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"Research Note"

MORPHOMETRIC VARIABLES AND INDIVIDUAL VOLUME OF *MACROCYCLOPS ALBIDUS* AND *CYCLOPS VICINUS* FEMALES (COPEPODA, CYCLOPOIDA) FROM HAZAR LAKE (ELAZIG–TURKEY)*

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Abstract – *Macrocyclops albidus* and *Cyclops vicinus* are the two important copepods living in Hazar Lake. For this study, 50 females for each species were collected. Samples were taken between December 1999 and March 2000. Length (PL), width (PW), and height (PH) of prosome and length (UL) and width (UW) of urosome were measured in each female and subsequently, the following ratios PL/PW, PL/PH, PW/PH, PL/UL and UL/UW were determined. Volumes for *M. albidus* and *C. vicinus* females were estimated following the morphometric method Regression tests were conducted for both species between volume and prosome length or width. Regression lines were compared through covariance analysis. PL/UL was the best ratio for separating one species from the other. Average individual volume and standard error estimated for *M. albidus* and *C. vicinus* were 0.0063 (±0.001) mm^3 and 0.0049 (± 0.001) mm^3 respectively. Differences between both copepods morphometric variable and rate values were observed. Measured size and volume values increased in March and June compared with December. According to R^2 values of regression lines, prosome width and prosome length were good volume predictors on different dates for *M. albidus* and *C. vicinus*. Differences in slopes and mean variances found between regression lines demonstrated variability according to different months.

Keywords – *Cyclops vicinus*, females, Hazar Lake, *Macrocyclops albidus,* morphometric variables, volume

1. INTRODUCTION

Macrocyclops albidus (Jurine, 1820) and *Cyclops vicinus* (Uljanin, 1875) are the two abundant copepods in the Hazar Lake. Copepods are translate animal protein that take phytoplankton for nutriment [1]. Copepods play an important role in the marine food chain, comprising ≥ 50% of total planktonic population.

In cyclopoid copepods, mechanoreception is the primary mechanism for the detection of food particles. Cyclopoid copepods are widespread and play an important role in the trophic dynamics of freshwater ecosystems. Adults are generally regarded as omnivorous, having broad trophic niches. Although some authors emphasize the carnivorous feeding habit of many adult cyclopoid [2, 3], numerous investigations have shown that some species are largely herbivorous [4-6]. *M. albidus* and *C. vicinus* are similar in size, but they have different body shapes.

This study aims to note the morphological differences between these zooplankters and the seasonal effects on their morphology.

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2. MATERIALS AND METHODS

In this study, females of *M. albidus* and *C. vicinus* were collected from Hazar Lake, during June 1999 and March 2000. Sampling was done with 0.25 m mouth diameter and 55 μm mesh open net, in several horizontal and vertical tows from 8 m deep to the surface. *M. albidus* and *C. vicinus* were separated and preserved in 4% formaldehyde. Females were studied within 20 days in order to avoid size differences caused by preservation time [7]. Temperature and the salinity of the surface water at the sampling dates were determined in the field.

The length, width and height of prosome, and the length and width of urosome were measured in each specimen with a Nikon mark research microscope. The volume of each female was estimated according to Choznocki and Hussein [8].

$$V= \pi (PLPWPH)/6 + \pi (ULUW^2)/4$$

Where

V= volume PH = prosome height
PL = prosome length UL = urosome length
PW = prosome width UW = urosome width

3. RESULTS

Table 1 shows that there is a seasonal effect on temperature and salinity. Salinity ranges from 0.32 to 0.42%. The salinity of the water sample collected during December 1999 and March 2000 were 0.32 and 0.33% repectively. Temperature values usually display large annual amplitude, ranging in 1999 from 23.5 ^{o}C in June to 2.9 ^{o}C in December. The temperature of the lake water during March 2000 was 11 ^{o}C.

Table 1. Temperature and salinity values observed in various days sampling

Date	Temperature (^{o}C)	Salinity (0%)
June 1999	23.5	0.42
December 1999	2.9	0.32
March 1999	11	0.33

3.1. *Morphometric variables and individual volume*

Mean *M. albidus* female morphometric variable values were smaller in December 1999 than in March 2000 (Table 2). Ratios between all but one morphometric variable were similar on both dates. PL/UL decreased markedly in March 2000 (Table 3). Mean *M. albidus* individual volume values increased from 0.0057 mm^3 in December to 0.0068 mm^3 in March (Table 2). Female individual volume average was 0.0063 (± 0.001) mm^3. Scatter plots from Fig. 1 show volume, prosome length, and width changes of *M. albidus* on both dates. Mean *C. vicinus* female morphometric variable values varied seasonally and were smaller in December 1999 than in June 1999 (Table 2). Generally, ratios found between variables were on both dates, with an increase in PL/UL during June and December (Table 3) being the most important variation. Mean *C. vicinus* individual volume values decreased from 0.0052 mm^3 in June to 0.0045 in December (Table 2). The female average was 0.0049 (±0.001) mm^3. Scatter plots from Fig. 2 show volume, prosome length and width changes of *C. vicinus* on both dates.

Mean *M. albidus* female morphometric variable values varied seasonally. According to a two way ANOVA test, for *M. albidus,* UL formed variation were the most important variation ($p<0.001$). The PL and UW formed variation were not important. PW and PH formed variations were less important from formed variation UL.

Acording to the two way ANOVA test, for *C. vicinus,* PL formed variation were the most important variation. The PW, PH, UL and UW formed variations were not important.

In both copepods, taking into account the coefficient of variation (CV), prosome length had a smaller variability than prosome width. Therefore, PL is the more stable measure. The larger variability of prosome width could be explained as the effects of food on fatness. *M. albidus* and *C. vicinus* individual volume data showed a high CV in December.

Table 2. *M. albidus* and *C. vicinus* female, morphometric variables and volume

Species / Dates		PL (mm)			PW (mm)			PH(mm)		UL(mm)		UW(mm)		VOLUME (mm^3)		
	N	M	SE	CV	M	SE	CV	M	SE	M	SE	M	SE	M	SE	CV
M. albidus																
December 1999	50	0.282	0.024	0.085	0.253	0.025	0.099	0.137	0.020	0.106	0.012	0.093	0.011	0.0057	0.001	17.50
March 2000	50	0.291	0.021	0.072	0.265	0.021	0.079	0.147	0.018	0.123	0.027	0.098	0.064	0.0068	0.001	14.70
Total average/range	100	0.287	0.023	0.079	0.259	0.023	0.089	0.142	0.019	0.115	0.020	0.096	0.038	0.0063	0.001	16.10
C.vicinus																
June 1999	50	0.264	0.026	0.098	0.227	0.027	0.119	0.138	0.023	0.144	0.015	0.091	0.009	0.0052	0.001	19.23
December 1999	50	0.252	0.015	0.060	0.217	0.013	0.060	0.129	0.018	0.140	0.012	0.088	0.007	0.0045	0.001	22.22
Total average/range	100	0.258	0.021	0.079	0.222	0.020	0.090	0.134	0.021	0.142	0.014	0.090	0.008	0.0049	0.001	20.68

Mean (M) ¯± Standard error (SE), coefficient of variation in percent (CV)

Table 3. *M. albidus* and *C. vicinus* morphometric ratios

Species/Dates	PL/PW		PL/PH		PW/PH		PL/UL		UL/UW	
	M	SE	M	SE	M	SE	M	SE	M	SE
M.albidus										
December 1999	1.096	0.147	2.085	0.186	1.853	0.133	2.681	0.142	1.127	0.054
March 2000	1.097	0.023	1.987	0.172	1.811	0.147	2.466	0.361	1.122	0.164
Total average	1.097	0.085	2.036	0.179	1.832	0.140	2.574	0.252	1.124	0.109
C. vicinus										
June 1999	1.164	0.073	1.935	0.275	1.677	0.221	1.842	0.180	1.587	0.149
December 1999	1.159	0.045	1.964	0.203	1.697	0.187	1.802	0.133	1.597	0.134
Total average	1.162	0.059	1.950	0.239	1.687	0.204	1.822	0.157	1.592	0.142

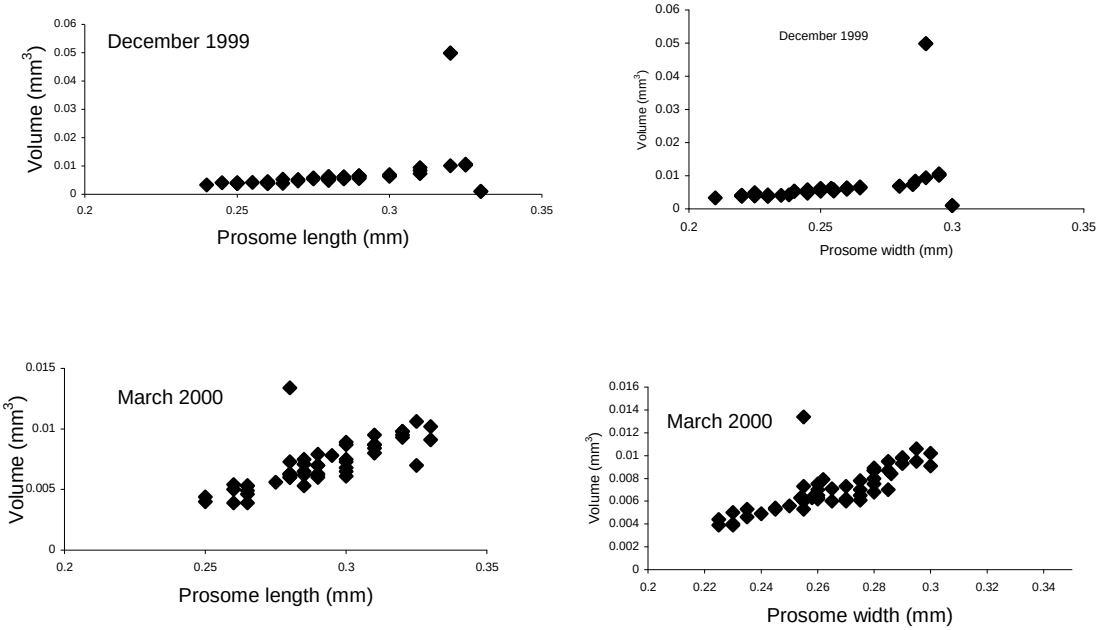

Fig.1. Scatter plots of *Macrocyclops albidus* females prosome length vs. volume and prosome width vs.volume

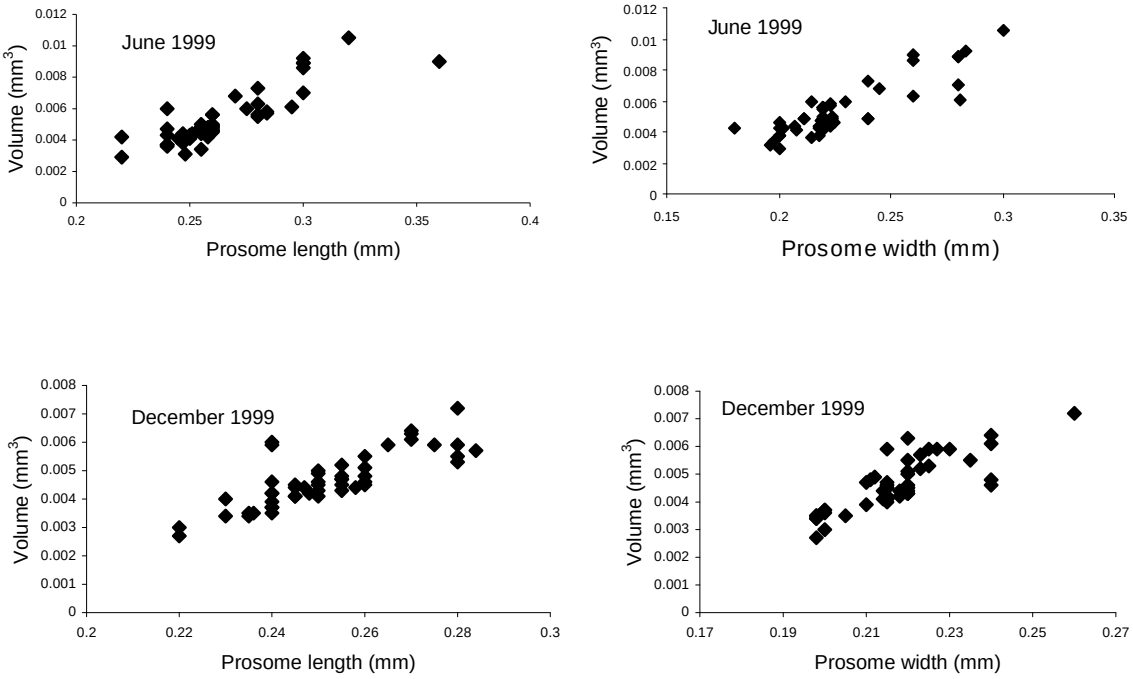

Fig.2. Scatter plots of *Cyclops vicinus* females prosome length vs. volume and prosome width vs.volume

3.2. *Regression test for prosome length (PL) – width (PW) vs. individual volume (V)*

Regression tests for *M. albidus* and *C. vicinus* PL, PW, PH, UL and UW and V relationships were conducted using data from two dates. According to these results, PW and UW of PL relationships; UL of PW relationship; UL of PH relationship; the UW of the UL relationship were the most important. The UL of the PL relationship and UW of the PH relationship were not important. However, the PH of the PW relationship were more important than the PH of the PL relationship and the UW of PW relationship.

3.3. *Regression lines comparison*

The comparison between the regression lines of *M. albidus* PL vs. V and PW vs. V relationships from December 1999 and March 2000 are shown according to these circumstances.

Y(lnV)= -1.0753+3.2192x(lnPL) and Y(lnV)= -1.0841+2.9322x(lnPW)

Y(lnV)= -1.1658+3.0854x(lnPL) and Y(lnV)= -01.375+2.7516x(lnPW) (Fig. 3A-D)

For December 1999, the R^2 was higher in the PL vs V relationship (67.03%) than that in the PW vs. V relationship (13.76%). For March 2000, the determination coefficient (R^2) was higher in the PW vs V relationship (70.28%) than that in the PL vs V relationship (13.43%). The latter means that PL was the best predictor in December 1999, explaining nearly 67% from the total variance, while PW was the best in March 2000, explaining 70% from variance.

The comparison between the regression lines of *C. vicinus* PL vs V and PW vs V relationships from June and December 1999 are shown according to these circumstances

Y(lnV)= -1.5364+2.8087x(lnPL) and Y(lnV)= -2.3698+1.9642x(lnPW)

Y(lnV)= -1.3773+2.91x(lnPL) and Y(lnV)= -0.973 + 2.894x(lnPW) (Fig. 4A-D)

For June and December 1999, R^2 values were higher in the PL vs.V relationships (75.66% and 75.13%) than those in the PW vs. V relationships (64.67% and 67.67%). Similar R^2 values were obtained for June and December, and this does not allow for any conclusion as to which of them explains more about the total variance than the other.

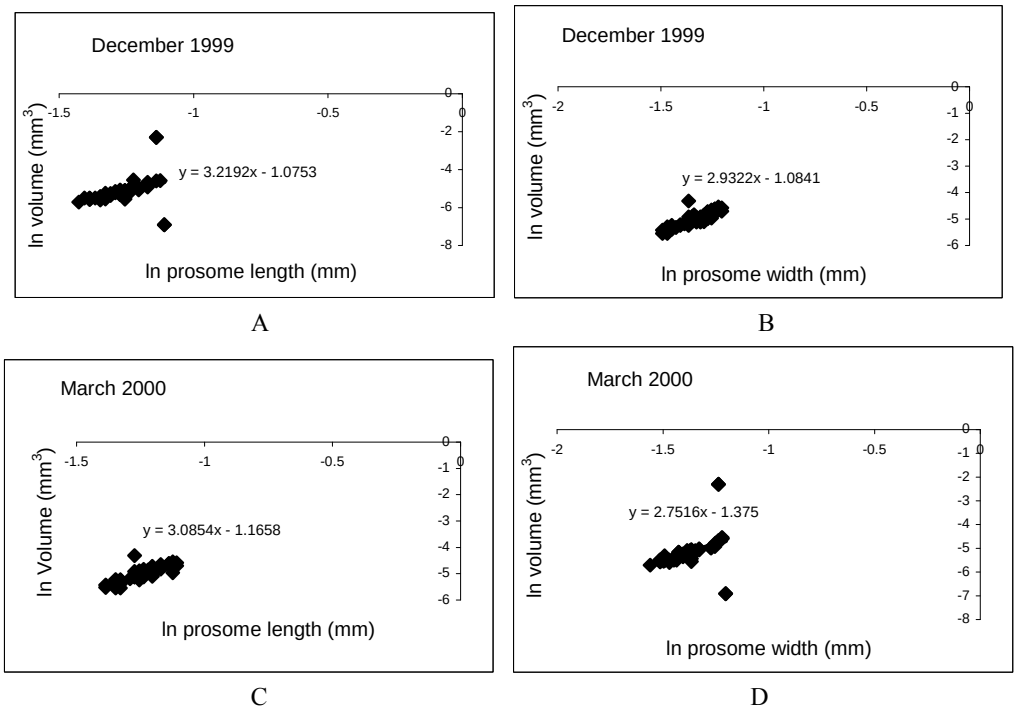

Fig. 3. Resulting general regression lines and equation of *Macrocyclops Albidus* prosome_length -prosome width vs. volume data

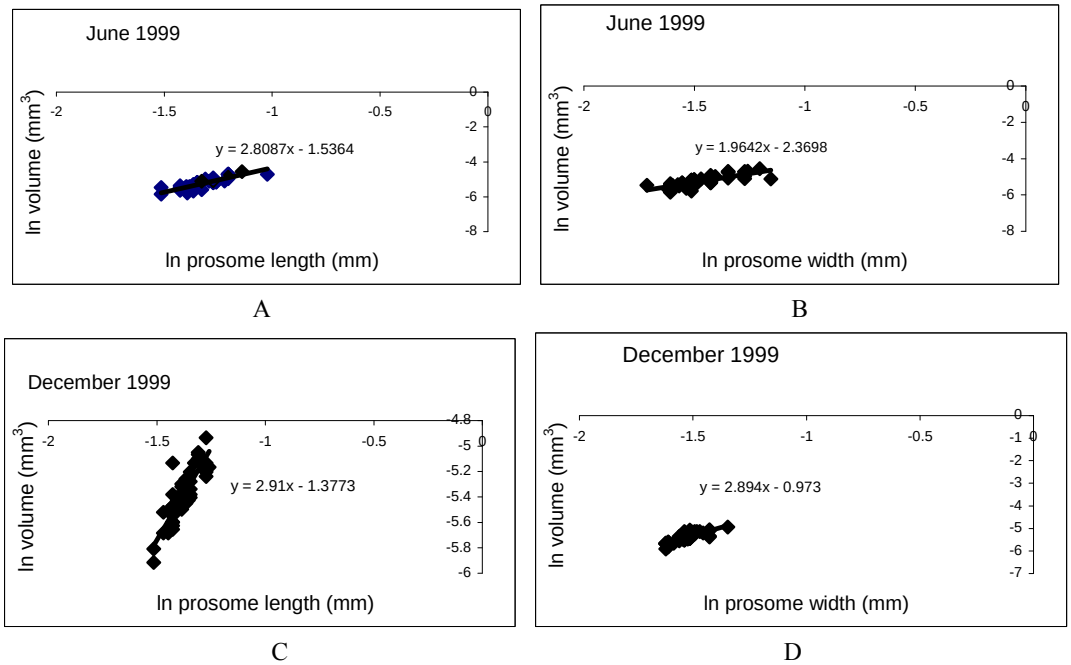

Fig. 4. Resulting general regression lines and equation of *Cyclops vicinus* prosome length -prosome width vs. volume data

4. DISCUSSION

Differences observed between morphometric variable values found in *M. albidus* and *C. vicinus* females obviously reflect the different body shapes of both copepods, particularly different prosome and urosome lengths.

Temperature seems to be the primary factor influencing *M. albidus* and *C. vicinus* body lengths in the Hazar Lake. According to Riccardi and Mariotta [9], the primary factor influencing copepod body length in the lagoon of Venice is temperature.

According to McLaren [10], Miller *et al.* [11] and Klein Breteler & Gonzales [12], temperature and food availability are the main factors acting in the seasonal control.

In *M. albidus* and *C. vicinus* prosome lengths are larger than urosome lengths. With regard to ratios between pairs of morphometric variables, mean prosome length to height (PL/PH) was 2 and mean prosome length to height (PW/PH) was larger than 1 in both copepods. PL/PW and UL/UW ratios were larger in *C. vicinus* than in *M. albidus.* PW/PH, PL/PH and PL/UL ratios were larger in *M. albidus* than in *C. vicinus.* Deevey *et al*. [13] pointed out that conditions prevailing during development regulate copepods size and weight. It was evident that PL/UL is the best ratio to morphologically separate both species, with the mean values being 2.574 in *M. albidus* and 1.822 in *C. vicinus.* For *Acartia tonsa* females from Buenos Aires coastal waters in October, 1982, Fernandez Araoz [14] found mean values of 4.17 for the PL/PW ratio, while for females from the San Jorge Gulf this author reported values of 3.61 and 3.11 for the PL/UL and PL/PW ratios for January 1985. Seasonal and geographic causes could be reflected in the observed differences with the Fernandez Araoz specimens

This study measured morphometric values for *M. albidus* that are higher in March than December. For *C. vicinus,* measured morphometric values are higher in June than in December. The size of both species evidenced seasonal variation linked to temperature and food conditions.

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