Bull. Inst. Oceanogr. & Fish, ARE, 8 (1) 1982 : 163–171.

EFFECT OF NILE RIVER DISCHARGE ON RELATIVE CONDITION FACTOR OF SARDINE POPULATION, SARDINELLA MADERENSIS LOWE.

MOHAMED A. IBRAHIM AND IBRAHIM A. SOLIMAN
Institute of Oceanography and Fisheries, Alexandria, Egypt.

ABSTRACT

A comparative study between the Sardine population of S.E. Mediterranean waters of Egypt in 1951, 1961, 1964-65, 1966 and 1975 was carried out to investigate the effect of the Nile discharge regulation on the mean individual fish weight and the Relative Condition Factors. The study revealed that the discharge regulation had reduced the mean individual fish weight as well the population size but the Relative Condition Factors of the sardines in this area.

INTRODUCTION

Sardine catch from the south eastern Mediterranean waters of Egypt was representing the most important commercial fish production amounting to a maximum of 18,166 tons (48 % of the total Mediterranean fisheries of Egypt) in 1962. From then on, the sardine catch showed a continuous decrease - probably as a result of an overfishing factor - which was drastic after the Nile discharge regulation due to the construction of the Aswan High Dam in 1965, as shown in table 1, which was compiled from the official reports on the U.A.R.Fishery Statistics 19621974.

From the previous studies by El-Zarka and Koura (1965); and Aleem (1969), it is well established that the biology of sardine is closely related to the Nile discharge into the Mediterranean waters of Egypt. This discharge results in a luxurious phytoplankton bloom which is the exclusive diet of sardine (El-Meghraby, 1960). The Nile discharge regulation started in 1965 led to a sharp reduction in the intensity of the autumnal phytoplankton bloom to approximately 10 times less than the beginning of the sixties (Halim et al, 1967).

This sharp environmental change (Nile discharge regulation) affected the conditions of sardine feeding that was detrimental to the changes in distribution and reproduction. This effect was evident on the population level, decreasing the annual sardine catch to a minimum of 464 tons in 1968 but never exceeding 1505 tons in the years after the Nile discharge regulation.

Recently, it is claimod that not only the discharge regulation affected the size of the total sardine catch, but also the population on the individual level namely the robustness of the individual fish itself.

TABLE (1)

Sardine catch and its percentage relative to the total fish catch (in metric tons) from the southeastern Mediterranean waters of Egypt (1962-1974).

Year	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Sardine catch	18166	12981	7372	7635	1232	812	464	600	575	1505	1405	599	988
%	48.02	39.45	28.38	30.93	8.19	6.65	3.41	7.04	7.09	14.28	13.62	8.94	14.43

The aim of this study is to confirm or reject such a claim using the well known biological character "Relative Condition Factor", K_n, (Le Cren, 1951).

SOURCE OF DATA

Sardinella maderensis Lowe, was chosen in this study due to the availability of data covering a long period of time namely from 1951 to 1975, that could provide a good basis for a comparative study.

To uniform the bases of calculations, the published data by (El-Maghraby 1960 and 1969; and Soliman et al, 1970) were used to recompute the length-weight relationships, represented by the general equation

$$W = a\ L^n,$$

where, W is the calculated weight in gm, L is the total length in cm, while a and n are constants.

The Relative Condition Factors were also calculated for those data using the formula

$$K_n = \frac{W}{W'}$$

where, W is the mean observed weight and W' is the calculated weight, both in gms.

Concerning the new data, random samples of **S. maderensis** were collected weekly during the summer season of 1966 and 1975 from fishermen operating in the waters infront of and in the eastern harbour of Alexandria. The total number of fish sampled during the mentioned two summer seasons were 1151 and 435 fish covering the length ranges 8.0 - 16.0; and 9.5 - 15.0 cm respectively. The fish were measured for total length to the nearest 1 mm, for total weight to the nearest 0.5 gm, then were classified into length groups regardless of sex. The length-weight relationship equations and the Relative Condition Factors of the summer seasons, populations were calculated for both the new data and the published data of 1961.

RESULTS AND DISCUSSION

The recomputed formulae for the length-weight relationship (whole year) of each of 1951, 1961 and 1964-65 are given table 2, together with the sampling year, the length-range of fish studied and the source of data.

Table (2)

Recomputed length-weight relationships of **S. maderensis** (whole year), where, W' is the calculated weight in gm., and L is the total length in cm.

Length - weight formula	Sampling year	Length range (cm)	Source of data
$W' = 0.0159\ L^{2.798}$	1951	9.0 - 17.0	El-Maghraby (1960)
$W' = 0.0102\ L^{2.99}$	1961	6.0 - 17.0	El-Maghraby (1969)
$W' = 0.0095\ L^{2.969}$	1964 - 1965	5.0 - 27.0	Soliman et al (1970)

From table 2, the calculated weights (W) and their overall means were obtained only for the paired length groups (10.0 - 17.0 cm) comparable in the three sampling years and are shown in table 3. In the last mentioned table, the number of fish in each respective length group, the average observed weight (W) and the Relative Condition Factors (K_n) and their means are also given.

The statistical method for comparison of two samples as described by Snedecor and Cochran (1968) at 95 % confidence level was used to compare the mean calculated weights obtained from the paired length groups (10.0 - 17.0 cm). The calculations showed that there is no significant statistical difference between the mean calculated weights of 1951 and 1961 **S. maderensis** populations ($t_{cal.} = 0.1767$). While a significant statistical difference was noticed between those of 1951 and 1964 - 65, and also between those of 1961 and 1964-65 ($t_{cal} = 26.0738$ and 5.169 respectively) comparable to a tabulated $t = 2.365$. This could lead to the conclusion that, on the average individual fish-weight basis, the overall mean fish-weight in 1951 is the same as in 1961, while those of 1951 and 1961 are higher than those of 1964-65.

The same statistical method mentioned above was also used to compare the values of the mean Relative Condition Factors (K_n) of the three sampling years. The results obtained showed that there is no significant statistical difference between these data of 1951 and 1961; 1951 and 1964-65; and 1961 and 1964-65 due to the small values of (t) that equal 0.5025, 1.9339 and 2.2976 respectively, comparable to ($t = 2.365$) as obtained from the standard statistical tables.

TABLE 3

Observed (W) and Calculated (W) weights in games, and Relative Condition Factor (K_n) of S. maderensis during the sampling years 1951, 1961 and 1964-65 (whole year).

	1951				1961				1964-1965			
length cm	No. of Fish	weight (gm) W	W	K_n	No. of Fish	weight (gm) W	W	K_n	No. of Fish	weight (gm) W	W	K_n
10	@	10.1	9.99	1.0110	18	10.17	9.61	1.0583	14	8.4	8.85	0.9492
11	@	12.9	13.04	0.9893	139	12.92	12.97	1.0102	76	10.6	11.74	0.9029
12	@	16.0	16.63	0.9621	281	16.67	16.60	1.0042	104	14.7	15.20	0.9671
13	@	21.0	20.81	1.0091	286	22.00	21.04	1.0456	213	19.9	19.28	1.0322
14	@	26.4	25.60	1.0313	169	26.88	26.30	1.0221	255	26.5	24.02	1.1032
15	@	31.0	31.05	0.9984	59	30.35	32.28	0.9402	88	24.7	29.48	0.8379
16	@	38.0	37.20	1.0215	27	39.74	39.17	1.0146	15	31.6	35.71	0.8849
17	@	44.9	44.08	1.0186	3	44.99	46.99	0.9540	3	39.2	42.75	0.9170
Total	@				982				762			
Mean			24.80	1.0052			25.60	1.0061			23.38	0.9493

@ Number of fish is not given in the original data

Due to the fact that there is no significant statistical difference between the calculated weights as well as the Relative Condition Factors of both populations of 1951 and 1961; hence; it could be assumed that the population of 1961 represents a steady state with the prevailing microenvironmental changes before the Nile discharge regulation.

This assution could be verified on the basis of Odum statement (1971) that; when the environment is unlimited, the specific growth rate (i.e. the population growth rate per individual) becomes constant and maximum for the existing microclimatic conditions. On the other hand, the population of 1964-65 that was possessing a particular population size and age structure was faced with the advance climatic conditions namely; the reduction of its food supply through the reduction of the Nile discharge from 63.7 to 35.9 km^3 in 1964 and 1965 respectively (El-Kholy and El-Wakeel 1975). A direct effect of this regulation was the decrease in the mean calculated weight - of the length range 10.0 - 17.0 cm - from 25.6 gm in 1961 to 23.38 gm in 1964-65, as well as the decrease in the population size from a maximum of 18,166 tons in 1962 to a mean of about 7,500 tons in 1964-65.

For studying the long term effect of such change in the environmental conditions, the length-weight relationship of **Sardinella maderensis.** For studying the long term effect of such change in the environmental conditions, , the length-weight relationship of **Sardinella maderensis** during summer season (June, July and August) of the years 1961, 1966 and 1975 were calculated from the published and new data , they are as follows:

$$W' = 0.0191 \cdot L^{2.7144} \qquad (1961)$$

$$W' = 0.0226 \cdot L^{2.6366} \qquad (1966)$$

$$W' = 0.01568 \cdot L^{2.7832} \qquad (1975)$$

From these three equations, the calculated weights (W'), the relative condition factor (K_n), and the mean for both were calculated only for the paired data and presented in table 4, together with the number of fish and the average weights (W) in the respective length groups.

When applying the same statistical method mentioned before on the paired data of the summer season of 1961 againest either of 1966 or 1975; it appeared that there is no significant statistical difference between the mean relative condition factors of the three populations ($t_{cal.}$ 0.5937 and 0.3415 respectively). The same statistics showed that the mean calculated weights of 1961 is greater than either of 1966 or 1975 ($t_{cal.}$ = 3.8075 and 23.3136 respectively). This could lead to the conclusion that the prevailed environmental conditions in 1966 and 1965 reduced the weights of the individual fish but its Relative Condition Factor. This means that the fish has been adapting itself to the prevailing environmental conditions.

TABLE 4

Observed (W) and calculated (Ŵ) weights in gms of S. maderensis for the summer seasons June, July and August of the sampling years 1961, 1966 and 1975.

length (cm)	1961 No. of Fish	1961 weight (gm) W	1961 weight (gm) Ŵ	K_{11}	1966 No. of Fish	1966 weight (gm) W	1966 weight (gm) Ŵ	K_{11}	1975 No. of Fish	1975 weight (gm) W	1975 weight (gm) Ŵ	K_{11}
8.0	-	-	-	-	4	5.5	-	-	-	-	-	-
8.5	-	-	-	-	-	-	-	-	-	-	-	-
9.0	-	-	-	-	121	7.2	-	-	-	-	-	-
9.5	-	-	-	-	-	-	-	-	1	9.00	-	-
10.0	6	11.17	-	-	353	10.0	-	-	7	9.57	-	-
10.5	-	-	-	-	-	-	-	-	23	11.17	-	-
11.0	27	12.68	12.82	0.151	432	12.4	12.58	0.9857	90	12.19	12.41	0.9823
11.5	50	14.44	-	-	-	-	-	-	44	14.09	-	-
12.0	94	16.09	16.23	0.9914*	117	16.2	15.83	1.0234	93	15.96	15.81	1.0095
12.5	104	18.27	-	-	-	-	-	-	87	14.70	-	-
13.0	98	20.51	20.17	1.0169	91	19.6	19.55	1.0026	63	20.57	19.75	1.0415
13.5	44	22.59	-	-	-	-	-	-	13	21.23	-	-
14.0	46	24.16	24.67	0.9793	29	23.0	23.77	0.9676	12	22.67	24.28	0.9337
14.5	28	27.57	-	-	-	-	-	-	1	28.00	-	-
15.0	15	28.43	29.75	0.9556	3	28.0	28.51	0.9821	1	29.00	29.42	0.9857
15.5	20	32.55	-	-	-	-	-	-	-	-	-	-
16.0	11	34.63	-	-	1	34.0	-	-	-	-	-	-
16.5	7	39.07	-	-	-	-	-	-	-	-	-	-
17.0	2	45.00	-	-	-	-	-	-	-	-	-	-
Total	552				1151				435			
Mean			20.73	0.9865			20.09	0.9923			20.33	0.9905

Moreover, this conclusion was confirmed when comparing the paired data of the summer season of 1966 against 1975. The results revealed that there is no significant statistical difference between the mean calculated weights as well as between the Relative Condition Factors ($t_{cal.}$ = 1.4784 and 0.1421 respectively). This means that a steady state was reached in the years after 1966.

CONCLUSION

The effect of the Nile discharge regulation due to the construction of the Aswan High Dam in 1965 was evident on **Sardinella maderensis** populations of the south-eastern Mediterranean waters of Egypt. It reduced the mean size of sardine catch from 15,574 tons in 1962-1963 to 7,500 tons in 1964-1965 and averaged to 909 tons in 1966-1974.

The studies of 1951 and 1961 revealed that a steady state was taking place during this period as shown from the equality of both the mean calculated weights as well as the mean Relative Condition Factors for these populations. This steady state was interrupted in 1964-1965 reducing the mean calculated weight from 25.6 gm in 1961 to 23.38 gm in 1964-1965, while the mean Relative Condition Factor did not show significant change. This indicates that the fish has been adapting itself by reducing its individual weight and its population size to cope with the prevailed environmental condition in 1964-1965 and the years thereafter.

A steady state was clearly menifested during the period from 1966 to 1975 based on the similarity of the Relative Condition Factor of both populations.

ACKNOWLEDGEMENT

The authors extends their great thanks to Dr. A.A. El-Sayes and Dr. M.T. Hashem who allowed us to use the unpublished raw data of 1975.

REFERENCES

Anon., 1962 - 1974. **Official reports on U.A.R. Fishery Statistics.** Published by the Academy of Scientific Research and Technology.

Aleem, A.A. 1969. Marine resources of the U.A.R. **Stud. Rev. gen. Fish. Coun. Medit.,** (43).

El-Kholy, A.A. and S.K. El-Wakeel, 1975. Fisheries of the South-Eastern Mediterranean Sea along the Egyptian Coast. " Soviet - Egyptian Expedition, 1970-1971". **Bull. Inst. Oceano. and Fish.,** (5) : 238.

El-Maghraby, A.M. 1960. The biology of the Egyptian Sardine. Preliminary account of the biology of **Sardinella eba** Cuv. & Val. **Alexandria Inst. Hydrobiol., Notes and Memoires,** (58) : 1-26.

El-Maghraby, A.M. 1969. The weight-length relationship of the U.A.R. **Sardinella. Stud. Rev. gen. Fish. Coun.Medit.,** (38) : 1-14.

El-Zarka, S.E. and R.A. Kora, 1965. Seasonal fluctuations in the population of the important food fishes of the warm waters of the Mediterranean Sea. **Alexandria Institute of Hidrobiol., Notes and Memoires**, (47): 1-67.

Halim, Y.; Sh. K. Guerguess and H.H. Salah, 1967. Hydrographic conditions and plankton in the south east Mediterranean Sea during the last normal Nile Flood, (1964). **Intern. Rev. Ges. Hydrob.**,(53): 3.

Le Cren, E.D. 1951. The length-weight relationship and seasonal cycle in gonad weight and condition in the Perch, **Perca fluviatilis** L. **J. Animal Zoology**, (20): 201-219.

Odum, Eugene, P. 1971. **Fundamentals of Ecology**. W. Saunders Co., London, 179.

Snedecor, G.W. and W.G. Cochran, 1968. **Statistical Methods**. Sixth Edition. The Iowa State Univ. Press, U.S.A.: 91-99.

Soliman, I.A.; G.A. Botros and A.M. El-Maghraby, 1970. Length-weight relationship and coefficient of condition of **Sardinella maderensis** Lowe and **S. aurita** Cuv. and Val. from the Mediterranean Sea at Alexandria, (U.A.R.). **Bull. Inst. Ocean. and Fish.**, Egypt, (1): 27-45.