A comparative study on the ability of tropical micro-crustaceans to feed and grow on cyanobacterial diets

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Controlling noxious phytoplankton blooms by biomanipulation largely depends on the presence of large-sized (>3000 µm) generalist grazers, not common in the tropics. Therefore, we compared the ability of small (≤2000 µm) microcrustaceans Ceriodaphnia dubia, Moina macrocoeca, Daphnia pulex, Simocephalus vetulus and Heterocypris incongruens to feed and grow on cyanobacterial diets. We studied their feeding preferences on phytoplankton from natural lake water with a dominance of Microcystis sp., Fragilaria sp. or Planktothrix sp. to which we added Scenedesmus acutus. Also tested were the ability of D. pulex, S. vetulus and H. incongruens to reduce cyanobacterial densities by grazing, and the rate of grazing and demographic responses of S. vetulus and H. incongruens on diets of S. acutus, Microcystis sp. and Planktothrix sp. All species fed on small colonies of Microcystis sp., but not on filamentous Planktothrix sp. or colonial Fragilaria sp. Simocephalus vetulus and H. incongruens were generalists and most capable of reducing cyanobacterial densities. Demographic variables of S. vetulus, but not H. incongruens, were significantly lower on the cyanobacterial diet; for instance, the population growth rates were between 0.07–0.2 day⁻¹ on cyanobacterial diets, but 0.31 on S. acutus while for H. incongruens they ranged between 0.07 and 0.08 day⁻¹, regardless of whether the diet was a cyanobacteria or S. acutus. Our study warrants further tests on the ostracod H. incongruens in order to test its efficacy in reducing cyanobacterial densities in shallow tropical ponds.

KEYWORDS: cyanobacteria; cladocera; ostracoda; feeding preference; grazing rates; demography

INTRODUCTION

Eutrophication often leads to noxious, and at times toxic, cyanobacterial blooms. In tropical ecosystems, these blooms occur throughout the year, possibly due to their preference for high temperatures (>25°C) (Paerl and Huismann, 2008; Paerl and Paul, 2010). Several physical and biological methods have been tested in order to control such blooms many of which focus on biomanipulation (Gulati, 1990; Cooke et al., 2005).

In several temperate water bodies, biomanipulation has been successful particularly when combining the use of large generalist filter feeders such as Daphnia magna and controlling the input of nutrients (particularly N and P) into the water body. In tropical waters, however, there is a predominance of small zooplankton (<1000 µm body length) such as rotifers and cladocerans, one of the reasons being the constant pressure from fish predation (Zaret, 1980; Gliwicz, 2003). The most...
common tropical cladocerans are Ceriodaphnia, Moina, Simocephalus, Diaphanosoma and several cladorids. Daphnia species are rarely found and if at all present, they are small sized (<1500 μm). Although these taxa may be able to reproduce on a cyanobacterial diet (Nandini, 2000), it is improbable that they would be able to prevent cyanobacterial blooms since their densities are never above 10 ind. L$^{-1}$ (Ramirez-Garcia et al., 2002).

The long-term impact of nutritionally poor cyanobacteria is evident in the zooplankton community structure. Brett and Müller-Navarra (Brett and Müller-Navarra, 1997) have shown that in the presence of long-term cyanobacterial blooms, zooplankton densities and diversity decrease considerably. This is most probably due to the low fatty acid content in cyanobacteria which is not beneficial for the long-term survival of the population (Wacker et al., 2001). Thus, in addition to fish predation, the year-long presence of cyanobacteria in tropical waters further exacerbates the problem of a small sized zooplankton community (Leonard and Paerl, 2005). This makes it necessary to identify other aquatic filter feeders to control cyanobacteria.

Mexican water bodies are generally shallow (De la Lanza-Espinosa and García-Calderon, 2002), with mixing due to wind action and nutrient suspension almost throughout the year. High densities of cyanobacteria are often present in reservoirs and shallow lakes for a greater part of the year, particularly from April to September. Among the large invertebrates found in several such water bodies are cladocerans such as Simocephalus and various species of ostracods (McKee et al., 2003). Much less is known about the capacity of these organisms to control cyanobacteria. Nandini and Rao (Nandini and Rao, 1998) and Nandini (Nandini, 2000) have shown that Simocephalus vetalus, unlike many other taxa, has positive growth rates (0.13–0.32 day$^{-1}$) when fed on colonial or single celled Microcystis aeruginosa. Ostracods, like many cladocerans, are also generalist feeders; more than 60 years ago, Liperovskaya (Liperovskaya, 1948) reported that ostracods feed on decaying organic matter, plants and even other animals. A few studies indicate that species of ostracods such as Cyprinotus carolinensis and Eucypris virens do feed on the non-toxic cyanobacteria Tolypothrix tenias (Schmit et al., 2007). In hot springs, ostracods are also known to feed on cyanobacteria (Wickstrom and Castenholz, 1983). Nevertheless, studies on the feeding preferences of this group are few; it is also not known whether ostracods can feed as efficiently on toxic cyanobacteria as on green algae.

The grazing effectiveness of cladocerans depends on various factors, including algal growth rates, clearance rates of the cladocerans, their threshold food levels and the population growth rates (Gulati et al., 1990). The ability of cladocerans to withstand the possible toxic effects of cyanobacteria should also be taken into account. For instance, Daphnia and Simocephalus resist the toxic effects of cyanobacteria more than Moina macrocopa (Nandini, 2000; Nandini et al., 2000). Thus, short-term studies such as feeding rates or prey preferences and long-term demographic experiments are complementary in determining the ability of a species to reduce cyanobacterial densities as well as to survive on such a diet.

In this study, we compared the feeding preferences and demography of the ostracod Hetocypris incongruens Ramdohr with the cladocerans Ceriodaphnia dubia Richard, Moina macrocoopa Goulden, Daphnia pulex Leydig and Simocephalus vetulus (O.F. Müller) offered algal and cyanobacterial diets. We also studied the grazing rates of Hetocypris incongruens and Simocephalus vetulus on cyanobacterial diets and the ability of these taxa and Daphnia pulex to reduce cyanobacteria in microcosm experiments.

**METHOD**

**Culture of test species**

The cladocerans Ceriodaphnia dubia (body length 747 ± 45 μm) and Simocephalus vetalus (1800 ± 100 μm) were isolated from Lake Zumpango. Daphnia pulex (2250 ± 90 μm) and Moina macrocopa (980 ± 30 μm) were isolated from Valsequillo, Puebla and the ostracod Hetocypris incongruens (1500 ± 50 μm) from a shallow water body in Guanajuato. All species were cultured in moderately hard water (EPA medium prepared by dissolving 96 mg NaHCO$_3$, 60 mg CaSO$_4$, 60 mg MgSO$_4$ and 4 mg KCl in 1 L of distilled water (Anonymous, 1985)) and fed the green alga Scenedesmus acutus at 23 ± 2°C. This alga was obtained from the University of Texas, cultured in Bold medium (Borowitzka and Borowitzka, 1988) and exposed to continuous photoperiod and aeration to prevent sedimentation. NaHCO$_3$ (0.25 g L$^{-1}$) and Na$_2$CO$_3$ (50 mg L$^{-1}$) were added every third day as a source of carbon. The algae were harvested after 8–10 days, allowed to sediment in a refrigerator for 24 h, decanted and enumerated using a Neubaur haemocytometer. The strains of Microcystis sp. and Planktothrix sp. were isolated from local water bodies. All were cultured using the BG-11 medium (Sigma chemicals), in transparent 250 mL flasks and exposed to a constant photoperiod from fluorescent tubes in a BOD incubator (Thermolyne) set at 22 ± 1°C.

**Toxicity testing**

Following the experiments proposed by Lampert (Lampert, 1987) to detect toxicity in cyanobacteria, we
compared the survival of the cladocerans *Ceriodaphnia dubia*, *Moina macrocopa*, *Simocephalus vetulus* and as well as the ostracod *Heterocypris incongruens* in moderately hard water without food and with *Microcystis* sp. (at 0.5 \times 10^6 cells mL^{-1}). Experiments were conducted in 100 mL vessels with 50 mL of test medium containing five neonates of each species with and without cyanobacteria. For each treatment, we set up three replicates. The medium was changed daily and all living individuals were transferred to a fresh medium. Experiments were discontinued after 1 week or earlier when the test individuals died.

**Feeding preferences**

Phytoplankton preferences of the micro-crustaceans on a mixed algal-cyanobacterial diet were tested using water from the reservoir Valle de Bravo (State of Mexico) and the rowing canal Virgilio Uribe (Xochimilco, Mexico City). The former had a higher proportion of *Microcystis* sp. (1.2 \times 10^6 cells mL^{-1}) in the form of small colonies (<40 \mu m) and low density of *Fragilaria* (0.04 \times 10^6 cells mL^{-1}), while the latter had fairly equal proportions of *Microcystis* sp. and *Planktothrix* sp. (2.3 \times 10^6 cells mL^{-1}). *Fragilaria* was present in the form of colonies of 4–5 frustules, while *Planktothrix* sp. measured between 40 and 150 \mu m. We did not find any other taxa, than those previously mentioned, in the samples used to conduct the experiments. To both samples, we added 0.5 \times 10^6 cells mL^{-1} of the chlorophyte *S. acutus* as a reference diet.

We starved the test species for 30 min prior to introducing them into 20 mL capacity glass tubes containing 10 mL of the reservoir or canal water to which was added *S. acutus* at the aforementioned density. After 30 min, we removed the micro-crustaceans and fixed the samples with Lugol’s solution. We used a Neubauer haemocytometer or a Sedgewick–Rafter cell to enumerate the algae and cyanobacteria.

To detect preference, the following index was used (Krebs, 1993):

\[
\alpha_i = \frac{n_i}{m} \left( \frac{1}{\sum (r_j/n_j)} \right)
\]

where \(\alpha_i\) is the Manly’s alpha for prey type \(i\); \(n_i, n_j\), proportion of prey type \(i\) or \(j\) in the diet \((i = 1, 2, 3\) and \(4, m)\); \(m, n_i, n_j\), proportion of prey type \(i\) or \(j\) in the environment; \(m\), number of prey species tested. When \(\alpha_i = 1/m (=0.25)\) feeding is not selective; \(\alpha_i > 1/m (=0.25)\), then prey species \(i\) is preferred in the diet and, \(\alpha_i < 1/m (=0.25)\), prey species \(i\) is avoided in the diet.
Fig. 2. Feeding preferences of the microcrustaceans *Ceriodaphnia dubia, Moina macrocopa, Daphnia pulex, Simocephalus vetulus* and *Heterocypris incongruens* in water from the rowing canal, Lake Virgilio Uribe and the reservoir Valle de Bravo. Shown are Mean ± SE of Manly's $\alpha$ based on four replicate observations.
Ingestion rates

Based on the results of an experiment in which *Simocephalus vetulus* and *Heterocypris incongruens* consumed cyanobacteria better than the other cladoceran taxa, we studied their grazing rate on *S. acutus*, *Microcystis* sp. and *Planktothrix* sp. The cyanobacteria were sonicated at 20 kHz for 5 min to get them in unicellular form or in fragment lengths of <20 μm. For each diet, the feeding rates were derived at five concentrations (0.0325 × 10^6, 0.065 × 10^6, 0.125 × 10^6, 0.25 × 10^6 and 0.5 × 10^6 cells mL⁻¹). All the tested crustaceans were starved for 30 min before use in feeding tests. Experiments, set up in quadruplicate, were conducted in 20 mL capacity test tubes with 10 mL EPA medium and the algae and/or cyanobacteria at the specified test concentration into which were introduced 10 individuals of each species. After 30 min, the micro-crustaceans were filtered out and the samples were fixed in Lugol’s solution. For each...
bioassay, we also set up the respective controls. The algal density was enumerated and results were analysed using ANOVA (Statistica 6.0). Grazing rates were measured using the formulae proposed by Downing and Rigler (Downing and Rigler, 1984):

\[ G = \frac{V \cdot (C_0 - C_t)}{tN} \]

where \( G \) is the filtration rate in mL ind\(^{-1}\) unit time\(^{-1}\); \( V \) is the volume of water in the container mL; \( C_0 \) is the cell count mL\(^{-1}\) in container of food at the beginning of experiment; \( C_t \) is the cell count mL\(^{-1}\) in container of food at the end of experiment; \( N \) is the number of individuals per container; \( t \) is the feeding time.

Microcosm experiments on the ability of micro-crustaceans to decrease cyanobacteria

We collected water from the rowing canal in Mexico City which had blooms of *Microcystis* sp. and *Planktothrix* sp. at the time of experiments. Based on previous studies, we only used *S. vetulus*, *D. pulex* and *H. incongruens* that had high filtering rates. Experiments were conducted in 1 L small aquaria with 500 mL of water from the canal to which we added *S. acutus* at a concentration of 0.5 \( \times 10^6 \) cells mL\(^{-1}\). The test taxa were introduced separately at two densities, 0.04 and 0.2 ind. L\(^{-1}\). Controls, without the micro-crustaceans, were also set up. For each treatment, we set four replicates [in all there were 32 test containers (4 species (including controls) \( \times \) 2 micro-crustacean densities \( \times \) 4 replicates)]. After 10 days, we enumerated the

![Fig. 4. Decrease in cyanobacterial densities, in terms of chlorophyll a concentration, by low (0.01 ind. L\(^{-1}\)) and high (0.2 ind. L\(^{-1}\)) densities of *Simocephalus vetulus*, *Daphnia pulex* and *Heterocypris incongruens*. Also shown is the increase in population density of the test zooplankton. Shown are mean \( \pm \) SE based on four replicate recordings.](https://academic.oup.com/plankt/article-abstract/34/8/719/1432720)
zooplankton numbers and analysed the chlorophyll a concentration using a trichromatic method (Clesceri et al., 1998) with an Elyptica 2000 spectrophotometer.

**Life table studies**

Life table demography experiments of *S. vetulus* and *H. incongruens* were conducted using *Scenedesmus acutus*, *Microcystis* sp. and *Planktothrix* sp. at 0.25 × 10⁶ cells mL⁻¹ of each. Experiments were conducted at 23 ± 1°C in 100 mL jars, each with 50 mL of the test medium and the desired concentration of each of the phytoplankton species. We set up four replicates for each of the treatments and thus in all there were 24 test jars (2 micro-crustaceans × 3 food types × 4 replicates). We introduced 10 neonates (<24 h old) of *S. vetulus* or five neonates of *H. incongruens* into each test jar. Every day, we counted the number of individuals in each cohort. The neonates and dead individuals of the original cohort when present were counted and eliminated. The surviving individuals of each cohort were transferred to fresh medium containing an appropriate concentration of the algae or cyanobacteria. Experiments were continued until the last adult of each cohort died. The survivorship and fecundity data were used to calculate variables such as average lifespan (ALS), gross and net reproductive rates, generation time (T) and the rate of population increase per day using the following equations (Krebs, 1985):

\[
\text{Gross reproductive rate} = \sum_{0}^{\infty} m_i
\]  

\[
\text{Net reproductive rate} R_o = \sum_{0}^{\infty} l_i \cdot m_i
\]  

\[
\text{Generation time} : T = \frac{\Sigma l_i \cdot m_i \cdot x}{R_o}
\]
Rate of population increase, Euler equation (solved iteratively)

\[ \sum_{k=0}^{n} e^{-r_t} \cdot l_x \cdot m_x = 1 \quad (4) \]

where \( l_x \) is the probability of an individual surviving to an age class, \( m_x \) is the age specific fecundity, \( R_0 \) is the average number of offspring per female and \( r \) is the growth rate of the population.

Data from life table experiments were assessed using analysis of variance (ANOVA) (Sokal and Rohlf, 1995). Post hoc (Holm–Sidak test) analysis was used for multiple comparisons utilizing the software Statistica version 6.

RESULTS

That the Microcystis strain used in this study was indeed toxic was evident since most of the test taxa died earlier on the cyanobacterial diet than under conditions of starvation. However, there were species-related differences in the susceptibility to the toxin: Simocephalus vetulus and Heterocypris incongruens were least susceptible (Fig. 1).

The diet preference studies indicate that among the cyanobacteria, Planktothrix sp. or the diatom Fragilariopsis sp. were definitely avoided by all the test micro-crustaceans (Fig. 2); on the other hand, Microcystis sp. in a unicellular form was selected against only by C. dubia and M. macrocopa. All the test species showed a distinct preference for S. acutus. We also observed that, in general, the larger (>1000 \( \mu \)m) taxa were less selective in their feeding than the smaller (<1000 \( \mu \)m) ones. Simocephalus vetulus and H. incongruens were among the least selective microcrustaceans (Fig. 2).

Since the above mentioned species had the highest consumption rates on cyanobacteria, we conducted further feeding preference and demographic experiments for these species. They both were non-selective in feeding and grazed equally well on the nutritionally poor Microcystis sp. as on S. acutus. Although S. vetulus did...
not consume *Planktothrix* sp., *H. incongruens* did, albeit showing no preference for it. Grazing experiments indicated that the rates varied depending on the species tested (Fig. 3). In general, *H. incongruens* had significantly higher grazing rates than *S. vetulus* regardless of the food quality. We also found that while *H. incongruens* reached its highest grazing rate at a food concentration of $0.2 \times 10^6$ cells mL$^{-1}$, *S. vetulus* had its maximal grazing at a lower concentration of $0.1 \times 10^6$ cells mL$^{-1}$ in the case of the cyanobacteria tested while for *S. acutus* its maximal rate was at a higher concentration ($0.2 \times 10^6$ cells mL$^{-1}$).

*Daphnia pulex*, *S. vetulus* and *H. incongruens* reduced the chlorophyll $a$ levels significantly compared with the controls (Fig. 4) in spite of the fact that *H. incongruens* showed no increase in population abundance during the test period; however, *S. vetulus* and *D. pulex* had high population growth rates ($0.3 - 0.45$ day$^{-1}$).

The survivorship curves (Fig. 5) indicated that *H. incongruens* was less affected by food type: it had a typical Type I survivorship pattern regardless of the diet. *Simocephalus vetulus* suffered a steep mortality on a diet of *Planktothrix* sp. but survivorship trends on *S. acutus* or *Microcystis* sp. were quite similar. The fecundity patterns (Fig. 6) were also similar.

Regardless of the food type, *S. vetulus* reproduced significantly earlier (4–10 day) than did *H. incongruens* (20–42 day) ($P < 0.01$, one-way ANOVA). Food type influenced the age at first reproduction (AFR) of the cladoceran but not the ostracod; *S. vetulus* reproduced

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**Fig. 7.** Demographic variables of *Simocephalus vetulus* on diets of *Scenedesmus acutus*, *Microcystis* sp. and *Planktothrix* sp. Shown are mean ± SE based on four replicate recordings. Bars bearing different alphabets (a, b, c, d) are significantly different (Holm–Sidak test, $P < 0.05$).
earlier on *S. acutus* than on the test cyanobacteria, while in the case of *H. incongruens* there was no effect of food quality on the AFR.

We did not observe statistically significant differences due to the diet type in any of the demographic variables except for life expectancy and average lifespan ($P < 0.05$, Holm–Sidak test) in the case of *H. incongruens* (Fig. 7). The population growth rate was significantly higher on a *Microcystis* sp. diet than on *S. acutus*. *Simocephalus vetulus* had a significantly longer lifespan and higher population growth rate on *S. acutus* than on either cyanobacterial diet. The adverse effect of *Planktothrix* sp. was more pronounced than that of *Microcystis* sp., while the gross reproductive rate and generation time on *Microcystis* sp. were not significantly different from *S. acutus*, the net reproductive rate was significantly lower ($P < 0.05$, Holm–Sidak test) on cyanobacterial diets (Fig. 8).

**DISCUSSION**

The generalist feeding behaviour of most cladocerans has been applied to biomanipulation for controlling cyanobacterial densities, especially in temperate water
bodies (Gulati, 1990). In the tropics, cyanobacterial blooms are more dense and persistent. In this region, cladoceran populations have a smaller size structure with dominant cladocerans such as Ceriodaphnia, Moina, Macrothrix and Chydorus which measure <1000 μm (Ramirez-Garcia et al., 2002; Nandini et al., 2005; Enríquez-Garcia et al., 2009). These taxa are generally capable of consuming all diets less than 30 μm and it appears that the little selection shown was related more to size than to the quality. Cladocerans, in general, exclude long filaments or large diatoms from their diet (Monakov, 2003). In the early stages of bloom formation, Microcystis sp. exists as single cells or in small colonies (Lampert, 1987) which do not pose mechanical problems for consumption by cladocerans. Mixed cyanobacterial–chlorophyte diets generally support the growth and reproduction of both rotifers and cladocerans better than cyanobacteria alone (Alva-Martínez et al., 2007, 2009). Thus, in spite of cyanobacterial blooms, zooplankton in nature can persist, by feeding on a mixture of bacteria, small chlorophytes as well as blooms, zooplankton in nature can persist, by feeding on a mixture of bacteria, small chlorophytes as well as cyanobacteria (Planktothrix spp.), but had similar survivorship and fecundity patterns on diets of Microcystis sp. with regard to the cyanobacterial diet. Nandini and Rao (1998) also found that the growth rates of S. vetulus was significantly higher (0.13–0.32 day^{-1}) on a diet of Microcystis sp., regardless of the temperature, as compared to a diet of Chlorella vulgaris (0.06–0.17 day^{-1}). Some species of Daphnia, however, are more sensitive to Microcystis sp. and do not grow well on an exclusively cyanobacterial diet (Nandini, 2000; Wilson et al., 2006; Alva-Martínez et al., 2007). These subtle differences in the effect of diets on the survival and growth of microcrustaceans suggest that mixed communities may be more effective than single microcrustacean taxa in controlling cyanobacterial blooms.

Controlling large colonies or filaments of cyanobacteria is generally achieved in the presence of high densities (>30–60 ind. L^{-1}) of large cladocerans. Daphnia magna (normally > 3.0 mm) has been extensively used in controlling cyanobacteria in temperate water bodies. However, this cladoceran is restricted to the temperate zones of Eurasia and North America (Benzie, 2005). In Mexico, 15 species of Daphnia are found and most measure <2.0 mm (Elias-Gutierrez et al., 2008). Certain large invertebrates such as the zebra mussel (Dreissena polymorpha) are also efficient grazers on cyanobacteria and can survive high tropical temperatures (McMahon and Ussery, 1995). There are, however, conflicting reports on the ability of this species to control cyanobacteria: Caraco et al. (Caraco et al., 1997) show that this species is capable of improving the water quality, while Sarnelle et al. (Sarnelle et al., 2005) have shown that it actually increases cyanobacterial densities.

Ostracods are quite common in most Mexican water bodies and therefore could be suitable for use in biomanipulation. They are generalist feeders with high grazing rates (Monakov, 2003) and reach densities as high as 15 ind. L^{-1}. Although cladoceran densities in nature can be up to an order of magnitude higher than ostracods (McKee et al., 2003), the latter can be more effective grazers than cladocerans. We observed this in our study also, where at a fourth of the densities of the cladocerans (S. vetulus and D. pulex), H. incongruens was as efficient in reducing chlorophyll a concentrations. We also found that H. incongruens had higher grazing rates at higher food concentrations when compared with S. vetulus and this is definitely an advantage under high food concentrations frequently found in eutrophic water bodies.

For a species to control cyanobacterial blooms, it should be capable of growing and reproducing on such a diet. It has been well documented that there are species-specific resistance to cyanotoxins (Nandini, 2000; Barros et al., 2001), also evident in our study where S. vetulus and H. incongruens were most resistant. Our demographic studies show that H. incongruens had no significant differences in the demographic variables regardless of the filamentous or unicellular nature of the cyanobacteria offered. Sinocephalus vetulus, on the other hand, neither survived nor reproduced well on the filamentous Planktothrix sp., but had similar survivorship and fecundity patterns on diets of Microcystis sp. compared with the green algal diet. Nandini and Rao (1998) also found that the growth rates of S. vetulus was significantly higher (0.13–0.32 day^{-1}) on a diet of Microcystis sp., regardless of the temperature, as compared to a diet of Chlorella vulgaris (0.06–0.17 day^{-1}). Some species of Daphnia, however, are more sensitive to Microcystis sp. and do not grow well on an exclusively cyanobacterial diet (Nandini, 2000; Wilson et al., 2006; Alva-Martínez et al., 2007). These subtle differences in the effect of diets on the survival and growth of microcrustaceans suggest that mixed communities may be more effective than single microcrustacean taxa in controlling cyanobacterial blooms.

Although H. incongruens has lower growth rates when compared with cladocerans (Juárez-Franco et al., 2009), it could be a viable option for biomanipulation efforts in the tropics. This species shows a higher growth rate and short generation time on diets of Selenastrum (Havel and Talbott, 1995) when compared with other chlorophytes but this alga is rarely found in high densities. Among the cyanobacterial and chlorophyte diets tested, we did not find any significant differences in the demographic variables regardless of the fact that cyanobacteria are well known to have lower concentration of lipids and other essential nutrients when compared with green algae (Gulati and DeMott, 1997). Another advantage that H. incongruens presents is its high fecundity and a variable egg hatching time (Havel and Talbott, 1995) which ensures sufficient individuals in a population over a longer time period of 2–4 months. It also has a wide distribution and is quite common in shallow Mexican water bodies, albeit in low densities (10 ind. L^{-1}) (McKee et al., 2003). Being benthic and detritivorous, it is possible that H. incongruens competes less with
cladocerans through interference or exploitative competition. Thus, the long lifespan, high filtering capabilities and low demographic response to diet regardless of the quality makes this ostracod an attractive option for biomanipulation trials in the tropics.

Zooplankton size structure tends to be small (<1000 μm) in eutrophic ecosystems which lowers the clearance rates on phytoplankton and makes algal control difficult (Vanni, 1987). Gulati (Gulati, 1990) suggests that more than a 1000 individuals of crustacean zooplankton are necessary to achieve a 25% daily clearance of seston in lake water under eutrophic conditions. Such high densities of cladocerans are almost never encountered in our tropical water bodies. It has also been well established that high and effective grazing rates are achieved by large cladocerans (Gliwicz, 1990) which, in turn, are subject to high predation pressure from fish throughout the year in the tropics (Zaret, 1980). It is possible that H. incongruens and S. vellutus, being predominantly non-planktonic, could escape fish predation to some extent. It remains to be tested whether introducing these cladocerans at densities of about 1–10 individuals per litre combined with measures such as control of nutrient inflow and planktivorous fish densities could help in controlling cyanobacterial blooms in tropical waterbodies.

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