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ON THE BIOLOGY OF SOME PENAEID SHRIMPS LANDED IN PORTUGAL,
WITH SPECIAL REFERENCE TO *PENAEUS DUORARUM* BURKENROAD

by

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Introduction

Penaeid shrimps are found in scarce quantities in the Portuguese waters. Apart from three species of economical value, which occur off the south coast of Portugal, namely, *Parapenaeus longirostris*, *Aristeus antennatus* and *Aristeomorpha foliacea*, the bulk of penaeid shrimps landed in Portugal is caught by commercial trawlers off the west coast of Africa.

This fishery in african waters has been started quite recently and consists mainly of *Penaeus duorarum*, *Plesiopenaeus edwardsianus* and still *Parapenaeus longirostris* that strikingly differs from those caught on Portuguese coast by its much lower size.

In view of this diversity of species and of their different origin and because very few is still known of their biology, both in portuguese and african waters, a research program, regarding in particular the reproduction of stated species, has been commenced since December 1967, at the Instituto de Biologia Marítima, Lisboa.

Methods

Samples of a variable number of individuals have been obtained at the market, in Lisbon, since December 1967 till June 1968. These included all the referred species, but a special attention has been paid to Penaeus duorarum on account of both its greater availability during the first two months of observations and of its higher commercial value. All the specimens have been observed, measured and weighed in fresh condition, and the carapace length, recorded to the lowest millimeter, has been adopted as the standard measurement. Further measurements have been obtained, namely, the total length, the abdomen, the telson and the rostrum lengths, all in millimeters. All the measurements have been determined as shown in fig.1.

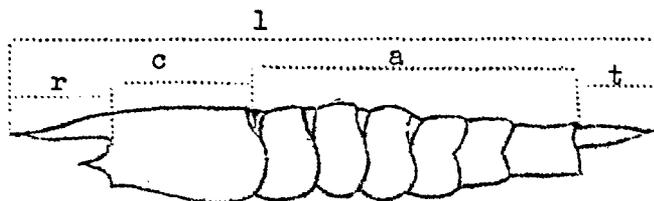


Fig.1 - Penaeid shrimp. Lengths adopted: a, abdomen; c, carapace; l, total; r, rostrum; t, telson

Penaeus duorarum BURKENROAD

The fishery

This species is commonly caught off the north west coast of Africa, between 15° 30' and 20° 05' Lat. N., in depths ranging from 40 to 60 meters. The fishery seems to be mainly confined to the autumn.

The trawlers leave from the portuguese south coast (Algarve) for cruises of about 30 to 35 days. The total catches varied between 710

kg in January and 7,250 kg in September. The higher value of the average capture per hour of trawling was also obtained in September (41,0 kg/h) and the lower in January (12,0 kg/h). Table I shows the results recorded for each cruise.

Sampling

A total of 20 samples of this species (Table II), including 1091 individuals (778 males and 313 females) has been observed at the laboratory, between the 30th November 1967 and the 21st May 1968. These samples, which have been obtained at the market, in Lisboa, were not coming directly from trawlers; they have been kept frozen for several days, weeks or even months before sale, according to market fluctuations. On account of this there has been no possibility of knowing the exact provenance of the material, excepting inferring from the departure and arrival dates of the trawlers.

An attempt was thus made to subdivide the total of the samples in two lots: 1, including samples 1 to 10 which probably came from cruises realized between October and December 1967 (Table I, cruises 4 and 5), thus representing the autumn catches; and 2, including samples 11 to 20, probably caught during the last cruise in January, representing therefore the early winter catches.

The two lots show real differences, as it will be remarked below, on the size distribution of females and on the ovary development.

Size distribution

The size distribution of lots 1 and 2 is shown in fig.2, separately for males and females. The lower classes, up to 29 mm of carapace length, consist mainly of males, which distribution is very similar in both periods. The higher classes (35 mm and above) are nearly all represented by females. The distribution of these shows a

considerable difference between the two periods. In the autumn, the higher classes are well represented, but the size decreases in the winter catches.

The sex-ratio, shown in fig.3, is therefore strongly affected by size; the 32 mm carapace length being obviously the class which approaches the 50 %.

Ovary development

The maturative development of the ovaries has been classified according an arbitrary scale of 5 stages described from fresh material, which runs as follows:

- Stage I - Ovary transparent white, very narrow, not visible through the integument. Eggs not visible to the naked eye.
- Stage II - Ovary transparent pink, narrow, not yet visible through the integument. Eggs still not visible to the naked eye.
- Stage III - Ovary yellowish-brown, transparent, less narrow than the previous stage, already visible through the integument as a narrow stripe along the dorsal surface of the abdomen. Eggs already visible to the naked eye. Central lobes well developed.
- Stage IV - Ovary yellowish-brown, wide, with central lobes very well developed. The stripe visible through the integument of the dorsal surface of the abdomen is wider.
- Stage V - Ovary light brown, wide and voluminous. Central lobes fully developed. The stripe visible along the abdomen occupies all its dorsal surface.

The percentage of the ovary development stages is quite different in lot 1 (autumn) and lot 2 (winter), as shown on next page.

Lots	Stages %				
	I	II	III	IV	V
<u>1</u> - 141 ex	37.6	26.2	24.2	9.2	2.1
<u>2</u> - 172 ex	95.3	4.1	0.6	-	-

During the autumn all stages were present, although stages IV and V were found in a very small percentage. In January, however, the bulk of the ovaries are shown in stage I, thus suggesting that the spawning period was over.

It appears therefore, that unlike the american specimens (Cumings, 1961), which spawn during the spring, the african Penaeus duorarum develops mature ovaries during the autumn, or possibly earlier, in the late summer.

Size maturity in females

The maturity size in females has been estimated during the presumed spawning period (lot 1) by the percentage of developing ovaries (stages II, III, IV and V) in each class of 3 mm of carapace length (Table III).

Females P. duorarum seem to be all mature at the length class of 32 mm. The first maturation is shown at 26 mm of carapace length; below this limit probably all females are immature.

Biometric relations

Carapace length (C), as the standard measurement, has been correlated with total length (L), abdomen length (A), telson (T) and rostrum (R) lengths and with the total weight. For these correlations, lots 1 and 2 have been considered together.

Regression equations have been estimated for the linear measurements separately for males and females. The results are recorded below.

<u>Nº of ex.</u>		<u>Equations</u>	
Males	497	$L=4.12 C + 16.69$	$r=0.997$
Females	186	$L=3.67 C + 26.73$	$r=0.997$
Males	425	$A=2.07 C + 10.06$	$r=0.998$
Females	223	$A=1.83 C + 15.47$	$r=0.998$
Males	383	$T=0.58 C + 1.13$	$r=0.996$
Females	204	$T=0.48 C + 3.25$	$r=0.989$
Males	390	$R=0.46 C + 4.83$	$r=0.996$
Females	189	$R=0.43 C + 5.13$	$r=0.991$

No significant differences seems to exist between sexes although it can be stated that, for the same carapace length, males generally possess a longer abdomen and a longer telson, at least in the lower classes. The size of the rostrum is very similar in both sexes.

No difference have been found between the average weight of males and females in each length class. So, sexes have been considered together and the average weight, in grammes, for each class of 3 mm of carapace length, is plotted on the graphic of the fig.4.

Parapenaacus longirostris(LUCAS)

A total of 26 samples consisting of 2049 individuals (1012 females and 1037 males) captured off the north west atlantic coast of Africa, has been obtained at the market, in Lisboa, between 30th November 1967 and 28th June 1968.

The specimens came from two different origins and were therefore subdivided in two groups: 1, consisting of 11 samples caught between 15º and 20º of Lat. N., and 2, consisting of 16 samples captured between

29° and 32° of Lat. N (Table IV). This shrimp is commonly caught in depths ranging from 200 to 300 meters.

A further sample of Parapenaeus captured off the south coast of Portugal, in the 22th May 1968, has been observed. This, unfortunately consisted of a very small number of individuals, and will be, at the end, confronted with the results of the two african groups. The african groups differ one from another mainly in the following three points: 1 size distribution of the females; 2 sex-ratio; and 3 ovary development.

Figs. 5 a and 5 b represent the size distributions, by classes of 1 mm of carapace length of males and females Parapenaeus longirostris, in groups 1 and 2.

As far as males are concerned, the size distributions of both groups are practically the same. On group 1 it ranges from 16 to 28 mm of carapace length and the best represented classes are 22 and 23 mm; on group 2 the size limits are closer, between 18 and 27 mm, and the best represented classes are somewhat lower, 21 and 22 mm.

Females, however, show a considerable difference between the two groups. The females of group 1 range from 16 to 33 mm of carapace length, and are mostly confined between 21 and 27 mm; those of group 2 range from 16 to 37 mm and are better represented in classes somewhat higher, 23 to 29 mm.

It appears therefore that the distributions of males and females greatly overlap in group 1 and have in common only two well represented classes (23 and 24) in group 2.

The sex-ratio (fig.6) is, consequently, affected, being considerable more in favour of males up to class 23 mm, in group 2 than in group 1. Considering the lot of the individuals, the sex-ration in both groups is, however, very close to the 50 %.

The ovary development is not expected to be processed in both groups during the same seasons. All the females in group 1 showed ovaries in undeveloped stages, and nearly all in group 2 possessed ovaries well developed although advanced stages were found to be rare (fig.7).

With basis on the ovaries of group 2, a scale of their maturative development was essayed, consisting, briefly, of the following four stages:

- Stage I - Ovary pale pink or white, transparent, very narrow, not visible through the integument.
- Stage II - Ovary orange transparent, narrow, already visible through the integument of the abdomen, as a long and narrow orange stripe.
- Stage III - Ovary bright orange, thick, wide, very well visible through the integument of the abdomen and of the cefalotorax as ^a small orange spot on its posterior portion.
- Stage IV - Ovary light brown and wide, very well visible through the integument of the abdomen and of the cefalotorax as a large brown spot on its posterior portion.

It must be noted that the exact date of recolt of the samples remains unknown, for the same reason pointed out above for P. duorarum. However, females from group 1 are expected to represent late winter and early spring catches, and those from group 2 to represent all seasons, except the summer.

Over the winter and early spring, females Parapenaeus caught between 15° and 20° Lat. N show therefore undeveloped ovaries; whereas those captured between 29° and 32° Lat. N over the same period, present great part of the ovaries in developing stages.

Nothing is consequently known about the spawning of group 1, but in group 2 females seem to be able to develop ovaries throughout the

year.

The eighteen specimens caught in May 1968 off the south coast of Portugal, show a much larger size, compared with the two african groups, ranging from 25 to 45 mm of carapace length. The females were bearing ovaries mostly in developing stages which appear to be somewhat different from the described scale, mainly as far as the colour is concerned. This, in fact, ranges from greenish white to olive green.

Other species

Little information has been obtained about these species on account of the small number of observations available. They have in common the fact of being all shrimps from very deep water (250 to about 800 meters).

Aristeus antennatus (RISSO)

Nine samples of this species, captured off the south coast of Portugal, have been observed between 8th January and 22th June 1968 and consist of a total of 210 individuals (14 males and 196 females).

The size distribution of the females, by classes of 3 mm of carapace length, is shown in fig.8 . Males are much smaller and confined to sizes ranging between 30 and 40 mm of carapace length.

Nearly all the females, in January-February, showed ovaries in very early stage of development. From April to June, however, the maturative process of the gonads has been very fast, so that great part of them had already reached full advanced stages of maturation. A few females had already spawned and were showing ovaries in typical stage of "post-spawning".

66,8 % of the females were found to possess spermatophores.

Aristeomorpha foliacea (RISSO)

Seven samples of this species, caught off the south coast of Portugal, and consisting of a total of 80 individuals (48 males and 32 females) have been observed between 8th January and 23th May, 1968.

Females are much larger than males. They were represented between 40 and 68 mm of carapace length, whereas males were confined between 36 and 49 mm.

Nearly all the ovaries were found to be in a very advanced stage of maturation, but no "post-spawning" stage has been observed. The spawning took possibly place during the spring, after what this rather uncommon species almost disappeared from the catches.

96,9 % of the females showed spermatophores.

Plesiopenaeus edwardsianus (JOHNSON)

Only 4 samples of this species, captured off the coast west of Morroco, have been observed during June 1968. They consist of 129 individuals (64 males and 65 females).

The size of females varies between 34 and 80 mm of carapace length, and males are much smaller, ranging from 42 to 54 mm.

Most of the ovaries are in an advanced stage of maturation so spawning will probably take place during the summer.

84,6 % of the females were found to bear spermatophores.

An arbitrary scale of 5 stages (I to V) of maturitive development of the ovaries concerning the three species has been briefly essayed as follows:

<u>Stages</u>	<u>Aristeus</u>	<u>Aristeomorpha</u>	<u>Plesiopenaeus</u>
I	Very narrow Transparent White	Very narrow Transparent Light pink	Very narrow Transparent Yellowish
II	Narrow Transparent Pale pink	Narrow Transparent Dark pink	?
III	Less narrow Thick Light lilac	Less narrow Thick Grey-blue	Less narrow Thick Bright yellow
IV	Wide Thick Bright lilac	Wide Thick Violet-blue	Wide Thick Dark orange
V	Very wide Thick Violet	Very wide Thick Dark blue	Very wide Thick Redish-brown

Conclusions

Ovaries in full maturation stages of development have been found quite frequently in the deep sea shrimps, Aristeus antennatus, Aristeomorpha foliacea and Plesiopenaeus edwardsianus. On the contrary shrimps from medium depths, Parapenaeus longirostris, and from relatively shallow waters, Penaeus duorarum, were very seldom caught with ovaries in full developed stages. These facts suggest that spawning of deep water shrimps takes probably place on the grounds where they generally live, whereas shrimps of small depths undertake migrations when the spawning period approaches.

As far as the spawning season is concerned it appears that, off the south coast of Portugal, Aristeomorpha is a spring spawner, Aristeus a summer one; Parapenaeus probably an autumn spawner. The african specimens seem to spawn mostly in the autumn, but for any definitive conclusions, a more detailed information is required.

Reference - Cummings, W.C. (1961). Maturation and spawning of the pink shrimp Penaeus duorarum Burken. Trans. Amer. Fis. Soc., 90, n^o 4, pp 462/8

TABLE I - The catches of P. duorarum off the north west atlantic coast of Africa, in 1967-1968

Cruise number	Departure date	Arrival date	Total catch	Average capture kg/h
1	9. Apr. 67	12. May. 67	2,650	13.5
2	21. Jul. 67	25. Aug. 67	2,440	20.0
3	4. Sep. 67	9. Oct. 67	7,250	41.0
4	17. Oct. 67	21. Nov. 67	2,140	16.0
5	9. Nov. 67	15. Dec. 67	6,450	25.0
6	9. Jan. 68	15. Feb. 68	710	12.0

TABLE III - % of females P. duorarum bearing ovaries in developing stages (II to V), inside each class of 3 mm of carapace length , during the presumed spawning season, Oct./Dec. 1967 (lot 1)

Carapace length mm	Number of females	% females with developing ovaries
23	6	0
26	14	14.3
29	22	45.5
32	27	77.8
35	24	75.0
38	23	78.3
41	10	90.0
44	12	66.7
47	2	100

TABLE II - Samples of P. duorarum, obtained at the market, in Lisboa, grouped in two lots according their provenance from (1) autumn catches (cruises 4 and 5) and (2) early winter catches (cruise 6), off the west coast of Africa, during 1967-1968.

	Sample n ^o	Date	Number of males	Number of females	Total number
	1	30.Nov.67	11	9	20
	2	5.Doc.67	27	19	46
	3	11.Dec.67	38	12	50
Lot 1	4	13.Dec.67	15	8	23
corresponding	5	18.Dec.67	37	10	47
to cruises	6	5.Jan.68	29	14	43
4 and 5	7	12.Jan.68	44	22	66
	8	19.Jan.68	38	26	64
	9	22.Jan.68	16	8	24
	10	13.Feb.68	<u>53</u>	<u>13</u>	<u>66</u>
			308	141	449
	11	23.Feb.68	46	24	70
	12	1.Mar.68	22	31	53
	13	2.Apr.68	74	12	86
Lot 2	14	5.Apr.68	30	22	52
corresponding	15	9.Apr.68	25	7	32
to cruise 6	16	17.Apr.68	24	27	51
	17	19.Apr.68	63	15	78
	18	25.Apr.68	66	10	76
	19	9.May.68	63	10	73
	20	21.May.68	<u>57</u>	<u>14</u>	<u>71</u>
			470	172	642

TABLE IV -- Samples of Penaeus longirostris captured on the north west atlantic coast of Africa, provenient from 15° to 20° Lat. N (1) and 29° to 32° Lat. N (2), in 1967-1968.

Group 1 15° to 20° Lat. N					Group 2 29° to 32° Lat. N				
Sample nº	Date	Nº females	Nº males	Total	Sample nº	Date	Nº females	Nº males	Total
1	3.4.68	48	28	76	1	30.11.67	10	15	25
2	4.4.68	32	41	73	2	6.12.67	16	51	67
3	11.4.68	40	45	85	3	15.12.67	47	22	69
4	18.4.68	32	38	70	4	20.12.67	26	29	55
5	26.4.68	31	39	70	5	29.12.67	28	19	47
6	3.5.68	73	59	132	6	3. 1.68	28	25	53
7	7.5.68	17	15	32	7	10. 1.68	25	7	32
8	14.5.68	17	22	39	8	31. 1.68	72	39	111
9	17.5.68	27	36	63	9	9. 2.68	64	66	130
10	19.5.68	68	55	123	10	8. 3.68	67	33	100
11	28.6.68	25	43	68	11	14. 3.68	44	85	129
					12	18. 3.68	34	29	63
					13	7. 5.68	47	62	109
					14	14. 5.68	22	27	49
					15	17. 5.68	20	45	65
					16	6. 6.68	52	62	114
Total		410	421	831			602	616	1218

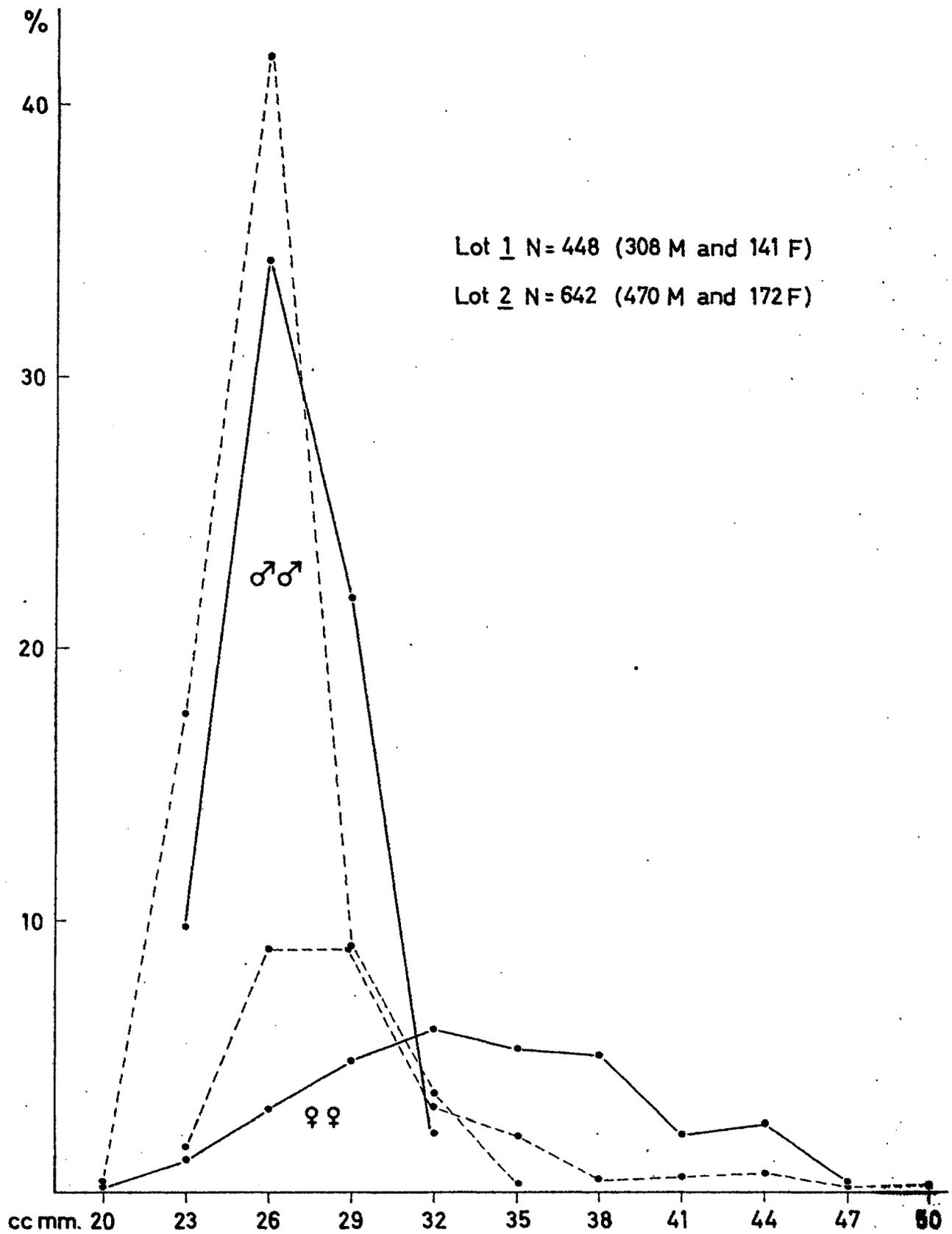


Fig. 2 - Size distribution of males and females *Penaeus duorarum*, by class of 3 mm of carapace length, in two lots of samples captured off the african coast, representing 1 autumn catches ——— and 2 the early winter catches - - - - -

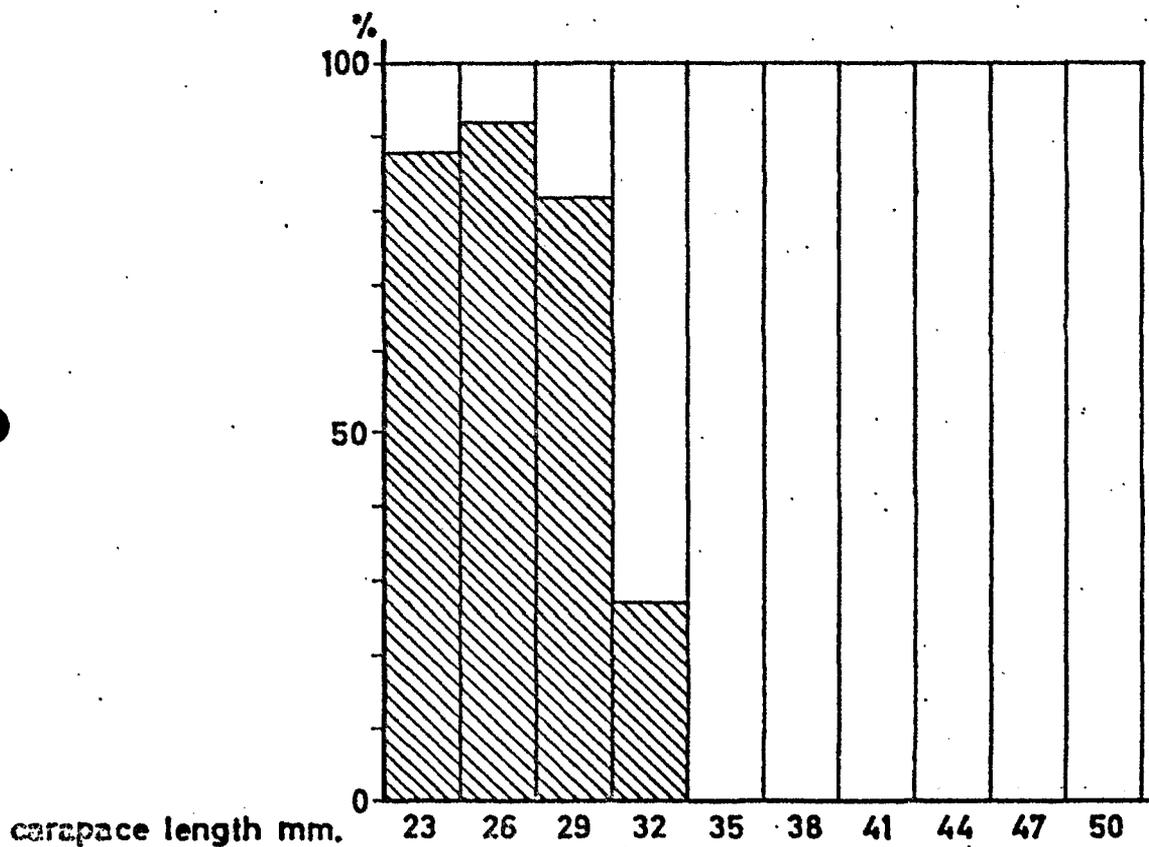
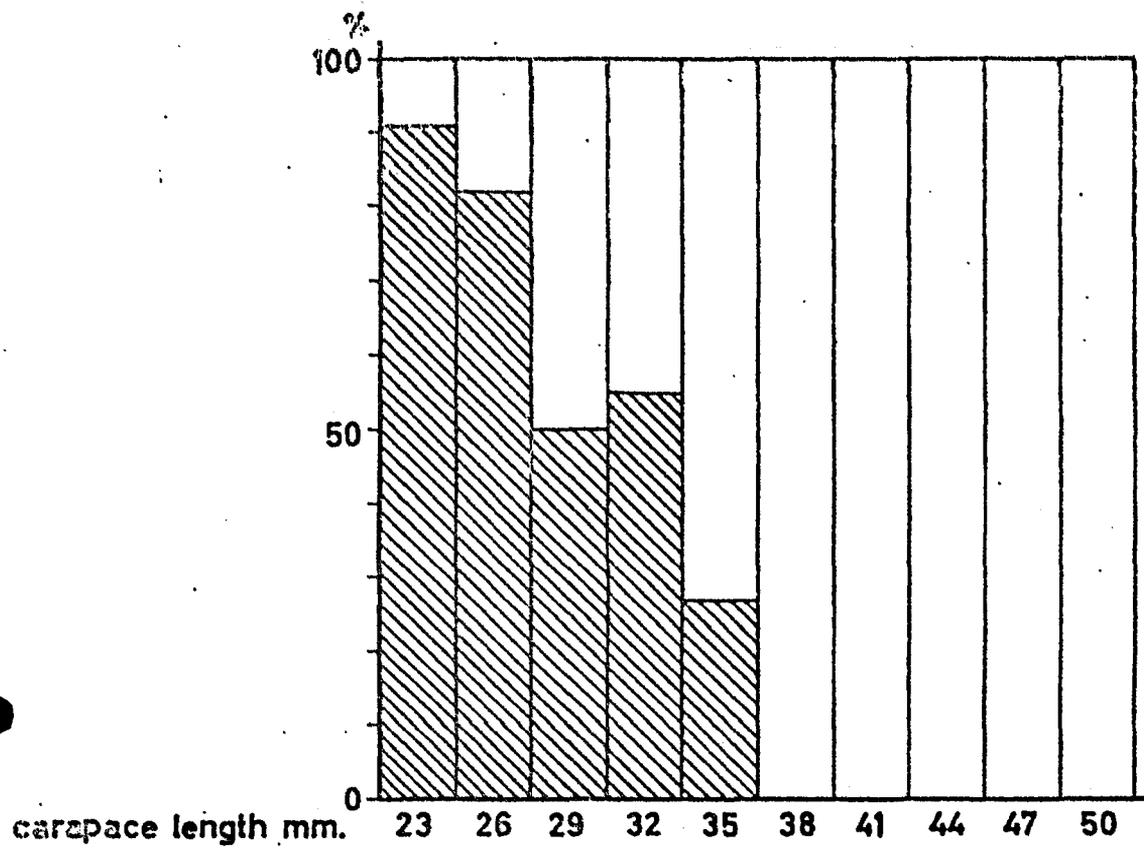


Fig. 3 - Sex-ratio of *Penaeus duorarum*, by class of 3 mm. of carapace length, in two lots of samples representing (1) the autumn catches and (2) the early winter catches.

 Males
  Females

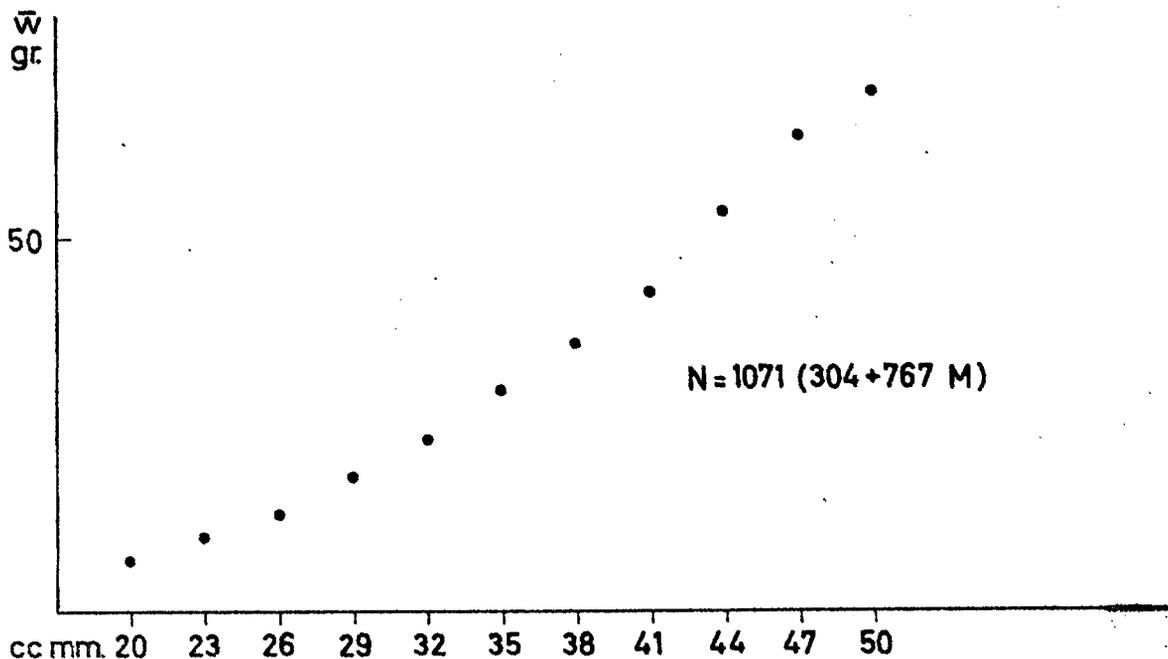


Fig. 4 - Average weight of *Penaeus duorarum* ($\sigma^2 \sigma^2 + \text{♀} \text{♀}$), by classes of 3 mm of carapace length, in 1967-68

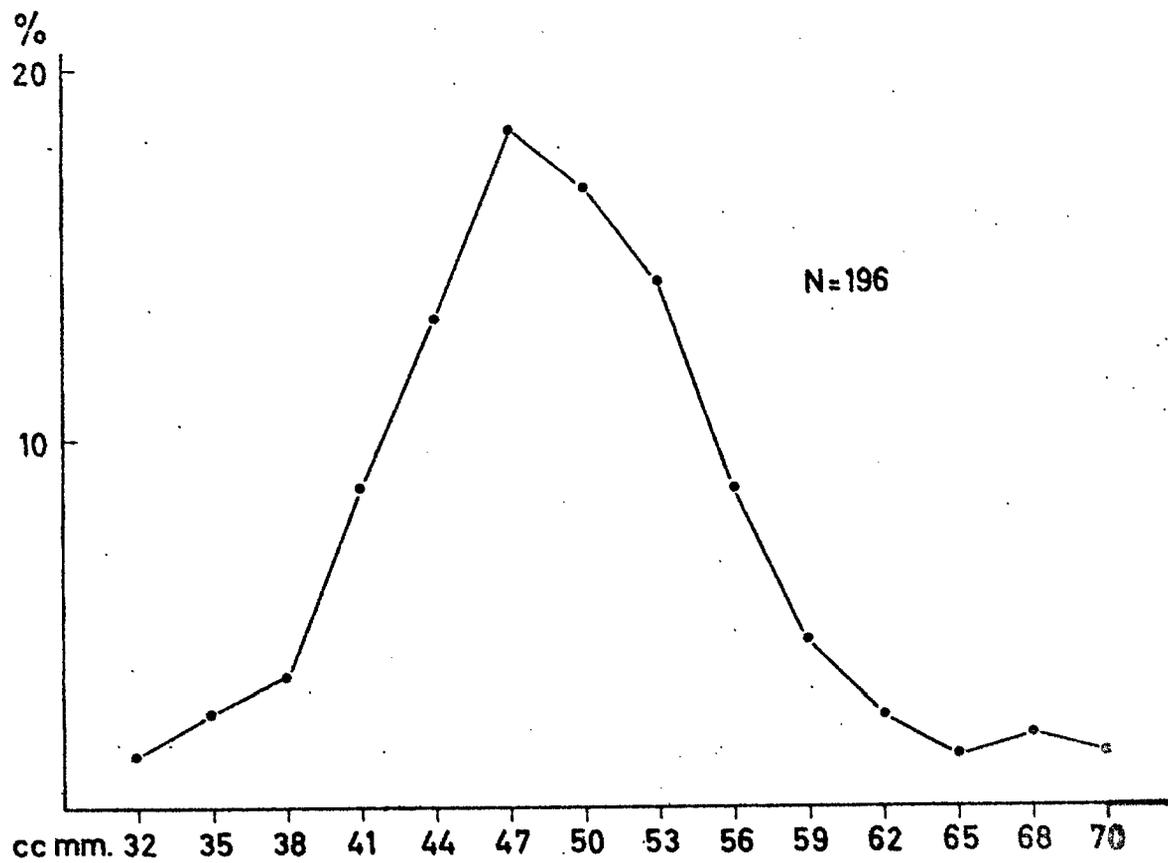


Fig. 8 - Size distribution of females *A. antennatus*, by classes of 3 mm of carapace length, in 1968

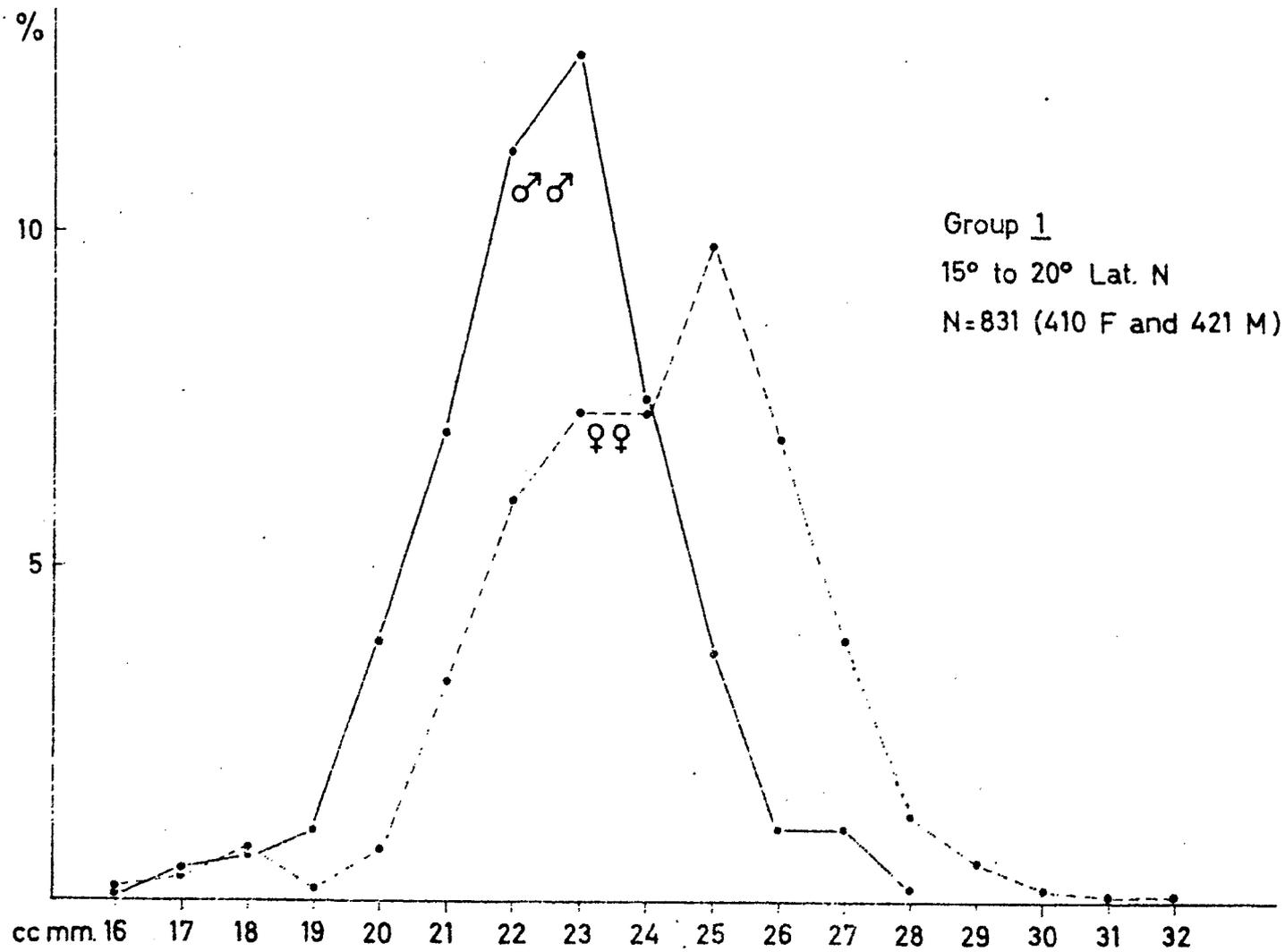


Fig. 5a. - Size distribution of males and females Parapenaeus longirostris, by classes of 1 mm of carapace length in group 1

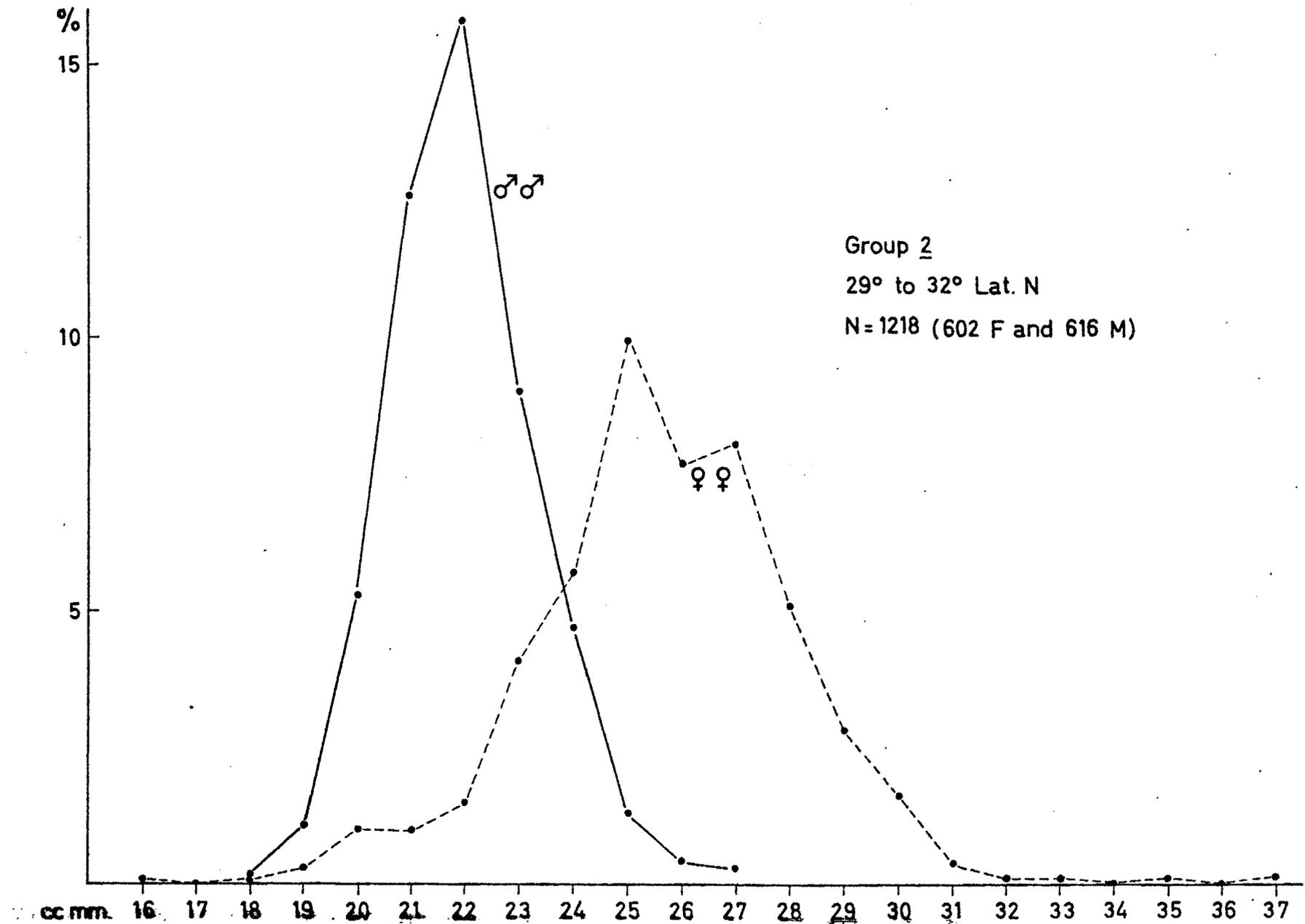


Fig. 5b-Size distribution of males and females Perapenaeus longirostris, by classes of 1 mm of carapace length in group 2

Group 1 (410 F and 421 M.)

Group 2 (602 F and 616 M.)

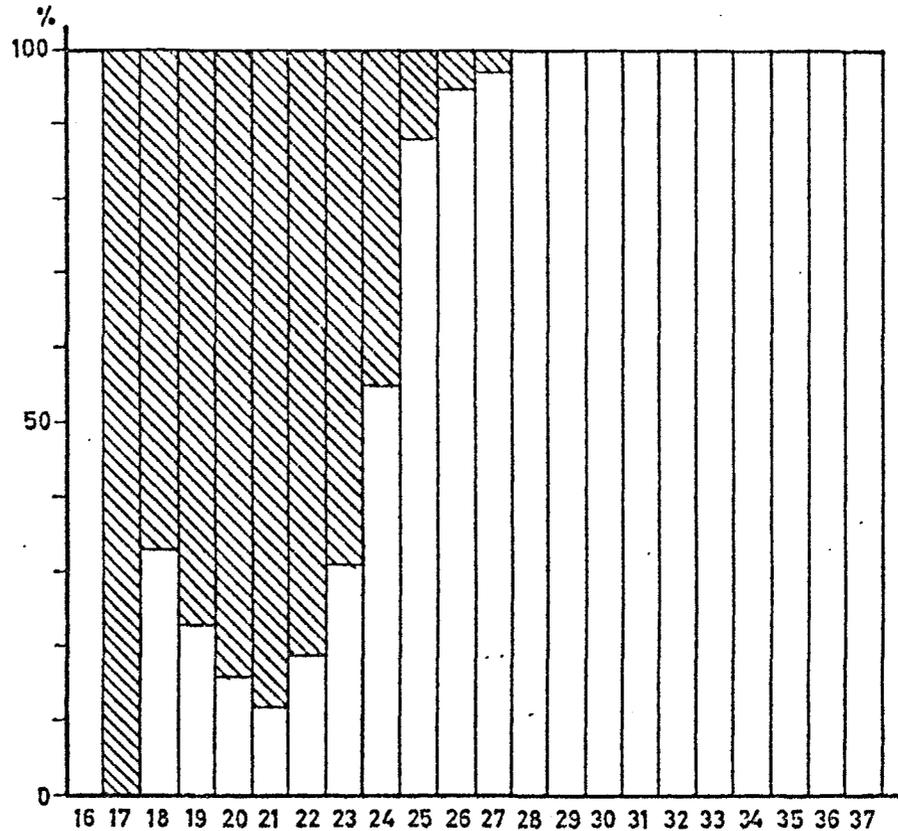
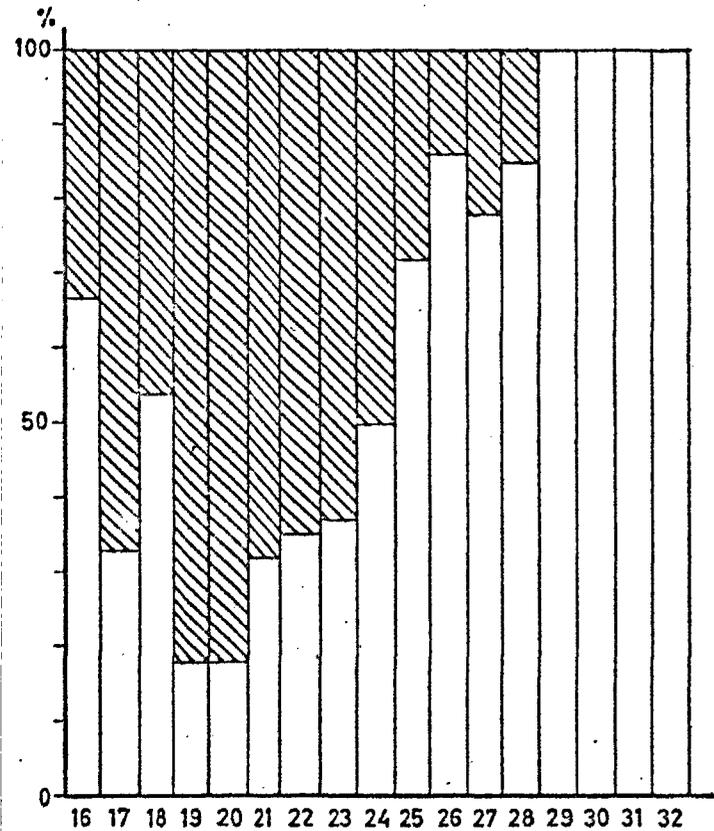


Fig. 6 - Sex-ratio of *Parapenaeus longirostris*, by class of 1 mm. of carapace length, in the african groups (1) and (2)

▨ Males □ Females

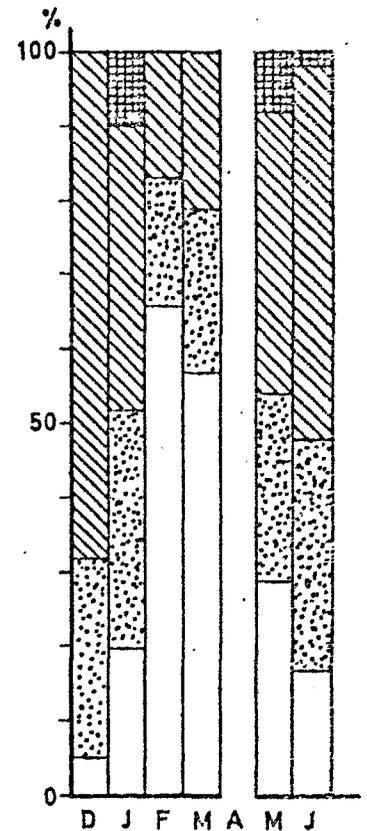


Fig. 7-Percentage of the development stages of the ovaries of females *P. longirostris*, by month, on the african group (2), caught between 29° and 32° Lat. N.

□ I ▨ II ▩ III ▧ IV