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BIOMETRICS METHOD FOR BIOMASS DETERMINATION OF THE DOMINANT COPEPODS IN THE NERITIC ZONE OF ALEXANDRIA (EGYPT)

By

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Key Words: Biometrics, Biomass, Zooplankton, Egypt, Mediterranean.

ABSTRACT

The principal objectives of this investigation is to apply volumes and weights of some dominant zooplankton copepods along the Alexandria waters to determine their biomass in relation to the prevailing hydrographic conditions. Zooplankton samples were collected from January to December, 1991 from seven sectors lying along Alexandria waters. Five dominant copepods species were selected for biomass assessment. The species are, ***Oithona nana, Paracalanus parvus, Euterpina acutifrons, Clausocalanus arcuicornis*** *and* ***Acartia clausi****. Volumes and weights of all adult copepod species were calculated according to the formula proposed by Chojnacki* ***et al.*** *(1980). Ten regression equations describing the dependence of weight on the total length of male and female of different species were obtained.*

INTRODUCTION

Several studies have been performed in recent years on the abundance of zooplankton in the Egyptian Mediterranean waters [Dowidar and El-Maghraby (1970a); Aboul Ezz (1975); Hussein (1977); El-Zawawy (1980); Samaan ***et al.*** (1983); Nour El-Din (1987) and Aboul Ezz ***et al.*** (1990)]. However, there are relatively few that have included estimates of biomass of individual species [El-Maghraby (1964); Dowidar (1981) and Abdel-Aziz (1997)]. The overall conclusions indicated that copepods are the most important groups of zooplankton population in the Egyptian waters forming a ratio ranging from 70% to 85% of the total community.

The principal objectives of this study is to determine the volumes and weights of the dominant copepod species in the Egyptian Mediterranean waters in relation to the environmental conditions to be used directly in biomass assessments. Hence, the most five dominant copepods species were selected for biomass assessment in the present study. They are namely ***Oithona nana*** Giesbrecht, ***Paracalanus parvus*** Claus, ***Euterpina acutifrons*** Dana, ***Clausocalanus arcuicornis*** Dana and ***Acartia clausi*** Giesbrecht.

MATERIALS AND METHODS

Zooplankton samples were collected during the period from January to December, 1991 from seven sectors lying in front of the stations: El-Anfoushi (A), the Eastern Harbor (B), Ibrahimia (C), Stanly (D), San Stifano (E), Sidi Bisher (F) and El-Mandara (G). Three stations were selected to represent each sector as shown in Fig.(1). Among the environmental parameters tested are: water temperature was determined by a reversing thermometer fitted on a Nansen Bottle, water salinity was determined by using an induction salinometer YSI Model 303 S.C.T. meter, pH values were measured using pH meter Model Orion, total alkalinity was determined by titrating 10 ml of water sample against 0.01 N HCL using Methyl orange as indicator, water transparency was estimated by white enameled Secchi disc, 30 cm in diameter and the determination of dissolved oxygen was carried out according to Winkler method as described by Strickland and parsons (1965).

Vertical zooplankton samples were collected monthly by using a standard closing plankton net (55μ mesh size), with a mouth diameter of 17cm. The samples were preserved in 5% formalin. Identification of zooplankton taxa was done under research microscope according to Rose (1933) and Tregouboff & Rose (1957). The zooplankton standing stock was calculated as total number of zooplankton taxa per cubic meter.

Copepod volume measurements were carried out seasonally on 30 adult individuals of both sexes. Organisms were selected randomly using an ocular

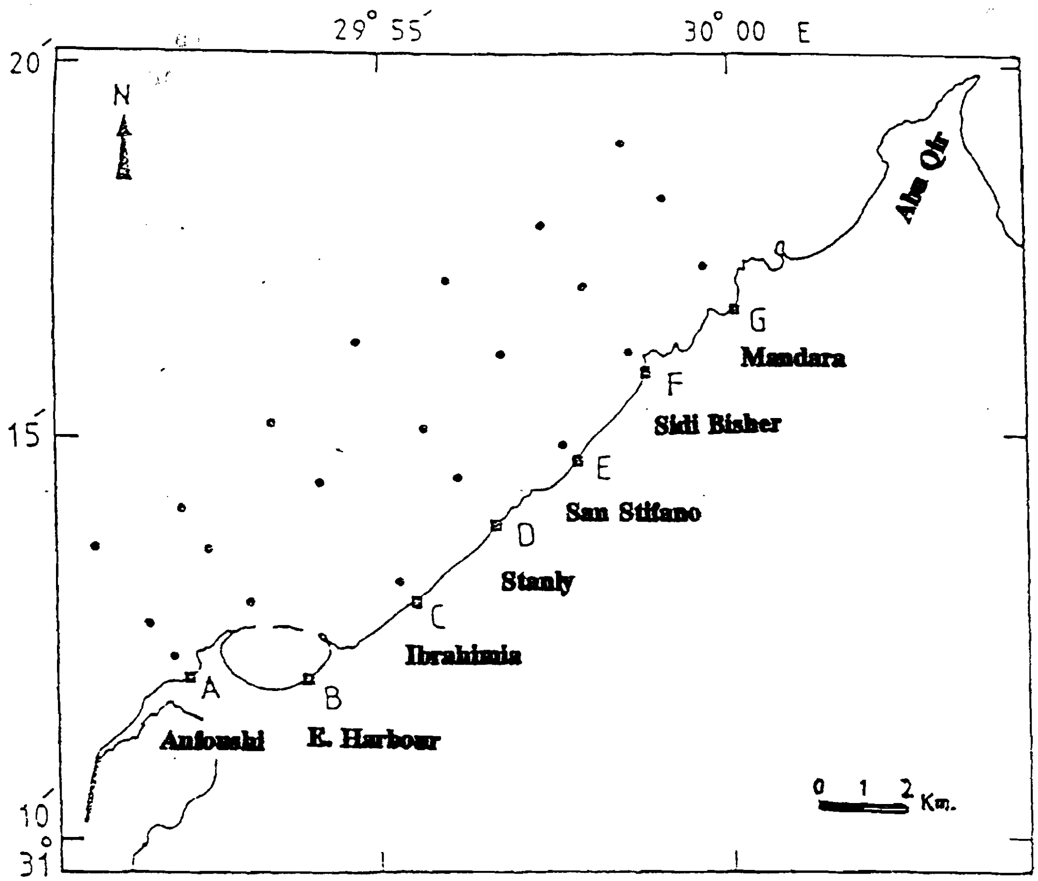


Fig. (1): Area of study and sampling location.

micrometer. The parameters measured are shown in Fig (2). Thoracic appendages were not measured as their contribution to the body volume is negligible (Herman and Dauphinee (1980). The volumes and weights of all adult copepod species at the different sectors and seasons were calculated according to formula (1) proposed by Chojnacki ***et al.*** (1980) and applied by Hussein (1984) in the Baltic Sea. The length-weight relationship for every species was obtained applying regression analysis through interactive outliner regation using a computer statgraphics (ver. s, 5.0) soft wear.

$$V = \pi \left[\frac{LcB^2K}{6} + \frac{LabD^2ab}{4} + \frac{LanD^2an}{6} \right] \qquad \text{.....................(1)}$$

Where V = the individual volume.

$$K = \frac{H}{B} \qquad \text{(Coefficient of flatting).}$$

Lc, Lab, Lan, B, Dab, Dan and H are the measurements of different parts of the copepod as given in Fig. (2). Hence, the individual weight is :

$$W = V \times 1.028 \text{ mg} \qquad \text{......................... (2)}$$

Where 1.028 is the specific weight coefficient.

The individual weight obtained from formula (2) was used to determin the length-weight relationship for every species.

RESULTS AND DISCUSSION

The prevailing environmental conditions are presented in Table (1). The average mean length of male and female individuals of the different copepod species and their calculated mean weights are given in Tables (2, 3).

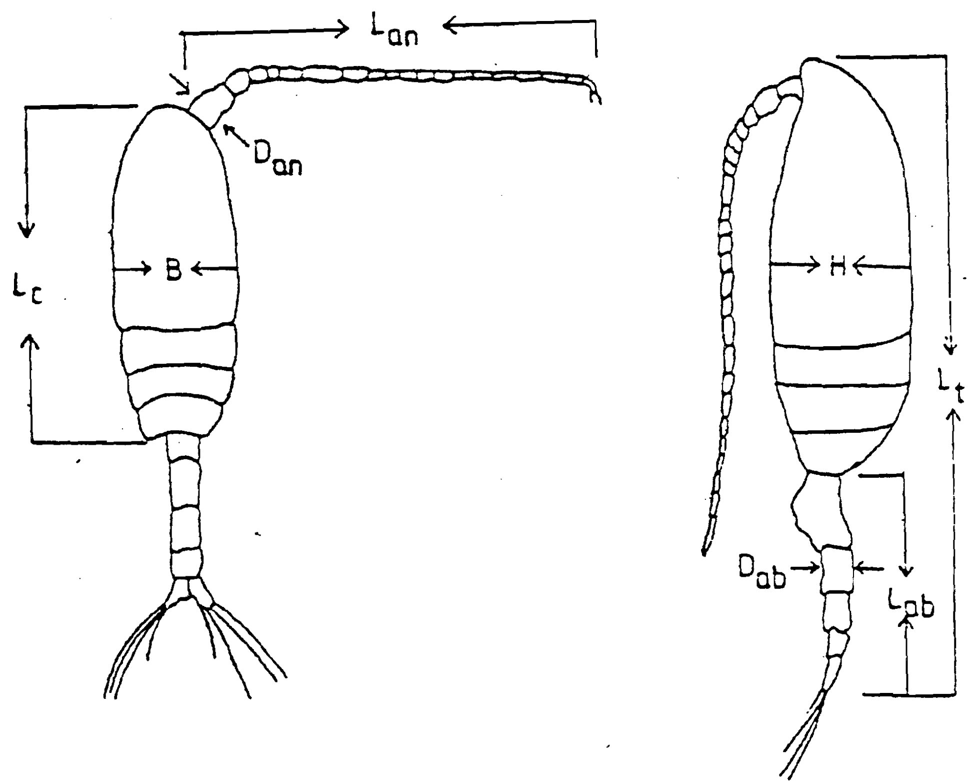


Fig. (2): Diagrammatic representation of measurements of copepods for volume determination after Chojnacki *et al.* (1980).

Lc = length of cephalothorax
B = width of cephalothorax
H = body depth
Lab = length of abdomen
Dab = diameter of abdomen
Lan = length of the first antenna
Dan = diameter of the first antenna
Lt = total length

Table (1): The averages values of the physico-chemical parameters collected from January to December, 1991 from Alexandria waters.

Parameters	***Season***			
	Winter	***Spring***	***Summer***	***Autumn***
Water temperature (^{o}C)	16	19.7	28.4	18.8
Water salinity (‰)	36.45	37.58	37.32	36.67
pH	8.20	8.20	8.10	8.12
Transparency (meter)	5.2	3.4	2.4	5.0
Alkalinity (eq/l)	3.0	2.8	3.1	3.2
Dissolved oxygen (ml/l)	4.59	4.10	4.25	3.60

1- *Oithona nana* Giesbrecht

Oithona nana is a neritic cosmopolitan, eurythermal and euryhaline species. The species was found in both the Mediterranean and Red Seas as well as the Suez Canal. In the Egyptian coasts it was recorded from neritic and offshore waters (Dowidar and El-Maghraby (1970a); Hussein (1977); Samaan ***et al.*** (1983); Aboul Ezz ***et al.*** (1990) and Abdel-Aziz (1997). In the present investigation, the cyclopoid ***Oithona nana*** contributed about 56.7% of adult copepod population.

The regression models (Fig. 3) describing the dependence of weight on the total length of male and female of ***Oithona nana*** are as follow:

For male W = - 7.0034 E-3 + 0.022953 L (Cor. coef. 0.9346)

For female W = - 5.4505 E-3 + 0.019868 L (Cor. coef. 0.8963)

These two models are adequate at 95% limit of confidence.

2- *Paracalanus parvus* Claus

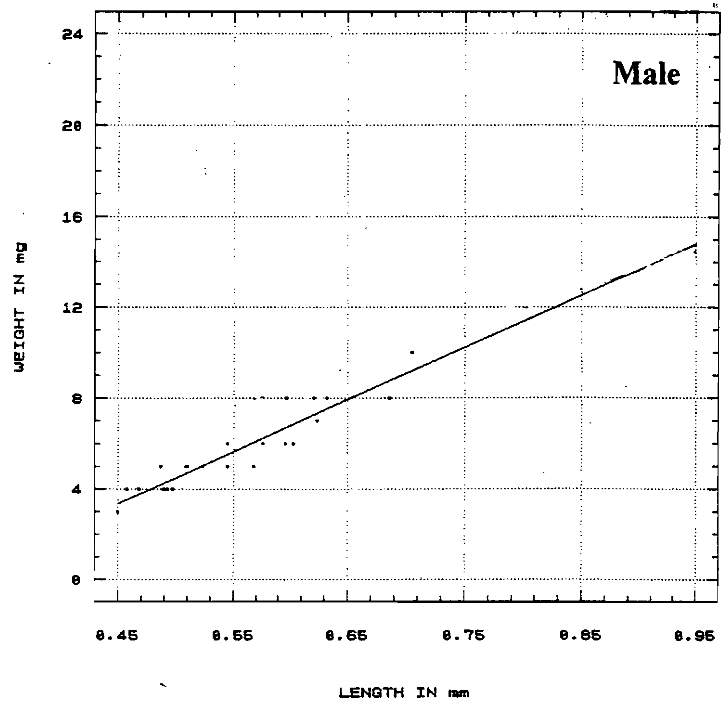
Paracalanus parvus is a cosmopolitan species with a variable ecological affinities occurring at variable depths in neritic and oceanic waters (Sewell (1948) and Digby (1950). The species was previously recorded as a dominant form in the Egyptian Mediterranean waters (Dowidar and El-Maghraby (1970a); Hussein (1977); Samaan ***et al.*** (1983) and Abdel-Aziz (1997). The species is eurythermal and euryhaline form. In the present study, the calanoid ***Paracalanus parvus*** contributed about 20.1% of adult copepods.

Table (2): Mean total length (mm) and mean weight (mg) of male of *Oithona nana* (1), *Paracalanus parvus* (2), *Euterpina acutifrons* (3), *Clausocalanus arcuicornis* (4) and *Acartia clausi* (5).

Season	Sector	Average mean total length of 30 samples (mm)					Average mean individual weight of 30 samples (mg)				
		1	2	3	4	5	1	2	3	4	5
	A	0.638	0.900	0.516	0.805	0.976	0.024	0.022	0.015	0.020	0.022
	B	0.632	0.867	0.139	0.760	0.905	0.008	0.026	0.006	0.019	0.023
	C	0.576	0.800	0.492	0.731	0.919	0.006	0.021	0.005	0.016	0.022
Winter	D	0.705	0.828	0.592	0.784	0.996	0.010	0.018	0.007	0.022	0.028
	E	0.621	0.786	0.490	0.812	0.914	0.008	0.020	0.005	0.021	0.024
	F	0.624	0.750	0.513	0.709	0.931	0.007	0.016	0.005	0.015	0.024
	G	0.686	0.850	0.550	0.877	0.989	0.008	0.025	0.006	0.026	0.033
	A	0.603	0.871	0.554	0.670	0.877	0.022	0.021	0.016	0.017	0.019
	B	0.597	0.856	0.541	0.644	0.792	0.006	0.020	0.005	0.009	0.013
	C	0.568	0.828	0.509	0.887	0.786	0.005	0.019	0.004	0.027	0.012
Spring	D	0.660	0.900	0.583	0.680	0.871	0.007	0.028	0.006	0.011	0.017
	E	0.545	0.876	0.483	0.742	0.870	0.005	0.026	0.004	0.014	0.016
	F	0.603	0.825	0.515	0.606	0.787	0.006	0.022	0.004	0.008	0.013
	G	0.596	1.015	0.550	0.805	0.938	0.006	0.040	0.005	0.017	0.019
	A	0.518	0.754	0.554	0.719	0.757	0.019	0.016	0.016	0.018	0.016
	B	0.508	0.742	0.560	0.705	0.706	0.008	0.016	0.007	0.014	0.010
	C	0.468	0.732	0.537	0.695	0.661	0.004	0.013	0.006	0.013	0.008
Summer	D	0.545	0.789	0.610	0.769	0.837	0.005	0.015	0.008	0.014	0.012
	E	0.468	0.726	0.534	0.674	0.499	0.004	0.013	0.006	0.013	0.004
	F	0.492	0.754	0.548	0.716	0.755	0.004	0.013	0.006	0.012	0.010
	G	0.523	0.761	0.592	0.725	0.808	0.005	0.016	0.008	0.016	0.012
	A	0.522	0.758	0.535	0.769	0.680	0.018	0.018	0.015	0.019	0.016
	B	0.497	0.724	0.519	0.773	0.728	0.004	0.016	0.006	0.015	0.009
	C	0.510	0.709	0.534	0.754	0.705	0.005	0.015	0.006	0.017	0.009
Autumn	D	0.489	0.742	0.571	0.783	0.700	0.004	0.017	0.007	0.019	0.009
	E	0.487	0.757	0.513	0.690	0.648	0.005	0.017	0.006	0.014	0.009
	F	0.450	0.695	0.532	0.737	0.664	0.003	0.014	0.006	0.015	0.008
	G	0.545	0.805	0.583	0.753	0.712	0.006	0.020	0.007	0.018	0.010

Table (3): Mean total length (mm) and mean weight (mg) of female of *Oithona nana* (1), *Paracalanus parvus* (2), *Euterpina acutifrons* (3), *Clausocalanus arcuicornis* (4) and *Acartia clausi* (5).

Season	Sector	Average mean total length of 30 samples (mm)					Average mean individual weight of 30 samples (mg)				
		1	2	3	4	5	1	2	3	4	5
Winter	A	0.726	1.098	0.673	1.005	1.045	0.028	0.029	0.020	0.025	0.028
	B	0.724	1.095	0.670	0.957	0.995	0.009	0.050	0.012	0.031	0.028
	C	0.639	1.044	0.629	0.880	0.956	0.007	0.043	0.009	0.023	0.026
	D	0.737	0.999	0.689	0.905	1.066	0.012	0.029	0.011	0.024	0.033
	E	0.744	0.974	0.586	0.996	1.048	0.009	0.032	0.008	0.036	0.032
	F	0.661	0.938	0.629	0.796	1.009	0.009	0.025	0.010	0.017	0.026
	G	0.829	1.048	0.679	1.057	1.135	0.011	0.041	0.011	0.044	0.041
Spring	A	0.617	0.987	0.626	0.944	0.982	0.025	0.025	0.016	0.024	0.021
	B	0.612	0.969	0.619	0.895	0.987	0.007	0.032	0.008	0.029	0.027
	C	0.610	0.934	0.612	0.568	0.964	0.006	0.029	0.008	0.005	0.025
	D	0.679	0.937	0.655	0.887	0.966	0.009	0.028	0.009	0.026	0.026
	E	0.574	0.935	0.554	0.845	0.912	0.005	0.029	0.006	0.022	0.021
	F	0.625	0.869	0.608	0.784	0.893	0.006	0.021	0.007	0.019	0.019
	G	0.625	0.805	0.618	0.935	1.001	0.007	0.017	0.007	0.027	0.028
Summer	A	0.597	0.857	0.529	0.867	0.763	0.022	0.021	0.017	0.022	0.017
	B	0.593	0.827	0.597	0.773	0.734	0.005	0.023	0.007	0.019	0.013
	C	0.590	0.813	0.566	0.777	0.703	0.005	0.021	0.006	0.022	0.010
	D	0.587	0.896	0.670	0.848	0.844	0.006	0.028	0.009	0.024	0.015
	E	0.499	0.787	0.597	0.755	0.766	0.005	0.020	0.008	0.018	0.011
	F	0.518	0.838	0.600	0.782	0.779	0.004	0.022	0.007	0.019	0.011
	G	0.539	0.844	0.667	0.825	0.870	0.006	0.024	0.009	0.024	0.017
Autumn	A	0.561	0.819	0.584	0.850	0.747	0.019	0.019	0.016	0.023	0.017
	B	0.544	0.798	0.597	0.835	0.769	0.005	0.021	0.007	0.023	0.014
	C	0.554	0.771	0.574	0.828	0.734	0.006	0.020	0.007	0.022	0.012
	D	0.568	0.805	0.615	0.821	0.764	0.007	0.022	0.008	0.024	0.011
	E	0.525	0.800	0.566	0.771	0.713	0.005	0.022	0.007	0.018	0.011
	F	0.535	0.772	0.587	0.782	0.726	0.006	0.019	0.007	0.020	0.010
	G	0.592	0.861	0.621	0.851	0.783	0.007	0.026	0.008	0.023	0.014



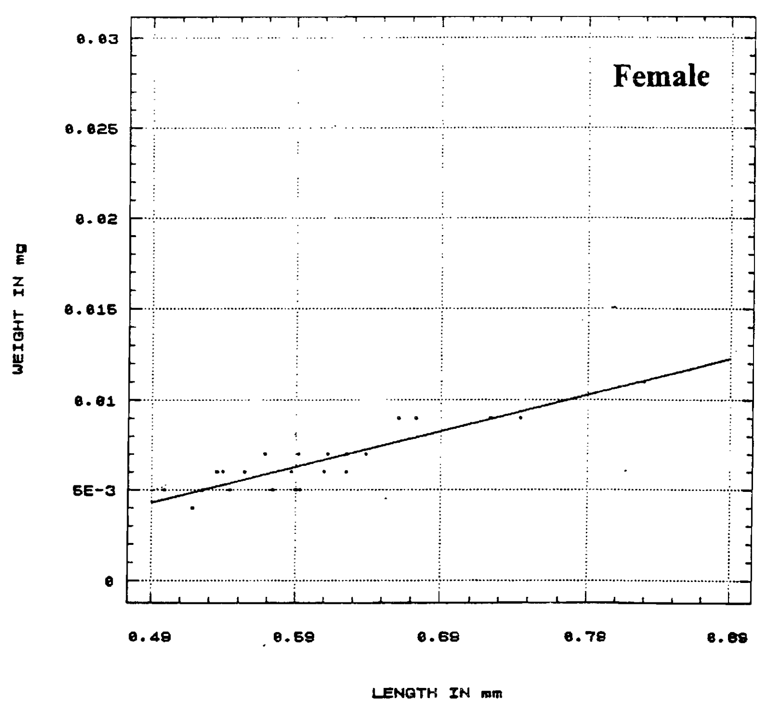


Fig. (3): Length-weight relationship of *Oithona nana*, Alexandria, (1991)

The regression models (Fig. 4) describing the dependence of weight on the total length of male and female of ***Paracalanus parvus*** are as follow:

For male W = - 0.42137 + 0.76523 L (Cor. coef. 0.9143)

For female W = - 0.033489 + 0.066855 L (Cor. coef. 0.9025)

These two models are adequate at 95% limit of confidence.

3- *Euterpina acutifrons* Dana

Euterpina acutifrons is neritic, temperate marine forms, with eurythermal and euryhaline tolerance, occurred in both Mediterranean and Red Seas. It was previously observed as a dominant form in the Egyptian waters [El-Maghraby (1964); Dowidar and El-Maghraby (1970a); Hussein (1977); Nour El-Din (1987) and Abdel-Aziz (1997). The species was observed in Lake Manzalah by El- Maghraby ***et al.*** (1963)]. In the present work, the harpacticoid copepod ***Euterpina acutifrons*** contributed about 17.6% of adult copepods.

The regression models (Fig. 5) describing the dependence of weight on the total length of male and female of ***Euterpina acutifrons*** are as follow:

For male W = - 7.3944 E-3 + 0.025518 L (Cor. coef. 0.4226)

For female W = - 0.015578 + 0.038314 L (Cor. coef. 0.8696)

These two models are adequate at 95% limit of confidence.

4- *Calausocalanus arcuicornis* Dana

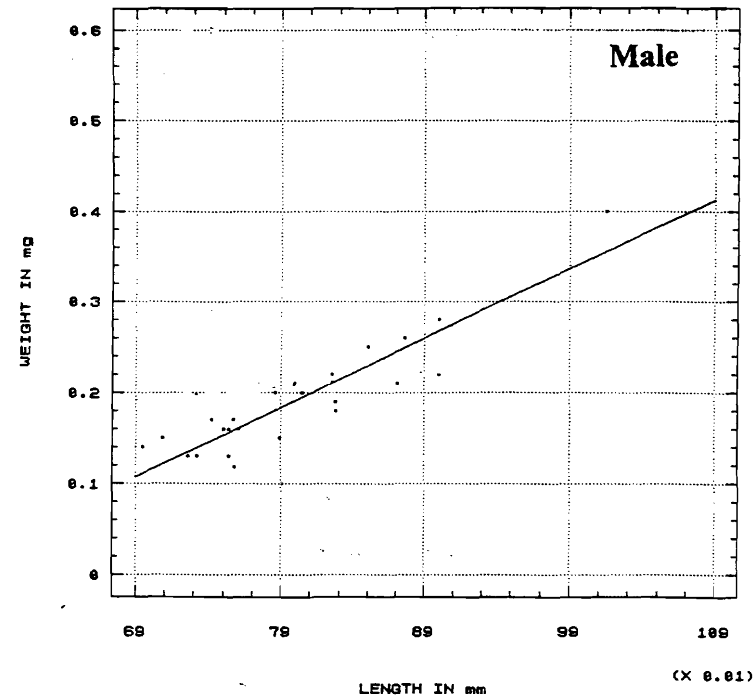
Calausocalanus arcuicornis is a cosmopolitan, eurythermal and euryhaline species occurring in both neritic waters. The species was previously dominant along the Egyptian waters (Dowidar and El-Maghraby (1970a); Hussein (1977); Nour El-Din (1987) and Abdel-Aziz (1997). In the present investigation, ***Calausocalanus arcuicornis*** appeared frequently in the zooplankton hauls.

The regression models (Fig. 6) describing the dependence of weight on the total length of male and female of ***Calausocalanus arcuicornis*** are as follow:

For male W = - 0.031957 + 0.064904 L (Cor. coef. 0.9156)

For female W = - 0.038965 + 0.073704 L (Cor. coef. 0.9312)

These two models are adequate at 95% limit of confidence.



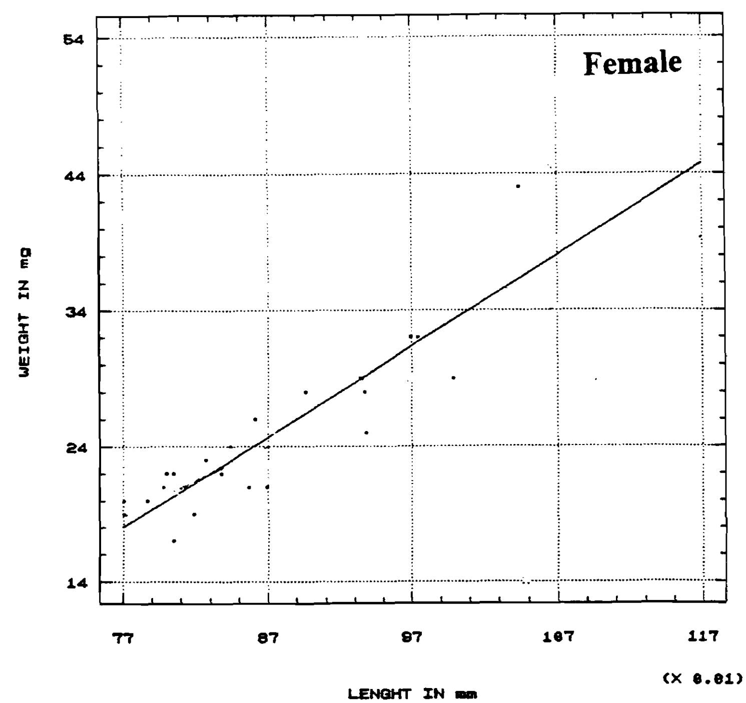
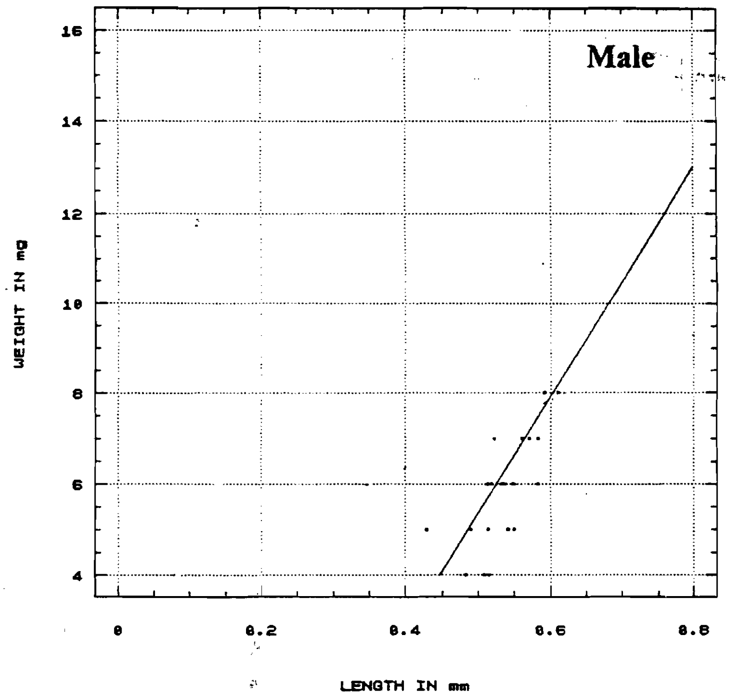


Fig. (4): Length-weight Relationship of *Paracalanus parvus*, Alexandria, (1991)



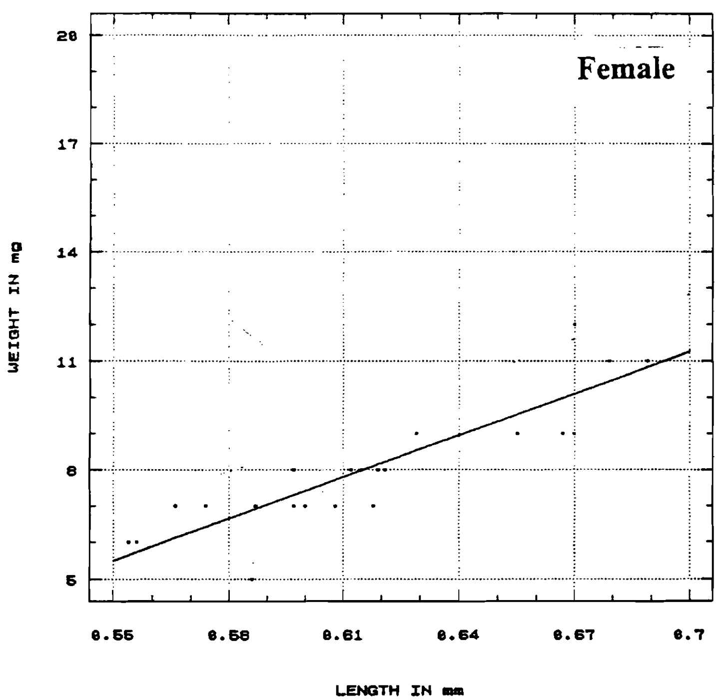


Fig. (5): Length-weight Relationship of *Euterpina acutifrons*, Alexandria, (1991)

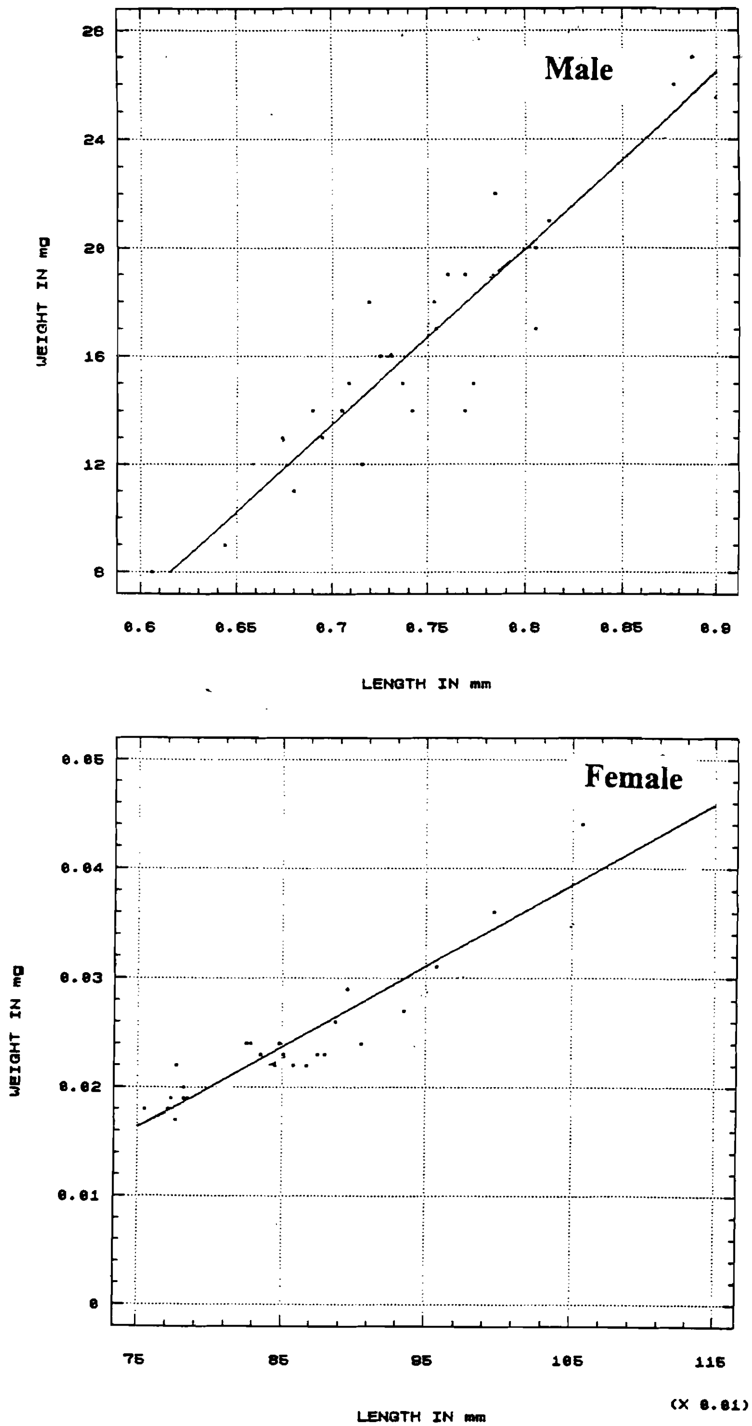


Fig. (6): Length-weight Relationship of *Clausocalanus arcuicornis*, Alexandria, (1991)

5- *Acaria clausi* Giesbrecht

Acaria clausi is widely distributed, truly euryhaline and eurythermic species along the Egyptian waters. The species was previously recorded in the Egyptian waters [Dowidar and El-Maghraby (1970a); Hussein (1977); Samaan ***et al.*** (1983); Nour El-Din (1987) and Abdel-Aziz (1997). It appeared in the brackish waters of Lake Manzalah (El- Maghraby ***et al.*** (1963)]. In the present study, the species appeared frequently in the zooplankton population.

The regression models (Fig. 7) describing the dependence of weight on the total length of male and female of ***Acaria clausi*** are as follow:

For male $W = - 0.25251 + 0.050744\ L$ (Cor. coef. 0.8948)

For female $W = - 0.033765 + 0.061188\ L$ (Cor. coef. 0.9559)

These two models are adequate at 95% limit of confidence.

Average length in relation to physico-chemical parameters:

The correlation coefficient of the average lengths and weights and physico-chemical parameters were calculated and results are given in Table (4). Results showed that the mean lengths are negatively correlated with temperature. This is an indication that although all the studied species are eurythermal [Dowidar and El-Maghraby (1970a) and Hussein (1977)]; they grow well in lower temperature. This may be also related to the high abundance of phytoplankton in the studied area during winter as indicated by El-Sherif (1994). The correlation coefficient showed also that the mean lengths did not changed with salinity changes (except for the females of ***Oithona nana*** and males ***Clausocalanus arcuicornis*** which favorite low water salinity) where all studied species are euryhaline [Dowidar and El-Maghraby (1970a) and Hussein (1977)]. Kinne (1963) reported that temperature and salinity are the most essential factors affecting the size and weight difference of animals in different waters.

Although the pH during the period of study changed between a maximum of 8.2 and a minimum of 8.1, it showed a positive correlation with lengths which is difficult to explain. On the other hand, the changes of water alkalinity showed negative correlation with mean lengths change showing an inhibition effect on copepod growth.

Of course less polluted water containing more oxygen content is favorable for copepod growth which is indicated by possitive correlation of dissolved oxygen with mean lengths.

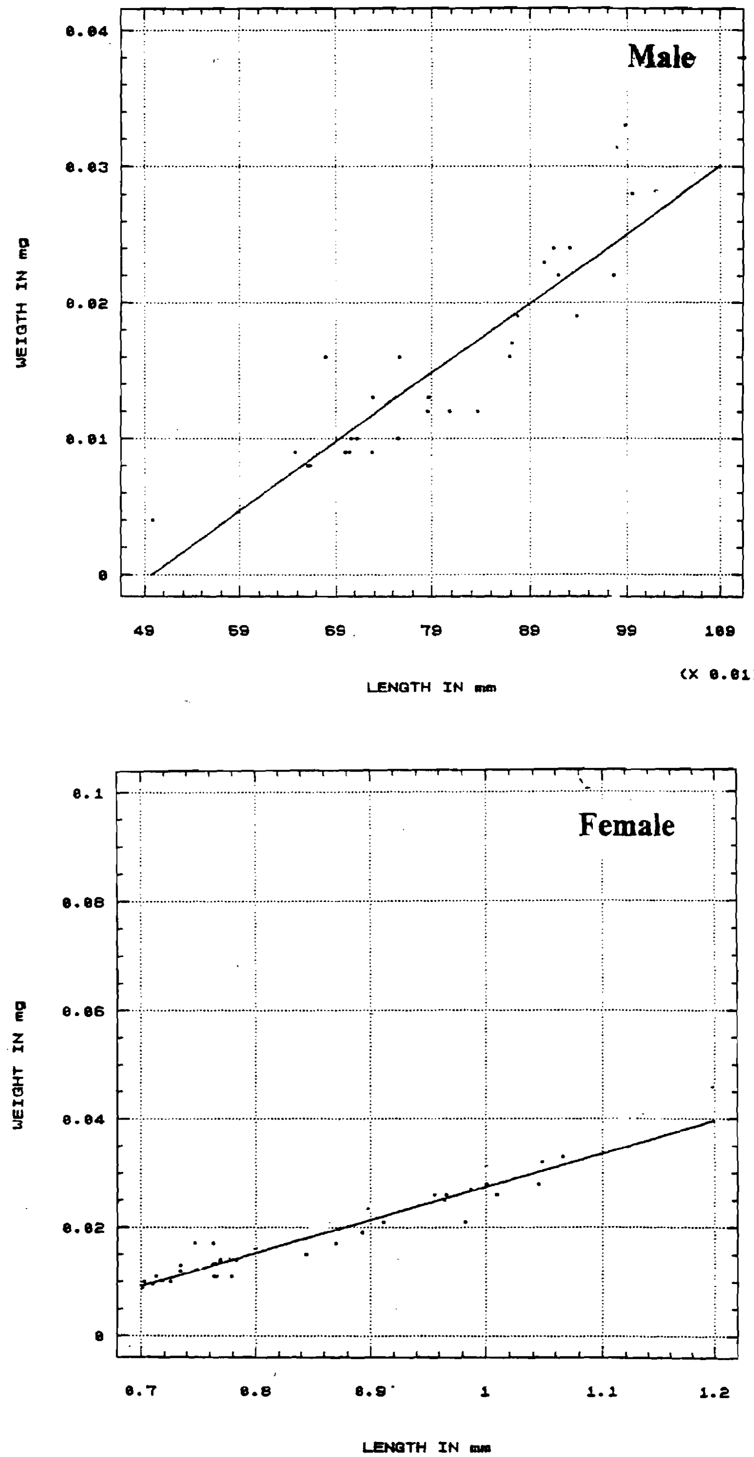


Fig. (7): **Length-weight Relationship of *Acartia clausi*, Alexandria, (1991)** Table (4): Correlation coefficient between mean total length variations and physico-chemical parameters.

Species / Parameters	*Oithona nana*		*Paracalanus parvus*		*Euterpina acutifrons*		*Clausocalanus arcuicornis*		*Acartia clausi*	
	M	*F*	*M*	*F*	*M*	*F*	*M*	*F*	*M*	*F*
Temperature	-0.48	-0.57		-0.51	0.39		-0.34*	-0.94	-0.59	-0.56
Salinity		-0.38					-0.41			
pH	0.75	0.72	0.73	0.75				0.62	0.75	0.89
Transparency		0.43					0.4	0.4		
Alkalinity	-0.61	-0.4	-0.78	-0.9					-0.92	-0.69
Dissolved oxygen	0.48	0.68		0.73		0.52		0.42	0.66	0.70

Significance level 5% M = Male
*Significance level 10% F = Female

CONCLUSION

Generally, the lengths and weights of females the different studied species were always heavier than the males. Also, the winter population of both sexes seemed to be longer and heaviest than the rest of the year.

The hydrographic condition prevailing during different seasons such as water temperature, water salinity and abundance of food seem to be the most important factors affecting the growth and size of the studied species.

The given model equation on weight dependence on body length of the different studied species provide a basis for the biomass assessment of dominant copepod species, helping in the estimation the secondary production of the area.

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