Feeding habits of *Dictyogenus fontium* (Plecoptera Perlodidae) in Alpine streams (Trentino - NE Italy)

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SUMMARY - Feeding habits of *Dictyogenus fontium* (Plecoptera Perlodidae) in Alpine streams (Trentino - NE Italy)

- Alpine high elevation streams host specialized benthic communities due to the harsh environmental conditions, and Plecoptera Perlodidae and Perlidae include the most important predator species. The feeding habits of *Dictyogenus fontium* (Plecoptera Perlodidae) was studied in high elevation Alpine streams. Sampling stations were on inlets and outlets of three alpine lakes: Lake Lungo, Lake Marmotte and Lake Nero. Gut content analysis was used to assess prey preferences. The composition of the benthic community of the sampling stations was assessed and the gut contents of 60 nymphs of *D. fontium* was analyzed. The benthic communities were dominated by Diptera, especially Chironomidae and Simulidae, followed by Plecoptera, Tricoptera and Ephemeroptera. Results show a relationship between the structure of the local zoobenthos community and prey selection of *D. fontium*. Nymphs appeared to be rather opportunistic, preying the most abundant invertebrate taxa present in the community.

RIASSUNTO - Abitudini alimentari di *Dictyogenus fontium* (Plecoptera Perlodidae) in torrenti alpini (Trentino - NE Italia)

- Nei torrenti Alpini d’alta quota, dove la comunità bentonica è altamente specializzata e adattata alle difficili condizioni ambientali, i Plecotteri Perlodidae e Perlidi sono i maggiori predatori. Nel presente lavoro sono state esaminate le abitudini alimentari dei Plecottero Perlodiade *Dictyogenus fontium* in ambiente alpino. Le stazioni di campionamento sono state poste su immissari ed emissari di tre laghi d’alta quota: il Lago Lungo, il Lago delle Marmotte e il Lago Nero. Le preferenze alimentari di questi animali sono state studiate con il metodo dell’analisi dei contenuti stomacali, basato sui residui chitinosi non digeriti. È stata individuata la composizione della comunità bentonica di tutte le stazioni e analizzato il contenuto stomacale di 60 ninfe di *D. fontium*. La comunità zoobentonica è risultata dominata dai Ditteri Chironomidi e Simulidi, seguiti da Plecotteri, Tricotteri ed Efemerotteri. I risultati mostrano una correlazione tra la composizione della comunità bentonica e la scelta delle prede da parte di *D. fontium*. Si è evidenziato che le ninfe di *D. fontium* sono predatrici opportuniste che predano i taxa più numerosi della comunità.

Key words: predation, stoneflies, gut contents, Alpine streams, Trentino

Parole chiave: predazione, Plecotteri, contenuti stomacali, torrenti alpini, Trentino

1. INTRODUCTION

“There is no discipline in hydrobiology that does not require a study of the feeding and nutrition of aquatic animals” (Monakov 2003).

The study of the feeding habits of aquatic macroinvertebrates has been implemented in the last ten years because of its important contribute to the understanding of the trophic structure of stream communities (Mihuc 1997; Resh & Rosemberg 1984). Predator species have a very important role because they exert a top-down control on the structure of the macroinvertebrate communities (Molles & Pietruszka 1987). In the last decades there was a strong impulse to the study of feeding habits of stoneflies of the northern hemisphere (Allan 1982; Stewart & Stark 1988). One recent issue is the linking of single species feeding habits with ecological processes at the population and community level (Williams et al. 1993). Alpine streams have a particular community structure in relationship with the harsh conditions of these habitats, due to low temperatures, channel instability, low nutrient availability etc. (Maiolini & Lencioni 2000; Maiolini & Lencioni 2001). In Alpine low order streams most predator species belong to the orders Plecoptera and Tricoptera. To date, the studies on predatory Plecoptera suggest the existence of different
feeding preferences in relationship with development, ability to handle inactive but also active preys, and dimensions of the nymphs (Walde & Ronald 1987). In fact, it has been demonstrated that there is a shift from an herbivorous/detritivorous habit in the first instars, to a strictly carnivorous diet in mature nymphs (Fuller & Stewart 1977). Knowledge of possible variation in diet is very important to understand the biology of a species and in defining its role in community dynamics. To study the feeding habits of predator stoneflies in the field, gut content analyses has proved to be a reliable method as it allows the identification of the preys by the presence of undigested chitinous parts (Peckarsky 1996; Allan 1995).

In this work we present results deriving from gut analyses of *Dictyogenus fontium* (Ris, 1896) in the aim of producing evidence of prey preferences and prey selection in relation to community structure.

2. **STUDY AREA**

The study area is Val Lagolungo, in the Noce Bianco basin, in Val de la Mare (Stelvio National Park, Trentino - Italy) (Fig. 1). **In the valley there are 5 glaciers:** Vedretta de la Mare, originating the Noce Bianco stream, glacier Careser, originating the Rio Careser stream, Vedretta Venezia, Vedretta Rossa and Vedretta del Cavaion (Gruppo Nazionale di Fisica Geomorfologica - C.N.R., 1986). A non glaciated sub basin with three alpine lakes (Lake Marmotte, 2705 m a.s.l.; Lake Lungo, 2550 m a.s.l.; Lake Nero, 2621 m a.s.l.) is located between the De La Mare and Careser glaciers. These first order streams may be assigned to the rhithron typology and are partially impacted by water withdrawing for hydropower production. Samples from four stations were considered in this work: two on the inlet of Lake Lungo (ImL1, 2730 m a.s.l., and ImL2, 2600 m a.s.l.), one on the outlet of Lake Marmotte (EmM2, 2350 m a.s.l.) and the last on the outlet of Lake Nero (EmN, 2620 m a.s.l.).

3. **METHODS**

Zoobenthic samples were collected seasonally from 2000 to 2002 and in each occasion the main environmental parameters, such as current velocity, conductivity, temperature and substrate composition, were recorded (details on physico-chemical features are in Boscaini et al. 2004). In each station and date five replicate benthic samples were collected with a 100 μm mesh pond net, disturbing for one minute a 0.1 m² area. Samples were preserved in the field with ethanol to a final concentration of 75%. Organisms were sorted under a dissection microscope and identified to the lowest possible taxonomical level.

The gut content of 60 nymphs of *Dictyogenus fontium* (Plecoptera, Perlodidae) (Fig. 2) was analyzed. Length and width of the cephalic capsule and length of the body (from the head to the last urite) was measured for each nymph (Fig. 3). Preys were identified using undigested chitinouse parts, especially head capsules. Gut content was compared with composition and abundance of the benthic community in order to evaluate prey selectivity of predaceous stoneflies.

4. **RESULTS**

60 nymphs of *D. fontium* were selected from the 116 sampled in the study area, and 44 of them had undigested chitinouse parts in the gut.
Fig. 3 - Abbondanza e diversità della comunità bentonica nelle stazioni indagate. a) Diversità in taxa e abbondanza relativa della comunità. b) Diversità in taxa e abbondanza relativa della comunità di Plecotteri. c) Taxa predati e numero di prede.
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(Fig. 3 - continued)

(Fig. 3 - continua)
In EmM2 the community was well diversified. Diptera represented 80% of the community, with Chironomidae as dominant family in every seasons (mean 78%). Plecoptera, Tricoptera and Ephemeroptera accounted for 5%, 3% and 0.5% of benthic community, respectively (Fig. 3).

*D. fontium* was the most abundant stonefly (61%) and was the only predator species, followed by *Leuctra* sp. (36%) and *Rhabdiopteryx alpina* (Kuehtreiber, 1934) (2%), both herbivorous species (Fig. 3).

Ten *D. fontium* nymphs were selected for analyses from this station. Body length of the nymphs ranged between 28 mm and 3 mm.

Three nymphs had chitinouse parts in the gut. 80% of the preys were Chironomid larvae (20 of 25 items).

Other preys were Simuliidae (2 larvae), Limoniidae (2 larvae) and Limnephilidae (1 larva) (Fig. 3).

In EmN the benthic community was dominated by Chironomidae (60%), and Simuliidae (34%). Plecoptera were 1.7%, Tricoptera 1% and Ephemeroptera 0.1% of the sampled community (Fig. 3). *D. fontium* was the most abundant predator stonefly (11% of the stoneflies), followed by *Perlodes* sp. (6%) and herbivorous stoneflies as *Leuctra* sp. (39%) and *R. alpina* (44%) (Fig. 3).

Two of the four analyzed nymphs of *D. fontium* had undigested residues in their gut. Their lengths were 11.7 mm and 7.1 mm. Preys were 15 Chironomidae (*Diamesa zernyi/cinerella* group and *Ortocladius* sp.) and one Simulidae (*Prosimulium latimucro* Enderlein, 1925) (Fig. 3).

ImL1 presented a well structured benthic community, Diptera were 73% of the total community with Chironomidae (62%) and Simuliidae (8.5%) as most abundant families. Within EPT, Tricoptera was the most represented (16%), followed by Plecoptera (7%) and Ephemeroptera (0.6%) (Fig. 3).

Plecoptera community was well diversified with the predator species *D. fontium* (58%) and *Isoperla rivulorum* (Pictet, 1842) (7%), and the herbivorous *Leuctra* sp. (17%), *Nemoura* sp. (5%), *R. alpina* (3%), *N. Ris 1902 mortoni* (0.8%) and *Protonemura* sp. (0.8%), (Fig. 3).

In this station, 37 nymphs of the 44 analyzed had chitinouse residues and their body length ranged between 17.1 mm and 2.2 mm. Chironomidae (especially *Diamesae* and *Ortocladius* sp.) were the most preyed organisms. In one nymph we found 36 Chironomid cephalic capsules. Residues of Athericidae, Limoniidae, Tricoptera Linnephiilidae and Plecoptera were also found (Fig. 3).

Finally, in ImL2 the community was dominated by Chironomidae (92%), followed by Simulidae (4%), Tricoptera (0.1%), Ephemeroptera (0.03%) and Plecoptera (1%) (Fig. 6a). The Plecoptera community was diversified with the predatory species *D. fontium* (12%) and the herbivorous ones *R. alpina* (21%), *Nemoura* sp. (39%), *Protonemura* sp. (24%). and *Taenoipteryx* (3%) (Fig. 3).

Four nymphs of *D. fontium*, with body length between 23 mm and 1.7 mm, were analyzed from ImL2: two had no preys and other two had undigested parts of Chironomidae (7 organisms) and one springtail (Fig. 3).

5. DISCUSSION

As expected in high Alpine streams, benthic communities were dominated by Diptera Chironomidae, followed by EPT taxa (Kownacki 1991; Milner & Pets 1994; Lencioni et al. 2002; Maiolini & Lencioni 2000).

*D. fontium* is widespread in the Italian Alps, where it populates rithral streams even at high elevation. In Trentino it was recorded up to 2700 m a.s.l. (Lencioni et al. 2001). Nymphs have an annual life-cycle with mature larvae from 15 to 25 mm long; adults emerge from June to September (Consiglio 1980). *D. fontium* is one of the biggest predatory stoneflies present in Alpine streams, but its feeding habits are still poorly known.

Studies regarding carnivorous species allow investigating the food chains that regulate the structure of stream communities (Allan 1995). Unfortunately, there are few studies on the predatory Plecoptera living in Alpine environments, probably due to the relative recent interest towards these ecosystems.

Of the 60 examined nymphs, 16 had empty guts, probably due to their larval stage as Perlodid and Perlid nymphs stop feeding during the last instars or near moults (Effiot 2000; Fenoglio 2003; Fenoglio & Tierno de Figueroa 2003; Tierno de Figueroa & Fochetti 2001). In two cases the absence of preys was probably due to bad health conditions of the nymphs, visibly wounded.

32 nymphs had ingested individuals belonging to only one taxon, 11 had ingested two different prey taxa. In one case a mature nymph (28 mm length, station EmM2) was found with gut residues. This is also the only case in which one nymph ingested preys belonging to three different taxa (Chironomidae, Tricoptera Limnephilidae and Simuliidae).

The choice of one or more prey taxa appeared not to be associated with dimensions and developmental stage of the nymphs. More data are needed to investigate statistical correlations.
Fenoglio and Bo (2004) found that *Dictyogenus alpinus* (Pictet 1842) living at lower elevations in the western Italian Alps (1500-2000 m a.s.l.) had a rather clear prey preference for Chironomidae and Baetidae, not strictly dependent on the available preys and in some cases the diet was integrated with vegetal fragments. Other studies (Dudgeon 2000; Fenoglio 2003) show a clear link between prey selection and composition of the local benthic community.

Our results indicate that *D. fontium* in high elevation Alpine streams feeds mainly on Chironomid larvae, which are the most abundant preys, and that other preys, though present, are not actively selected.

The second preferred prey were blackfly and caddisfly larvae, which were also the second and third abundant taxa in the benthic community. Thus, predation in high elevation habitats with low macroinvertebrate densities seems driven by relative availability of possible preys.

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REFERENCES


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