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On the Biology of Pagellus Canariensis (Valenciennes) of the Western African Coast

by

V. I. Skornyakov

In 1957 the Soviet Union began to carry out regular investigations off the western African coast, with the purpose of studying the fish fauna and determining the perspectives of the commercial fishing there.

Among a huge amount of different species of demersal fish the family of Sparidae predominates in the catches taken in these waters. This family is presented by 1o genders with 3o species in the area between the Khubi Cape and the Guinea Bay. The following species are the most widely distributed: Pagrus pagrus (Linné), Pagrus ehrenbergii (Valenciennes), Dentex filosus (Valenciennes), Dentex canariensis (Steindachner), Pagellus canariensis (Valenciennes), Pagellus eruthrinus (Linné), Box boops (Linné).

Let us dwell on some aspects of the biology of a species - Pagellus canariensis - which is distributed everywhere within the area investigated. This species is found in all the trawl catches, while in some areas, especially north of the Sherbo Island, it forms isolated concentrations and makes up to 6o-7o% of the catches.

A clearly marked regularity in the distribution pattern of different species of Sparidae at depths is observed: mature specimens of every species or group of species occupy their ecological layer. Species of Pagrus dominated in the catches taken at 3o-4o m depth, while Pagellus and Dentex prevailed at depths of 4o-6o m. At depth of 7o m. and below the number of Box boops (Linné) increases, while at 9o m Dentex macrophtalmus (Blach) appears in the catches.

Undoubtedly, in different seasons the distribution pattern varies by depths but during the feeding period when these Sparidae accumulate in fishable concentrations in waters between the Green Cape to the Guinea Bay the above-mentioned regularity of the distribution of species by depths was observed everywhere.

Young Pagellus canariensis inhabit inshore/shallow waters and so they were almost absent in the trawl catches.

Pagellus canariensis does not make significant vertical diurnal migrations. In the day-time specimens stay at the sea-bed and that is why even large concentrations are not registered by hydro-acoustic devices. In the night-time they are above the sea-bed (up to 2 m) and then their concentrations are recorded by echo-sounders as indistinct traces.

In order to study morphological characteristics of Pagellus canariensis (Val.) we made an analysis of 98 specimens sampled in the Takoradi area and 79 specimens collected in the Dakar area. All the measurements were done according to the scheme adopted in the USSR on studying morphological characteristics of the order of Perciformes.

Variation-statistical treatment of the data showed that some features of Pagellus canariensis varied but slightly. These features are the following:- the minimum height of the body, tail stem length, ventral fin length, length of the third spine of the anal fin head length, snout length, horizontal diameter of the eye and maxillary length. Of the accounting features the following do not vary:- number of gill rakers, number of unbranchy and branchy rays in the dorsal and anal fins, number of scales above and below the lateral line, number of precaudal and caudal vertebrae. These characteristics are the most permanent for Pagellus canariensis (Val.).

Small ante-dorsal distance and length of the tail stem, rather high body and large pectoral fins characterise Pagellus as a fish species, which does not undertake great horisontal migrations. Apparently, over a huge territory of the area in question (extending for more than 3ooo km) Pagellus canariensis form local shoals trending to certain areas.

To test this assumption we have made a comparison of morphological features of Pagellus canariensis taken in the Takoradi and Dakar areas. The results of this comparison are given in Table 1. There are only those features which give real differences of the variation rows according to the theory of probability.

Morphological differences of Pagellus from the Dakar and Takoradi areas (see Table 1) as well as the peculiarities of the annual rings' formation on the scales of this species show that there are two local stocks of Pagellus canariensis (Val.) in these two areas. Pagellus canariensis of the Takoradi area differs from that of the Dakar area by length of the tail stalk and by the snout length being less as well as by greater diameter of eye and greater length of the upper jaw.

In catches taken in the Takoradi area Pagellus canariensis is met with in the range 10-23 cm, its weight being 15-230 g (here under l_3 we mean the body length from the snout tip to the end of the middle rays of the tail fin). Males are larger than females. The mean length of the male is 16.6 ± 0.2 cm, with a mean weight of 91.5 g, while the mean length of the female is 15.4 ± 0.15 cm with a mean weight of 84.3 g.

In the Dakar area Pagellus of the same size is met with but in catches the greatest part belongs to larger specimens (16-19 cm in bngth, 98-132 g in weight). The mean length of the male is 17.0 ± 0.21 cm (mean weight 117.9 g), while the mean length of the female is 16.2 ± 0.2 cm (mean weight 95.14 g) (see Figure 1).

There is a logarithmic dependence between the weight and the body length of Pagellus canariensis (Val.), i.e. the body length is directly proportional to the logarithm of its weight. This dependence is given graphically in the logarithmic scale in Figure 2.

Dependence between the body length and weight of Pagellus canariensis is expressed as a broken line consisting of two sections. It shows that the logarithmic dependence between the body length and weight established by many investigators for fish of temperate latitudes is real for tropical fish species as well. Apparently, this dependence is a common regularity of growth for the bulk of bony fish. The break of the straight line in Figure 2 does not change the character of this regularity. Only the angular coefficient is changed, i.e. at a certain stage the intensity of the weight growth of Pagellus canariensis is changed, this alternation not being connected with the onset of the sexual maturity of the fish.

Age of Pagellus canariensis (Val.) is determined after the scale. Its scales are ktenoid, of mean sizes. Annual rings are clearly seen and when reading, additional rings are distinguished from annual ones.

In trawl catches taken in the Dakar area Pagellus canariensis is met at an age of one to five years with predominance of fish at an age of 2-3 years (Figure 3).

To calculate the linear growth of fish by scale we used the formula of the direct proportionality by Einar Lea (E.Lea, 1910). Comparison of measured fish length of every age group with that one obtained by the method of back computation by scales showed that the difference between the values of the lengths obtained by the two methods does not exceed the sum of mistakes of their mean$(m_1 + m_2)$. Therefore the length of scales of Pagellus canariensis (Val.) changes with age in direct proportion to the length of the body (See Table 2).

The linear growth of Pagellus canariensis is not similar in the different years. Thus, in 1960 the length of the fish of the different age groups and the rate of the linear growth were much lower than in 1958.

Judging from the catches of Pagellus canariensis per unit of effort and stability of the age composition in 1958 and 1960 there were no essential changes in the stock abundance. Consequently, a sharp drop in the growth rate in 1959-60 compared with 1957-58 was seen, due to fluctuations of the environmental conditions.

While determining age and linear growth of Pagellus canariensis it was found that the rate of linear growth in the Takoradi area is much lower than in the Dakar area. One should seek for causes of these differences in the environment peculiarities. Climatic conditions of the Dakar and Takoradi areas are different:- in the Dakar area the climate is typically tropical with a sharply expressed rain period while in the Takoradi area the climate is equatorial monsoonal, characterised by a high humidity, frequent claudiness, high air temperature and high quantity of precipitation with two peaks.

It is well-known that a member of a fish species inhabiting waters with the monsoonal climate have two seasonal rings laid on scales per year (L. Hattori, 1953; G. Seshappa and B. S. Bhimachar, 1954). G. Seshappa and B. S. Bhimacher call these rings monsoonal ones.

In connection herewith the supposition arose that the formation of two year rings could take place in the case of Pagellus canariensis in the Takoradi area.

It was found that in the Dakar area the formation of a seasonal (annual) ring takes place in June/July. In the Takoradi area two seasonal rings are laid on scales for a year (the first one in April/May, the second one in December/January - see Table 3).

Terms of season rings' formation in these areas are in a good agreement with changes of hydrological seasons, established by Berrit (G. Berrit, 1959), see Figure 4. From these data (Fig.4) it is seen that the laying seasonal rings on the scales of Pagellus canariensis in the Takoradi area depends mainly on the changes in salinity and occurs twice a year at its increasing. Both rings are analogous by their structure and it is impossible to distinguish them. The first ring is laid when the fish reach a length of 8-11 cm. As we have revealed the spawning period of Pagellus canariensis is prolonged. It is therefore impossible to read the age by scales of this species in the Takoradi area, as it is also impossible to guess the moment of the first ring formation. The first ring of a population of early spawning is formed in December/January, while that of a population of late spawning is laid in April/May.

In the Dakar area the rings' formation on the scales (unlike Takoradi waters) occurs once a year and besides at a sharply decreasing in salinity. Investigations on maturation of ovocytes and fecundity demonstrated that Pagellus canariensis is referred to fish with intermittent spawning. Ovaries at the fourth maturity stage contain three clearly seen portions of eggs (Figure 5).

Ovarian eggs of the first portion at the fourth maturity stage are of 0.71 mm in diameter on an average, while eggs of the second one are 0.41 mm and those of the third one 0.26 mm. At further maturation the diameter of ovocytes of the first two portions increases, while in ovaries close to the fifth maturity stage the diameter of eggs of the first portion is 0.79 mm and that of eggs of the second one is 0.48 mm. The diameter of ovocytes of the third portion is not changed. Hence intensive growth of ovocytes of the third portion does not take place till the extrusion of the first portion of eggs.

The fecundity of Pagellus canariensis varies from 30.000 to 71.000 eggs, depending on length of specimens, making up 53.000 eggs on an average (Table 4).

The spawning of Pagellus canariensis occurs in the Dakar and Tahoradi areas mainly during the period from November/December to March (Figure 6). In the Dakar area the spawning takes place in a cold and salty season (S = 35.5‰, t = 27°C), while in the Takoradi area it occurs in a small and cold season (S = 35‰, t = 27°C) as well as in a big and warm season (S = 32‰, t = 30°C). It may be an indirect evidence of the fact that the eggs and larvae of Pagellus canariensis are mainly euryhaline.

Apparently, the spawning of Pagellus canariensis takes place in the coastal zone. This is proved by the fact that specimens with gonads close to maturation are met with in the catches obtained in the Takoradi area at depths of 20-30 m as a rule, while during the feeding period Pagellus canariensis stays at depths of 40-60 m.

Eggs of Pagellus canariensis are pelagic. At stages IV and IV-V they have a clearly seen fat globule, its diameter being 25-30% that of an egg.

Undoubtedly, the intermittent spawning and its time prolongation are of adaptive importance to maintain the abundance of the species, especially at such an age structure (See Figure 2), when the stock consists mainly of three generations and, consequently, the recruiting of a poor year-class sharply decreases the abundance of a stock.

Pagellus canariensis feed intensively all year round and do not cease feeding during the spawning period. The feeding intensity sharphly increases after spawning (February). According to the character of feeding Pagellus canariensis is a benthos feeder. Its diet consists of polychaete and decapodae (young shrimp, Mysidacebe). Fish are also frequently found in their stomachs, while molluscs are met with rather seldom. To the benthic character of the feeding of Pagellus canariensis testifies the visceral apparatus: protruded mouth, heart-shaped teeth on both jaws, short and thick gill-rakers, their number on the first gill cover not exceeding 15. Fatty accumulations in the intestines of Pagellus canariensis are insignificant. A minimum quantity of fat accumulation was observed in February, i.e. after spawning, when Pagellus canariensis feed in a very intensive way. While fattening, the quantity of fat accumulation in the intestines begins to increase slowly reaching its maximum in December, i.e. by the beginning of the spawning. But even at that time the quantity of fat accumulation in the intestines is low (average index does not exceed 0.76).

Summary

Since 1957 the Soviet Union has carried out regular ichthyological investigations off the western African coast. These investigations showed that in the area between the Khubi Cape to the Guinea Bay species of the family Sparidae dominate in the catches of groundfish. As a result of the studies of the biological characteristics of a widely-distributed species, Pagellus canariensis (Val.) it has been established:-

1. In the Dakar and Takoradi areas Pagellus canariensis accumulates in local stocks, their specimens differing by a number of morphological features and terms of annual rings' formation on the scales.

2. In the Dakar and Takoradi areas specimens of 1o-23 cm long are met with in the trawl catches. In the Takoradi area specimens of 14-17 cm predominate, while in the Dakar area there is a clear predominance of individuals of 16-19 cm long. Males are larger than females.

3. There is a logarithmic dependence between the length and weight of Pagellus canariensis, i.e. the body length is directly proportional to the logarithm of the weight of the fish. And besides, at a certain stage of development the intensity of the growth in weight is changed.

4. Fishable concentrations of Pagellus canariensis of the Dakar and Takoradi areas consist mainly of two and three-year-olds.

5. The scale length of Pagellus canariensis fluctuates with its age in the direct proportional dependence to the body length.

6. The growth rate of Pagellus canariensis can be sharply changed under the influence of the environmental conditions. So in 1959-6o the growth rate was much lower than in 1957-58.

7. In the Takoradi area during a year two seasonal (annual) rings are laid on the scales of Pagellus canariensis due to climatic peculiarities in the area. Their formation takes place in April/May and in December/January at a sharp rise in the salinity. That is why it is impossible to determine the age by the scales as the prolongation of the spawning does not allow us to detect the time of the first seasonal ring formation.

8. The fecundity of Pagellus canariensis varies from 3o.ooo to 71.ooo eggs according to their body sizes, making up some 5o.ooo eggs on an average.

9. The spawning of Pagellus canariensis is an intermittent one, it occurs in the inshore zone from November/December to February/March. In their ovaries one can distinguish three portions of eggs. The eggs are pelagic.

1o. Pagellus canariensis feed intensively all the year round without ceasing to feed even in the spawning period. Its diet consists mainly of polychaeta, decapodae and fish.

11. Fat accumulations of the intestines of Pagellus canariensis are insignificant all the year round.

12. Commercial concentrations of Pagellus canariensis in the Dakar and Takoradi areas are fattening ones.

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Explanation of Figures

Figure 1 — Size-composition of Pagellus canariensis (Val.) in trawl catches.

Figure 2 — Correlation between the body length and weight of Pagellus canariensis (Val.)

Figure 3 — Age composition of Pagellus canariensis (Val.)in the trawl catches taken in the Dakar area.

Table 1. Morphological differences of *Pagellus canariensis* (Val.) in the Takoradi and Dakar areas.

Areas	Length (cm)	n	Tail stalk length in the body length (%) M ± m	Mdif	Snout length in the head length (%) M ± m	Mdif	Horisontal diameter of eye in the head length (%) M ± m	Mdif	Upper jaw length in the head length (%) M ± m	Mdif
Takoradi	13.1-15.0	31	13.074±0.15	4.17	34.476±0.35	3.3	31.711±0.27	6.1	23.905±0.32	7.4
Dakar		31	13.850±0.11		35.945±0.28		29.324±0.28		20.357±0.31	
Takoradi	15.1 - 17.0	50	12.821±0.1	4.76	35.03 ± 0.27	3.97	31.07 ± 0.27	3.63	23.53 ± 0.28	4.8
Dakar		31	13.494±0.1		36.55 ± 0.27		29.84 ± 0.25		21.679 ± 0.25	
Takoradi	17.1 - 20.0	17	12.834±0.14	3.20	35.674 ± 0.56	3.10	30.021 ± 0.3	3.60	23.617 ± 0.41	3.50
Dakar		17	13.554 ± 0.19		37.847 ± 0.45		28.727 ± 0.19		21.836 ± 0.29	

Figure 4 Shift of hydrological seasons and terms of rings' formation on scales of *Pagellus canariensis* (Val.)

Figure 5 Sizes of ovarian eggs at the IVth maturation stage of *Pagellus canariensis* (Val.)

Figure 6 Changes in gonads' maturation of *Pagellus canariensis* (Val.)

Table 2. Mean length of Pagellus canariensis (Val.) of different age groups in 1958.

Age	Length of fish l_s (cm)			
	Measured ($M_1 \pm m_1$)	n	Calculated ($M_2 \pm m_2$)	n
I	10.4 ± 0.4	21	10.1 ± 0.1	260
2	15.6 ± 0.5	20	15.1 ± 0.2	163
3	19.2 ± 0.3	45	18.6 ± 0.3	72
4	21.3 ± 0.4	30	21.6 ± 0.4	30

Table 3. Terms of rings' formation on scales of Pagellus canariensis (Val.)

Area investigated	Period of observations	No. of fish % having		
		the last ring already formed	the last ring not formed yet	
Dakar	June	24	76	100
	July	80	20	100
	April	89	11	100
Takoradi	May	88	12	100
	December	21	79	100

Table 4. Fecundity of Pagellus canariensis (Val.) in the Takoradi area, January 1962.

	Length of specimens l_s (cm)						
	13	14	15	16	17	18	19
Mean fecundity in thousands of eggs	30	46	56	71	41	44	53
No. of fish in a sample	3	9	21	9	15	12	69