A quantitative sampler for collecting invertebrates associated with deep submerged vegetation

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Abstract Only few of the numerous samplers for collecting invertebrate fauna associated with vegetation permit sampling at depths of more than approximately 0.5 m. This paper describes a sampler allowing collection of epifauna from submerged plants at a depth of up to approximately 2 m, growing in varied densities. The sampler is composed of two panels made of duralumin, connected on one side by means of piano-hinges. One of the panels has an opening covered with mesh, and the other is equipped with a cone-shaped net and detachable sample concentrator at its end. The sampler is coupled with a manipulator with a several meter extension for lowering the sampler under water, as well as for its opening, and closing. The initial assessment of the sampler efficiency, verified in beds of *Potamogeton perfoliatus*, provided similar results as two other, older and commonly used samplers. In comparison with the older devices, the sampler has the advantage of permitting collecting samples from greater depths. It also enables studying both the vertical and horizontal distribution of invertebrates within a plant patch.

Keywords Sampling methods · Epiphytic fauna · Macrophytes

Introduction

Macrophytes together with the epiphytic assemblages inhabiting their surface, such as bacteria, fungi, algae, and protozoa, as well as invertebrates grazing on such organisms (epifauna), constitute a specific biocoenosis in the littoral of various aquatic, both freshwater and saline ecosystems. Due to its frequent mass occurrence, epiphytic fauna can be of considerable importance as a consumer of phytoperiphyton and therefore a “cleaner” of the surface of plants (e.g., Kairesalo et al. 1987; Brönmark 1994; Jones et al. 2002; James et al. 2000). In certain situations it can also cause a substantial loss of plant biomass (Newman 1991; Kornijów 1996; Gross and Kornijów 2002). Epiphytic fauna is readily eaten by many fish species (Jones et al. 1998; James et al. 2000; Jones and Waldron 2003; Kornijów et al. 2005). This may lead to a cascading effect and enhanced growth of macrophytes (Brönmark 1994). The predation pressure of fish on epiphytic fauna depends, among others, on the plant density and the resources of alternative food, e.g., zoobenthos and planktonic crustaceans (e.g., Diehl and Kornijów 1998; Perrow et al. 1999; Kornijów et al. 2005). High importance of epifauna as food supply for waterfowl is also well known (Matuszak et al. 2014).

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Research on such relationships requires the application of relevant sampling techniques. Whereas collecting quantitative samples of phytoplankton poses no significant methodological problems, sampling epiphytic fauna constitutes a serious challenge for limnologists (Moss 2010). Sampling fauna associated with vegetation involves the application of various types of equipment, from very simple (Kangas 1972; Kornijów 1998; Colon-Gaud and Kelso 2003) to very complex ones (e.g., Gillespie and Brown 1966; McCauley 1975; Galanti 1995). The high number and variety of technological solutions probably results not only from the inventiveness of the authors, but also from the vast variety of the morphological structure of plants sampled for analyses. Notice, for example, the differences between the delicate thalli of filamentous algae and the hard stems of reed. Moreover, vegetation coverage may vary from very dense carpets to dispersed single patches or stems. The selection of the sampler should also consider the specificity of the groups of animals subject to the study, including those firmly or rather loosely attached to plant surfaces, as well as those swimming among the vegetation.

Two types of epiphytic fauna samplers are generally distinguished:

1. for emergent plants (Gerking 1957; McCauley 1975; Amoros 1980; Kornijów and Kairesalo 1994),
2. for submerged vegetation, floating-leaved plants, and algal mats (e.g., Macan 1949; Gerking 1957; Korinkova 1971; Kangas 1972; McCauley 1975; Martin and Shireman 1976; Minto 1977; Downing 1986; Czernik and Rybak 1995; Kornijów 1998; Marklund 2000; Colon-Gaud and Kelso 2003).

The variety of methods encourages researchers to undertake studies aimed at the comparison of various samplers (e.g., Macan 1977; Cheal et al. 1993; Garcia-Criado and Trigo 2005; Sychra and Adámek 2010).

In spite of the availability of a high number of different samplers, only some of them permit sampling epiphytic fauna from depths higher than 1 m (literature review in Downing 1984). Because of the above, it is frequently necessary to collect samples by SCUBA diving or snorkeling (e.g., Kangas 1972; Gross and Kornijów 2002), which is not always possible for various reasons.

This paper presents the construction of a quantitative sampler for collecting epifauna associated with

Fig. 1 General view of the sampler in the open position

submerged plants growing at a depth to about 2 m, and in various covers.

Technical description

The main sampling part of the sampler resembles apparatuses by other authors (Downing 1986; Kornijów 1998; Colon-Gaud and Kelso 2003). It is composed of two panels, made of duralumin, connected on one side by means of piano-hinges, and a manipulator with 1–2 m extension used for lowering the sampler under water, opening, and closing it (Fig. 1).

The panels have dimensions of 30 cm × 20 cm × 16 cm (height × width × depth). One panel has an opening covered with mesh, and weather stripping along its external edge. The other panel is coupled with a cone-shaped net with a length of 30 cm. The purpose of the net is to reduce back pressure while closing the sampler. A similar solution preventing the occurrence of a shock wave is applied in some other samplers (Czernik and Rybak 1995; Marklund 2000).

A ring (3 cm long, 10 cm in diameter) with a detachable sample concentrator (10 cm long, 10 cm in diameter), both made of PVC, is mounted at the end of the net (Figs. 2, 3). Mesh identical as that used for making the net is glued to the lower part of the sample

Fig. 2 Detachable sample concentrator with the sieve (*left*) and the lower part of the manipulator with the spindle for closing the sampler (*right*)

concentrator, functioning as a sieve. The concentrator is attached to the ring by means of rubber expanders.

The sampler is opened and closed by means of the manipulator—a system of two tubes made of aluminum, one inserted inside the other. At the top end, they are equipped with handles facilitating manipulation. At the bottom end, they are connected to the panels, whereas the external tube is permanently connected to the panel with the cone-shaped net, and the internal tube pulls or pushes the other panel by means of a spindle therefore opening or closing the sampler (Figs. 2, 3). The closing mechanism is very effective and permits closing the sampler even onto stiff vegetation.

The length of the manipulator depends on the sampling depth. At depths of more than 2 m, the application of the sampler becomes more difficult.

The mesh used in the cover of the panel opening, the cone-shaped net and the sample concentrator should have the same size depending on the size of collected invertebrates and the study objective. In the sampler presented here, the mesh size amounted to 200 μm . It seems to be a good compromise, permitting minimizing the risk of escape by small invertebrates, and simultaneously ensuring easy filtration of water.

Operation of the sampler

Sampling should be performed from a boat. It involves slow lowering of the closed sampler to the plants while holding the manipulator. Immersing the sampler in the closed position permits the avoidance of sieving and trapping of dislodged or actively swimming invertebrates, such as water mites, bugs, and beetles, and their overrepresentation in the sample. Only when the sampler reaches the plants, it is opened by means of the handles and placed so that the plants are between the panels. The sampler is then closed and retrieved to the boat together with the plants and fauna. Water leaks out from the sampler through the mesh. Any stems of plants protruding outside of the sampler are trimmed manually with scissors.

Next, the sample of aquatic vegetation together with fauna is transferred into the sample concentrator by rinsing the net with water from outside. When no more debris on the net is visible, the sample concentrator can be detached from the ring, and the sampled material can be transferred to plastic containers or zip bags, and kept in a cooler.

I recommend keeping samples in containers without water, but with air volume at least the same as the

Fig. 3 Details of the construction of the sampler. The panel (2) with an opening covered with mesh (3), closed or opened by means of the spindle (9) connected with the internal tube (8) of the manipulator. The other panel permanently connected to the external tube (11) of the manipulator (1) with weather stripping (7) and the cone-shaped net (4) with the ring (5) and detachable sample concentrator at its end (6). Handles of the manipulator (10) coupled with the internal and external aluminum tube

plant volume. In this way, samples can be safely stored in the field in a cooler for several hours, and in a fridge even for several days, with no threat to the condition of the organisms. The humidity inside the container will prevent fauna and plants from drying off. The organisms will have sufficient amount of air. Lack of water and low temperature will make it difficult for predators to move freely and potentially consume their prey. Such a manner of storage of samples has been successfully practiced not only in the cool and moderate climate zones, but also in considerably warmer, e.g., Mediterranean (Sahuquillo et al. 2008) and tropical climate (Kornijów et al. 2001). Should it be impossible to store samples at a low temperature, e.g., in a cool box, in hot weather, it is safer to preserve the samples immediately after their collection, e.g., by means of 4 % formalin solution. Samples should not

Table 1 Mean densities (number of individuals per 100 g of plant wet weight⁻¹) $\pm$ SD ($n = 6$) of the most abundant animal taxa associated with *P. perfoliatus* estimated by means of three samplers: *D*—Downing's (1986) sampler, *K*₁—Kornijów's (1998) sampler, and *K*₂—the new sampler

Taxa	<i>D</i>	<i>K</i> ₁	<i>K</i> ₂
<i>Palaemon</i> sp.	59 $\pm$ 37	73 $\pm$ 55	65 $\pm$ 26
<i>Gammarus</i> sp.	131 $\pm$ 54	155 $\pm$ 44	147 $\pm$ 72
Chironomidae	53 $\pm$ 27	65 $\pm$ 31	52 $\pm$ 22
Total	243 $\pm$ 96	293 $\pm$ 86	264 $\pm$ 68

Means not significantly different at $p < 0.05$ (the Kruskal–Wallis nonparametric ANOVA tests, StatSoft STATISTICA 10 software)

be frozen. Freezing may cause disintegration of delicate oligochaetes worms *Naididae*.

Material collected by the sampler permits the estimation of faunal density per plant mass unit (after prior weighing) or per plant surface unit (methods of measurement in: Morse et al. 1985; Watala and Watala 1994; Sher-Kaul et al. 1995). The estimation of the density of fauna in relation to the bottom surface requires a separate estimation of the biomass of plants at the study site by means of larger conventional grab samplers, and the application of the regression analysis for estimating the faunal abundance (Downing 1986).

Preliminary assessment of sampler efficiency

The efficiency of the new sampler was preliminarily compared with that of two others, constructed by Kornijów (1998), Downing (1986). The study was carried out on June 15, 2014, in the Vistula Lagoon, Southern Baltic (54°20'01N, 19°32'53E), at a depth of 0.5 m, in *Potamogeton perfoliatus* beds. Six samples, each consisting of about 20–30 g wet weight, were collected with each sampler. The mean densities of the most abundant epiphytic taxa obtained with the application of the three samplers were comparable. Differences between the means were statistically insignificant. This suggests that the applied samplers provide similar results (Table 1).

The presented sampler has the advantage of permitting collecting samples from greater depths. Moreover, it allows for collecting epifauna samples from fragments of single stems of plants located at

various depths, for the analysis of vertical distribution of invertebrates on plants. It also enables studying the effect of horizontal distribution of invertebrates within a plant patch (e.g., interior and edge).

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