ABSTRACT

The predation behavior of *Thais haemastoma floridana* on bivalve *Crassotrea rhizophorae* under laboratory conditions was studied. Adult samples of the predator and its prey were collected at the Vizinho Beach (03º42'46"S; 38°27'85"W), Fortaleza, Ceará State. In laboratory, 40 thaidids were placed individually in 5-liter aquariums and after 10 days of alimentary abstinence an oyster was added in each aquarium. Each observation period lasted approximately 48 hours. The predator perception to the presence of the prey was immediate. The predator, when going on top of the prey, selects a place for the attack that is, in general, distant from the umbus and close to the shell border. The handling time lasted approximately 35 hours. 500 consumed oyster shells were analyzed considering the shell perforations. Four different kinds of perforation were observed on the right valve of the oysters: complete circular perforation (CCP); complete half-moonlike perforation (CHP); complete irregular perforation (CIP) and incomplete perforation (IP). The "CHP" was the most frequent one during the experiments. Complete circular perforations with irregular borders were also common. In most of the cases, the chosen area was the lateral region, always in points distant from the umbus and close to the shell border. The predation under oysters without drilling them was observed when these were offered cemented to each other and supplied the predator with a supporting point. The choice of the predation strategy could be influenced by several factors, such as physiological and protection conditions of the prey, the tidal period and local hydrodynamism.

INTRODUCTION

The knowledge of prey-predator relationship is important to understand the distribution, zonation and diversity of rocky shores intertidal species.

Carnivorous gastropods are very common in the rocky shores intertidal zones and their alimentary habits have been widely studied (Menge, 1976; Ingham & Zinschke, 1977; Bayne & Scullard, 1978; Garrity &
Levings, 1981; Jillson, 1981; Menge & Lubchenko, 1981; Broom, 1982; 1983; Spight, 1982). Among these molluscs, the muricaceans possess proboscis and radula specialization to drill a circular hole through the prey shells (Fretter & Graham, 1962). Some species have an accessory-boring organ, which produces acid secretions to facilitate this process (Carriker, 1981).

*Thais haemastoma floridana* is an important predator in the Brazilian rocky shores intertidal zones. This snail is very skilled to select and acquire its prey (Duarte, 1996).

According to Duarte & Holler (1987), the kind and the size of the species can be decisive to the *Thais haemastoma* prey selection, considering that it preys many different organisms, such as *Perna perna* (bivalve), *Balanus solisianus* (barnacle), *Chthamalus bisinuatus* (barnacle) and *Phragmatopoma lapidosa* (polychaets). Matthews & Matthews-Cascon (1987) observed *Thais haemastoma floridana* predation on *Crassotrea rhizophorae* under natural conditions. Rocha et al. (1997) studied the alimentary habits and growth of *Thais haemastoma floridana* juvenils, in laboratory.
The knowledge of the alimentary ecology of this gastropod assumes a great importance due to many of their preys being commercially explored bivalves. In mussel and oyster cultures, they enter the cages as larvae and prey cultivated organisms causing great damages to the producer. Pereira et al. (1988) described the impact of *Thais haemastoma* attacks on cultivated *Crassostrea brasiliana*.

The present study describes *Thais haemastoma floridana* predation strategies on the bivalve *Crassotrea rhizophorae* under laboratory conditions.

**MATERIAL AND METHODS**

Adults of *Thais haemastoma floridana* and *Crassostrea rhizophorae* were collected at Vizinho Beach (03°42'46"S; 38°27'85"W), Fortaleza, Ceara State, Brazil.

Thaidids were placed in a 25 liter aquarium for 5 days for acclimatization. After that, they were individually transferred to ten 5 liter aquariums and maintained in alimentary abstinence for 10 days.

Predation experiments were accomplished in the same aquariums of the alimentary abstinence. In each aquarium, containing a predator, an oyster was placed. Each observation period lasted approximately 48 hours, having been observed (1) perception; (2) approach; (3) selection of the place to be attacked; (4) manipulation and (5) ingestion.

The 500 consumed oysters shells were analyzed considering the shell perforations.

**RESULTS**

**Predation strategy**

*Thais haemastoma floridana* noticed the immediate presence of the prey inside the aquarium. The approach occurred around 30 minutes to 1 hour after the preys were offered. Frequently the predator didn't go straight to the prey, but strolled the bottom and the aquarium walls before the attack. During this period, siphon and tentacles movements were observed.

The predator in contact with the prey employed receptors on the propodium to confirm the presence of the prey. Snails often raised the anterior part of the foot "standing" on the posterior tip of it. The predator explored the oyster surface, searching areas ideal for penetration (Figure 1a). This exploration ranged from a few minutes to half an hour. During the search the proboscis was extended intermittently towards the shell surface. After the attack site was selected, the predator swung the propodium back and forth and tried to rotate the right valve of the prey. Thereafter the posterior part of the foot remained firmly attached to the shell in the same position. The anterior part of the propodium was then retracted deeply and the lateral propodial ridges were over-folded, forming a fleshy tube over the borehole site down which the proboscis was extended. Sometimes, the predator abandoned this boring site and restarted the selection in another site for its attack. Frequently, oysters with more than one borehole were observed, however only one of them was complete.

During the penetration, the predator did not move, sometimes accomplishing slow pressure movements. The predator liberated great amount of transparent mucus during this process. The proboscis activity was not possible to observe, once the predator expanded the lateral borders of the propodium totally involving the oyster surface.

The penetration in the shell involved a cyclical interaction of proboscis, propodium and accessory boring organ (ABO). The predator extended its proboscis and began the process of ingestion of the prey when the perforation was completed.

The handling time of *Thais haemastoma floridana* was around 35 hours under experimental conditions.

A significant number of oysters (30,6%) were consumed without penetration. In these cases, the predator forced the lateral borders of the valves to
separate them. This predation method was common when some supporting points existed for the predator, as when the oysters were cemented to each other.

**Prey shell perforations analysis**

For the perforations analysis, 500 consumed oysters during all the experiment stages were observed. Boreholes were observed in 69.4% of the prey shells. The number of perforations reached up to 4, however, in most of the cases, they presented only one perforation (60.6%).

When the oysters were cemented to each other, 63% were perforated. When they were offered separately, 73% presented boreholes. This result shows that perforation is the most common way to consume prey under laboratory conditions. There is a predator tendency to force the borders of the prey shells when a support point exists.

Four perforation types were observed on the right valve of oysters: complete circular perforation (CCP) (Figure 1b); complete half-moonlike perforation (CHP) (Figure 1c); complete irregular perforation (CIP) and incomplete perforation (IP) (Figure 1d). The "CHP" presents semicircular format, being located on the margin of the oyster valve. This type was the most frequent one during the experiments (62.3%). Complete circular perforations with irregular borders on the shell border were also common (30.5%) (Figure 2).

Considering the borehole site, three areas in the right valve surface were attacked: ventral, lateral and central regions. In most of the cases, the chosen area was the lateral (63.2%), followed by the ventral region (36.2%), always in points distant from the umbus and close to the shell border (Figure 3).

![Figure 3. Preferential areas on the oyster shells to perforation by Thais haemastoma floridana during laboratory experiments.](image)

**DISCUSSION**

*Thais haemastoma floridana* presented predatory behavior very similar to other muricaceans species (Carriker, 1981; Duarte & Holler, 1987; Palmer, 1990).

Prey selection by predators could be influenced by many factors, including detectability, ease of capture, nutrient or energy content, time required to process the prey and time required for non-predatory behavior (Hughes & Dunkin, 1984). According to optimal foraging theory, animals will select diets that maximize the energy assimilated per unit of metabolic cost, including all costs of handling the food from its

![Figure 2. Perforation types by Thais haemastoma floridana on the oyster shells during laboratory experiments.](image)
Predatory Behavior of "Thais haemastoma floridana" (CONRAD, 1837) (Mollusca) in Laboratory pursuit, capture and ingestion to digestion (Krebs, 1977; Pyke et al., 1977; Hughes, 1980; Townsend & Hughes, 1981); Crawley & Krebs, 1992). Therefore, the attack method and ingestion of prey are also important to obtain significant energy.

The fast answer to the presence of the prey inside the aquarium indicates that Thais haemastoma floridana, like most predatory gastropods (Hughes & Dunkin, 1984), detects its prey by olfaction and by touch. The predator can detect metabolites solutions released by the living organisms. Some of these chemicals serve as signals which provide critical sensory information and mediate the interactions of predator and its prey (Carriker & Van Zandt, 1972). Experimentation on other carnivorous Neogastropoda and on Mesogastropoda suggests that the osphadium may play a primary role in distance perception (Alexander, 1970). Carriker & Van Zandt (op. cit.) also observed in Urosalpinx cinerea the same tentacles and siphon movements of Thais haemastoma floridana, which frequently also raise the anterior part of the foot and extends the propodium.

According to Hughes (1986), the handling time (pursuit, attack, ingestion, digestion) varies with size and thickness of prey shells. The handling time of adults of Thais haemastoma floridana was smaller than juveniles (Rocha et al., 1997) which spent around 41.5 hours to eat oysters completely.

The exploration time Thais haemastoma floridana to selected the attack site is plenty variable. According to Carriker & Van Zandt (1972) what determines the specific site of attack has not been ascertained. Nicella lapillus inspected individuals Mytilus edulis usually over than 1 hour before deciding to attack or not (Hughes & Dunkin, 1984). Prey inspection before acceptance or rejection has been recorded also for Morula granulata (Wu, 1965) and Urosalpinx cinerea (Carriker & Van Zandt, 1972) feeding on bivalves and for Achantina puntulata feeding littorinids (Menge, 1974). Selection of the penetration site is known for several muricaceans and naticaceans. In most of the cases, borehole location corresponds to the thinnest part of the shell in Venus striatula feeding Natica alderi (Ansell, 1960), to the position of the underlying gonad in Macoma balthica feeding Natica alderi (Verlaine, 1936) and to the position of the gonad and digestive gland in Pateloidea alticosta feeding Dicathais aegrota (Black, 1978). Speed of access to, or ingestion of, energy-enriched tissue did not seem to explain borehole site in other cases (Hughes & Dunkin, 1984). Achantina punctulata drilled the thickest part of the shells of Littorina spp., but this may have reflected a strategy of covering the shell aperture and of quickly attacking the columellar muscle, so incapacitating prey (Menge, 1974). In this study, Thais haemastoma floridana drilled mainly the lateral and ventral area of the oysters shells, always on a point distant from umbus and close to the shell border. Probably, these are little resistance areas, more distant from the hinge and adductor muscle, responsible for maintaining the valves closed.

Matthews & Matthews-Cascon (1987) observed predation strategy of Thais haemastoma floridana, in natural conditions, and verified that these animals consume oysters forcing the valves and shell aperture without drilling them. This strategy was observed when these were offered cemented to each other in laboratory, supplying the predator when a supporting point existed. In laboratory, it was not registered the handling time of Thais haemastoma floridana when this opened the oysters without perforation. According to Matthews & Matthews-Cascon (1987), under natural conditions this process can take about 25 minutes, being constituted in a faster predation method than the penetration process. Considering these authors' observations, it is believed that even under
natural conditions, the penetration is the most used method. The choice of which predation strategy to use could be influenced by several factors, such as physiological and protection conditions of the prey, the tidal period and local hydrodynamism.

ACKNOWLEDGEMENTS

To Ariel Vaisman for helping with Spanish translate and to Daniel Amorim Oriá Fernandes for reading the manuscript.

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(Received: January, 14, 2004. Accepted: July, 16, 2004)