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**PENAEUS KERATHURUS FORSKAL,  
A PROTANDRIC HERMAPHRODITE**

by

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ABSTRACT

Il paraît, par des mesures et des analyses morphologiques, que *Penaeus kerathurus* Forskal est un hermaphrodite protandrique qui dans sa seconde année devient un mâle, et dans sa troisième une femelle, puis elle meurt après le frai. Il semble que la transformation d'un mâle en femelle n'implique aucune augmentation de mortalité.

In May 1971 I visited Tunisia and through courtesy from the government's marine biological station INSTOP in Salammbô I had the opportunity to go out with their fishing steamer for collecting *Penaeus kerathurus* in the Bay of Tunis. We were not very succesful on that trip as regards *Penaeus*. In two days fishing, we only got 47 specimens, both males and females, all with unripe gonads. I therefore went to Sfax, the Tunesian goverment landing port for « des crevettes », where the prawns were brought in in large numbers from the Gulf of Tunis (région de Radès). Also here the *Penaeus* showed sexual immaturity in the last part of May. An examination of the gonads indicated that spawning would not likely take place before the end of June — midle of July, which also agreed with the experience of the local fishermen.

From the catch brought in, a crate of unsorted prawns, totaling 572 specimens, were sex-determined and measured. Measurements were taken from the tip of the rostrum to the distal tip of the telson plate. This gave 253 males and 319 females, of which 30 specimens (« females ») were in an intersexual stage with no petasma, and the female thelycium was not yet fully developed. These intersexual specimens were as large as the largest males and the smallest females, falling in the overlapping area of the male and female size-curve.

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Fig. 1. A shows the first pleopod of a male with the endopods from both sides grown together and shaping the petasma. Fig. 1. B shows part of the first pleopod of an intersexual female. The petasma has been lost and instead an endopod has grown out. It is known from the law of Dollo (1893) that an organ which once has been lost can never be replaced in the normal way again. Therefore the endopod of the asexual, juvenile form, where exopod and endopod on the pleopods are nearly equal, can never be reestablished in the same way. The endopod is here after the male stage has passed, two-jointed, but without movability between the first and second joint, and as can be seen on Fig. 1. B, it is very small and without any function. It has become a vestige of an endopod once placed here in the juvenile days of the prawn's life.

In the fully grown female with growing ovary, although not ripe for spawning at the time of the investigation, the endopod of the first pleopod looked the same as in the intermediate stage (Fig. 1. C, D). Some of the endopods had a few abnormally developed plumose setae, as shown on the figures. These setae may be placed on the medial side either on the first or on the second joint. Such smaller variations are typical for vestigial organs. These anatomical facts strongly suggest that *Penaeus kerathurus* is a protandric hermaphrodite. This is in no way surprising, as it has been found in later years that protandric hermaphroditism is the general rule for the major part of the group *Penaeus*, as well as occurring in several other species belonging to the penaeid group (Mistakidis 1970).

The number of males and females caught gave 20 % more females than males; while this may seem to argue against protandric hermaphroditism, one must remember that the material came from a commercial catch, where the meshes of the trawl used are relatively large, being 50 mm in the arms and 24 mm in the front and main part of the bag. This will allow many of the smaller males and all the juveniles, if they already should be there, to escape, which of course both from a commercial as well as from an ecological point of view is most desirable. One might ask whether the mesh-size of the trawl not should be further increased in order to let most of the males escape and thus give a higher quality fished prawn and a larger tonnage in the final catch through waiting to catch them till they have grown into larger females.

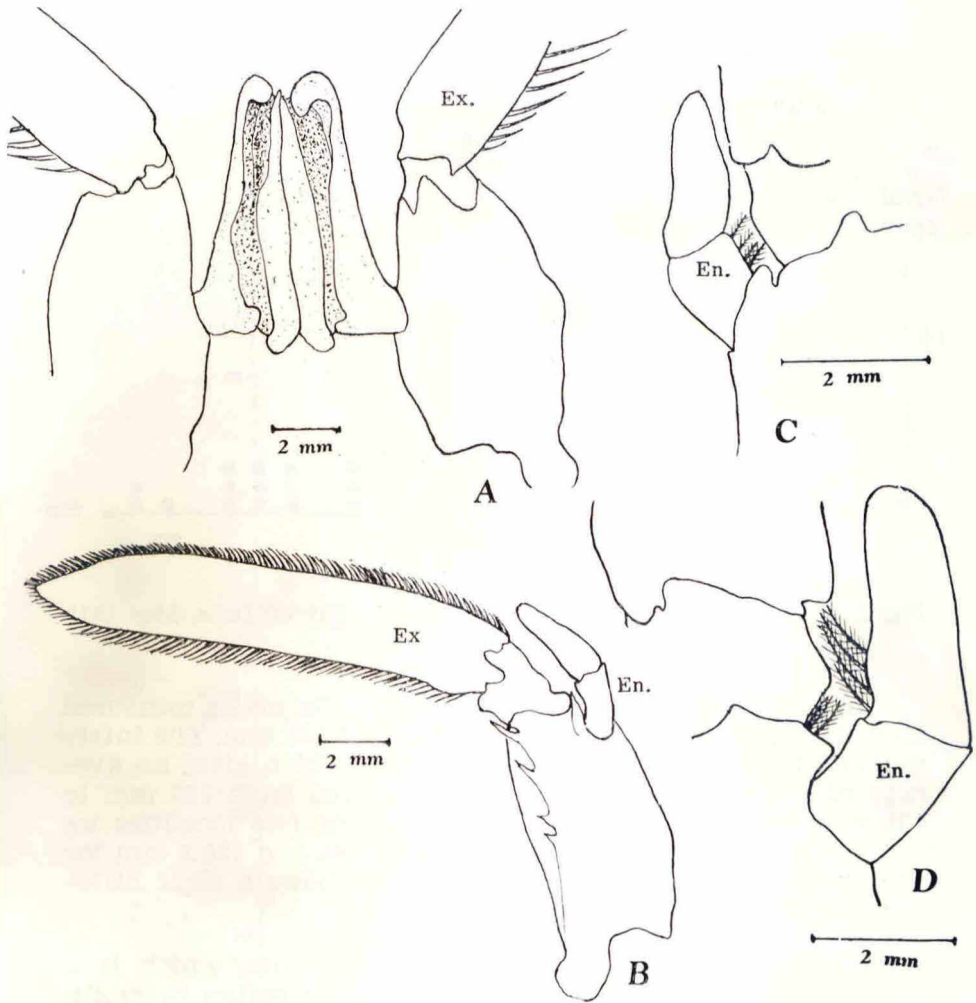


Fig. 1. A : Part of first pleopod in the male showing the transformed endopod shaping the petasma; B : Same from an intersexual specimen showing the vestigial endopod C-D : Part of first pleopod of fully transformed females giving two examples of the development of the endopod.

When looking at the size-curves of catches from the Bay (Fig. 2) and the Gulf of Tunis (Fig. 3), it can be seen that in the catches of the Bay the size of the males goes from 130 mm to 170 mm, the intermediate forms from 140 mm to 165 mm and the females from 150 to 205 mm, which gives an average of 150 mm for the males, and 170 mm for the females, the females averaging 20 mm larger than the males.

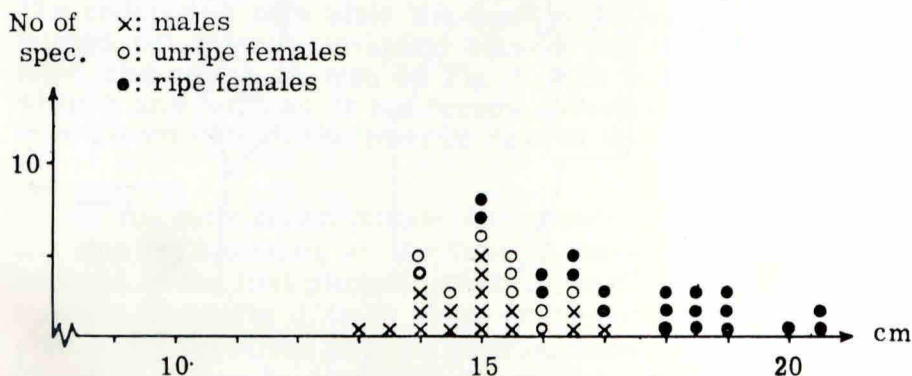


Fig. 2. Specimens of *Penaeus kerathurus* from the Bay of Tunis, May 1971.

In the catch from the Gulf (Fig. 3) the males measured from 95 mm to 165 mm with an average of 135 mm. The intermediate forms were 115 mm to 155 mm, which gives an average of 150 mm, and the females measured from 120 mm to 195 mm, average 155 mm. In total for the two localities we have an average of 135.4 mm for the males and 156.2 mm for the females. Although overlapping, this shows a clear difference in length of nearly 21 mm.

Heldt (1932) has under *Penaeus caramote*, which is a synonym for *P. kerathurus*, shown the sex difference in length from 22 different catches. The catches were distributed throughout the year and taken at different localities in Tunis : Porto-Farina, the mouth of Medjerda, Bizerte, Gulf of Tunis, Sfax and from lac des Bibans, but there is no information of which catch is from where. However, Heldt gives date of catches, number of males and females from each catch and the maximum, minimum and average length of each sex from each catch. Taking the average of her averages, counting in the number of each catch, I reach an average length of 130.9 mm for the males and 147.2 mm for the females, which gives a sex difference of 16.3 mm.

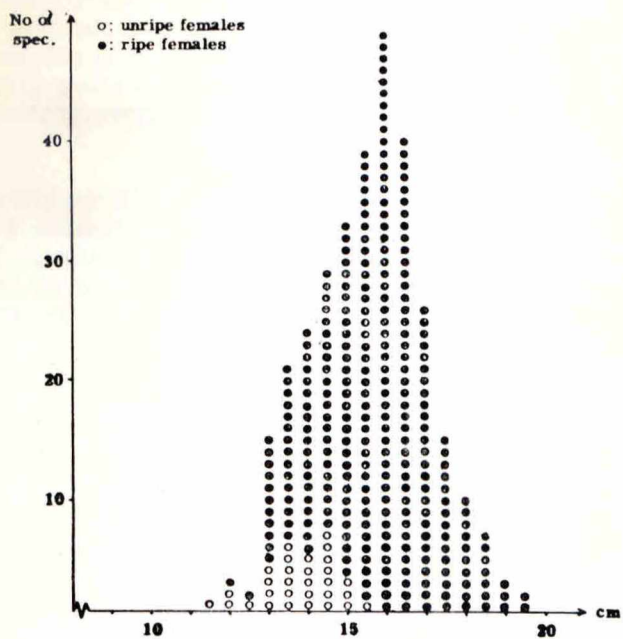
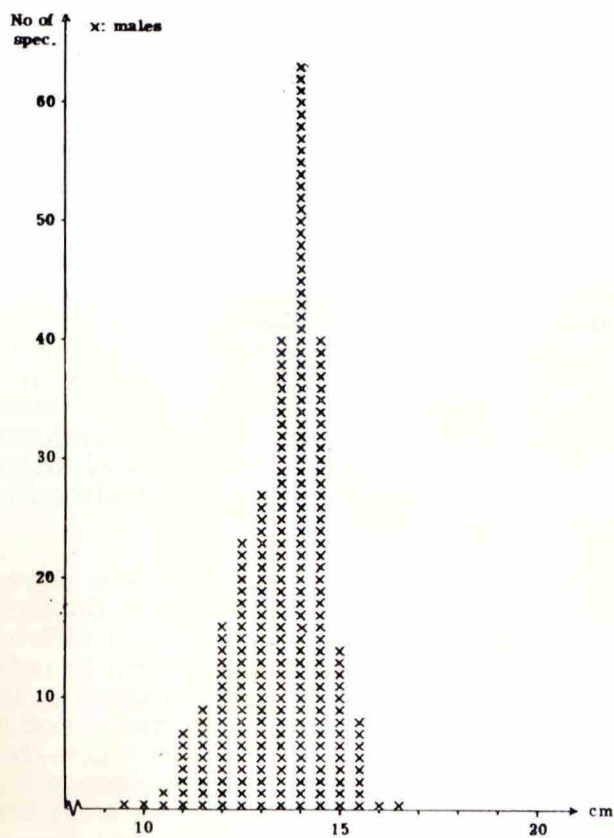


Fig. 3. Examined material of *Penaeus kerathurus* from the Gulf of Tunis, landed in Sfax, May 1971.

As can be seen, these three figures are slightly smaller than the corresponding ones of mine, but as we shall see, the spawned females dies after spawning, and sex change from male to female may mainly take place shortly after the breeding season, which will give the largest prawns around the time for the breeding season, and the smallest when the spawned females have died, which also can be read out of Heldt's figures. Therefore the average figures for the year (Heldt) must be smaller than the average figures during the breeding season (mine). Because of the small number of specimens available, both in Heldt's material and in mine, the figures must be taken with reservation. Heldt's material consists of a total of 594 specimens, 296 males and 298 females, and is further, as mentioned, divided into 22 samples taken at different dates and from different places, although all along the coast of Tunesia.

With reference to season, Heldt's figures show that the female prawns are largest in September to October, but not the males, which therefore gives the largest differences between the sexes in these months. This seems to indicate that the females are still alive and continue growing to the end of October while the males have a retarded period of growth just after spawning. It may be the time when the internal changes from male to female are taking place in the gonads, which does not allow ecdyses and growth during that period. It may also be caused by the yet unspawned females, which increase in size during late summer and thereby enlarge the size gap between the sexes during the late summer months. Again, the limited number of observations must be kept in mind; the figures are not reliable enough to allow any definite statements in this direction and further investigations would be most desirable.

Figure 4 shows my total catches of the three groups : males, females, and intersexual specimens. For each group the number of individuals is plotted against their length. The male and female curves overlap for about one third of the specimens, in which overlapping space the curve for the intersexual specimens is found.

These curves show that males measure from 95 mm to 165 mm, with an average of 135.4 mm. The curve peaks at 140 mm. The females range from 115 mm to 205 mm in length, the average being 156.2 mm, and the female curve peaks at 160 mm. This gives an average difference between the sexes of nearly 21 mm. All these figures, as well as those of Heldt, indicate a protandric change of sexes. In my material the average growth in length during the year from male to female

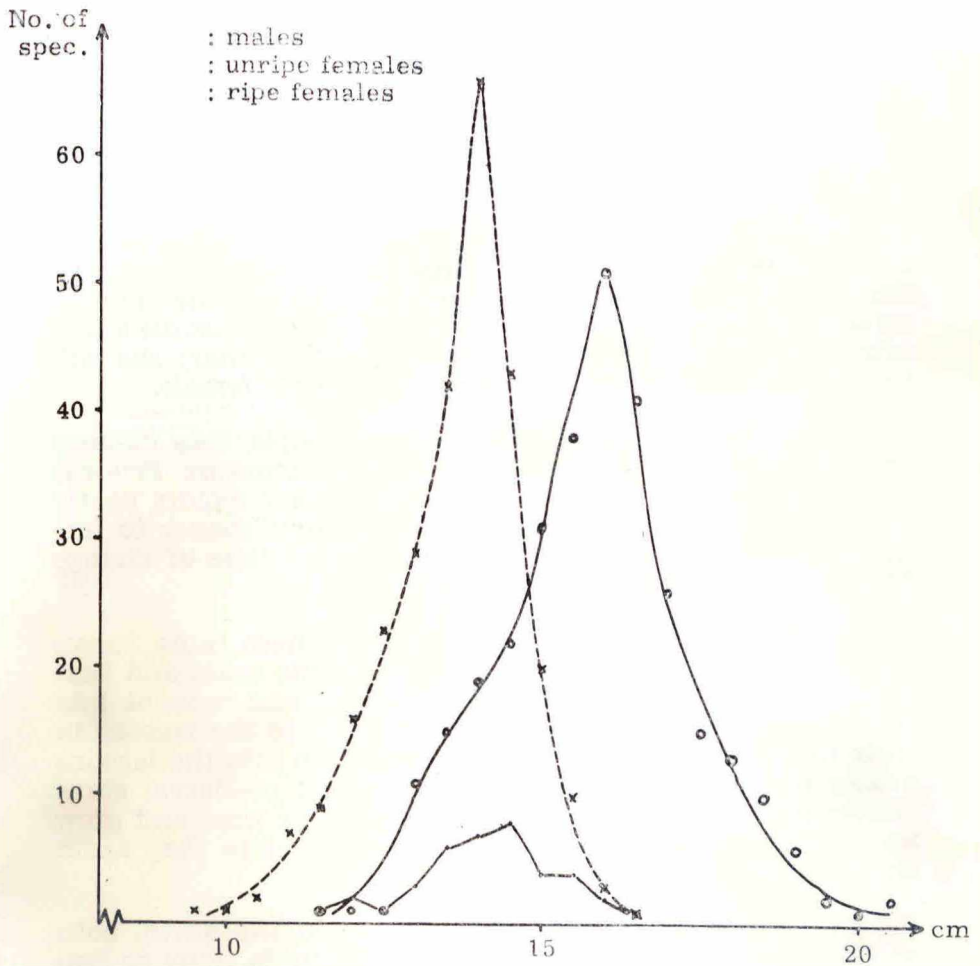


Fig. 4. *Penaeus kerathurus* from the coast of Tunisia giving curves of males, intersexual specimens and females.

is only 20.8 mm, but the female has at the same time grown much stouter, so that the total weight has nearly doubled, which gives a better understanding of the figures. As both males and females are found throughout the year, we must conclude that the females are one year older than the males as both the male and the female curves have only one peak. It must thus be reasonable to assume that each curve represents a single year-group.

Going back to the catch taken in May with an average male length of 135 mm, and remembering that the spawning took place in the middle of July or later, it does not seem likely that the male within less than ten months is able to grow from a Nauplius of about 0.3 mm to an adult male of 135 mm, or in about eight months, of which at least half of the time is during winter, from a postlarval stage of 6-7 mm to the size of the ripe male. Therefore the male must already be about two years old when it reaches the breeding season, which gives three years to the female, and because there is no second peak on the female curve, the female must die either after spawning or during the autumn and winter; she will never reach the second spawning season as a female.

When discussing this with the local people, they claimed that they had never found such young immature *Penaeus kerathurus*, which must be somewhere if they require nearly two years to grow to mature males or have a chance to fertilize the eggs of the females, as the exact time of change from juvenile to male is as yet unknown.

It is known from other penaeid species from India, Japan and America that the adults spawn near the coast and that the larvae are transported by the current and brought into the brackish lagoons. They reach the inlets to the lagoons in their first and second Mysis stage and reach into the lagoons proper in their second Mysis stage or first postlarval stage (Heegaard 1953). Here they remain for some time and grow up in this area to a length of 50-100 mm before they again leave the lagoons for the open ocean.

In Tunisia such large lagoons occur in the North, both at Bizerte and Tunis, and in the South partly in Golfe de Bou Grara and in the many Sebkhass, which are plentiful along the southern coast of Tunisia. It should be of interest to see if the first year prawns not are to be found in these waters.

Finally it is of interest to see the consequences of the change of sex. Do these relatively large, especially internal, changes have a negative influence with a much higher mortality in this section of the shrimp's life? Figure 5 therefore gives the curve of the whole catch, both males and females, on size and number with a sex change size at the bottom, between 125 mm and 155 mm. The curve shows clearly that this part is also the peak of the curve with the largest number of prawns, which indicates that sex change has no larger influence on the mortality. Of course it must be remembered that this only represents a small catch and therefore may have the possibility of slight errors.

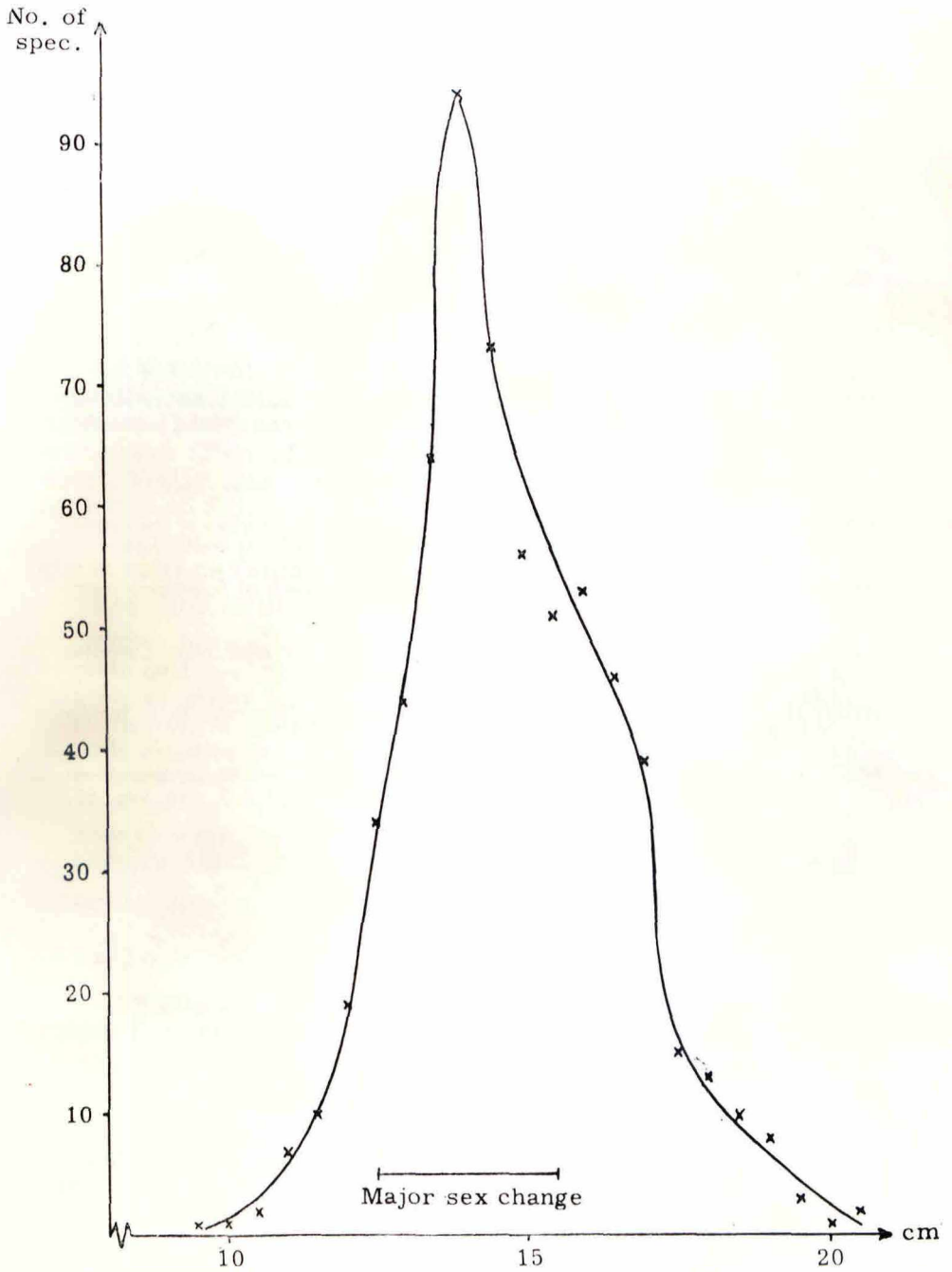


Fig. 5. Curve of total examined specimens of *Penaeus kerathurus* with a length measure for specimens in the change of sex.

### Aknowledgements

It is my pleasant duty to thank INSTOP, Salammbô, the Government Fishing Center at Sfax, and the Mediterranean Marine Sorting Center, Khereddine for kind help, support, and hospitality, together with thanks to the Danish Carlsberg Foundation whose grant covered expenses in connection with the visit.

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