Queen Conch Predators: Not a Roadblock to Mariculture

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ABSTRACT

The many queen conch *(Strombus gigas)* predators known use different attack methods. Some predatory gastropods enter the conch shell through the aperture. Certain crabs and the spiny lobster peel open the conch's lip. Some animals crush the conch shell while others resort to drilling it or just pull the conch out of the shell. More than one attack method may be used by the same predator, and several animals may attack the same conch simultaneously. The number of conch predator species decreases with increasing conch shell length suggesting that the best size to release hatchery-reared conchs is as large as possible, which is not economically practical. The suggested size of release is between 10-15 cm, because there appears to be a considerable decrease in predation mortality after this size range is reached. Also, since there appears to be a seasonal component in the predation rates of some conch predators, it may be best to release conchs during the winter months, when some predators feed less intensively. Another measure that could reduce certain types of predation is to release conchs over a large rather than a small area. We believe that if these measures are taken the effects of predators will be greatly reduced.

Mariculture of the queen conch, *Strombus gigas*, has been advocated as the result of the decline of stocks throughout the Caribbean due to overfishing (Brownell, 1977). Recent developments in hatchery techniques make possible the raising of many conch larvae from the egg through metamorphosis to juveniles. It has been proposed that hatchery-reared juveniles could be seeded on natural grassbeds, for re-establishing and/or replenishing natural conch populations (Brownell et al., 1977). However, an essential consideration of such seeding programs would be to determine the impact of natural predators on these released conchs. In nature, high predation especially of small conchs gives incentive for extensive mariculture. The objectives of this study were, (1) to identify as many conch predators as possible, (2) to determine the extent of predation carried out by some of these and (3) to suggest areas and optimum size and time of year to release hatchery-reared juvenile conchs so as to increase their chances of survival.

METHODS

Predation experiments were carried out in indoor glass aquaria, outdoor tanks and field enclosures, in which known or potential conch predators were confined with several conchs of different shell lengths for periods of up to 1 year. The purpose of these experiments was to determine predation rates, defined as the number of conchs consumed/predator/unit-time. Also the size range of conch eaten and any preference in conch size eaten were determined. Laboratory work was carried out at the Rosenstiel School of Marine and Atmospheric Science of the University of Miami, and field experiments and observations were made in the Berry Islands, Bahamas.

RESULTS AND DISCUSSION

Methods of Attack

Many conch predators, ranging from molluscs to reptiles, are known (Table 1), mostly based on the early work of Randall (1964) in the U.S. Virgin Islands. Different attack methods are used by these animals. Some predatory gastropods, such as tulip snails *(Fasciolaria tulipa)*, lamp shells *(Xancus angulatus)* and horse conchs *(Pleuroploca gigantea)* enter the conch shell through its aperture to feed on the soft tissues by rasping, using their radulae. More than one attacker may be involved, possibly attracted by some chemical from the prey. Another attack method is that used by box crabs of the genus *Calappa*, which make use of a special adaptation on their crusher claws to peel the lip of a conch's shell in a characteristic spiral pattern, much in the way a can opener would do. The spiny lobster *(Panulirus argus)* also peels conch shells, but it makes a characteristic hole on the body whorl.

Some predators crush conchs, and shell fragments are common in shallow waters of the Berry Islands and other areas of the Caribbean. Loggerhead turtles *(Caretta caretta)*, spotted eagle rays *(Aetobatus narinari)* and hogfishes *(Lachnolaimus maximus)* use their powerful mandibles and specialized dentition, and stone crabs *(Menippe mercenaria)* and coral crabs *(Carpilius coralinus)* use their strong claws to crush even quite large conchs (about 15 cm). These crabs are also capable of forcefully extracting conchs from their shells. Groupers of the genus *Epinephelus* have been observed to pull conchs out of their shells in Bahamian waters by Mr. Benjamin Rose of Freeport (Pers. comm.). Finally, octopods *(Octopus vulgaris)* and muricid snails *(Murex* spp.) may resort to drilling the shells of conchs, but the latter can also forcefully enter through the aperture.

In the laboratory and in the field we have observed more than one predator attacking simultaneously a single conch, as is the case with tulip snails, horse conchs and giant hermit crabs *(Petrochirus diogenes)*. Also, the attackers may not be of the same species: on one occasion at Cat Cay, Berry Islands, five muricid snails and one tulip snail were found feeding on one conch. More than one attack method may be used by some predators, such as the giant hermit crab, commonly found inhabiting conch shells. It can crush small conchs or remove large ones by inserting its claws into the conchs' aperture and pulling out the conch. On several occasions both in the laboratory and in the field, two and three hermit crabs were observed doing this.

Table 1. Common and scientific names of known predators of queen conch (conch size range consumed by predators in cm).

Common Name	Scientific Name	Common Name	Scientific Name
Common octopus	*Octopus vulgaris*	Horse conch (3.0-23.0)	*Pleuroploca gigantea*
Lamp shell	*Xancus angulatus*	Nassau grouper	*Epinephelus striatus*
Tulip snail (3.0-18.0)	*Fasciolaria tulipa*	Mutton snapper	*Lutjanus analis*
Apple murex	*Murex pomum*	Dog snapper	*Lutjanus joco*
Hermit crab	*Paguristes grayi*	Gray snapper	*Lutjanus griseus*
Giant hermit crab (3.0-20.0)	*Petrochirus diogenes*	Graysby	*Petrometodon cruentata*
Coral crab	*Carpilius corallinus*	Yellowtail snapper	*Ocyurus chrysurus*
Stone crab (3.0-12.0)	*Menippe mercenaria*	White grunt	*Haemulon plumieri*
Yellow box crab (1.0-5.5)	*Calappa gallus*	Bluestripped grunt	*Haemulon sciurus*
Blue crab	*Callinectes sapidus*	Permit	*Trachinotus falcatus*
Spiny lobster	*Panulirus argus*	Hogfish	*Lachnolaimus maximus*
Tiger shark	*Galeocerdo cuvieri*	Queen triggerfish	*Balistes vetula*
Spotted Eagle Ray	*Aetobatus narinari*	Porcupinefish	*Diodon hystrix*
		Loggerhead turtle	*Caretta caretta*

Table 2 lists some potential conch predators, including those crab and fish families which are known to feed by crushing hard-shelled prey. The cushion star *(Oreaster reticulatus)* has been reported to have the physical capability of digesting large pieces of flesh, and has been observed feeding on fish chunks in aquariums (Anderson, 1978). However, results from our experiments suggest that the role of this sea star is more that of a scavenger rather than an active conch predator. Our results suggest this is also the case with some *Murex* species.

Table 2. Potential Predators of Queen Conch.

Common Name	Scientific Name	Common Name	Scientific Name
Tritons	*Cymatium spp.*	Xanthid crabs	*Xanthidae*
Crown conchs	*Melongena spp.*	Box crabs	*Calappidae*
Whelks	*Busycon spp.*	Spider crabs	*Majidae*
Cone shells	*Conus spp.*	Red-tipped bristle worm	*Chloeia viridis*
Moon shells	*Natica spp.*	Green bristle worm	*Hermodice carunculata*
Moon shells	*Polinices spp.*	Cushion star	*Oreaster reticulatus*
Trumpet shell	*Charonia variegata*	Nurse shark	*Ginglymostoma cirratum*
Snapping shrimps	*Alphaeus spp.*	Snake eels	*Ophichthidae*
Mantis shrimps	*Squilla spp.*	Seabasses	*Serranidae*
False squillas	*Pseudosquilla spp.*	Flounders	*Pleuronectidae*
Swollen-claw squillas	*Gonodactylus spp.*	Puffers	*Tetraodontidae*
Scaly-tailed squillas	*Lysiosquilla spp.*	Porcupinefishes	*Diodontidae*
Bar-eyed hermit crabs	*Dardanus spp.*	Triggerfishes	*Balistidae*
Thumb-clawed hermit crab	*Pagurus spp.*		

Predator-Prey Size Relationships

Table 1 lists the range of conch sizes consumed by some predators, as determined from our experiments. Within these ranges certain sizes were more often consumed than others, indicating a particular preferred size of prey. This is a common pattern of prey utilization among predators in general. In addition, with most species preying on conch we found that prey size increases with predator size, with the minimum, maximum and mean size of conch consumed all increasing with increasing predator size.

For predators in general, some optimal prey size exists (Stein and Magnuson, 1976), based on the time and the energetic benefit obtained in return (Krebs, 1978). There is a point during the growth of many prey species in which they surpass the ability of some of their predators to consume them; these prey species then attain a size after which they are no longer vulnerable to some of their smaller species of predators, and in this way attain refuge in size (Paine, 1976). From our experiments it appears that there is a marked decrease in the number of conch predator species once the conch reaches a size range of 10-15 cm in shell length. This size-limited predation can have an important effect on a prey population such as conchs, because it provides a refuge for a portion of the population.

Seasonal Variation In Predation

Our experimental results suggest that there are seasonal variations in the intensity of predation, and that this variation, at least with some predators, is related to water temperature, with the highest levels of predation occurring during the summer months and lowest during the winter months. Temperature is well documented in the literature as the environmental factor most responsible for increasing feeding rates due to the increase in metabolic expenditure (Newell and Kofoed, 1977). The implication for mariculture is clear: the best time to release hatchery-reared conch juveniles is during the winter months, when it appears some of its predators feed less intensively.

Predation and Prey Abundance

It was apparent with some conch predators that the number of conchs eaten depends on the number of conchs available to them, that is, as more conchs were available, the predation rates increased. This is a well known predator-prey functional response: when the prey abundance is low, the predator does not learn to search efficiently and recognize the prey. When the prey reaches a certain density the predator may encounter it often enough so that it learns how to capture and handle that prey (McNaughton and Wolf, 1979). Again, the implication for conch mariculture is clear: if prey animals such as conchs are not very abundant, then the chances for a predator to find and consume them are less than if the prey density is higher.

ACKNOWLEDGMENTS

The authors wish to thank Wallace Groves of Freeport, Bahamas, for its financial support, and also the many persons who participated during the Berry Islands field trips.

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