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Dietary Shifts in the Queen Triggerfish, *Balistes vetula,* in the Absence of its Primary Food Item, *Diadema antillarum*

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With 2 tables

Key words: Queen triggerfish, *Diadema,* mass mortality, diet, dietary shift, Caribbean.

Abstract. The long-spined sea urchin *Diadema antillarum* has been reported to be the major food item of the queen triggerfish, *Balistes vetula* in the Caribbean. This sea urchin has undergone a massive mortality on reefs throughout the Caribbean during 1983. The dietary habits of twenty-three queen triggerfish from patch reef habitats in Belize were examined. It was found that crabs and chitons now form the major dietary items when *D. antillarum* is not available. It is suggested that this predator, which was previously specialized on a single food item, is able to shift resource utilization in the absence of its primary food source, and that the queen triggerfish can capture diverse prey from a wide variety of habitats.

Problem

The queen triggerfish, *Balistes vetula* LINNAEUS, is a common Caribbean reef fish noted for the predominance of echinoids in its diet. RANDALL (1967) reported that 72.8 % by volume of stomach contents of 95 specimens of *B. vetula* examined were echinoids. The principal item in the diet of these fish is the long-spined sea urchin, *Diadema antillarum* PHILIPPI (RANDALL *et al.,* 1964; RANDALL, 1967), of which the spines and test are eaten along with the soft tissue.

It has recently been reported that in various localities throughout the Caribbean Sea, populations of *D. antillarum* have suffered mass mortalities (LESSIOS *et al.,* 1983). *Diadema antillarum* was formerly the most abundant echinoid in shallow water (RANDALL *et al.,* 1964). Current population densities are approximately 2 % of their original levels. This mass mortality has also been found in Belize, Central America, with a similar density reduction (LEWIS & RÜTZLER, pers. comm.). However, the effect on *B. vetula* of the die-off of its principal food item, is not known. In order to determine the dietary shift of a specialized predator in the absence of its preferred food resource, we examined stomach contents of *B. vetula.* Here we present the principal dietary items of *B. vetula* from a patch reef habitat in which *D. antillarum* was absent.

Material and Methods

The study was conducted at the Smithsonian Institution laboratory on Carrie Bow Cay, Belize, Central America (16°48′N, 88°05′W) in November, 1983. Twenty-three individuals of the queen triggerfish *B. vetula* were collected by spearing, from a shallow patch reef habitat where *D. antillarum* had previously been very abundant (RÜTZLER & MACINTYRE, 1982). The mass mortality of the *D. antillarum* occurred in this area sometime between July and October 1983, reducing the population to $\leqslant 1$ individual per $10\,m^2$. Individual fish ranged from 155 mm to 300 mm standard length (mean 218 mm). Stomachs were immediately dissected out of the fish after collection. The contents were rinsed in seawater and sorted to major taxonomic groups under a dissecting microscope. The contents of individual stomachs were combined and total volume for each category was estimated by water displacement. Each group was then sorted to the lowest possible taxon.

Results

Table 1 presents the proportion of the pooled stomach contents by major food categories. Table 2 presents the major taxa comprising each category. These results show the importance of crabs and chitons as food items of *B. vetula* in the absence of *Diadema*. The major food items represent organisms from a broad range of habitats, ranging from sand and seagrass beds to coral rubble.

Table 1. *Balistes vetula* collected November, 1983, from a patch reef habitat near Carrie Bow Cay, Belize: Stomach contents by volume.

Category	%
Crabs	48.4
Chitons	11.1
Polychaetes	4.4
Echinoids	4.2
Stomatopods	1.8
Fish remains	1.2
Bivalves	0.9
Sipunculans	0.4
Shrimps	0.3
Ophiuroids	0.2
Gastropods	0.2
Amphipods/Isopods	0.2
Scaphopods	0.1
Animal remains	26.7
Total	100.1

Discussion

Previous studies (RANDALL *et al.*, 1964; RANDALL, 1967) indicated the importance of *D. antillarum* as the major food item for the queen triggerfish, *B. vetula*, accounting for 72.8 % of the volume of its diet. Given the lack of this echinoid in the habitat examined, we expected one of two possible patterns to emerge. First, the triggerfish could be adversely affected by the absence of its primary food source, but the overall condition of the fish and full stomachs indicated that this was not the case. In the absence of the echinoid we could then expect other

Table 2. Major organisms consumed by *Balistes vetula,* at Carrie Bow Cay, Belize, during November, 1983. Estimates of minimum number of individuals in pooled stomach contents is given in parentheses.

Crabs[1]
- *Pitho* spp. (55) (mostly *P. anisodon* and *P. aculeata*)
- *Mithrax* spp. (45) (mostly *M. forceps* and *M. coryphe*)
- Xanthids (12) (including *Eriphia* sp.)
- Porcellanids
- Portunids (2)
- *Dardanus venosus* (1)
- *Ebalia* sp. (1)
- Unidentified hermit crabs (10)

Chitons[2]
- *Ischnochiton erythronotus* (170)
- *Acanthochiton* sp. (13)
- *Acanthochiton* cf. *pygmaea* (11)
- Unidentified chitons (3)

Polychaetes
- *Diopatra* sp. (5)
- *Glycera* sp. (4)
- *Neanthes* (4)
- *Nereis* sp. (4)
- *Onuphis* sp. (4)
- *Arabella* sp. (1)
- *Cistenides gouldii* (1)
- *Dasybranchus* sp. (1)
- *Eunice schemacephala* (1)
- *Lumbrineris* sp. (1)
- *Lysidice* sp. (1)
- Maldanids (several fragments)
- Nephthyid (1)
- *Palola sicilensis* (1)
- *Platynereis* sp. (1)
- *Psammolyce* sp. (1)

Echinoids[3]
- *Diadema antillarum* (1)
- *Echinometra lucunter* (1)
- *Echinoneus cyclostomus* (1)
- *Eucidaris tribuloides* (1)

Stomatopods
- *Gonodactylus oerstedii* (12)

Bivalves
- *Barbatia* sp. (4)
- *Chama* sp. (3)
- *Cardium* sp. (1)
- *Isognomon* sp. (1)
- *Lima* sp. (1)
- *Lithophaga* sp. (1)

Sipunculans
- Unidentified (9)

Shrimps[4]
- Alpheids (29)

Ophiuroids
- *Ophiocoma echinata* (1)

Gastropods
- *Acmaea* sp. (7)
- Buccinid (3)
- *Bulla striata* (3)
- *Cerithiopsis* sp. (2)
- *Hipponix* sp. (2)
- *Lucapina eolis* (2)
- *Tegula* sp. (2)
- *Cerithium eburneum* (1)
- *Rissoina* sp. (1)
- *Strombiformis* sp. (1)
- *Triphora* sp. (1)

Amphipods/Isopods/Tanaids
- Unidentified amphipods (26)
- *Bagatus algicola* (2)
- *Excorallana tricornis* (2)
- *Cirolana* sp. (1)
- Sphaeromatid (1)
- Unidentified tanaidacean (1)

Scaphopods
- *Dentalium* sp. (5)

[1] Individuals estimated by counts of left or right chelae, whichever being higher.
[2] Individuals estimated by counts of whole animals plus head valves.
[3] *Eucidaris* spines accounted for most of the volume; the single specimen of *D. antillarum* was a juvenile, test diameter 2 mm.
[4] Individuals counted by large chelae.

food items to increase proportionately. Crabs were previously noted to be the second most common item (5.4 %) in the triggerfish diet (RANDALL, 1967) and they became the most important item in this study (48.4 %). However, chitons, previously one of the least common items (0.1 %), became the second most important food item (11.1 %). Bivalve molluscs were found to be the third most common item (4.6 %) by RANDALL (1967), but we found bivalves to make up only 0.9 % of the diet. Overall, the *B. vetula* collected in Belize appeared to be as wide-ranging and omnivorous in their predation as were the fishes examined by RANDALL (1967) but showed a marked shift in dietary emphasis.

The observed diet of *B. vetula* indicates a wide range of foraging behaviours in several distinct habitat types. The items in the food list represent at least three different methods of food capture, in addition to the simple snatching up of mobile animals exposed on substrate surfaces.

Members of the family *Balistidae* have been known to possess an elaborate behavioural mechanism for feeding on *Diadema* (FRICKE, 1971, 1975). By blowing a stream of water against an urchin, *Pseudobalistes fuscus* (BLOCH) in the Red Sea is able to turn it upside-down, exposing the vulnerable underside. Many of the polychaetes (K. FAUCHALD, pers. comm.), the scaphopods, and the *Ebalia* crab, are sand-dwellers (especially coarse sand in seagrass beds). The queen triggerfish, therefore, probably uses some water-blowing technique to expose these animals. Water-blowing into sand has been observed in the queen triggerfish and the hogfish, *Lachnolaimus maximus* (P. REINTHAL, pers. obs.).

The inclusion of chitons, *Chama* sp., and *Acmaea* sp. in the diet suggests that *B. vetula* is able to remove molluscs that cling to the rocky surfaces. In the case of the chitons, the majority of the animals were in the adult size range.

The echinoid *Echinoneus cyclostomus* normally lives under rocks (P. KIER, pers. comm.), which suggests that the queen triggerfish has the ability to move rocks and thus expose the undersides. The authors have observed *B. vetula* picking up pieces of coral rubble, dropping these some distance from the original site, and feeding on the exposed animals. All the stomatopods were *Gonodactylus oerstedii,* the most common species found in rubble-seagrass substrates (R. MANNING, pers. comm.).

The die-off of *D. antillarum* may also be affecting the diet of other species of fish. HOFFMAN & ROBERTSON (1983), in a study conducted off the Caribbean coast of Panama, show that *D. antillarum* forms the major food item for two toadfishes *(Batrachoididae), Amphichthys cryptocentrus* and *Sanopus barbatus.* They estimate that *A. cryptocentrus* could consume 20,000 urchins/ha/year. RANDALL (1967) reports a number of other fish which consume *Diadema,* including certain labrid and pomadasyid species (RANDALL *et al.,* 1964; RANDALL, 1967). Information is needed about the effects of the *Diadema* die-off on these other predators and monitoring of *B. vetula* populations to determine the long-term effects and dietary habits during the *Diadema* recovery.

Summary

Populations of the long-spined sea urchin *Diadema antillarum* have been reported to be dying off through-out the Caribbean, with densities of 2 % of

original levels being frequent. It has been reported that this sea urchin forms up to 72 % of the diet of the queen triggerfish. Examination of the stomach contents of 23 queen triggerfish from Carrie Bow Cay, Belize, from an area previously well populated with *D. antillarum,* has revealed a shift in the diet. Crabs and chitons are now the major food items, with bivalve, scaphopod, and gastropod molluscs, polychaetes, sipunculans, shrimps, hermit crabs, isopods and amphipods, and echinoid and ophiuroid echinoderms all contributing to the diet.

The queen triggerfish probably uses some water-blowing techniques to capture sand-dwelling animals, as well as being able to remove organisms from rocky surfaces, and to move rubble to capture underlying exposed animals.

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Announcement

Advanced Phytoplankton Course: Taxonomy and Systematics

A phytoplankton course for experienced participants will be offered by the 'Stazione Zoologica di Napoli', Italy, in conjunction with faculty members of the Universities of Oslo and Bergen, Norway, and Department of Natural Resources Florida, U. S. A.

The course to be given in Naples, will have a duration of 3 weeks (1–21 July, 1985). Participation will be limited to 15 candidates with a PhD, Masterial MSc or BSc degree or equivalent, and with experience in phytoplankton work (species identification, cell enumeration by microscopy). The program will consist of training in identification of marine planktonic algae, with emphasis on use of taxonomic literature and light microscopy.

Address enquires and request for application forms to Dr. CARMELO R. TOMAS, Head of Marine Botany Laboratory, Stazione Zoologica, Villa Comunale, I - 80121 Naples, Italy.

Deadline for applications is 1st January, 1985.