SQUID TALKS: AN OBSERVATIONAL STUDY ON THE VARIOUS BEHAVIORS OF CARIBBEAN REEF SQUID (*SEPIOTEUTHIS SEPIOIDEA*)

Exploring social, defensive and predatory mechanisms exhibited by reef squid of Bermuda through interspecies and intraspecies relationships in both daytime and nighttime settings.

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Abstract The purpose of this study is to use pre-existing research on the reef squid *Sepioteuthis sepioidea* to further refine known behavioral patterns in squid communication. Squid communication involves changes in body color, movement, and documented body positions. This observational study focuses on two different scenarios of squid lifestyle: intraspecies and interspecies signaling. The intraspecies portion studied group dynamics, such as body positions and of color displays, of three different squid pods (5, 8 and 13 squids per pod) and was conducted during the daytime. The interspecies portion, conducted at nighttime examined foraging and predatory behavior of three individual squid. Squid leadership and communication was found to be vital to survival, and offers insight on non-vertebrate communication in other species.

Key Words: Behavior, Communication, Squid

Introduction

The Caribbean reef squid *Sepioteuthis sepiodea* located commonly in the Caribbean, Bermuda, and off the coast of Florida. They are torpedo shaped cephalopods that grow to be around 12-20 cm in length. Their body consists of a mantle (head) that contains their stomach, gills, ink sac, digestive organs and reproductive organs. They have two large eyes, eight short tentacles and two longer tentacles which house suckers to catch prey. Their tentacles are circled around their beaks (mouth). Squid are “daytime schoolers” and travel in schools of other squid their same size (Boom et al. 2001). They tend to travel in pods of 4-30 squid, and remain in shallower waters coupled with reefs. These invertebrates are able to camouflage and communicate with each other by rapidly changing color and body position. Squid are color-blind, so their high display of color is understood through contrast in the group (Messenger 1991). The most common situational body positions include striking prey with their tentacles, flaring their tentacles violently upward in dispute, pointing their heads down when threatened by a predator, and curling their tentacles when informing the group of a change in direction.

The basic coloration of *S. sepiodea* includes a molted green-brown on the dorsal side of their mantle, and a lighter nude coloration on their ventral side: communication is done by controlling the pigment in their skin. They are closer to a dark greenish-brown color when near shallow waters or reef, and change to a lighter-transparent nude color when in open water, to better disguise themselves from predators such as yellowfin groupers. When feeding, *S. sepiodea* use their two larger tentacles as clubs, and then cut their

prey into pieces with their relatively sharp beak. They feed on small surface fish, mollusks and crustaceans.

This study includes data collected from three different beaches located in Bermuda: Tobacco Bay, Shelly Beach, and Whale Bone Bay. Intraspecies communication (signaling) was studied during the daytime, within squid pods that were found in each location previously listed. In a study by Hanlon and Messenger (1988) squid skin components were studied in great detail using photography software, which revealed the intricacy of squid communication. Interspecies communication (predation) was observed at night in Whalebone Bay. The squid behavior captured on video was analyzed and compared to the pre-existing definitions of "squiddish" patterns, a term dubbed by Moynihan and Rodaniche (1982) who were the first to record and interpret body patterns displayed by *S. sepiodea*. While Moynihan focused on both squid coloration patterns and communication within the pod, this study is an extension of mainly squid communication (pattern determination was too difficult to discern clearly on the video footage), and looks at how the leader of the pod (usually the largest) controls the group dynamic, and the chain of reactions (color change, group direction, tentacle flares) that follow.

Squid are unique and fascinating animals, being able to change color, shape and patterns. They provide a strong example of the important role communication plays in survival and growth, and present us with many expandable research opportunities.

Materials and Methods

This study was completely observational, and involved a US divers snorkel gear set, a dive light and a Kodak Sport® underwater video camera. Noise, movement, and other distractions were kept to a minimum, as the purpose of this study was to observe reef squid in their natural habitats. The squid were filmed over the course of five days, and their behaviors and color changes were later analyzed once the recordings were uploaded to the computer. Due to low camera quality, pattern changes on individual squid were not discernible, so pattern changes on the dorsal side of the mantle, other than distinct full body color changes, were not noted in this study.

This study used iMovie®8.0.6., iPhoto®8.1.2. and QuickTime 7.2® (Apple, Inc., Cupertino CA, USA) to edit and analyze the video recordings. The various squid behaviors observed during this study were camouflage postures, defensive postures, inking, basic communication, elusive techniques, resting, and attempted feeding. It was too difficult to notice the color and pattern changes rather than the arm and posture changes, so patterns were not noted, however both are important in contributing to the overall understanding of the multiple levels of communication. Video images described in this paper are located at http://www.youtube.com/watch?v=4VlW9pq-faU&feature=youtu.be.

The reef squid used in this study were found and recorded in three different Bermuda locations: Whalebone Bay, Tobacco Bay and Shelly Bay. Whalebone Bay was the only site that involved night filming. A previous study looking at squid attraction to dive lights noted that predatory behavior was emphasized on the various fish that were also

attracted to the dive lights, as opposed to the fish that were not near the lights. The squid would swim in and out of the lights, and would display agonistic body positions while hunting small prey (Perez, 2006). The filming at Whalebone Bay was in open water that ranged from 0.3-0.9 m deep. The filming at Tobacco Bay was in both reef covered and open water 0.7-1.2 m deep. At Shelly Beach filming was in both reef covered and open water, 0.6- 3.0 m deep.

To get clear footage of the squid, I would follow them for a minute before filming, ensuring that my presence did not cause an initial reaction. After a minute, I would begin filming the squid, by mimicking their actions of hovering near the surface, while using minimal movement to disturb them. After realizing that I was not a threat to them (around 5 min of filming later), the squid would become less interested in my presence, stop swimming around, and finally "relax" by hovering in the water in a single-file line formation, as opposed to the bundled group appearance they form as they swim.

The "plaid" position and "zebra" position were terms given to frequently documented body position and color variation in reef squid (Wood 2003). There are more than 15 documented color change patterns and body positions, but since these two in particular involve color and change in resting body position, they were the easiest to note on film (Moniyahan 1998). Both these positions were witnessed, as noted later.

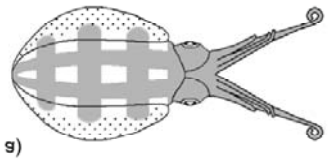

Fig. 1. Plaid body position. The full-V displayed in the arms (Wood, 2003).

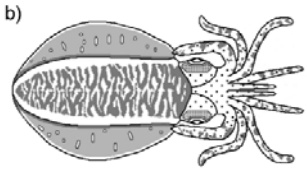

Fig. 2. Zebra position. Notice the change in color and arm position (Wood, 2003).

Results and Discussion

Squid displays often involve color change and arm postures. The following figures are picture clips taken from the videos. The term Plaid (Wood, 2003) is often seen in juveniles as a camouflage technique. It is when the stripes and bars are seen on the mantle, and the arms curl into a full-V position. In the video linked above (3:19 minutes), the plaid body coloration and technique most commonly displayed is seen in the squid pod. It was never displayed by all the squid at once, but rather sporadically down the line of 13 squid. It seemed that one squid would be signaling the rest of the group, then the leader (the largest Squid at the head of the pod) would respond accordingly.

Body coloration was noted only five times during 70 minutes of filming. One squid would often change from plaid to a bright greenish-yellow, and then change right back to the color of the pod.

Fig.3. One squid would change to a bright-greenish yellow color, then change back to its normal coloration. This could be a signal to other squid near it. Only once did one other squid change to the same color, a second after the first squid did, as a type of response. Located at Shelly Bay, Bermuda.

The body position “Zebra” is observed in the video (4:04 minutes). First, one squid (top right) flashes the zebra stance, and then the squid to its left displays the same zebra stance less than a second after. The zebra involves sprawled arms, change in dorsal mantle coloring to a zebra-like pattern, and often is displayed by males as a territorial technique. This was only exemplified once after 40 minutes of following the squid pod at Shelly Beach Bay. It was only seen in two of the squids, and only happened when I moved the camera really close to the squid (almost touching distance).

Squid are active hunters at night. However, in the presence of dive lights, the squid would often freeze in the artificial light, or attack the dive lights. In the video (6:56 minutes) a hunting squid attempts to catch small surface fish, but is unsuccessful. This may be due to the presence of the dive lights. At night, squid were found to be either alone or in pairs, and often were at the surface, hunting, as indicated by their tentacles being constantly raised, exposing their inner beaks. The squid were in this position 85% of the time they were filmed at night. The other 15% they were usually actively swimming, or retreating to the bottom of the ocean floor. Also noted, night-time squid behavior is less active.

Fig. 4. An example of Zebra (Wood, 2003) displayed by the squid on the right at Shelly Beach. Notice color and body position change. This was flashed for one second, then the squid returned to its “resting” position, as is the squid on the left.

Fig. 5. An example of the raised “V” position displayed most often at nighttime, considered to be a predatory stance. The squid would skim along the surface in this position, and snatch little fish easily with its tentacles ready. This was exhibited at Whalebone Bay.

In the video (7:53 minutes), a squid inks when provoked by light and human presence. Inking is a defense technique that allows the squid to confuse its attacker, by releasing a squirt of “ink” into the water, making it murky and harder for the attacker to see. This squid ink is not like the black ink seen in cartoons, where a huge cloud of black liquid envelopes the ocean, but is a cream color, and is a small amount (no bigger than the squid) that allows for a quick distraction.

Fig. 6. A squid inking at nighttime in Whalebone Bay. The ink cloud lasts for a couple of seconds, and is a defensive technique that the squid uses to escape.

In all pods during the daytime filming (2:12, 2:47, 3:35 minutes), there was a distinct leader. In all three pods followed and recorded, each pod had one distinct leader. Male squid are larger than female squid, so for this study it is assumed that in all pods the leader was male. He was distinct because he often swam with his tentacles in the opposite direction of the rest of the group, and was at the head of the school 98% of the time the squid were in the school formation. Notably, when threatened, the leader would often speed into the deeper end of the reef, while the rest of the pod would gather 0.3 meters from the leader, seemingly waiting for him to come back. This appeared to be a diversionary tactic, and the leader would then meet up with the rest of the pod after a bit of quick and jagged swimming (in attempts to lose me/the predator). This was the most interesting behavior, and it was obvious that the leader was communicating with the rest of the pack by putting his tentacles up, and also swimming in the opposite direction. Further studies of the leader independently could also give insight on squid behavior, group dynamics and communication.

Ideally, this study was conducted to study the squid sign language. Can squid converse with one another, and how effective is there means of communication? How does a squid society function? Squid behavior within pods is particularly intriguing since its interesting to see how squid behaviors contrast when there are large numbers of them in one area. A school of squid acts as one unit, often signaling to each other and keeping in constant communication. The leader is easy to identify, as he will usually be facing a direction different from the rest of the pod. At night, they hunt alone or in pairs, and then regroup during the day to swim and pod together. Relatively little is known about squid behavior, but more extensive studies could help clarify unanswered questions. If allowed more time and resources, tagging each squid within one pod, and following that specific pod throughout both day and night settings over an extended period of time would allow for a more in-depth study, and could help to further understand the communicative functions of their movements and postures.

Fig. 7. The leader of the pod is swimming in the opposite direction. He will raise his tentacles, sway in a back and forth motion, then the rest of the group would follow his lead. This was at Tobacco Bay.

Fig. 8. The leader would raise all tentacles, rock back-and-forth, lower his tentacles, then proceed to swim in the direction of his mantle. The entire pod would then re-orient itself to follow.

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Literature Cited

Hanlon, R. T., Hixon, R. F., Forsythe, J. W., & Hendrix Jr, J. P. (1979). Cephalopods attracted to experimental night lights during a saturation dive at St. Croix, US Virgin Islands. *Bulletin of the American Malacological Union* .

LaRoe, E. (1971). The culture and maintenance of the loliginid squids Sepioteuthis sepioidea and Doryteuthis plei. *Marine Biology , 9* (1).

Mather, J., Griebel, U., Byrne, R. (2010). Squid dances: an ethogram of postures and actions of Sepioteuthis sepioidea squid with a muscular hydrostatic system. Marine and Freshwater Behaviour and Physiology 43:1, 45-61.

McKay, K., Wood, J. (1987). Marine Invertebrates of Bermuda, Caribbean Reef Squid (*Sepioteuthis sepioidea*).

Ross, Erin "Cephalopod Intelligence." *Reef Squid*. Ecology of Atlantic Shores, 2010. Web. 04 Nov. 2012. <http://www.clarku.edu/departments/biology/biol201/2010/erross/reefsquid.html>

Wood, J., Byrne, R. A., Griebel, U., & Mather, J. A. (2003). Squid say it with skin: A graphic model for skin in caribbean reef squid. *Berliner Palaeobiol , 03*, 029-035.