HYPORHEIC CHIRONOMIDS IN ALPINE STREAMS

By Valeria Lencioni.[1*], Marziali, L.[1] & Rossaro, B.[2]

With 1 table and 2 figures

ABSTRACT: Chironomids were collected in the hyporheic zone of two Alpine streams (2270 m a.s.l., NE Italy) with a Bou-Rouch pump and artificial devices. A total of 28 genera were identified, mainly belonging to Orthocladiinae and Diamesinae. The hyporheic was visited by I-IV instar larvae and pupae as (i) atrophic source, (ii) a refuge from spates, droughts, freezing and predators, (iii) a migratory corridor and (iv) as a nursery.

RESUMO: No presente trabalho os quironomídeos foram recolhidos na zona hiporreica de dois rios Alpinos (2270 m, NE Italia) através de uma bomba "Bou-Rouch" em conjunto com outros dispositivos artificiais. Foram identificados 28 géneros de quironomídeos, pertencentes maioritariamente aos Orthocladiinae e Diamesinae. A zona hiporreica é utilizada por pupas e larvas entre o primeiro e o quarto instar, principalmente como: (i) fonte de alimento; (ii) refúgio face a cheias, secas, gelo e a predadores; (iii) corredor migratório; e (iv) zona de reprodução.

*corresponding author. [1] Museo Tridentino di Scienze Naturali, Section of Invertebrate Zoology and Hydrobiology, Via Calepina 14, 38100 Trento, Italy, lencioni@mtsn.tn.it, laura.marziali@mtsn.tn.it
[2] University of Milan, Department of Biology, Section of Ecology, Via Celoria 26, 20133 Milan, Italy, bruno.rossaro@unimi.it

Bol. Mus. Mun. Funchal, Sup. N.º 13: 127-132, 2008 ISSN 0870-3876

INTRODUCTION

The hyporheic zone is an active ecotone bounded by the stream channel above and the true groundwater below (BENCALA, 2000). Some benthic species use this zone to avoid competition and predation and it has been suggested to be a nursery and a refuge from substrate movement and flow variance due to spates, floods or drought (WILLIAMS & HYNES, 1974). The importance of this zone for recolonization mechanisms and successional processes has been stressed by several authors (e.g. DOLE-OLIVIER *et al*., 1997) but little information is available on high mountain streams, especially glacier fed systems (MAIOLINI *et al*., 2005). These streams are characterized by high degree of patchiness and extreme environmental conditions, mainly in summer, when discharge and turbidity are high with wide diurnal variation (up to 5-10 times higher in the afternoon than in the morning) and the substrate is very unstable (CASTELLA *et al*., 2001). The aim of this study was to investigate which role the hyporheic plays in high altitude Alpine streams dominated by chironomids.

MATERIAL AND METHODS

The hyporheic zone (0-30 cm depth) of two Alpine streams with different origins was investigated (2270 m a.s.l., NE Italy): the glacial stream Noce Bianco (*gl*) and its non-glacial tributary, the Larcher (*ngl*). The glacial stream is fast-flowing (2.0 ± 0.5 m s^{-1}), large (4-20 m), meandering and dominated by gravel substrate, with a mean temperature 3.9 ± 1.4 °C in the summer and 0.6 ± 0.4 °C in the winter. The non-glacial stream is a smaller (3 m wide) and slower-flowing (0.7 ± 0.2 m s^{-1}) pebble stream, rich in mosses and with vegetated banks, with a mean temperature 5.1 ± 1.8 °C in the summer and 1.9 ± 0.8 °C in the winter (LENCIONI *et al*., 2006).

Aquatic invertebrates were sampled in 2003-2005, every 15 days in summer and from one to three months in the other seasons. A Bou-Rouch pump was used (BOU & ROUCH, 1967). Three pipes were fixed at 30 cm depth into the sediment along the river transect, one at the left bank, one in the middle channel and one at the right bank. Ten liters of water were pumped at each site. Two types of artificial substrates (traps and tubes) were also used. Traps were made from one litre plastic bottle with the opening cut off and inserted upside down. At each station, nine traps and three 1 meter long plastic tubes were buried horizontally in the substrate, at depths of 10 to 30 cm and at -10 cm respectively. Each tube was filled with pebbles (total surface 0.2 m^2) and had only the downstream end open. Each tube was divided into two 50 cm long halves to detect which organisms were able to migrate upstream and how far the distance they migrated (up to 50 or 100 cm). Samples were preserved in 75% ethanol and chironomids were identified to genus/species under the microscope (1000x). Differences between samples and dates were analyzed with the nonparametric tests of Mann-Whitney and Kruskal-Wallis. The

statistical analysis software program STATISTICA Version 6.0 was used.

RESULTS

A total of 800 individuals were collected, distributed between 28 genera and 63 species/groups of species, mainly belonging to Orthocladiinae (Fig. 1). Higher abundance (76% of individuals) and richness (26 genera in *ngl* and 19 in *gl*) were recorded in the non-glacial reach (Table 1).

TABLE 1. Number of chironomid specimens and genera recorded in tubes, traps and Bou-Rouch pump.

	Tubes		**Bou-Rouch pump**		**Traps**	
	gl	***ngl***	***gl***	***ngl***	***gl***	***ngl***
N. specimens	4	202	39	97	159	336
N. genera	4	19	13	16	15	24

Significant differences (Kruskal-Wallis test, $p < 0.05$) were found for Diamesinae (more abundant in *gl*), Chironominae (more abundant in *ngl*) and Tanypodinae (exclusive of *ngl*). At species level, *gl* was characterized by high abundance of *Pseudodiamesa branickii* (Nowicki, 1873), *Chaetocladius piger* gr., *Parakiefferiella bathophila* (Kieffer, 1912) and *Stilocladius montanus* Rossaro, 1979 while *ngl* by *Cricotopus* sp., *Micropsectra radialis*-type, *P. branickii*, *Parametriocnemus stylatus* (Spärck, 1923) and *S. montanus*.

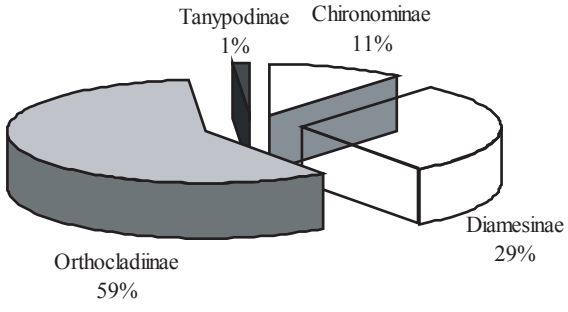

Figure 1. Relative composition of the Chironomidae in the hyporheic zone of two alpine streams.

Most individuals (59%) were captured with traps, 25% with the tubes and 16% with the pump. The highest diversity was found in the traps (Table 1), the lowest in the tubes at *gl* and

in the pump samples at *ngl*. Three different assemblages were found, with some taxa abundant only in the Bou-Rouch samples (e.g., *Micropsectra radialis*-type and *Paratanytarsus austriacus* (Kieffer, 1924) at *ngl*, *P. bathophila* and *S. montanus* at *gl*), others in the tubes (e.g. *Cricotopus* sp., *Euorthocladius rivicola* gr.) and others in the traps (*Diamesa* spp., *P. branickii* and *P. stylatus* at *ngl*; *P. branickii* and *Chaetocladius piger* gr. at *gl*).

Mature larvae (IV instar) were found as predators (e.g. *P. branickii*) and prey (orthoclads) down to 30 cm in the traps, where also some pupal exuviae and few adults (*Gymnometriocnemus volitans* (Goetghebuer, 1940)) were recorded. All larval instars were observed moving upstream in the tubes, among which *Euorthocladius rivicola* gr., *Cricotopus* sp., *Diamesa bertrami* Edwards, 1935 and *Eukiefferiella brevicalcar* (Kieffer, 1911) showed the strongest positive rheotaxis. Young larvae (I instar) were collected mainly deep in the sediment with the Bou-Rouch pump, and II-III instars resulted dominant in the artificial substrates (Fig. 2).

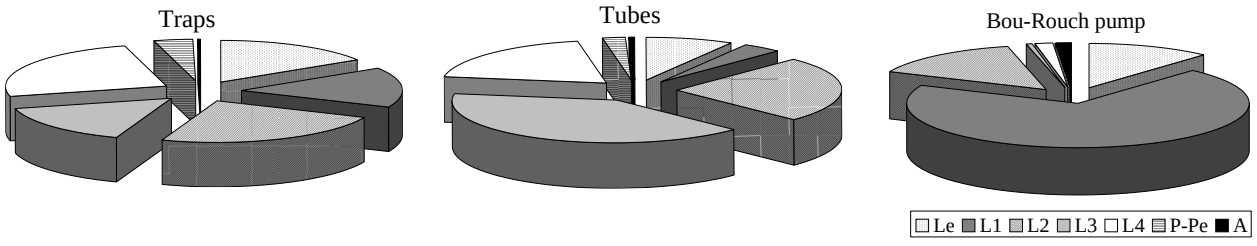

Figure 2. Relative presence of larvae (L1, L2, L3, L4), larval exuviae (Le), pupae and pupal exuviae (P-Pe) and adults (A) in the hyporheic zone of two alpine streams.

DISCUSSION

The use of artificial substrates has been recognised as a valid method for investigating high mountain streams invertebrate community in, even in the hyporheic zone (LENCIONI *et al*., 2006). However, tubes and traps seem to be not always effective at the glacial station due to the large amount of silt and high channel instability that clog and damage them, especially in summer. Furthermore, the accumulation of fine sediment in the substrate limits the pumping action within the first 30-50 cm of depth.

In both streams the hyporheic was visited by stygoxen and stygophile chironomids for several reasons: (i) as trophic source for mature larvae; (ii) as refuge area for overwintering quiescent larvae (LENCIONI, 2004) and for larvae and pupae in summer, when spates are frequent; (iii) as a migratory corridor for all instar larvae and (iv) as nursery for young larvae, as highlighted by other authors for invertebrates inhabiting glacial streams (MALARD *et al*., 2003) or highly instable river systems (FOWLER & DEATH, 2001).

Orthocladiinae, co-dominant with Diamesinae in the kick samples (LENCIONI *et al*., 2006), generally prevailed in the artificial substrates, exhibiting high mobility, as already noticed in other studies (FENOGLIO *et al*., 2002). These results highlighted the importance of vertical connectivity in maintaing zoobenthic biodiversity in highly disturbed habitats characterized by strong seasonality.

ACKNOWLEDGEMENTS

These data were produced within the two projects VETTA (*Valenza Ecologica dello zoobenThos di Torrenti Alpini*), funded by the Autonomous Province of Trento, and CRYOALP (*Ruolo della criosfera alpina nell'equilibrio idrologico*), funded by the Italian Mountain Institute (IMONT). The authors thank the staff of the Natural Science Museum of Trento for help in field and laboratory activities.

BIBLIOGRAPHY

BENCALA, K. E.:
2000. Hyporheic zone hydrological processes. *Hydrological Processes*, **14**: 2797-2798.

BOU, C. & R. ROUCH:
1967. Un nouveau champ de recherches sur la faune aquatique souterraine. *Comptes Rendus de l'Académie des Sciences de Paris*, **265**: 369-370.

CASTELLA, E., H. ADALSTEINSSON, J. E. BRITTAIN, G. M. GISLASON, A. LEHMANN, V. LENCIONI, B. LODS-CROZET, B. MAIOLINI, A. M. MILNER, J. S. OLAFSSON, S. J. SALTVEIT & D. L. SNOOK:
2001. Macrobenthic invertebrate richness and composition along a latitudinal gradient of European glacier-fed streams. *Freshwater Biology*, **46**: 1811-1831.

DOLE-OLIVIER, M.-J., P. MARMONIER & J.-L. BEFFY:
1997. Response of invertebrates to lotic disturbance: is the hyporheic zone a patchy refugium? *Freshwater Biology*, **37**: 257-276.

FENOGLIO, S., P. AGOSTA, T. BO & M. CUCCO:
2002. Field experiments on colonization and movements of stream invertebrates in an Apennine river (Visone, NW Italy). *Hydrobiologia*, **474**: 125-130.

FOWLER, R. T. & R. G. DEATH:
2001. The effect of environmental stability on hyporheic community structure. *Hydrobiologia*,

445: 85-95.

LENCIONI, V.:

2004. Survival strategies of freshwater insects in cold environments. *Journal of Limnology*, **63**: 45-55.

LENCIONI, V., B. MAIOLINI, R. FOCHETTI, M. GRASSO, A. BOSCAINI & E. DUMNICKA:

2006. Artificial substrate colonization by invertebrates in two high altitude Alpine streams. *Verhandlugen der Internationale Vereinigung für Theoretische und Angewandte Limnologie*, **29**: 1866-1870.

MAIOLINI, B., V. LENCIONI, R. BERERA & V. COTTARELLI:

2005. Effects of flood pulse on the hyporheic fauna in two high altitude Alpine streams. *Meiofauna Marina*, **14**: 105-108.

MALARD, F., D. GALASSI, M. LAFONT, S. DOLEDEC & J. V. WARD:

2003. Longitudinal patterns of invertebrates in the hyporheic zone of a glacial river. *Freshwater Biology*, **48**: 1709-1725.

WILLIAMS, D. D. & H. B. N. HYNES:

1974. The occurrence of benthos deep in the substratum of a stream. *Freshwater Biology*, **4**: 233-256.

Date received: 06-04-2008.