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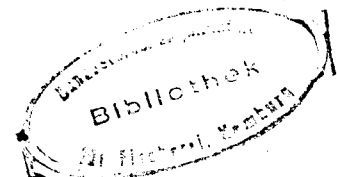
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ON PECULIARITIES IN THE BIOLOGY OF  
HORSE-MACKEREL (TRACHURUS TRACHURUS)  
FROM THE CENTRAL-EAST ATLANTIC



Horse-mackerel (*Trachurus trachurus*) is the most numerous species in the Central-East Atlantic.

The migrations of horse-mackerel are related to regularities of seasonal changes in the intensity of vertical water movement.

In spring and summer seasons, at the moment of highly intensive vertical circulation horse-mackerel is migrating to the slope of the continental shelf off shore.

In autumn and winter seasons when the intensity of vertical circulation is more significant in the shelf zone compared with the open sea, horse-mackerel is migrating inshore,

The major area of distribution of horse-mackerel commercial concentrations lies between  $26^{\circ}$  and  $14^{\circ}$ N, though in general this species can be found from the northern extremity of the African continent to the southern one.  $13-16^{\circ}$  are the main pre-bottom temperatures characteristic of horse-mackerel habitat.

The size structure of horse-mackerel commercial concentrations in the major area of occurrence is given in table 1.

It should be noted that there exists a direct correlation between the fish length and the depth of occurrence. In shallow water (the depth above 40 m) the young *Trachurus trachurus* around 20 cm in length occurs.

In the depth range of 50 to 200 m horse-mackerel of about the same size can be observed with a certain shift of length frequency peak to the right. At the depths of 225-300 m also

Table 1

Size-composition of horse-mackerel, %.

The position 20-25°N

Length, in cm	Years		
	1971	1972	1973
8	0.2	-	-
9	2.6	-	-
10	4.4	-	-
11	3.7	-	-
12	1.2	-	-
13	0.9	1.3	0.3
14	0.9	1.7	4.4
15	0.6	1.5	5.3
16	0.5	1.9	9.0
17	0.3	3.7	9.1
18	0.7	6.5	13.4
19	1.7	9.6	12.1
20	4.3	12.9	8.9
21	6.5	12.6	1.0
22	6.8	1.8	8.4
23	6.8	4.8	5.4
24	1.0	3.8	3.0
25	4.4	3.0	1.6
26	2.9	1.6	1.8
27	0.5	1.2	1.4
28	8.7	1.0	1.6
29	13.0	1.7	2.1
30	12.0	6.1	1.9
31	6.7	5.6	1.9
32	1.9	4.3	1.1
33	0.8	2.7	0.3
34	-	2.1	-
35	-	1.0	-
36	-	0.7	-
37	-	0.2	-
38	-	0.1	-
39	-	0.2	-
40	-	0.1	-
%	100	100	100
Sp. No.	13757	4063	10358

the fish of 26-30 cm in length prevails.

Vertical migrations of horse-mackerel have the following pattern. In the daytime *Trachurus trachurus* forms the schools of 100 m in extent. In the evening the fish is dispersed to a certain degree, the size of the dense schools increases and they raise to the surface. At night dense pre-bottom schools are not formed as a rule. In the morning horse-mackerel is grouped in schools and lowering to the bottom keeps there all the day round. This is the time when the schools can be easily found by searching instruments.

The commercial stock size of fish is known to be determined by the recruitment rate.

In *Trachurus trachurus* inhabiting the areas contiguous to our area of studies the following correlations were observed.

*Tr. trachurus capensis* becomes mature at the length of 22-27 cm, 3-4 years of age (Komarov, 1964; Overko, 1964).

The results of studies on maturation of *Trachurus trachurus* from different areas obtained by A.S. Polonsky are as follows.

Horse-mackerel from the English Channel becomes mature at the same age as *Trachurus capensis* but at somewhat smaller size. In the Celtic Sea horse-mackerel matures at the age of 4-5 years. Horse-mackerel inhabiting the area westward of Ireland attains maturity at 22 cm in length, while that from the southern North Sea - at 20-24 cm. The rate of entering of the Bay of Biscay horse-mackerel the spawning population is somewhat lowered and even at the length of 26 cm the

immature individuals occur.

*Trachurus trachurus* attains the sexual maturity extremely early. This species becomes mature in the second year of life at the length of 14-17 cm.

The analysis of gonadal development in horse-mackerel clearly demonstrates a pattern of prolonged spawning.

In June-August the female gonads in the major area are characterized by post-spawning condition, that is the stages of maturity during this period are VI, II. In September stage II prevails. Stage III is characterized by short duration, the percentage of individuals with gonads in stage IV considerably predominating in this period. A certain part of females has laid the first portion of eggs (stages VI-IV). In October the number of fish in stages IV and VI-IV sharply increases.

In November a massive spawning of horse-mackerel took place, when the largest per cent of running and pre-spawning females (stages V, IV-V) was marked. Simultaneously a sharp decrease of gonads in stages VI, II was observed. In December the spawning was still intensive and a great number of females had already laid a portion of eggs. The number of individuals in stage II is further decreased due to its transition to stage III.

In January stages IV and VI-IV predominate in the northern parts of the shelf (24-20°N) where some post-spawning individuals in stages VI and II occur. The number

of running females sharply decreased.

In the southern part of the area ( $15^{\circ}\text{N}$ ) in January the spawning is still intensive. Over 60% of females here are running in this time. In February the stages IV and VI-IV prevail. A small number of running individuals can be found. In March the gonads were in stages IV, VI-IV of development. In the northern part of the fishing area, in March, a large per cent of gonads entered the stages VI, II, while in the south less than 50% of females were in pre-spawning condition.

In April, in the north ( $22^{\circ}$ - $21^{\circ}\text{N}$ ) a number of individuals in post-spawning condition increases (stages VI, II). In the southern part of the area ( $17^{\circ}\text{N}$ ), in this month the females with laid eggs prevail as before (stages VI-IV). In May the stages VI-IV were chiefly observed and the number of pre-spawning females sharply decreased.

According to data obtained by SRTR 9019 a spawning of *Trachurus trachurus* in the area of the shelf of Mauritanie begins from November.

In February-March there could be regularly observed pre-spawning horse-mackerel with gonads in stage IV approaching the spawning grounds. In the area between  $19^{\circ}$  and  $17^{\circ}\text{N}$  spawning was observed from December to March. Prespawning horse-mackerel regularly approached this area as well.

In November (operations in the area of  $36^{\circ}$ - $30^{\circ}\text{N}$ ) pre-spawning concentrations were not almost available. In December

(36-39°N) the bulk of the concentrations was made of fish either with laid eggs (stages VI-IV), or ready for spawning.

In February (operations in the area of 30-18°N) horse-mackerel concentrations were in stages IV, VI-IV, while on the southern shelf (18°N) 23% of females were running. The spawning terms were undoubtedly related to general thermal conditions of water masses, and possibly coincided with the periods of massive bloom of phytoplankton being the main object of the larvae and zooplankton.

The mean annual sex ratio in *Trachurus trachurus* over the whole fishing area is nearly uniform, the females predominating insignificantly.

A. Polonsky presented the data on sex ratio in *Trachurus trachurus* from the English Channel. In most cases it is uniform, excluding the summer spawning period, when a certain predominance of females was marked. According to Aleev (1957), the predominance of females during the spawning period is stipulated by the fact that the females prevailed quantitatively in pre-bottom layer fished by the trawl. We consider Aleev's explanation convincing and acceptable for our case. However, it should be noted that all the above-said is true of the spawning period, since in post-spawning period the sex ratio becomes uniform and is 1:1.

The southern shelf area (15-17°N) is warmer (compared

with the northern one, 18-24°N) which conditions a more prolonged spawning. This is confirmed by the observations obtained during the expedition of SRTR 9019 in winter-spring period (F. Alekseev).

In the northern part of the area where the spawning period is shorter the sex ratio quickly equalizes.

Partial egg-laying is characteristic of all the representatives of the genus *Trachurus* (Aleev, 1957; Svetovidov, 1964, et al.), namely of *Trachurus capensis* (Overko, 1964) as well as of horse-mackerel of the north-western African coast (Overko, 1964).

The results of the oocyte diameter measurements showed the presence of various oocyte generations. The partiality in maturation of oocytes resulting in successive laying of mature eggs can be estimated as an adaptation of fish to utilization of the same spawning grounds, as well as to an increase in fecundity to a value providing the optimum abundance of a species.

The partiality in horse-mackerel spawning confirms the results of microscopic analysis of the ovaries (stage IV).

The oocytes of trophoplasmic growth period are represented by a series from those of a vacuolization phase to oocytes approaching the phase of an "oocyte filled by yolk". Simultaneously, the oocytes of the earlier stages of vitellogenesis are represented by a continuous series from those with the vacuolization started to the oocytes where yolk formation begins, only the older generation of oocytes



being clearly delimited from the previous ones. It is likely that horse-mackerel is characterized by continuous asynchronism of vitellogenesis which makes it difficult to determine the number of portions.

The data on *Tr. trachurus* fecundity from the shelf areas close to our investigation region are given by Komarov and Polonsky.

Komarov (1964) estimated the absolute fecundity of *Tr. trachurus* from the South-West Africa. In fish of 22 to 38 cm in length it makes from 22 to 346 thous. eggs.

According to Polonsky, the absolute fecundity of *Tr. trachurus* from the English Channel of 21-29 cm in length makes 76-209 thous. eggs.

*Tr. trachurus* inhabiting the area at the north-west extremity of Africa is characterized by a higher fecundity than horse-mackerel from Cap Blanc-Cabo Verde area. It should undoubtedly be connected with thermal conditions in the areas. The northern one is characterized by less stable thermal regime as compared with Cap Blanc-Cabo Verde area. Therefore higher fecundity of *Tr. trachurus* approaching that of horse-mackerel from the English Channel serves as a peculiar adaptation providing better reproduction of the species.

The spawning of *Tr. trachurus* takes place in separate parts of a vast shelf area, the densest spawning concentrations

being formed from 14 to 24°N over the depths of 80-250 m at surface water temperatures of 16-21°. The most massive spawning was marked in the areas of Cap Blanc, Saint Louis and Cabo Verde.

Pre-spawning and spawning horse-mackerel forms dense concentrations effectively fished by a commercial fleet. The stability of these concentration is directly related to the state of horse-mackerel gonads.

In post-spawning period, when the individuals in stages VI, II and III predominate in the concentrations the catches decrease, since the fish begins an intensive feeding and is dispersed in search of feeding grounds over the vast area.

The distribution of eggs and larvae also coincides with the areas where the densest spawning concentrations of this species occur. These are the areas of Cap Blanc, Saint Louis and Cabo Verde, but generally speaking, the eggs and larvae were found between 23 and 8°N over the depths from 30 to 300 m.

Egg laying takes place from October to April; it is most intensive in November in Cap Blanc area at surface temperatures 18-19° and in March in Cabo Verde area at surface temperatures 18-21°. The eggs are laid in several stages, they are pelagic, of spheric form with a thin transparent membrane and without any outlines or appendages. The yolk is degmented into large lobes; it contains 1-7 lipid droplets of 0.08-0.2 in size; the diameter of eggs is 0.9-1.1 mm (according to Sedletskaya).

Maximum number of eggs was taken in Cap Blanc area in December-January (surface temperature 16-18°) and in Cabo Verde area in April (temperature - 22-23°).

The major area of the young horse-mackerel distribution is Cape Blanc characterized by the availability of large plankton biomasses.

Some material on growth and age of *Tr. trachurus* from different areas of the Atlantic ocean are presented by Komarov (1962) on *Tr. capensis* and by Baidalinov, Staroselskaya (1964), Polonsky (1965) on horse-mackerel from the English Channel. Relatively stable temperature regime in the central-east Atlantic results in certain peculiarities in growth of horse-mackerel.

Various growth zones on the otoliths of *Tr. trachurus* caught at the same time shows that the laying of the rings in different individuals does not take place simultaneously. In other words the laying of an annual ring is not timed to a definite season of the year. The laying of the annual ring we relate to the spawning period. This view is confirmed by Lipskaya as well (1966).

The age was determined by otoliths and the cuts of the rays of pectoral fins.

The observations showed that there were not any significant differences in growth rate between the males and females. The growth rate of *Tr. trachurus* from the area of Agadir-Casablanca (33-29°N) is similar to that of horse-mackerel from Cap Blanc - Cabo Verde area.

Growth increment to the first year of life in *Tr. trachurus* is 12.2 cm, to the second year - 17.7 cm; to the

third year - 21.9 cm, to the fourth - 25.4, to the fifth - 29.8 cm, to the sixth - 32 cm. The linear growth is gradually retarded with age, however, the dynamics of weight increment has another trend.

Horse-mackerel can be attributed to predators of pelagic zone.

No differences in feeding of males and females were marked, neither we can speak of clear selectivity in horse-mackerel diet. The fish feeds on the organisms prevailing in its distribution areas.

In stomachs of *Tr. trachurus* the following forms were found: invertebrates - euphausiids, smaller forms of Calanoida and Cyclopoida, squids, shrimps, scallops, mysids; phytoplankton; vertebrates:

1. Engraulidae (*Engraulis hepsetus*)
2. Clupeidae (*Pellonula vorax*)
3. Myctophidae (*Myctophium* sp.)
4. Tryglidae (*Trygla* sp.)
5. Carangidae (*Trachurus* sp.)

Maximum size of feeding objects (fish) did not exceed 9 cm. In some most filled stomachs about 15 specimens of *Engraulis hepsetus* (1-4-9 cm) were found.

In the northern parts of the West African shelf (33-30°N) smaller forms of Calanoida and Cyclopoida predominated in a

food clot.

In the major area from Cape Blanc to Cabo Verde the bulk of a diet was represented by euphausiids.

Horse-mackerel becomes ichthyophage on attaining 23-25 cm in length.

The fishes were 11.9% of a food clot and represented by *Engraulis hepsetus* (3.3%), *Pellomula vorax* (5.2%), Myctophidae (0.5%), *Trachurus* sp. (0.2%), *Treyglidae* (0.1%); fish larvae (0.1%); unidentified fish (3.5%). Other components included: mysids - 0.4%, shrimps - 0.3%, scallops - 0.2 %, phytoplankton - 0.1%.

## REFERENCES

- Aleev, Yu. G., 1957. Horse-mackerels of the USSR seas. Trans. of Sevastopol biological station, v.9.
- Baidalinov, A.P., Staroselskaya, A.G., 1964. On age composition and growth rate of horse-mackerel from the English Channel and the Bay of Biscay. Tr. AtlantNIRO, iss.13.
- Komarov, Yu.A., 1962. Horse-mackerel from the South Atlantic. Rybnoe choziaistvo, No.2.
- Komarov, Yu.A., 1964. Some data on reproduction of horse-mackerel from the south-west African coast. Tr. AtlantNIRO, iss.II.
- Lipskaya, N. Ya., 1966. On peculiarities in fish growth in the tropical ocean zone. Respublikansky mezhvedomstvennyy sbornik "Ekologo-morfologicheskie issledovaniya nektonnykh zhivotnykh". Acad. nauk Ukr. SSR, Kiev.
- Overko, S.M., 1964. Some data on biology, distribution and fishing of the major commercial species in the south-west African waters and the prospects of development of home fishery. Tr. molodych uchenykh, VNIRO. "Pischevaya promyshlennost".
- Overko, S.M., 1964. The biology and fishing of the main fishes in the south Atlantic. Rybnoe choziaistvo, No.4.
- Polonsky, A.S., 1965. Horse-mackerel of the east Atlantic and its fishery. Rybnoe choziaistvo, No.6,7.
- Svetovidov, A.N., 1964. The fishes of the Black Sea. USSR Acad. of sciences.