SHORT COMMUNICATION

Using plankton nets as light traps: application with chemical light

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A great number and variety of light traps have been employed to attract and capture mainly fish larvae in marine and freshwater ecosystems. In most of these devices, the light was produced from battery-powered fluorescent lamps or light-emitting diodes (see Hickford and Schiel, 1999; Gyekis et al., 2006). Chemical light has also been used in a few light traps and proved efficient in attracting fish larvae (Gehrke, 1994; Kehayias and Doulka, 2007), benthic crustaceans (Hovda and Fosshagen, 2003) and lake cladocerans (Kehayias, 2006). Plankton nets are widely used for sampling zooplankton and ichthyoplankton, and in a few cases light sources have been used in combination to enhance the attraction of such organisms (Rooker et al., 1996; Wiebe et al., 2004), although none of these designs operated with chemical light. The aim of this study was to modify two common plankton nets into light traps using Cyalume® light sticks as the light source, and to test their effectiveness in attracting and capturing aquatic organisms in two different aquatic ecosystems in western Greece.

Experimental sampling was carried out in the inland Stratos reservoir and the brackish Amvrakikos Gulf. A Hydrobios plankton net (100 cm in length, 40 cm in diameter, 50 μm mesh size) and a conical net (160 cm in length, 50 cm in diameter, 200 μm mesh size) were used in the two areas, respectively. The sampling in Stratos reservoir was conducted from a bridge on 4–5 July 2004, while in Amvrakikos Gulf the sampling was carried out on 21–22 July 2006 from a boat anchored 2 km from the shore. The depths of the sampling locations were 8 m in Stratos reservoir and 21.5 m in Amvrakikos Gulf. Moon light was absent on both occasions and the sampling was carried out between 22:00 and 02:00 (local time). Green, blue and red light sticks (LSTs) were used during the first night of sampling in Stratos reservoir and white and yellow in the second. In Amvrakikos Gulf, green and blue light colors were used during the first night and red, white and yellow during the second. Three 15 cm long LSTs were attached to the net using transparent adhesive tape. One light stick was attached on a wire across the opening of each net and the other two were placed on the rope of each net, so that the upper light stick was positioned not higher than 1 m from the opening ring of the net (Fig. 1). During the sampling procedure, the nets were lowered into the water and were held stationary for 3 min in the case of Stratos reservoir, and 5 min in Amvrakikos Gulf, at a depth of 2 m and with the LSTs turned on. The nets were then lifted rapidly to
the surface with a tow speed of nearly 1 m s⁻¹. This procedure was repeated six times for each light color, while six “dark” samples (the LSTs were not producing light) were also collected at the beginning of each sampling occasion. All specimens from all the samples were identified and counted in the laboratory. No counts were made for the rotifers in Stratos reservoir due to their great density. Comparisons between “dark” and “bright” samples for each species were made using the Mann–Whitney (U-test).

The aquatic bug Corixa sp., fish larvae of Barbus albani cus and Scardinius erythrophthalmus and the copepod Limnocalanus sp. were recovered only from the bright samples in Stratos reservoir (12, 8, 5 and 46 specimens, respectively). It is noteworthy that, during a 2-year sampling in Stratos reservoir using the same plankton net, not a single specimen of Corixa sp. or fish larvae has been caught, while Limnocalanus sp. was rarely found (Kehayias et al., 2008). Comparison of the number of specimens found in the bright and dark samples revealed positive phototactic responses of the cladocerans Bosmina longirostris and Daphnia cucullata to most of the colors. Positive phototactic responses for the former species to a light trap using green LSTs have also been reported by Kehayias (2006) in the same area. Considering the bright/dark ratio of the average number of specimens for each light color (Table I), B. longirostris showed higher values for blue and yellow light and D. cucullata for white and yellow light. Diaphanosoma sp. showed positive phototaxis to the blue, green and yellow lights. Alona sp. was absent from the dark samples on the first day, while it showed positive phototaxis to all light colors. The highest ratio of bright/dark samples was recorded for the chironomid pupae, which showed preference for the green, blue and yellow lights. Negative phototactic responses were only found for green light in the case of the copepod nauplii (U-test, P = 0.004).

Statistically significant phototactic responses were also recorded for six species found in Amvrakikos Gulf (Table I). The larger specimens of the cladoceran Brinlia awostris bearing embryos showed positive phototactic responses to all colors having a greater bright/dark ratio for red, yellow and white light. In contrast, the smaller specimens of P. awostris without embryos showed negative phototaxis for green and blue light. Pseudoevadne tergestina also showed negative phototactic response to all colors, while there was no differentiation in the phototactic response within its population. Polycheate larvae and the chaetognath Sagitta setosa were attracted by most colors, showing higher bright/dark ratios for white and yellow. Positive attraction of crab larvae was found only for the color white. Anchovy (Engraulis encrasicolus) larvae and eggs were recovered in considerably higher numbers from the bright compared with the dark samples, and the highest bright/dark ratios were recorded in the red and blue light colors, respectively (Table I). There were also qualitative differences between anchovy eggs and larvae from the bright and dark samples: the larvae caught in the bright samples were larger than those caught in the dark ones (4.8–21.3 mm instead of 3.0–4.2 mm). Moreover, the anchovy eggs recovered from all the bright samples were newly spawned and classified as stage I (Moser and Ahlstrom, 1985), while those caught in the dark samples were in later development stages (VII–X). The reproductive period of E. encrasicolus in the Mediterranean lasts from spring to autumn, peaking from May to July. The spawning females lay eggs every night between 22:00 and 02:00, mainly in the upper 20 m. In the regions of high surface temperature, such as the eastern Mediterranean, the egg stage duration is generally short (<2 days), and eggs can be easily grouped into “spawning nights” (Somarakis et al., 2004). Thus, an explanation for these high numbers of newly spawned eggs, recovered from a relatively small volume of water (<400 L in each of the 0–2 m hauls), could be the phototactic attraction of spawning females of E. encrasicolus in the sampling area, or close to the net. Although more experimental data are needed, the repetition of these results in two sampling nights, when different light colors were used, seems to enhance the above hypothesis.

The use of five light colors, the exposure time for each color during sampling (3–5 min) and the collection of multiple (6) dark and bright samples, necessitated the whole experiment being extended to two
nights on both sampling occasions. Thus, although there were certain color preferences among the species in the two areas, unbiased comparisons concerning the phototactic attraction among the five light colors cannot be made, and the only indications are provided by the ratio of bright/dark samples. Considering the low movement rates of most zooplankters and given the short duration of the light trap exposure (3–5 min), it is suggested that many specimens could have been attracted by the light, but did not approach close enough the net to be captured. Thus, we assume that increasing the exposure time of the LSTs during the collection process would enhance the effectiveness of the nets as light traps and greatly increase the total number of phototactic organisms captured.

Historically, the plankton net was designed for quantitative studies, where the volume of water filtered can be defined, and also for qualitative studies, if sufficiently large volumes of water are filtered to ensure the collection of rare species. On the other hand, light traps have also been used in qualitative studies, although they are actually selective samplers for positively phototactic species. The present results show that the placing of LSTs in front of plankton nets can increase their efficiency in capturing zooplankton and ichthyoplankton, and makes them effective traps for fast moving or/and rare aquatic species. It should be pointed out, however, that the use of nets as light traps made them inappropriate for quantitative sampling, due to the possible variability in phototactic responses of the different species. On the other hand, the main advantage of the proposed method is that the same device (plankton net) can be applied easily in both quantitative and qualitative studies and can be transformed to a light trap with only a few simple modifications. In this sense, when conducting a field study, the net can be used in the traditional way as a towed plankton sampler with the LSTs off, while with the LSTs on the same net can be used as a previously described light trap, which increases the collection of positively phototactic aquatic species that are scarce in the water or avoid a towed net.

The two nets with the particular dimensions and mesh sizes were selected because they are already widely used in freshwater and marine studies. However, the same methodology could be applied to analogous nets with several modifications (e.g. in the number, position and colors of LSTs), or to nets with closing mechanisms used to collect organisms from greater depths. Moreover, a number of LSTs could be simply attached in front of hauling nets and trawls to increase their collecting abilities, instead of using lights powered by batteries in more elaborate and expensive constructions (Wiebe et al., 2004). Indeed, the simplicity, low cost and ease of handling were the main advantages of this design making it useful for studies in various aquatic ecosystems, notably in shallow lakes and marshes where it would not be possible to haul a net to filter large water volumes.

### REFERENCES


