International Council for the
Exploration of the Sea

C.M.1968/K:2

Shellfish and Benthos Committee

On the Biology of Shrimps (Penaeus duorarum Burkenroad) from the Biafra Bay

by

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The work presented here was undertaken because the biological features of P. duorarum from the African coast were almost unknown. The collection of material was made on board the vessel SRT-R 9086 in the eastern Guinea Gulf outside the fishery zone, in the Biafra Bay, at the mouth of the rivers Niger, Calabar and Cameroon. The material was collected at the end of the dry period and at the beginning of the wet period (May-June 1967). During two months of observation 140 analyses of shrimp catches were made. The shrimps were measured from the base of the eye to the end of the telson. About 25.000 specimens were measured altogether. In addition, the sex, the condition of carapax and the presence or absence of spermatophores in the moulting females' telycum were determined.

At the mouth of all three rivers shrimps of a length of 100-110 mm prefer a depth of 40-45 m, while the larger shrimps were found at all depths down to 70 m (Figure 1).

Shrimps with a mode of 107 mm were found in the largest catches taken at the mouth of all three rivers. The larger the mode of shrimp length in the catch, the smaller were the catches themselves (Figure 2). In the catches where shrimps were found individually, only very large specimens were observed.

The optimal near-bottom temperature for the shrimps was 20-21°C during the period of investigation. The depth of the optimal temperature varied according to the interaction of tidal currents with the river discharges. Due to this interaction (Figure 3-A), in May during the syzygies the optimal temperatures were observed at lesser depths than at the neap tide. In June the general picture was disturbed. After the last syzygy the optimal temperature displacement to lesser depths continued. This may be attributed to the increase in inshore discharge after the beginning of the rainy period in June.

The changes in the average size of the shrimp by five-day intervals (Figure 3-B) show that the average size decreases considerably at the time of syzygies. This is due to the fact that by this time the young individuals approach the fishing grounds, using the ebb currents for easing the movement. After the second half of June a large, constant arrival of young individuals is observed, which coincides in time with the development of the rainy period and, therefore, with the increase in inshore discharge.

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The changes in depth with the optimal temperature for shrimp compared with changes in the average size during two months (Figure 3) show that in the Biafra Bay there is a double mechanism easing the departure of young specimens from the estuaries, since not only the syzygial ebbs help them, but also the optimal temperatures are found at lesser depths in June, and, consequently, the extent of the movements of the young specimens decreases.

The males are generally much smaller than the females. From the graphs (Figure 4, A, B) it is seen that the length of males is not more than 137 mm, the proportion of males below 120 mm being not more than 5-8 %. The females from the Bay are much greater, their lengths reaching 175 mm. This difference may be due to one of two reasons: either the females have a longer life, or they grow faster than the males. We assume the second hypothesis. If the females had a longer life, there would be several peaks in the size-curves of the females, but only two such peaks were, however, observed, and they coincided with the time of approach of the young individuals.

Secondly, it may be noted that the left parts of the graphs, i.e. the males and females just coming out from the estuaries, coincide very well by size and number. This coincidence is observed up to sizes of 90-95 mm.

At last, the proportion of moulting females almost always exceeds the number of moulting males (Figure 5). Only in the periods when young individuals are leaving, the numbers become nearly equal, and this agrees well with the number and size coincidence of young males and females, as was pointed out in Figure 4.

It may thus be deduced that the females on leaving the estuaries begin to grow faster than the males. The rate of growth may be approximately determined by the shifting of the mode by five-day intervals. For males the growth rate is considerably lower than that of the females. Only a part of the males increase in length by 10 mm during one month, while the females increase in length by 30-35 mm at the same time. It may be noted (for females) that the growth rate decreases as the individuals grow. This is particularly well seen in May. In the second five-day period the size of the females increases by approximately 15 mm as compared to the first one. In the following five-day period the increase was 7-10 mm, and after the fourth five-day period the increase was only 5 mm.

The copulation takes place between moulting females and non-moulting males (Cummings, 1961). We also observed fresh spermatophores only in females without the firm carapax. In addition, moulting females were always in maturity stage II (or in stage I, if they were maturing for the first time). Females in stages III, IV and V at which the maturing of the ovocyte takes place are never moulting. This allows the conclusion that the fecundation of this species of shrimps stimulates the beginning of maturing of the ovary, and the shrimp does not grow during the maturing period.

However, we constantly found moulting shrimps without spermatophores. Therefore, not every moulting is accompanied by fecundation, and we can thus divide all moulting into two groups:- feeding moultings and reproductive moultings. If we again refer to Figure 5, we can see that the average proportion of moulting females is greater than that of the moulting young individuals. As to the males, the position is reverse: the average proportion of moulting males is less than that of the moulting young specimens. Thus, we can assume that the males have no special moultings connected with reproduction.

When studying the size composition of the moulting females with and without spermatophores (Figure 6) one can see that the first peak of abundance for moulting females without spermatophores refers to females of 117 mm in length, the overwhelming majority of which are immature. Frequent moultings of young specimens just after they arrive to the shelf, is the reason for their fast growth during this period.

The first peak of abundance of females without the spermatophores is followed by a peak of abundance of fertilized females with a mode of 122 mm. From this moment the shrimps may be considered mature. Then the second peak of females without spermatophores, with a mode of 132 mm, follows; this is in turn followed by the second peak of fertilized females.

From this two conclusions can be drawn. Firstly, the shrimps have periods of feeding and periods of reproduction. In the feeding period the shrimp grows, in the reproduction period it does not grow, but its gonads develop. Secondly, the shrimp spawn not less than twice during their life, and probably more than twice. This may be concluded from the fact that in the catches females filled with eggs and being 150-170 mm long - and therefore spawning at least for the third time - are regularly found.

From the above conclusions, the biology of P. duorarum from the Biafra Bay can be described as follows:-

P. duorarum has a short life-cycle, about 1.5 to 2 years (Williams, 1965), 6 to 8 months of this period it is living in estuaries (Manning, 1963). The young individuals 70-100 mm long (average 90 mm) come into the shelf area from the estuaries with the syzygial ebbs or with an increased inshore discharge in the rainy period, and direct to the shelf areas with optimal temperatures and with a depth of not more than 45 m. In these areas the males continue their growth at approximately the same rate as before. The females moult more actively at this time, grow fastly and attain a length of about 120 mm in a month. Thereafter, the reproductive moultings are observed, accompanied by copulation, stimulating the development of the females' gonads. This development of the gonads lasts for approximately one month, and the shrimp is not growing during that period. After spawning, there is a feeding period, during which the shrimp again moults and grows. It may be supposed that this period lasts approximately 2 months, during which the shrimp attains a length of 140 mm on an average, then it undergoes a new reproductive moulting, and gonads again begin to develop. The females of this size are less bound to the optimal temperatures and are distributed more or less evenly at all depths.

References

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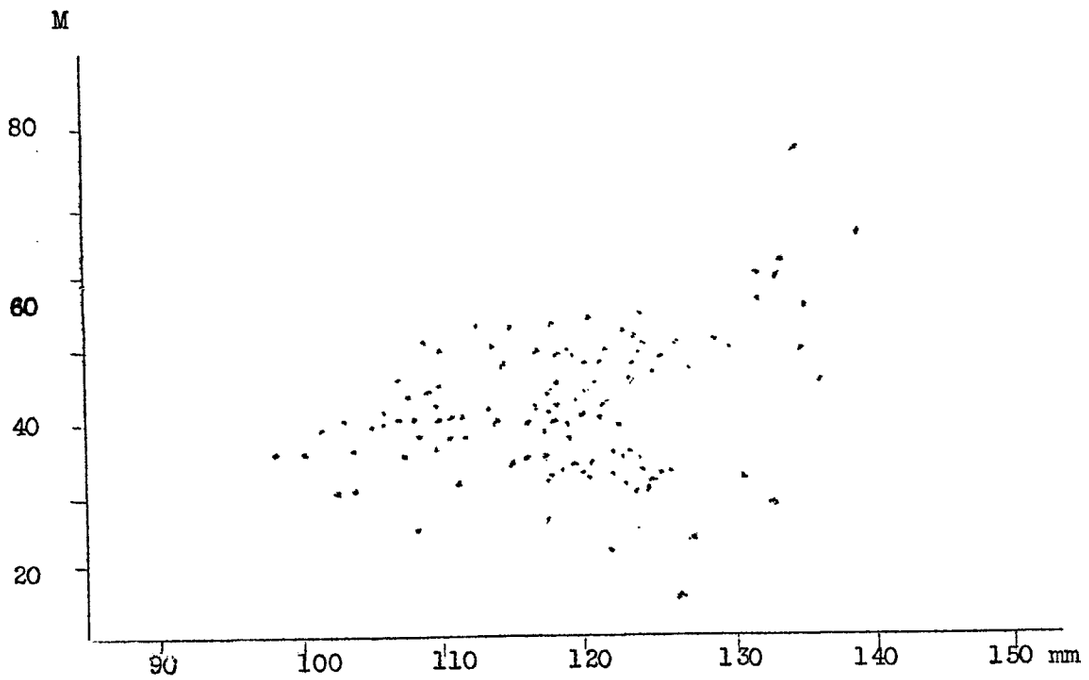

Figure 1. Distribution of shrimps of different sizes according to depths (X-axis: the length of shrimps; Y-axis: depth in metres).

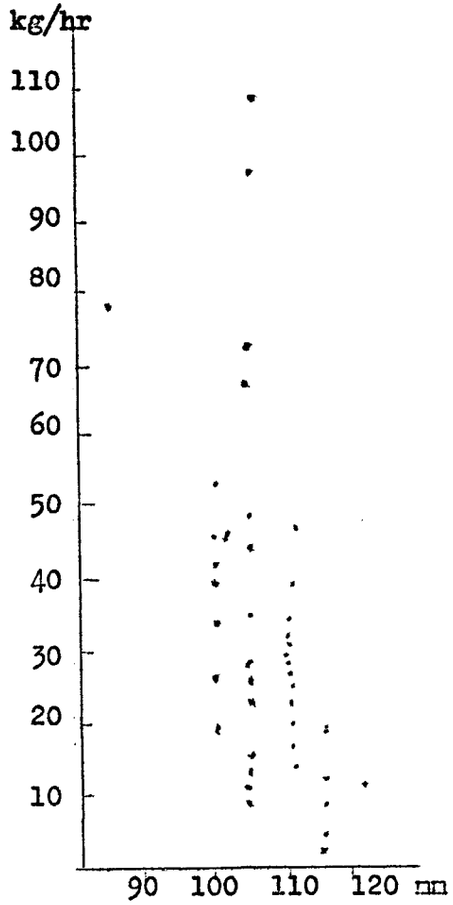

Figure 2. Interdependence between the catches and the nodal sizes of shrimps.

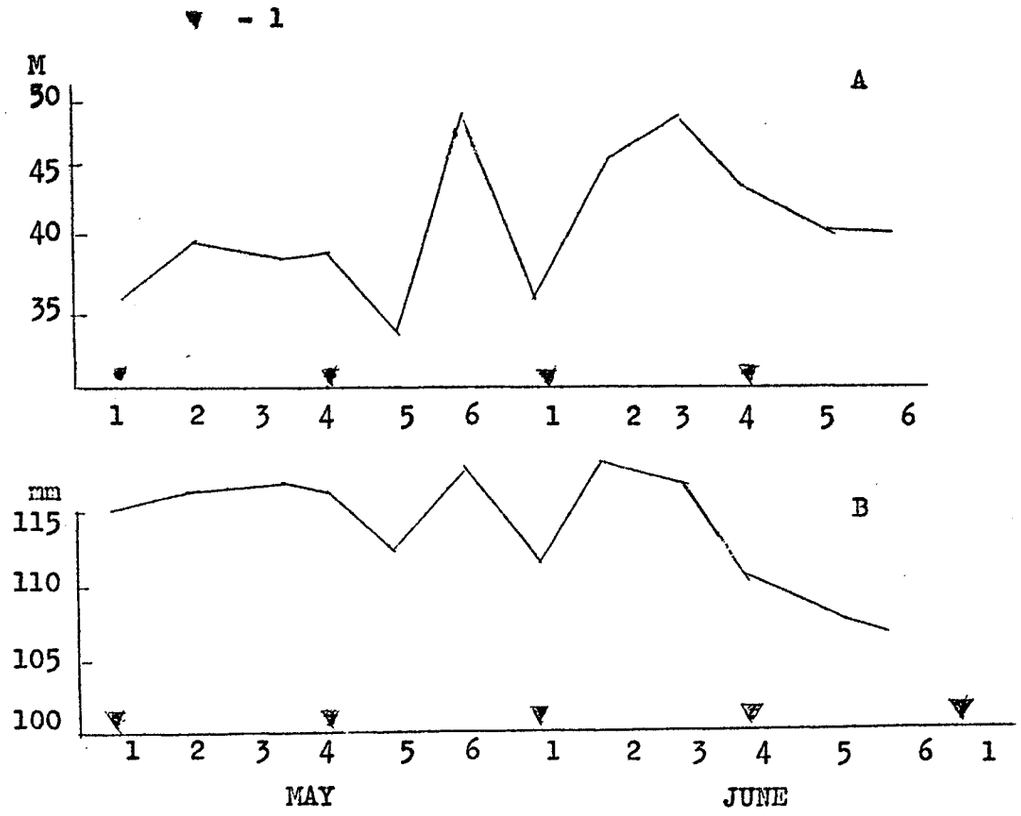

Figure 3. A. Variations in the depth of optimal temperature in May-June.

B. Changes in the average size of shrimps in the Biafra Bay in 5-day periods in May-June.

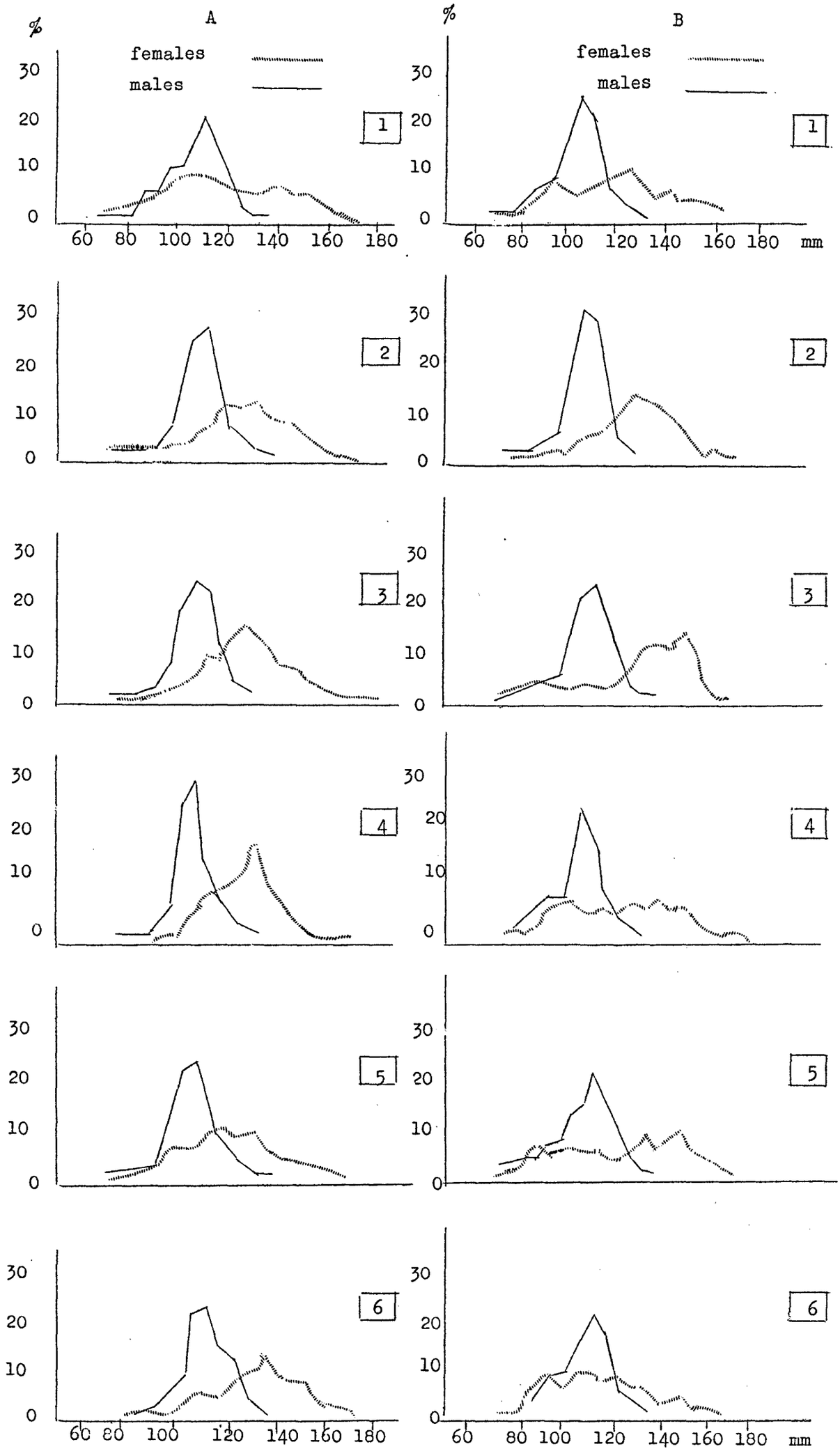

Figure 4. Changes of shrimp size composition by five-day periods in May and June. A: May, B: June. In squares: numbers are five-day periods.

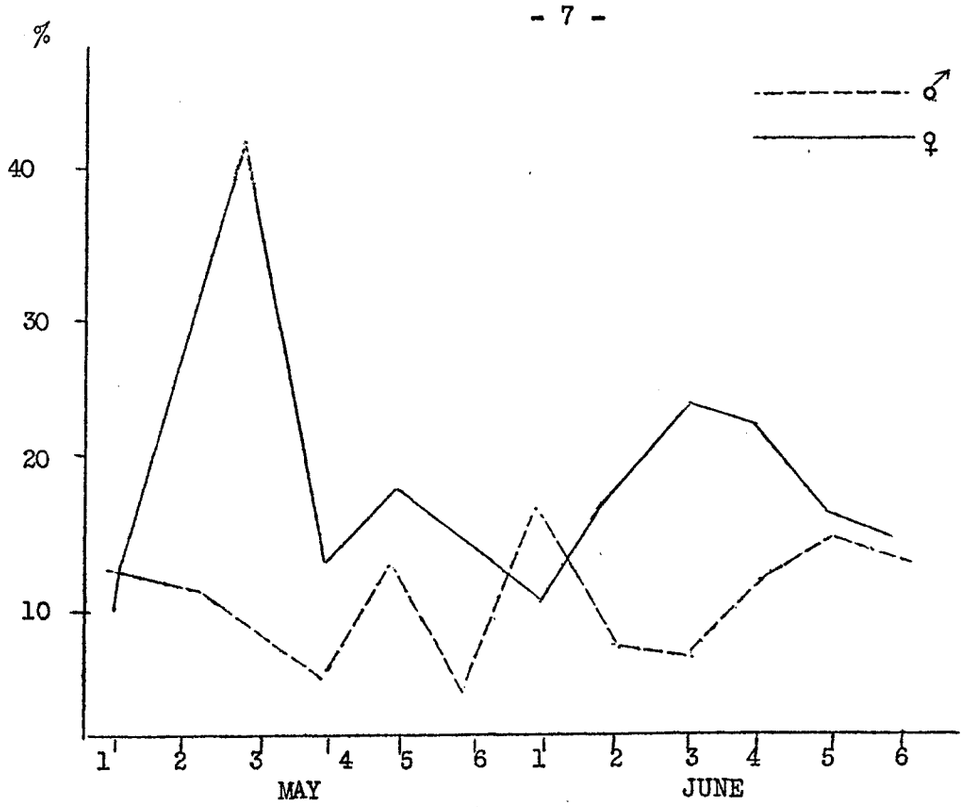

Figure 5. Changes in percentage of moulting shrimps in May-June (X-axis: five-day periods).

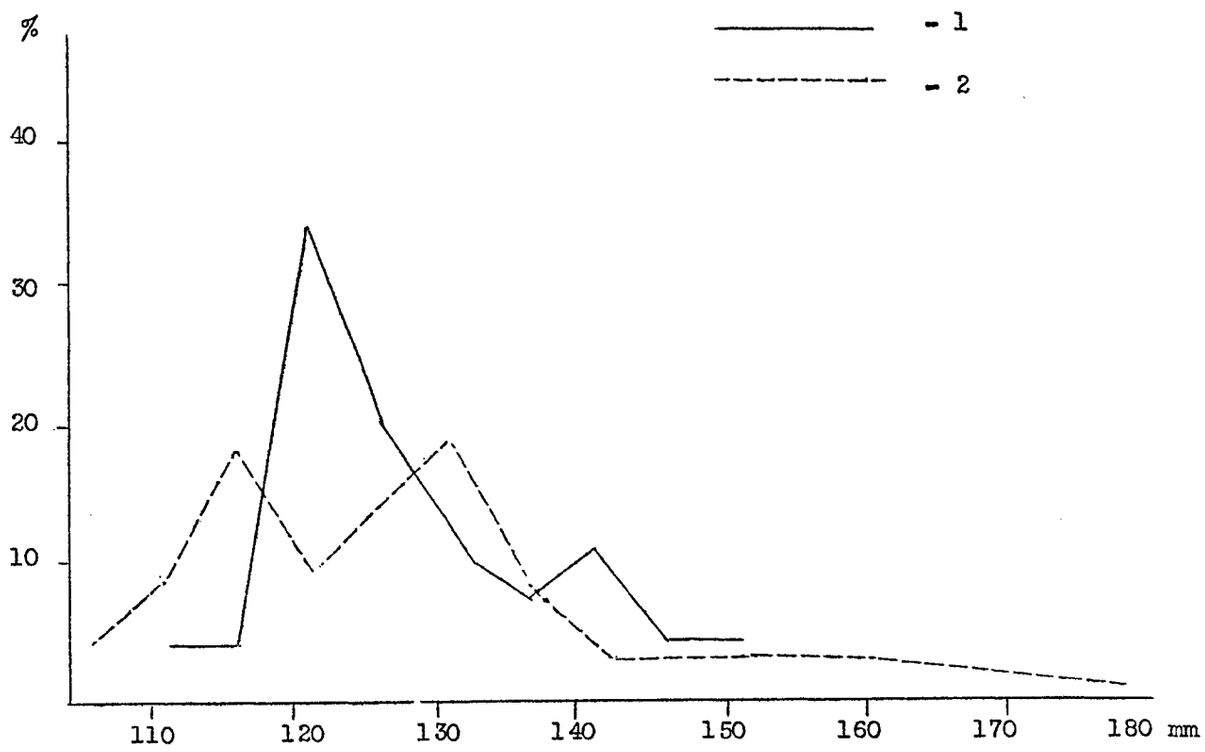

Figure 6. Size composition of moulting shrimps.

1 - with spermatophores.
2 - without spermatophores.