EPHEMEROPTERA OF AN ARTIFICIAL DANUBE BACKWATER IRRIGATION SYSTEM IN AUSTRIA

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Between July 1992 and June 1993 the «Giessgang», an artificial wetland irrigation system in the impoundment area of the Danube power plant Greifenstein (Lower Austria), was investigated regarding its aquatic macroinvertebrates. Nineteen species of mayflies, including some rare and endangered ones, have been recorded in three different habitat types. The changes in fauna that are due to river regulation and impoundment constructions are discussed with respect to the alterations of the benthic communities.

INTRODUCTION

The success of wetland restoration-measures depends largely on their ability to fulfill the suite of ecological functions that formerly pristine habitats performed. The difficulty in both defining and assessing ecosystem functions contributes to the controversies that surround habitat rehabilitation (GORE, 1985; BOON *et al.*, 1992). The growing awareness of the destruction of European rivers and their wetlands (FITTKAU & REISS, 1983) leads to increasing efforts in habitat rehabilitation.

The «Giessgang», an artificial wetland recharge system, was initiated in 1984, as a product of the rising environmental conciousness, as a mitigation measure for the loss of habitat through the construction of the Greifenstein hydro-power plant. Faunistic surveys of such anthropogenically affected habitats in comparison with historical data document changes due to habitat degradation and can contribute to a better irrigation management of former floodplains.

STUDY SITE AND METHODS

This study took place north west of Vienna on the orographic left bank of the River Danube, in the Tullnerfeld. Here, within the impoundment area of the power plant Greifenstein, the Giessgang system functions to irrigate the floodplain by interconnecting former side channels, sometimes with the help of canals. The system totals approximately 42 km in length, beginning with an overflow channel at river-km 1976.4 (Altenwörth), and re-entering the Danube above the Korneuburg wharf at river-km 1943.6 (see Fig. 1). It is mainly fed by the Danube and the «Altenwörther Arm» and, together with a few tributaries, maintains a minimum flow of 4.5-5 m^3/s. Within the Giessgang, 25 traverses or small dams have been constructed. Thus the conditions alternate continuously between nearly stagnant flow and mud substrates behind the traverses to relatively high flow velocities and gravel substrates just below the outlet of each dam.

Between July 1992 and June 1993 the aquatic macroinvertebrate fauna at 12 different sites (see Fig. 1) was sampled monthly using qualitative methods. Site choice was based on substrate types and flow conditions. Three lotic sites with gravel substrate (sampling sites 4, 7, 10), three impounded sites with mud and silt substrate (sampling sites 5, 8, 9), and the aquatic and bank vegetation of four primarily lentic sites (1, 5a, 8a, 9a) were sampled. In addition to the Giessgang itself a natural wetland pool (sites 6 (mud), 6a (bank vegetation)) was included in the study. Each of these habitat types were sampled separately: the lotic areas were investigated by sampling with a surber sampler (mesh size of the net 100 µm), for the vegetation a hand net (mesh size 100 µm) and for mud and silt an «Ekman-grab» were used.

RESULTS AND DISCUSSION

During the investigation in the area of the Giessgang a total of 19 Ephemeroptera species was recorded. 113 species have been identified in Austria (MOOG, 1995); in the wetland habitats of the Austrian Danube MOOG *et al.* (1995) named 16 mayfly species.

The 12 sampled sites correspond to three different habitat types based on flow velocity and substrate: aquatic and bank vegetation in areas with reduced flow velocity (phytal), gravelly substrate in lotic areas (lithal), mud and silt substrate in stagnant water areas (pelal). The ephemeropteran communities have been grouped according to this habitat typology. Table 1 shows a species list and the occurrence of the species at the different habitat types. Species with an additional «s»

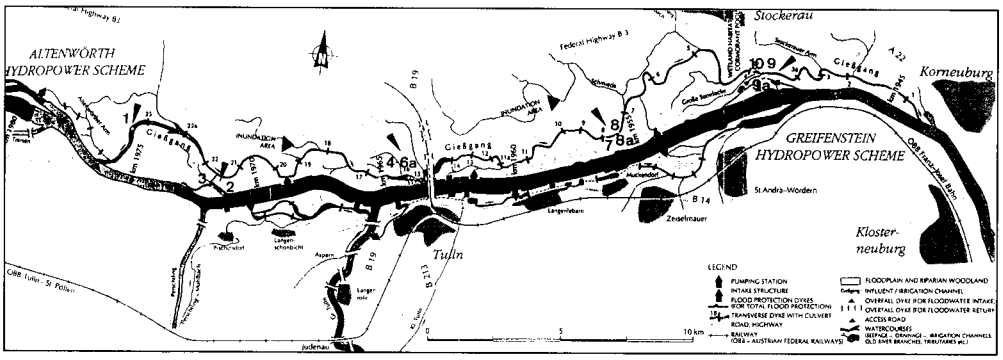

Fig. 1. Map of study site and investigation sites.

indicate single findings and are considered not to be typical for that substrate type.

Phytal

As mentioned above the ephemeropteran assemblage of the phytal consisted of 15 species. *Cloeon dipterum* was the most dominantly present faunal element in the vegetation was, followed by *Centroptilum luteolum*. Six of the 15 recorded species regularly occurred only in this habitat and are therefore considered to be typical for the phytal (*Cloeon dipterum, C. simile, Centroptilum luteolum, Procloeon bifidum, Ephemera vulgata, Siphlonurus aestivalis*).
The majority of the species were stagnophilic, typical for both stagnant waters and lentic zones of flowing waters. With the exception of *Cloeon dipterum*, which shows a clear preference to aquatic vegetation (ELLIOTT *et al.*, 1988; MALZACHER, 1973), the remaining species also occur on stony substrates.

Lithal

The gravel substrates of the Giessgang were inhabited by 13 species. The most frequently identified species was *Caenis luctuosa*. This result corresponds with MALZACHER (1986) who found the highest densities of this species on gravel substrates with a firmly attached fine detrital surface. Due to this study 7 species clearly turned out to prefer the lithal as their habitat (*Baetis fuscatus, B. lutheri, B. rhodani, B. vardarensis, Heptagenia flava, H. sulphurea, H. confusa, Ephemerella ignita*).
All identified species were rheophilic, demonstrating morphological adaptations to an environment with swift-flowing currents.

Pelal

Six species in low densities were identified in the pelal with the exception of the genus *Caenis*, none of them showing a clear preference for this substrate.

Evaluation of the Giessgang as habitat

Table 2 compares the occurrence of Ephemeroptera of the River Danube (old records are characterized by the year of the last appearence) and different floodplains in Austria and Slovakia. Most of the species recorded in the Giess-

Table 1. Occurrence of the species at the different habitat types.

	Records		
Species	**Phytal**	**Lithal**	**Pelal**
SIPHLONURIDAE			
Siphlonurus aestivalis	X		
BAETIDAE			
Baetis fuscatus		X	
Baetis lutheri	Xs	X	
Baetis rhodani		X	
Baetis vardarensis	Xs	X	
Centroptilum luteolum	X		
Centroptilum pennulatum	Xs		
Cloeon dipterum	X		Xs
Cloeon simile	X		Xs
Procloeon bifidum	X	Xs	Xs
HEPTAGENIIDAE			
Heptagenia flava	Xs	X	
Heptagenia sulphurea		X	
LEPTOPHLEBIIDAE			
Habroleptoides confusa		X	
EPHEMERIDAE			
Ephemera vulgata	X		
EPHEMERELLIDAE			
Ephemerella ignita	Xs	X	
CAENIDAE			
Caenis horaria	X	X	X
Caenis luctuosa	X	X	X
Caenis macrura	X	X	
Caenis robusta	X	Xs	X
Total	**15**	**13**	**6**

gang-system are already known from the Austrian stretch of the Danube and its backwaters, but some rare components were also found. As far as we know (compare MOOG *et al.*, 1995), *Baetis vadarensis* and *Procloeon bifidum* are recorded for the first time in the Austrian Danube-system. New species in the wetlands of the riparian forests are *Caenis macrura, Heptagenia sulphurea* and *Habroleptoides confusa*; all three are known from the main channel of the Austrian Danube.

The frequent appearance of *Caenis robusta*, which was first identified in Austria in 1986 in the Giessgang area, demonstrates the importance of this habitat. The same applies to *Ephemera vulgata*, which was recorded in the backwaters of the Austrian Danube for the first time since 1881, supported by collections in the wetlands of Klosterneuburg (Bauernfeind, in prep.). The occurrence of these two species appears to signify that these species are no longer endangered. *Heptagenia flava*, collected for the first time since 1942 in the Austrian Danube-system, must be considered as an indicator of ecologically valuable river stretches (BAUERNFEIND & WEICHSELBAUMER, 1994).

With the results of these investigations, based on the data of the «Fauna Aquatica Austriaca» (MOOG, 1995), the attempt has been made to classify the Giessgang according to the biocoenotic regions of ILLIES & BOTOSANEANU (1963) who discuss the longitudinal distribution patterns along a river channel. The deviation of a benthic invertebrate community from the accordingly natural target composition is a good tool to demonstrate the reaction of the faunal assemblages to physiographical, physical and chemical changes within a river section.

The standardization was done for selected investigation sites with a representative ephemeropteran fauna determined to species level. The result reveals three distinct sections within the Giessgang:

- At investigation sites «phyto» (1 and 8a) the biocoenosis is dominated by littoral elements (e.g. *Cloeon dipterum, Centroptilum luteolum, Ephemera vulgata, Caenis horaria*). Epi-

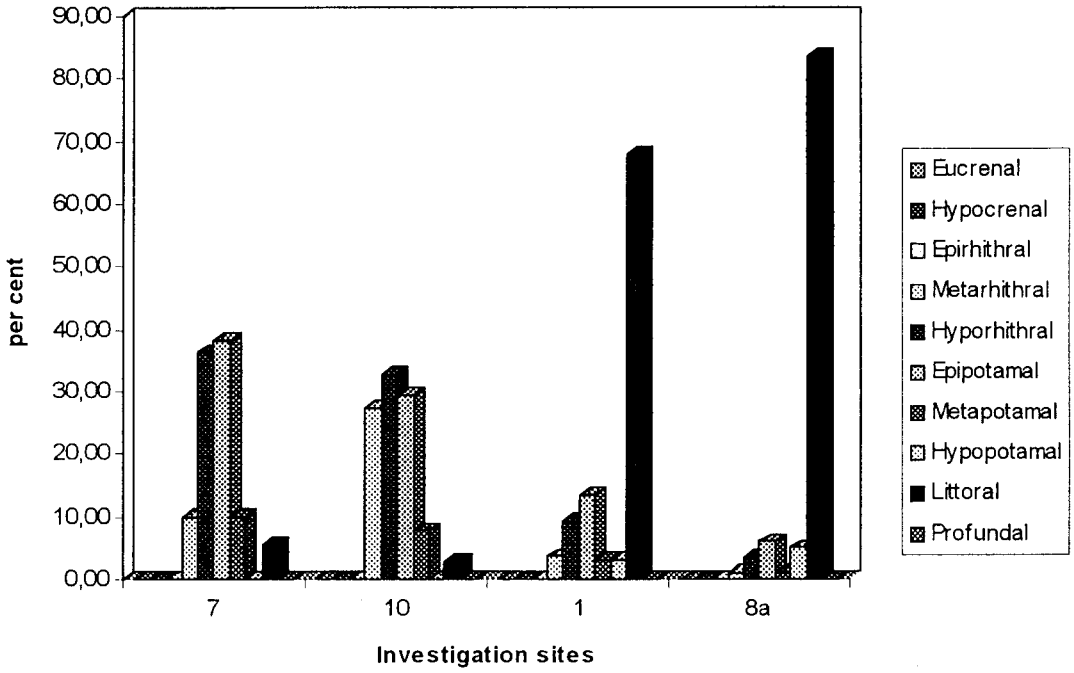

Fig. 2. Biocoenotic Regions of the Giessgang (sensu ILLIES & BOTOSANEANU, 1963).

Table 2. Occurrence of Ephemeroptera in the Danube (D), along the stretch from Altenwörth to the Greifenstein power plant (DG), in the floodplains of the Danube (DA), in the Giessgang (GG), in the wetlands of Klosterneuburg (KA) and in the Slovakian Danube (Bratislava to Palkovicovo) and ist floodplains (CZ); compare HUMPESCH & MOOG, 1994; KRNO, 1990; MOOG *et al.*, 1994, 1995.

	RECORD					
SPECIES	D	DG	DA	GG	KA	CZ
SIPHLONURIDAE						
Siphlonurus aestivalis			X	X	X	X
Siphlonurus alternatus	1942					
Siphlonurus armatus					X	
BAETIDAE						
Baetis buceratus			X		X	
Baetis fuscatus	X	X	X	X	X	X
Baetis lutheri			X	X		
Baetis niger						X
Baetis pentaphlebodes	X					
Baetis rhodani	X	X	X	X	X	
Baetis scambus			X			
Baetis vardarensis				X		X
Baetis vernus			X		X	X
Centroptilum luteolum			X	X	X	X
Centroptilum pennulatum				X		
Cloeon dipterum	X		X	X	X	X
Cloeon simile			X	X		
Procloeon bifidum				X		
HEPTAGENIIDAE						
Ecdyonurus aurantiacus	1919					X
Ecdyonurus dispar					X	
Ecdyonurus ruffii	1879	1879	X			
Ecdyonurus venosus Gr.	X					
Epeorus sylvicola	X					
Heptagenia coerulans	X	X			X	X
Heptagenia flava	1942		X	X	X	X
Heptagenia fuscogrisea	1967					
Heptagenia longicauda	before 1905					
Heptagenia sulphurea	X	X		X	X	X
Rhithrogena germanica	before 1900					
Rhithrogena landai	X	X				
Rhithrogena semicolorata Gr.	X					
LEPTOPHLEBIIDAE						
Habroleptoides confusa	X			X	X	
Habrophlebia lauta					X	
EPHEMERIDAE						
Ephemera danica			X			
Ephemera glaucops			X			
Ephemera vulgata	X		X	X	X	X
EPHEMERELLIDAE						
Ephemerella ignita	X	X	X	X	X	X
Ephemerella mesoleuca	1857					
Ephemerella mucronata	1952					
Ephemerella notata			X			
CAENIDAE						
Caenis horaria	X		X	X	X	X
Caenis luctuosa	X		X	X	X	X
Caenis macrura	X			X	X	X
Caenis pseudorivulorum						X
Caenis rivulorum	X	X			X	
Caenis robusta			X	X	X	X
OLIGONEURIIDAE						
Oligoneuriella rhenana	X					
PALINGENIIDAE						
Palingenia longicauda						X
POLYMITARCYIDAE						
Ephoron virgo	1868				X	
POTAMANTHIDAE						
Potamanthus luteus	X					X
Total	29	8	20	19	22	20

potamal and hyporhithral faunal aspects play a minor role (see Fig. 2). This distribution characterizes the Giessgang as a floodplain system and can be found in the broadened sections with often dense submerged vegetation and nearly stagnant flow. These results correspond well with the transversal community distribution as described by the «Connectivity Concept» (CASTELLA *et al.*, 1984).

- Sites with gravel sediments are inhabited by hyporhithral-epipotamal communities, that are typical for the free flowing section of the Danube below Vienna (BIFFL *et al.*, 1988).
- The 25 «traverse» weirs which control the seepage of the backwaters section and concentrate the throughflow in centrally located headraces cause quite untypically flow patterns for these floodplain waterbodies. The faunas consist of rhithralic as well as potamalic elements as represented at site 10 (compare Fig. 2).

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