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Effect of algal concentration and initial density on the population growth of Diaphanosoma brachyrum Liévin (Crustacea, Cladocera)

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ABSTRACT

The effect of algal concentration and initial density on the population growth of the estuarine cladocera. Diaphanosoma brachyrumLiévin, were evaluated in an indoor experiment. A 2x4 layout that included two algal concentrations (Chlorella vulgaris 1x10^6 and 3x10^6 cell/mL) and four inoculation densities (100, 200, 300 and 400 ind./L) were established.Diaphanosoma brachyrum were reared in 150 mL flasks containing 50 mL of algal medium at 23 ±1 ^{o}C, under salinity of 10 and a photoperiod of 12 h L: 12 h D. The lag phase required to initiate continuous population growth following inoculation was shorter for D. brachyrum fed 1x10^6 cell/mL and inoculated at 300 or 400 ind./L than that for D. brachyrum fed 3x10^6 cell/mL and inoculated at 100 or 200 ind./L. However, D. brachyrum fed 3x10^6 cell/mL and inoculated at 100 or 200 ind./L exhibited longer periods of positive population growth. The maximum population densities were 5245 ± 370, 6700 ± 710, 7 390 ± 150 and 6 540 ± 70 ind./ L for D. brachyrum fed 1x10^6 cell/mL and inoculated at 100, 200, 300 and 400 ind./L, respectively, and 15100 ± 445, 12780 ± 249, 11850 ± 171 and 16980 ± 327 ind./L for D. br achyrum fed 3x10^6 cell/mL and inoculated at 100, 200, 300 and 400 ind./L, respectively. The average daily increasing rates of population were 0.122 ± 0.012, 0.1 05 ± 0.014, 0.09 ± 0.013 and 0.080 ± 0.01 for D. brachyrum fed1 x10^6 cell/mL and inoculated at densities of 100, 200, 300 or 400 ind./L, respectively, and 0.173 ± 0.015, 0.161 ± 0,013, 0,137 ± 0,014 and 0.116 ± 0.015 for D. bra chyrum 3x10^6 cell/mL and inoculated at densities of 100, 200, 300 and 400 ind./mL, respectively. The result of the present experiment indicate that the algal concentration and inoculation density significantly affect population growth of D. brachyrum. Furthermore, the results suggest that the optimal algal concentration and inoculation density fort he mass culture of D. brachyrum should be 3x10^6 cell/mL and 100 ind./L.

Keywords: *Diaphanosoma brachyrum*, population growth, algal concentration, inoculation density

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INTRODUCTION

Cladocera, which are a majör component of freshwater zooplankton are on excellent natural food source for aquatic animals such as finish and shellfish, andare widely used as live food in freshwater fish hatcheries. Cladocerans, by virtue of their small size and short generation times, respond rapidly to changes in algal food densities. One of the most important variables affected by changing food levels is the reproductive rate [1]. The population growth of cladocerans, in general, is better under food levels lower than those of rotifers [2].

The differences in the body size of cladocerans within a given genus are much lower than among genera [1]. Therefore, any generalization based on intense study of one genus may distort the actual picture obtained as compared to the study of several genera. For example, much of the work on the threshold food hypothesis has concentrated on the genus *Daphnia.* Although other genera *Moina*, *Ceriodaphnia*, and *Simocephalus* are equally, these have rarely been considered [3]. At best, the information available on these genera is fragmentary.Furthermore, the coice of different food types, levels and experimental designs restricts generalizations.

For example, the peak population densities reported for the same cladoceran species could vary by a magnitude of more than 10-fold depending on the food type and density, making body size-related inferences highly variable [4].

Algal conditions (species and concentration) and initial density are important factors in the mass culture of zooplankton [5]. The quality and quantity of algae are involved in regulation of the population growth of cladocera [4, 6], and initial density effects the interactions among coexisting zooplankton species [7].

The effects of food on the dynamics of cladoceran species have been a well – researched issue [6, 8-15].

The aim of work was, conducted to evaluate the population growth of *D. brachyrum* in response to different algal concentration and inoculation densities.

MATERIALS AND METHODS

D. brachyrum were isolted from the lake Hazar – Elazığ – Turkey, and maintained for at least 3 monts prior to experimentation. For routine maintanence as well as the experiments, used well water. Parthnogenetic reproductioned *D. brachyrum*, food with *Scenedesmus acuminatus. S. acuminatus*was cultured in 6 l botteles using Bold's basal medium. Algae in the log phase of growth was centrifuged and resuspended in well water. The density of this stock concentrate was determined using "neubauer" counting chamber.

A factorial layount including two algal concentrations ($1x10^6$ and $3x10^6$ cell/mL) and four inoculation densities (100, 200, 300 and 400 ind./L) was designed. At the begining of the experiment, a previously established cohort of *D. brachyrum* was shorted into 32 test tube of 150 mL capacity each contained 50 mL of algal medium. Each treatment had three replicates. The test tubes were placed in incubators. Experiments were conducted pH 7.0 – 7.5, photoperiod of 12 h L: 12 h D and23 $\pm^oC$ temperature. During the experiment, the number of living individual *D. brachyrum*, in each experimental tube was determined one every two days, after that the algal medium was renewed. The experiment was ceased when the population density of *D. brachyrum* no longer increased continuously in most of the test tubes.

The daly increasing rate of population (r) was calculated using the equation :$r = (\ln N_t - \ln N_o)/t$, where N_o (ind.) is number of *D. brachyrum* at the start of a time period and N_t (ind.) at the end, and t (days) is duration of the period. The average increasing rate of population (r_A) was calculated as : $r_A = \sum r_i/N$, where r_i is r during each time period, and N is the number of periods. Differences in T (the time during which the *D. brachyrum* reached the maximum population density) and D_M (the maximum population density) and$r_A$among the treatments, were analyzed using ANOVA fort he factorial layount, and multiple comparisons between treatments, were conducted using Duncan's test. The relationships between r_A and the inoculation density was examined by multiple regression. Differences were considered to be significant at $p< 0.05$.

RESULTS

The population density of *D. brachyrum* in each of the treatment groups increased slowly during days 1 to 5, after which it climbed rapidly (Fig.1). The maximum population densities were 5245 ± 370, 6700 ± 710, 7 390 ± 150 and 6 540 ± 70 ind./L for *D. brachyrum* fed $1x10^6$ cell/mLand inoculated at densities of 100, 200, 300 and 400 ind./L, respectively. The maximum population densities for *D. brachyrum* fed $3x10^6$ cell/mL and inoculated at densities of 100, 200, 300 and 400 ind./L, (Fig. 2) were 15100 ± 445, 12780 ± 249, 11850 ± 171 and 16980 ± 327 ind./L, respectively. The maximum population density occurred earlier when *D. brachyrum* were fed $1x10^6$ cell/mL than that when fed $3x10^6$ cell/mL ($p< 0.05$). When inoculated at the same density, *D. brachyrum* fed $3x10^6$ cell/mL had higher D_M than those fed$1x10^6$ cell/mL($p< 0.05$). No significant difference in D_M was observed among *D. brachyrum* fed the same concentration of algae but inoculated at different densities ($p> 0.05$).

The daily increasing rate of population was negative in all treatments during days 1 to 2, and ranged from –0.4 to 0.27 throughout the experiment (Fig.3). The duration for positive population growth was longer in the *D. brachyrum* fed $3x10^6$ cell/mLand inoculated at densities of 100 or 200 ind./L (20 days positive increase) compared with the *D. brachyrum* fed $1x10^6$ cell/mLand inoculated at densities of 300 or 400 ind./mL(19 days positive increase). During the experiment, the r_A values were 0.122 ± 0.012, 0.105 ± 0.014, 0.09 ± 0.013 and 0.080 ± 0.01 for *D. brachyrum* fed$1x10^6$ cell/mL and inoculated at densities of 100, 200, 300 or 400 ind./L, respectively (Fig. 4). The r_A values were 0.173 ± 0.015, 0.161 ± 0,013, 0,137 ± 0,014 and 0.116 ± 0.015 for*D. Brachyrum*$3x10^6$ cell/mL and inoculated at densities of 100, 200, 300 and 400 ind./mL, respectively (Fig. 4). The average daily increasing rate of population was higher in the *D. brachyrum* fed $3x10^6$ cell/mL than *D. brachyrum* fed $1x10^6$ cell/mL ($p< 0.05$), and these rates decreased linearly as the inoculation density increased with regardless of algal concentrations ($p< 0.05$).

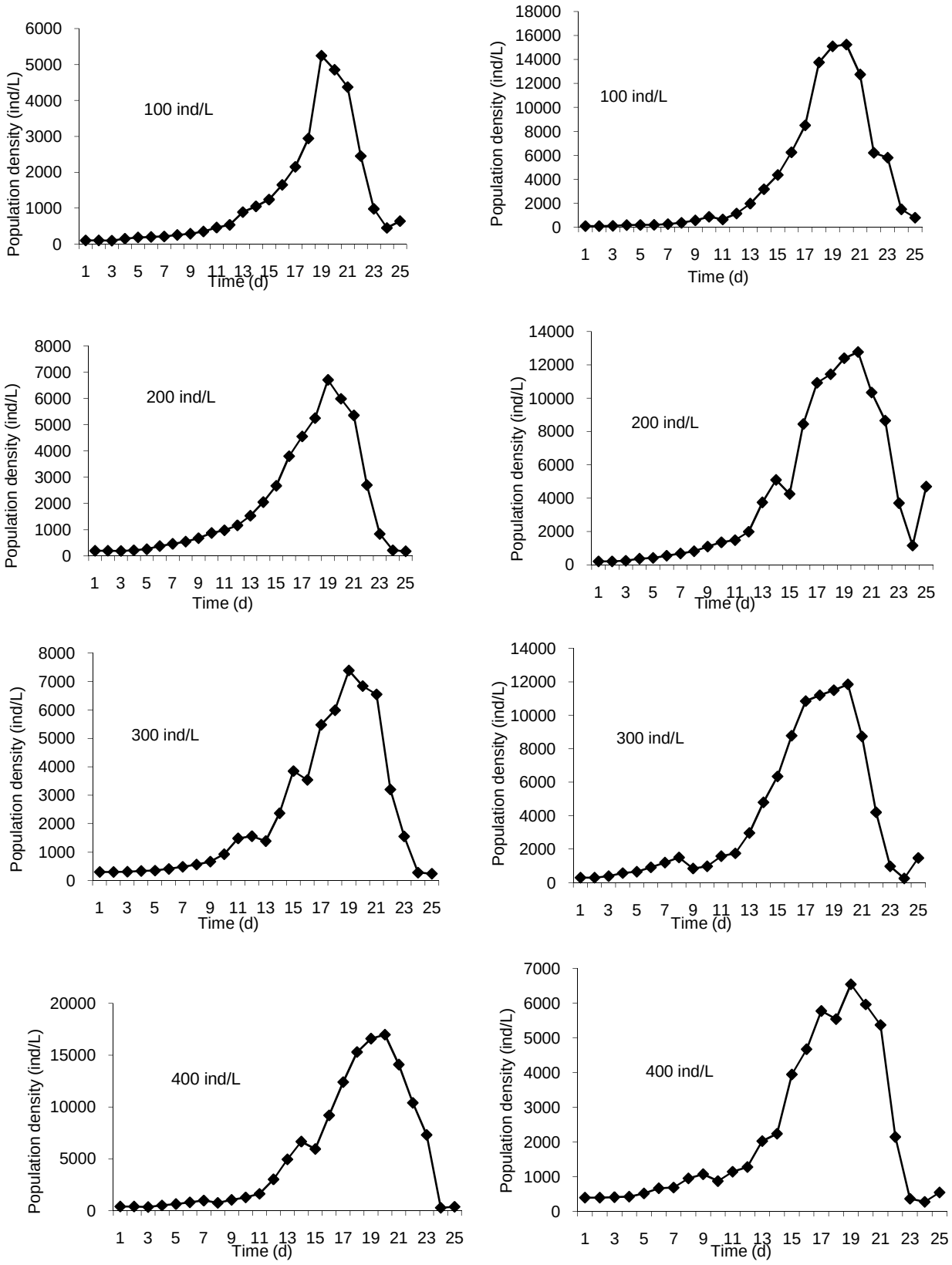


Fig.1. Population density of *Diaphanosoma brachyrum* fed at two algal concentrations and inoculated a four densities

Date are expressed as the means ±SE (n=4). The left panel algal concentration 1x10^6 cell/mL; the right panel: algal concentration 3x10^6 cell/mL

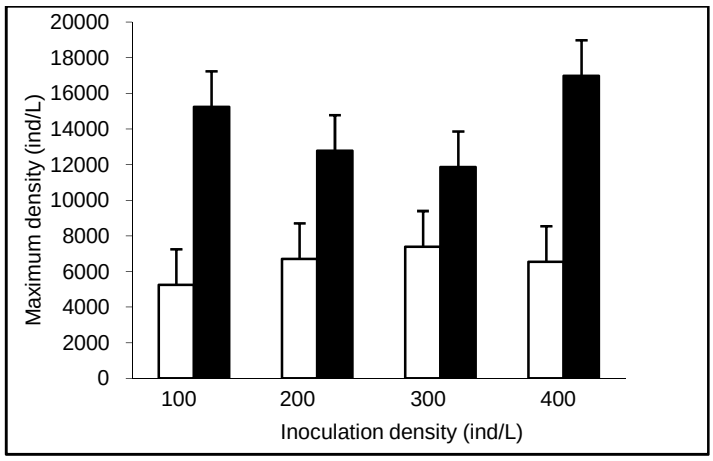
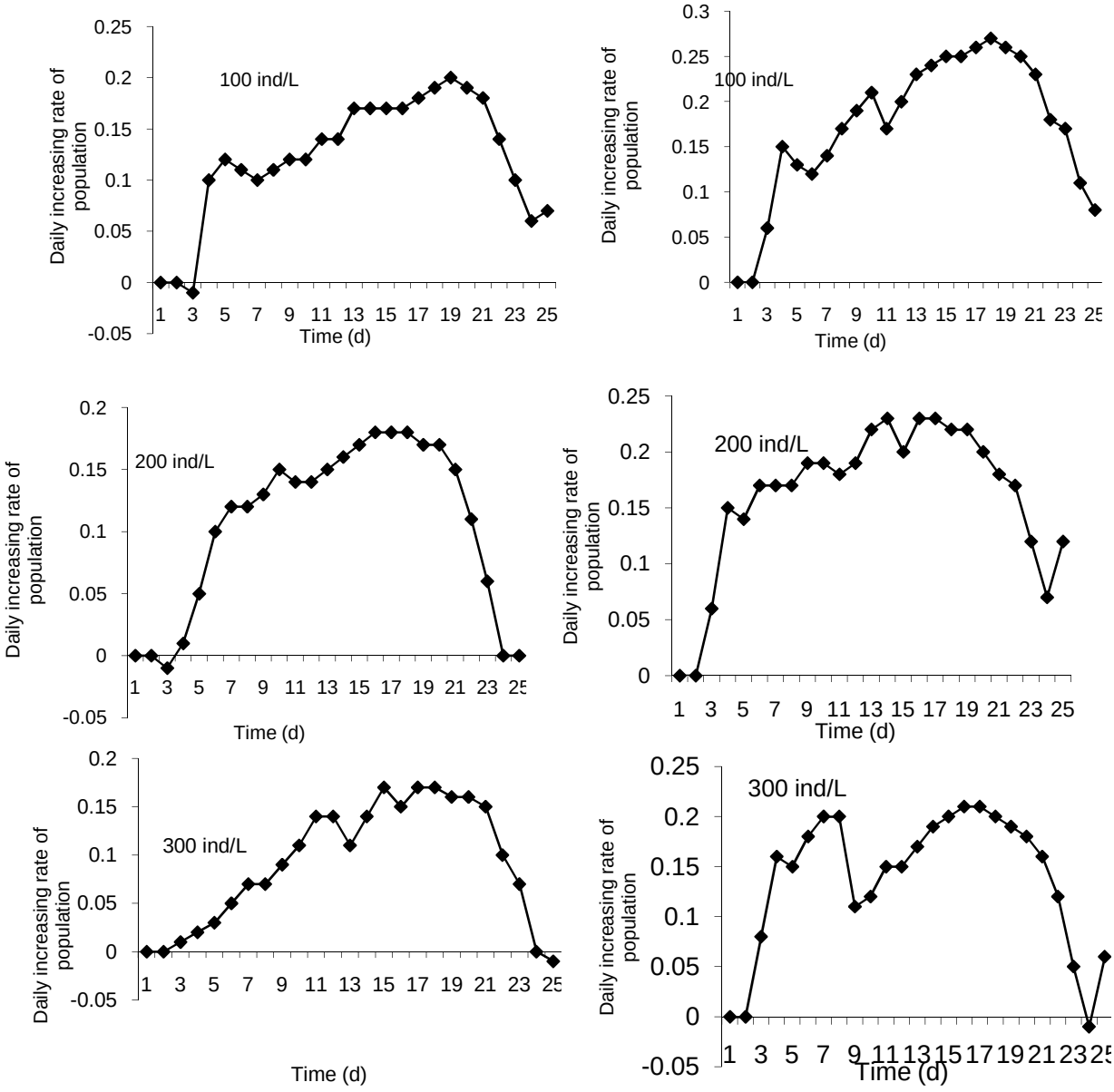


Fig. 2. The maximum population density of *Diaphanosoma brachyrum* fed at two algal concentrations and inoculated at four densities
Data are expressed as the means ±SE (n=4) : □ algal concentration 1x10^6 cell/mL; ■: algal concentration 3x10^6 cell/mL



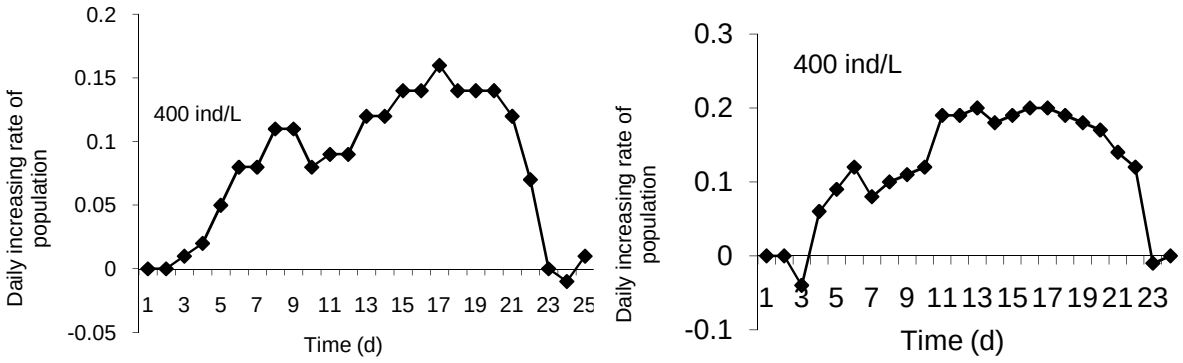


Fig.3. Daily increasing rate of population of *Diaphanosoma brachyrum* fed two algal concentrations and inoculated at four densities.
Date are expressed as the means ±SE (n=4). The left panel algal concentration 1x10^6 cell/mL; the right panel: algal concentration 3x10^6 cell/m

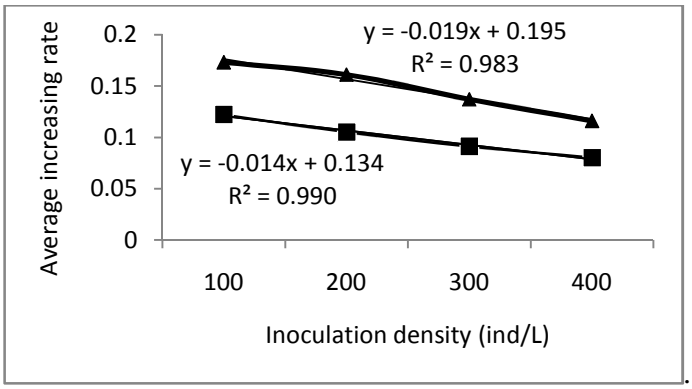


Fig.4. Average increasing rate of population of *Diaphanosoma brachyrum* fed at two algal concentrations and inoculated at four densities.
Data are expressed as the means ±SE (n=4) : ■ algal concentration 1x10^6 cell/ml; ▲: algal concentration 3x10^6 cell/ml

DISCUSSION AND CONCLUSION

Micro-algal density is major factor affecting the rate of cladocerans development in cultures [6, 12, 13]. However, the population growth could vary depend on the cladoceran body size and species [14]. The effect of varing food concentrations cladocerans may be quantified using population growth studies and life – table demography aspects. Furthermore, population on growth studies provide information on the effect of food level on individuals of various generations simultaneously occurning in growing culture[14, 16]. The increasing population density of cladoceran with increasing food concentration, up to a level, is common in laboratory conditions [14].

Shrivastava et al. [17] reported that species and concentration had a significant effect on the survival time and fecundity of individually cultured *D. celebensis.* In addition, [14] reported that the population growthof seven species of cladoceran (*Alona rectangula, Ceriodaphnia dubia, Daphnia laevis, Diaphanosoma brachyurum, Moina macrocopa, Scapholeberis kingi* and *Simocephalus vetulus*) decreased in response to a reduction in the concentration of *Chlorella vulgaris*. However, an excessive algal concentration was reported to have a negative effect on the population growth of *Moina micrura*[6]. Feeding *Moina macrocopa* and *Ceriodaphnia dubia* high concentrations of undesired algae has been found to induce declining population density or population crash [4]. In the present study, food concentration has a significant effect on population density and population growth rate. A further increase in food level did not result in a higher peak population density. In the study determining population growth of some genera of cladocerans in relation to algal food (*Chlorella vulgaris*) levels, Nandini and Sarma [14] have recorded the peak population density value 17.1±0.4 for *C. dubia* at food concentration from 0.05 to 1.6x10^6 cells mL^{-1}. Cladocerans have r values in range of 0.01 – 1.5 depend on the species, food type, temperature levels [14]. Using the life table demography approach, Nandini and Sarma (2000) have recorded r values ranging from 0.17 – 0.23, for *Ceriodaphnia cornuta* at food concentration from 0.5 to 45x10^6 cells mL^{-1}. The peak r value in the present study was show similarity to theirs value.This study, D_M and r_A were higher in the *D. brachyrum* fed 3x10^6 cell/mL than *D. brachyrum*fed 1x10^6 cell/mL, suggesting that low algal concentration limited population growth. Although the *D. brachyrum* fed 3x10^6 cell/mL exhibited a longer period of positive population growth and higher D_M than of the *D. brachyrum* inoculated at the same density but fed 1x10^6 cell/mL than the *D. brachyrum*fed 3x10^6 cell/mL. These facts could be attributed to a mechanism that the minimum algal concentration for population growth of *D.*

*brachyrum*increased with the increase of population density of the cladocera. Similarly, the minimum concentration of food required for population growth of *M. mongolica* invreased as the population density increased [18].

High population densities have been found to induce negative effects on the *Daphnia* population via release of chemical metabolites [20], while low inoculation densities have been found to lead failure of initiation of *M. mongolica* mass culture [18]. In the present study, *D. brachyrum*inoculated at 300 or 400 ind./L exhibited earlier exponential growth than those fed the same algal concentration but inoculated at 100 or 200 ind./L, although stable population growth was achieved in *D. brachyrum*inoculated at densities of 100 to 400 ind./L.

These facts were likely due to the negative effect of inoculation damage on survival and population growth was relatively low in the *D. brachyrum*inoculated at high densities. In the present experiment, the average Daily increasing rate of population of *D. brachyrum*fed either $1x10^6$ cell/m L or $3x10^6$ cell/mL decreased as the inoculation density increased. This trend is similar to that observed in *M. mongolica* [18]. Result of the present study demonstrate that the relationship between population growth and the inoculation density of *D. brachyrum* is independent on the algal concentration.

REFERENCES

[1] SI Dodson; DG Frey, Cladocera and other branchiopoda. In Thorp, J.H. & A. Covich (eds). Ecology and Classification of North American Freshwater Invertebrates. Academic Press, San Diego, U.S.A. **1991**; pp. 732-776.
[2] SSS Sarma; N Iyer; HJ Dumont, **1996**,*Hydrobiologia*,331, 1.
[3] W Lampert; U Sommer, Limnoecology. The Ecology of Lakes and Streams. Oxford University Press, New York, **1997**.
[4] AF Alva-Martınez; SSS Sarma; S Nandini, **2001**,*Crustaceana*,74, 749.
[5] J Vijverberg;**1989**,*Freshwater Biology*,21, 317.
[6] S Ovie;ABM Egborge,**2002**,*Hydrobiologia*,447, 41.
[7] MD Hurtado-Bocanegra; S Nandini; SSS Sarma, **2002**,*Hydrobiologia*,468, 13.
[8] BB Jana; GP Pal,**1983**,*Water res.*17 **(**7), 735.
[9] MZ Gliwicz;C Guisande, **1992**,*Ecologia*,91, 463.
[10] M Boersma; J Vijverberg,**1996**, *Freshwater Biology*,35, 25.
[11] S Nandini; TR Rao,**1998**. *Aquat. Ecol*.,31, 283.
[12] RM Rose; MSJ Warne;RL Lim,**2000**,*Hydrobiologia*,427, 59.
[13] A Benıder; A Tifnouti;R Pouriot,**2002**,*Hydrobiologia*,468, 1.
[14] S Nandini; SSS Sarma, **2003**,*Hydrobiologia*,491, 211.
[15] AF Alva-Martınez; SSS Sarma; S Nandini, **2004**,*Crustaceana*,77, 973.
[16] MDH Bocanegra; S Nandini;SSS Sarma,**2002**,*Hydrobiologia*,468**,** 13.
[17]Y Shrivastava; GG Mahambre; CT Achuthankutty; B Fernandes; SC Goswami; M Madhupratap; **1999**,*Marine Biology*,135,663.
[18] L Li;Y Wang;B Lou,**2005**. *Journal of Fishery Science in China*.,12, 253.
[19] CW Burns,**2000**,*Freshwater Biology*,43, 19.