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Observations and experiments on grooming behavior of the tropical stomatopod *Gonodactylus oerstedii*

ABSTRACT

Grooming behavior and morphology of the tropical stomatopod *Gonodactylus oerstedii* is described. Amputation experiments demonstrated significant microbial fouling on the antennules of stomatopods prevented from groming; gill filaments of these experimentals were less obviously fouled.

Key words: grooming behavior; fouling; maxilliped; gonodactylid stomatopods.

Introduction

Grooming behavior in a crustacean can be defined as the scraping and brushing of body surfaces and appendages by brushes of ultrastructurally complex setae. In spite of the apparent importance of grooming in a stomatopod's behavioral repertoire (R.L. Caldwell, pers. comm.; Reaka, 1979a), there has been little work on the functional morphology of grooming and its adaptive value to the animal. Giesbrecht (1910) described and figured different grooming behaviors for *Squilla mantis* and hypothesized about the survival value of grooming. More recently, Jacques (1981, 1983) used scanning electron microscopy to describe ultrastructural details of setal groups on stomatopod maxillipeds, including presumed grooming brushes on the first and fifth maxillipeds. In this report, I describe the basic grooming behaviors of the tropical stomatopod *Gonodactylus oerstedii*, describe the distribution and ultrastructure of setae involved in grooming, and report the results of amputation experiments on the adaptive value of grooming behavior in this species. This work was first prepared for and presented at the Ist International Workshop on Stomatopod Biology at Trieste, Italy, in September, 1985. An expanded version, with additional observations and analyses, is given in Bauer (1987).

Materials and Methods

Gonodactylus oerstedii were collected by breaking open small fire coral (*Millepora*) colonies located near or on seagrass meadows near the Isla Magueyes marine laboratories of the University of Puerto Rico, Mayaguez. Observations

of grooming behavior were taken on animals maintained in aquaria with sand sub-
strate and pieces of coral rubble. Two experiments were performed to determine
what effects absence of grooming would have on this stomatopod species. In both
experiments, segments distal to the ischiomerus on the first maxilliped were am-
putated in the experimental group. In the control group, exopodal segments of
the eighth thoracopod were removed in order to submit control animals to the
same trauma as the experimentals. Both experimental and control animals were
placed in small plastic dishes, perforated to permit water flow, on a water table
with running seawater. During the «dark» experiment, stomatopod chambers were
shaded with fine mesh black plastic screen; during the light experiment, the shading
was replaced by a perforated transparent plastic sheet. Duration of the «dark»
experiment was 15 days (n = 10 experimentals, 8 controls), similar to that of
the «light» experiment (14 days, n = 5 experimentals, 7 controls).

Results

The most frequent grooming activity is preening of the antennular flagella
with the grooming appendages, the first maxillipeds. In antennular grooming,
an antennule of one side is lowered while the first maxillipeds reach out to grasp
it near its peduncle. The antennular (and frequently the antennal) flagella are
drawn up between the medial surfaces of the first maxillipeds' carpal segments.
Another frequent behavior is eye-wiping, in which the first maxillipeds reach
forward, mesial to the antennules, to scrape an individual eye or both eyes simul-
taneously with the carpal and propodal grooming brushes. The animal also spends
much time using the first maxillipeds to clean each other, maxillipeds 2-5, and
the region below the carapace.

Brushing the pleopodal gills with the first maxillipeds is a much less fre-
quent activity. However, when gill grooming occurs, it is usually prolonged, e.g.,
several seconds or several minutes of repeated gill grooming interrupted by peri-
ods of inactivity or other behaviors. Gill brushing is usually accomplished when
the stomatopod is curled upside down, resting its posterior thoracic region on
the dorsal surface. Both maxillipeds reach into the mass of gill filaments and
brush them rapidly.

Very little general body grooming (*sensu* Bauer, 1981) was observed in several
hours of direct observation on *G. oerstedii*, certainly nothing like that described
by Giesbrecht (1910) and Morin et al. (1989, in this volume) for *Squilla mantis*.
I have observed brief wiping of the lateral surface of the carapace in *G. oer-
stedii*, and R. L. Caldwell (pers. comm.) has observed cleaning of the telson and
uropods in other gonodactylids.

Although the fifth maxilliped has a small brush of presumed grooming se-
tae (Jacques, 1983), the only potential grooming act by this appendage that I
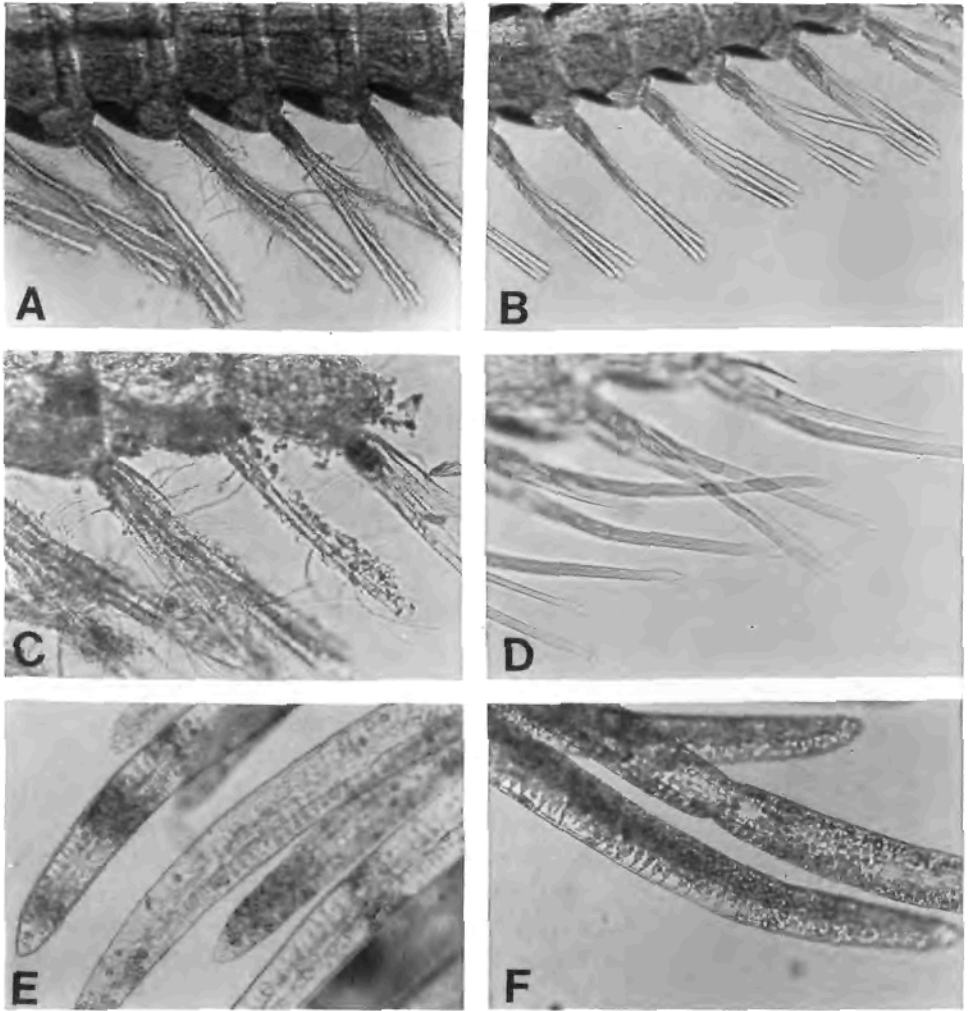observed was a few rapid scratching movement at the anterior pair of pleopods.

Fig. 1. Results of amputation experiments on *Gonodactylus oerstedii*. (A) outer antennular flagellum of an experimental animal («dark» experiment) showing microbial fouling of aesthetascs (130 ×); (B) flagellum and clean aesthetascs from control animal («dark» experiment) (130 ×); (C) flagellum and aesthetascs with microbial fouling from an experimental animal («light» experiment) (260 ×); (D) clean aesthetascs from a control animal («light» experiment), (260 ×): (E) gill filaments from an experimental animal («dark» experiment) (130 ×); (F) gill filaments from a control animal («dark» experiment) (130x).

Brushes of setae on the mesial surfaces of the propodus and carpus of the first maxillipeds rub and scrape body surfaces during grooming. The ultrastructure of carpal and propodal grooming brush setae is unique to the first maxilliped (with the possible exception of maxilliped 5). Grooming setae have a high density of toothed or denticulate setules, an obvious adaption for scraping and cleaning the exoskeleton. Most of the mesial carpal surface is set with rows of

serrate setae (see Jacques, 1983, Figs. 10-13). On the flexor margin and espe-
cially on the distal edge of the carpus, there is a high density of elongate setae
which are studded with digitate scale setules. Multiscaled setae on the distal por-
tion of the carpus are directed towards the tip of the appendage and completely
overlap the mesial surface of the propodus. Below this cover of «scale» setae
are a large number of setae which Jacques (1981, 1983) has called «soies de râpe»
or rasp setae (Jacques, 1983, Fig. 33). A few stout, serrate setae («soies à dents
double peigne», Jacques, 1983) are located near the distal end of the propodus.

    The distal end of the propodus of the fifth maxilliped of *G. oerstedii* also
bears a brush of ultrastructuraly complex (denticles, scales) setae, as in most other
stomatopods (Giesbrecht, 1910; Jacques, 1983). There is no similar group of se-
tae on maxillipeds 2-4.

    After two weeks exposure in running seawater to sediment and epizoic foul-
ing, experimentals showed no signs of microscopic fouling. When containers with
experimentals and controls were shaded, little or no algal fouling took place on
the container walls. However, in the unshaded or «light» experiment, a notice-
able film of microscopic green algal filaments developed inside the stomatopod
chambers. To observe microscopic fouling, two body parts which had been ob-
served to be the focus of grooming with maxilliped 1, the antennules and pleopodal
gills, were examined at higher magnification. Aesthetascs from the outer anten-
nular flagellum showed heavy microbial fouling in non-grooming (experimental)
stomatopods, both in the «dark» and «light» experiment (Fig. 1 A, C). Aes-
thetascs of control (grooming) stomatopods showed little or no fouling (Fig. 1
B, D). Fouling on aesthetascs of experimental animals consisted chiefly of a coating
of bacterial cells and strands of a microbe similar to *Leucothrix mucor*.

    First examination of gill filaments of experimentals with light microscopy
revealed little obvious fouling, similar to that on gill filaments of controls (Fig.
1 E, F). However, more detailed quantitative and scanning electron microscop-
ic observations on gill filaments (Bauer, 1987) did demonstrate significant microbi-
al fouling in exerimentals but not controls.

    The film of green microalgae that developed in stomatopod containers in
the light experiment did not appear on aesthetascs or other body parts of ex-
perimental or control animals.

Discussion

    When the grooming morphology of a stomatopod such as *G. oerstedii* is com-
pared to that of decapod crustaceans (review in Bauer, 1981), certain generali-
zations can be made. Stomatopod grooming brushes and combs are almost en-
tirely confined to the first maxillipeds; in decapod crustaceans, grooming struc-
tures are distributed on a wide variety of different thoracic appendages. The lack
of diversity in grooming appendages in stomatopods is probably related to the

conservativeness of stomatopod body morphology. However, an examination of setal ultrastructure on maxilliped 1 of *G. oerstedii* (this study) and other stomatopods (Jacques, 1983) reveals that nearly the entire range of decapod grooming setal diversity can be seen on this single specialized stomatopod grooming limb. In the stomatopod, serrate setae set in rows on the carpus of the first maxilliped, used in grooming the antennules, are very similar to those on the third maxilliped, also used in cleaning antennules (Bauer, 1981). Multiscaled carpal setae are ultrastructurally very similar to decapod crustacean setae involved in gill cleaning (Bauer, 1981), and a similar function is hypothesized for stomatopods. The rasp setae (Jacques, 1981, 1983) on the propodus of the first maxilliped are unique to stomatopods, and probably are analogous to the stout serrate setae of the general grooming brushes of decapod crustaceans (Bauer, 1981).

Grooming in *G. oerstedii* is organized in a similar fashion to that of *Squilla mantis* (see Morin et al., 1989, in this volume) and some decapods (Bauer, 1981). There is a decrease in frequency of grooming acts directed at body parts from anterior to posterior. Grooming of antennules, antennae, eyes, and maxillipeds are far more frequent than gill grooming in *G. oerstedii*. One major difference between *G. oerstedii* and *S. mantis* is that the latter species appears to expend much more time at grooming; *G. oerstedii* was not observed to engage in extensive general body grooming.

Extensive microbial fouling occurred on the antennular aesthetacs of the *G. oerstedii* that were prevented from grooming by amputation of the first maxillipeds. Control stomatopods exposed to the same fouling sources maintained clean antennules. Aesthetascs have been shown in decapod crustaceans to be a major site of distance chemoreception (Ache, 1982, Gleeson, 1982), and Bauer (1981) has suggested that extensive microbial fouling could interfere with this important sensory input. A major difference between the fouling which developed on aesthetascs of stomatopods in the «light» experiment and those of caridean shrimp in similar experiments (Bauer, 1977) is that microalgal fouling was slight on stomatopods aesthetascs but heavy on caridean ones. In amputation experiments with decapod shrimps (summarized in Bauer, 1981), fouling on nongroomed body parts was identical to that on glass slides or other inanimate substrates in the vicinity of the experiment.

Gill fouling in experimental *G. oerstedii* was not so extensive as that found on their aesthetascs. However, detailed observations and measurements (Bauer, 1987) showed that significat microbial fouling occurred on experimental gill filaments.

Body parts other than aesthestascs and gill filaments lacked microbial fouling in both experimentals and controls. *G. oerstedii* might have another antifouling mechanism besides grooming, i.e., secretion of antifouling compounds onto the exoskeleton by the tegmental glands. Reaka (1979b) has suggested that stomatopods have particularly low rates of molting. An antifouling defense supplemental to mechanical grooming would certainly be adaptive if the stomatopod exoskeleton

is indeed exposed to environmental fouling for long time periods without a cleansing molt.

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