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CHEMICAL COMPOSITION OF INVERTEBRATE ANIMALS FROM LAKE QARUN (UPPER EGYPT). 1- ACARTIA LATISETOSA (KRICZAGUIN) (COPEPODA, CRUSTACEA).

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ABSTRACT

The seasonal and spatial variations of the organic content (total protein, lipids, carbohydrate and ash) as well as the seasonal variations in length, weight and water content of the adult individuals of **Acartia latisetosa** in Lake Qarun were studied. On the average, the dry body weight / individual varied between 5.73 µg and 1.54 µg with a mean of 2.93 µg. Higher values were recorded in summer (average 4.1 µg) while lower values occurred in winter (average 2.0 µg).

The protein content of the species varied between 75.0 % and 52.5 % of the dry body weight with a mean of 66.1 %. High values were recorded during spring and autumn seasons. The fat content ranged from 26.0 % to 8.0 % with a mean of 15.2 %. An inverse correlation was found between the lipid and protein content of the species. The carbohydrate content varied between 6.25 % and 0.73 % of the dry body weight with a mean value of 3.20 %. These variations were discussed in relation to the prevailing environmental conditions.

INTRODUCTION

Acartia latisetosa is one of the endemic zooplankton elements in the Mediterranean Sea (Sewell, 1948). In the inshore Mediterranean waters of Egypt, it is considered, numerically, the most important species of the genus **Acartia** (Dowidar and El-Maghraby, 1970). It is a highly tolerant species as it abounds the brackish water Delta lakes thriving at very low salinities, ca. 8‰(El-Maghraby et al, 1963). It is also reported from the Suez Canal at a fairly high salinity, ca. 46‰ (Fox, 1927). Between 1928 and 1933, the species had been introduced into Lake Qarun in connection with the processes of transplanting the lake by fish fry from the Mediterranean Sea. Since then, it has flourished and reproduced successfully and became self maintained. Nowadays, **Acartia latisetosa** is numerically the most abundant zooplankton element in the lake. It constitutes about 72 % - 100 % by number of the total zooplankton community and thus forms the main food item for zooplankton feeding animals in the lake. No previous work was done on the biochemical composition of this species.

This paper entails the results of the biochemical study of the species in Lake Qarun. The seasonal as well as the spatial variations in the protein, lipid, carbohydrate, ash and water content of the species are studied together with the seasonal variations in size and weight of the adult animals in the lake. The results are discussed in view of the prevailing environmental conditions.

Physiography of the Present-day Lake:

Lake Qarun is an inland closed lake, occupying the deepest part of Faiyoum depression in Upper Egypt (Fig. 1). It lies between longitudes 30°24' and 30°49'E and latitudes 29°25' and 29°32'N. It has a rectangular shape, length 40 km., average breadth 5.7 km. and maximum width about 9.25 km. Its area amounts to 240 km^2 at the level of about 44 m. below the mean sea level. The Faiyoum depression lies in the western desert about 100 km. southwest of Cairo and is separated from the Nile Valley by a narrow strip of desert land. The lake is considered as divided into two basins (eastern and western) by means of a constriction at nearly its middle. The eastern basin is shallower than the western basin (average depth 3 m.) and occupies about 37% of the total area of the lake. The average depth of the western basin is about 5 m. The maximum depth recorded is 8.5 m. in the center of the lake north west of El-Qarn Island (which is a sandy island having an area about 3 km^2.). The mean depth of the lake (volume/ area) is 4.2 m. The northern parts of the lake are deeper and of steeper slope compared with the southern parts.

Drainage Water:

Lake Qarun, serves as a natural reservoir for the drainage water of the lands of the Faiyoum province, as these lands slope with steep inclination towards the lake. The drainage water forms about 21.6% of the total irrigation water entering the Faiyoum province from the Nile River. El-Wadi and El-Bats are the two main drains conveying about 93% of the total amount of drainage water received by the lake. El-Wadi drain conveys about 57% of the drainage water joining the lake from the south at nearly its middle part; El-Bats drain joins the lake from the eastern side and carries about 36% of the drainage water reaching the lake. There are a number of minor drains which joins the lake from the south eastern parts and conveys about 4% of the total drainage water. The influx of drainage water from these drains reaches its maximum usually in September while minimum quantities occure in January when the irrigation canals are partly closed for cleaning purposes (El-Bilbisy, 1973; Meshal, 1973).

MATERIAL AND METHODS

1- Collection and Preparation of Samples

Plankton samples were collected by a medium net (size of aperture 0.158 mm.) from 7 stations which nearly cover the area of the lake (Fig. 1). On

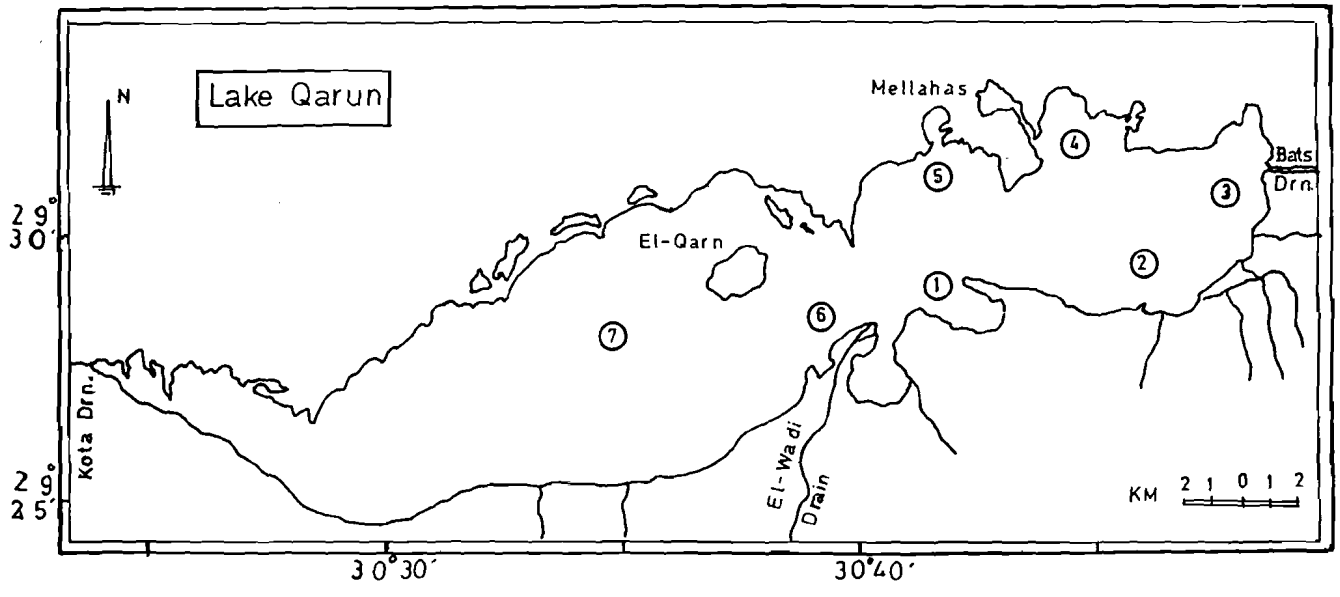

Fig. 1: Showing the area of Lake Qarun and stations sampled.

some occasions a Clark-Bumpus net provided with a flow meter was used. At each station the net was towed horizontally for about 15 minutes and the sample collected were placed in a refrigerator at a constant temperature (-10°C.). The samples were collected seasonally during 1974 in Winter (January), spring (May), summer (August) and autumn (November).

In the laboratory, one day after collection, the samples were gradually thowed and a reasonable aliquot of each sample was filtered through a course net in order to remove phytoplankton cells and small zooplankton organisms from the sample. The filtered sample was then placed in a Petri dish and examined under the microscope using a low power, and the remaining zooplankton animals except adult **Acartia latisetosa** were removed.

Aliquots 2 - 6 ml. of each sample were counted under the microscope and the average number of **Acartia latisetosa** per ml. of the sample was finally obtained. The total length of 50 individuals from the purified sample was also measured and the mean values in each season were recorded.

2- Methods of Analysis

a- Determination of the water content

A known volume of the sample, sufficient to give a reasonable weight (810×10^4 to 50×10^4 individuals) was filtered and washed with distilled water to remove traces of salt and other contaminations. The animals were left to dry in open air for about 15 minutes, dried on a filter paper and weighed on a direct semiautomatic balance to the nearest 0.01 mg. The samples were then dried at 70°C (for about 48 hours) until constant weight, cooled in a desiccator and the dry weight was obtained to the nearest 0.01 mg. The difference between the wet and dry weight gives the amount of moisture from which the percentage of water content in the sample was obtained.

b- Determination of Ash

A known weight (200-300 mg) of the dry and crushed sample was ashed, to constant weight, in a porcelain crucible at 500°C in an electric muffle furnace for about 24 h. The ashed sample was colled in a desiccator and weighed. The ash content of the sample was calculated as percentage of the dry body weight.

c- Determination of Carbohydrates

The carbohydrate content was determined spectrometrically following the procedure of Hemitt (1958) which involves the addition of anthrone reagent to a suspension of a known weight (2-3 mg) of the finely ground dried sample. The mixture was well mixed and heated in a boiling water bath for about 7 minutes. The sample was immediately cooled and analysed photometrically at 620 mu. The carbohydrate content was obtained by reference to a calibration curve previously prepared using glucose solutions of kown concentrations. The results were expressed as percentage of the dry body weight.

d- Determination of Lipid

The lipid content of the dried samples was determined using the method of Folch, Lees and Stonley (1956). Anhydrous sodium sulphate and a mechanical electrical stirrer was used for dehydration and disintegration of samples. Extraction of fat was achieved by using a Soxhelt apparatus and a mixture of chloroform and methanol 2 : 1 v/v at 60-70°C for about 20 hours. The purified extract was evaporated to dryness in presence of a current of nitrogen. The results were expressed as percentage of the dry body weight.

e- Determination of Proteins

The protein content of the dried sample was determined as total nitrogen using the micro-Kjeldahl method (Mann and Saunders, 1960; Vogel, 1968). The percentage of nitrogen obtained was multiplied by 6.25 to obtain the percentage of total protein content in the sample (Raymont et al., 1964).

RESULTS

1- Some Hydrographic Features

a- Temperature

Due to the shallowness of the lake, variation in the surface water temperature nearly follows that of the atmosphere. Generally, the surface water temperature is high during summer (June to September), the maximum i.e 30.4°C was recorded in July. Low temperature occurs in winter (December to February), the minimum temperature i.e 13.0°C occurred in December, (Table 1).

b- Salinity

During the present century, the salinity of the lake has been progressively increased as a result of the high rate of evaporation and the increased supply of drainage water (salinity 1.25‰) reaching the lake. The lake receives about 430 x 10^3 tons of salts annually from the drainage water reaching it. According to Meshal (1973), the salinity of the lake water increases at a rate of 0.48‰ per year. The maximum surface salinity recorded in the lake was about 34.0‰ at station 7 in October while the minimum surface salinity (1.30‰) occurred in June at station 3. On the average, the highest salinity in the whole lake i.e 31.9‰ was recorded in July and the lowest value i.e. 23.0 ‰ occurred in december, (Table 2). Station 3 (infront of El-Bats Drain) and station 6 (near El-Wadi Drain) showed the lowest salinities, average i.e. 23.3‰ and 17.9‰, respectively due to the dilution caused by both drains. El-Bats Drain usually floods in June when the surface salinity at station 3 reached 1.3‰ while the salinity of the water near the bottom was 30.8‰. The amount of drainage water conveyed by El-Wadi Drain was usually high throughout the period from August to December with higher quantities in September and December, when the surface salinity at station 6 reached a minimum

TABLE 1
Monthly variations of surface water temperature in Lake Qarun.

Station / Date	Surface temperature °C							
	1	2	3	4	5	6	7	8
January	17.0	17.0	16.9	16.5	17.1	16.3	16.1	16.7
March	19.7	21.2	22.0	19.9	20.8	19.9	21.0	20.6
April	22.5	21.0	21.7	22.0	20.5	21.7	24.8	22.0
June	26.9	27.1	28.0	26.4	26.3	30.2	28.2	27.6
July	28.1	30.4	29.2	29.5	28.2	28.1	29.6	29.0
August	28.1	29.0	29.1	28.8	28.5	29.1	29.4	28.9
September	25.4	25.1	26.4	25.7	24.9	27.6	28.0	26.2
October	21.4	21.5	22.2	21.4	22.8	24.0	22.8	22.3
December	14.3	14.4	15.4	13.9	14.4	14.6	13.0	14.3
Mean	22.6	23.0	23.4	22.7	22.6	23.5	23.7	23.1

TABLE 2
Monthly variations of surface salinity in Lake Qarun.

Station / Date	Surface salinity ‰							
	1	2	3	4	5	6	7	Mean
January	30.2	30.4	26.1	28.1	30.2	22.4	31.4	28.3
March	30.6	29.3	18.5	30.1	29.3	3.7	31.8	24.7
April	29.4	31.3	26.9	31.4	29.8	31.3	31.8	30.3
June	31.5	32.5	1.3	32.5	31.3	26.7	32.7	26.9
July	32.4	31.8	30.8	32.9	31.3	31.7	32.7	31.9
August	32.8	32.3	28.2	33.5	31.7	15.9	33.7	29.7
September	32.9	33.3	21.8	32.8	32.1	4.1	33.8	27.3
October	32.1	32.6	28.9	25.6	30.6	21.6	33.7	30.4
December	26.4	27.7	27.4	30.3	28.1	3.7	22.1	23.0
Mean	30.9	31.2	23.3	30.8	30.5	17.9	31.5	28.1

of 4.1‰ and 3.7 ‰, respectively. The salinity near the bottom at these stations in both months was still high being 32.9‰ and 30.2‰, respectively. From these observations, it is clear that the dilution caused by those drains is mostly pronounced only on the surface layer, variations in the subsurface salinity of the lake were on the whole not significant. On the average, the subsurface salinity reached its maximum during summer and autumn, low values were generally found in winter and spring. Station 7 maintained the highest average salinity, i.e. 32.6‰ while station 3 showed the lowest average, i.e. 30.4‰.

2- Seasonal Variations in Length and Weight

As shown Table (3), the mean length of **Acartia latisetosa** varied between a minimum of 0.9 mm in summer and a maximum of 1.1 mm in winter. As pointed out by several authors (Deevey, 1960; El-Maghraby, 1965) seasonal variations in length of marine copepods are mostly controlled by temperature variations of the environment. The large sized individuals usually occur in cold seasons. In Lake Qarun, large sized individuals occurred in winter when the water temperature was at its minimum (13-17°C) while the smallest size individuals occurred during the hot summer season (water temperature 28-30.4°C). On the other hand, seasonal and regional variations in the weight of the species seem to be more interesting, (Table 3). During the winter the values of dry weight (per 100 individuals) were remarkably low varying between 154 µg at station 4 and 278 µg at station 5. The progressive increase in the average weight of the species commenced in spring, reached its maximum during the summer season when the values varied between a minimum of 287 µg and a maximum of 573 µg/100 individual with an average of 412 µg/100 individual. In autumn, the average weight values were low and nearly comparable to those of spring. It is obivous that seasonal variations in the dry weight of the species are mostly

TABLE 3
Mean length (mm) and mean dry weight (micrograms per 100 organism) of **Acartia latisetosa** from Lake Qarun.

Season	Mean length mm	Mean dry weight ug/100 individual in the stations sampled							
		1	2	3	4	5	6	7	Mean
Winter	1.10	178	170	218	154	278	200	206	201
Spring	1.02	340	177	264	172	402	204	382	277
Summer	0.90	573	287	288	433	490	381	431	412
Autumn	0.95	235	265	268	395	410	190	212	282
Mean		331	225	260	313	395	244	308	293

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controlled by its feeding activity. In winter, the low standing crop of phytoplankton and the low water temperature seem to surpress the feeding activity of the species (Dowidar and El-Maghraby, 1970). On the other hand, the increased feeding activity during the spring blooming of phytoplankton resulted in the high weight values of the species during summer.

It appears from these data that variations in the dry weight of the species are inversely related to variations in its length. The small sized summer population was the heaviest while the large sized winter population was remarkably lighter in weight.

Concerning the regional variations, it was found that high values (average 395 µg) were recorded at station 5 while minimum values (average 225 µg) occured at station 2. These regional variations in the weight of the species may be attributed to the variable environmental conditions at the different stations. Variations in both the biotic and abiotic environmental conditions were observed in the different regions of the lake (Meshal, 1973; El-Bilbisy, 1973; Atta, 1977).

3- Water Content

The percentage of the water content of **Acartia latisetosa** in Lake Qarun is shown in Table 4. High values were usually found in winter, average 85.3 %, while low values were recorded in summer, average 78.2 %. Concerning the regional variations, station 2 showed the highest values (average 85.2 %) while low values occurred at station 5 (average 74.9%).

4- The Organic Content

The results of analysis of the organic content of the species i.e. total protein, lipids, carbohydrates and ash are respectively presented in Tables 5-8.

TABLE 4
Seasonal variations of the percentage of the water content of **Acartia latisetosa** in Lake Qarun.

Station	Percentage of the water content							
	1	2	3	4	5	6	7	Mean
Winter	84.0	87.9	86.9	87.5	86.6	83.0	81.2	85.3
Spring	82.0	87.0	84.5	85.2	65.2	76.4	80.0	80.0
Summer	80.0	84.0	83.0	74.5	72.0	75.0	74.0	78.2
Autumn	83.7	81.8	73.6	75.9	73.1	82.0	80.0	78.6
Mean	82.4	85.2	82.0	80.8	74.9	79.1	78.8	80.5

DISCUSSION

The water content of the planktonic copepod **Acartia latisetosa** in Lake Qarun displayed both seasonal and spatial variations. The values varied between 65.2% and 87.9% of the total body weight. The annual being 80.5%. These data seem to be in agreement with the results obtained for other crustaceans by different authors. Raymont et al. (1964) found that the water content in **Neomysis integer** amounted to an average of 78%. In **Euphausia superba** the water conent varied between 77% in January and 82% in December (Raymont et al., 1971).

The seasonal variations in the water content of the species would be easily correlated with the prevailing environmental conditions particularly the ambient water temperature and salinity. During winter both the water temperature and the salinity were low (Tables 1 and 2) thus favouring the high water content of the animal (average 85.3%). At low temperature, the organism tends to absorb water (Russell, 1971). Salinity also affects the organism through influencing the density of the medium and its osmotic pressure. The low water content of the summer population was probably favoured by the high water temperature and high salinity.

On the other hand, spatial variations in the water content of the species were less significant in winter probably reflecting effective processes of both vertical and horizontal mixing of the water of the lake; on the contrary, wide variations were observed in the other seasons. On the whole, the water content of the samples from the eastern part were significantly higher than those from the western region of the lake; low values (average 74.9%) were recorded at station 5 which was less affected by drainage water. On account of the shallowness of the eastern part, its water temperature was relatively high during the warm seasons of the year. Furthermore, the salinity of the eastern region was mostly low throughout the year due to the discharge of several drains. These conditions may account for the high average water content of the population in the eastern part of the lake.

The annual average of the protein content of **Acartia latisetosa** in Lake Qarun amounted to 66.1%. According to earlier data quoted by Vinogradov (1953) the average value of the protein content of marine copepods is about 64.5% of the dry body weight. Orr (1934) found that the protein content of **Calanus** varied between 30% and 77%. Krey (1950) gave a range of 71-77% for total protein in copepods.

The protein content of the species in the lake displayed wide seasonal and regional variations. During the period of study the values fluctuated between 75.0% and 52.5% (Table 5). These data fairly agrees with that of **Calanus** and other copepods (Orr, 1934; Raymont et al., 1971). Apart from the low values recorded at station 6 (average 58.2%9), variations in the mean values of the other stations were on the whole less pronounced.

TABLE 5
Seasonal variations in the protein content of **Acartia latisetosa** in Lake Qarun as percentage of the dry body weight.

Station	Percentage of the protein content							
	1	2	3	4	5	6	7	Mean
Winter	70.60	67.50	61.50	71.25	61.50	52.50	59.37	63.46
Spring	70.00	61.25	68.75	75.00	68.75	52.50	71.87	66.96
Summer	72.50	62.50	62.50	71.25	71.50	56.25	62.50	62.50
Autumn	61.25	70.00	75.00	61.25	70.00	71.50	70.00	68.40
Mean	68.58	65.30	66.93	69.69	67.90	58.19	65.93	66.10

Concerning the seasonal variations in the protein content of the species, it was found that high values occurred in the spring and autumn seasons (average 66.95% and 68.40% respectively). Low values were, on the other hand, recorded during winter and summer; the lowest arithemtic mean i.e. 63.5% occurred in winter and conincided with the period of minimum temeprature and lowest phytoplankton crop in the lake. The high protein content of the species during the spring and autumn seasons may be a direct result of the suitable biotic and abiotic environmental conditions prevailing in the lake in both seasons. In the lake (as well as in the neretic waters of the eastern Mediterranean) the phytoplankton cycle is usually bimodal with blooms occurring in early spring and autumn (Dowidar, 1965). In both seasons, the temperature of the lake, is considered optimum for the successful propagation of the species (Dowidar and El-Maghraby, 1970). The efficiency of the feeding activity of this filter feeding copepod is probably at its optimum in both seasons. Thus, the increased rate of grazing, the abundance of suitable food and the suitable environmental conditions may account for the high protein content of the species during the spring and autumn seasons.

The lipid content of zooplankton organisms in general and of marine copepods in particular is highly variable. Orr (1934, a and b) found that the fat content of **Euchaeta norvegica** is relatively high, ranging between 18% and 36% of the dry body weight, while that of **Calanus finmarchicus** ranged from 10.5% to 47.0%. Krey (1950) gave a range of 4.6 - 19.2% for mixed copepods. Lafon et al. (1955) found that the fat content of copepods dominated by **Acartia** ranged from 5% to 9%. In **Acartia clausi** (Nakai, 1955) the average value was 5.8% of the dry body weight. Bogorov et al. (1966) found that the lipid content of the Indian Ocean plankton varied between 9 - 20% of the dry body weight. It appears, however, that the fat content of copepods is usually higher than in other crustaceans. Konosu et al. (1958) gave low values of 0.52% for the blue crab and 1.46% for lobsters; Dabrouski et al. (1969) gave 0.91% for **Parapenaeus** spp.

The lipid content of **Acartia latisetosa** from Lake Qarun was remarkably high. The values ranged from a minimum of 8.0% and a maximum of 26.0% of the dry body weight; the annual mean being 15.22% (Table 6). Regarding the seasonal variations of lipids, it was found that high values (average 18.69%) occurred in winter (January), i.e. at low water temperature and salinity. This may inidcate that lipids may be used as an energy store for these animals. In spring the fat content decreased sharply (average 14.5%) insipte of the abundance of plankton food. This drop may be due to consumption of the fat content during cold months. On the other hand, the buoyancy of this planktonic copepod of marine origin is probably regulated by high fat and water contents particularly in seasons of low water salinity in the lake environment. An inverse correlation was found between the lipid and protein contents of the species (r= -0.7 and t= -7.53), high protein values were, on the whole, associated with low values of lipids. Concerning the spatial variations, it was found that animals from stations 1,3 and 6 (which are more or less affected by land drainage) showed high values (Table 6); this may be related to variations in the amount and kind of food available, low water salinity and other environmental conditions.

TABLE 6
Seasonal variations in the lipid content of **Acartia latisetosa** in Lake Qarun as percentage of the dry body weight.

Station	Percentage of lipid content							
	1	2	3	4	5	6	7	Mean
Winter	19.0	18.0	17.85	14.85	20.76	20.0	20.4	18.69
Spring	14.4	17.0	14.77	10.00	10.80	26.0	8.5	14.50
Summer	17.0	12.0	18.50	10.00	12.00	25.0	10.0	14.93
Autumn	23.0	8.0	13.00	13.30	8.30	8.5	15.2	12.76
Mean	18.35	13.75	16.03	12.04	12.96	19.9	13.52	15.22

According to the data given by Krey (1950), the carbohydrate content in copepods is generally low varying between 0.0 and 4.4% of the dry body weight. In the present study, the carbohydrates in **Acartia latisetosa** represented the lowest component of the dry body weight, being on the average 3.2%. The values varied between 0.73% and 6.25%. On the other hand, seasonal variations in the mean values were less pronounced; the maximum being 4.3% and occurred in spring and the minimum 2.8% occurred in winter and autumn seasons. The low and more or less constant carbohydrates level may suggest that glycogen cannot be a significant storage material in this species. The relatively high values recorded during spring were probably due to the increased feeding efficiency on the spring

diatom bloom developed in the lake. The carbohydrate content of the spring phytoplankton in the lake was determined and found to be 5.3% of the dry weight. On the other hand, regional variations in the carbohydrate content of the species in the lake were more pronounced. The population of station 5 which is less affected by drainage water showed the highest values (mean 5.84%) while the lowest values were recorded in station 2 (mean 1.88%), Table 7. These variations are probably attributed to variations in the kind and abundance of available food and other environmental factors at the different stations.

TABLE 7
Seasonal variations in the carbohydrate content of **Acartia latisetosa** in Lake Qarun as percentage of the dry body weight.

Station	Percentage of carbohydrate							
	1	2	3	4	5	6	7	Mean
Winter	3.80	1.83	2.50	2.83	5.60	2.93	2.50	2.80
Spring	5.25	2.40	3.80	3.30	6.00	4.20	4.80	4.30
Summer	4.20	1.20	1.60	1.60	4.32	5.00	3.00	3.00
Autumn	5.00	2.08	1.90	2.24	6.25	0.73	1.40	2.80
Mean	4.56	1.88	2.75	2.50	5.84	3.22	2.92	3.20

The ash content of **Acartia latisetosa** in Lake Qarun showed wide regional variations (Table 8). The values determined in the different stations sampled varied between 4.5% and 13.0% of the dry body weight with an annual average of 8.2%. Seasonal variations in the mean values were, however, less pronounced. High values were recorded in autumn (average 9.3%) while low values occurred in spring (average 6.8%). Brandt (1898, cf. Raymont et al., 1971) suggested a value of 9.3% for the ash content of mixed copepods. In **Calanus finmarchicus** (Orr, 1934) the value of ash varied between 3%-4%, while in **Acartia clausi** (Nakai, 1955) the ash content amounted to 3.3%. According to the data of Krey (1950) the ash content of copepods varied between 4.2% and 6.4%. From these data, it is obvious that the ash content of **Acartia latisetosa** is significantly high.

The results obtained from the present study, summerised in Table 9, clearly demonstrate that **Acartia latisetosa** is an excellent food source for zooplankton and filter feeding animals in the lake. The water content of the species is almost comparable to that of fish flesh. The average water content of fish flesh is about 80% of the living weight (Lagler et al., 1962). According to Lagler et al., (1962), in fishes, proteins make up between 14 and 23% of the wet weight and the carbohydrates present in muscles for immediate energy release make up less than 1% of the wet weight.

TABLE 8
Seasonal variations in the ash content of **Acartia latisetosa** in Lake Qarun as percentage of the dry body weight.

Station	Percentage of ash content							
	1	2	3	4	5	6	7	Mean
Winter	5.6	5.2	10.2	6.3	6.8	12.0	11.4	8.2
Spring	5.0	9.3	6.3	6.0	7.3	7.5	6.4	6.8
Summer	4.5	13.0	9.3	9.3	8.0	6.8	8.2	8.4
Autumn	8.3	12.0	5.5	11.8	9.5	11.0	7.2	9.3
Mean	5.9	9.9	7.8	8.4	7.9	9.3	8.3	8.2

TABLE 9
Balance sheet of the parameters determined for **Acartia latisetosa** in Lake Qarun (mean values)

Season	Wet wt. ug/ind.	Dry wt . ug/ind.	% of water content	Organic content % of dry body weight			
				Protein	Lipid	Carbhydrate	Ash
Winter	13.67	2.01	85.30	63.46	18.69	2.80	8.20
Spring	13.85	2.77	80.00	66.95	14.50	4.30	6.80
Summer	18.90	4.12	78.20	65.50	14.93	3.00	8.40
Autumn	13.18	2.82	78.60	68.40	12.76	2.80	9.30
Mean	15.02	2.93	80.50	66.08	15.22	3.20	8.20

In **Acartia latisetosa** from Lake Qarun proteins, fate and carbohydrates constitute on the average 12.9%, 2.97% and 0.6% of the wet weight respectively. In other words, every kilogram wet weight of the species contains 129 gm protein, 30 gm fat and 6 gm carbohydrates. These figures are highly important knowing that the largest stock of living animal protein consists of the copepods of the zooplankton. Russell-Hunter (1970) states that, at least three quarters of the marine protein productivity at the second tropic level occurs in the zooplankton which is in turn the direct food of zooplankton feeding animals. In this concern, the role played by **Acartia latisetosa** in Lake Qarun is not exceeded as it constitutes, on the average, about 85%, by number, of the total zooplankton community of the lake.

SUMMARY AND CONCLUSIONS

Lake Qarun is an inland closed lake occupying the deepest part of Faiyoum depression in Upper Egypt. It lies between longitudes 30° 34' and 30° 42' E and latitudes 29° 25' and 29° 32' N. Its surface area is about 240 km^2 at about 44 m BMSL, the maximum depth of water is about 8.5 m and the maximum salinity recorded is about 34‰.

The marine planktonic copepod **Acartia latisetosa** was introduced into the lake between 1928-1933 in connection with the processes of trasplanting the lake by marine fishes. Since then it has flourished and nowadays it is the dominant zooplankton in the lake constituting about 72-100% by number of the total zooplankton community. Consequently it forms the main food item for zooplankton feeding animals and plays an important role in the food web in the lake.

The seasonal and spatial variations of the organic content (total protein, lipids, carbohydrates and ash) as well as the seasonal variations in length, weight and water content of the adult individual of **Acartia latisetosa** in Lake Qarun was studied. The samples were collected seasonally during 1974 from 7 stations distributed in the lake.

On the average, the wet weight of the species varied between a maximum of 18.9 µg/individual in summer and a minimum of 13.2 µg/individual in autumn with an annual mean of 15.0 µg/individual. The dry body weight values/individual varied between 5.73 µg and 1.54 µg with a mean of 2.93 µg. High values (average 4.12 µg) were recorded in summer while low values (average 2.01 µg) occurred in winter. The water content of the species varied between 87.9% of the fresh body weight and 65.2% with an annual mean of 80.5%. High values (average 85.3%) occurred in winter while low values (average 78.2%) were recorded in summer. The total length of the species reached its maximum (average 1.1 mm) in winter and its minimum in summer (average 0.9 mm). These variations were discussed in view of the prevailing environmental conditions. It was found that variations in the dry body weight of the species were inversely related to variations in its length. The small dry weight of the large sized winter population was due to the high water content of the species. The latter was favoured by the low water temperature and low salinity during winter. Seasonal variations in size were on the other hand, mostly correlated with water temperature, low temperature favoured the formation of large sized individuals. Seasonal variations in the dry body weight of the species was mostly correlated to the efficiency of the feeding activity and the abundance of suitable food during the spring and autumn outbursts.

The protein content of the species was relatively high. The values varied between 75.0% and 52.5% of the dry body weight with an annual mean of 66.1%. High values were recorded during spring and autumn seasons (average 66.95% and 68.40% respectively) and are probably attributed to the increased efficiency of grazing on the abundant food in both seasons.

The protein content of the winter population was significantly low and coincided with the period of minimum temperature and lowest phytoplankton crop.

The fat content of the species was relatively high compared with other copepods. The values ranged from 26.0% to 8% of the dry body weight with an annual mean of 15.2%. The highest value (average 18.7%) occurred in winter and probably indicate that lipids may be used as an energy store for these animals. In spring the fat content decreased sharply (average 14.5%) probably due to its consumption during the cold season. An inverse correlation (r= -0.7) was found between the lipid and protein contents of the species. On the other hand, it was found that the high lipid content of the species was more or less directly related with its high water content and low water salinity being associated with seasons and/or regions of low salinity in the lake. It is probably the buoyancy of this planktonic copepod of marine origin is mostly regulated by high water and fat contents, particularly during periods of low water salinity.

The carbohydrate content of the species varied between 6.25% and 0.73% of the dry body weight with an annual mean of 3.20%. Relatively high values (average 4.3%) were recorded in spring, probably due to the increased feeding efficiency on the spring phytoplankton bloom; otherwise seasonal variations in the mean values of the carbohydrate content of the species were not significant. The low and more or less constant carbohydrate level, may suggest that glycogen cannot be a significant storage material in **Acartia latisetosa.**

The ash content of the species was significantly higher than that reported for other copepods. the values varied between 13.0% and 4.5% of the dry body weight with an annual mean of 8.2%.

It is concluded that **Acartia latisetosa** with its high nutritive value constituted an important food item for many zooplankton and filter feeding animals in Lake Qarun.

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