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SPECIES COMPOSITION OF JUVENILE (0+) FISH ASSEMBLAGES IN THE SZIGETKÖZ FLOODPLAIN OF THE DANUBE

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Abstract. Samples of juvenile fishes were collected with a point abundance sampling strategy using electroshocker at 27 sites in the Szigetköz floodplain in late summer 1992. Species composition of assemblages was examined and related with the habitat types (parapotamon, plesiopotamon) by principal component analysis. From the 27 species recorded the juveniles of 21 species were found. The distribution of juvenile fishes was correlated with the general flowing conditions of the backwaters and their actual connectivity with the main channel.

Keywords: parapotamon, plesiopotamon, backwater, electrofishing, point abundance sampling, principal component analysis

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Introduction

The enormous variability of the braided hydrosystem in the Szigetköz floodplain made possible the development of diverse potamic biocenoses unique in Europe. Szigetköz is the geographical unit of the alluvial cone of the Little Danubian Plain on the right side of the Danube. Its borders are clearly marked by a 59 km section of the main river and the 129 km Mosoni Danube, a meandering arm.

In the second half of the 19th century the extensive regulation of the Szigetköz became necessary because of navigational problems and damages caused by inundation. The flood protection dikes divided the original floodplain into two ecologically distinct areas: the old floodplain is protected from floods by dikes, the active floodplain is situated between the dikes and the main channel of the Danube. It had an area of only 6 % of the former floodplain. The rolling and suspended alluvial sediment having been deposited on the former floodplain accumulated on the narrow active floodplain, and this process accelerated the aggradation of the main channel and the silting up of the side arms (Guti 1993). A new extensive regulation of the Szigetköz started in the 1960's. Since the 1980's, the intensive gravel extractions from the main channel have resulted in the deepening of the river bed, and the side arm systems were fed by surface water directly from the Danube during only 20 % of the year. The construction of the Gabčikovo River Barrage has exacerbated the situation. Since the end of 1992, its implementation, the diversion of the Danube's discharge away from the floodplain, has threatened the region's environment (Daubner 1981, Holčik *et al.* 1981, Holčik 1991, Guti 1993).

Despite numerous regulation hitherto made, there is a wide spectrum of aquatic habitats in the Little Danubian Plain (Bastl 1991). In general, owing to the great diversity of floodplain habitats, the number of fish species, the density of their populations, the ecological production and the fishery catch in the sections of rivers bordered by floodplains are very high. Adjacent reaches, which do not have such an extensive diversity of habitats, have lower value (Holčik *et al.* 1989).

Before the operation of the Gabčikovo River Barrage, the side arms of the active floodplains in the Little Danubian Plain were connected with the main channel of the Danube and they played a prominent role in the reproduction of fish, especially for open substratum spawning phytophils, phytolithophils and lithophils (Holčik *et al.* 1981, Holčik 1991). The spatial distribution of juvenile fish is related to the reproductive potential of floodplain habitats, and so it provides essential information for any future floodplain restoration attempts. The juveniles of nearly all species remain in their spawning ground and use it as a nursery area, and the density of juveniles tends to stabilize towards the end of the spawning season in late summer and early autumn (Copp 1989, Penáz *et al.* 1991). The present study aimed to describe the species composition of juvenile (0+) fish assemblages in the active floodplain of the Szigetköz before the hydrological changes caused by the Gabčikovo River Barrage.

Methods

The classical methods for the examination of the natural fish assemblages are based on the qualitative estimation of the composition of the temporary assemblages, i.e. the De Lury method applying the data of cumulative fish catches efforts or the mark and recapture Petersen method (Ricker 1975). These methods produce reasonable data first of all on streams and small rivers. The spatial and temporal distribution of fish assemblages in large rivers is quite heterogeneous. As a result, classical population density estimation methods would require huge samples to avoid miscalculations, but it is not realistic (Persat and Oliver 1991). A new approach to the study of riverine fish assemblages was the point abundance sampling method and strategy (Nelva *et al.* 1979). It was basically a high number of small samples instead of several large ones, which provides better statistical data for indicating the presence of populations with patchy distribution and a description of the spatial structure of the assemblages. At the end of the 1980's Copp and Penáz (1988) developed a new version of the point abundance sampling for the investigation juvenile fish assemblages by some technical changes, and it was a purposeful complement of the research programme of fluvial ecosystems in the Rhone river (Penáz *et al.* 1991).

Our study was implemented in 27 sampling sites in the active floodplain of the Szigetköz between rkm 1817 and 1840. The investigated sites were subdivided into parapotamic and plesiopotamic type of habitats (Roux *et al.* 1982, Amoros *et al.* 1987). At each sites, sampling was carried out with point abundance sampling strategy at 20-40 sampling points at a distance of approximately 10 m-s from each other in a random distribution. Fish were collected with a battery-powered electroshocker of a low output (80 W). A special anode of 10 cm developed for the catching of juvenile fish was used. A rubber boat was needed to reach the sampling points. The anode was put fast at a depth of 50 cm and the shocked fish were collected with a 1 mm mesh size dipnet of 35 cm in diameter. Small fish specimens were preserved in a 4 % formaldehyde solution.

From the material recorded, a data matrix of sampling points by fish species was created and the mean number of fish per sample, the index of aggregation (Southwood 1984) and the frequency distribution were calculated for each species. For the typological analysis of sampling sites (habitats), another matrix was derived from the data set. The numerous point samples taken from one site were summed and the resulting matrix contained the abundance of the fish species at each sampling site. This sites by species matrix was converted to absence/presence and then submitted to centered and normalized principal component analysis (Copp 1989).

Results

Samples were taken at 27 sampling sites in the active floodplain of the Szigetköz between August 4 and 19, 1992. Seven sites were plesiopotamic, the others parapotamic (Table 1). In the sampling period the water level of the Danube was very low and the side-arms were fed only by groundwater. Slow, local flow was observable at the narrow and shallow sections of some parapotamic side arms. Most of the plesiopotamic habitats were completely disconnected to other side arms.

During the survey, 5923 individual fish were caught in 730 samples from the 27 sampling sites. The standard length of the fish varied between 12 and 353 mm. From the 27 species recorded the juveniles (0+) of 21 species were found (Table 2). Altogether 4849 fry were collected, which was 82 % of the total number. There were six species *Carassius carassius, Cobitis taenia, Lota lota, Stizostedion lucioperca*, *Gymnocephalus schraetzer* and *Gymnocephalus baloni*, which were represented only by 1+ or older individuals.

The juveniles of *Rutilus rutilus* were the commonest. It was followed by *Alburnus alburnus*, *Blicca bjoerkna*, *Rhodeus sericeus amarus*, etc. (Fig. 1). The average individual number per sample was low with the exception of roach, which were represented by more than four individuals in a sample as an average. The aggregation index was the highest again with roach. It was high with *A. alburnus, R. sericeus, Leuciscus leuciscus* and *Barbus barbus* as well indicating the common occurrence of this species in groups.

The ordination resulting from the PCA of the 27 sampling sites by 21 fish species matrix (Fig. 2a) distinguished the slow flowing and stagnant sites, with most of the variance being accounted by PC1,

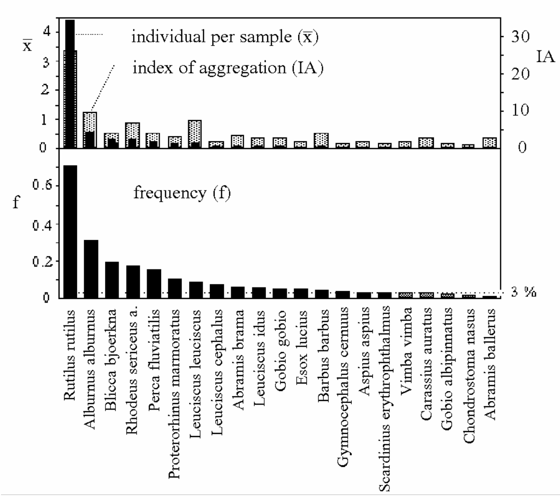

Fig. 1. The mean number of individuals per samples (X), the index of aggregation (IA) and the frequency of occurrence (f) of 0+ fish species collected in the Szigetköz floodplain, in August 1992.

as well as the species-poor and species-rich sites (PC2). The first two component of the analysis accounted for 34 % of the variation. The species richness of the sites is indicated with a square size relative to the numbers of species sampled. The presentation of the PC1×PC2 ordination by the habitat types (Fig. 2b) demonstrated that stagnant plesiopotamon type habitats (Sites: 2, 5, 6, 8, 10, 23, 24) are ordinated to the lower right, whereas the parapotamic habitats are ordinated from the left side to the upper right, which indicates their greater variance. The sampling sites where slow flow was observable (Sites: 3, 7, 15, 17, 20) are ordinated to the left side. In the stagnant sites, the grain size of the deposited mineral sediments referred to the slope gradient of the channel and the current velocities during inundation, therefore these sites were subdivided into two groups according to the dominant bed materials. Stagnant parapotamic sites where the bottom was composed of gravel (Site: 4, 9, 12, 13, 16, 21) are ordinated to the lower central, while the sites where the bottom consisted of sand and silt (Sites: 1, 11, 14, 18, 19, 22, 25, 26, 27) are ordinated to the upper right.

According to the groups of the sampling sites, the frequency distributions of juvenile fish species

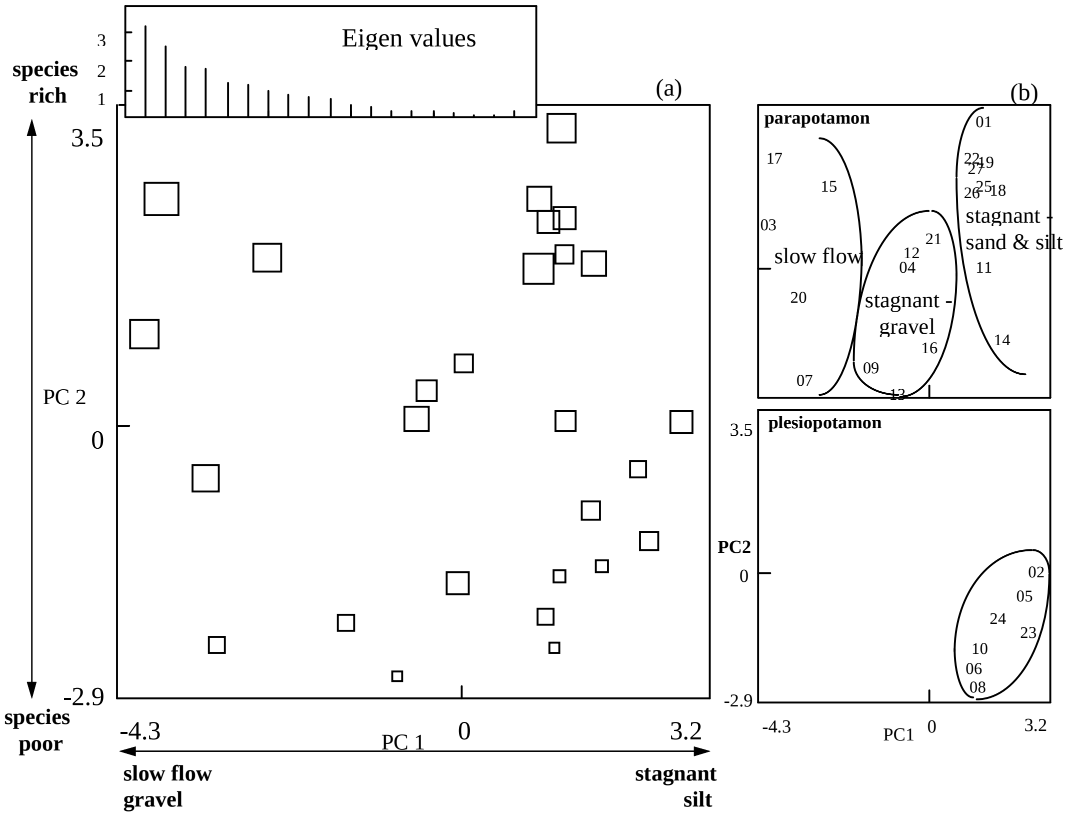

Fig. 2. Ordination of the PCA of the Sites by Species matrix. In (a), the size of squares relative to the number of species collected. In (b), the same ordination is presented according to the habitat character.

were calculated (Fig. 3). Rheophilic fishes occurred in the parapotamic side arms, however three of them, *Leuciscus cephalus*, *Gobio gobio* and *Aspius aspius* were collected from plesiopotamic waters, too. Eurytopic and limnophilic species were present both in parapotamic and plesiopotamic habitats, though *Abramis brama* was not found in plesiopotamon type of water.

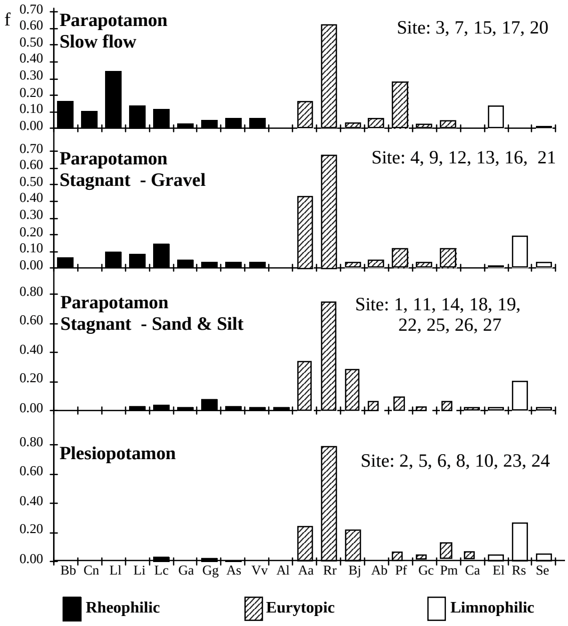

Fig. 3. Frequency of occurrence (f) of 0+ fish species in the habitat types subdivided according to the PCA ordination of the sampling sites in Fig. 2.

In the samples, 48 % of the species were rheophilic, 38 % of the species were eurytopic and 14 % of the species were limnophilic. PCA ordination of the fish species as defined by sampling sites (Fig. 4) presented the rheophilic, eurytopic and limnophilic fishes, however ecological groups were not distinguished sharply. Rheophilic species are ordinated to the lower left, some of them were in the upper centre. Limnophilic species are ordinated to the lower right. The three most frequently encountered species *(R. rutilus, A. alburnus* and *B. bjoerkna*) were eurytopic, which are ordinated to the central zone.

Discussion

Before the operation of the Gabčikovo River Barrage, at the end of 1980's, and at the beginning of 1990's most side arms were parapotamic and plesiopotamic in the active floodplain in the Szigetköz. Parapotamic side arms are permanently connected with the main channel at their downstream ends. Their flow, which is fed by both surface and groundwater may reverse due to water level fluctuations in the main channel of the river. Macrophytes are scarce but phytoplankton is rich and abundant. The fish fauna is rather diversified and the ichthyomass is moderate. Plesiopotamic backwaters are permanent or temporary stagnant formerly side arms. They are sometimes fed by groundwater. Their size changes according to the hydrological conditions. Macrophytes grow densely, phytoplankton is very abundant, algal blooms frequently occur. The fish fauna is mildly diversified and icthyomass varies from very low to very high (Holčik *et al*. 1989).

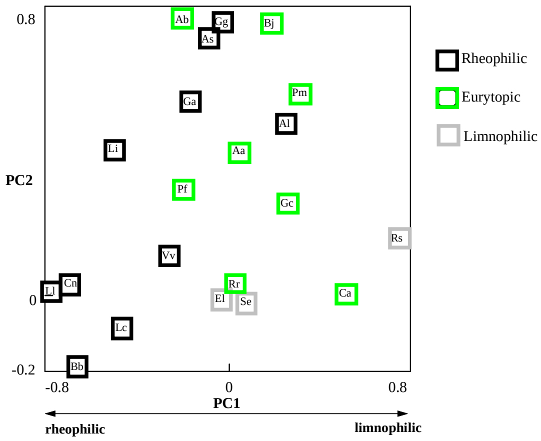

Fig. 4. The PCA of the fish species (see Table 2) as defined by the stations, from the Sites by Species matrix.

Over the sampling period, in August 1992, the backwaters were not fed by surface water in the Szigetköz, and as a consequence the current velocity decreased in the side arms and water temperature was higher than in the main channel. According to the deposition of the suspended sediment turbidity declined, primary production increased, the dissolved oxygen was higher and its daily fluctuation was more extreme. The hydrochemical and hydrobiological changes were more pronounced in more disconnected side arms (Tevanné Bartalis 1987). In stagnant backwaters there was a considerable vertical and diurnal thermal and dissolved oxygen stratification.

The species composition of juvenile fish assemblages and their distribution were related to the general flowing conditions of the sampling sites studied in the Szigetköz. The species richness of the assemblages were different in the parapotamic and plesiopotamic backwaters, the juveniles collected represented 21 and 13 species, respectively. In the subdi

Table 1: List of the sampling sites in the active floodplain of the Szigetköz. Habitat: para = parapotamon, plesio = plesiopotamon, * = slow flow, Sampl.: number of samples per site; F. ind. = number of collected juvenile fish per site; F. sp. = number of juvenile fish species.

Code	Site	Habitat	Date	Sampl.	F. ind.	F. sp.
1	Szigeti arm	para	Aug.12	20	194	13
2	Jegenyés arm	plesio	Aug.12	10	95	10
3	Kecölcés weir	para*	Aug.04	30	171	13
4	Csákányi arm I.	para	Aug.04	30	135	11
5	Csákányi backwater	plesio	Aug.07	30	118	7
6	Muki oxbow	plesio	Aug.12	10	88	7
7	Doborgazi canal weir	para*	Aug.06	20	48	7
8	Schisler oxbow	plesio	Aug.07	30	38	4
9	Csákányi arm II.	para	Aug.05	30	46	7
10	Akali arm	plesio	Aug.06	30	75	5
11	Kerekesciglés arm I.	para	Aug.11	30	209	9
12	Kerekesciglés arm II.	para	Aug.11	20	105	9
13	Bodaki arm I. (Kôhíd)	para	Aug.11	30	21	4
14	Bodaki arm II.	para	Aug.05	30	44	5
15	Gombócos weir	para*	Aug.17	25	235	13
16	Újszigeti arm	para	Aug.17	35	200	10
17	Halrekesztô weir	para*	Aug.17	40	238	15
18	Halrekesztô arm	para	Aug.15	30	348	11
19	Morva arm	para	Aug.15	20	207	10
20	Szürke weir	para*	Aug.19	30	364	12
21	Öntési arm	para	Aug.19	30	124	8
22	Pókmacskási arm	para	Aug.19	30	303	11
23	Pókmacskási oxbow	plesio	Aug.19	30	146	8
24	Ásványi backwater	plesio	Aug.16	20	248	8
25	Béka arm	para	Aug.16	30	452	
26	Szilfási arm I.	para	Aug.18	30	275	14
27	Szilfási arm II.	para	Aug.18	30	322	10

Table 2: Species recorded in juvenile fish assemblages in 1992 in the active floodplain of the Szigetköz, with indication of their ecological groups (Schiemer and Spinder 1989) and their occurrence (+) in parapotamic and plesiopotamic habitats.

Code	Species	Ecol. group	Parap.	Plesiop.
Bb	*Barbus barbus*	rheophilic	+	-
Cn	*Chondrostoma nasus*	rheophilic	+	-
Ll	*Leuciscus leuciscus*	rheophilic	+	-
Li	*Leuciscus idus*	rheophilic	+	-
Lc	*Leuciscus cephalus*	rheophilic	+	+
Ga	*Gobio albipinnatus*	rheophilic	+	-
Gg	*Gobio gobio*	rheophilic	+	+
As	*Aspius aspius*	rheophilic	+	+
Vv	*Vimba vimba*	rheophilic	+	-
Al	*Abramis ballerus*	rheophilic	+	-
Aa	*Alburnus alburnus*	eurytopic	+	+
Rr	*Rutilus rutilus*	eurytopic	+	+
Bj	*Blicca bjoerkna*	eurytopic	+	+
Ab	*Abramis brama*	eurytopic	+	-
Pf	*Perca fluviatilis*	eurytopic	+	+
Gc	*Gymnocephalus cernuus*	eurytopic	+	+
Pm	*Proterorhinus marmoratus*	eurytopic	+	+
Ca	*Carassius auratus*	eurytopic	+	+
El	*Esox lucius*	limnophilic	+	+
Rs	*Rhodeus sericeus amarus*	limnophilic	+	+
Se	*Scardinius erythrophthalmus*	limnophilic	+	+

visions of the parapotamon type arms, the number of the species was same, but the composition of the assemblages was slightly dissimilar. Great differences were detected in terms of the nursery capacity of the parapotamic habitats in the French section of the Rhone river. Such aspects the actual degree of connectivity with the main channel, and the intensity of groundwater alimentation appeared to be especially decisive. The increasing intensity of primary production considerably deteriorated the nursery of juveniles (Penáz *et al.* 1991). According to these experiences, a decreasing tendency of abundance of rheophilic species appeared in the habitats in the direction from slow flowing parapotamon towards stagnant parapotamon with sand and silt composed bottom in the Szigetköz.

Owing to the low input of water in the floodplain, the distribution of rheophilic fish was limited and the occurrence of limnophilic species were relatively wide-spread. Juveniles of rheophilic species clumped in the slow flowing habitats, mainly below the cross weirs, which may function as refuges for them, during the low discharge period in late summer.

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