

## Droughts and distribution of hyporheos: perspectives from the Po River (Natural Park of the Po River)

Tiziano BO\*, Stefano FENOGLIO, Massimo PESSINO & Giorgio MALACARNE

Dipartimento di Scienze dell'Ambiente e della Vita, Università del Piemonte Orientale, Via Bellini 25, 15100 Alessandria, Italia

\*Corresponding author e-mail: [tbo@unipmn.it](mailto:tbo@unipmn.it)

**SUMMARY** - *Droughts and distribution of hyporheos: perspectives from the Po River (Natural Park of the Po River)* - In this study we analysed the role of hyporheic zone as refugium for the benthic macroinvertebrates in the high reach of the Po River (Parco del Po Cuneese - NW Italy). Aim of our study was to investigate the vertical distribution of macroinvertebrates within the stream substrate in the period June 2004 - December 2005. We positioned 12 hyporheic traps in the streambed. Each trap consisted in an outer structure containing three inside bags. The structures were buried in the streambed in June 2004 with a mini excavator Kubota and still remain in place. The inside traps were filled with clean sterile substrate, similar to the streambed composition, and placed at different depths: the top trap was positioned from 0 to 30 cm, the medium one from 30 to 60 cm and the bottom one from 60 to 90 cm. In this work we present our data about distribution, stratification and abundance of stream benthos within the substrate during the dry season in the period August 2004 - December 2005.

**RIASSUNTO** - *Secche e distribuzione della fauna iporreica: un'esperienza sul Fiume Po (Parco Naturale del Po)* - In questo lavoro viene analizzato il ruolo della zona iporreica come rifugio per la fauna invertebrata nel tratto saluzzese del Fiume Po, nel Parco Naturale del Po Cuneese. Lo scopo dello studio è stato quello di investigare la distribuzione verticale della fauna invertebrata all'interno del substrato fluviale nel periodo compreso tra giugno 2004 e dicembre 2005. Sono stati posizionati in alveo 12 "campionatori iporreici" costituiti esternamente da una struttura rigida in ferro, contenenti tre trappole a tre differenti livelli. Le trappole sono state posizionate nel subalveo durante il mese di giugno 2004, avvalendosi di un mini escavatore Kubota, e tuttora sono attive. Le trappole contenute nei campionatori erano riempite con materiale litoide sterile e dalla granulometria simile a quella dell'alveo bagnato. Esse intercettavano tre differenti profondità: 0-30 cm, 30-60 cm, 60-90 cm. Nel presente contributo si presentano i risultati relativi alla distribuzione, stratificazione e abbondanza degli invertebrati bentonici all'interno del subalveo durante i periodi di crisi idrica del periodo agosto 2004 - dicembre 2005.

*Key words:* droughts, hyporheos, vertical distribution, Po River, Piedmont, north western Italy

*Parole chiave:* secche, fauna iporreica, distribuzione verticale, Fiume Po, Piemonte, Italia nord occidentale

### 1. INTRODUCTION

There is a growing interest in the vertical dimension of stream systems: traditionally, aquatic ecologists perceived streams and rivers as bounded systems, consisting in riverbed and overlying water, and only in the last decade the exchanges of water, detritus, nutrients and organisms between groundwater and stream channel has become a central element in freshwater ecology (Vallet *et al.* 1993). Orghidan (1959) considered the hyporheic zone as the subsurface region of lotic systems that exchanges water with the surface, while in a more recent perspective White (1993) considered the hyporheic zone as the saturated interstitial areas beneath the

riverbed and into the stream banks that contain some proportion of channel water or that have been altered by channel water infiltration: this is a functional interface between ground-water and surface-water ecosystems. The importance of the hyporheic zone as refuge for stream invertebrates, for example to escape unfavourable conditions, is an important topic in this field (Boulton 1989). This study provides information about macroinvertebrate colonisation of the interstitial riverbed in the upper Po River. In perennial lotic systems, such as Italian prealpine rivers, the presence of water is typically continuous all year, with some seasonal variation. However, in the last five decades there has been a conspicuous increase in drought periods, mainly

caused by climate changes, water management and human influence: agricultural withdrawals in the medium reaches and hydroelectric uses in the upper reaches are among the most important causes of this phenomenon. Aim of our study was to investigate the vertical presence and distribution of macroinvertebrates within the substrate during droughts.

## 2. METHODS

The study was conducted in the Po River, in the protected area near Saluzzo (Parco del Po Cuneese).

In two stations (Martiniana and Revello) we placed 12 vertical traps in the highly permeable substrate (25 June 2004). The traps consisted of a basic plastic-covered metal net frame, measuring 30 cm x 30 cm x 90 cm (Fig. 1). The top trap was positioned from 0 to 30 cm, the middle one from 30 to 60 cm and the bottom one from 60 to 90 cm. Traps were filled with clean, sterile substratum according to the granulometry of the stream reach. Traps were buried in the streambed with a mini Kubota and left for a period to allow invertebrate to colonize. During droughts, the traps were removed to investigate the role of the substrate as a refuge during adverse hydrological conditions. Two traps were removed each time from Station 2 on different dates after the drought period began: 17/8/2004,

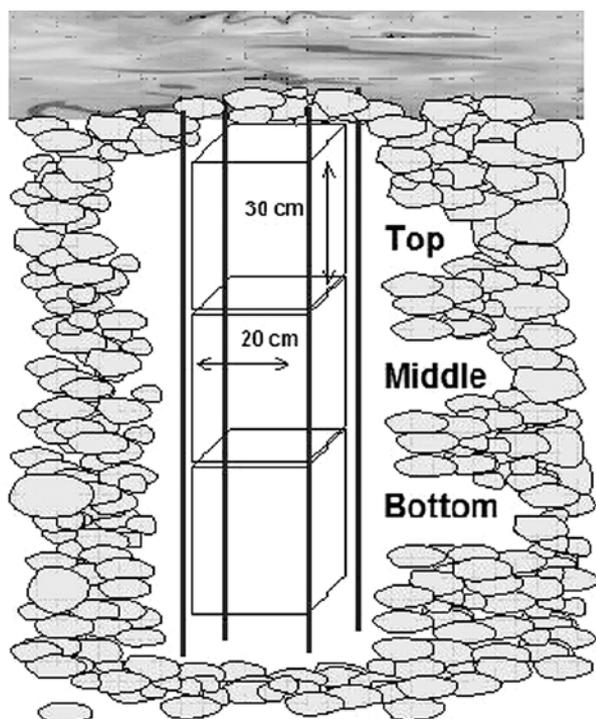


Fig. 1 - Hyporheic trap.  
Fig. 1 - *Trappola iporreica*.

16/9/2004, 27/10/2004 and 26/9/2005; and from Station 3 on 26/11/2004 and 19/05/2005. In the laboratory, all organisms were counted and identified to the genus level, except for Chironomidae, Simuliidae and early instars of some Trichoptera and Diptera, identified to the family level. Each taxon was also assigned to a Functional Feeding Group (FFG: scrapers, shredders, collector-gatherers, filterers and predators) according to Merritt & Cummins (1996). Moreover, a classification of taxa into seven biological and seven ecological groups was conducted according to the species traits approach of Usseglio-Polatera *et al.* (2000).

## 3. RESULTS

In the study period (June 2004 - December 2005) we collected 3136 organisms in total, belonging to 39 taxa with the hyporheic traps, and 25,933 organisms belonging to 57 taxa with the surber sampler (Tab. 1). Taxa found in the substrate traps are reported in table 1.

The most represented taxa were Diptera (mostly Chironomidae) and Annelida (Lumbriculidae, Lumbricidae, Naididae), followed by Plecoptera *Leuctra* sp., Ephemeroptera *Baetis* sp., and Trichoptera *Limnephilidae*. Chironomidae and Annelida, respectively 65,3% and 26,5% of the total number of organisms, dominated the assemblages of the substrate during droughts. Most taxa (81,2%) were present with a small number of individuals (< 20 organisms). Considering the functional composition of assemblages (Fig. 2), collector-gatherers was the dominant functional feeding group (81,7%), followed by shredders (8,36%) and predators (7,46%). Filterers and scrapers were almost absent. Considering the biological traits, "e group" organisms were the most abundant (66,7%), followed by "f group" organisms (27,5%). Considering the ecological traits, the most important groups were F (67,9%) and D (27,9%), while the C group, which was abundant in the surface, was almost absent in the interstitial zone.

## 4. DISCUSSION

In lotic ecosystem droughts strongly influence structure and composition of macrobenthos (Boulton 2003). Only a few taxa were able to survive drought periods by colonising the substrate in this prealpine stream: the assemblages found during periods without running water consisted almost entirely of small or medium-sized, short-lived organisms with aquatic respiration, mainly collector-gatherers. Chironomidae constituted more

Tab 1 - Taxonomic list of the hyporheic fauna in the two stations of the Po River.

Tab. 1 - Lista dei taxa rinvenuti nelle due stazioni sul Fiume Po.

Taxa	Martiniana	Revello
PLECOPTERA		
<i>Amphinemura</i> sp.	X	
<i>Nemoura</i> sp.		X
<i>Leuctra</i> sp.	X	
EPHEMEROPTERA		
<i>Ephemera danica</i>		X
<i>Serratela ignita</i>	X	
<i>Centroptilum luteolum</i>	X	X
<i>Siphonurus lacustris</i>	X	X
<i>Baetis</i> sp.	X	X
TRICHOPTERA		
<i>Odontocerum al bicorne</i>	X	
<i>Sericostoma pedemontanum</i>	X	
Limnephilidae	X	
<i>Hydropsyche</i> sp.	X	
DIPTERA		
Chironomidae	X	X
Anthomyidae		X
Ceratopogonidae	X	X
Limoniidae	X	X
Tabanidae	X	X
Simuliidae	X	X
Dolichopodidae	X	
Psychodidae	X	
<i>Tipula</i> sp.	X	X
<i>Atherix ibis</i>	X	
COLEOPTERA		
<i>Helichus substriatus</i>	X	X
<i>Agabus paludosus</i>	X	
<i>Agabus biguttatus</i>		X
Elminthidae	X	
Hydraenidae	X	
HETEROPTERA		
<i>Micronecta</i> sp.	X	
OLIGOCHAETA		
Naididae	X	X
Lumbricidae	X	X
<i>Eiseniella tetraedra</i>	X	X
Lumbriculidae	X	X
Tubificidae		X
HYRUDINEA		
<i>Dina</i> sp.	X	X
GASTROPODA		
<i>Lymnaea per egra</i>		X
<i>Physa</i> sp.	X	
Planorbidae	X	X
NEMATODA	X	
HYDRACARINA	X	

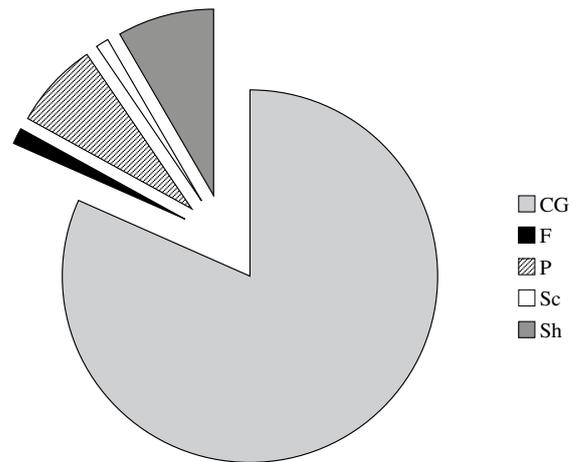


Fig. 2 - Functional composition of invertebrates in the substrate during droughts (Cg: 81, 7%; F: 1,40 %; P: 7,50; Sc: 1,10; Sh: 8,40).

Fig. 2 - Composizione funzionale del popolamento a invertebrati bentonici nel subalveo durante le secche (Cg: 81, 7%; F: 1,40 %; P: 7,50; Sc: 1,10; Sh: 8,40).

than 2/3 of all invertebrates, confirming previous findings (Weigelhofer & Waringer 2003; Bo *et al.* 2006, 2007). In prealpine traits of the Po River, few taxa appear to be able to colonise reaches with intermittent flow. This finding underlines the great ecological difference between perennial and intermittent streams, as invertebrate communities in the latter have evolved strategies to survive recurrent water shortage (Boulton 1989; Stanley *et al.* 1994; Hose *et al.* 2005). Although some studies have claimed that periodic droughts may be important in maintaining the diversity of freshwater systems (Everard 1996), our study provides evidence that intermittent drought severely disturbs the benthic coenoses of Italian prealpine rivers.

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