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First reconnaissance of habitat partitioning and fish diversity in the alluvial zone of the river Vjosa, Albania

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Knowledge and understanding on habitat ecology of fish is a basic step for developing management and conservation measures. We investigated fish species distribution and fish habitat partitioning at the Poçemi floodplain area of the Vjosa River. The study was conducted during one week in April 2017. Sixteen species, including several protected and endangered species were captured. The results of this study provide first insights of fish habitat use for the river Vjosa, exhibiting distinct fish assemblages of different aquatic habitat types. The heterogenic habitat configuration provides conditions for a variety of ecological guilds and consequently significantly increases the recorded fish biodiversity. Finally, the results are discussed with regard to the life cycle of riverine fish and different seasonal and daily habitat demands and migration patterns.

Meulenbroek P., Shumka S. & Schiemer F., 2018: Erste Erkenntnisse zur Fisch Diversität und Lebensraumnutzung in der Furkationszone der Vjosa, Albanien.
Grundlegende Kenntnisse zur Habitatnutzung von Fischen sind eine Voraussetzung für die Entwicklung von Management- und Schutzmaßnahmen der Fischfauna in Flüssen. Die vorliegende Studie gibt einen ersten Einblick der Fischartenzusammensetzung und ihrer Lebensraumnutzungen in der Počemi-Furkationszone der Vjosa in Albanien. In der einwöchigen Untersuchung im April 2017, konnten insgesamt 16 Arten, darunter mehrere geschützte und vom Aussterben bedrohte Arten, nachgewiesen werden. Die Ergebnisse liefern erste Erkenntnisse in der Nutzung diverser aquatischer Lebensräume durch verschiedene Fischarten und Altersstadien. Die heterogene Lebensraumausgestaltung bietet für eine Vielzahl von ökologischen Gilden optimale Bedingungen und erhöht damit die detektierte Fischartenvielfalt. Abschließend werden die Ergebnisse unter Berücksichtigung des Lebenszyklus von Flussfischen, saisonalen und täglichen Änderungen der Lebensraumansprüche sowie die damit verbundene Migration diskutiert.

Keywords: Fish habitat, Life cycle, Habitat niche, Riverine fish.

Introduction

For conservation measures and proper understanding of the ecology of riverine fish, there is an urgent need to quantify and asses physical riverine habitat characteristics and their effects on fish species composition and distribution (Gorman & Karr 1978, Yu & Lee 2002). Fish are commonly used as indicators, since a broad spectrum of abiotic variables of different spatio-temporal scales are linked to their habitat requirements and ontogenetic stages (Jungwirth et al. 2000, Schiemer 2000). More knowledge about these diverse requirements will increase their significance as bio-indicators also for Albanian rivers. Studies on fish communities and habitat choice of characteristic species provide insight for ecologically orientated river management. Especially for non-commercial species, such information is lacking worldwide (Rosenfeld 2003). This is also valid for the Mediterranean fish species. There is an urgent need for scientific research on the freshwater fish of Albania (Rakaj & Flloko 1995). Among other factors, habitat loss is one of the most important conservation problems for fish species (Dudgeon et al. 2006). This is especially acute in seasonally semi-arid environments where many small watersheds are vulnerable to human pressures. The western Balkans have one of the largest concentrations of range-restricted species (Economouå et al. 2007). The Vjosa stands out as a special case. It is widely undisturbed and has maintained fluvial dynamics throughout its course from the headwaters in Greece (Aoos) through southern Albania (Vjosa). Thus, the Vjosa represents a model system that is typical of the dynamic floodplains that have been lost in Central Europe (Schiemer et al. 2018 this volume). Therefore, the study aims to give a first insight into the spatial distribution and habitat-use patterns of the encountered fish species at the Poçemi floodplain of River Vjosa.

Methods

The main sampling campaign compromised electrofishing (EF) for juvenile and adult fish by point abundance sampling (Copp & Peňáz 1988) in April 2017 at wadable sites. The effort was kept constant and catch per unit effort (CPUE) was used for further comparisons. For EF, the backpack-generator ELT60-IIH from H. Grassl was used, according to the code of practice and national standard in Austria (Haunschmid et al. 2010). The generator operates with direct current at 1.3 kW and 500 V. Additional gill nets were used at selected sites with a mesh size of 20 mm and 50 mm.

The study site is located in the Poçemi floodplain area near the village of Kutë. The paper of Schiemer et al. (2018 this volume) provides an overview of the broad range of aquatic habitat types, especially within the active channel, ranging from fast current to stagnant conditions. Most of these habitat types were sampled for this study:

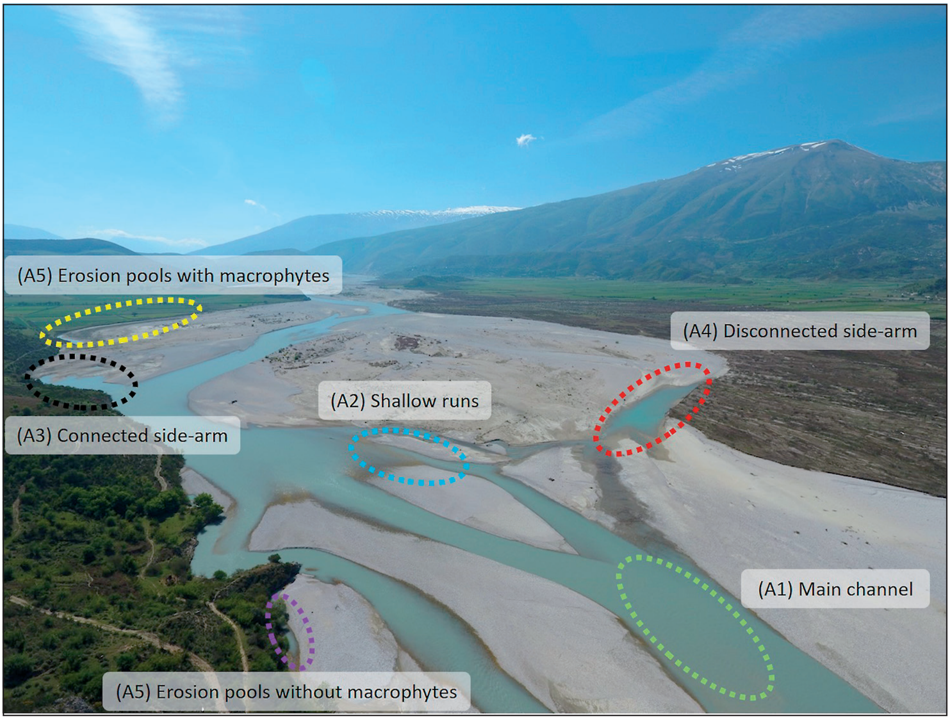

Fig. 1: Fish habitats within the active channel at the Poçemi floodplain area. Picture © Gregor Šubic. – Abb. 1: Fischhabitate innerhalb des aktiven Gerinnes der Poçemi-Furkationszone. Foto © Gregor Šubic.

(A1) Main channel of the river (litoral zones), (A2) shallow runs, (A3) downstream connected side-arms, (A4) disconnected side-arms, (A5) erosion pools within the active channel without- and with aquatic macrophytes, and (A7) waterbodies within the floodplain fed by hillside streams with clear water and macrophytes.

Such braided reaches with moderate floodplain development represent highly unstable lotic to semi-lotic alluvial channels (for a detailed description of habitat distribution and dynamics, see Schiemer et al. 2018 this volume). The dominating coarse material of bed and banks is transported and deposited by fluvial action. Very diverse and heterogeneous current and substrate patterns dominate the aquatic environment. The range of different morphological types within braided systems is very broad. A characteristic feature is the very long shoreline due to numerous channels (Jungwirth et al. 2000).

Results and Discussion

In total, the 16 verified species represent more than half of all species that have been sampled along the River Vjosa (Shumka 2018). This does not necessarily mean that other species do not inhabit this river section, as our sampling methods were limited to the shoreline and rare species are likely to be overseen with limited sampling effort. However, one of the species (*Anguilla anguilla*) recorded in this study is considered Critically Endangered, one (*Gobio skadarensis*) as Endangered, and a further three species (*Chondrostoma vardarense, Pelasgus thesproticus* and *Oxynoemacheilus pindus*) are Near Threatened and Vulnerable according to the IUCN red list. Three species are also listed in Annex III of the Bern convention (*Alburnoides bipunctatus, Chondrostoma vardarense* and *Pachychilon pictum*).

Species-specific habitat use

There were clear spatial distribution patterns for the species recorded (Tab. 1): Sites within the main channel (A1, A2) were dominated by Barbus prespensis, Chondrostoma vardarense and *Gobio skadarensis*. *Anguilla Anguilla* and *Squalius platyceps* were also commonly found. High numbers of *Oxynoemacheilus pindus* were caught in the shallow runs within the Main channel accompanied mainly by *Gobio skadarensis* and *Barbus prespensis*. The downstream connected side-arms (A3) still show species found in the running waters, though the most abundant species were *Alburnus scoranza* and *Squalius platyceps*. *Pachychilon pictum* and *Alburnoides bipunctatus* additionally characterize this habitat type.

In contrast, the three disconnected habitat types show a distinct pattern: Disconnected side-arms (A4) and small erosion pools (A5) were mostly inhabited by *Alburnus scoranza, Squalius platyceps, Cobitis ohridana* and *Pseudorasbora parva* and some individuals of the non-native *Gambusia holbrooki*. In the larger erosion pools within the active channel with a generally high cover of macrophytes and clear water situations (A5), and in the waterbodies within the floodplain fed by hillside streams (A7), *Pelasgus thesproticus*, *Alburnoides bipunctatus* and *Gambusia holbrooki* prevail, but *Pachychilon pictum, Alburnus scoranza, Squalius platyceps, Cobitis ohridana* and *Pseudorasbora parva* are also represented (Tab. 1).

The scarce available literature on habitat preferences of the native Albanian fish species derives from neighbouring countries and is in line with our results. *Oxynoemacheilus pindus* is described from rivers to brooks, over stone to rock bottom, with fast to strong cur-

Tab. 1: List of fish species found in April 2017 in different habitats types of the Poçemi floodplain area. 3: abundant, 2: common, 1: rare. – Tab. 1: Häufigkeiten der im April 2017 nachgewiesenen Fischarten für die verschiedenen Habitattypen in der Poçemi-Furkationszone. 3: häufig, 2: verbreitet, 1: selten.

	(A1) Main channel	(A2) Shallow runs	(A3) Connected side-arm	(A4) Disconnected side-arm	(A5) Erosion pools (without Veg.)	(A5, A7) Clear water (with Veg.)
Chelon sp.	2		1			
Barbus prespensis	3	2	1			
Chondrostoma vardarense	3	1	2			
Anguilla anguilla	2		1			
Gobio skadarensis	3	2	2			
Oxynoemacheilus pindus	1	3				
Dicentrarchus labrax	1					
Luciobarbus albanicus	1					
Pachychilon pictum	1		2			1
Alburnoides bipunctatus	1		2			2
Alburnus scoranza	1	1	3	2	1	1
Squalius platyceps	2		3	2	2	1
Cobitis ohridana			1	2	2	1
Pseudorasbora parva				2	1	1
Gambusia holbrooki				1	1	2
Pelasgus thesproticus						3

rent (ECONOMIDIS 2005). *Pachychilon pictum* inhabits near-shore lakes and slow-flowing stretches and backwaters of streams and rivers. Adults of *Pelasgus thesproticus* are found in springs, streams, ponds, usually in shallow, quiet water with dense vegetation (KOTTELAT & FREYHOF 2007). *Cobitis ohridana* occur in rivers and lakes, over fine to muddy sand and among algae (SANDA et al. 2008).

Figure 2 presents the relative distribution of the selected species for running waters (main channel and shallow runs), connected side-arms and standing waters (disconnected side-arm, backwaters and groundwater/alluvially fed ditches). *Chondrostoma vardarense* and *Barbus prespensis* represent more than 60% of all caught species in the running sections. They are also present in the connected side-arms but their dominance decreases as more *Squalius platyceps* and *Alburnus scoranza* appeared in the catches. Standing waters do not show these "rheophilic" species anymore where they are replaced by stagnophilic species like *Cobitis ohridana* and *Pelasgus thesproticus*. Those habitats and oxbows in the floodplains are an additional important element of the overall system (MUHAR 1996). The species are the same indifferent and stagnophilic forms that contribute to broadening the species spectrum toward potamal communities in the extensive alluvial floodplain systems of meandering rivers (JUNGWIRTH et al. 2000).

More detailed studies on these aspects are therefore essential. However, the habitat diversity and complexity found in the Pocemi floodplain provide the basis for a rich species diversity as diverse niches for different species are available (JUNGWIRTH et al. 2000).

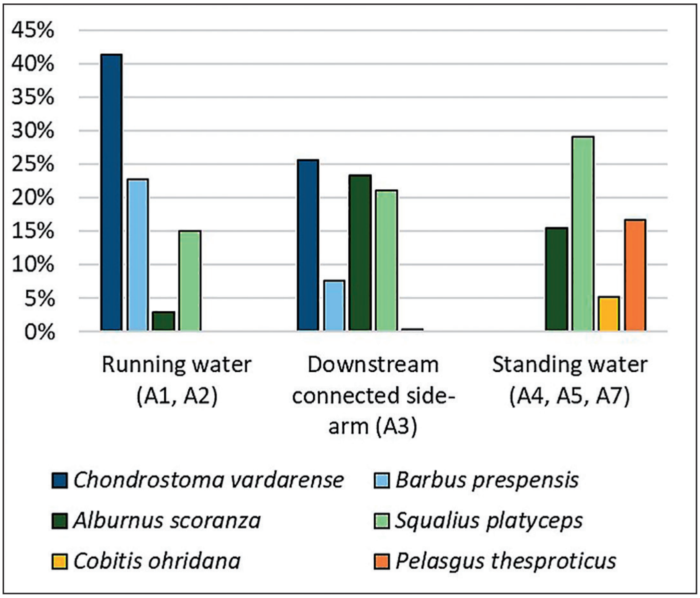

Fig. 2: Relative distribution of selected fish species for different habitats at the Poçemi floodplain area. – Abb. 2: Relative Verteilung ausgewählter Fischarten für die verschiedenen Lebensräume der Poçemi-Furkationszone.

Life cycle habitats of riverine fish

For most species the relevant biological requirements change during their life cycle and during ontogeny (Karr 1991, Schiemer 2000). In rivers, a number of studies have documented these changes by fishes within the main channel environment (Copp 1990, Schiemer & Zalewski 1991, Scott & Nielsen 1989). The various guilds integrate a wide range of riverine conditions via migration (Copp 1989, Schiemer et al. 2001, Schiemer & Waidbacher 1992). The following basic scheme (Fig. 3) gives an overview of these ontogenetical, seasonal, daily and facultative habitat shifts for stream fish.

Many riverine fish migrate to species-specific reproduction areas. This is generally a seasonal event which forms a fundamental part of the life cycle strategy of most fish species (Carolsfeld et al. 2004).The spawning habitats are sometimes located close to resting areas to recover between spawning acts (Sempeski & Gaudin 1995b).

After an incubation period lasting anywhere from a few days to several months, and after larval emergence, most species drift to some extent to nursery areas with distinct microhabitats (Lechner et al. 2016, Meulenbroek et al. 2018). Even within these rather short early life stages, niche shifts have been described (King 2004). These shifts are expressed in changes in microhabitat occurrence, which highlights the importance of a rich structure of the littoral zone with a close proximity of different habitat types (Schiemer & Spindler 1989).

Juvenile fish usually then move to “feeding habitats”, where most growth and development occurs. These “feeding habitats” normally consist of a complex mosaic of several habitat

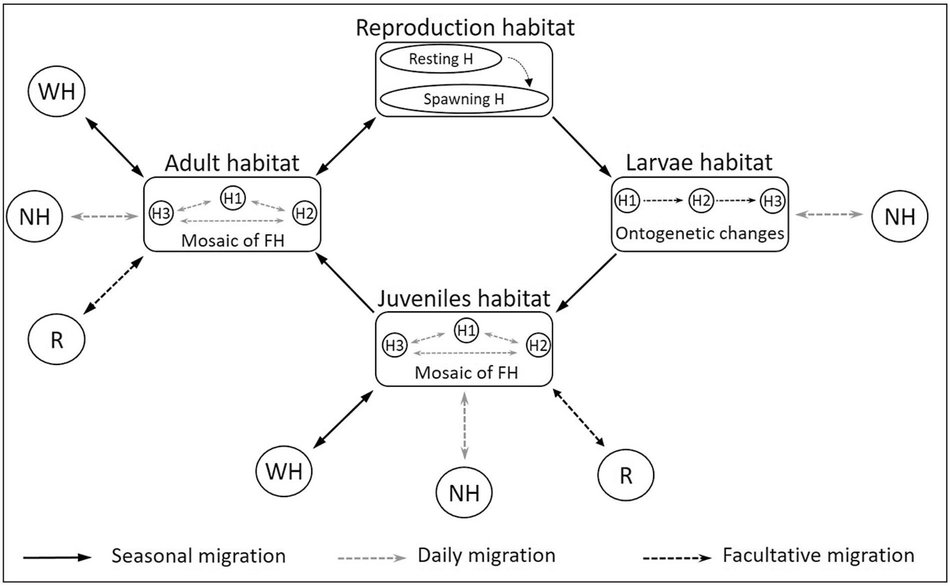

Fig. 3: Basic scheme of seasonal and daily migration pattern for riverine fish with emphasis on their life cycle and habitat use. Each box/cycle represents a specific habitat with certain characteristics: WH: Winter habitats, NH: Night Habitats, R: Refugia from harsh environmental conditions, FH: Feeding Habitat; Lines indicate seasonal, daily, and facultative migration between them (JUNGWIRTH et al. 2012, SCHIEMER & SPINDLER 1989, SCHLOSSER 1995). – Abb. 3: Grundschema der saisonalen und täglichen Migrationsmuster von Flussfischen unter Berücksichtigung ihres Lebenszyklus und verschiedenen Habitatnutzungen. WH: Winterhabitat, NH: Nachthabitat, R: Refugialbereiche bei rauen Umweltbedingungen, FH: Futterplätze; Linien kennzeichnen saisonale, tägliche und fakultative Wanderungen (JUNGWIRTH et al. 2012, SCHIEMER & SPINDLER 1989, SCHLOSSER 1995).

types (SCHLOSSER 1995). There are distinct seasonal habitat preferences of different juvenile age classes. Specific seasonal shifts between various instream and shore habitats and niche occupancy prove to be obligatory phenomena in the life cycle (JUNGWIRTH et al. 2012). The interconnectivity of the various habitat patches is required for favourable growth conditions and fulfilling the requirements of the life cycle (SCHIEMER & SPINDLER 1989). Such life stage-dependent habitat choices are also indicated by our captures. The smallest individuals (< 80 mm) of *Barblus prespensis* and *Chondrostoma vardarense* were caught in flooded shallow areas, while larger individulas (>200 mm) were exclusively caught in the nets in the middle of the main channel at a depth of around 2 m and high flow velocity.

The encountered migratory species include potamodromous species (*Barbus prespensis, Chondrostoma vardarense, Luciobarbus albanicus* etc.) that migrate within the river system, and long-distance migrants which also need access to the sea (*Anguilla anguilla, Alosa sp., Mugil sp., Dicentrarchus labrax* etc.) (KOTTELAT & FREYHOF 2007, ZOGARIS et al. 2018). The European sea bass, *Dicentrarchus labrax*, is a truly marine fish, but is euryhaline at all developmental stages (PICKETT & PAWSON 1995) and is able to grow and thrive in freshwaters (CHERVINSKI 1974). Mullets (Mugilidae) often enter estuaries and sometimes swim far up-river, (LÉVÊQUE et al. 1990). There is absence of an obligatory freshwater phase in their life cycle (BOK 1984). Transparent eel larvae (leptocephali) are brought to the coasts of Europe by the Gulf Stream in 7 to 11 months' time, but can last for up to 3 years. They are transformed into glass eels (6–8 cm length), and enter the estuaries and colonize rivers and lakes. At the end of their growth period, they become sexually mature, migrate back to the sea and cover great distances during their spawning migration (5,000–6,000 km) to the depths of the Sargasso Sea to spawn (van Ginneken & Maes 2005).

It is apparent that anadromous and catadromous migrators like sturgeons and eels require connectivity at a catchment scale and access to the sea. Potamodromous species like *Barbus prespensis, Chondrostoma vardarense* and *Luciobarbus albanicus* migrate within the river system at a smaller scale, while stagnotopic species like *Pelasgus thesproticus* are exclusively found in strongly fragmented and vegetated environments that must endure for long enough and are dependent on groundwater exchange (Kottelat & Freyhof 2007).

Daily and facultative migration

Apart from seasonal migration to different life cycle habitats, daily and facultative habitat changes are also necessary (Fig. 3) (Schlosser 1995). Fish normally experience a series of seasonally favourable periods with rapid growth and seasonably unfavourable periods. In north-temperate streams these favourable and unfavourable periods frequently involve movement between summer feeding habitats and winter habitats (Cunjak 1988, 1996). Furthermore, the availability of refugia under harsh environmental conditions, e.g. during floods, draughts or in the case of environmental disturbances are crucial (Schlosser 1995). Suboptimal conditions and the restricted availability of these habitats leads to reduced individual performances in growth or reproduction and population losses, which in turn can lead to changes in the composition of the fish community (Schiemer 2000, Schlosser 1995). Fish of all development stages also perform daily migration to night and day habitats (Crook et al. 2001, Sempeski & Gaudin 1995a) as well as different feeding habitats during the day (Schiemer & Spindler 1989, Schlosser 1995). Such patterns are also shown in the gillnet catches, exhibiting high numbers of *Alburnus scoranza* migrating from the main channel into a downstream connected side-arm during the night, while *Gobio skadarensis* and *Squalius platyceps* were more abundant during day.

Conclusion

Our results clearly show that the taxonomic composition and distribution of the fish fauna varied among the different habitats, which is based on high variability of the habitat conditions (water depth, flow velocities, substrate, etc.). This is in line with one of the key elements of ecology that habitat heterogeneity increases biodiversity (Ricklefs & Schluter 1993). Based on the reviewed literature, the availability of different habitat types provides the basis for:

(1) different species and their habitat niches/requirements,
(2) changing requirements concerning species specific demands to close the life cycle (spawning ground, nursery and feeding habitats),
(3) a daily migration to night and feeding habitats, and
(4) facultative refugia from harsh environmental conditions.

A prerequisite for a migration between these different habitats is a functioning connectivity at different scales. Further research is required to obtain a detailed understanding of the requirements of characteristic species and finally for an understanding of the river system's fish fauna. One must be aware that, rather than isolated surveys, detailed studies of the population structure are essential. The conservation of freshwater habitats is more important than that of individual species (Crivelli & Maitland 1995, Dudgeon et al. 2006). The results of this study therefore provide the first insights for the river Vjosa and could build a basis for effective conservation and management of riverine fish populations.

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