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Field Experiment on Drift and Colonization of Benthic Macroinvertebrate in Gökpınar Stream (Denizli, E Turkey)

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Abstract: The colonization pattern by macroinvertebrates in a stony stream was measured. We placed two groups of bare nylon substrates in two sites of Gökpınar stream in the period December 2003-November 2004. In total we collected 5010 organisms belonging to 29 taxa in the traps and 12579 organisms belonging to 58 taxa in the natural stream bottom. Comparing the F (Flow direction = downstream) and O (Opposite to flow direction = upstream) traps with the C traps we found a significant difference in the number of organisms but not on number of taxa. C traps were the most colonized substrates, both in number of individuals and taxa, than F traps and the O traps. The population outcomes of differences in mobility among taxa are discussed.

Key words: Macroinvertebrate, colonization, drift, Gökpınar stream

INTRODUCTION

Many studies have described recolonization mechanisms in North America and Europe, but until now there have been no similar investigation in Turkish lotic environments. Colonization depends on many elements, like invertebrate mobility and substrate texture (Wise and Moller, 1979; Lancaster and Belyea, 1997; Melo and Froehlich, 2004) and competition, food suplies, habitat and predation (Mackay, 1992) and season (Williams, 1980) and dritf (Townsend and Hildrew, 1976). Townsend and Hildrew (1976) reported that drift was responsible for 82% of the colonization of denuded areas of streambed in Broadstone stream, where as Williams and Hynes (1976) noted that 42% of colonization was due to drift in a Canadian stream. There are different types of drift, which present seasonal and diel periodicity patterns and differ in qualitative and quantitative characteristics (Brittain and Eikeland, 1988). Flowing water acts as a transport medium for organism by drift and generates heterogeneous patterns of deposition (Winterbottom *et al*., 1997). It is widely accepted that individuals of a single species might move in different manners and in different direction throughout life (Townsend and Hildrew, 1976; Williams and Hynes, 1976).

Bare substrates placed in a stream have shown some colonization by invertebrates within 24 h and downstream drift may provide a large proportion of such colonists (Deog *et al*., 1989). Environmental changes might terminate or destroy a benthic community. However, a recolonization process begins as soon as conditions are improved (Fenoglio *et al*., 2002).

The objective of the present study was to examine quantitative and qualitative characteristic of movements upstream and downstream by analysing colonization patterns of macroinvertebrates in stony Gökpınar stream.

MATERIALS AND METHODS

Present study was conducted at Gökpınar stream (geographical co-ordinates 29°11' E, 37°44' N) and located in northeast Denizli. The average discharge was 2,86 m^3/sn. The substrate consists of natural various sizes of rocks, cobbles, gravel and little sand in the study stream. The stream mainly receives towns sewage and agricultural runoff and people use the water for irrigation and fish-farming. The riparian vegetation is dominated by trees, which are mainly *Populus*, *Platanus orientalis* and *Salix*.

Two groups of bare nylon substrates were placed in the two sites of Gökpınar stream in the period December 2003-November 2004 (Fig. 1). Each group contained three traps; Control (Control), F (Flow direction = downstream) and O (Opposite to flow direction = upstream). The traps consisted of a basic wooden frame, measuring 50 cm long, 40 cm wide and 60 cm high. The bottom of each trap was covered by polyethylene plastic to prevent colonization vertically from the substrate. Control traps (C) were completely open allowing colonization from all directions. Flow direction traps (F) were covered with a nylon net (mesh with 250 μm), allowing access only from flow direction and opposite to flow direction traps (O) were covered with a nylon net (mesh with 250 μm), allowing access only from opposite to flow direction. Traps were

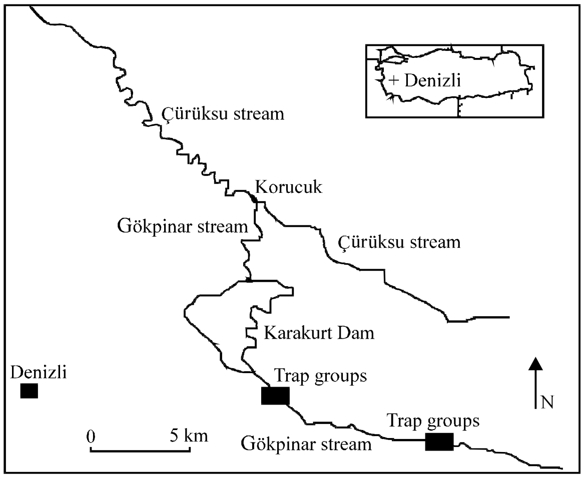

Fig. 1: Location of traps in the Gökpınar stream study area

removed after 2, 6 and 12 weeks before the traps were taken from the streambed a nylon cover was slipped around it to prevent loos of organisms.

We also conducted a sampling to quantify macroinvertebrate community structure on the natural bottom of the stream every two weeks. The samples were taken Surber sampler (500 µm mesh). All the animals collected were immediately fixed in formaldehyde (4%) in the field and then transferred to 70% ethyl alcohol. The macroinvertebrates were sorted, identified to the lowest possible taxonomic level and counted under a stereo or a compound microscope.

RESULTS

In total 24 samples were collected from the natural bottom of the stream. The traps evaluated every season. In total we collected 5010 organisms belonging to 29 taxa in the traps and 12579 organisms belonging to 58 taxa in the natural stream bottom (Table 1). Comparing the F and O traps with the C traps we found a significant differences in the number of organisms (Fig. 2, One-Way ANOVA $F = 7.38$, $p = 0.024$) and number of taxa ($F = 6.77$, $p = 0.029$). C traps were the most colonized substrate, both in number of individuals and taxa (Fig. 3) and the F traps were also more colonized than the O traps.

Analyzing the macroinvertebrate abundance in the natural stream bottom a significant differences was detected between natural samples and traps (One-Way ANOVA $F = 3170$, $p = 0.000$). Total mean benthic densities during the experiment were calculated 1746 m^{-2} for the natural stream bottom and 1045 m^{-2} for the traps. Analyzing the macroinvertebrate taxa richness, we found a significant differences between natural stream

Table 1: Occurrence of macroinvertebrate taxa in Control (C), Flow Direction (F), Opposite to Flow Direction (O) and natural stream bottom (by Surber sampler [S])

	2 weeks			6 weeks			12 weeks			
	C	F	O	C	F	O	C	F	O	S
Tricladida										
Polycelis sp.				x						x
Dugesia tigrina							x	x	x	x
Dugesia gonocephala										x
Dugesia polychroa										x
Planaria torva.										x
Tubificida										
Tubifex sp.							x			x
Nais sp.							x			x
Hirudina										
Helobdella stagnalis										x
Pharyngobdellida										
Erpobdella octoculata										x
Prosobranchia										
Theodoxus sp.										x
Pulmonata										
Lymnaea stagnalis										x
L. peregra							x	x	x	x
Physa acuta										
Unionoida										
Pisidium sp.							x			x
Araneae										
Argyroneta aquatica								x		x
Amphipoda										
Gammarus sp.	x	x	x	x	x	x	x	x	x	x
Isopoda										
Asellus aquaticus										x
Decapoda										
Potamon potamon							x	x	x	x
Ephemeroptera										
Ephemerella sp.										x
Baetis sp.	x	x	x	x	x	x	x	x	x	x
Cloeon sp.							x			x
Ecdyonurus sp.										x
Odonata										
Cordulia sp.									x	x
Calopteryx sp.								x		x
Coenagrion sp.										x
Gomphus sp.				x						x
Platycnemis sp.										x
Plecoptera										
Taeniopteryx sp.										x
Leuctra sp.										x
Hemiptera										
Notonecta sp.										x
Plea leachii										x
Trichoptera										
Philopotamus sp.				x		x				x
Lype sp.							x			x
Psychomyia sp.										x
Hyropsyche sp.	x	x	x	x	x	x	x	x		x
Polycentropus sp.										x
Holocentropus sp.										x
Glossosoma sp.							x			x
Lepidoptera										
Paraponyx stagnalis										x
Diptera										
Tipula sp.					x				x	x
Pedicia sp.										x
Dicronata sp.										x
Atherix sp.		x						x		x
Limnophora sp.										x
Bezzia sp.									x	x
Culex sp.					x	x	x	x	x	x

Table 1: continued

	2 weeks			6 weeks			12 weeks			
	C	F	O	C	F	O	C	F	O	S
Dixa sp.										x
Simulium sp.	x	x		x		x	x	x		x
Chironomus sp.	x			x	x		x	x		x
Chironomus thummi										x
Cricotopus sp.				x			x			x
Diamesa sp.				x	x	x	x		x	x
Tabanus sp.										x
Empidia sp.										x
Sepedon sp.						x			x	x
Coleoptera										
Haliplus sp.										x
Gyrinus sp.				x	x					x
Dytiscus sp.										x
Hydrophilus piceus				x			x			x

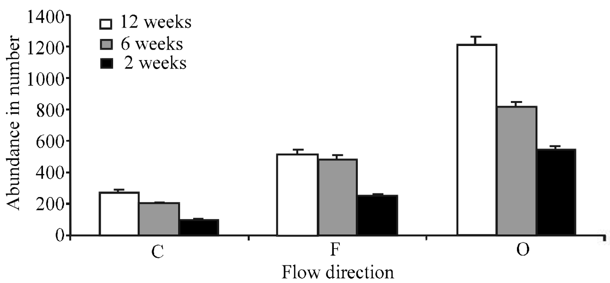

Fig. 2: Abundance of macroinvertebrates (24 traps of mean±SE) after a year colonization period in the C (Control), F (Flow direction = downstream) and O (Opposite to flow direction = upstream)

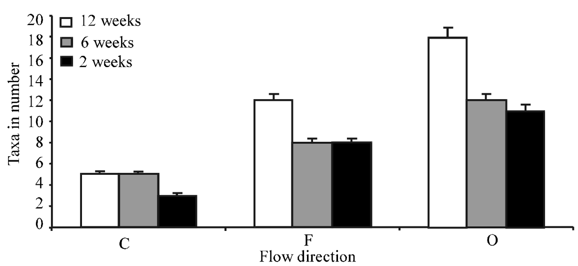

Fig. 3: Taxa number of macroinvertebrates (24 traps of mean±SE) after a year colonization period in the C (Control), F (Flow direction = downstream) and O (Opposite to flow direction = upstream)

bottom and traps (F = 104.9, p = 0.000), but not on three traps (F = 1.11, p = 0.390), C and F traps (F = 0.85, p = 0.409), C and O traps (F = 1.98, p = 0.232) and F and O (F = 0.24, p = 0.640).

The faunal composition differed among the three traps and there also differences between the traps and the natural stream bottom (Table 1). However, *Gammarus* were the most abundant organism in all traps; they represented 57, 83.3, 51 and 22.5% of the total number of macroinvertebrate in the C, F, O and natural stream bottom respectively. Also, *Baetis* and *Hyropsyche* were found in all traps. *Spedon* and *Calopteryx* were found only in the O traps, *Atherix*, *Argyroneta aquatica* and *Caenagrion*, were found only in the F traps and *Polycelis*, *Nais*, *Tubifex*, *Psidium*, *Gomphus*, *Lype*, *Glassosoma* and *Hydrophilus piceus* were found only in the C traps. There were also seasonal differences in the recolonization patterns (Kruskal-Wallis test = 10.18, p = 0.004).

DISCUSSION

The C traps, open in all direction, were colonized by a higher number of individuals than others traps. According to the results drift direction migth be most important colonization way of new areas. This confirmed by Allan (1995) that the considerable importance of downstream movement as a primary source of colonization of new areas. In addition, Allan (1995) reported that drift and upstream movements have always non-accidental and an adaptive value and drift and upstream movements have always occurred. In contrast, Fenoglio *et al.* (2002) reported that we detected no significant difference between the Surber samples and Downstream and Upstream traps. However, there was a significant difference between the Surber samples and control traps in this study.

The preferential direction of migration for different groups of organism showed variety. Winterbottom *et al.* (1997) reported that the mobility of most taxa was dependent mainly on discharge and colonization varied among species. Some groups were particularly abundant in the stream bottom and some were represented by many organism in all traps; *Gammarus*, *Baetis* and *Hyropsyche* were the most widespread taxa in all type of traps (Shaw and Minshall, 1980). Present results were detected a strong positive rheotaxis in *Gammarus* sp., *Baetis* sp. and *Hyropsyche* sp. This result agrees report by Brittain and Eikeland (1988) that taxa that regularly occur in the active drift include; *Ephemeroptera* sp., *Plecoptera* sp., *Trichoptera* sp., *Similium* sp. and *Gammarus* sp. In contrast, *Atherix, Argyroneta aquatica* and *Calopteryx* were found only in F traps and *Spedon* and *Cordulia* were found only in O traps. This might be explained phenomenon by tropic competition in species in agreement with previous studies on feeding ecology (Cummins and Klug, 1979). In these taxa *Spedon* was collector and others were predator (*Atherix*, *Argyroneta aquatica*, *Cordulia* and *Calopteryx*).

Comparison of the structural composition of the communities that colonized the bare nylon substrate disclosed an apparent seasonal pattern in the study period. In particular, some diptera species moved into the traps only in winter (e.g., *Similium*, *Bezzia*) and some species occupied the substrates only in summer (e.g., *Cordulia, Spedon*). This result agrees with the report by Fenoglio *et al*. (2002) that colonized in the study period revealed an evident seasonal pattern in some groups (e.g., *Capnia*, *Brachyptera*).

The abundance of macroinvertebrate in natural stream bottoms might show noticeable geographic differences such as substrate texture, water current, physico-chemical and biotic parameters. On this occasion the abundance of macroinvertebrate in natural stream bottom was higher than that in the artificial substrate of the C traps and others traps. Indeed the natural stream bottom represents good and various environment for macroinvertebrate.

Gökpınar stream bottom have noticeable geographic differences. These might be played a significant role in colonization process. Consequently, Present results have probably showed that constantly drifts have a significant effect for recolonizations even bare nylon substrates and downstream movement as a initial source of colonization of new areas.

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