Deep Sea Scavenging Fauna in the Northeast Exuma Sound

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Introduction

Depletion of coastal resources has forced large scale commercial fishing operations offshore, putting significant stress on the deep-sea communities (Norse *et al.* 2011). The lack of knowledge regarding life histories of deep-sea fauna has increased the vulnerability of these species to anthropogenic pressures and increased the difficulty of managing deep-sea resources (Bailey *et al.* 2009). Consequently, it has become imperative to study the relatively unexplored deep-sea ecosystem dynamics to gather baseline knowledge regarding faunal abundance, diversity and distribution (Norse *et al.* 2011). Benthic and demersal scavengers form the base of the deep-sea ecosystem and redistribute large forms of detritus through "sloppy feeding" and defecation, making nutrients available to the greater community. (Yeh and Drazen. 2008). This study therefore aims to gather baseline knowledge of the essential niche occupied by mesopelagic scavenging fauna of the north-east Exuma Sound (Figure 1, 2).

Figure 1 – Deep sea scavenging shrimp (*Heterocarpus cutressi*)

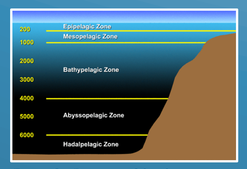

Figure 2 – Diagram of depth zones (www.seasky.org).

Hypothesis

Hypothesis 1 - Species diversity will increase with depth
Hypothesis 2 - Size of individuals increases with depth

Purpose

The purpose of the study is to gather baseline measurements regarding scavenging species, to determine variation in species assemblages among different depths to observe possible patterns in species distribution and to create profiles of drop sites using temperature-depth recorders.

Methods

This study was conducted in the northeast Exuma Sound (Figure 3a). Due to lack of mapping, the continental shelf of the basin was used as a proxy for depth, as seen in figure 3b. A series of 10 rigs were deployed at varying depths for 24-hour periods. These rigs were positioned on transects at increments of 500 meters.

Figure 3a- Map of Cape Eleuthera and Exuma Sound.

Figure 3b – Magnified view of study site, northeast Exuma Sound

Trapping rigs (Figure 4, 5) were composed of approximately 1000 meters of line beginning with a buoy, then a Temperature Depth Recorder (TDR), followed by one rectangular and one cylindrical trap, and terminated by a weight.

Figure 4 – Components of a rig. 100m of line (top left), TDR (top right), Square trap (bottom left), Cylindrical trap (bottom right)

After a 24-hour period, an electric pot hauler was used for the retrieval of the rigs, a process that takes approximately 50 minutes. Specimens were brought back to the lab and frozen prior to processing. Later, each individual was identified; recording the total length, weight, and sex of each individual.

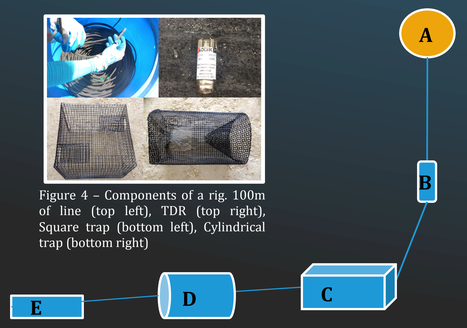

Figure 5 – Diagram of a rig. A: Buoy. B: TDR. C: Rectangular trap. D: Cylindrical trap. E: Weight.

Results

Table 1- Number of individuals within each species caught between different depth zones.

Species	Zone 1 (600 - 760 m)	Zone 2 (>760m)
Bathynomus giganteus	16	62
Bathynomus sp.	40	2
Boorolana tricarinata	141	1
Booralana nov.sp.	53	0
Heterocarpus cutressi.	55	4
Gaza superba	0	1
Myropsis quinquespinosa	1	0
Conger sp.	1	0
Total No. Individuals	306	70
Total No. Species	7	5

Figure 6 - Deep-sea scavenging crab (*Myropsis quinquespinosa*),

Figure 7 –Trap retrieved from 850m capturing a conger eel (*Conger sp.*), giant isopods *Bathynmous giganteus* (3) and scavenging shrimp *Heterocarpus cutressi.* (5).

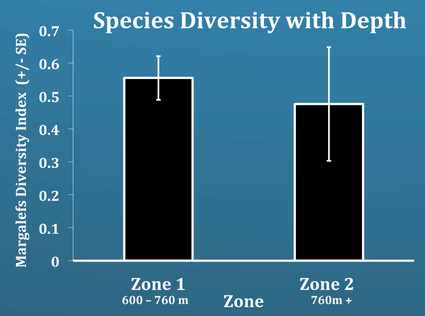

Figure 8 – Species diversity has no statistical change with depth. In zone 1, 600-760 meters, the diversity value was 0.55. In zone 2, >760, the diversity value was 0.47. There was not a statistically significant difference in diversity values between zone 1 (mean= 0.55489135 ± 0.06656515 SE) and zone 2 (mean= 0.47576385 ± 0.1725395 SE) (Wilcoxon test, s=, df= 1 P > 0.05).

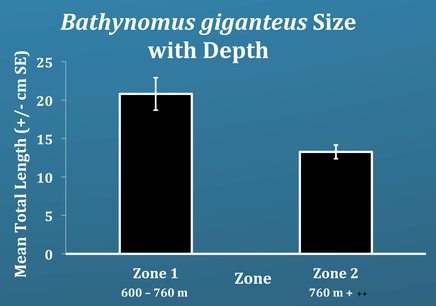

Figure 9 – *Bathynomus giganteus* size over the two depth zones recorded. This shows that species get smaller with depth in the Exuma Sound. In zone 1, 600-760 meters, the mean total length of *B. giganteus* was 20.8 cm. In zone 2, >760meters , the mean total length B. *giganteus* was 13.2cm. There was statistically significant difference in mean total length of between zone 1 (mean = 20.81 ± 2.11 cm S.E.) and zone 2 (mean = 13.26 ± .88 cm S.E.) (Wilcoxon test, s = 539, df = 1, $P < 0.05$).

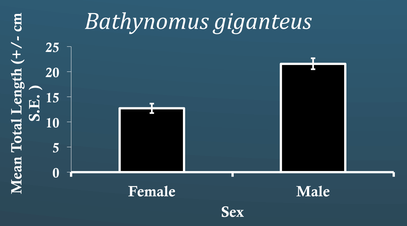

Figure 10 – Mean total lengths of *Bathynomus giganeus* females and males. Female mean total length was 12.7cm and male was 21.6cm. There was a statistically significant difference in mean length between males (mean = 21.57 ± 1.06 cm S.E.) females (mean = 12.73 ± .93 cm S.E.) (Wilcoxon test, s = 1774, df = 1, $P < 0.05$).

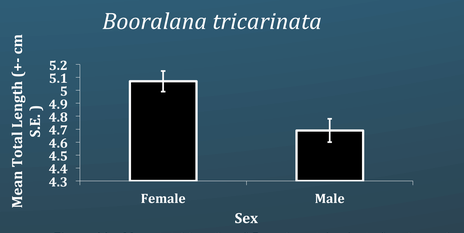

Figure 11 - Mean total lengths of *Booralana tricarinata* females and males. There was a statistically significant difference in mean length between *B. tricarinata* males (mean = 4.69 ± .09 cm S.E.) and females (mean = 5.07 ± .08 cm S.E.) (Wilcoxon test, s = 2293.5, df = 1, $P < 0.05$).

New Species

In this study a new species of *Boorolana* sp. was discovered. The new species, *Boorolana* nov. sp., is not just special because it is new globally, it is also the only type of *Boorolana* sp other than *Boorolana tricarinata* to be found in the Caribbean. The most significant area of difference between these two species is found within the telson. The uropodal exopods (Figure 13) are significantly longer on *Boorolana* nov. sp. compared with *B. tricarinata*. The telson of the new species also has a significantly greater amount of telsonic setae compared to *B. tricarinata.*

Figure 12 – Dorsal view of *Booralana tricarinata* (left) and *Booralana nov. sp.* (right)

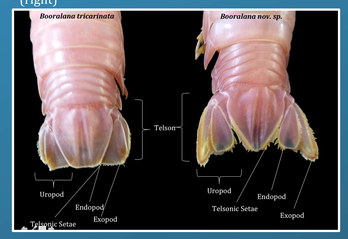

Figure 13 – Magnified dorsal view of *Booralana tricarinata* (left) and *Booralana nov. sp.* (right)

Discussion

Statistical analysis revealed no significant difference in species diversity between zone one (shallow) and zone two (deep) (Figure 8), straying from findings from other geographic locations (Powell *et al.,* 2003). Therefore, results may be due to a lack of data regarding natural regional boundaries.

Previous research suggests that the size of individuals increases with depth, a theory termed 'gigantism'. However, when analyzing the size of *Bathynomus giganteus* (Figure 9), data was not in agreement. This discrepancy among studies demonstrates not only the degree of potential interspecies variation, but also variation among geographic locations.

Morphometric analysis on the two most abundant species, *Booralana tricarinata* and *Bathynomus giganteus*, compared the size of individuals in relation to sex (Figure 10, 11). Female *B. tricarinata* were significantly larger than males whereas female *B.giganteus* were smaller than males. Prior to this study, data regarding these species, of the family *Cirolanidae*, were not extensive enough to illustrate such biological divergence. Future studies may investigate the causes of such sexual dimorphism to further develop a crucial understanding of ecosystem dynamics.

Finally, during this novel deep-water study, a new species of *Booralana* was discovered. This alone validates future studies, but the looming spread of overfishing to these ecosystems is the real driver towards additional investigation. This study provides a unique and critical opportunity where science is ahead of commercial fisheries interests.

Acknowledgements

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