1 to 5 m and 10 to 15 m observations. However, the number of predators did not increase at these depths. Gallaway and Lewbel (1982) found that the biomass of algae and invertebrates was higher at shallower depths which may limit the numbers of blennies found at greater depths due to lack of prey. Additionally, because blennies shelter and spawn in barnacle cavities, the distribution of barnacle cavities may limit the distribution of blennies (Smith-Vaniz 1980, Rauch 2003).

I found that fishes which produced a predator avoidance response in blennies (predators) were less abundant in observations taken in a current when compared to observations taken in the absence of a current. These fish abundance patterns are consistent with hydroacoustic measurements taken by Stanley and Wilson (1997). When predators were less abundant, the blennies spent more time outside their cavity. The greater proportion of time spent outside of shelters in a 'high current' suggests that these blennies are able to assess the reduced threat of predation (Lima and Dill 1990). The frequency of sheltering behavior supports the hypothesis of currents producing 'enemy free space' which the blennies exploit by increasing their movement out of shelters.

On offshore petroleum platforms, blennies experience a temporally changing risk of predation and would be expected to minimize their risk of predation by feeding at a greater rate in a 'high current.' I found higher feeding rates when fewer predators were present ('high current' periods). Changes in blenny behavior associated with 'enemy free space' would reduce the opportunities for predators to prey upon blennies and thus reduce the potential for predation to affect the distribution and abundance of these blennies. My observations of the distribution and abundance of blenniid predators failed to support a hypothesis that predation is an important biotic interaction in producing the abundance and distribution patterns of blennies around offshore petroleum platforms. Further research should focus on factors restricting the numbers of blennies with increasing depth.

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