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UNIQUE BEHAVIOURS OF THE HYDROIDS OF *EUGYMNANTHEA* (HYDROZOA, LEPTOMEDUSAE, EIRENIDAE) LIVING IN THE MANTLE CAVITY OF BIVALVES

SUMMARY

The hydroids of *Eugymnanthea inquilina* and *E. japonica* associated with *Mytilus galloprovincialis* exhibit some passive but unique behaviours: no escape reactions against mechanical and light stimuli; an uncontracted body with extended tentacles with or without captured food, even when the gastric cavity is full. These behaviours may have evolved in correlation with the protected life-style of *Eugymnanthea* hydroids, which encounter no natural enemies in the mantle cavity of the host, where plenty of safe food is freely available. On the contrary, the feeding behaviour observed in the present two species (passive capture) is common among hydroids.

RIASSUNTO

Gli idroidi di *Eugymnanthea inquilina* e *E. japonica,* associati con *Mytilus galloprovincialis,* esibiscono un comportamento passivo ma unico: nessuna reazione di fuga agli stimoli meccanici e luminosi; il corpo rimane disteso, con tentacoli estesi con o senza cibo catturato, anche quando la cavità gastrica è piena. Questi comportamenti possono essersi evoluti in correlazione con lo stile di vita protetto degli idroidi di *Eugymnanthea,* che non incontrano nemici naturali all'interno della cavità del mantello, dove il cibo sicuro è liberamente disponibile in abbondanza. Al contrario il comportamento alimentare osservato nelle 2 specie (cattura passiva), è comune tra gli idroidi.

INTRODUCTION

Various behavioural patterns have been discriminated in a total of 26 species belonging to 24 genera of hydroid by analysis of reactions to mechanical and light stimuli, as well as prey capture and ingestion, digestion, and egestion (MIGLIETTA *et al.*, 2000). The adaptive responses to the external stimuli and the feeding behaviour are basic traits that allow hydrozoans to survive in nature, assisted by their great capabilities for regeneration and sometimes even for reversing the life cycle (PIRAINO *et al.*, 1996). There is a vast of array of behavioural traits in the diversified taxonomic group of hydroids, according to their colonial or solitary form and the shape and size of the hydranth and hypostome (MIGLIETTA *et al.*, 2000). Therefore, it is highly expected that unique types of hydroid should exhibit undescribed behavioural traits.

In the present paper, a unique hydrozoan among the thecates, *Eugymnanthea*, is selected to test this hypothesis. *Eugymnanthea* hydroids are the only solitary, motile, and naked hydroids in this group. This is related to life on soft body parts in the mantle cavity of the host bivalve (CROWELL, 1957; PIRAINO *et al*, 1994; KUBOTA, 1979; 2000). As expected, peculiar behaviours were detected in both known species of this genus, *E. inquilina* Palombi from the Mediterranean Sea and *E. japonica* Kubota from East Asia. These behaviours are here described together with their evolutionary interpretation.

MATERIALS AND METHODS

Hydroids of *Eugymannthea inquilina* and *E. japonica*, both associated with *Mytilus galloprovincialis* Lamarck, were collected from the intertidal regions of Torre dell'Inserraglio, SE Italy, and from just below the sea surface at Atami, Shizuoka Prefecture, Japan, respectively, in late summer in 1999 (see KUBOTA, 2004). Many hydroids were removed from the hosts and tranferred into a transparent 80cc polystyrene or glass vessel filled with natural seawater from Porto Cesareo, SE Italy, with a salinity of 38-40 ‰. The hydroids were kept in the laboratory under constant conditions of 15L: 9D photoperiod and 23° C. Some hydroids reattached to the flat bottom of the vessel. Those individuals were observed by the same methods adopted by MIGLIETTA *et al.* (2000): stimulation by a stiff, hand-held, stainless steel needle in various strengths and directions and also stimulation by light of different strengths from the bottom side of the rearing container under a stereoscopic microscope (Leica MZ12). Such observations on starved hydroids were repeated several times and recorded on videotape.

By using *Artemia* nauplii as food, the feeding and ingestion behaviours of the hydroids were observed. Hydroids with full gastric cavities were also stimulated

similarly to the above (the resulting behaviours were the same as in the starved hydroids; therefore, they are not described separately).

RESULTS

Reactions to mechanical and light stimuli

Neither contraction nor bending of the body took place in hydroids of either species of *Eugymnanthea*, irrespective of strength and direction of the two stimuli; moreover, folding of tentacles towards the hydrocaulus and hypostome was not observed. With a gentle touch to the tentacles by a needle, some tentacles sometimes stuck to the needle, but only for a moment. When strongly touched by a needle, the tentacles usually moved (twinkling) around the mouth without contracting; however, sometimes all the tentacles synchronously contracted immediately, but quickly re-extended and reverted to the prior state.

Prey capture and ingestion

Items of food (*Artemia* nauplii) were caught by many, long, filiform tentacles when they came in contact with them; several tentacles sometimes wrapped themselves around the same prey. The paralyzed nauplii were immediately brought to the mouth without contracting and bending the body. The hydroids do not create water currents with their tentacles to catch food.

Prey ingestion is extremely rapid. After engulfing several *Artemia* nauplii one after another, soon after capturing them, the hydroids become swollen due to the accumulation of food in the middle part of the body. In this full-gastric-cavity state, the body did not contract and the tentacles remained extended. Food was still continuously captured by the fully extended tentacles, but ingestion slowed. Temporarily paralyzed nauplii could then escape because the hydroids never commenced to ingest them.

DISCUSSION

In reaction to mechanical and light stimuli, in *Eugymnanthea* hydroids neither folding of tentacles towards the hydrocaulus as happens in the thecate hydrozoan *Halecium pusillum*, nor folding of the tentacles towards the hypostome, as in an athecate hydrozoan, *Eudendrium* species, it was observed. Only in response to gentle prodding, though not always the case, did some tentacles respond by attaching to the needle for a moment. This response is due to the nematocysts (microbasic mastigophores or basitrichous isorhizas) found in the tentacles of the present hydroids (KUBOTA, 1979), which probably discharge after entering in

contact with the needle. The hydroids of *Eugymnanthea* do not show any of the three types of escape reaction currently recognized (MIGLIETTA *et al*., 2000), and thus fall into a new category termed as "No escape reaction" (Table 1).

For the present observations, the substrate of the hydroids was not a natural, living one; nonetheless, we expect that the hydroids also show the above-described passive and unique behaviours in their original site, the mantle cavity of the host. This unique behaviour could have evolved in a special environment, i.e. on and around the living soft body parts of bivalves, where there are no natural enemies and predators to attack and kill the hydroids. There is no need for such a protected hydroid to possess any special escape reaction.

Eugymnanthea hydroids are likely to be stimulated very frequently by the labial palps, foot, and gills of the host. If they reacted to such stimuli, including ciliary movements of the host, all the time, they could not survive in this habitat. However, in response to unnatural, strong, sudden stimuli never encountered in nature, e.g. artificial contact with a stiff needle, as was done in this study, they can quickly contract their tentacles. Still, they revert to the original state immediately, and this kind of reaction is considered to be a primitive trait for self-protection.

Among the three recognized patterns of feeding behaviour, that of the present hydroids falls under the category "passive capture" (MIGLIETTA *et al*., 2000). This is known to be a typical method of capturing food by hydroids (MIGLIETTA *et al*., 2000); it involves waiting for the prey to collide with the fully extended tentacles, which occupy the largest possible feeding space. Although the usual food of *Eugymnanthea* hydroids is not known, it is possible that they eat small, unharmful organic particles taken by the host bivalve. If so, they do not need to respond to food actively and can merely wait for food within the mantle cavity of the host by just spreading their many, long tentacles without bending the body towards the food. Moreover, they do not need to create water current by beating the tentacles, as has been observed in the thecate *Aglaophenia octodonta*, in order to take small particles actively, since the ciliated mantle or gill provides a current.

The uncontracted body posture with extended tentacles, even with a full gastric cavity after engulfing many *Artemia* nauplii, may also be related to the peculiar habitat of *Eugymnanthea* hydroids. The usual method of responding to enemies by contracting the body and the tentacles is not needed, nor is nematocyst discharge. This is a new behavioural type, which we call the "absence of contraction response" (Table 1).

The hosts of *Eugymnanthea* species can take food all the time; the hydroids never starve and can obtain food as much as needed at any time since the shell of *Mytilus galloprovincialis* is always open (FUJII *et al.*, 1982) and the mussel can take in food and eject pseudofaeces continuously (KUBOTA, 1996).

Table 1 - Behaviours of hydroids in three categories, compiled from MIGLIETTA *et al.*, (2000) and the present study.

Category	Behaviour (number of species)
Reaction to mechanical stimuli	Escape (13); Approach (9); Unidirectional bending (4); No reaction*(2)
Prey capture	Passive (23); Active (2); Passive/active (1); Random (1)
Feeding	Decrease of feeding space (17); Inhibition of capture ability (5); Inhibition of ingestion ability (1); Absence of contraction response* (2)

* New type, detected in the present study in two species of *Eugymnanthea*.

The passive but unique behaviours reported here for *Eugymnanthea* hydroids are related to the special morphology of *Eugymnanthea* adapted to a unique habitat. These behaviours differ from those of any other thecates, and also differ from those of the athecates so far studied by MIGLIETTA *et al*. (2000). Only two other genera of hydroids live in such a wide, body-defined space of other animals as the mantle cavity of bivalves. One is what is believed to be the more ancestral type of bivalve-inhabiting hydroid belonging to the genus *Eutima* (KUBOTA, 2000) and the other is the taxonomically remote hydrozoan *Bythotiara* (= *Endocrypta*), which is symbiotic with tunicates, living on the incurrent siphon by the stolon (KUBOTA and YAMADA, 1988). Unique behaviours different from the present ones may be expected to be found in *Endocrypta* in the future, but this may not be so in *Eutima*.

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