Charles C. Naughton
Biology Department
Western Washington State College
Bellingham, Washington

Setae on the Chela of Shore Crabs, *Hemigrapsus*: Function

The shore crabs *Hemigrapsus nudus* and *H. oregonensis* have, on the inferior surface of the propodus, an aggregate of setae that forms a spongy pad or tuft. The pad is present on the males of both species and female *H. nudus,* but is reduced on the chela of female *H. oregonensis*. Upon microscopic examination the setae appear setuled, very flexible, and to mesh together giving the tuft a spongelike appearance and consistency.

Since there are few forms without a function, and because I was unable to find in literature a reference to function of these tufts, I took the animals into the laboratory to see what the tufts might do. The observations and experiments are discussed herein.

It was noticed that crabs in captivity occasionally passed the tufts over the frontal region of the carapace. This brushing of the eyes, antennules and mouth region appears to be an extension of their characteristic stance. In this stance the chelipeds are held close to the body and are pulled toward the top of the carapace in rhythmic alternate motions while the body is held above the substrate by the first three pairs of walking legs. In brushing, the cheliped is pulled higher than usual and pushed toward the orbit. Thinking this to be a cleaning mechanism similar to the eye-wiping with the maxilliped in *Uca,* I washed and brushed out the orbits, and placed the crabs into clean tanks containing no sediment. The wiping behavior was still observed. This brushing did not occur while the crabs were covered with water, but only when they were exposed to air. This observation suggested that the tufts might be used for wetting the eyes when the crabs are not covered by water during low tide.

The tuft of setae is not unique to *Hemigrapsus* or to these species. Similar structures are found on other crustacea: *Petrolisthes, Pachycheles,* and *Tetragrapsus.* Although these crabs have similar tufts I have not observed these crabs using them as *Hemigrapsus* appears to. Others have observed similar features and eye care. *Cancer magister* possess an aggregation of long, fine, nonsetuled setae on the cheliped and the anterior lateral portion of the carapace. According to F. W. Weymouth, these setae, with the help of tubercules on the carapace, filter sand particles from the water as it is circulated over the gills. The water direction is periodically reversed to clean the setae. *Uca,* while emerging from its burrow on muddy shores, cleans its eyes by placing the endopodite of the third maxilliped over the orbit and flips the eyes up to clean them.

Another mechanism has been observed which may result in moistening the eyes and other areas of the frontal region. Water is drawn by surface tension through channels between the maxillipeds and the orbital cavities and along communicating setae from the abdomen to the orbit, into which the crabs retract their eyes. The orbital cavities are deep and lined with rows of setae. These rows of setae communicate with the eye from a reservoir formed by a narrowing of the eye stalk as it enters the cavity. The reservoir is filled when the crabs form a froth above the maxillipeds by extruding water from the branchial chamber (frothing). This water then flows through the maxilliped-orbital channels to the reservoir.

Because blinking in *Hemigrapsus* seems a more efficient eye-wetting mechanism than the use of the tuft, it was assumed that the tuft is used to transfer moisture to the eyes when other methods of wetting become less effective. To observe if this happens it was necessary to make the alternative wetting mechanisms less effective. It was possible to do this for wetting by capillary action by reducing or removing the volume of water in which the crabs were kept. I could not control frothing.

The crabs used were obtained from Lummi Island, Whatcom County, Washington, during low tides. Experiments were performed in the biological laboratories of Western Washington State College, Bellingham, Washington. The crabs were placed in green plastic trays measuring 14″ x 11″ x 6″. A small hole had been bored through the bottom for introduction of water by gravity from a common reservoir. The crabs were subjected to the same photoperiod as the ones in nature. Tank temperatures ranged between 18 and 20° C. Water was evacuated from the tanks during the low-tide periods and reintroduced through the bottom when the tides were flooding. Each species was exposed to air only during that period of the tidal cycles in which they would be exposed in nature. The observations began with the crabs in dry tanks. Forty individuals were used for each species and sex. Observation of each group lasted 120 minutes. Actual counts of motions were recorded as (1) eye-wiping motions with the tuft (wiping); and (2) eye-retracting motions—left or right (blinking). These data were plotted as eye wipes or eye retractions as a function of water depth according to sex and species. The results are shown in Figures 1 and 2.

In a water depth of 1 mm, eye-wiping with the use of the tuft is more frequent than retraction of the eyes into the orbital cavities in *H. oregonensis;* there is no difference seen in *H. nudus. H. oregonensis* wipes about five times more and retracts its eyes twice as frequently as *H. nudus.*

In 4 mm of water, *H. nudus* eye-retraction and -wiping increase. In this species females wipe and retract eyes at the same frequency; however, it was found that males wipe more than they blink. *H. oregonensis* eye-wiping decreases and -retracting increases. There is no difference seen between the sexes of this species in wiping frequency, but females are the more active eye retracters.

Eye-retracting activity is different between the species. *H. oregonensis* is the more active, retracting five times more often than *H. nudus* during a 2-hour observation period. Females are more active eye retracters in both species. The two species of crabs react in different ways when placed under the same condition. *H. nudus* wiping has its highest frequency in 4 mm of water. *H. oregonensis* has its highest in 1 mm of water. Similar behavioral responses are observed with eye-retracting, *H. nudus* having its greater activity in 4 mm of water as did *H. oregonensis.* When after 2 hours in 1 mm of water, the depth of water was increased to 4 mm, it was noted the highest frequency of wiping by *H. nudus* occurred within the first

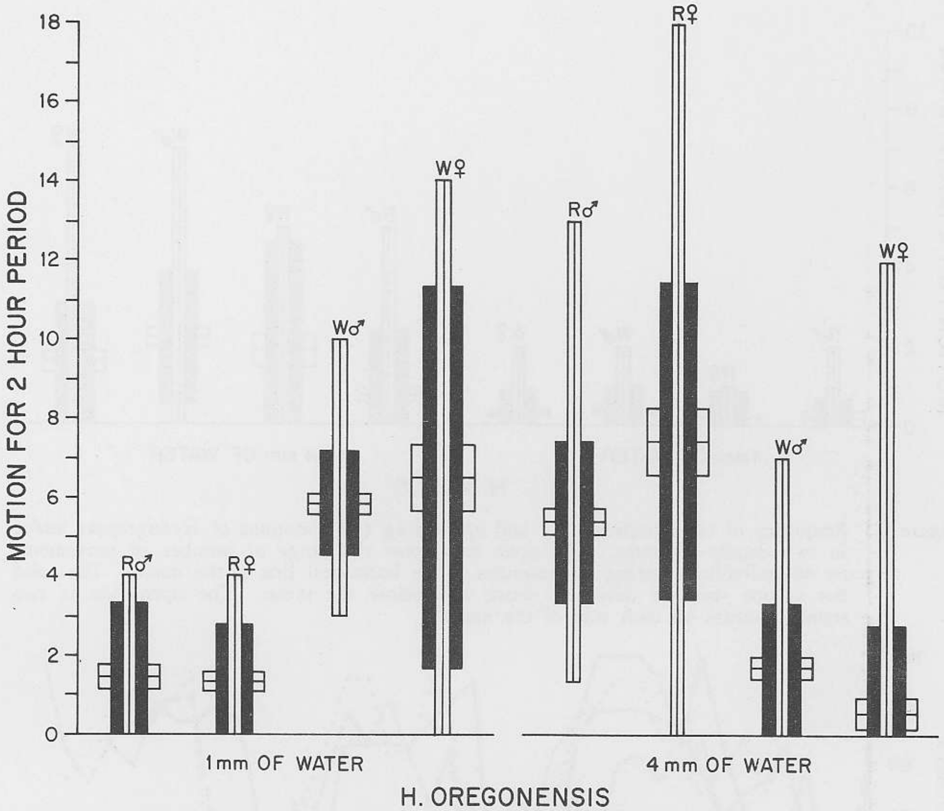

Figure 1. Frequency of eye-retraction (R) and eye-wiping (W) motions of *Hemigrapsus oregonensis* in two depths of water. The open bars show the range of number of movements by 40 individuals during 120 minutes. The horizontal line is the mean. The solid bar is one standard deviation above and below the mean. The open box is two standard errors on each side of the mean.

20 minutes of the observation period. This suggests that the tufts in *H. nudus* are wetting to dilute salts that may have crusted and to keep the eyes moist.

Although eye-brushing is seen in both species and each sex, female *H. oregonensis* lack the tuft. If the tufts moisten the eyes when the crabs are out of water, and for some reason they require moistening, then how do female *H. oregonensis* moisten the eyes without one? A possible answer to this question was found in the research notebooks of Wallace G. Heath and Lowell T. Crow. These data are plotted in Figure 3. As interpreted from these graphs the female *H. oregonensis* bury more frequently than do the males of the same species. No difference is observed between sexes in *H. nudus,* both of which have tufts. More frequent burying on the part of the female *H. oregonensis* could compensate for the lack of a tuft.

Both sexes of *H. nudus* bury at the same frequency and seem not to use the tufts to any appreciable degree. This suggests that they have a more efficient mechanism for retaining moisture and wetting the eyes, which appears to be by capillary attraction of water through the maxilliped-orbital channels filled by frothing. It was observed that *H. nudus* froths more frequently than *H. oregonensis.* The eye-wetting and

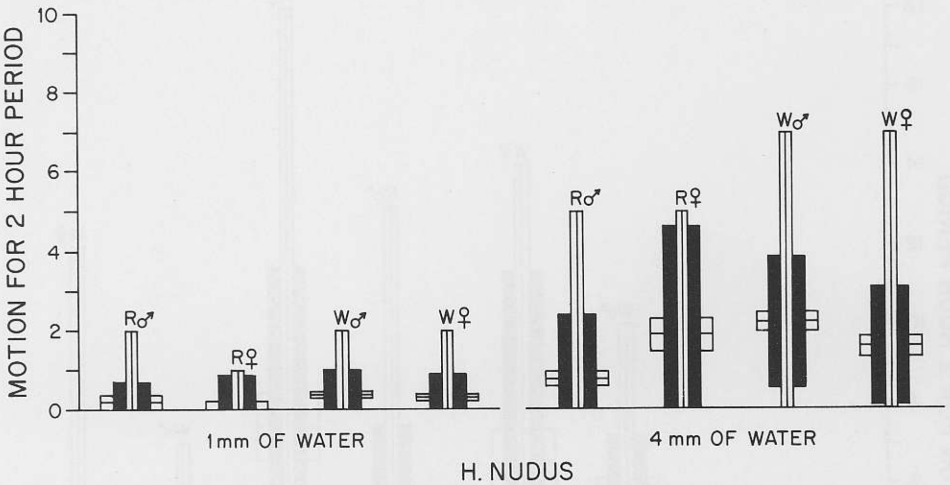

Figure 2. Frequency of eye-retraction (R) and eye-wiping (W) motions of *Hemigrapsus nudus* in two depths of water. The open bars show the range of number of movements by 40 individuals during 120 minutes. The horizontal line is the mean. The solid bar is one standard deviation above and below the mean. The open box is two standard errors on each side of the mean.

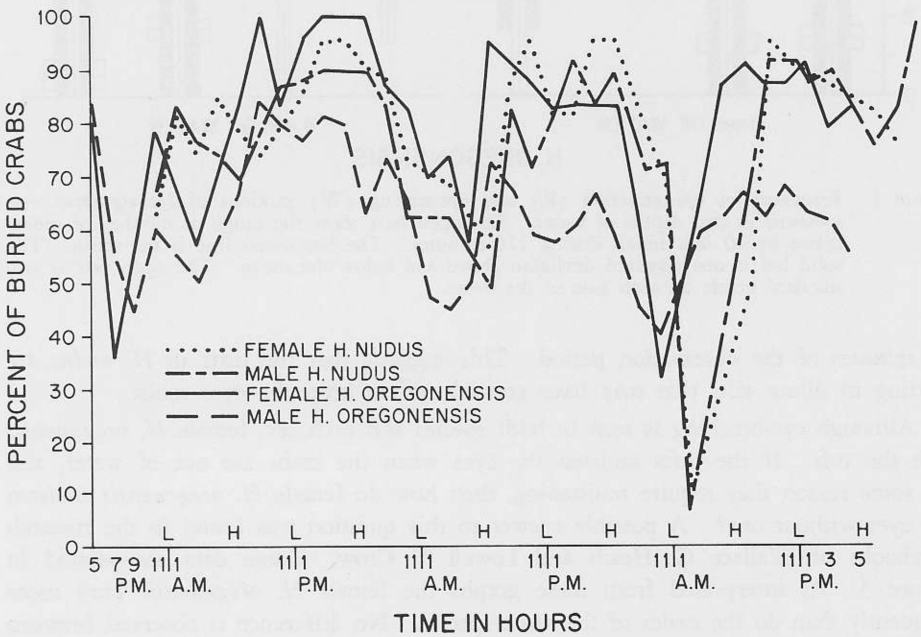

Figure 3. Behavior of *Hemigrapsus* species as a function of time. Crabs subjected to normal photoperiod and simulated tidal cycle in the laboratory. Data based on observation of 40 crabs in each group, observation at half-hour intervals. L and H designate time of low and high tides, respectively.

-frothing resembles that of *Pachygrapsus crassipes,* a nontufted crab that lives high on the shore. *P. crassipes,* however, does not have the eye-wiping behavior observed in *Hemigrapsus.*

Since *H. oregonensis* lives at a lower level of the intertidal zone than *H. nudus,* it may have less-efficient compensatory mechanisms to inhibit desiccation. This may be why *H. oregonensis* retains such an active use of the tuft and also froths less than *H. nudus*—and why the females not having such a tuft bury or cover themselves more frequently.

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