*Reprinted from*
BULLETIN OF MARINE SCIENCE
OF THE GULF AND CARIBBEAN
Vol. 11, No. 2, pp. 267-279
JUNE, 1961

# OBSERVATIONS ON *PINNAXODES FLORIDENSIS*, A NEW SPECIES OF PINNOTHERID CRUSTACEAN COMMENSAL IN HOLOTHURIANS

HARRY W. WELLS AND MARY JANE WELLS
*Department of Zoology, Duke University*

ABSTRACT

*Pinnaxodes floridensis* is described from the northern part of the Gulf of Mexico. Sexual dimorphism in this species involves size, shape of the carapace and frontal area, and degree of fusion of ischium and merus of outer maxillipeds, as well as shape of the abdomen. Adult and pre-adult crabs were recovered from the cloaca and respiratory tree of the holothurian *Theelothuria princeps* where they normally filter their food from water circulated by the host. Juvenile crabs were recovered from anterior regions of the holothurian digestive tract. The ectoproct bryozoan *Triticella elongata* is reported from *P. floridensis*.

## INTRODUCTION

While many protozoans, turbellarians, and mollusks, and the pearlfish *(Carapus* sp.) are well-known commensals of holothurian echinoderms, fewer cases of such a relationship have been recognized between decapods and holothurians. The decapods that have been reported as regularly inhabiting the cloaca of holothurians are crabs of the family Pinnotheridae (Bürger, 1895; Rathbun, 1918; Tesch, 1918; Tao, 1930; Chopra, 1931). These records all emanate from Indo-Pacific regions; no pinnotherid crabs have been reported from holothurians in the greater Atlantic Ocean.

This report concerns a member of the genus *Pinnaxodes* which inhabits the cloaca and respiratory tree of a holothurian on the northern coast of the Gulf of Mexico. The morphological variation of this species is discussed, with notes on its life history and commensal relationships.

## OBSERVATIONS

On February 28, 1960, the authors found thousands of sea cucumbers in windrows on the outer beach near Fort Walton Beach, Florida, about 40 miles east of Pensacola. In the highest windrow, left by an unusually high tide, sea cucumbers were dry and dead; but on the lowest part of the beach, several specimens were found that were still capable of contraction. These holothurians were long (85 to 200 mm) and cigar-shaped, with a brown-colored dermis. Dr. Elisabeth Deich-

mann of the Museum of Comparative Zoology, Harvard College, kindly identified these holothurians as *Theelothuria princeps* (Selenka). This species was treated previously by Deichmann (1954) as *Holothuria princeps* Selenka. It typically occurs in sand at some depth, in the West Indian region. Dr. Deichmann indicates that numbers of this species are found only after storms, or by extensive dredging over a sandy bottom. The appearance of large numbers on this beach was undoubtedly due to a severe storm which had affected the area several days before.

By chance, an individual sea cucumber was collected which bore a small crab protruding from the posterior orifice. Subsequent examination of hundreds of specimens on the beach revealed only one other example of this situation. Further investigation revealed the common occurrence of a crab in the respiratory tree of this holothurian.

On the same day, in relatively quiet waters at East Pass, between Choctawatchee Bay and the northern Gulf of Mexico, numbers of *Theelothuria princeps* lay visible in shallow water near the shoreline. Most of these individuals were still alive. One hundred specimens were collected and dissected in search of commensal crabs. A longitudinal incision through the body wall exposed the digestive system, gonads, and respiratory (or anal) tree. Although the respiratory tree frequently was clogged with sand, contained commensal crabs often were visible through its transparent walls. Palpation of some of the sand-filled regions revealed other specimens. Forty-five of these relatively fresh holothurians harbored live commensal crabs. Although a holothurian usually contained but a single crab, pairs (one male and one female) were recovered in five cases.

Subsequent examination of two hundred *Theelothuria princeps* from Fort Walton Beach revealed crabs in various parts of the respiratory tree of 122 holothurians. These holothurians had been collected in an intermediate part of the beach, where they were dead but not completely desiccated. The 16 per cent difference in degree of infestation probably reflects their different fates, when washed inshore. Apparently, many of the holothurians at East Pass were incapacitated by the large amounts of sand taken in by respiratory currents; the resulting congestion of the respiratory system severely reduced the normal movement of water through the cloaca. Under these conditions, commensal crabs could escape into the water from flabby, narcotized holothurians. However, on the exposed beach, the effects of contrac-

tion of the cloacal sphincter and the effects of drying would likely trap these crabs inside. The proportion of infested holothurians from the beach (61 per cent) is probably closer to the original level of infestation, although, even there, escapes are possible, as indicated by the first two specimens observed, protruding from the cloaca.

In three hundred holothurians examined for the presence of commensal crabs, individuals were found in the enlarged cloacal region only thirteen times. The other crabs were found more anteriorly in the respiratory tree, which extends to the region of the teeth. In several cases, crabs found in the cloaca were males, but males were not restricted to this region.

Females were more abundant in this population. A total of 138 females were recovered as compared with 36 male crabs. This proportion approaches a 4:1 ratio between sexes. In view of the much larger number of females, one can deduce that each male usually copulates with more than one female, and that males must move about from host to host in search of females. As a consequence of this movement, males are subject to predation and similar hazards of life outside the host, and their numbers are likely reduced. Taking such mortality into account, the initial proportion of males probably was greater than that observed.

## Description

A description follows based upon a series of 174 adult or sub-adult crabs. The female holotype and a series of paratypes are to be deposited in the U. S. National Museum, Washington, D. C.

### *Pinnaxodes floridensis,* n. sp.

*Carapace* convex, smooth, minutely punctate, subcircular, slightly wider than long, widest anterior to mid-point, moderately calcified; line of hair extending lateral to buccal cavity; lateral margins indistinct, rounded.

*Outer maxillipeds* broad, with large palp (Figs. 2F, G); inner edge of the merus produced, forming a distinct angle; propodus larger than carpus, spatulate, about twice as long as wide; dactylus spatulate, two-thirds of length of the propodus, attached at side of propodus one-third of distance from proximal end, extending very slightly beyond its tip; both propodus and dactylus provided with long hairs.

*Chelae* (Figs. 2A, C, E) moderately long, smooth, minutely punc-

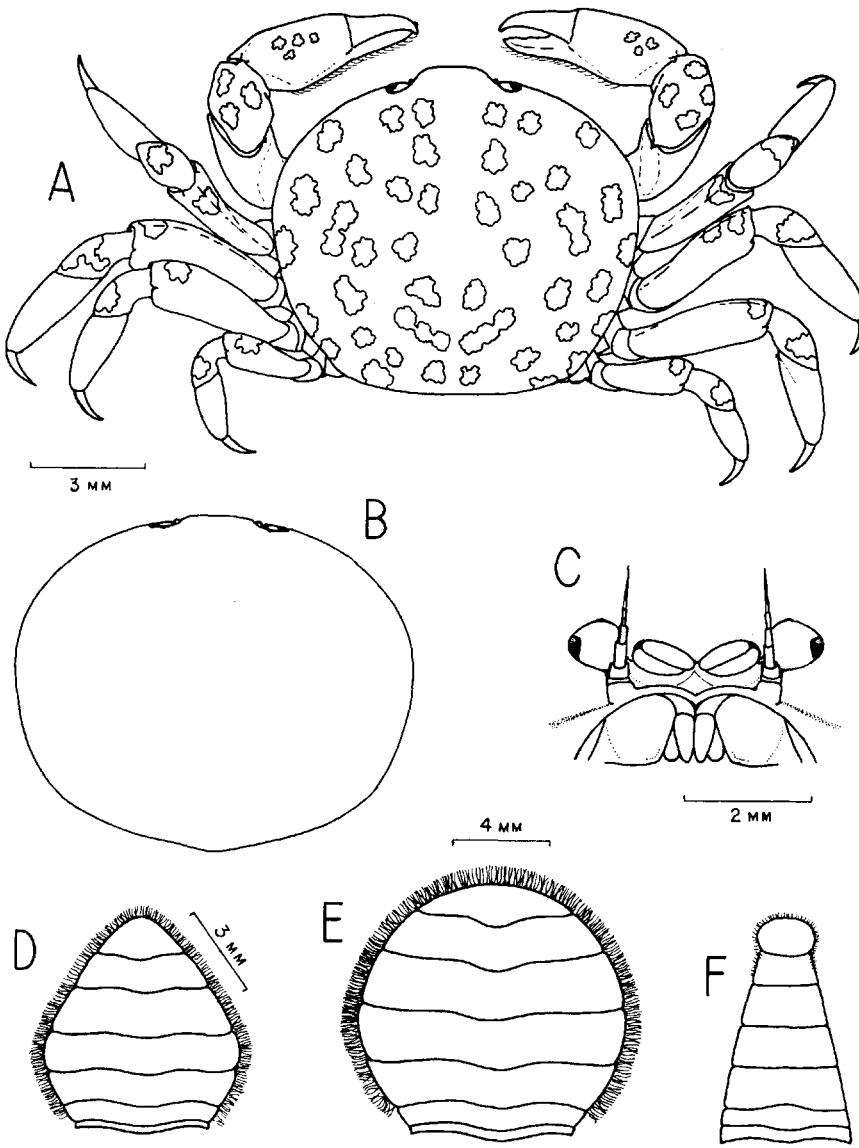


FIGURE 1. *Pinnaxodes floridensis*. A. Dorsal view of male showing color pattern in outline. B. Outline of adult female carapace. C. Frontal view of adult female. D. Abdomen of immature female. E. Abdomen of adult female. F. Abdomen of male. (A and B to same scale; D and F to same scale.)

tate; carpus slightly swollen; palm elongate, subcylindrical, increasing distally; fingers tapering, gaping through most of length, crossing at tips, somewhat spooned, with hairy internal crest; movable finger curved inward, with a basal tooth, and with inconspicuous dorsal tuft of hair near articulation point; immovable finger deflexed, with small sinus and tooth; line of stout hair extends along a low crest on lower edge of inner surface of palm, from near carpal articulation to lower margin of immovable finger (Fig. 2E).

*Legs* moderately short, relatively stout; second pair longest, shorter than chelae; fourth pair much the shortest; propodus elongate; dactylus curved, horny at tip; line of hair along dorsal crest and posterior ventral margin of merus, dorsal and ventral crests of propodus, and dactylus.

*Color:* many small red spots scattered on a white ground on dorsal surface, less developed on ventral surface, distributed in an imperfectly symmetrical pattern (Fig. 1A); spot of color typically on distal portion of carpal segments of walking legs and on merus of maxillipeds.

*Measurements:* carapace length of an ovigerous female—9.5 mm, carapace width—11.0 mm; carapace length of a male—8.0 mm, carapace width—9.0 mm; carapace length of largest immature female—8.75 mm, carapace width—9.75 mm.

*Morphological variation.*—As in most pinnotherid crabs, there is a marked sexual dimorphism in *Pinnaxodes floridensis*. This sexual dimorphism involves both overall size and structural differences in various parts of the body. In Figure 3, width measurements are presented for 115 females and 35 males. Because the frontal region is usually produced in males, measurements of width are more suitable for comparisons between sexes and indicate more accurately the overall size of the crabs than would length measurements. Although mature females are generally wider than males, there is much overlap in this dimension. Several immature females are larger than the smallest ovigerous females.

As mentioned above, the front is usually somewhat produced in males, the orbits being visible in dorsal aspect (Fig. 1A). In contrast, the front is usually deflexed in females, and the orbits are often concealed from dorsal view (Fig. 1B). This forward projection in males significantly contributes to the total length, producing a difference evident in width : length proportions. The carapace width of mature

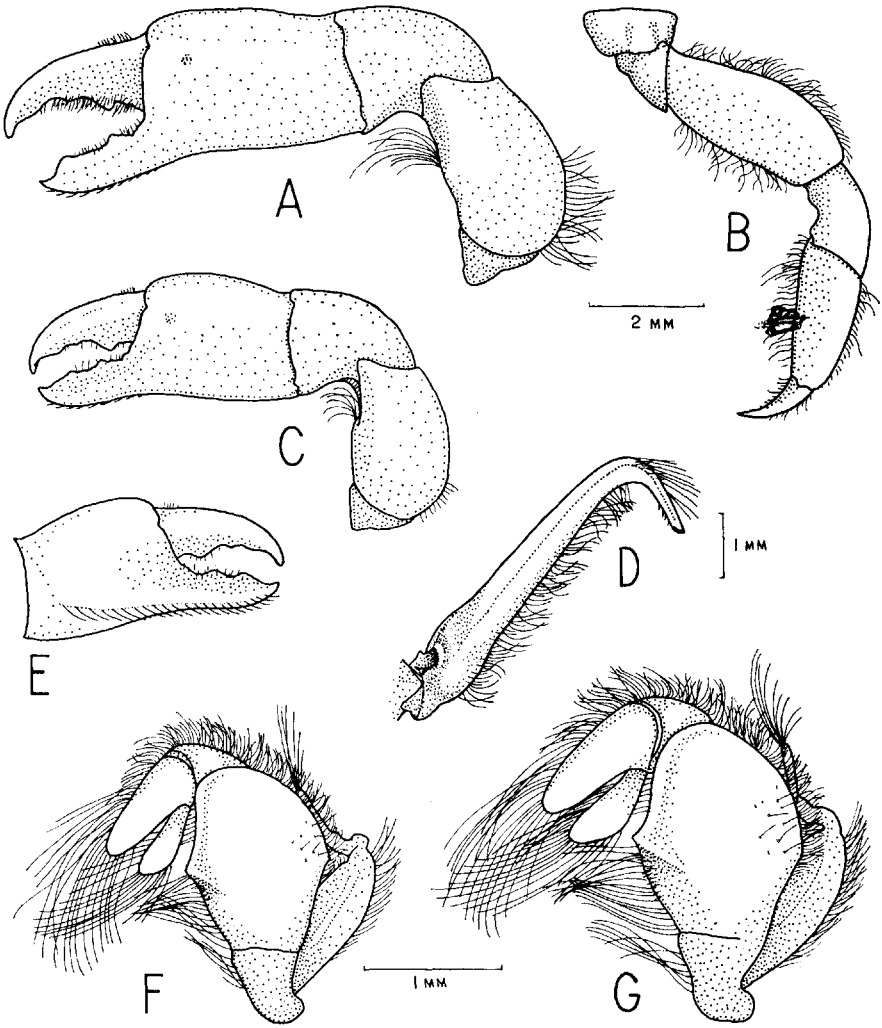


FIGURE 2. *Pinnaxodes floridensis*. A. Left chela, female, outer view. B. Third right leg, female. C. Left chela, male, outer view. D. First pleopod, male, left side. E. Manus of male left chela, internal view showing line of stout hair. F. Left maxilliped, male, outer view. G. Left maxilliped, female, outer view. (A, B, C and E to same scale; F and G to same scale.)

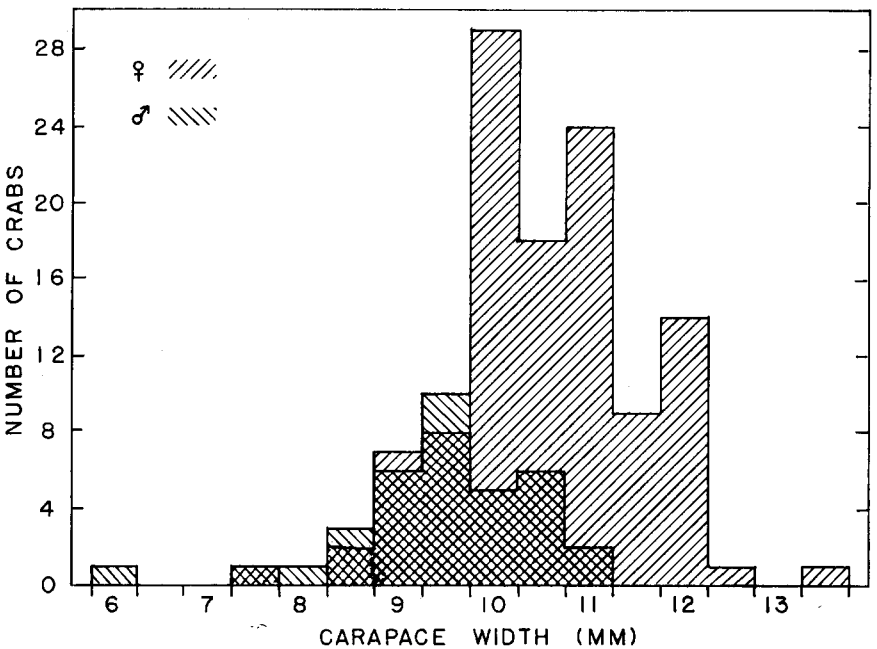


FIGURE 3. Frequency distribution of width measurements of 35 male and 115 female *Pinnaxodes floridensis*.

females is 1.14 to 1.25 times the length, while the carapace width of males is 1.03 to 1.19 times the length. The carapace of immature females more closely resembles the male form, the width being 1.11 to 1.20 times the length. Some of the smaller ovigerous females retain this slightly projecting front. Additionally, there is a significant difference in the interorbital distance between sexes. In males, the interorbital distance is considerably greater than in females of comparable size (as represented by width) (Fig. 4).

The carapace of mature females is higher and more convex than that of males. In males, there often are indistinct shallow grooves or depressions in the cardiac region, and the transition from dorsal to lateral surfaces is more distinct, being marked by a low ridge in the anterolateral region, although these characters are somewhat variable.

In the outer maxillipeds, one of the most important morphological variations occurs. In females, the fusion between the ischium and merus of this maxilliped is incomplete, a more or less distinct suture extending about two-thirds across the breadth of the endognath (Fig.

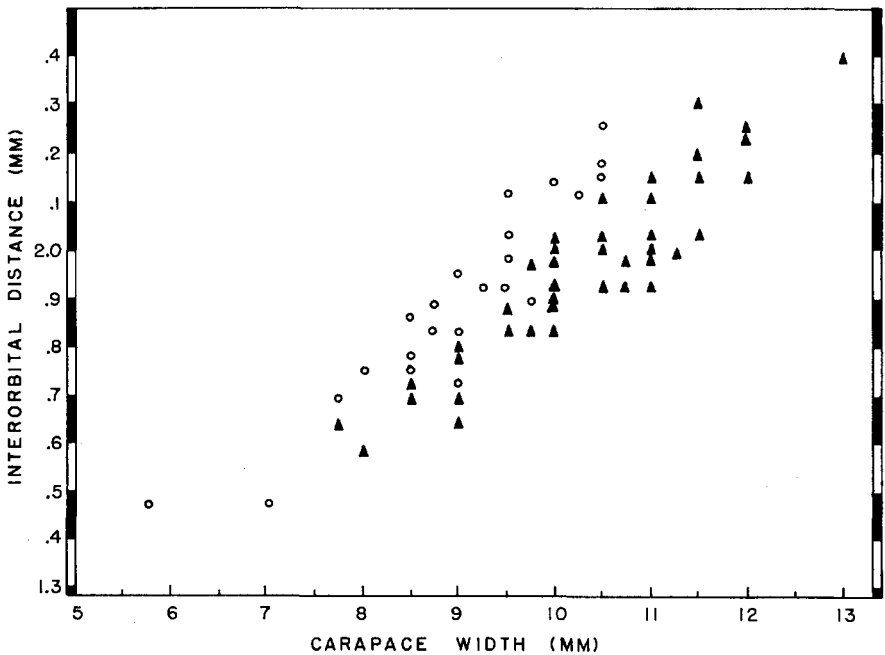


FIGURE 4. Relation of interorbital distance to width in *Pinnaxodes floridensis;* open circles indicate males, closed triangles indicate females.

2G). However, in males, this suture continues across the endognath, effecting a complete separation between the ischial and meral segments (Fig. 2F). This dimorphism in the maxillipeds is quite constant in the specimens examined.

The most obvious sexual difference in *P. floridensis* is the shape of the abdomen. Adult females possess a broad subcircular abdomen, fringed with hair (Fig. 1E), that effectively covers the ventral surface. Males possess a narrow, triangular abdomen with an enlarged, rounded terminal segment (Fig. 1F). Immature females possess a broadly triangular abdomen with a narrow anterior segment (Fig. 1D). The abdomen of an adult female is so large that in a non-ovigerous female, it extends forward to the buccal region, where it may be exposed to injury. In several cases, the abdomen of the female had suffered injury or erosion by the larger chela. In one specimen, the terminal segments of the abdomen were asymmetrically malformed as though such injury to its margin had been repaired with a subsequent moult. In this case,

the fifth and sixth segments were distinct on the left side, but fused on the right; the suture between the sixth and seventh segments was oblique, with the last segment skewed.

A number of stages in the reproductive cycle of the female were represented in our collections: immature females, females with full ovaries in which oviposition had not occurred, ovigerous females with fresh egg masses, ovigerous females with eggs displaying eyespots, and mature females with indications of having been ovigerous recently. The collection of such a wide range of stages indicates that oviposition is not restricted to a brief interval, but occurs over an extended period of time. Sperm were found in the spermathecae of an immature female, indicating that copulation had already taken place, well before the female assumes the mature form.

A number of tiny, nearly transparent juvenile crabs were also recovered from these holothurians. Because their presence was not suspected until late in the study, only a few holothurians were adequately examined for their presence. These yielded 22 specimens ranging from 1 to 3 mm in carapace width. Examination showed their maxillipeds, chelae, and pigment distribution to be essentially similar to corresponding characters of adults recovered from the respiratory tree. However, these juvenile crabs were found in the anterior part of the digestive system: in the buccal cavity, among the teeth, or in the anterior part of the esophagus in sand. They undoubtedly represent broods released earlier. Whether the holothurian digestive system is a normal path of invasion, a temporarily satisfactory orifice for would-be inhabitants of the cloaca, or another hazard for young crabs seeking the cloacal opening of their host is unknown.

These observations lead to the following tentative conclusions. Evidently, males of *Pinnaxodes floridensis* move about from host to host in search of females. Copulation occurs within the host, before the female reaches maturity. After copulation, sperm are stored in the spermathecae of the female. Shortly after the female undergoes the maturation molt, oviposition occurs. Males persist in the population during the egg-bearing period, in contrast with the disappearance of *Pinnotheres ostreum* males after copulation (Christensen and McDermott, 1958). The eggs begin development, are released, and continue larval development in the water. In view of the collection of young stages from the host, this species must invade its host at an

early stage, perhaps the first crab which Christensen and McDermott regard as the infective stage in *Pinnotheres.*

## Commensal Bryozoan

Of 174 adult crabs recovered, ten contained colonies of the stolonate ectoproct *Tricitella elongata* (Osburn) living commensally upon the legs and lateral surfaces of the carapace. This bryozoan has previously been reported in the gill chambers and on the legs of *Callinectes sapidus, Libinia* sp., and *Hepatus epheliticus,* and on the commensal crab *Pinnixa chaetopterana* found in the tubes of the polychaete *Chaetopterus variopedatus* (Maturo, 1957). Its collection on *Pinnaxodes floridensis* is a new record for that species, and an extension of its range from the middle Atlantic Coast (Massachusetts to North Carolina) to the northern Gulf of Mexico.

## Relationship to Host

The relationship between *P. floridensis* and *T. princeps* is definitely commensal. While the crab receives protection and obtains food from water currents in the respiratory tree of the holothurian, the holothurian apparently does not suffer from its presence there. Because the respiratory tree opens at the posterior end of the holothurian, *P. floridensis* does not steal food that otherwise would be utilized by its host.

Like commensal crabs of the genera *Scleroplax* and *Pinnixa,* which are able to filter food from water by their feathery mouth parts (MacGinitie and MacGinitie, 1949), *Pinnaxodes floridensis* bears long hairs on its mouthparts. Utilizing bands of hair on the chelae and anterolateral regions, in addition to its feathery mouthparts, this species must be able to filter food particles from the water in a similar fashion.

Such a feeding method contrasts with that employed by most crabs of the genus *Pinnotheres,* which typically live in the mantle cavity of bivalves. The oyster crab, *Pinnotheres ostreum,* a typical example, ingests food which has been filtered and aggregated into strands by the oyster's gills (Christensen and McDermott, 1958).

The habitat of *P. floridensis* may appear to be a poor location when compared with that of other commensal crabs. In the branchial region of bivalves, in the test of tunicates, and in the U-shaped tube of *Chaetopterus,* commensal crabs are presented a unidirectional

flow of water. However, because the holothurian circulates water in and out of the same aperture, the flow in the holothurian respiratory system must reverse direction frequently. Certain crabs of the genus *Pinnixa* may live in worm holes in loose sand where the flow of water similarly reverses at intervals, as it does in the respiratory tree of a holothurian. The many crabs which obtain their food directly or indirectly from a unidirectional current are probably more efficient in their food gathering operations than those species obtaining their food from such a reversing current. The presence of sizable colonies of the bryozoan *Triticella elongata* on the carapace of *P. floridensis* indicates that a plentiful supply of food occurs in water circulating in the respiratory system. This bryozoan feeds on plankton, and is often found in the branchial chamber of much larger decapods, where it collects food from respiratory currents maintained by its decapod host.

## Discussion

Because the degree of fusion of ischium and merus of the maxilliped is an important character in the separation of genera in the Pinnotheridae, the observed disparity between the sexes could lead to individual specimens of this species being placed in different genera, or even subfamilies. In her definition of the genus *Pinnaxodes*, based on known species, Rathbun (1918) noted that the merus is either fused or partly fused with the ischium of the outer maxilliped. Whereas the female *P. floridensis* falls within this definition, the male does not fit because of the complete separation of merus and ischium. On the basis of other characters, *floridensis* should be placed in *Pinnaxodes*. Therefore, the definition of the genus given by Rathbun is here emended to account for the condition of the male maxilliped in *floridensis*: merus and ischium fused, partly fused, or separate.

In her treatment of the grapsoid crabs of America Rathbun (1918) included a species from Brazil (*P. tomentosa* Ortmann) in the genus *Pinnaxodes*. As she suggested at that time, *P. tomentosa* should be considered a species of *Pinnotheres*. This leaves *Pinnaxodes floridensis* the only known representative of the genus in Atlantic waters.

The brief, superficial description of *Pinnotheres hirtimanus* Milne-Edwards (1853) would apply to *Pinnaxodes floridensis*, particularly in regard to the possession of a row of hair on the chelae. Because that species had been described twelve years before the genus *Pinn-*

*axodes* was separated from *Pinnotheres,* and because it was poorly known, it was possible that this holothurian commensal was *P. hirtimanus.* Through the generous cooperation of Dr. Jacques Forest of the Paris Museum, specimens of *Pinnaxodes floridensis* have been compared with the type and only known specimen of *Pinnotheres hirtimanus.* Whereas the carapace of that species is thin and fragile, the carapace of *Pinnaxodes floridensis* is firm; there are many additional characters that separate these two entities.

*Pinnaxodes floridensis* is to be compared with two Pacific Coast representatives of this genus, *P. chilensis* (Milne-Edwards) and *P. silvestrii* (Nobili). While the legs of *P. floridensis* are much shorter than in *chilensis,* they are not as stout as in *silvestrii;* additionally, details of the maxillipeds separate it from both of these species. Although *P. floridensis* shares a coloration of red spots with *Opisthopus transversus* Rathbun, also of the Pacific Coast, a different shape to the carapace and maxillipeds readily serve to distinguish that somewhat related species.

## Acknowledgments

The authors wish to express their appreciation to Dr. Elisabeth Deichmann of the Museum of Comparative Zoology, Harvard, for identifying the holothurian; and to Dr. Jacques Forest of the Muséum National d'Histoire Naturelle, Paris, for comparing specimens with the type of *P. hirtimanus.*

## Literature Cited

Bürger, O.
1895. Ein Beitrag zur Kenntniss der Pinnotherinen. Zool. Jahrb. Abt. Syst., *8:* 361-390.

Chopra, B.
1931. Further notes on Crustacea Decapoda in the Indian Museum. II. On some Decapod Crustacea found in the cloaca of holothurians. Rec. Indian Mus., *33:* 303-325.

Christensen, A. M. and J. J. McDermott
1958. Life history and biology of the oyster crab, *Pinnotheres ostreum* Say. Biol. Bull., *114:* 146-179.

Deichmann, Elisabeth
1954. The holothurians of the Gulf of Mexico. *In* Gulf of Mexico: Its Origin, Waters, and Marine Life. U.S. Fish & Wildlife Serv., Fishery Bull., *89:* 381-410.

MacGinitie, G. E. and N. MacGinitie
1949. Natural History of Marine Animals. McGraw-Hill Book Co., New York, 473 pp.

MATURO, F. J. S.
1957. A study of the bryozoa of Beaufort, North Carolina, and vicinity. J. Elisha Mitchell Soc., *73:* 11-68.

MILNE-EDWARDS, H.
1852. Mémoire sur les famillie des Ocypodiens. Ann. Sci. nat., sér. 3, *20:* 163-228.

RATHBUN, MARY J.
1918. The grapsoid crabs of America. Bull. U. S. nat. Mus., *97:* 1-461.

SAKAI, T.
1939. Studies on the Crabs of Japan. IV. Brachygnatha, Brachyrhyncha. Tokyo, pp. 365-741.

TAO, L.
1930. Notes on the ecology and physiology of *Caudina chilensis* (Müller), in Matsu Bay. Pacific Sci. Congr., *3:* 7-11.

TESCH, J. J.
1918. The Decapoda Brachyura of the Siboga Expedioitn. II. Goneplacidae and Pinnotheridae. Siboga-Expeditie, *39C (pt. 1):* 1-295.