A new model of enclosure for experiments in lentic water.

ARCIFA[1], M. S. & GUAGNONI[1], W.

[1] **Universidade de São Paulo, Departamento de Biologia, FFCLRP, Laboratório de Limnologia, Av. Bandeirantes, 3900, 14040-901 Ribeirão Preto - SP, Brazil.**

e-mail: marcifa@usp.br., guagnoni@keynet.com.br

ABSTRACT: A new model of enclosure for experiments in lentic water. **This enclosure is filled directly with lake water, without the need of any other equipment. Its mouth is made of two thick aluminum concentric frames, where the plastic bag (enclosure body) is screwed. Each floating unit is made of six 2 L-colorless plastic bottles (PET type) attached to 4 or 5 aluminum bars around the mouth. The enclosure can be used in different experimental designs, closed or open to the sediment. In both cases, the plastic bag is filled with lake water by lowering the whole structure into the water and then adding the floats. The way of filling is different for open or closed enclosures.**
Key-words: **opened or closed enclosure, floats of plastic bottles, direct filling in the lake.**

RESUMO: Um novo modelo de "enclosure" para experimentos em água lêntica. **Este "enclosure" é enchido diretamente com água do lago, sem necessidade de nenhum outro equipamento. Sua boca é feita de dois aros de alumínio grosso, onde o saco plástico (corpo do "enclosure") é parafusado. Cada unidade flutuadora é feita de seis garrafas plásticas de 2 L, sem cor, tipo PET, acoplada a 4 ou 5 barras de alumínio ao redor da boca. O "enclosure" pode ser usado em diferentes desenhos experimentais, fechado ou aberto para o sedimento. Em ambos os casos, o saco plástico é enchido com água do lago, descendo-se toda a estrutura na água e adicionando os flutuadores. A maneira de encher de água é diferente para "enclosures" fechados ou abertos para o sedimento.**
Palavras-chave: **"enclosure" aberto no fundo ou fechado, flutuadores de garrafas plásticas, enchimento direto no lago.**

Introduction

Enclosures are useful devices for testing hypotheses *in situ*, although presenting some problems such as algae sedimentation, water circulation alteration, among others. However, unless using a whole pond or a small lake as experimental units, for testing hypotheses in a lake it is necessary to enclose part of it in smaller units.

One of the difficulties for setting mesocosm replicates in a lake is how to fill them with water. Usually, water is pumped from the lake into the enclosure units (e. g. Arcifa et al., 1986) bringing problems, such as the time needed for this procedure, considering the enclosure sizes and the number of replicates. A pump with high flow would fill the bags quickly but can damage part of the aquatic organisms, depending on the pump type (M. S. Arcifa, unpublished), thus not being suitable for experiments. The floating devices can be difficult to handle when they are large structures, such as the ones made of wood and styrofoam (Arcifa et al., 1986).

Here a model is presented, which is suitable for experiments connected or not with the sediment. This enclosure model offers several advantages: 1. it can be filled directly with lake water in a relatively short time; 2. the mouth structure is light; 3. the floating device is light, inexpensive, easy to make, to handle, and to adjust to the enclosure.

Enclosure description

The mouth is made of two thick aluminum concentric round frames with several screws joining them (Fig. 1). The mouth diameter is calculated for being a little smaller

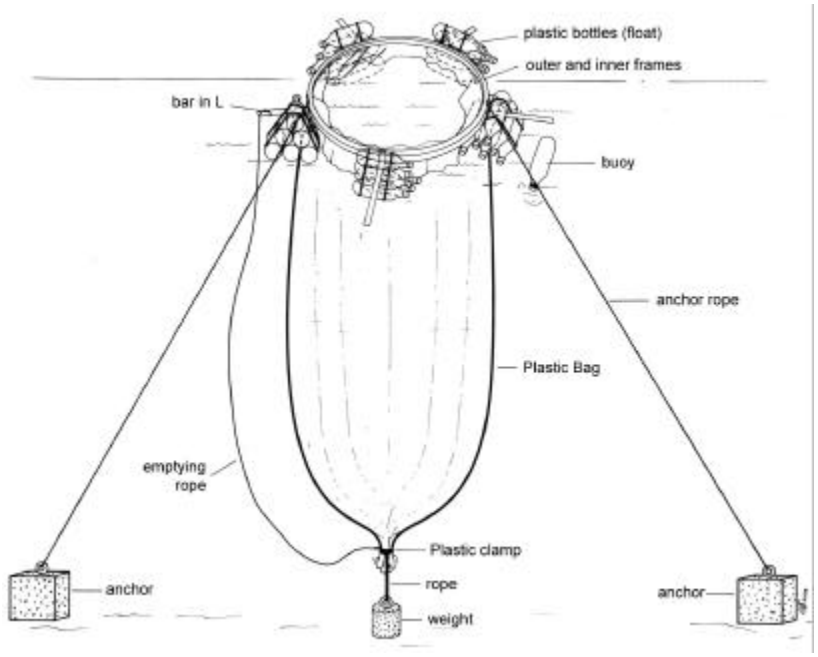

Figure 1: The components of the enclosure closed to the sediment.

than the plastic bag diameter. Five aluminum bars in L (it can be four), 35 cm in length, extend laterally, being screwed around the outer frame. To each of these bars a floating device is adapted, which is composed of groups of six 2 L-colorless plastic bottles (PET type) tied together by two plastic clamps. The plastic bag, which is the enclosure body, is attached to the mouth by the screws, between the outer and inner aluminum frames.

Procedure for setting the enclosure in the lake

There are several ways for setting the enclosure unit in the lake, depending on the research purpose:

Enclosure isolated from the sediment.

The way to set the enclosure is shown in the sequence of pictures (Fig. 2). Previously, the enclosure must be prepared, attaching the plastic bag to the aluminum mouth. Two people in the boat take the structure with the mouth upside down (Fig. 2A) and then lower the whole structure slowly into the water, keeping the end of the plastic bag open, allowing air to escape (Fig. 2B). Very close to the water surface, the end of the plastic bag is closed by a rope and a plastic clamp (Fig. 2C), so the remaining amount of air will be very small. To the closed end, a weight and the

emptying rope, longer than the bag length, seen in Figure 1, are bound; the upper end of this rope is previously tied to the boat and later, when the enclosure is already set, it is bound to one of the mouth bars. Then, the bag is filled by pulling the mouth ropes, which have been previously hooked to the tip of the mouth bars (Fig. 2D), and whose single upper end was kept bound to the boat during the enclosure setting. As soon as the enclosure mouth reaches the water surface, the floating units (six bottles each) are adjusted to the bars and bound to them with ropes, for preventing them to be blown away by the wind (Fig. 2E). The group of six bottles are adjusted to the bar, five beneath and one over it, in order to keep the mouth *ca.* 20 cm above the water surface (see Figs 1, 2E). It is recommendable to set the enclosure anchors in the lake the day before, leaving the ropes marked by buoys. In this way, when the whole procedure is finished, the enclosure is quickly tied to the two anchors (Fig. 1).

Figure 2: Sequence of pictures showing the procedure for setting the enclosure, closed to the sediment, in the lake.

The procedure shown in the sequence of pictures (Fig. 2 A-E) takes approximately 10 minutes. For emptying the enclosure, at the end of the experiment, it is easy and quick by removing the floating bottles out of the bars and pulling up the emptying rope.

Enclosure isolated from the sediment with a net in the mouth

For an experiment designed to exclude part of the community, the same enclosure structure can be used. A second pair of aluminum frames is added to the mouth, to which a net is attached between the outer and inner circles. This device is firmly inserted into the enclosure mouth and if small spaces still remain between the mouth and the net circles, they can be closed with non-toxic modeling clay (the type for children). On filling the enclosure, part of the community is excluded. Once an enclosure has been set, the same net frames can be taken from it and transferred successively to the mouth of other replicates to be set.

Enclosure open to the sediment.

The same mouth structure can be used in this kind of enclosure. Additional aluminum frames must be made for the bag lower opening, and a few thinner rings are distributed along the plastic bag, for maintaining its cylindrical shape. The thin rings are glued to the bag with non-toxic silicon glue. The lower frames can be similar to those of the enclosure mouth. The plastic bag is screwed in the outer an inner frames of the mouth, as well as of the lower opening.

The way to set the enclosure in the lake is different from the two previous descriptions. The whole cylinder is lowered into the lake, filling with water while it goes down. Once the lower circle is buried into the sediment, the floating devices are attached to the mouth bars and, then, the enclosure is tied to two anchors. The time spent in this procedure is less than 10 minutes.

Final Remarks

It takes a relatively long time for manufacturing and preparing the enclosure, but it is quickly set in the lake. The material used for building the enclosure structure is durable and light, not too difficult for carrying or handling. It can be used in various experimental designs, just needing some adjustments.

The first and second types of enclosures were used in Lake Monte Alegre for testing the influence of zooplankton and fish on the phytoplankton, through herbivory and nutrient excretion (L. H. S. Silva et al., in preparation). Two treatments, with three replicates each, were used: A - with zooplankton + fish and B - zooplankton and fish free. A 60 mm net was adapted to the enclosure B mouth for preventing zooplankton entrance, but allowing free access for most planktonic algae. The net efficiency was relatively high, allowing only a low number of small rotifers to pass through the net holes, but blocking microcrustaceans and larger rotifers. As an additional care for avoiding contamination, the enclosures B were always sampled first. Even so, at the end of the experimental period, contamination by other rotifers and a few crustaceans increased in B, and then the experiment was interrupted.

The third enclosure type was used in the same lake for studying *Chaoborus* predation effects on zooplankton. *Chaoborus* instars III and IV can bury into the sediment (S. E. N. Cleto Filho, in preparation) and migrate to the water column for preying on zooplankton (Arcifa, 1997, 2000; Perticarrari, 2000). In this case, it was important for larvae to have free access to the sediment and the water column. Two treatments, with three replicates each, were made: A - *Chaoborus* present and B - *Chaoborus* free. The enclosure B was provided with a 1 mm net, mounted in an aluminum ring, glued in the plastic bag, half a meter from the lower frames, which were buried into the sediment. The net was more efficient in preventing the entrance of older *Chaoborus* larvae, but allowed a low number of larvae I and II to pass vertically through the net pores. But, as the treatment B replicates were covered by

tulle to prevent *Chaoborus* oviposition, after some time *Chaoborus* virtually disappeared from the enclosures. The 1 mm net located near the lower end, although not a hundred percent efficient during the setting procedure proved to be so afterwards, during the course of the experiment. In this way, it was possible to investigate the effect of *Chaoborus* predation on the density and dynamics of zooplankton populations, by comparing both treatments (Castilho-Noll, 2002).

At the start of the experiments, most limnological conditions were similar in the replicates and the environment. During the experimental period, different features inside and outside the enclosures, as well as in the treatments A and B have developed. These findings assured that the setting procedure and the enclosure isolation from the environment were successful.

Experiments with enclosures open to the sediment ran for a month, in summer, without any sign of water deterioration. In closed enclosures water remained in good conditions for 25 days in winter and 15 days in summer.

Acknowledgements

We thank L. H. Sampaio da Silva for providing data of experiments, M. S. M. Castilho-Noll for helping on manufacturing the enclosures, and FAPESP for financial support to M. S. A. (97/10407-6).

References

Arcifa, M. S. 1997. Fluctuations and vertical migration of *Chaoborus* in a tropical Brazilian Reservoir: Lake Monte Alegre. Acta Limnol. Bras., 9:93-103.

Arcifa, M. S. 2000. Feeding habits of Chaoboridae larvae in a tropical Brazilian reservoir. Rev. Bras. Biol., 60:591-597.

Arcifa, M. S., Northcote, T. G. & Froehlich, O. 1986. Fish-zooplankton interactions and their effects on water quality of a tropical Brazilian reservoir. Hydrobiologia, 139: 49-58.

Castilho-Noll, M. S. M. 2002. A predação de larvas de *Chaoborus brasiliensis* sobre populações zooplanctônicas. São Paulo, USP, 101p (Tese de Doutorado).

Perticarrari, A. 2000. Migração vertical de microcrustáceos, Chaoboridae, e Hydracarina no Lago Monte Alegre. Ribeirão preto, USP, 94p (Dissertação).

Received: **30 September 2002**
Accepted: **24 January 2003**