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CORRELATIONS BETWEEN PHYSICO - CHEMICAL FACTORS AND POPULATION DENSITY OF CLADOCERANS IN THE TIGRIS AND DIYALA RIVERS AT BAGHDAD - IRAQ

Key Words : Cladocera , Population Density , Physico - Chemical Factors , Tigris River , Diyala River .

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ABSTRACT

Seasonal variation of some environmental factors such as water temperature, dissolved oxygen, hydrogen ion concentration, transparency, electrical conductivity , velocity of water flow and chlorophyll a were studied for one year in two rivers , Tigris and Diyala at Baghdad.

Seasonal qualitative and quantitative studies of the cladocerans of the two rivers are reported. Eight species comprise the cladoceran fauna of Diyala River , Bosmina longirostris , Moina affinis , Ceriodaphnia cornuta, Simocephalus vetulus, Daphnia lumholtzi, Chydorus sphaericus , Macrothrix laticornis, Diaphanosoma brachyurum, whereas at Tigris River five species comprise the cladocerans fauna

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B. longirostris, M. affinis, C. cornuta, S. vetulus ,S.vetulus and D. brachyurum .

Population density of these cladocerans was studied in relation to some physico-chemical factors as mentioned previously and found there is a positive relationship between population density and dissolved oxygen concentration , velocity of water current, and transparency for both rivers and negative relationship with surface water temperature and chlorophyll a .

INTRODUCTION

The Cladocera live and reproduce in natural and artificial water bodies under different climatic conditions. Most studies on the natural populations of Cladocera deal with important environmental conditions such as physico - chemical factors and food for the animals.(e.g.1-4).

In many of these studies the food was the most important single factor controlling the population dynamics, in addition to affecting rates of population change and mortality (5-7).Investigations on the bio-ecological studies of aquatic invertebrates on the Iraqi rivers has been studied by 8-11. Diel variations of some physico-chemical factors of rivers Tigris and Diyala has been studied by 12. From these studies as mentioned above, no detailed investigation has been made of the biology of the Iraqi cladocerans in their natural habitat. The present work describes the results of a year-round study showing the seasonal variation in physico-chemical factors in two Iraqi rivers Tigris and Diyala which might effect the cladocerans population and the correlation between these factors and population density of cladocerans .

MATERIALS AND METHODS

The water samples were collected from the Tigris and Diyala Rivers at weekly intervals from August 1985 to July 1986. Determination of dissolved oxygen and water temperature were measured at the time of sampling and carried out according to the portable oxygen meter (YSI

Model 51B) oxygen percentage saturation was calculated from standard table (13), light penetration was estimated with a secchi disk having a diameter of 20cm. The hydrogen ion concentration was determined in pH meter (Orion research digital pH meter model 221).The specific conductance was recorded by the use of EC meter.Phytoplankton for pigment analysis was concentrated from 300ml of sample onto a Whatman GF/C fiber - glass filter (1.5cm diameter) placed in a Buchner type glass filter funnel fitted on a suction flask attached to a suction pump, the filter with phytoplankton was ground up in a glass homogenizer in a 5ml of 95% acetone, after extraction the content of the bottles was centrifuged for 10 minutes and the optical densities of the supernatant were measured with a Shimadzu UV-240 spectrophotometer. The amount of chlorophyll a present in each sample was calculated from (14). Velocity of water was calculated using a SEBA-Universal Current Meter FI. Quantitative samples of cladocerans were taken regularly at weekly intervals by the use of water flow meter and plankton net mesh size 0.1mm. The samples were collected through a plankton net and the animals were washed into a small jar and preserved in 70% alcohol for later identification and counting.

RESULTS

Environmental Conditions :

Water Temperature :

The temperature was measured between August 1985 and July 1986 as shown in Fig.(1). Seasonal variation of surface water temperature at Baghdad in Tigris and Diyala Rivers varied from a high temperature in summer ranging from 25-30°C and 25-31°C in Tigris and Diyala Rivers respectively, to a low temperature in winter ranging from 10-18°C and 13-20°C in Tigris and Diyala Rivers respectively.

In general in both rivers water temperature was relatively high by June and peaked in July, by October water temperature began to decline but did not droped below 11°C.

Dissolved Oxygen :

The content of dissolved oxygen has been measured (Fig.1), the minimal values of dissolved oxygen were recorded in summer 2.2mg/l and 4.4mg/l in Diyala and Tigris Rivers respectively, while the maximum concentration were recorded in winter 6.5mg/l and 7.5mg/l in Diyala and Tigris Rivers respectively. As expected dissolved oxygen varied inversely with water temperature, $r= -0.742$ $p<0.01$ in Diyala River and $r= -0.661$ $p<0.01$ in Tigris River (Fig.1B).

pH :

Hydrogen ion concentration measured during the study period, the pH ranged between 7.4 and 8.3; 7.8 and 8.4 in Diyala and Tigris Rivers respectively, as shown in Fig(2A).

Electrical Conductivity :

Mean electrical conductivity of the surface waters for Diyala and Tigris Rivers ranged from a minimum 700μmhos in both rivers to a maximum of 3800μmhos in Diyala River and 1200μmhos in Tigris River, in general as shown in Fig.(2B) there was no obvious gradient in conductivity from Tigris River while in Diyala River the variation in conductivity ranged from 700μmhos to 3800μmhos during the study period.

Chlorophyll a :

The seasonal variation in chlorophyll a content of the water is shown in Fig.(2C), the chlorophyll a content was used as a quantitative estimate of the unicellular algae available as food for Cladocera .During August 1985 - July 1986 the highest value for chlorophyll a content was 50 μg/l on March in Tigris River, whereas in the Diyala River was 41 μg/l on June. In Tigris River the chlorophyll a content was high in the February and March, but fell to a low level during the rest of the study period, mostly zero. In Diyala River the chlorophyll a content of the water showed distinct peaks during May and June with rapid fall at the end of July.

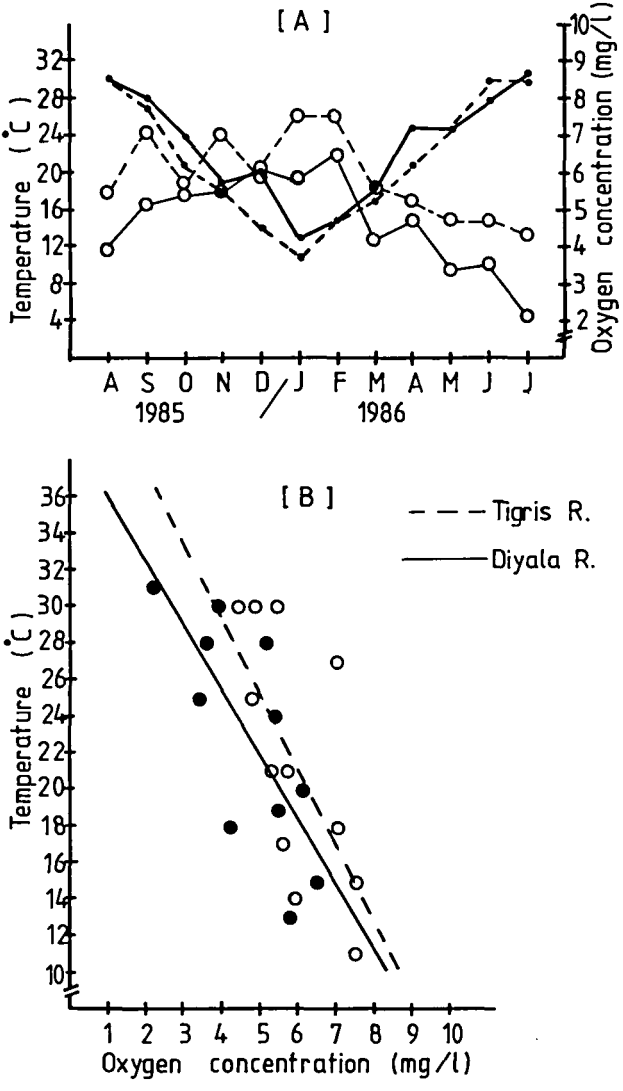


Fig. 1- A: Seasonal variation in water temperature (.———. Diyala River; .– – –. Tigris River) and dissolved oxygen concentration (o———o Diyala River; o– – –o Tigris River) during August 1985-July 1986 at Baghdad.

B: The relationship between dissolved oxygen concentration and water temperature. (o) Tigris River, (•) Diyala River.

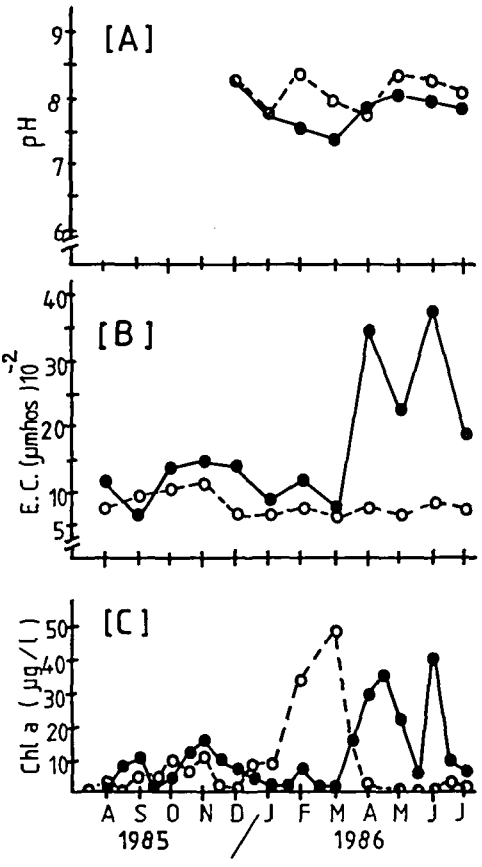
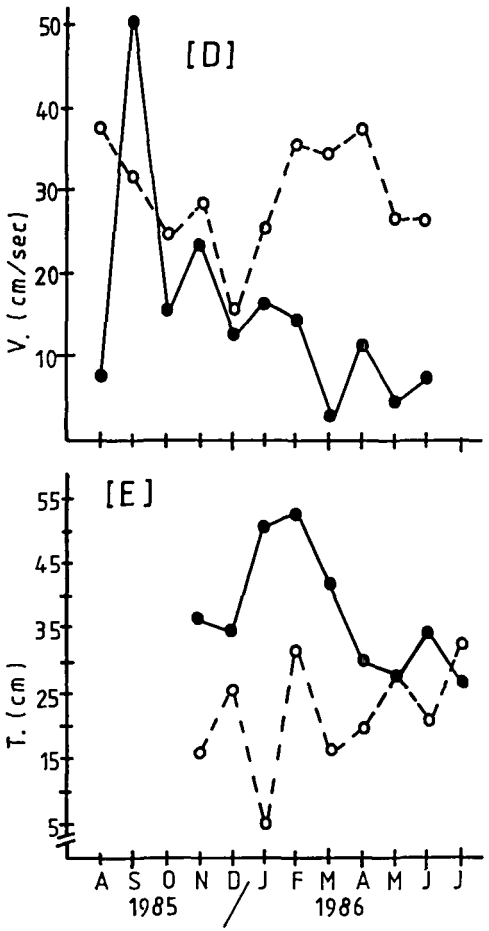


Fig. 2- Seasonal variation in the mean value of A:(pH) Hydrogen ion concentration, B:(E.C.)Electrical Conductivity, C:(Chl a)Chlorophyll a concentration, D:(V)Velocity of water flow,E:(T) Transparency , during August 1985-July 1986 in Tigris River (o— —o) and Diyala River (●——●) at Baghdad .



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Velocity :

Seasonal variation in the velocity of water in the Tigris and Diyala Rivers is shown in Fig.(2D).The highest value for velocity were 51cm/sec and 38cm/sec for Diyala and Tigris Rivers respectively. In general the velocity of water during the study period showed fluctuations varied between 3-51cm/sec and 16-38cm/sec with a mean of 16.7cm/sec and 29.9cm/sec in Diyala and Tigris Rivers respectively.

Transparency :

There was no clear seasonal pattern of transparency the values varied between 5cm and 33cm with a mean of 22.1cm for Tigris River, whereas the values for Diyala River varied between 27cm and 53cm with a mean of 37.6cm (Fig.2B).

Seasonal Pattern of Cladoceran Abundance :

Eight species comprise the cladoceran fauna of Diyala River Bosmina longirostris, Moina affinis, Ceriodaphnia cornuta, Simocephalus vetulus, Daphnia lumboltzi, Chydorus sphaericus, Macrothrix laticornis, Diaphanosoma brachyurum, whereas at Tigris River, five species comprise the cladoceran fauna B. longirostris, M. affinis, C. cornuta, S. vetulus and D. brachyurum .

Estimates of population density of total cladoceran during August 1985-July 1986 are summarized by the histogram (Fig.3). The maximum numbers of animals per cubic meter were $29/m^3$ on April in Tigris River and $292.5/m^3$ on March in Diyala River . The seasonal pattern of percentage composition of cladocerans species are shown in Fig.(4). Some species continued reproducing throughout the year while others do not reproduce during winter or during the early part of the year, and it was found in a few numbers.

Population Density in Relation to Water Velocity :

In both rivers water velocity was correlated with cladoceran density . This relationship showed considerable variability but did not show significant differences between two rivers (Fig.5A) $r= 0.368$ $p<0.1$ for Diyala River and $r= 0.476$ $p<0.1$ for Tigris River.

Population Density in Relation to Temperature :

The number of individuals per cubic meter was inversely correlated with temperature. In Fig.(5B) the data of one year are grouped together and the mean number of animals for each river is calculated. There is an inverse relationship between number of individuals and surface water temperature ($r= -0.904$ $p>0.001$ and $r= -0.682$ $p<0.02$ for Diyala and Tigris Rivers respectively).

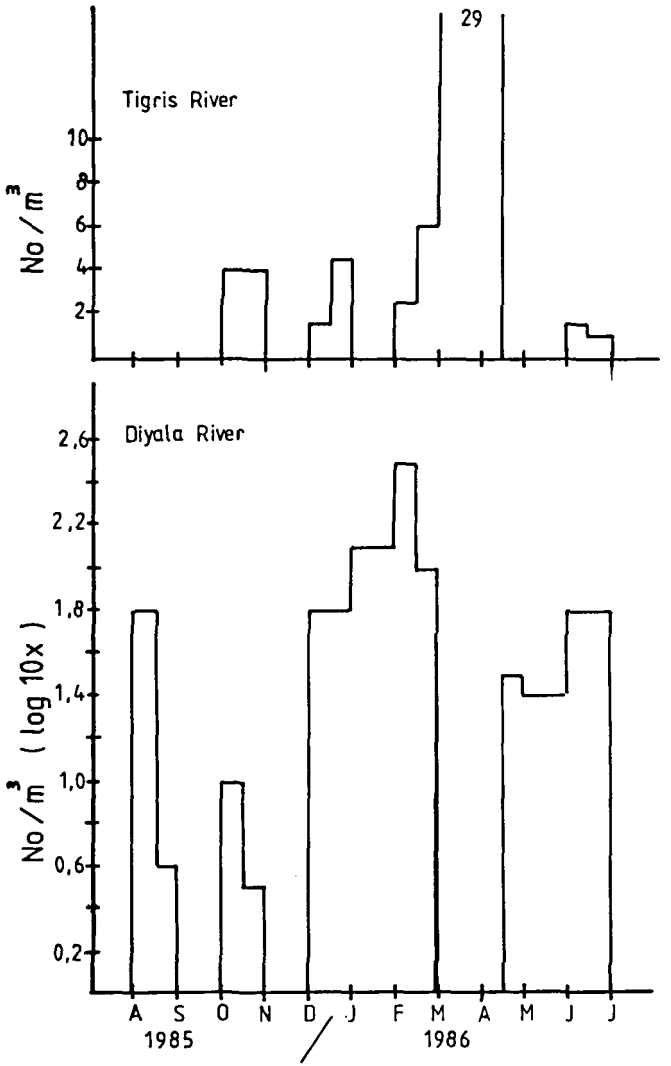

Fig. 3- Seasonal variation in the mean number of cladocerans per cubic meter during August 1985-July 1986 in Tigris and Diyala Rivers at Baghdad .

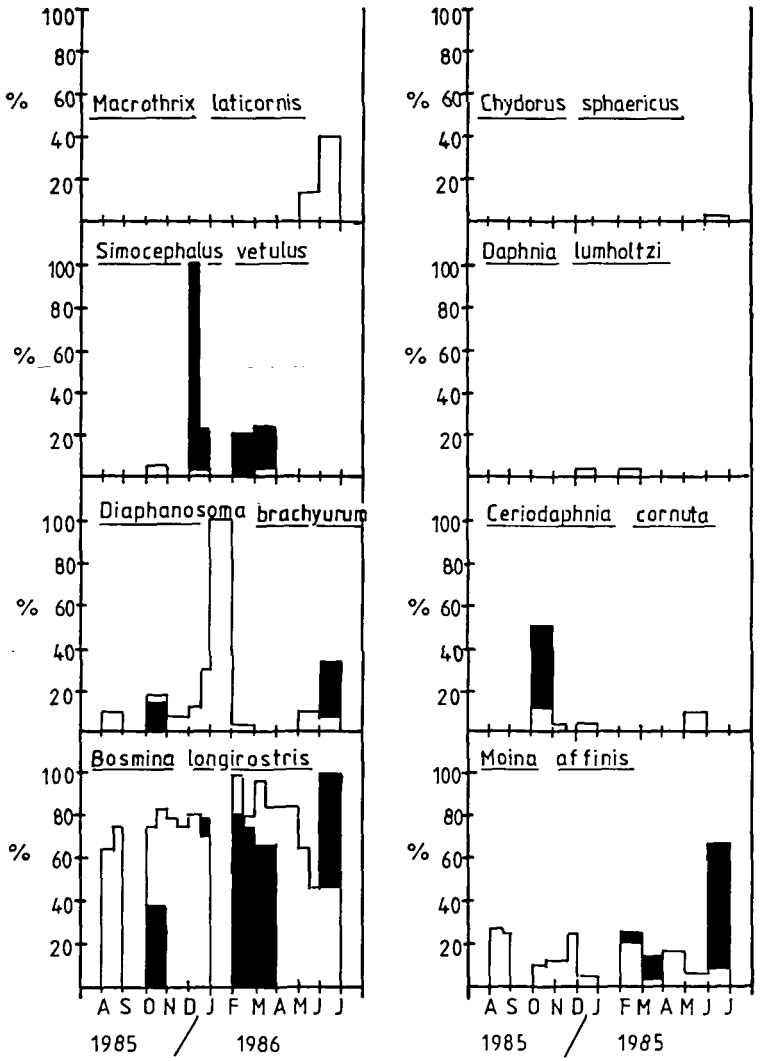

Fig.4- Percentage composition of cladocerans collected from August 1985 to July 1986 from Tigris ■ and Diyala □ Rivers at Baghdad.

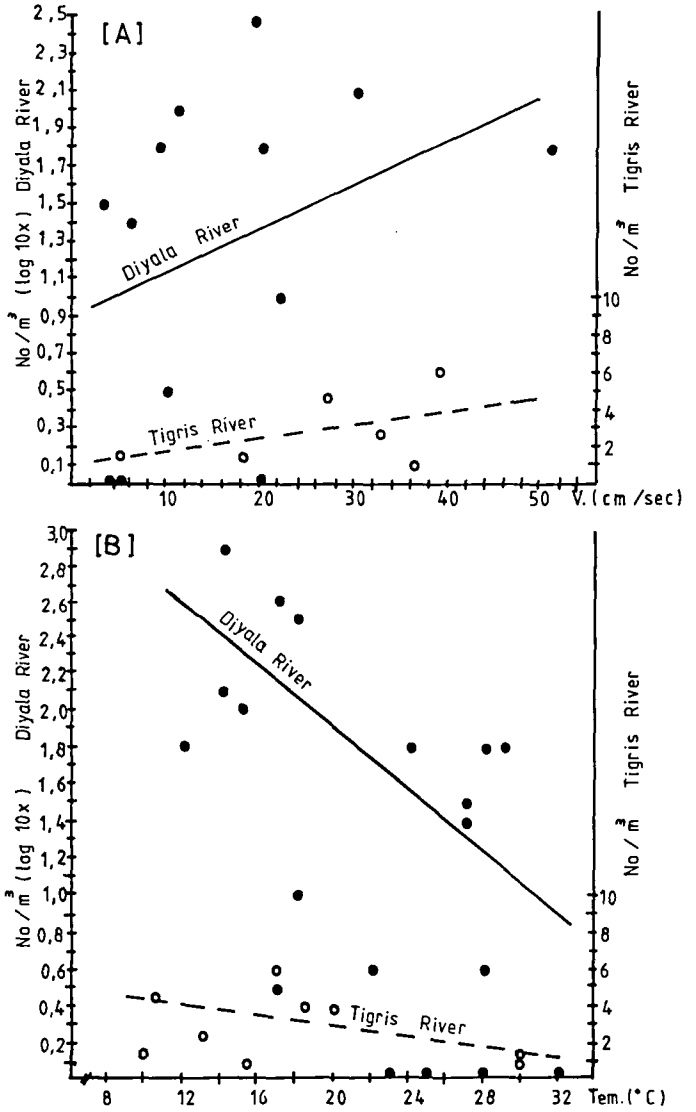

Fig.5- A: The relationship between population density of cladoceran and velocity of flow water during August 1985-July 1986 in Diyala (•) and Tigris (o) Rivers at Baghdad.

B: The relationship between population density of cladocerans and water temperature during August 1985-July 1986 in Tigris (o) and Diyala (•) Rivers at Baghdad.

Population Density in Relation to Food :

The factor which affects the population density is the food as chlorophyll a. The number of cladocerans per cubic meter in Diyala River appears to have a negative correlation with chlorophyll a ($r= -0.833$ $p>0.001$) whereas the relationship in Tigris River is weaker, and probably not significant ($r= -0.344$ $p<0.1$) as shown in Fig.(6A).

Population Density in Relation to Dissolved Oxygen :

In Fig.(6B) the number of individuals per cubic meter during the study period has been plotted against dissolved oxygen, the data of one year are grouped together and the mean number of animals for each river is calculated. The mean number of individuals and dissolved oxygen concentration generally fluctuated together; whenever there was an increase in number of animals there was an increase in oxygen concentration, and the regression analysis shows that $r= 0.609$ $p>0.05$ for Diyala River and $r= 0.617$ $p<0.05$ for Tigris River.

Population Density in Relation to Transparency :

This optical property reflect the abundance, or suspended particulate material. Turbidity by reducing light penetration, may affect the population density . There was no clear pattern of transparency with population density but the regression analysis shows the positive correlation with population as shown in Fig.(7). ($r= 0.728$ $p<0.02$; $r= 0.858$ $p>0.005$ in Diyala and Tigris Rivers respectively.

DISCUSSION

If we consider the results as a whole we see that none of the rivers agree exactly with any other, although the samples were collected and examined on the same days, since we have seen that cladocerans show differences in season and in range of occurrence : Tigris River $1-29/m^3$, Diyala River $3-292.5/m^3$. It is of interest to see if these differences are in any way correlated with the effect of

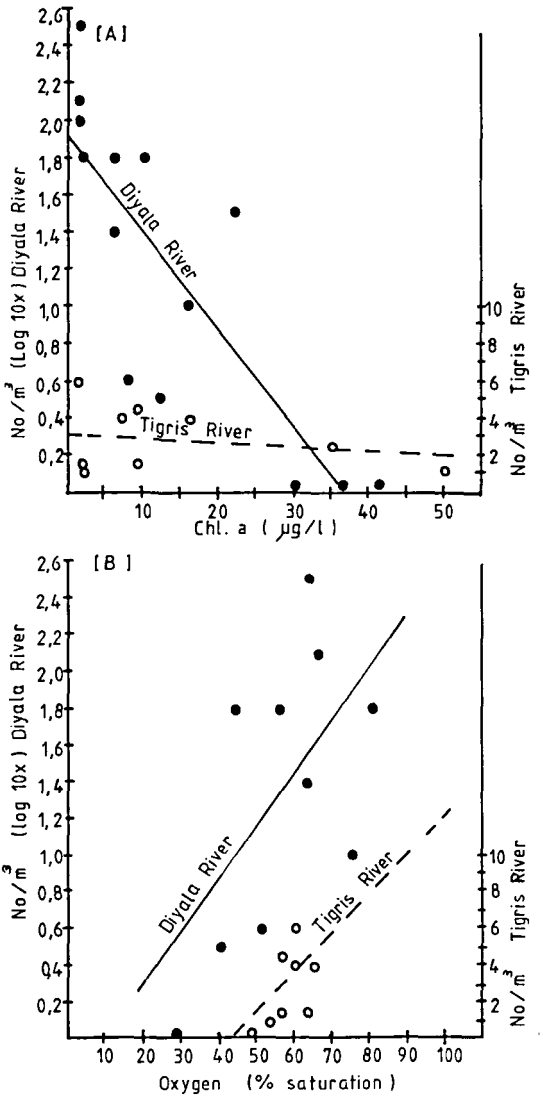

Fig. 6- A: The relationship between population density of cladocerans and chlorophyll a during August 1985-July 1986 in Diyala (•) and Tigris (o) Rivers at Baghdad.

B: The relationship between population density of cladocerans and dissolved oxygen during August 1985-July 1986 in Diyala (•) and Tigris (o) Rivers at Baghdad.

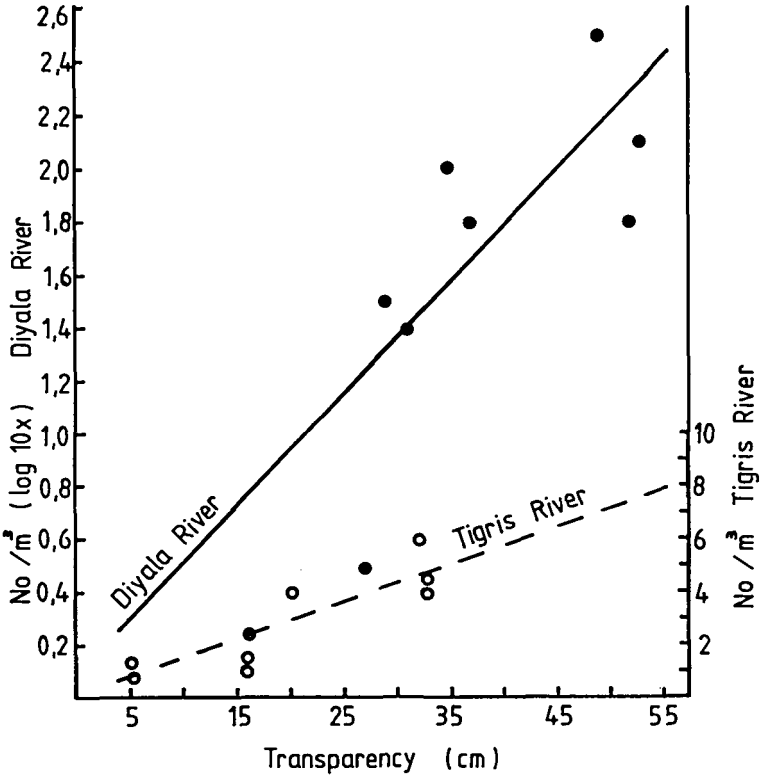

Fig. 7- The relationship between population density of cladocerans and transparency of water in Diyala (•) and Tigris (o) Rivers at Baghdad during August 1985-July 1986 .

environmental factors. In both rivers water temperature was negatively correlated with cladoceran density for the period of the study (Fig.5B), while (3,4,15) found positive correlations between water temperature and population density. Explanation for this results probably dependent on the variation of water and air temperature at the time of collection, it is well known water temperature varied seasonally in accordance with changes in air temperature .

The slight variations of air , and average water temperatures found in each season are most probably due to the differences in the time of measurements (16) and for other reason increasing temperatures in some way might effect juveniles either in hatching or in the development, so it decreased the population density.

The second factor which affects the population density is food as chlorophyll a . The number of cladoceran per cubic meter in Diyala River appears to have a negative correlation with chlorophyll a (Fig.6A), while in Tigris River the relationship is weaker and probably not significant. Perhaps the populations never reached large numbers relative to the food present, so that food never become a critical determinant of the populations. Another possibility of this result is that food quality might have been the cause of the variation in the relationship and there is also possibility that cladocerans may utilise some non algal food, such as Bacteria and this would weaken the relationship with chlorophyll a .

There is another factor affects the population density is the concentration of dissolved oxygen in the water at the time of collection, there is a positive relationship between population density and percentage saturation of dissolved oxygen (Fig.6B), this result probably related to the time of sampling, the noticeable local variations in the average sissolved values in each season were probably influenced somewhat by the time of sampling. The average values of dissolved oxygen showed generally noticeable seasonal changes at each river. The minimum seasonal concentration of dissolved oxygen found in July coincided with the relatively low unicellular algae (17) which is interpreted as due to the increase of current and turbidity (18) resulting from the highest discharge. In February surface water tended to have higher oxygen concentrations collected in the Tigris and Diyala Rivers rather than the oxygen concentrations in July in both rivers, possibly reflecting diel photosynthetic activity. In Diyala River the relatively low average dissolved oxygen values comparing with the values at Tigris River,

this might be due to the more sluggish movement of water in Diyala River and also this variations in the dissolved oxygen values may be related to certain local and seasonal conditions, such as water temperature, photosynthetic activity and decomposition of organic matter (18).

Changing pattern of cladoceran dominance in both rivers have been attributed to the effect of size-selective predation by fish (19). Pridation by certain planktivores upon zooplankton can result in the elimination of the large-sized crustacean dominants and their replacement by small species especially Bosmina longirostris (4,20,21,22),this seems to be so in the Diyala River and Tigris River where small-sized cladocerans such as Bosmina and Diaphanosoma are abundant (Fig.4) and planktivorous fishes are not infrequent (4,9,23).

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