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Studies on Sea Breams from the North-West African Region

by

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The majority of bottom fish caught in the North-west African region belongs to the family Sparidae. Important among this family are the sea breams (genus Pagellus). The northern boundary for these fish in the Eastern Atlantic are the British Isles, and no data are available concerning their occurrence south of the equator.

The genus is still relatively unknown, apart from Gueguen's (1969) research on Pagellus centrodontus (Delaroche) from the Bay of Biscay.

This paper presents investigations on the biology of the two species most frequently met with: Pagellus acarne (Risso) and Pagellus canariensis Val. on the North-west African shelf, from 16° to 24° N.

The material was collected from 5 December 1968 to 21 February 1970. The majority of the fish were caught at depths from 80 to 150 m. A total of 2 046 P. acarne and 2 952 P. canariensis were investigated. Measurements, with an accuracy of 1 mm, were taken of the head length, eye diameter, interorbital distance and the width of the preorbital. The total length was measured with an accuracy of 1 cm. Age determination was based on the number of rings in the otoliths and, for the sake of comparison, on the scales. The back reading of the growth-rate was made by means of a microscope with a micrometric screw. The maturity stages were determined according to Maier's eight-degree scale.

I. Pagellus acarne (Risso)

Morphological features

The interorbital distance, eye diameter, and width of the preorbital, for fish of 17-35 cm total length, have been expressed in per cent of the total length. The values thus obtained are different in the Rio de Oro region and in the Cape Blanc region. Statistical analysis showed significant differences between these mean values in P. acarne from the two regions. It may be supposed, therefore, that this species forms at least two separate stocks in the investigated area.

	Cape Blanc region 18° N - 20° N	Rio de Oro region 23° N - 24° N
Interorbital space		
range	6.35 - 8.90	6.35 - 9.10
$\bar{x}$	7.73	7.93
n	77	65
Eye diameter		
range	6.55 - 9.50	7.45 - 9.40
$\bar{x}$	7.73	8.18
n	73	64
Width of preorbital		
range	3.30 - 5.00	3.75 - 5.10
$\bar{x}$	4.25	4.41
n	75	64

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Length and age

The length of the fish varied from 17 to 35 cm, the majority falling into the 21-26 cm length classes. According to Coupé (1952), young sea breams live in shallow waters, which would explain the lack of fish smaller than 17 cm in catches from waters deeper than 80 metres. The average length of the females is greater than that of the males. This does not mean, however, that the growth-rate is higher for females than for males. The difference is due to the males changing to females at an older age. This will be dealt with in detail later on.

The length of the fish caught in the Cape Blanc region was about 1 cm greater than that of the fish from the Rio de Oro region.

The length distribution curves for the P. acarne caught in December 1968 and 1969 have several peaks, namely in the 21, 24-25, 26 and 27-28 cm groups (Figure 1). From the age determination based on otoliths it can be seen that these peaks correspond to age groups III, IV, V and VI respectively. It was found that the otolith rings are formed once a year, mainly from December to February (earlier in younger fish). Groups III and IV dominated in the catches both in the Cape Blanc and Rio de Oro regions.

Age composition of catches (in %)

Region, year	Age groups								Total
	I	II	III	IV	V	VI	VII	VIII	
Cape Blanc 1969	0.3	14.1	47.5	20.3	11.5	4.7	1.4	0.2	100.0
" " 1970	-	8.5	45.5	24.0	11.3	9.8	1.4	-	100.0
Rio de Oro 1969	-	16.0	45.5	31.0	5.2	0.7	0.6	-	100.0

The total mortality rate was calculated on the basis of the age distribution. In the Cape Blanc region the total mortality coefficient ($Z = F + M$) in 1969 and 1970 was 1.05 and 0.781 respectively, while the total mortality rate ($1 - S$) was 0.650 and 0.541 respectively. In the Rio de Oro region, the total mortality coefficient was 1.27 while the total mortality rate was 0.719.

Growth-rate

After measuring 580 fish it was found that the relation between the total length and the longer radius of the otolith is close to a straight line originating near zero: $R = 2.196 + 2.786\ L$ (R = longer radius of otolith; L = total length of fish). This justifies the use of simple proportionality in back calculation of the growth-rate. The back readings of the growth-rate of P. acarne are shown in Figure 2. The average length in groups I to VII is 13.7; 18.8; 21.9; 24.6; 26.8; 28.9 and 30.5 cm respectively. The differences between the back readings and direct measurements are very small (see Figure 2) which means that the back readings may be regarded as reliable.

The relation between length and weight has been found using the method of least squares, and is expressed by the formula $W = 0.0124L^{3.0865}$. This equation was further used to calculated the weights of the fish in age groups I to VII (Figure 3). It can be seen from Figures 2 and 3 that P. acarne achieves good length increments during the first two years, and good weight increments from the second till the seventh year of life, and in particular after the fourth year. The parameters of von Bertalanffy's growth equation have been found to be $L_\infty = 36.0$ cm; $K = 0.23$ $t_o = -0.97$ year.

Reproduction

Hermaphroditism can be observed in P. acarne. The gonads of these fish are found to consist of the testis part and the ovary part. This hermaphroditism is of the protandric type. The stock consists of young hermaphroditic individuals which act as males (they will be referred to as "males" below), and of older individuals transformed into females. In the length groups below 17 cm (age 1+) the percentage of "males" is 100. With the increase in length this percentage decreases so that the length groups above 29 cm consist of females only.

It is interesting to note that the sex change phenomenon is of a different character in the two regions. The length for which the number of "males" is equal to that of females is 23.2 cm in the Rio de Oro region and 25.5 cm in the Cape Blanc region. This means that the sex change in the former region takes place earlier than in the latter. It may follow from this that P. acarne forms isolated local stocks in the two regions which could already be seen from the previous analysis of the morphological features. This supposition is in conformity with the observations made by Alekseev (1969) in the same region.

It follows from the observations of the maturity of the gonads that P. acarne spawn in this region from November to March, larger spawning concentrations occurring from December to February. Farther north, the spawning period may even be still longer, which, among others, is proved by the investifations of Woźniak (1965). The gonads of the "males" mature earlier than those of the females. Three groups of eggs can be distinguished in the gonads at the same time: the first consisting of eggs less than 0.16 mm in diameter, the second from 0.16 mm to 0.36 mm, and the third from 0.36 to 0.80 mm. This means that the spawning of P. acarne is of the portion type, and that the eggs are laid at least three times a year. The absolute fecundity is from 85 000 to 536 000 eggs, the average being 244 000 eggs. In the spawning period ripening fish were observed throughout the catch area, between 17° and 24° N. The spawning area of P. acarne is then very large. It seems that the first reproduction is at the age of 1+ ("males").

Feeding

It can be seen in Figure 6 that the composition of the food was different according to the season. In winter Ophiuroidea, Pisces and Decapoda were the prevailing groups while in spring there were only two groups, Pisces and Polychaeta. Thus, the food of P. acarne in the region consisted mainly of Decapoda and Pisces, while Ophiuroidea and Polychaeta were found in significant quantities only during some periods, thus being supplementary food.

The composition of the food of the Rio de Oro fish is similar to that of the Cape Blanc fish (Figure 6).

In both regions, Amphipods were found more frequently and in greater quantities in the stomachs of younger fish than in those of older fish. From the observations on the degree to which the alimentary tracts were filled, it seems that P. acarne feed intensively from May to September. During the rest of the year, and during the spawning period in particular, this intensity is much lower, but even the ripening individuals are found to have food in their stomachs. It should be added that the period of intensive feeding coincides with the higher water temperatures.

The seasonal variations of the intensity of feeding correspond to variations in the condition (Fulton's) coefficient. The lowest value of this coefficient, 1.31 was found in March, while the highest value, 3.47 was measured in May. The condition of the fish caught in the Cape Blanc region was better than in the Rio de Oro region. The average values in the two regions were 1.512 and 1.286 respectively. This phenomenon is due to higher biological productivity of the waters in the Cape Blanc region where intensive upwelling can be observed in spring and summer. This is also a firm proof of the supposition made previously that P. acarne form separate local stocks in the two regions.

II. Pagellus canariensis Valenciennes

Morphological features

The eye diameter and the width of the preorbital are expressed in per cent of the head length for fish of 18 to 31 cm in length. These values were different in the region north of Dakar and in the Rio de Oro region.

	Rio de Oro region 23° - 24° N	North of Dakar region 16° N
Eye diameter		
range	24.3 - 31.9	27.3 - 31.9
$\bar{x}$	28.24	30.48
n	23	40
Width of preorbital		
range	15.8 - 21.0	15.7 - 20.4
$\bar{x}$	18.24	17.44
n	23	40

Statistical analysis showed that the differences are significant. It should be added that the investigations on the relation between eye diameter and head length in this species, made by Skornyakov (1963) in the Takoradi region (4° N) and the Dakar region, gave 31.71% and 29.32% respectively. It follows from these data that the eye diameter in P. canariensis decreases northwards.

Length and age

The length of P. canariensis was from 7 to 35 cm, the average being 19.3 cm. No significant differences were found between the length of males and females. The average length of P. canariensis depends on the depth at which the fish were caught. For example, from 23 December 1969 to 19 January 1970, the average length was 10.0 cm for a depth of less than 50 m, 17.7 cm for 50 - 100 m and 18.3 for 100 - 150 m. Thus, P. canariensis live in various ecological niches. The fry live in the shallow littoral waters and move to deeper water as they grow bigger. It may also be supposed that the reproduction of P. canariensis takes place in the littoral area.

The length distribution curves for P. canariensis caught in February 1970 had peaks in the length groups 14 - 15, 18 - 19 and 22 cm (Figure 4). From age determinations based on the otoliths it follows that these peaks correspond to age groups II, III and IV respectively. The observations show that the otolith rings are formed once a year, from December to April, i.e. a relatively long period.

The fish caught north of Dakar belonged to 9 age groups. The percentage of the groups from 0 to VIII was 4.7 (0 and I); 35.3; 45.3; 10.7; 2.8; 0.5; 0.4 and 0.2 % respectively. It is evident that the catches of P. canariensis consist mainly of fish belonging to age groups II, III and IV. The estimates showed that the total mortality coefficient for P. canariensis north of Dakar was 1.58; while the total mortality rate found by means of Ricker's tables (1958) was 0.7941.

Growth-rate

The otolith measurements in 316 fish from 8 to 31 cm in length show that the relation between the longer radius of the otolith and the total length of the fish is almost directly proportional and is expressed by the following formula $R = 3.3014 + 2.995\ L$. The straight line corresponding to this equation passes very close to the zero point. Consequently, no corrections were made when making back readings of the growth-rate, and the method used was based on simple proportionality.

The back readings are shown in Figure 5. Similar results were obtained by direct measurements of the lengths in the individual age groups.

The growth-rate in the Rio de Oro region was higher than north of Dakar and statistical analysis showed that the difference is significant. Skornyakov (1969) found that the growth-rate of P. canariensis was lower in the Takoradi region than in the Dakar region. It seems from these data that P. canariensis forms three different stocks in the regions of Takoradi, Dakar and Rio de Oro. The growth-rate of the individuals from these stocks increases northwards (from Takoradi towards Rio de Oro). This conclusion is in conformity with the results of the morphological studies.

Measurements of 200 fish were used to determine the relation between length and weight. It can be expressed by means of the formula $W = 0.0139L^{2.9910}$. This equation was used to calculate the weights in age groups I to VII (Figure 3). It can be seen that the annual weight increment increases up to the sixth year.

The parameters of the von Bertalanffy's equation for the Dakar region have the following values: L_∞ = 39.37 cm; K = 0.18; t_o = -0.81 year, and for the Rio de Oro L_∞ = 40.17 cm; K = 0.19; and t_o = -0.63 year.

Reproduction

Like P. acarne, P. canariensis show hermaphroditic features. Unlike P. acarne, however, this hermaphroditism is of a protogynic type, i.e. the individual acts as female at a younger age and then transforms into a male. The spawning of P. canariensis is long and lasts from May to September. Male gonads reach maturity earlier than those of female. The average female/male ratio in the catch was 48.3:51.7. The absolute fecundity varied from 60 200 to 406 800 eggs. During the spawning period, individuals with ripening sexual products were found from 21° N to 24° N. It can be seen from Skornyakov's investigations (1963) that ripening individuals were also found in the regions of Takoradi and Dakar. It seems, therefore, that the fish spawn where they live, but for the reproduction period they move to shallower waters where the fry will find better feeding conditions. The observations show that the first spawning in this species takes place at the age of 1+.

Feeding

The percentages of the different groups of food are shown in Figure 7. It can be seen that the food of P. canariensis consists mainly of Decapoda, Cephalopoda, Pisces, Amphioxus and Polychaeta, but each of these components predominates in a different season. The analysis of the degree to which the alimentary tracts were filled shows that the feeding was more intensive in summer and less intensive in winter. It is interesting to note that the fish were also feeding during full spawning. Completely filled stomachs were even found in individuals with ripening sexual products.

Conclusions

1. Pagellus acarne lives in the North-west African shelf, from Morocco in the north to Dakar in the south, mainly in water depths from 40 to 180 m. The largest concentrations are found between 19° and 25° N.

Pagellus canariensis is found from Morocco in the north to the Ghana coast in the south, mainly in water depths from 30 to 150 m. The largest concentrations are found at the coasts of Rio de Oro, Senegal, the Republic of Guinea and Sierra Leone.

2. In their living area, both species form local stocks, differing among others in morphological features, condition and growth-rate. This is probably associated with the small mobility of this genus which favours isolation. In fact, unlike the pelagic fish (mackerel, Sardinella), it does not make long migrations along the shelf, but makes periodical migrations across the shelf.

3. The catches of P. acarne consist mainly of age groups III and IV, and those of P. canariensis of age groups II, III and IV. The individuals predominating among P. acarne were 21-26 cm in length and the average length of P. canariensis was 19.3 cm.

4. The total mortality coefficient for P. acarne in the Cape Blanc region was 1.05 (1969) and 0.781 (1970) and in the Rio de Oro region 1.27. For P. canariensis this coefficient in the Dakar region was 1.57.

5. The relation between the total length of the fish and the longer radius of the otoliths is close to a straight line in both species which enables simple proportionality to be used in back readings.

6. P. acarne grow faster than P. canariensis, especially as to weight increase.

7. Both species are hermaphroditic, P. acarne being protandric and P. canariensis being protogynic. P. acarne reproduce in summer while P. canariensis spawn in winter. The spawning grounds are very extensive, situated in shallow littoral waters. The spawning is portional.

8. The food of P. acarne consists mainly of Decapoda and Pisces, and also of Ophiuroidea and Polychaeta. The food of P. canariensis consists mainly of Decapoda, Cephalopoda, Pisces, Amphioxus and Polychaeta.

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Fig. 1. The length distribution curves of Pagellus acarne.

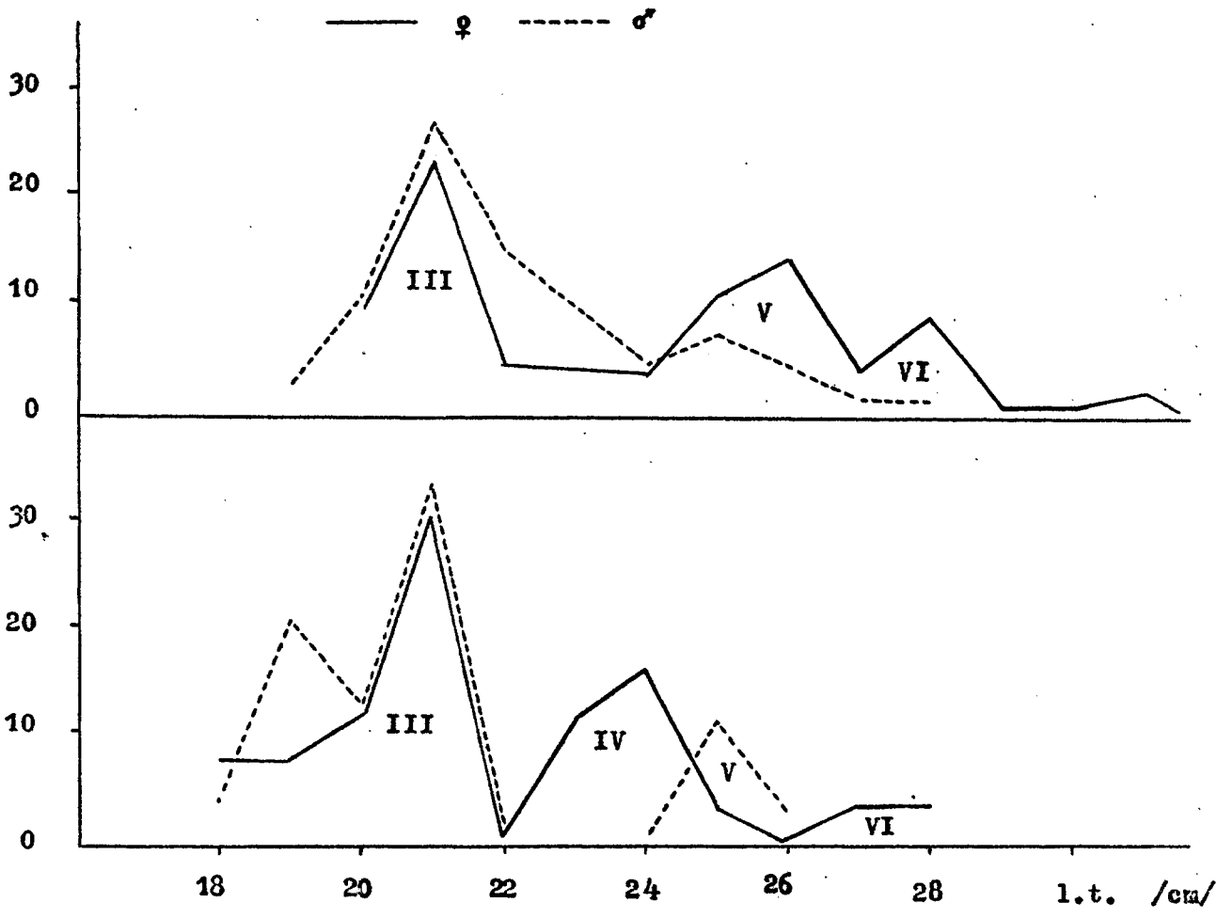

Fig. 2. The growth-rate of Pagellus acarne.

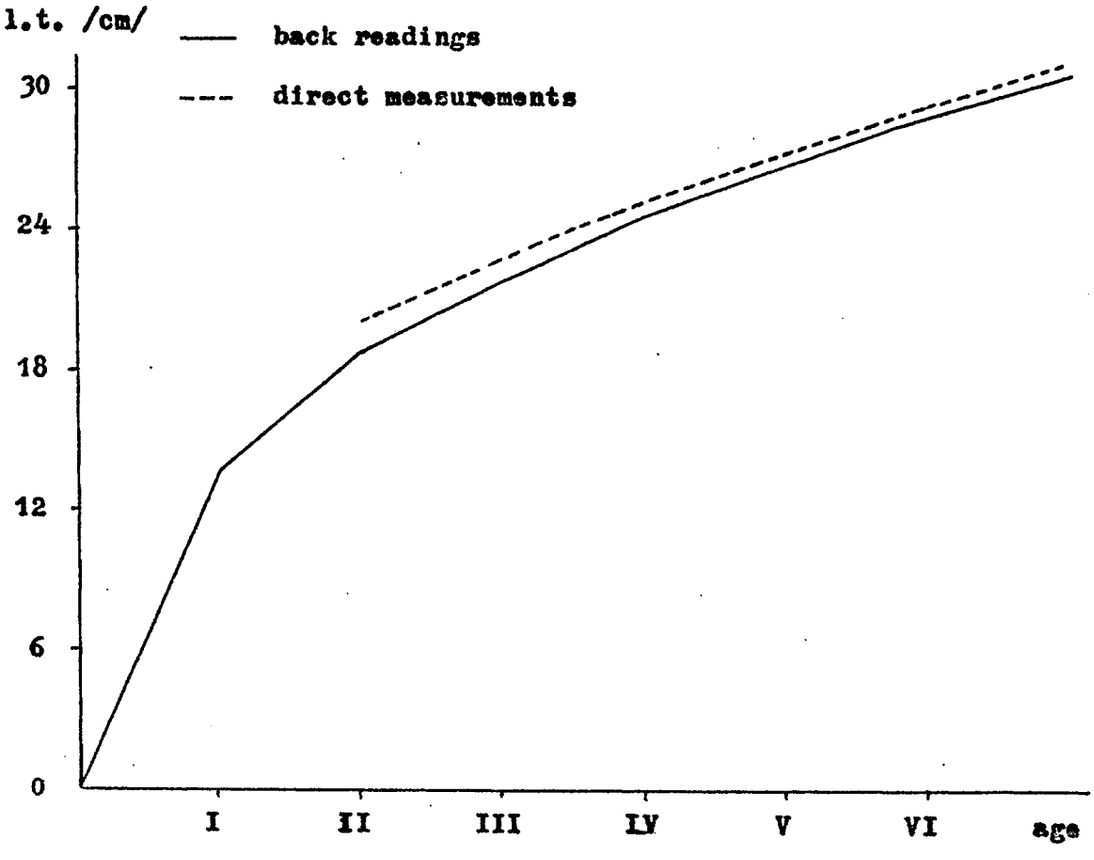

Fig. 3. The growth in weight of Pagellus acarne /a/ and Pagellus canariensis /b/.

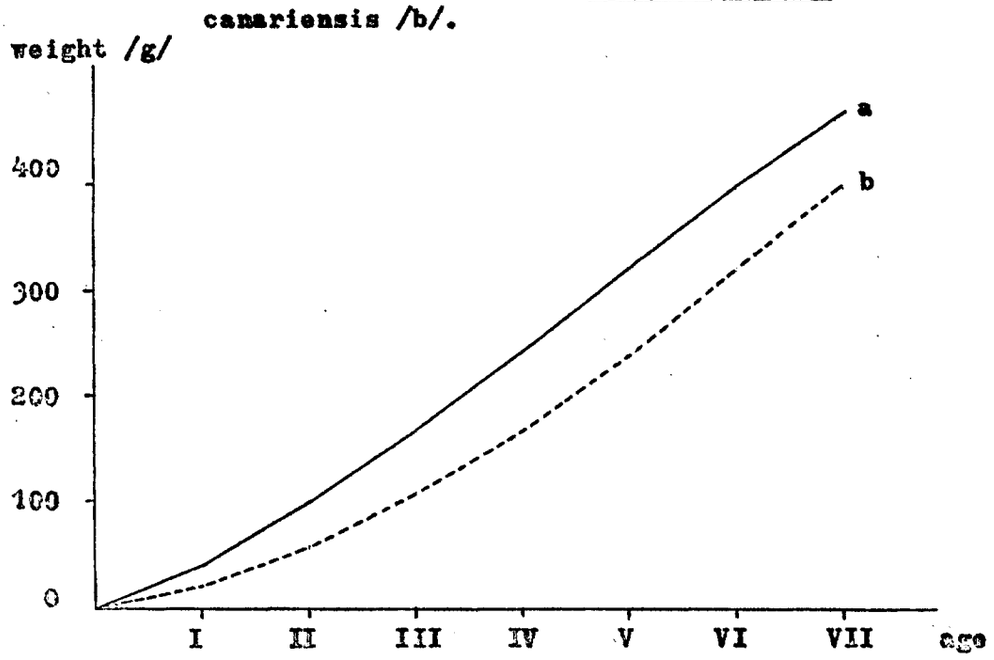

Fig. 4. The length distribution curves of Pagellus canariensis II. 1970. —— ♀ ---- ♂

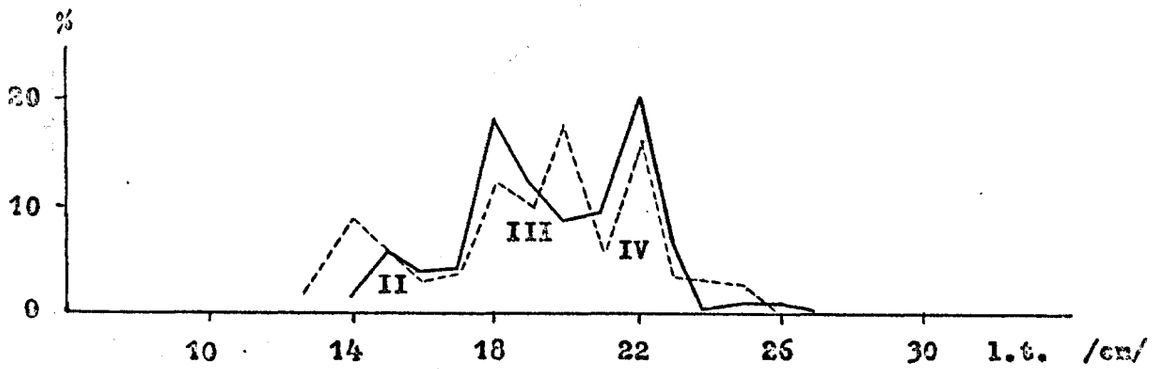

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Fig. 5. The growth-rate of Pagellus canariensis /back readings/ from Dakar /——— / and Rio de Oro /------ / region.

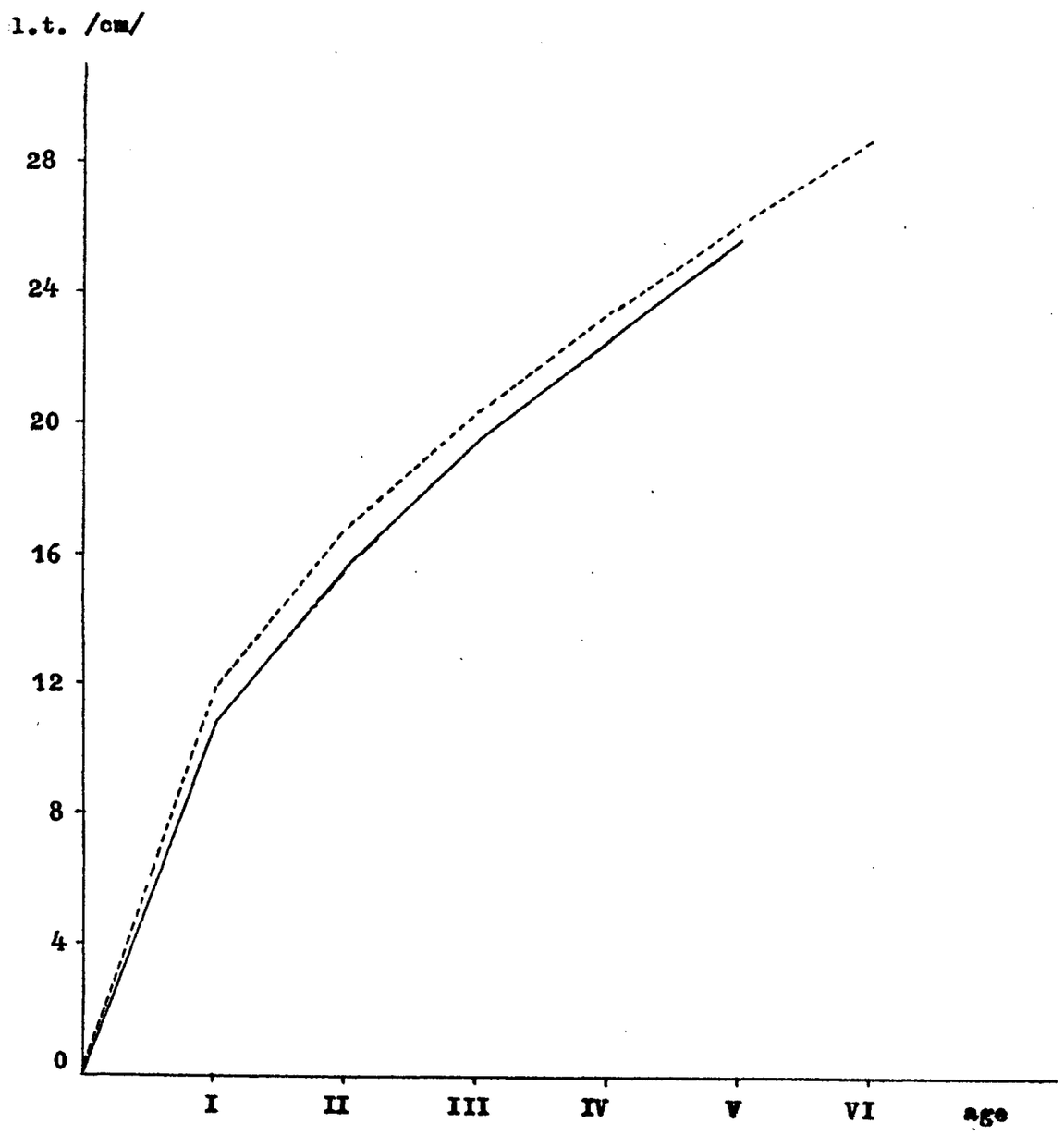

Fig. 6. Food composition of Pagellus acarne. 1. Decapoda, 2. Pisces, 4. Ophiuroidea, 4. Polychaeta, 5. Amphipoda.

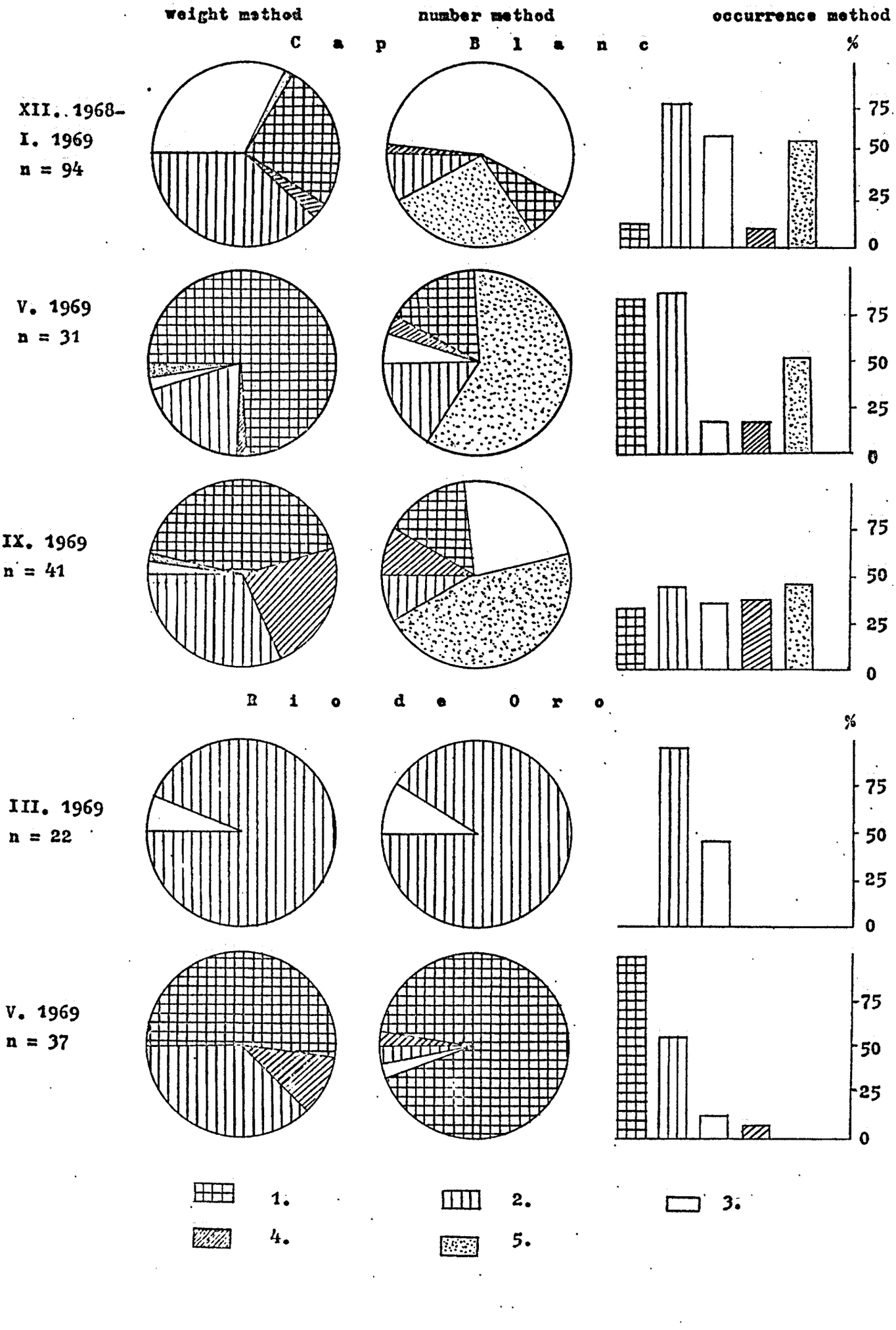

Fig. 7. Food composition of Pagellus canariensis. 1. Decapoda, 2. Pisces, 3. Polychaeta, 4. Amphipoda, 5. Euphasiidae, 6. Cephalopoda, 7. Amphioxus.