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Microhabitat preference of caddisfly (Trichoptera) communities in a medium-sized lowland stream in Latvia

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Abstract

The microhabitat preference of caddisfly (Trichoptera) communities was studied in 8 types of microhabitats in a fast-flowing, medium-sized, lowland stream in Latvia. A total 36 caddisfly taxa belonging to 14 families were recorded in microhabitat samples. A PCA biplot of caddisfly taxa abundance in microhabitats showed 3 distinct caddisfly taxa groups: depositional [Limnephilidae Gen. sp., *Anabolia laevis* (Zetterstedt) and *Lasiocephala* basalis (Kolenati)], lithal [*Agapetus ochripes* Curtis and *Psychomyia pusilla* (Fabricius)], and submerged macrophyte and water moss caddisfly microhabitat communities (*Ithytrichia lamellaris* Eaton, *Hydropsyche siltalai* Döhler and *Hydropsyche* spp. juv.). The habitats of these groups differed in current velocity and the amount of plant detritus. All size lithal microhabitat samples were characterized by grazer and scraper dominance and a similar proportion of gatherers/collectors. Macrolithal microhabitat with *Fontinalis* sp. and submerged macrophyte microhabitats were rich with passive filter feeders. Functional feeding type ratios were equal, with dominance of shredders, in FPOM, CPOM in akal microhabitats. Submerged macrophyte and *Fontinalis* sp. provided suitable niches for higher species numbers than the other microhabitat types, whereas abundance was the highest in the lithal microhabitats with the largest particle size.

Key words: Tumsupe stream, PCA, functional feeding groups

Introduction

Caddisfly microhabitat preference have been widely studied since the middle of the 20th century (e.g., Allan 1995, Ward 1992), however, such investigations have been conducted relatively rarely in Latvia (Kachalova 1972) and in the Baltic Ecoregion. In Latvia, a very low level of fertilizers is typical in comparison with that in other European countries (Springe *et al*. 2006).

Medium-sized streams are hierarchically structured and heterogeneous ecosystems. The local community composition results from an interplay of local and regional factors, both abiotic and biotic (Poff 1997). However, numerous studies have demonstrated that the local scale environmental variables explained most of the variance of macroinvertebrate community data (e.g., Galbraith *et al*. 2008, Sandin & Johnson 2004, Costa & Melo 2008).

Ward (1992) stated that streambed substratum type is the major factor affecting the distribution and abundance of lotic invertebrates, which provides habitat space, food, and protection. Also, Beisel *et al*. (1998) found that the co-structure between community organization and environmental variables indicated that substrate may be a primary determinant of community structure, but current velocity and water depth emerged as secondary factors. Stream substrate usually is highly variable

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with small-scale patchiness. Substrate changes over time in response to fluctuations in flow. However, microhabitat structure can persist for weeks to years (Allan 1995). Changes in the proportional balance between terrestrially linked heterotrophy and channel-based autotrophy constitute a dominant control of broad scale differences in community structure (Cummins & Klug 1979). The distribution or dynamics of many taxa have been described in relation to their environment. At microscale, interest in microdistribution has focused on physical environment constraints – substrate composition, hydraulic conditions, or food availability (Beisel *et al*. 1998). Caddisflies are of special interest in distribution studies since most species use substrate units in case construction (Cummins 1964). Spatial distribution patterns of lotic caddisfly larvae have been well established at different spatial scales (e.g., Urbanič *et al*. 2005, Wiberg-Larsen *et al*. 2000, Galbraith *et al*. 2008).

The aim of this study was to investigate the microhabitat preference of caddisflies in a fast-flowing, medium-sized, lowland stream in Latvia.

Material and methods

Study site

Tumsupe is a medium-sized, silicious, lowland stream (2nd order) with catchment area of 106.4 km^2 and distance to source of 28.71 km. The stream is of the rhythral type (v>0.2 m/s), with mean depth 0.25 m, average stream width 8.5 m. Land use in the catchment area consists of mixed native forest (50%), crop land (30%), open grass-/bushland (10%) and pasture (10%). Land use in the investigated stream reach (1 km length) consists of mixed native forest (70%), open grass-/bushland (30%).

Sampling

Five replicates were taken with Surber sampler (frame size 0.25 x 0.25 m; mesh size 0.5 mm) in 8 types of microhabitats: akal (>2 mm−2 cm), microlithal (>2 cm−6 cm), mesolithal (>6 cm-20 cm), macrolithal (>20 cm), and macrolithal (>20 cm) with *Fontinalis* spp. cover, FPOM (fine particulate organic matter), CPOM (coarse particulated organic matter) and submerged macrophytes, along a 50-meter reach on 27 May 2005. Microhabitat types were estimated in the field. Current velocity was measured at each microhabitat.

Species identification

Species were identified using keys by the following authors: Wallace *et al*. (2003), Edington & Hildrew (2005), Waringer & Graf (1997), and Lepneva (1964, 1966).

Data analysis

A standard deviation (SD), evenness (E) and Shannon's diversity index (H) were calculated using PC-ORD 4 software for the each microhabitat replicate. An indirect-gradient Principal Components Analysis (PCA) was selected for the microhabitat species data analysis (DCA Axis 1 gradient length was SD<4). Species data were log-transformed: (ln(Ay+B), where: A=1.0; B=1.0). Canoco for Windows 4.5 was used for the ordination analyses (Lepš & Šmilauer 2003).

Caddisfly feeding types (%) were calculated using ASTERICS 3.1.1. software (Anonymous 2008).

Results

Species diversity and abundance in microhabitats

A total of 36 caddisfly taxa belonging to 14 families were recorded in the microhabitat samples. The highest species diversity was found in the macrolithal with *Fontinalis* sp. cover (18 taxa) and submerged macrophyte microhabitats (15 taxa). The lowest species diversity was established in the akal (5 taxa) and FPOM microhabitats (6 taxa) (Fig. 1 and Table 1).

TABLE 1. Total abundance (ind. m^{-2}), standard deviation, evenness and Shannon's diversity index (H) in the 8 microhabitat types May 27, 2005 in the Tumsupe stream.

No.	Microhabitat	Total abundance (m^{-2})	SD	Evenness	H
1	FPOM_1	448	2.82	0.66	1.19
2	FPOM_2	192	0.89	0.91	1.63
3	FPOM_3	176	1.04	0.79	1.42
4	FPOM_4	96	0.56	0.90	1.24
5	FPOM_5	416	3.35	0.51	0.83
6	CPOM_1	208	1.36	0.90	0.98
7	CPOM_2	800	5.04	0.62	1.21
8	CPOM_3	1888	15.49	0.38	0.91
9	CPOM_4	1056	7.98	0.48	1.16
10	CPOM_5	304	1.59	0.83	1.61
11	Lithal 6_20_1	1504	10.70	0.54	0.97
12	Lithal 6_20_2	624	5.34	0.44	0.70
13	Lithal 6_20_3	896	5.06	0.67	1.40
14	Lithal 6_20_4	848	4.69	0.70	1.36
15	Lithal 6_20_5	1200	6.31	0.68	1.49
16	Lithal >20_1	1280	10.36	0.45	0.87
17	Lithal >20_2	768	4.22	0.76	1.36
18	Lithal >20_3	3920	34.90	0.28	0.72
19	Lithal >20_4	1664	9.44	0.61	1.50
20	Lithal >20_5	1808	9.91	0.65	1.62
21	Lithal 2_6_1	224	1.23	0.86	1.38
22	Lithal 2_6_2	688	4.25	0.62	1.36
23	Lithal 2_6_3	928	4.07	0.80	1.91
24	Lithal 2_6_4	896	3.87	0.83	1.91
25	Lithal 2_6_5	896	5.95	0.58	1.13
26	Akal_1	160	0.94	0.88	1.22
27	Akal_2	112	0.82	0.99	0.68
28	Akal_3	80	0.68	0.72	0.50
29	Akal_4	304	1.99	0.87	0.96
30	Akal_5	288	1.80	0.76	1.23
31	Lithal >20+*Fontinalis* sp._1	1280	4.62	0.83	2.20
32	Lithal >20+*Fontinalis* sp._2	1232	4.28	0.89	2.13
33	Lithal >20+*Fontinalis* sp._3	1536	6.17	0.76	2.11
34	Lithal >20+*Fontinalis* sp._4	1920	6.60	0.79	2.28
35	Lithal >20+*Fontinalis* sp._5	1200	5.30	0.82	1.95
36	Submerged macrophyte_1	1200	4.64	0.80	2.18
37	Submerged macrophyte_2	3520	22.17	0.58	1.57
38	Submerged macrophyte_3	1120	5.12	0.82	1.88
39	Submerged macrophyte_4	1024	3.37	0.88	2.26
40	Submerged macrophyte_5	1200	4.46	0.83	2.19

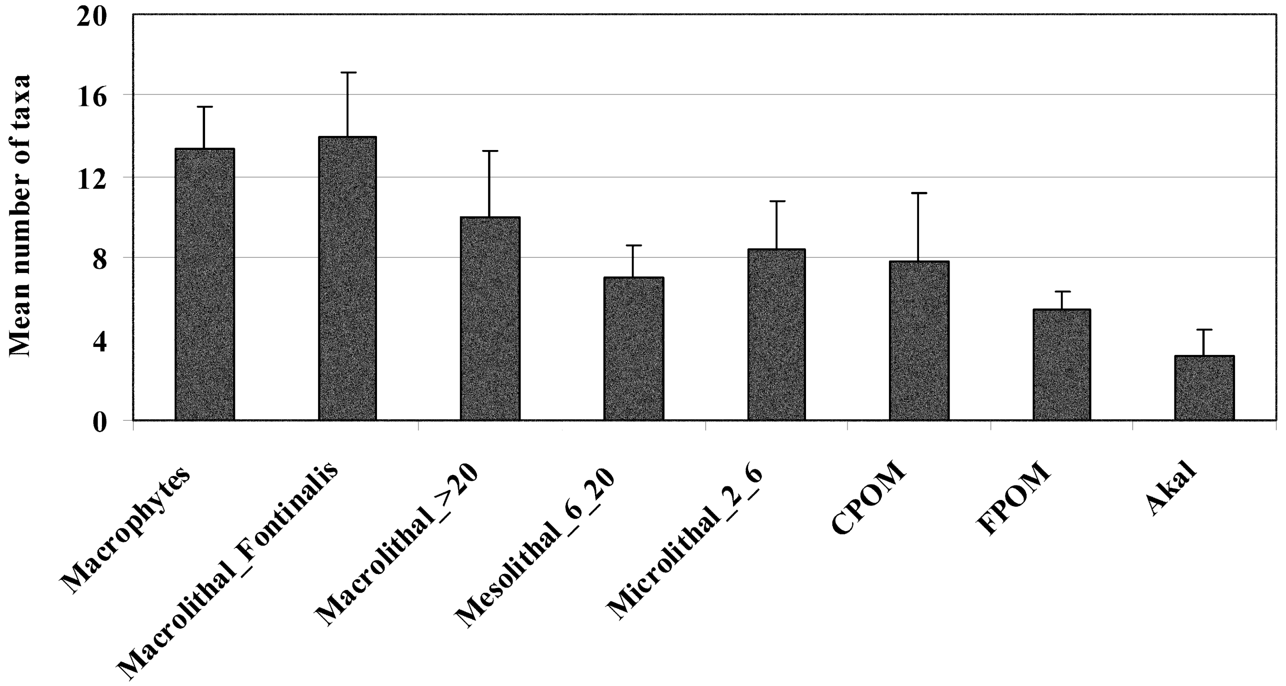

FIGURE 1. Mean number of taxa of caddisflies (Trichoptera) in 8 habitat types (n=5) in Tumsupe stream (error bars show SD).

The highest mean abundance was found in the macrolithal (>20 cm), submerged macrophyte and macrolithal with *Fontinalis* sp. cover microhabitats, but the lowest, in the akal and FPOM microhabitats (Fig. 2).

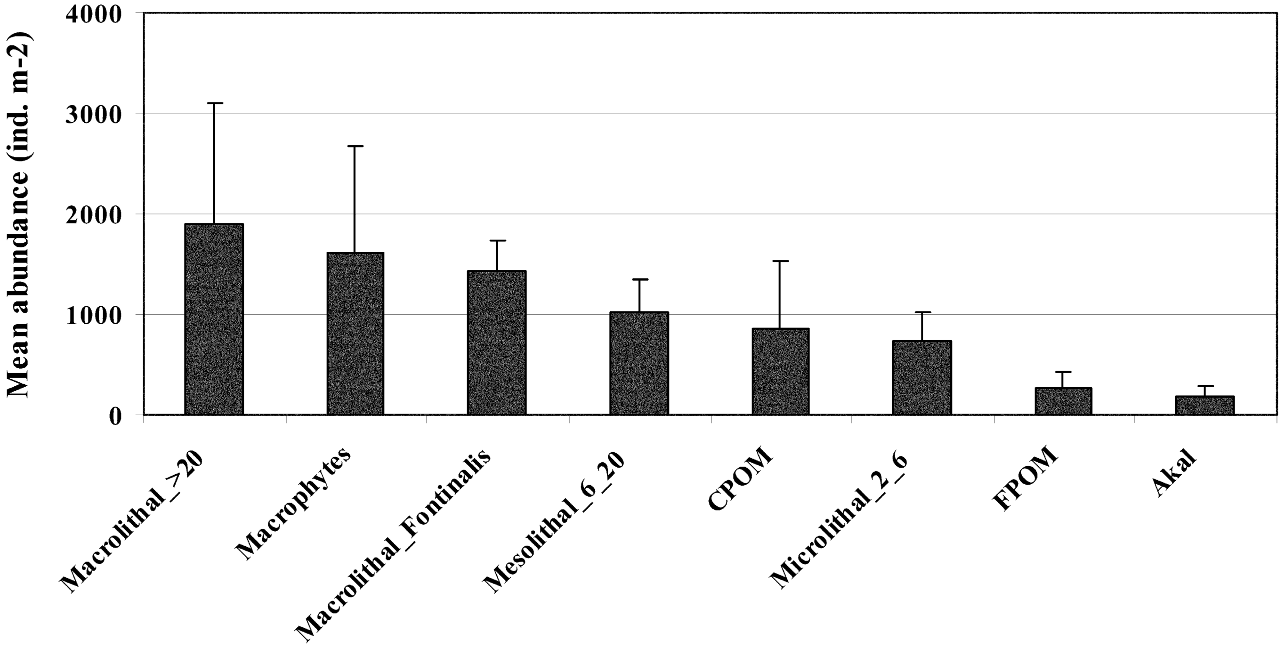

FIGURE 2. Mean abundance (ind. m^{-2}) of caddisflies (Trichoptera) in 8 habitat types (n=5) in Tumsupe stream (error bars show SD).

Principal Components Analysis

The PCA biplot showed 3 distinct groups of Trichoptera taxa in Tumsupe stream. The first one was composed of the FPOM, CPOM and akal microhabitat species (Limnephilidae Gen. spp. and *Anabolia laevis* (Zetterstedt 1840) were the most characteristic taxa), the second one was composed of the microlithal (>2 cm−6 cm), mesolithal (>6 cm−20 cm) and macrolithal (>20 cm) microhabitat species [*Agapetus ochripes* Curtis 1834 and *Psychomyia pusilla* (Fabricius 1781) were the most characteristic species], but the third—macrophyte and macrolithal with *Fontinalis* sp. cover microhabitat species (*Ithytrichia lamellaris* Eaton 1873, *Hydropsyche siltalai* Döhler 1963 and *Hydropsyche* spp. juv. were the most characteristic taxa) (Figs 3 and 4). The current velocity differed between these microhabitat groups (Fig. 5). Axis 2 was related to the detritus amount in the microhabitats. Axis 1 showed the gradient of the current velocity (Figs 3, 4 and 5).

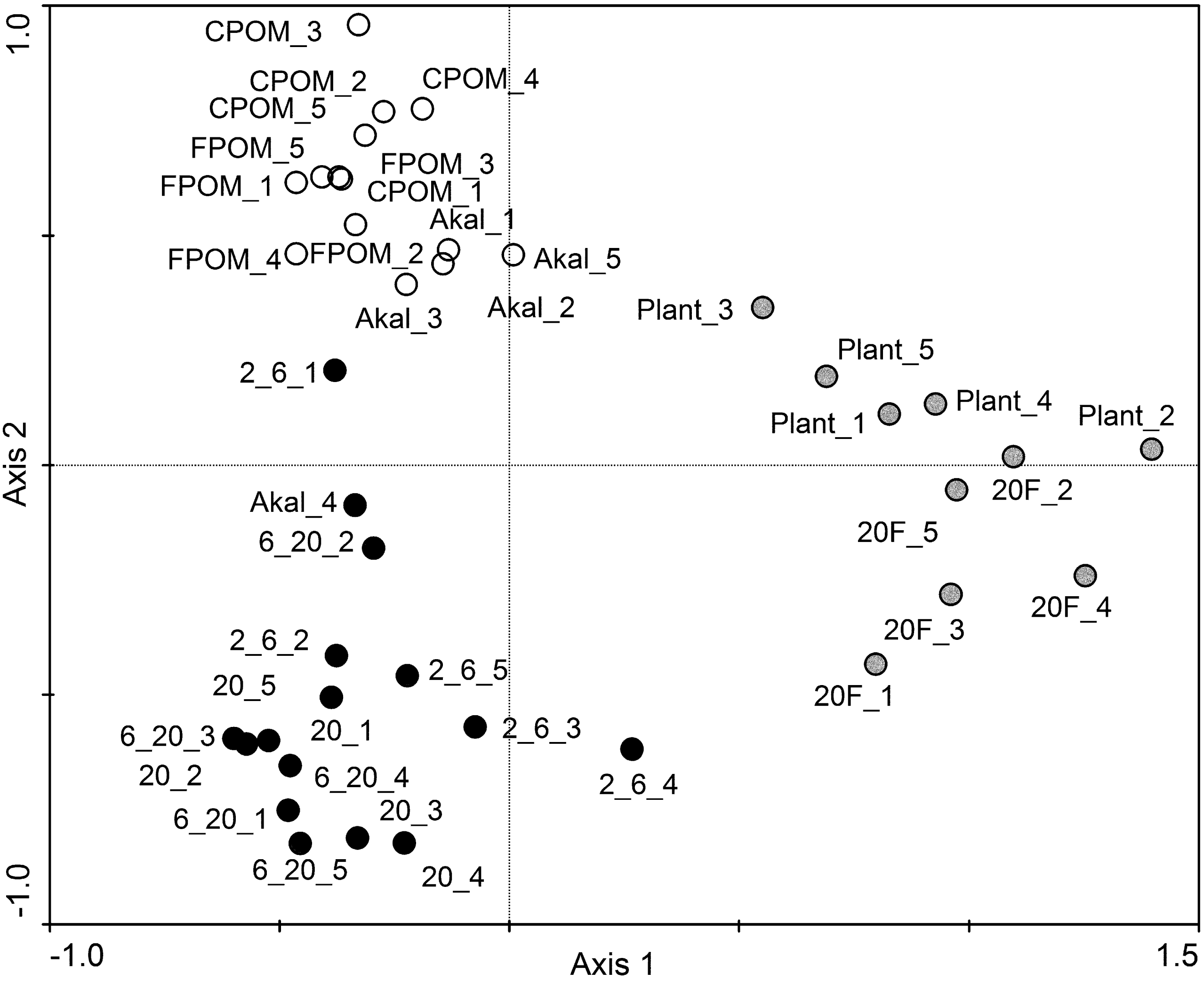

FIGURE 3. PCA ordination scatter plot of caddisfly samples in 8 microhabitat types [CPOM, FPOM, akal, submerged macrophytes (Plant), macrolithal (>20 cm) with water moss *Fontinalis* sp. cover (20F), microlithal (2_6) (>2 cm−6 cm), mesolithal (6_20) (>6 cm−20 cm), macrolithal (20) (>20 cm)] on 27 May 2005 in Tumsupe stream. Axis 1 explained 33.7% and Axis 2–28.7% of the total data variance.

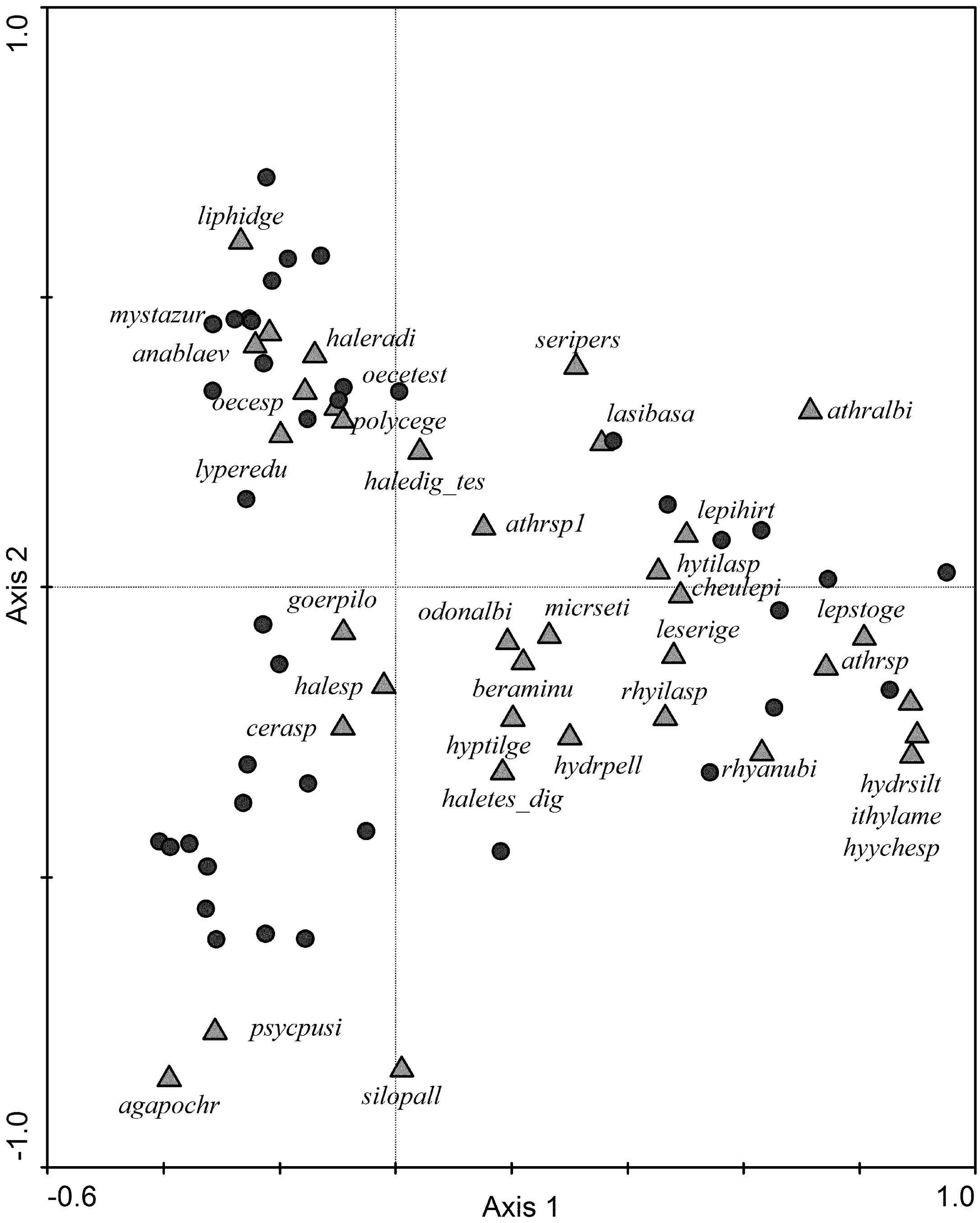

FIGURE 4. PCA ordination biplot of macroinvertebrate samples in 8 microhabitat types [CPOM, FPOM, akal, submerged macrophytes (Plant), macrolithal (>20 cm) with water moss *Fontinalis* sp. cover (20F), microlithal (2_6) (2–6 cm), mesolithal (6_20) (6–20 cm), macrolithal (20) (>20 cm)] on 27 May 2005 in Tumsupe stream. Axis 1 explained 33.7% and Axis 2–28.7% of the total data variance.

Species abbreviation: beraminu—*Beraeodes minutus*, micrseti—*Micrasema setiferum*, agapochr—*Agapetus ochripes*, goerpilo—*Goera pilosa*, silopall—*Silo pallipes*, cheulepi—*Cheumatopsyche lepida*, hydrsilt—*Hydropsyche siltalai*, hyychesp—*Hydropsyche* sp., hytilasp—*Hydroptila* sp., hyptilge—*Hydroptilidae* Gen. sp., ithylame—*Ithytrichia lamellaris*, lasibasa—*Lasiocephala basalis*, lepihirt—*Lepidostoma hirtum*, lepstoge—Lepidostomatidae Gen. sp., athralbi—*Athripsodes albifrons*, athrsp1—*Athripsodes* sp.1, athrsp—*Athripsodes* sp., cerasp—*Ceraclea* sp., leserige—Leptoceridae Gen. sp., mystazur—*Mystacides azurea*, oecesp—*Oecetis* sp., oecetest—*Oecetis testacea*, anablaev—*Anabolia laevis*, haledig_tes—*Halesus digitatus/tesselatus*, haleradi—*Halesus radiatus*, haletes_dig—*Halesus tesselatus/digitatus*, liphidge—Limnephilidae Gen. sp., odonalbi—*Odontocerum albicorne*, polycege—Polycentropodidae Gen. sp., lyperedu—*Lype reducta*, psycpusi—*Psychomyia pusilla*, rhyanubi—*Rhyacophila nubila*, rhyilasp—*Rhyacophila* sp., seripers—*Sericostoma personatum*.

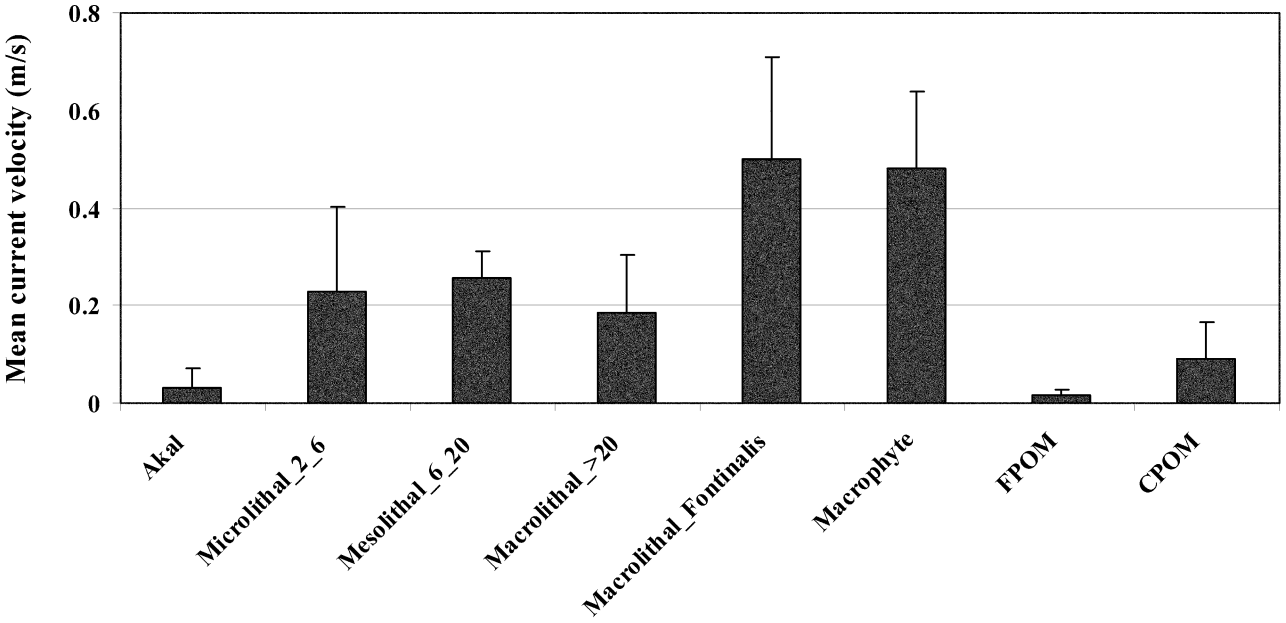

FIGURE 5. Mean current velocity at 8 studied microhabitat types (n=5) (error bars show standard deviation) on 27 May 2005 in Tumsupe stream.

Functional feeding groups

Similar feeding group ratios were observed for all size lithal microhabitat samples, with grazers and scrapers dominant and a similar proportion of gatherers/collectors. Macrolithal microhabitat with *Fontinalis* sp. was characterized by 4 abundant feeding types; in contrast to lithal habitats, passive filter feeders were abundant. Submerged macrophyte microhabitat feeding types were similar to macrolithal microhabitat with watermoss; FPOM and CPOM feeding type ratios were equal with dominance of shredders. Akal microhabitat feeding type ratios were closer to those for the depositional microhabitats than to those for lithal microhabitats. Active filter feeders were not found (Table 2).

TABLE 2. Caddisfly functional feeding types (average %) in 8 microhabitat types in May 27, 2005 in the Tumsupe stream.

Functional feeding types (%)	**FPOM**	**CPOM**	**Macrolithal (>20 cm)**	**Mesolithal (>6–20 cm)**	**Microlithal (>2–6 cm)**	**Akal (>2 mm– 2 cm)**	**Macrolithal (>20 cm) with *Fontinalis* sp.**	**Submerged macrophytes**
Grazers and scrapers	**18.54**	**21.43**	**69.99**	**69.93**	**66.99**	**13.87**	**39.20**	**42.96**
Miners	0	0	0.08	0	0	0	0.07	0.18
Xylophagous taxa	0.15	4.50	0.30	0.16	0.95	0	0.60	3.02
Shredders	**40.41**	**39.97**	4.15	3.03	9.67	**42.41**	**15.71**	**21.63**
Gatherers/collectors	12.75	8.97	**17.32**	**17.35**	**13.65**	**24.41**	5.13	8.89
Passive filter feeders	0	0.33	2.94	3.82	2.86	0	**18.06**	8.46
Predators	**15.86**	**17.19**	5.23	5.33	5.88	**19.31**	**20.75**	**13.92**

Discussion

Most benthic species exhibit distinct preferences for one or another general bottom type (Ward 1992). The microhabitat samples showed 3 relatively homogeneous caddisfly taxa groups, except for several samples from the submerged macrophyte, akal and lithal microhabitats. The heterogeneity of these latter samples could be attributed to sampling from different macrophyte species and to the microhabitat heterogeneity of the akal and lithal microhabitats. It verified that the microhabitat heterogeneity was not sufficiently estimated during the sampling and more attention needs to be given to the composition and spatial configuration of substrate patches, which cause the variations in the sample scale (Boyero 2003).

Caddisfly taxa diversity and richness patterns in the studied microhabitats corresponded to those from the other investigations (e.g., Mackay & Kalff 1969). Submerged macrophyte and *Fontinalis* sp. provided suitable niches for a higher species number than other microhabitat types. Bryophytes are substrates with a high intra-habitat heterogeneity, which are assumed to be of considerable importance to invertebrate micro-distribution because they provide a wide range of refugia which can serve to buffer populations against a variety of abiotic perturbations or biotic interactions. These substrates can act as coarse detritus collectors in addition (Beisel *et al*. 1998). The mean abundance was the highest in the lithal microhabitats with the largest particle size. According to Allan (1995), the larger the particle size, the longer its expected residence in place.

The dominating functional feeding groups (grazers and scrapers) indicate that the main food for the caddisflies in the investigated stream was periphyton, followed by detritus and fine – ultrafine particulate organic matter (UPOM). My results agreed with the findings of Urbanič *et al*. (2005), who found that shredders and collector-gatherers preferred microhabitats with larger amounts of CPOM, whereas filter feeders preferred shallow coarse substrate with low amounts of CPOM. Food can roughly be split up in 2 aspects important to invertebrates—food quantity and food quality (Peeters *et al*. 2004). Animal prey have been considered the highest quality food resource in stream environments relative to CPOM, FPOM, UPOM, periphyton and macrophytes (Cummins & Klug 1979). *Anabolia laevis*, Limnephilidae Gen. sp., *Agapetus ochripes, P. pusilla, I. lamellaris, H. siltalai* and *Hydropsyche* spp. juv. showed distinct habitat preferences.

The current study illustrated microhabitat preferences only for species whose larvae develop in the summer period. The sampling time was late for species with a spring flight period. Besides, the instars of the larvae were not studied in detail. However, Fig. 4 showed that the last instar larvae (identified to the species level) and the first instar larvae (identified to the genus level) preferred similar microhabitats.

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