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BIOLOGICAL INVESTIGATION ON SOME PELAGIC FISH SPECIES.

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ABSTRACT

The length-weigth relationships of **Sardinella aurita, Sardinella maderensis, Sardina pilchardus, Dussumieria acuta, Engraulis encrasicholus, Boops boops, Trachurus mediterraneus,** and **Scomber japonicus** in the catch of shansoulla from the area between Abu Kir Bay and El-Alamein during 1977 are calculated.

Age, growth rates, maturity stages, fecundity and stomach contents of most of the referred species in the same area are also studied.

INTRODUCTION

The pelagic, **Sardinella aurita, Sardinella maderensis, Sardina pilchardus, Dussumieria acuta, Boops boops,** as well as **Trachurus mediterraneus** caught by purse seine (shanshoulla) are among the most important fishes contributing to the Egyptian Mediterranean fisheries. These constitute on the average of 30% from the total catch of the Mediterranean Sea during the period 1977-82. Of which the sardines dominate the catch of shanshoulla and are represented by about 70% followed by **B. boops** about 18% and Anchovy about 9%.

Information about certain biological aspects for some of these fishes are essential for fishery management. Thus, the present work embraces the studies of length-weight relationship, age and growth rates, maturity, fecundity, and stomach contents.

This paper is a part of the work concerned with the project: "Fisheries Investigation of the Sardine and other Pelagic Fish, along the Egyptian Mediterranean coast from Rashid to El-Salloum". This project was carried out during the period from July 1976 to November 1978, under the supervision of Prof. Dr. M.T. Hashem.

MATERIALS AND METHODS

I. Length-weight relationship

The length-weight relationship was calculated for different fish species (without differentiation of sexes) from shanshoulla catch during 1977. This

relationship was from samples of 1867 fish of **S. aurita** ranging in total length between 7.0 and 28.0 cm; 448 fish of **S. maderensis** ranging between 10.0 and 18.0 cm in total length; 1874 fish of **S. pilchardus** ranging from 7.0 to 15.0 cm in total length; 206 fish of **D. acuta** ranging betwen 12.0 and 16.0 cm total length; fish of **E. encrasicholus** ranging from 6.0 to 12.0 cm total length; 8395 fish of **B. boops** varying between 9.0 and 24.0 cm total length; 2290 fish **T. mediterraneus** ranging from 12.0 to 27.0 cm total length and 318 fish of **S. japonicus** ranging in total length between 15.0 and 29.0 cm.

II. Age determination and growth studies

Age determination is based on the examination of scales and otoliths of the referred fish species (without differentiation of sexes) taken from the catch of shanshoulla during April-October 1977. These fishes are:

115 **S. aurita** of total length ranging between 14.2 and 24.6 cm;
102 **S. maderensis** of total length ranging between 11.5 and 17.9 cm;
93 **B. boops** of total length ranging between 13.2 and 22.1 cm; and
618 **T. mediterraneus** of total length ranging between 17.6 and 26.6 cm.

Scales of the first three species were cleaned in 10% ammonia soultion and examined under binocular microscope. The otoliths of **T. mediterraneus** was immersed in xylol and examined under binocular microscope with black background (Macer, 1968; and Reay, 1972).

III. Maturation and Fecundity:

The monthly variations of maturity stages were studied, (during the period from April-October 1977), for 907 **S. aurita** ranging in total length from 12.0 to 25.0 cm; 291 **S. maderensis** varying between 10.0 and 15.0 cm total length; 1102 **B. boops** ranging from 13.0 to 22.0 cm total length; and 1345 **T. mediterraneus** varying in total length from 17.0 to 28.0 cm.

The states of gonads were determined visually according to the simplest universal scale, which only represents the course of maturation of the gonads in general terms to six stages (Nikolsky, 1963).

The absplute and relative fecundity (F_A and F_R), for most of the referred fish species were recorded. The curvilinear and least square relations between absolute and relative fecundity against fish length and weight are estimated, at the same time relation of fecundity with age is also calculated.

IV. Food Investigation :

The monthly variations of food items were examined during the period from April to October 1977, for 82 **S. aurita; 30 S. maderensis;** 103 **B. boops;** and 321 **T. mediterraneus.** The different food items in the stomachs of these fish species were examined. The percentage composition and occurrence were also determined.

RESULTS AND DISCUSSION

Length-weight relationship:

The analysis of the length-weight data has been directed towards describing mathematically the relationship between length and weight. The length-weight relationship can usually or always be adequately represented by a formula:

$$W = a\ L^n$$

(W = weight, L= length, a = constant, and n = exponent)

The exponent "n" has a value nearly always between 2.5 and 4.0, often close to 3, (Hile, 1936; and Martin, 1949). The value n= 3 indicate that the fish grows isometrically, (Allen, 1938). Values other than 3 indicates allometric growth (n > 3, the fish becomes heavier for its length as it grows larger).

Calculating the length-weight relationship for the different fish species (sexes combined), the following equations are obtained:

S. aurita : $W = 5.15205 \times 10^{-6}.\ L^{3.086}$

S. maderensis : $W = 3.52286 \times 10^{-5}.\ L^{2.701}$

S. pilchardus : $W = 5.96343 \times 10^{-6}.\ L^{3.042}$

D. acuta : $W = 2.45158 \times 10^{-5}.\ L^{2.761}$

E. encrasicholus: $W = 199089 \times 10^{-5}.\ L^{2.733}$

B. boops : $W = 9.21442 \times 10^{-6}.\ L^{3.009}$

T. mediterraneus: $W = 3.44608 \times 10^{-5}.\ L^{2.741}$

and

S. japonicus : $W = 6.86192 \times 10^{-6}.\ L^{3.049}$

Using these equations for determining the calculated weights, it is found a very close argeement between the empirical and calculated ones. However, for sardine, some variations in the weights of individuals fish within the same length group, in the different seasons were noticed. This can be attributed to cyclic changes in the quantity of fat stored in the fish associated with/or following feeding and breeding activities (El-Saby, 1937; El-Maghraby, 1960 & 1969; and Soliman et al, 1970).

Age determination and growth studies:

The growth studies of the two species of sardinella were previously attempted in the Mediterranean by (Fage, 1920; Navarro, 1932; Dieuzeide, 1950; Ananiades, 1951; Postel, 1955; Rossignol, 1955; Ben-Tuvia, 1956; Dieuzeide and Roland, 1957; Ben-Tuvia, 1960; El-Maghraby, 1960; Lee, 1961; and El-Maghraby et al, 1970).

Mean values of length at time of formation of each annulus were back-calculated for separate age-groups. Then the lengths were calculated by the summation of the annual length increments. In this study the determined age for **S. aurita** is 5 years. The lengths from first to fifth years of life are found to be; 123, 162, 193, 223 and 238 mm respectively. Table (1) representing the lengths in mm of **S. aurita** at different age groups from Alexandria (1977) compared with those of other localities. It is found that these lengths are slightly less than those previously obtained.

Applying the length-weight formula of **S. aurita**, the respective weights for the lengths at each year of life were calculated. The respective weights from first to fifth years are found to be : 15, 34, 58, 89 and 109 grams respectively.

For **S. maderensis**, it was found that it reached 4 years old. The estimated lengths from first to fourth years of life are presented by: 106, 125, 142 and 164 mm respectively. Table (2) representing the lengths in mm of **S. maderensis** at different age-group from Alexandria (1977) compared with those of other localities. It is showing slight difference from El-Maghraby (1970) and nearly coincides with those of Fage (1920); and El-Maghraby (1960).

The length equation of **S. maderensis** was applied to calculate the weights of the respective lengths at each year of life. These are found to be: 10, 16, 22 and 32 grams respectively.

The age of **B. boops** under study was estimated to be 4 years old. The calculated total lengths at the end of different years of life are represented by: 112, 149, 178 and 201 mm respectively. Applying the length-weight equation of **B. boops**, the weights of the respective lengths at the end of different years of life were calculated as: 13, 31, 54 and 79 grams respectively.

Studies on the age of **T. mediterraneus** revealed that it reached 5 years old. The calculated total lengths at the end of different years of life are found to be: 153, 192, 217, 236 and 255 mm respectively. The estimation of the weights for the respective lengths at the end of different years of life were found to be: 33, 63, 89, 113 and 140 grams respectively.

TABLE 1

The lengths (mm) of S. aurita attained at different age-groups from Alexandria compared with those of other localities.

Country	Authors	Age groups					
		0	1	2	3	4	5
Balearic	Navarro,1932	130	182	218	238	-	-
Canary	Navarro,1932	137	189	236	268	285	-
Aegean Sea	Ananiades,1951	-	120	170	210	240	260
Senegal	Postel,1955	-	150	210-220	250-260	290-300	330-340
Middle Congo	Rossignol,1955	-	150	230	270	290	-
Palestine	Ben-Tuvia,1956	112	158	192	217	234	257
Algeria	Dieuzeide and Roland, 1957	60-120	130-160	170-260	210-260	-	-
Gulf du Lion	Lee,1961	105	169	214	234	-	-
Alexandria	El-Maghraby et al,1970	-	149	178	200	206	-
Alexandria	Present work	-	127	163	188	217	237

TABLE 2

The lengths (mm) of S. maderensis attained at different age groups from Alexandria compared with those of other localities.

Country	Authors	Age groups						
		1	2	3	4	5	6	7
Egypt	Fage,1920	110-115	120-125	135	140-150	-	-	-
Algeria	Dieuzeide,1950	-	-	-	175	180-220	230-255	-
Alexandria	El-Maghraby,1960	111	127	139	163	-	-	-
Palestine	Ben-Tuvia,1960	115	145	175	195	220	-	275
Alexandria	El-Maghraby,1970	113	135	145	-	-	-	-
Alexandria	Present work	108	125	136	163	-	-	-

S. maderensis:

The absolute fecundity of **S. maderensis** varied from 8077 to 14467 egg for the lengths from 100 to 150 mm respectively. The examination of data representing the average total number of eggs with the successive length groups (10 mm interval), a curvilinear relationship was observed. Therefore, the relation between the absolute fecundity and fish length can be represented by an exponential equation.

A relationship between the total length of fish and both the absolute and relative fecundity was worked out by adopting the curvilinear relationship. The calculated relationships coul be expressed by the following equations:

$$\log F_A = 1.139 + 1.381 \log L$$
$$\log F_R = 1.139 + 0.381 \log L$$

It is quite clear that the production of eggs increases with increase of fish length.

On the other hand, the least square method was applied to data for both the absolute and relative fecundity against the total weight of **S. maderensis.** The calculated formulae were as follow:

$$F_A = 5612.93 + 307.56\ W$$
$$F_R = 788.55 - 5.57\ W$$

The absolute fecundity for **S. maderensis** according to age groups was calculated. The average absolute fecundity are found to increase steadily with age. It reaches 9560 (age group I), 10943 (age group II), and 13276 egg (age group III).

B. boops:

In the present work, the fecundity of **B. boops** was investigated. The absolute fecundity varied from 5185 to 52208 egg for fish ranging in size from 130 to 220 mm. It is obvious that the observed absolute fecundity increases gradually with the increase of body length.

Therefore, curvilinear relationships are used to relate both the absolute and relative fecundity to the total body length of **B. boops.** The calculated relationships could be expressed by the following equations:

$$\log F_A = -0.9503 + 4.2531 \log L$$
$$\log F_R = -0.9224 + 3.231 \log L$$

Such curvilinear relationship fits well the relations between the total body length and both the absolute and relative fecundity of **B. boops.**

The relationships between the absolute as well as the relative fecundity

against the average gutted weight of fish were examined. Such relationships are investigated by applying the method of least squares which fit well these relations. The following are the equations attained:

$$F_A = -6614.76 + 656.16\ W$$
$$F_R = 317.3 + 3.386\ W$$

It is obvious that the absolute and relative fecundity of **B. boops** increase with increase of gutted weights.

The absolute fecundity for **B. boops** was determined according to ages. It appears that the average number of eggs increases with ages as follows: 10678, 20234, 34228 and 50261 egg for ages I to IV respectively.

T. mediterraneus:

The absolute fecundity of **T. mediterraneus** varied between 25081 and 215595 egg for fishes ranging in length from 170 to 280 mm. The relationships between the absolute and relative fecundity against the total lengths fit well by the curvilinear relation. The following are the estimated equations:

$$\log F_A = -4.8221 + 4.1524 \log L$$
$$\log F_R = -4.8169 + 3.1502 \log L$$

It is quite clear that egg productions increase with increas of fish length.

The relation between fecundity and gutted weight of fish was examined for **T. mediterraneus** by applying the least square method which fits this relation. The following equations were obtained:

$$F_A = -43248 + 1581\ W$$
$$F_R = 505 + 5.94\ W$$

It is obvious that the absolute and relative fecundity increase with the increase of gutted weight of fish.

Also, it was found that the average absolute fecundity for **T. mediterraneus** increases with age. It reaches 45180 egg (age group I), 74347 egg (age group II), 110361 egg (age group III), and 179507 egg (age group IV).

Food Investigation

Microscopic examination of the stomach contents of the different fish species was carried out.

Monthly varitations of food items for **S. aurita** are observed. It is clear that, Copepoda, Amphipoda, Isopoda, Decapoda (shrimp), fish fry, Zoea

of crabs, Polychaeta and eggs of fishes and invertebrates were present in the examined stomachs. The percentage occurence of the different food items varies from one month to the other. The copepoda scarcely compose food item of **S. aurita**, the same for polychaeta and the eggs of fish and invertebrates. The decapoda is the only food item present and compose the main food in the stomachs of **S. aurita**. The decapoda are found in variable amounts during April-October. The same thing for isopoda, but it is absent during May, while for amphipoda, it is absent during June and September. The digested food present in nearly all the examined stomachs.

Monthly variations of food items of **S. maderensis** are observed. It is found that food taken by the fish is represented by Amphipoda, Isopoda, Decapoda (shrimp), fish fry, Zoea of crabs, Polychaeta and eggs of fish and invertebrates. The presence of these food items are variable from one month to another. The decapoda (shrimp) are found all the period of study in the stomachs of the fish. The amphipoda present all the period excep in September. The zoea of crabs are absent during June, while isopoda and fish fry are also absent in June and September. The polychaeta and eggs of fish and invertebrates are scarcely present.

Befor the regulation of Nile-flood, El-Maghraby (1960) demonestrated that the food items of **S. maderensis** was composed exclusively of plankton organisms, both phytoplankton and zooplankton. The food of fish was sorted into the following different categories: Diatoms, Peridinians, Planktonic copepods (mainly Calanoid species) including the adults and younger copepodite stages, Harpacticoid copepodes, eggs and larvae particularly those of invertebtates, and other organisms such as Tintinids, Rotifers, Cladoceran Podon sp., and small Amphipods. He also concluded that the monthly qualitative variation of the stomach content of the sardine fish demonestrates, to an extent the variation which takes place in the plankton of the fishing areas.

In this connection El-Maghraby (1960) mentioned the following notes:

1) The most important food eaten during the winter months is the nauplii of barnacles which are very common in the plankton.
2) During the spring months, the eggs of anchovy characterized both the plankton and stomach content, nauplii and eggs of copepodes were the dominant organisms.
3) During the summer months, the production of invertebrate larvae in the plankton was very high. The contents of the sardine stomachs consisted mainly of copepode eggs and nauplii in addition to the planktonic eggs and trochophore larvae of several molluscs and some polychaete larvae.
4) Diatoms and Dinoflagellates were the main constituents of the autumn phytoplankton bloom. They were injested in thousands by the sardine fish giving their gut content a green brownish colour.

The monthly variations of food items of **B. boops** are also noticed. The food items taken by the fish are found to be: Polychaeta, Decapoda, Isopoda, Amphipoda, fish fry Bivalva, Ascidian, fish scales, Foraminifera and green algae. These food items are present in variable amounts from one month to the other. The isopoda were present all the period from April to October, while decapoda and fish fry were absent in September. The polychaeta and bivalvia were absent during July and September, while amphipoda in May and September. The foraminifera and green algae are rarely present.

The monthly variations of food items of **T. mediterraneus** are observed. The following food items are presented by: fish fry, elvers, Decapoda (shrimp), Isopoda, Amphipoda, Cephalopoda, fish scales, flat fishes, Polychaeta, unidentified fish and digested food. These food items are variable in their occurrence. The fish fry, decapoda, isopoda, fish scales are dominated during April-October. The elvers, amphipoda, and cephalopoda are absent only in September, while the flat fish, polychaeta and unidentified fish are scarcely present.

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