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LENGTH-WEIGHT RELATIONSHIP AND RELATIVE CONDITION FACTOR OF THREE SPECIES OF CICHLID FISHES INHABITING LAKE MANZALAH EGYPT.

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ABSTRACT

The present study deals with a comprehensive analysis of length-weight relationship and relative condition coefficient of three species of cichlid fishes, **O. niloticus** (Linn.), **T. zillii** (Gerv.) and **S. galilaeus** (Linn.), inhabiting three different ecological zones; (El-Gamil, El-Ginkah and Middle zones) at Lake Manzalah throughout the period 1986-1988. It could be reported that the pooled regression coefficient revealed an allometric growth for **O. niloticus** and **T. zilli** at the Middle and El- Ginkah zones, while growth isometry was evident for the three studied species at El-Gamil zone. The highest relative condition factor was recorded at the Middle and El-Ginkah zones for the three cichlid species except **S. galilaeus** which had the highest relative condition at El-Gamil zone. Test of significance indicated the highest relative condition for **S. galilaeus**, followed by **O. niloticus**, and the lowest for **T. zillii**. The representation of relative condition factor as a function of length, revealed a strong positive linear correlation for **O. niloticus** and **T. zillii** and a weak correlation for **S. galilaeus**. Comparing the relative condition factor at present study with that at previous years has shown a decreasing tendency due to progressive accumulation of pollutant in the Lake's water.

INTRODUCTION

From the economical point of view, Lake Manzalah is considered the most important Delta lake in Egypt. Since its annual fish catch comprises more than 50 % of total catch from the Nile Delta lakes (El-Zarka et al., 1970). The specifications of the Lake and its ecological zones were mainfested previously by several authors (Wahby et al., 1972; Bishara, 1973; Dowidar and Abd-El-Moati, 1983 ; Dowidar and Hamza, 1983 and Abd-El-Baky, 1989).

Cichlids are the most common fish species amongst the annual catch of Lake Manzalah (i.e. more than 80 % - IOF). Cichlids are considered a favourable edible source of protein food for Egyptians. Several investigations have been done on the biology of cichlid species, **Oreochromis niloticus** (Linn.), **Sarotherodon galilaeus** (Linn.) and **Tilapia zilli** (Gerv.), (Jensen, 1957; El-Bolock and Koura, 1960 & 1961; El-Zarka, 1961; El-Zarka, et al.,1970; El-Maghraby et al., 1972; Bishara, 1973; Mahdi et al., 1973; Blay, 1981; Chehab 1987 and Abd El-Baky, 1989). The length-weight analysis of cichlids did not receive much attention by most of the authors, since they used to employ only one regression equation regardless the nature of the regression coefficient "b" Further they have applied the normal conditon factor "K" in their computations. Therefore the present study deals with a comprehensive and comparative analysis of the length-weight parameters and relative condition factor of **O. niloticus, T. zillii** and **S. galilaeus** of three different ecological zones of Lake Manzalah, which may be helpful in the management of cichlid fisheries in the Lake.

MATERIAL AND METHODS

A total number of 2899, 3637 and 771 specimens of **Oreochromis niloticus** (Linn.), **Tilapia zillii** (Gerv.) and **Sarotherodon galilaeus** (Linn.) respectively were sampled from three different ecological zones (El-Gamil, El-Ginkah and Middle zones) of Lake Manzalah during 1986-1988. The fish were collected monthly amongst the catch of trap fisheries. The length-weight data were assembled with respect to each sex separately and combined in each season for each of the three studied zones. The length-weight relationship was computed using a formula of the type: $W = a L^b$ (Le Gren, 1951; Tesch, 1968 and Ricker, 1975), where W=weight in grams, L is the total length in cm, and a & b are the regression parameters. The coefficient "b" was subjected to test of homogenity i.e. isometric or allometric; t and F tests were applied to compare the significant difference between sexes, season and localities.

The relative condition factor "K_b" was calculated from the formula $K_b = W/\hat{W}$ (Le-Cren, 1951), where W is the observed weight and $\hat{W}$ is the calculated weight from the equation : $W = a L^b$. The t-test of significance was applied to compare the differences between sexes, seasons, localities and species. As well as the dependence of relative condition factor upon length was derived for each of the three studied species. Moreover, the coefficient of variation % V (calculated as : % V = s/m x 100, where s=standard deviation and m is the average value of relative condition) was employed to examine the variability among sexes, season and locality. The statistical procedures applied in this context are according to Bailey, (1959) and Ricker, (1975).

RESULTS

A-1 Length-weight relationship of Oreochromis niloticus (Linn.):

As shown in Table 1 it is evident that the regression coefficient "b" of O. niloticus at El-Gamil zone has shown growth isometry for pooled regression in both sexes (i.e. 2.93596 & 2.9868 for males and females respectively) and combined sexes (2.8431). Insignificant difference has been observed between the pooled regression coefficient of males and females. The seasonal variability of the exponent "b" at El-Gamil zone was far less evident. The growth isomery was the distinguished feature in all seasons except winter in which lower growth allometry was noticed for males, (i.e., 2.5325).

In El-Ginkah zone, the pooled regression coefficient showed allometric growth for the sexes jointly and separately. Statistical insignificant differences was revealed between the sexes. The seasonal fluctuation of the exponent "b" was markedly pronounced and showed an identical trend for males and females as well as for the sexes combined, except in autumn in which lower allometric growth was noticed for females (i.e., 2.8678).

In the Middle area, the pooled regression coefficient of O. niloticus, was significantly higher than 3.0 in both sexes separately (i.e. 3.0878 for males and 3.1396 for females) and jointly (3.1025). The males and females exponents did not show significant difference. The seasonal variability of the allometry and isometry of the exponent "b" was highly distinctive. Males and females revealed higher allometric growth during winter and spring seasons, and an isometric growth during summer. The regression coefficient of each sex was different in autumn, i.e. allometric for males and isometric for females.

The regional variation of regression coefficient proved insignificant difference between the three studied zones.

Regarding the length-weight relationship of O. niloticus in all zones together (Table, 1), it could be stated that the regression coefficient of the pooled data did not prove significant deviation from 3.0 for females (2.9696) and sexes combined (3.0282), while that of males indicated a higher allometry (3.0711). Nevertheless there was no statistical difference between sexes. Both sexes showed growth isometry during summer and autumn seasons. The above trend was reserved in winter and spring . The male isometric growth occurring in winter is accompanied by an allometric growth for females and the reverse was noticed in spring. The sexes combined showed higher growth allometry during winter and spring and isometric growth during summer and autumn. The regression parameter "b" of the combined sexes in different seasons showed a noticeable differences. In winter, the exponent "b" was significantly higher than those in summer and autumn, but it was insignificantly different than that in spring. The exponent "b" in spring revealed higher significant value than that in autumn, while

Table 1

Parameters of regression equations of length-weight relationships, correlation coefficients (r) and their probabilities, test of homogenity and test of significance of O. niloticus in three different zones of Lake Manzalah (1986-1988).

Season	Sex	El-Gamil Zone NO	Log a	b	Test of homog.	r (% P)	El-Ginka Zone NO	Log a	b	Test of homog.	r (% P)
Winter	M	44	-1.3052	2.53250	Allo.	0.9747 (>99.9)	195	-1.8649	3.06536	Allo.	0.9998 (>99.9)
	F	51	-1.9194	3.07688	Iso.	0.9912 (>99.9)	154	-1.8746	3.07476	Allo.	0.9990 (>99.9)
	C.s.	95	-1.4892	2.69565	Iso.	0.9878 (>99.9)	349	-1.8631	3.06203	Allo.	0.9996 (>99.9)
Spring	M	96	-1.8422	3.02431	Iso.	0.9985 (>99.9)	282	-1.8118	3.00811	Iso.	0.9986 (>99.9)
	F	113	-1.8212	3.00768	Iso.	0.9980 (>99.9)	274	-1.8317	3.01855	Iso.	0.9950 (>99.9)
	C.s.	209	-1.8090	2.99316	Iso.	0.9985 (>99.9)	556	-1.8897	3.07520	Iso.	0.9986 (>99.9)
Summer	M	16	-2.0660	3.21014	Iso.	0.9964 (>99.9)	122	-1.5472	2.79363	Allo.	0.9999 (>99.9)
	F	17	-1.7909	2.96360	Iso.	0.9925 (>99.9)	147	-1.3835	2.64782	A[illegible]	0.9933 (>99.9)
	C.s.	33	-1.8381	3.01212	Iso.	0.9988 (>99.9)	269	-1.4570	2.71138	Allo.	0.9968 (>[illegible])
Autumn	M	28	-1.6779	2.91409	Iso.	0.9968 (>99.9)	151	-1.7316	2.96635	Iso.	[illegible]
	F	38	-1.7952	3.02152	Iso.	0.9966 (>99.9)	93	-1.6223	2.86784	Allo.	0.9997 (>99.9)
	C.s.	66	-1.7272	2.96098 *	Iso.	0.9982 (>99.9)	244	-1.7178	2.95022 *	Iso.	0.999[illegible] (>99.9)
Pooled regression	M	184	-1.7277	2.93596 *	Iso.	0.9969 (>99.9)	750	-1.8810	3.07725 *	Allo.	0.9995 (>99.9)
	F	219	-1.7861	2.98681 **	Iso.	0.9984 (>99.9)	668	-1.8439	3.04067 **	Allo.	0.9997 (>99.9)
	C.s.	403	-1.6200	2.84310	Iso.	0.9671 (>99.9)	1418	-1.8766	3.07169	Allo.	0.9997 (>99.9)

(b) Statistically significant at 0.05 p. Allo. - Allometric growth (i.e b # 3); Iso - Isometric growth (i.e b # 3); M - Male; F Female; C.s. - Combined sex; No - number of fish, + - Regression coefficient; * - Regression coefficient

Table 1 (Cont.)

Middle Zone					All Zones				
NO	Log a	b	Test of homog.	r (% P)	NO	Log a	b	Test of homog.	r (% P)
257	-1.8913	3.10217	Allo.	0.9989 (>99.9)	496	-1.8196	3.03227	Iso.	0.9990 (>99.9)
260	-1.9595	3.15520	Allo.	0.9995 (>99.9)	465	-1.9224	3.11623 *++	Allo.	0.9994 (>99.9)
517	-1.9048	3.10790	Allo.	0.9995 (>99.9)	961	-1.8616	3.06464	Allo.	0.9995 (>99.9)
101	-1.9900	3.16777	Allo.	0.9985 (>99.9)	479	-1.9260	3.10717	Allo.	0.9987 (>99.9)
131	-2.0672	3.24522	Allo.	0.9973 (>99.9)	520	-1.8777	3.06320 **+	Iso.	0.9981 (>99.9)
234	-2.0290	3.20567	Allo.	0.9980 (>99.9)	999	-1.9074	3.08852	Allo.	0.9983 (>99.9)
31	-1.4346	2.72231	Iso.	0.9924 (>99.9)	169	-1.9227	3.11609	Iso.	0.9952 (>99.9)
61	-1.7654	2.98272	Iso.	0.9971 (>99.9)	225	-1.7804	2.97646 +**	Iso.	0.9956 (>99.9)
92	-1.7542	2.97510	Iso.	0.9973 (>99.9)	394	-1.7232	2.93277	Iso.	0.9972 (>99.9)
112	-1.9404	3.13567	Allo.	0.9984 (>99.9)	291	-1.7140	2.95296	Iso.	0.9989 (>99.9)
123	-1.9018	3.09107	Iso.	0.9978 (>99.9)	254	-1.7449	2.96568 ++*	Iso.	0.9989 (>99.9)
235	-1.9312	3.12216 *	Allo.	0.9989 (>99.9)	545	-1.7343	2.96409 *	Iso.	0.9993 (>99.9)
501	-1.8841	3.08778 *	Allo.	0.9994 (>99.9)	1435	-1.8716	3.07108 *	Allo.	0.9997 (>99.9)
577	-1.9474	3.13956 **	Allo.	0.9989 (>99.9)	1464	-1.7626	2.96964	Iso.	0.9948 (>99.9)
1078	-1.9049	3.10249	Allo.	0.9995 (>99.9)	2899	-1.8174	3.02823	Iso.	0.9993 (>99.9)

it did not differ from that in summer. Insignificant difference has been revealed between summer and autumn exponents.

A-2 Length-weight relationship of **Tilapia zillii** (Gerv.):

As presented in Table 2, it could be mentioned that an isometric growth for **T. zillii** is manifested at El-Gamil zone. Throughout the year except summer and autumn females have revealed an allometric growth. Moreover the pooled regression coefficients for males and/or females and sexes combined did not indicate significant deviation from 3.0.

At El-Ginkah zone, the pooled regression coefficient was 3.29997. It was significantly higher than the cube. The pooled allometric exponent of males was significantly greater than that of females. The isometry and allometry trend of the regression parameter "b" of males and females throughout the whole seasons was identical except in autumn in which allometric and isometric growth was evident for males and females respectively.

At the Middle zone the pooled regression coefficients have revealed an isometric growth for each sex separately and combined. The above deduction is clearly evident during winter and autumn, while in spring and summer an altered trend is observed. The male isometric exponent indicated in spring is accompanied by an allometric one for females. A reverse phenomenon is occurred in summer.

The regional variation of the regression coefficient proved that El-Ginkah zone had the higher allometric significant exponent (3.29997). No significant difference was observed between exponents of El-Gamil and the Mid zones.

Concerning the regression parameter "b" in all zones jointly, it could be stated that an allometric growth is observed for the pooled regression as well as for females. The males proved an isometric growth. An analogous trend of growth isometry was observed for both sexes during winter and spring. A contrary trend is observed during summer and autumn seasons. However the sexes combined revealed growth isometry during the whole year. Therefore the seasonal variation of the regression parameter "b" was far less pronounced, i.e. insignificant differences have been observed between different seasons, (Table 2).

A-3 Length-weight relationship of **Sarotheroden galilaeus** (Linn.):

Equation parameters of length-weight relationship of **S. galilaeus**, as well as correlation coefficient and test of significance are presented in Table 3. It is conspicuous that **S. galilaeus** fish was very few or almost devoid amongst the sampled fish of cichlid species, during summer season at each zone. An isometric fish growth was evident for the pooled regression at El-Gamil (2.9320) and the Middle

Table 2

Parameters of regression equations of length-weight relationships, correlation coefficients (r) and their probabilities, test of homogenity and test of significance of *T. zillii* in three different zones of Lake Manzalah (1986-1988).

Season	Sex	El-Gamil Zone NO	Log a	b	Test of homog.	r (% P)	El-Ginka Zone NO	Log a	b	Test of homog.	r (% P)
Winter	M	87	-1.8646	3.05230	Iso.	0.9989 (>99.9)	19	-1.7561	2.97598	Iso.	0.9989 (>99.9)
	F	63	-1.8645	3.06150	Iso.	0.9955 (>99.9)	24	-1.9145	3.12324	Iso.	0.9877 (>99.9)
	C.s.	150	-1.8705	3.06250	Iso.	0.9994 (>99.9)	43	-1.8366	3.04755	Iso.	0.9988 (>99.9)
Spring	M	482	-1.6134	2.86160	Iso.	0.9947 (>99.9)	197	-2.2735	3.43921	Allo.	0.9986 (>99.9)
	F	447	-1.5785	2.82740	Iso.	0.9964 (>99.9)	200	-1.9954	3.21866	Allo.	0.9984 (>99.9)
	C.s.	959	-1.6312	2.88250	Iso.	0.9960 (>99.9)	397	-2.1313	3.32500	Allo.	0.9989 (>99.9)
Summer	M	210	-1.8495	3.01880	Iso.	0.9955 (>99.9)	22	-1.4202	2.70700	Iso.	0.9942 (>99.9)
	F	116	-1.9974	3.19950	Allo.	0.9983 (>99.9)	5	-1.1044	2.39312	Iso.	0.9759 (<99)
	C.s.	326	-1.9020	3.08200	Iso.	0.9993 (>99.9)	27	-1.4544	2.73488	Iso.	0.9939 (>99.9)
Autumn	M	250	-1.7771	3.02110	Iso.	0.9975 (>99.9)	37	-2.1878	3.40804	Allo.	0.9978 (>99.9)
	F	173	-1.5622	2.78840	Allo.	0.9992 (>99.9)	26	-1.7593	2.97079	Iso.	0.9944 (>99.9)
	C.s.	423	-1.7247	2.96840	Iso.	0.9983 (>99.9)	63	-1.9042	3.12073	Iso.	0.9962 (>99.9)
Pooled regression	M	1029	-1.7699	* 299890 *	Iso.	0.9982 (>99.9)	275	-2.2474	* 3.42010 *	Allo.	0.998 (>99.9)
	F	928	-1.7111	2.93500 +*	Iso.	0.9980 (>99.9)	255	-1.9669	3.18778 ++	Allo.	0.9991 (>99.9)
	C.s.	1858	-1.7804	3.01130	Iso.	0.9990 (>99.9)	530	-2.1033	3.29997	Allo.	0.9990 (>99.9)

Table 2 (Cont.)

Middle Zone					All Zones				
NO	Log a	b	Test of homog.	r (% P)	NO	Log a	b	Test of homog.	r (% P)
127	-1.9541	3.15230	Iso.	0.9960 (>99.9)	233	-1.9101	3.10750	Iso.	0.9988 (>99.9)
111	-1.8272	3.02360	Iso.	0.9970 (>99.9)	198	-1.8529	3.04980 ***	Iso.	0.998 (>99.9)
238	-1.8768	3.08100	Iso.	0.9978 (>99.9)	431	-1.8760	3.07730	Iso.	0.9989 (>99.9)
354	-1.7570	2.99640	Iso.	0.9988 ([illegible]9.9)	1033	-1.6963	2.94430	Iso.	0.9960 (>99.9)
424	-1.8768	3.12570	Allo.	[illegible].9995 (>99.9)	[illegible]	-1.7443	3.00680 ***	Iso.	0.9968 (>99.9)
778	-1.8439	3.09030	Allo.	0.9989 (>99.9)	2134	-1.7443	3.00080	Iso.	0.9968 (>99.9)
45	-2.0825	3.30030	Allo.	0.9964 (>99.9)	277	-2.0652	3.25850	Allo.	0.9983 (>99.9)
43	-1.4724	2.72300	Iso.	0.9843 (>99.9)	164	-1.6770	2.89870 ***	Iso.	0.9959 (>99.9)
88	-1.4799	2.72640	Iso.	0.9873 (>99.9)	441	-1.7500	2.96990	Iso.	0.9945 (>99.9)
79	-1.5378	2.79410	Iso.	0.9896 (>99.9)	366	-1.7491	2.99330	Iso.	0.9977 (>99.9)
66	-1.6319	2.87250	Iso.	0.9905 (>99.9)	265	-1.6011	2.83400 ***	Allo.	0/9986 (>99.9)
145	-1.6171	2.86470	Iso.	0.9922 (>99.9)	631	-1.6989	2.94350	Iso.	0.9984 (>99.9)
		*					*		
605	-1.6411	2.89710 *	Iso.	0.9949 (>99.9)	1909	-1.8052	3.03910 *	Iso.	0.9985 (>99.9)
644	-1.7795	3.03560 *+	Iso.	0.9959 (>99.9)	1728	-1.8584	3.10060	Allo.	0.9992 (>99.9)
1249	-1.7676	3.02210	Iso.	0.9964 (>99.9)	3637	-1.8518	3.08970	Allo.	0.9990 (>99.9)

Table 3

Parameters of regression equations of length-weight relationships, correlation coefficients (r) and their probabilities, test of homogenity and test of significance of *S. galilaeus* in three different zones of Lake Manzalah (1986-1988).

Season	Sex	El-Gamil Zone					El-Ginka Zone				
		NO	Log a	b	Test of homog.	r (% P)	NO	Log a	b	Test of homog.	r (% P)
	M	29	-1.2024	2.45800	Iso.	0.9981 (>99.9)	38	-1.9220	3.12340	Allo.	0.9988 (>99.9)
Winter	F	32	-1.4324	2.7003	Iso.	0.9968 (>99.9)	22	-1.8178	3.05190	Iso.	0.9958 (>99.9)
	C.s.	61	-1.2225	2.48020	Allo.	0.998 (>99.9)	60	-1.8417	3.06050	Iso.	0.9987 (>99.9)
	M	54	-1.6834	2.88350	Allo.	0.9956 (>99.9)	29	-1.9295	3.12270	Iso.	0.9956 (>99.9)
Spring	F	102	-1.9164	3.09590	Iso.	0.9959 (>99.9)	28	-1.7282	2.91610	Iso.	0.9934 (>99.9)
	C.s.	156	-1.8488	3.02160	Iso.	0.9961 (>99.9)	57	-1.8577	3.04960	Iso.	0.9992 (>99.9)
	M										
Summer	F										
	C.s.										
	M	33	-1.4201	2.65790	Iso.	0.9870 (>99.9)	1				
Autumn	F	39	-1.5990	2.81780	Iso.	0.9864 (>99.9)	6	-1.9216	3.08440	Iso.	0.9895 (>98)
	C.s.	72	-1.4756	2.71090	Iso.	0.9917 (>99.9)	7	1.9166	3.07880	Iso.	0.9899 (>99)
				+					*		
	M	116	-1.4912	2.73610	Allo.	0.9962 (>99.9)	68	-1.9569	3.14910	Allo.	0.9989 (>99.9)
Pooled				+					*		
regre-ssion	F	173	-1.8198	3.01340	Iso.	0.9926 (>99.9)	56	-1.9306	3.12850	Iso.	0.9981 (>99.9)
				+*					+*		
	C.s.	289	-1.7278	2.93200	Iso.	0.9976 (>99.9)	124	-1.9139	3.11070	Allo.	0.9989 (>99.9)

Table 3 (Cont.)

Middle Zone NO	Log a	b	Test of homog.	r (% P)	All Zones NO	Log a	b	Test of homog.	r (% P)
74	-2.0741	3.25620	Allo.	0.9968 (>99.9)	141	-1.6984	2.95010	Iso.	0.9983 (>99.9)
98	-1.9294	3.14430	Allo.	1.0000 (>99.9)	156	-1.7529	2.99760 **	Iso.	0.9969 (>99.9)
127	-1.9121	3.12660	Allo.	0.9986 (>99.9)	297	-1.7412	2.98820	Iso.	0.9982 (>99.9)
15	-1.8074	2.99800	Iso.	0.9969 (>99.9)	94	-1.7342	2.93870	Allo.	0.9996 (>99.9)
57	-1.7125	2.91750	Iso.	0.9984 (>99.9)	187	-1.8462	3.02520 **	Iso.	0.9981 (>99.9)
72	-1.7285	2.93240	Iso.	0.9989 (>99.9)	281	-1.8488	3.02890	Iso.	0.9989 (>99.9)
9	-1.6947	2.93300	Iso.	0.9869 (<90)	9	-1.6947	2.9330	Iso.	0.9869 (<90)
59	-1.9893	3.19190	Iso.	0.9958 (>99.9)	93	-1.9266	3.13490	Iso.	0.9990 (>99.9)
46	-1.5503	2.83120	Iso.	0.9728 (>99.9)	91	-1.6681	2.91540 **	Iso.	0.9968 (>99.9)
105	-1.8002	3.04060 +	Iso.	0.9938 (>99.9)	184	-1.8271	3.05350 *	Iso.	0.9982 (>99.9)
148	-2.0069	3.19390 +	Allo.	0.9972 (>99.9)	328	-1.7168	2.95200 *	Iso.	0.9990 (>99.9)
210	-1.7823	2.99530 **	Iso.	0.9980 (>99.9)	443	-1.7995	3.00790	Iso.	0.9979 (>99.9)
358	-1.8390	3.04770	Iso.	0.9985 (>99.9)	771	-1.7991	3.01230	Iso.	0.9989 (>99.9)

(3.0477) zones, whereas growth allometry was shown at El-Ginkah zone, (3.1107). The t-test revealed that the regression coefficient had a higher significant value at El-Ginkah than at El-Gamil. Insignificant difference has been recorded between the Middle and El-Ginkah. Males pooled regression coefficient proved a different allometric growth at each of the studied zones, while an isometric growth was evident for females. The sex difference in the studied zones indicated a higher significant value for females than males at El-Gamil zone. The opposite was noticed at the Middle zone, while El-Ginkah zone did not prove significant difference between sexes.

The seasonal isometry and allometry trend of the exponent "b" at each of the studied zones was rather identical. spring, summer and autumn seasons revealed an isometic growth for the sexes combined. In winter growth allometry was evident at El-Gamil and Middle zones, while growth isometry was occurred at El-Ginkah.

Regarding the whole zones combined, it could be reported that regression coefficient for the pooled data as well as at different seasons of the year did not significantly deviate from 3.0 (isometric). Further the t-test did not indicate significant differences between seasons.

B- Relative condition coefficient :

The relative condition factor of the three species of cichlid fishes is presented as a function of size, sex, locality and season (Tables 4 & 5, Figs. 1 & 2).

B-1 Relative condition coefficien of Oreochromis niloticus,L.:

As illustrated in Table 4 it could be noted that the relative condition factors at El-Ginkah (1.0161) and Middle (0.9992) zones were significantly higher than that at El-Gamil (0.9569) zone. The male relative condition in the three studied zones was statistically higher than that for females. This fact was also pronounced at each zone separately except El-Gamil in which insignificant difference was observed.

The dependence of relative condition coefficient of O. niloticus upon its length (Fig. 1) for the three zones combined was well expressed by a linear function of the type: $K_b = 0.91695 + 0.0052\ L$ where K_b = relative condition and L is the fish length. The correlation coefficient was strong and highly significant (i.e. $r = 0.5949$ & $p > 99.9\ \%$).

The seasonal variation of the relative condition of O. niloticus in the studied zones (Fig. 2) revealed unexpected elevation of fish condition during spring and summer (spawning season). While the lower condition was recorded during winter.

Table 4: Regional variation of relative condition coefficient (Kb), coefficient of variation (%V) and t- test of significance of O. niloticus, T. zillii and S. galilaeus, in three different zones of Lake Manzalah (1986-1988).

Fish species		O. niloticus				T. zillii				S. galilaeus			
Zone	Sex	Fish No.	Kb	s	%V	Fish No.	Kb	s	%V	Fish No.	Kb	s	%V
	M	184	0.9582 %	0.0667	6.96	1029	0.9586 +	0.0357	3.37	116	0.9786 +	0.0592	6.05
El-Gamil	F	219	0.9631 %	0.0633	6.57	829	0.9900 +	0.0174	1.75	173	1.0451 +	0.0882	8.44
	C.s.	403	0.9569 ++	0.0571	5.96	1858	0.9726 ++	0.0251	2.59	289	1.0330 +*	0.0640	6.20
	M	750	1.01214 +	0.0268	2.62	275	1.0122 +	0.0727	7.18	68	1.0104 +	0.0377	3.73
El-Ginkah	F	668	1.0096 +	0.025	2.48	255	1.0004 +	0.0508	5.08	56	1.0052 +	0.0416	4.14
	C.s.	1418	1.0161 ++	0.0229	2.25	530	1.0086 ++	0.0552	5.47	124	1.0105 ++	0.0312	3.08
	M	501	1.0050 +	0.0255	2.53	605	1.0669 +	0.0566	5.30	148	1.0296 +	0.0358	3.48
Middle	F	577	0.9937 +	0.0301	3.02	644	1.0896 +	0.0405	3.72	210	1.0349 +	0.0539	5.21
	C.s.	1078	0.9992 ++	0.0231	2.31	1249	1.0776 ++	0.0283	2.63	358	1.0291 *+	0.0381	3.70
	M	1435	0.9903 +	0.0267	2.70	1909	0.9452 +	0.0405	4.29	332	1.0200 +	0.0346	3.39
All zones	F	1464	0.9794 +	0.0283	2.89	1728	0.9817 +	0.0220	2.24	439	1.0120 +	0.0427	4.22
	C.s.	2899	0.9847 ++	0.025	2.54	3636	0.9626 ++	0.0300	3.11	771	1.0150 ++	0.0315	3.18

+ - Kb, statistically significant at 0.05 level of probability, % - Kb, statistically insignificant at 0.05 level of p
s - Standard deviation; %V - Variation coefficient (s/mean x 100), M - Male ; F - Female ; C.s. - combined sex.

Table 5: Seasonal variation in the mean relative condition coefficient (Kb), of *O. niloticus*, *T. zillii* and *S. galilaeus* in Lake Manzalah (1986-1988).

Fish species		*O. niloticus*				*T. zillii*				*S. galilaeus*			
Season	Sex	Fish No.	Kb	S	%V	Fish No.	Kb	S	%V	Fish No.	Kb	S	%V
	M	496	0.9801	0.0417	4.26	233	0.9831	0.0399	4.06	141	0.9842	0.0493	5.01
Winter	F	465	1.0040 +++	0.0311	3.10	198	0.9957 +++	0.0561	5.64	156	0.9909 +**	0.0553	5.58
	C.s.	961	0.9890	0.0311	3.15	431	0.9792	0.0443	4.53	297	0.09942	0.0497	5.00
	M	481	1.0092	0.0372	3.68	1033	0.9412	0.0604	5.35	94	1.0188	0.0230	2.25
Spring	F	520	1.0113 +++	0.0355	3.51	1101	0.9444 +++	0.0271	2.87	187	1.0449 +++	0.0588	5.62
	C.s.	1001	1.0169	0.0291	2.86	2134	0.9394	0.0334	3.56	281	1.0392	0.0484	4.66
	M	169	1.0276	0.0432	4.20	277	0.9969	0.0245	2.46				
Summer	F	225	1.0352 +++	0.0370	3.58	164	0.9561 +++	0.0602	6.29	9	0.9668 *+*	0.0948	9.81
	C.s.	394	1.0295	0.0271	2.64	441	0.9444	0.0503	5.33	9	0.9668	0.0948	9.81
	M	291	0.9963	0.0213	2.14	346	0.9741	0.0495	5.08	93	1.0088	0.0239	2.37
Autumn	F	254	1.0009 +++	0.0327	3.27	265	0.9924 +++	0.0227	2.28	90	1.9914 *+*	0.0252	2.52
	C.s.	545	1.0000	0.0207	2.07	611	0.9735	0.0340	3.49	183	0.9938	0.0170	1.71

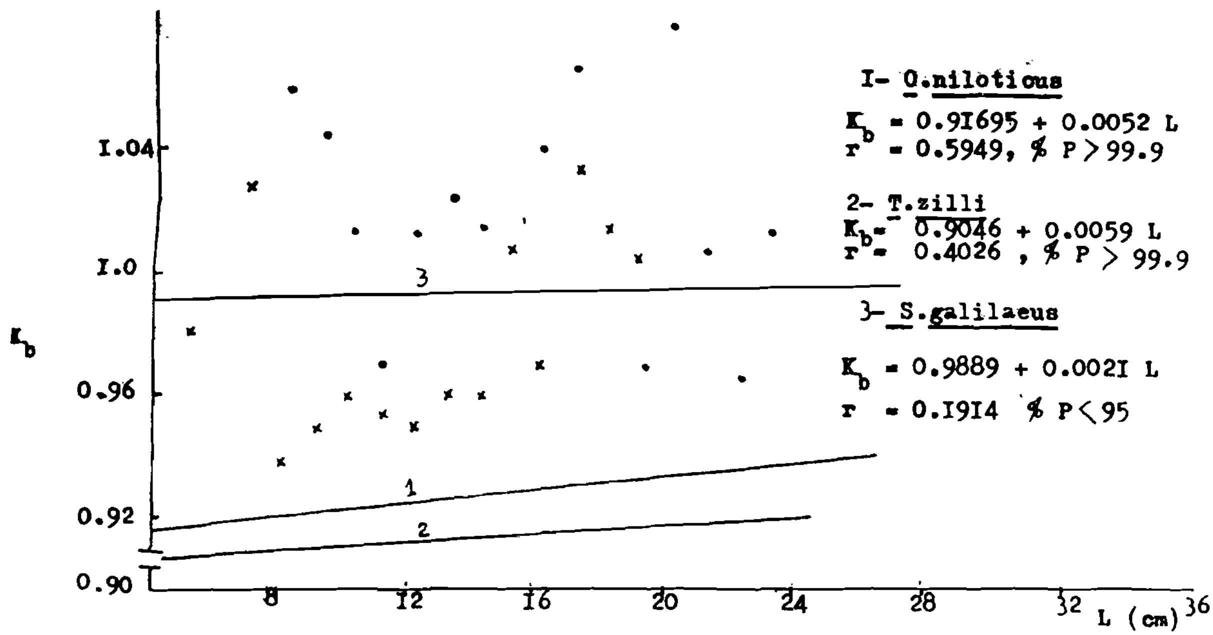

Fig. 1

Relative condition (Kb)-total length relationship of O. niloticus, T. zillii and S. galilaeus in Lake Manzalah (1986-1988).

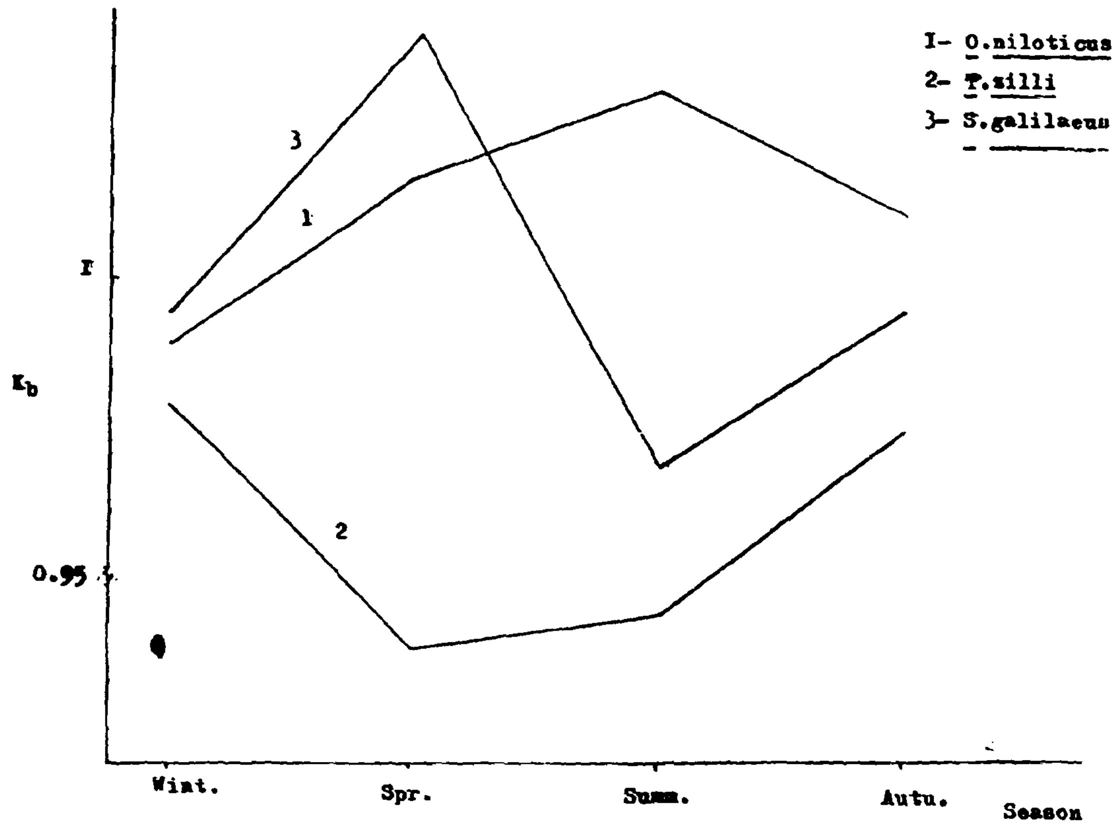

Fig. 2

Seasonal variation of the relative condition coefficient (Kb) of O. niloticus, T. zillii and S. galilaeus in Lake Manzalah (1986-1988).

B-2 Relative condition coefficient of Tilapia zillii G.:

Comparing the relative condition of T. zillii in the studied zones (Table 4), it could be emphasized that the best relative condition has been recorded at the Middle zone (1.0776). The lowest condition was found at El-Gamil (0.9726) zone. The grouped data for all zones have revealed a significant higher condition for females than males. This observation was also occurred at El-Gamil and the Middle zones, and a contrary to that was noticed at El-Ginkah zone.

The relative condition factor and length relationship of T. zillii (Fig. 1) for the grouped data in all zones revealed a positive linear correlation. It was fitted by a linear function as K = 0.9046 + 0.0059 L. This correlation was highly significant (i.e = 0.4026 & p>99.9 %). It probably indicates a growth allometry.

The seasonal fluctuation of the relative condition (Fig. 2), declared that the maximum value was recorded in winter (0.9792), then the fish condition dropped to its lowest value in spring (0.9394). Another low value of fish condition was attained in summer. Beyond summer the condition increased progressively to reach its highest value at autumn and winter seasons.

B-3 Relative condition coefficient of Sarotherodon galilaeus L.:

As shown in Table 4, the relative condition of S. galilaeus recorded a higher significant value at El-Gamil (1.0330) and the Middle (1.0291) zones than that at El-Ginkah (1.0105). The grouped data revealed a higher condition for males (1.0200) than females (1.0120). The relative condition difference between sexes did not prove statistical significance in each of the studied zones except El-Gamil in which female condition was significantly higher than male.

The seasonal variability of the relative condition (Fig. 2) of S. galilaeus was markedly pronounced. A highest remarkable fish condition was observed in spring. Then a keen decline was recorded during summer. A slight dependence of relative condition of S. galilaeus upon its length (Fig. 1) was evident. The correlation was weak and not significant (r = 0.1914 & p < 95 %).

DISCUSSION

The analysis of length-weight of O. niloticus, T. zillii and S. galilaeus, which is based on all the available data colledted during three years from three different ecological zones in Lake Manzalah, showed an isometric growth for O. niloticus (b = 3.02823) and S. galilaeus (3.0123), while an allometric growth was evident for T. zillii (3.0897). However, growth isometry and allometry for each of the studied species were quite different in each of the studied zones. The three studied fish species showed an allometric growth at El-Ginkah zone indicating that the fish changes its body shape during growth stanza (Vaznetsov, 1953). At El-Gamil and the Middle zones an isometric growth was noticed for the studied cichlid fishes except O. niloticus which declared allometric growth at the Middle zone. The isometric growth assumes an ideal fish growth with unchangeable body shape (Le Cren, 1951; Bagenal & Tesch, 1978).

The seasonal variability of the regression coefficient for each of the studied species revealed insignificant differences (i.e. isometric growth) except O. niloticus which showed a higher allometric growth in winter and spring than other seasons. However, the seasonal isometry and allometry trend was remarkably different from one zone to another. The above phenomenon may reflect the effect of the state of gonads and feeding intensity (Ricker 1975; Bagenal & Tesch 1978).

The present results declared insignificant differences between sexes for their pooled regression coefficient in the grouped zone for each of the studied species. The above result is consistent with that obtained for O. niloticus and T. zillii in each of the studied zones except El-Ginkah which showed a higher growth for T. zillii males. Further, irregular trend for S. galilaeus regression coefficient was noticed at each of the studied zones.

Concluding the previous statements, it could be stated that no single regression can adequately describe the length-weight relationship in Lake Manzalah. This opinion is supported from Table 6 which represents a comparison of this equation for each of the three studied species according to different authors at different localities. The differences in the value of the regression coefficient may be referred to the difference in the ecological conditions (Rounsefell & Everhart, 1953, Ezzat at al., 1982).

Comparing our data with that obtained by Chehab (1987), at the same zones in Lake Manzalah, it is obvious that the present data revealed lower growth at El-Ginkah and El-Gamil zones for O. niloticus, while higher growth was noted at the Middle zone. The lower value at El-Gamil zone may be attributed to a relatively high salinity (Bishara, 1973) while the lower value recorded at El-Ginkah may be ascribed to the excessive eutrophication and water pollution (Zawisza et al., 1979). The higher values of "b" in case of T. zillii in the present observations may reflect the high tolerance of this euryhaline species. However, the higher values of the regression coefficient for S. galilaeus than that reported by Chehab (1987), may be attributed to its success in such environmental condition.

The relative condition factor K_n, illustrates the deviation of the average observed weight from the calculated one for a given size without interference of length and its correlated variables (Le-Cren, 1951). The present results revealed a strong positive linear correlation of the

Table 6

Comparison of length-weight equation of *O. niloticus*, *T. zillii* and *S. galilaeus* at different localities.

Locality	Sex	No.	*O. niloticus*	No.	*T. zillii*	No.	*S. galilaeus*	Author
			Length-weight equation					
Barrage Ponds	Combined Sex			540	$W=2.544 \times 10^{-5} L^{2.9467}$			El Bolock & Koura (1960)
Institute Ponds	"			669	$W=2.368 \times 10^{-5} L^{2.9428}$			" "
Beteha area (Syria)	"	263	$W=3.182 \times 10^{-5} L^{2.9007}$	176	$W=1.195 \times 10^{-4} L^{2.6226}$	272	$W=1.282 \times 10^{-5} L^{3.1023}$	El Bolock & Koura (1961)
Lake Quarun	"				$W=1.49 \times 10^{-5} L^{3.0883}$			El Zarka (1961)
Lake Edku	"				$W=1.408 \times 10^{-5} L^{3.0595}$			" "
Lake Borollus	"				$W=5.671 \times 10^{-6} L^{3.2419}$			" "
Lake Mariute	"	1367	$W=1.261 \times 10^{-5} L^{3.0762}$					El Zarka et al. (1970)
Lake Manzalah	Male		$W=1.502 \times 10^{-2} L^{3.0464}$		$W=1.319 \times 10^{-3} L^{3.1296}$		$W=1.698 \times 10^{-2} L^{3.0175}$	Bishara (1973)
	Female		$W=1.45 \times 10^{-2} L^{3.0476}$		$W=1.876 \times 10^{-2} L^{2.9889}$		$W=2.175 \times 10^{-3} L^{3.8042}$	
Sudanese Inland Fish	Comb. Sex	869	$W=1.249 \times 10^{-5} L^{3.1483}$					Mahdi et al (1973)

Table 6 (Cont.)

Locality	Sex	No.	O. niloticus	No.	T. zillii	No.	S. galilaeus	Author	
Manzala Lake:									
Middle (III)	Comb. Sex	306	$W=1.538 \times 10^{-2} L^{3.0293}$	250	$W=2.279 \times 10^{-2} L^{2.8700}$	155	$W=1.935 \times 10^{-2} L^{2.9292}$	Chehab	(1987)
El-Gamil (IV)	"	290	$W=1.366 \times 10^{-2} L^{3.0753}$	600	$W=1.745 \times 10^{-2} L^{2.9816}$	90	$W=2.155 \times 10^{-2} L^{2.9484}$	"	"
El-Ginkah (V)	"	506	$W=9.876 \times 10^{-3} L^{3.2127}$	240	$W=1.356 \times 10^{-2} L^{3.0739}$			"	"
All zones	"	1102	$W=6.347 \times 10^{-2} L^{3.1284}$	1660	$W=1.667 \times 10^{-2} L^{2.9976}$		$W=2.133 \times 10^{-2} L^{2.9034}$	"	"
Manzala Lake :									
Middle	Comb. Sex	1078	$W=1.245 \times 10^{-3} L^{3.1025}$	1249	$W=1.708 \times 10^{-2} L^{3.0221}$	358	$W=1.449 \times 10^{-2} L^{3.0477}$	Present study	
El-Gamil	"	403	$W=2.399 \times 10^{-2} L^{2.8431}$	1858	$W=1.658 \times 10^{-2} L^{3.0113}$	289	$W=1.872 \times 10^{-2} L^{2.9320}$	"	"
El-Ginkah	"	1418	$W=1.329 \times 10^{-2} L^{3.0717}$	530	$W=7.883 \times 10^{-3} L^{3.2999}$	124	$W=1.219 \times 10^{-2} L^{3.1107}$	"	"
All zones	"	2899	$W=1.523 \times 10^{-2} L^{3.0282}$	3637	$W=1.407 \times 10^{-2} L^{3.0897}$	771	$W=1.588 \times 10^{-2} L^{3.0123}$	"	"

relative condition with the body length to O. niloticus and T. zillii, whereas a week correlation is evident for S. galilaeus (Fig. 1). The male relative condition of two species (O. niloticus and S. galilaeus) revealed higher statistical significant value than female. This was noticed by Bishara, (1973). However the T. zillii females had a higher relative condition than males. This is probably due to the effect of weight of gonads of females particularly in small size fishes, as it is well known that this species reproduces more than three times a year (El Zarka, 1958).

Generally it is obvious that O. niloticus and T. zillii have a higher relative condition at the Middle and El-Ginkah zones than at El-Gamil; whereas S. galilaeus has a high condition at the Middle and El-Gamil zones. This indicates a favourable environmental conditions at the Middle zone.

Regarding the relative condition differences amongst the studied species, the present data revealed a better condition for S. galilaeus, followed by O. niloticus. This phenomenon was observed by Bishara (1973).

The seasonal variation of the relative condition of the three studied species at Lake Manzalah revealed unexpected elevation on the K_b value of O. niloticus during spring and summer. This may be elucidated from the fact that fish feed vigorously on the blooming plankton at that time. The relative condition of T. zillii and S. galilaeus has showed a marked contrast to the above result, since a decline in the value of K_b was observed during the spawning season which reflects the effect of the empty gonads. Many authors attributed the seasonal fluctuation in K_b to the gonad cycle and fat deposition (Le Cren, 1951; El Maghraby et al., 1972; Weatherley, 1972; El-Serafy et al., 1987 and Abdel-Baky, 1989).

Comparing the present observation with others is not possible, since most authors used different fermulae. However, the results obtained by Bishara, (1973), can be compared with the present data (Table 7). It is clearly seen that the relative condition of present data is less than those obtained by Bishara (1973). This can be explained as mentioned previously due to the worse ecological conditions of Lake Manzalah as a resuit of a progressive accumulation of pollutants. This fact agrees with opinion of Hofsetede, (1974), Bagenal (1978), Zawisza et al. (1979), Cazemir (1982), Wyatt (1988), working in different localities of the world.

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Table 7

Comparison of the relative condition factor (Kb) of **O. niloticus**, **T. zillii** and **S. galilaeus** according to the available data in Lake Manzalah.

Locality	O. niloticus	T. zillii	S. galilaeus	Author
Lake Manzalah:				
El-Gamil	1.0529	1.0025	0.9460	
El-Ginkah	1.0022	0.9987	1.0127	Bishara (1973)
All Zones	1.0167	1.0116	1.0171	
Manzalah Lake :				
El-Gamil	0.9569	0.9726	1.0330	
El-Ginkah	1.0161	1.0086	1.0105	Present study
Middle	0.9992	1.0776	1.0291	
All Zone	0.9847	0.9626	1.0150	

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