Acta ZooBot Austria **155**, 2018, 135–153

Contribution to the knowledge of aquatic invertebrate Fauna of the Vjosa in Albania

Wolfram Graf, Michal Grabowski, Monika Hess, Ullrich Heckes, Wolfgang Rabitsch & Simon Vitecek

This paper summarises the results regarding aquatic invertebrates of a few excursions to the Vjosa in Albania, in the vicinity of the villages Poçem und Kutë. It mainly aims to document the status of one of the last free-flowing rivers in Europe, based on its aquatic communities prior to the realisation of the planned building of hydropower plants.
In total, 91 taxa of Caddisflies (Trichoptera), Stoneflies (Plecoptera), Dipterans (Diptera), Alder flies (Megaloptera), Bugs (Heteroptera), Beetles (Coleoptera) and Crustaceans were recorded.
Additionally, the development of aquatic invertebrate communities of large rivers in Central Europe is shortly debated underlining the outstanding ecological status of the Vjosa. Remarks on scientific knowledge gaps in river functioning of large rivers as well as conservation issues in an international context are added.

Graf W., Grabowski M., Hess M., Heckes U., Rabitsch W. & Vitecek S., 2018: Beitrag zur Kenntnis der aquatischen wirbellosen Fauna der Vjosa in Albanien.
Die Arbeit fasst die Ergebnisse einiger Sammelreisen an die Vjosa in Albanien um die Dörfer Poçem and Kutë zusammen. Diese erste Bestandesaufnahme der aquatischen Fauna ist vor dem Hintergrund der geplanten Eingriffe in die ökologische Situation des Flusses in Form von Kraftwerksbauten eine letzte Möglichkeit, den Ist-Zustand und das Vorkommen sensitiver Arten eines der letzten frei fließenden Flüsse Europas zu dokumentieren.
Insgesamt wurden 91 Taxa aus den Gruppen Köcherfliegen (Trichoptera), Steinfliegen (Plecoptera), Zweiflügler (Diptera), Schlammfliegen (Megaloptera), Wanzen (Heteroptera), Käfer (Coleoptera) und Krebse (Crustacea) erfasst.
Zusätzlich wird die Entwicklung der aquatischen Zönosen der Wirbellosen großer Flüsse in Europa kurz dargestellt und damit die Bedeutung der Vjosa hinsichtlich notwendiger Forschungsschwerpunkte und naturschutzfachlicher Fragen im internationalen Kontext unterstrichen.

Keywords: Trichoptera, Plecoptera, Diptera, Megaloptera, Heteroptera, Coleoptera, Crustacea, large rivers,conservation.

Introduction

Aquatic invertebrates are highly diverse and comprise large groups of different systematic units, including flatworms, annelids, nematodes, molluscs, crustaceans and insects.

They are decisive elements for ecosystem functioning and are essential parts of the riverine food web, covering all levels from primary consumers to predators, and are considered a major food resource for fishes. Although most of these groups are small in body size, their high productivity and population densities lead to significant overall biomass which, in the case of merolimnic organisms, is transferred via emergence to other habitats and is an important resource for terrestrial predators like amphibians, reptiles, birds and bats.

Prehistoric events in geological timescales entailing orogenesis, glaciation, plate tectonics or the Messinian salinity crisis shaped the present zoogeography at large scales. On a site-scale, hydraulic conditions, temperature, oxygen content, substrate composition and turnover, food resource quality and availability, as well as intra- and interspecific competition are observed to be the main parameters controlling species distribution along different environmental gradients. In turn, this results in typical distribution patterns, as most invertebrate species are restricted to distinct and quite small environmental niches. Detailed knowledge on autecological (micro-) habitat preferences of species makes the benthic invertebrate communities ideal bio-indicators in various kinds of environmental analyses, as they respond not only to organic pollution but to any change in environmental conditions.

A recent bibliographical survey conducted at Berkeley University (USA) revealed that macro-invertebrates are the most popular group for assessing the ecological integrity of freshwater systems (Mandaville 2002). Within insects, mayflies (Ephemeroptera), stoneflies (Plecoptera) and caddisflies (Trichoptera) are summarised as the so-called EPT-taxa that play an outstanding role as focal elements in ecological assessment systems and in monitoring water quality worldwide (e.g. Barbour et al. 1999, Barbour & Yoder 2000, Birk et al. 2012, Wright et al. 2000, AQEM consortium 2002, Hering et al. 2006).

Besides some iconic odonates, molluscs and crayfish, the contribution of benthic invertebrates to biodiversity in natural riverine systems is not acknowledged by the general public. This is due to the fragile and often minute bodies of aquatic invertebrates. Likewise, the relevance of benthic fauna as keystone elements that maintain aquatic ecosystem services is disregarded.

Aquatic biodiversity is being extirpated at both regional and worldwide scales through modification of natural habitats, with the highest losses in species that are sensitive to environmental degradation. Particularly areas comprising high numbers of (micro-) endemic species are losing biodiversity at an unprecedented pace. In Europe, the Balkan represents such a hot-spot, created by complex speciation processes, but where information on distribution or ecological needs of species is gravely deficient. Unfortunately, this is not comprehensively reflected by any legislation, neither within the European Union nor on a national level, although the Convention on Biodiversity was signed by all European states. Enhanced conservation efforts to stop irretrievable losses of biodiversity and crucial ecosystem services are therefore urgently needed. Concerning aquatic ecosystems, conservation efforts need to be linked to riverine management plans on a catchment scale as a prerequisite to maintaining aquatic diversity and ecosystem function.

Natural river systems like the Vjosa and the Vjosa catchment are virtually eradicated in Europe because of historic and on-going anthropogenic interventions. At the same time, we generally lack detailed information on the complex interlinkages between complementary riverine biota (algae, microbes, invertebrates and fishes), energy and nutrient cycling and general abiotic processes within these highly dynamic systems. Likewise, the role of recurring disturbances induced by hydrological dynamics, sediment load and turnover, and many other factors on ecosystem function is seldom studied and even more rarely understood. Aquatic invertebrate communities integrate and reflect these processes over time and space. However, the majority of taxa dependent on large, undisturbed rivers are now confined to scattered small-scale refugia, like the Vjosa. At the same time, to improve our basic understanding of riverine systems at a catchment scale, studies on such dynamic environments are direly needed.

The Vjosa is one of the few remaining ecological islands left in Europe and is therefore a scientific and cultural model-case of international importance.

Methods

Information on the aquatic invertebrate fauna of the Vjosa valley is scarce. Beqiraj et al. (2008) and Chatzinikolaou et al. (2008) analysed the benthic invertebrate fauna of the Vjosa under aspects of assessing the ecological status, but the taxonomical resolution remained at genus and family level. Therefore, four short-term expeditions were conducted in June 2014 (Poçem and Tepelena; M. Hess, U. Heckes & W. Graf), in October 2016 (Poçem and Kutë; S. Beqiraj & W. Graf), April 2017 (Kutë; U. Heckes, S. Vitecek, S. Beqiraj, W. Rabitsch & W. Graf) and September 2017 (Kutë; W. Graf) in order to investigate the invertebrate community on the species level. The following results refer to these dates.

Aquatic stages of invertebrates were sampled qualitatively with a hand-net while disturbing the bottom substrate. Specific habitats like large woody accumulations or macrophytes were sampled by hand-picking the specimens from the surface. Adults were collected by sweeping the riparian vegetation with a net or/and with light traps of different settings placed directly on the river banks (Figure 7).

We tried to screen all different aquatic habitats described by Schiemer et al. (2018 this volume). As the aim of the present study is to document the biodiversity of the Vjosa, and only qualitative samplings on few occasions were taken between the villages Kutë and Poçem, we refrain from any abundance criteria.

Fig. 1: Diptera attracted by light at Kutë. – Abb. 1: Diptera am Licht bei Kutë.

Organisms were identified by the following experts: Grabowski M., Lodz, Poland – Decapoda; Hess M. & Heckes U., Munich, Germany – Coleoptera; Rabitsch W., Vienna, Austria – Heteroptera; Graf W., Vienna, Austria – Trichoptera, Plecoptera, Megaloptera, Blephariceridae; Malicky H., Lunz a. See, Austria – Trichoptera;

Photos, if not mentioned otherwise, were taken by W. Graf.

Fig. 2: *Rhyacophila diakoftensis* (Trichoptera: Rhyacophilidae). – Abb. 2: *Rhyacophila diakoftensis* (Trichoptera: Rhyacophilidae).

Fig. 3: *Hydroptila* sp. (Trichoptera: Hydroptilidae) (Photo: Kunz G.). – Abb. 3: *Hydroptila* sp. (Trichoptera: Hydroptilidae) (Foto: Kunz G.).

Fig. 4: Larva of *Marthamea vitripennis* (Plecoptera: Perlidae). – Abb. 4: Larve von *Marthamea vitripennis* (Plecoptera: Perlidae).

Fig. 5: Male of *Perlodes* cf. *floridus* (Plecoptera: Perlodidae). – Abb. 5: Männchen von *Perlodes* cf. *floridus* (Plecoptera: Perlodidae).

Fig. 6: *Atyaephyra thyamisensis* (Crustacea: Decapoda). – Abb. 6: *Atyaephyra thyamisensis* (Crustacea: Decapoda).

Results

Although this study reflects only a snapshot of the existing diversity, 91 taxa (Decapoda – 2 species, Amphipoda – 1 species, Trichoptera – 37 species, Plecoptera – 8 species, Megaloptera – 1 species, Blephariceridae – 1 species, Coleoptera – 35 species, Heteroptera – 6 species) were documented:

Insecta

Order Trichoptera

Family Rhyacophilidae

Rhyacophila diakoftensis Malicky, 1983
Rhyacophila nubila (Zetterstedt, 1840)

Family Glassosomatidae

Agapetus laniger (Pictet, 1834)
Agapetus rectigonopoda Botosaneanu, 1957

Family Hydroptilidae

Allotrichia vilnensis Raciecka, 1937
Allotrichia pallicornis (Eaton, 1873)
Hydroptila angulata Mosely, 1922
Hydroptila angustata Mosely, 1939
Hydroptila brissaga Malicky, 1996
Hydroptila occulta (Eaton, 1873)
Hydroptila simulans Mosely, 1920
Hydroptila sparsa Curtis, 1834
Hydroptila tineoides Dalman, 1819
Hydroptila vectis Curtis, 1834
Oxyethira falcata Morton, 1893
Stactobiella risi (Felber, 1908)

Family Hydropsychidae

Cheumatopsyche lepida (Pictet, 1834)
Hydropsyche bulbifera McLachlan, 1878
Hydropsyche incognita Pitsch, 1993
Hydropsyche modesta Navas, 1925
Hydropsyche mostarensis Klapalek, 1898

Family Polycentropodidae

Cyrnus trimaculatus (Curtis, 1834)
Polycentropus ieraptera dirfis Malicky, 1974

Family Psychomyiidae

Lype reducta (Hagen, 1868)
Psychomyia pusilla (Fabricius, 1781)
Tinodes unicolor (Pictet, 1834)
Tinodes waeneri (Linnaeus, 1758)

Family Ecnomidae

Ecnomus tenellus (Rambur, 1842)

Family Limnephilidae

Limnephilus graecus Schmid, 1965
Stenophylax mitis McLachlan, 1875

Family Lepidostomatidae

Lepidostoma hirtum (Fabricius, 1775)

Family Leptoceridae

Adicella syriaca Ulmer, 1907
Leptocerus interruptus (Fabricius, 1775)
Leptocerus tineiformis Curtis, 1834
Mystacides azurea (Linnaeus, 1761)

Family Sericostomatidae

Sericostoma flavicorne Schneider, 1845

Family Beraeaidae

Beraeamyia schmidi Botosaneanu, 1960

Since many Southeastern European species are not determinable in the larval stages, all listed species were identified in adult stages. The impressively high diversity of the family Hydroptilidae is surprising, as most of the species are restricted to slowly flowing habitats with filamentous algae (habitat A2 and A3). They probably live in discrete aquifers at the very lateral edge of the active floodplain and were caught with light traps. In such small streamlets, larvae and pupae of *O. falcata* were found in high numbers. The main channel (habitat A1) is predominantly colonised by the families Rhyacophilidae and Hydropsychidae, while Leptoceridae are restricted to the macrophyte-rich, slowly running waters far from the dynamic channels with high substrate turnover (habitat A7).

Among wide-spread European species like *L. hirtum*, *R. nubila*, *L. interruptus*, *M. longicornis*, *P. pusilla* and most of the hydroptilids, some recorded species are Balkan endemics, such as *A. vilnensis*, *R. diakoftensis*, *L. graecus*, *B. schmidi* and *A. rectigonopoda*. *S. risi* is another example of a typical large-river species which apparently has lost large parts of its range in Europe.

Order Plecoptera

Family Leuctridae
Leuctra fusca (Linnaeus, 1758)

Family Chloroperlidae
Xanthoperla apicalis (Newman, 1836)
Chloroperla tripunctata (Scopoli, 1763)

Family Perlidae
Eoperla ochracea (Kolbe, 1885)
Marthamea vitripennis (Burmeister, 1839)
Perla marginata (Panzer, 1799)

Family Perlodidae
Perlodes cf. *floridus* Kovács & Vinçon, 2012
Isoperla vjosae Graf & Vitecek, 2018

Although only a snapshot, the species list of Plecoptera contains several rare and endangered species (*Marthamea vitripennis*, *Xanthoperla apicalis*, see above), the larvae and adults of which (in particular of *Xanthoperla apicalis*) occurred in high densities. A single male of *Perlodes* cf. *floridus* (Fig. 5) was caught in April 2017 at the river bank. Egg-bearing females would be necessary to verify the identification. The recently described *Isoperla vjosae* was abundantly present in April and dominated the benthic community together with *Perla marginata* (habitat A1 and A2).

Because larvae cannot be identified to species level and because adults emerge only briefly, predominantly during winter and spring, earlier collecting trips (December to March) would probably considerably enlarge our knowledge on the Plecoptera fauna of the Vjosa.

Plecoptera generally need cold and well-oxygenated water bodies. Large lowland rivers that carry high organic loads (as is typical nowadays for such rivers in Europe) are therefore rarely colonised by a high diversity of Plecoptera, but natural rivers like the Vjosa have a typical stonefly community. In Central Europe, only *L. fusca* can frequently be found along similar watercourses, and was also found at the Vjosa far away from the main channel (habitat A3).

Order Diptera

Family **Blephariceridae**
Blepharicera fasciata (Westwood, 1842)

Larvae and pupae were attached to the surface of cobbles and boulders of side arms near Kutë (habitat A2).

Order Megaloptera

Family Sialidae
Sialis nigripes Pictet, 1865

One adult male was collected at a macrophyte-rich and slowly running backwater near Kutë (habitat A7).

Order Heteroptera

Family Aphelocheiridae
Aphelocheirus aestivalis (Fabricius, 1794)

Family Hydrometridae
Hydrometra stagnorum (Linnaeus, 1758)

Family Corixidae
Corixa affinis Leach, 1817

Family Gerridae
Aquarius paludum (Fabricius, 1794)
Gerris maculatus Tamanini, 1946

Family Notonectidae
Notonecta viridis Delcourt, 1909

Aphelocheirus aestivalis represents the first record for Albania. The distribution of the species in Southeastern Europe is not well known. It was long considered rare, but more recently it is found regularly in benthos samples. It prefers fast running waters with high oxygen concentrations because of its respiration system (plastron), and is frequently found associated with sandy or fine- to coarse-grained riverbeds (habitat A1). It feeds on different aquatic invertebrates and prefers unpolluted waters. For this reason it is a useful indicator of natural riverbed dynamics and ecosystem quality, although it can sometimes also be found in slow running waters of regulated and disturbed habitats. It is often included in national red lists of endangered species because of the loss of its habitats. The predaceous species is abundantly present at the main and side arms of the Vjosa.

Order Coleoptera

Laccophilus hyalinus (De Geer, 1774)
Laccophilus minutus (Linnaeus, 1758)
Hydaticus leander (Rossi, 1790)
Helophorus brevipalpis Bedel, 1881
Georissus costatus Laporte de Castelnau, 1840
Georissus crenulatus (Rossi, 1794)
Georissus laesicollis Germar, 1831
Laccobius alternus Motschulsky, 1855
Laccobius gracilis Motschulsky, 1855
Laccobius obscuratus Rottenberg, 1874
Laccobius cf. *striatulus* (Fabricius, 1801)
Laccobius simulatrix D'orchymont, 1932
Helochares lividus (Forster, 1771)
Enochrus sp.
Berosus affinis Brullé, 1835
Berosus jaechi Schödl, 1991
Coelostoma hispanicum (Küster, 1848)
Ochthebius foveolatus-group
Ochthebius striatus (Castelnau, 1840)
Ochthebius uskubensis Hebauer, 1986
Hydraena bicolorata Jäch, 1997
Hydraena simonidea D'orchymont, 1931
Hydraena subjuncta D'orchymont, 1929
Hydraena vedrasi D'orchymont, 1931
Limnebius perparvulus Rey, 1884
Dryops subincanus (Kuwert, 1890)
Potamophilus acuminatus (Fabricius, 1792)
Elmis rioloides Kuwert, 1890
Limnius cf. *intermedius* Faimare, 1881
Limnichus incanus Kiesenwetter, 1851
Byrrhidae Gen. sp.
Heterocerus fenestratus (Thunberg, 1784)
Heterocerus flexuosus Stephens, 1828
Augyles pruinosus (Kiesenwetter, 1851)
Augyles flavidus (Rossi, 1794)

The aquatic Coleoptera sensu latu, including some riparian families, comprises 34 species, which can be ecological characterised as follows:

Species bound to the main and side-arms like the families Elmidae and Hydraenidae. Remarkable is the occurrence of *Potamophilus acuminatus* (Fig. 12), which lives exclusively on large woody debris (see comments above) (habitat A1).

Species of gravel banks and newly created backwaters like *Laccobius alternus* and *Dryops subincanus*, which were documented in high densities. Species also belonging to that specific ecological niche are *Laccobius gracilis*, *Ochthebius uskebensis*, the *O. foveolatus*-group and *Limnebius perparvulus*.

Species of fine sediments like sandy and loamy banks belonging to the family Heteroceridae, which dwell at the land-water interface with sparse vegetation (especially algae and mosses): three species of the genus *Georissus* and *Limnichus incanus*.

Species of small backwaters like ponds: genus *Berosus*, *Helochares lividus* and *Helophorus brevipalpis* (habitat A4).

Species of macrophyte-rich backwaters: *Laccophilus* sp., *Hydaticus leander* (and other representatives of the family Dytiscidae), *Laccobius striatulus* and *L. simulatrix*, *Coelostoma hispanicum* (habitat A6).

Crustacea

Decapoda

Family Atyidae
Atyaephyra thyamisensis Christodoulou, Antoniou, Magoulas & Koukouras, 2012

Family Palaemonidae
Palaemon antennarius H. Milne Edwards, 1837

Amphipoda

Peracarida

Family Gammaridae
Echinogammarus cf. *thoni* (Schäferna, 1923)
There were three malacostracan species in the material from the Vjosa. Two of them were decapod shrimps – *Atyaephyra thyamisensis* Christodoulou et al. 2012 (Atyidae, Fig. 6) and *Palaemon antennarius* H. Milne Edwards, 1837.

The first, *A. thyamisensis*, was only recently described based on the molecular evidence and on rather subtle morphological differences to *Atyaephyra desmarestii* (Millet 1831). The species is endemic to the south-western part of the Balkan Peninsula and, besides north-western Greece (including the Ionian islands of Corfu and Lefkada), it was already reported from Greece, Albania and Macedonia (Jabłońska et al.2018). It inhabits places rich in submerged vegetation in rivers, streams and freshwater lakes. The species was only recently recorded for Albania (Jabłońska et al. 2018). At the Vjosa it is exclusively associated with large woody debris and other organic material like roots or parts of terrestrial vegetation (habitat A2).

The other shrimp species, *P. antennarius*, has been recorded for the Central and Eastern Mediterranean, namely for Sardinia, Sicily, the Apennine Peninsula, Balkan and Peloponnese Peninsula including a few adjacent Ionian and Aegean islands (Tzomos & Koukouras 2015). Like the previous species, *P. antennarius* occurs in vegetated habitats of larger streams, rivers and freshwater lakes. Most recent molecular data point out that several Balkan populations belong to old, divergent, and locally endemic phylogenetic lineages that may represent cryptic or pseudocryptic and formerly undescribed species (Jabłońska & Grabowski, unpublished) (habitat A7).

The third malacostracan species is an amphipod, *Echinogammarus* cf. *thoni* (Schäferna 1923). The morphospecies *E. thoni* is known to occur along the eastern Adriatic coast, from Croatia to Albania (Žganec et al. 2010) in various types of fresh and slightly brackish waterbodies. It is also characterised by quite high geographical morphological variability. Thus the taxonomic position of particular populations remains unclear. Most recently, molecular data have shown that *E. thoni* is, in reality, a complex of divergent phylogenetic lineages that may represent formerly undescribed species.

It was found in swampy spring areas in Poçem and at large woody debris in the Vjosa.

State of selected benthic invertebrates of large rivers in Central Europe

Large European Rivers have undergone anthropogenic modifications and have lost a high share of their indigenous fauna, especially sensitive insects like Ephemeroptera, Plecoptera and Trichoptera. Den Hartog et al. (1992) documented a disappearance of 85% of these species in the Lower Rhine, Mey (2006) describes a similar phenomenon regarding Trichoptera, and Fittkau & Reiss (1983) highlighted this fact in general.

National red lists of all European countries duly reflect this fact that some potamal invertebrates (i.e., taxa restricted to large downstream river sections) belong to the most endangered aquatic species on a European scale, due to many complex and interwoven factors such as habitat degradation, organic and toxic pollution, straightening, damming and other hydromorphological impacts (pulse releases, residual flow), loss of habitats such as wetlands, as well as population pressure by invasive species. Rates of habitat modification are currently so high that virtually all natural habitats and protected areas are destined to become ecological 'islands' in surrounding wastelands of altered habitats. This process of fragmentation and isolation in landscapes under human influence – main concepts in island biogeography theory – is predicted to lead directly and indirectly to accelerated species extinctions at both the local and the global scales, thus reducing the world's biodiversity at all levels (McArthur & Wilson 1967, Lawton & May 1995). In the context of the so called 'McDonaldization' of the biosphere (Lövei 1997) the dispersal of many species is inhibited, while others – mostly more flexible species in ecological terms – become common and overtake the niches of indigenous species. Replacement of vulnerable taxa by rapidly spreading taxa that thrive in human-altered environments will ultimately produce a spatially more homogenised biosphere with much lower diversity, and reduced ecosystem function. Regarding aquatic ecosystems and large rivers in particular, similar processes have already been observed by Fittkau & Reiss (1983), Zwick (1984, 1992) and Fochetti & Tierno de Figueroa (2006).

Nowadays, already impaired potamal communities at the edge of their ecological capability might collapse when temperature increases, amalgamating global and climate change to a deadly anthropogenic cocktail (Travis 2003). Surprisingly, there are but few examples of decreasing species numbers with increasing habitat-related and climatic tribulations in Central European lowlands. This is due to the fact that most of these communities already suffered from anthropogenic impacts and now comprise reduced and rather flexible riverine and wetland assemblages. These few surviving organisms are tolerant cosmopolitans that cover large areas and multiple ecoregions.

In particular the typical habitats of larger lowland rivers have been altered enormously within the last century by human habitat modifications. After river regulations for flood protection and navigation in the second half of the 19th century, and after pollution due to industrialisation and increasing human population, the building of power plants and damming opened a new chapter of river modifications. Nowadays, large rivers have completely different stream characteristics regarding physical, chemical and hydromorphological features like dynamics, substrates and flow velocities. Moreover, large rivers have been subject to invasions of non-indigenous species within the last decades that afflict additional negative effects on the remaining native fauna and flora.

Extant populations of autochthonous potamal organisms are isolated and persist exclusively in small and severely fragmented refugia. Examples include *Marthamea vitripennis* in the river Lafnitz/Raaba in Hungary and the Theiss/Tisza in Hungary (Graf & Kovács 2002, Kovács & Ambrus 2002), and the majority of species listed below, demonstrated and reported by e.g. Fittkau & Reiss (1983), Zwick (1984, 1992) and Fochetti & Tierno de Figueroa (2006).

The faunal assemblage recovered from the Vjosa is typical for natural large rivers that once covered large areas across Europe. Rigorous river basin management actions and the strict prohibition of further anthropogenic impact may conserve the legacy of the Vjosa for forthcoming generations, but need to implemented and fully observed soon.

Among the highly diverse benthic community found at the Vjosa there are several rare and endangered species. Five selected invertebrate species inhabiting the Vjosa may exemplarily illustrate this fact:

Marthamea vitripennis (Plecoptera: Perlidae) and *Xanthoperla apicalis* (Plecoptera: Chloroperlidae)

Both predatory species were once typical inhabitants of large rivers in Europe. Zwick (1984) already registered "a dramatic decline of the species practically everywhere in cen-

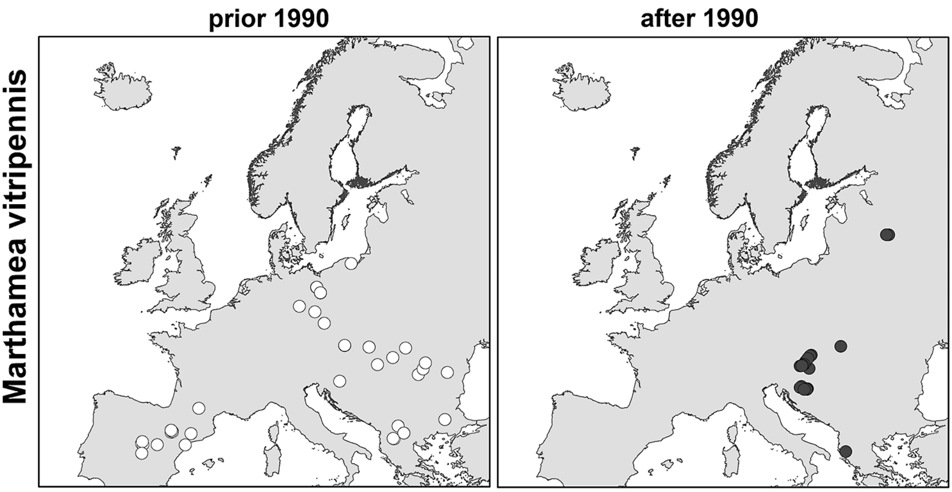

Fig. 7: Location of records of *Marthamea vitripennis* prior to 1990 (left) and after 1990 (right) (Graf et al. 2016). – Abb. 7: Nachweise von *Marthamea vitripennis* vor 1990 (links) und nach 1990 (rechts) (Graf et al. 2016).

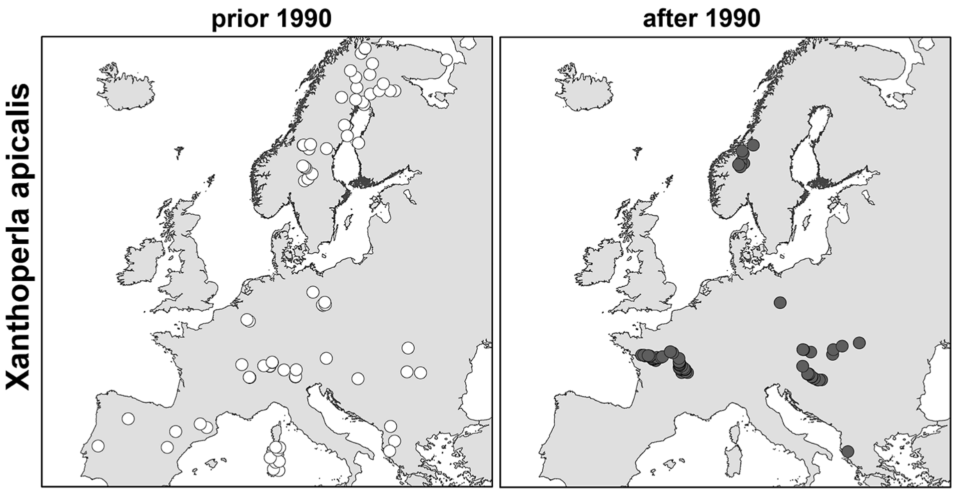

Fig. 8: Location of records of *Xanthoperla apicalis* prior to 1990 (left) and after 1990 (right) (Graf et al. 2016). – Abb. 8: Nachweise von *Xanthoperla apicalis* vor 1990 (links) und nach 1990 (rechts) (Graf et al. 2016).

tral Europe" regarding *Marthamea vitripennis* (Fig. 4). The same is true for *Xanthoperla apicalis* which lost considerable parts of its range due to anthropogenic effects (Fig. 7 & 8).

The Vjosa apparently provides suitable habitat to these plecopterans, as numerous larvae were found at the river bottom. As in many species, we know very little about their ecological prerequisites, and intensive autecological studies could provide crucially needed baseline information to enhance management plans in Central Europe.

Isoperla vjosae (Plecoptera: Perlodidae)

This species was collected for the first time during the Vjosa Science Week in April 2017 that was initiated by Riverwatch and supported by private funds. *Isoperla vjosae* (Fig. 9) was only described recently (Graf et al. 2018) and is known worldwide exclusively from the Vjosa at Kutë. As all other systematically close species from the *tripartita*-group are known from montane to submontane headwaters, the species is most likely adapted to the highly dynamic conditions presently occurring at the Vjosa. Any environmental changes obstructing the dynamic gravel-shifting conditions will seriously endanger this rheobiont species which means the worlwide extinction of this particular Albanian Plecoptera species.

Prosopistoma pennigerum (Ephemeroptera: Prosopistomatidae)

Prosopistoma pennigerum (Fig. 10) is a small Ephemeroptera with a larval body size up to 6 mm and a peculiar larval morphology indicating a derived evolutionary lineage within the order. Little is known about the ecology of this enigmatic species and very little material is available (Bauernfeind & Soldán 2012, Schletterer et al. 2016). Molecular analysis indicates that the only known populations since 2010, at the Volga river and at the Vjosa (Schletterer et al. 2018), share identical haplotypes of partial mtCOI sequences. Larvae were found in the Vjosa at Poçem and Kutë on cobbles in flow velocities between 30 and 100 cm/s, and the species is reported to occupy similar habitats in the Volga River. River

Fig. 9: *Isoperla vjosae* at the river bank of the Vjosa. – Abb. 9: *Isoperla vjosae* am Ufer der Vjosa.

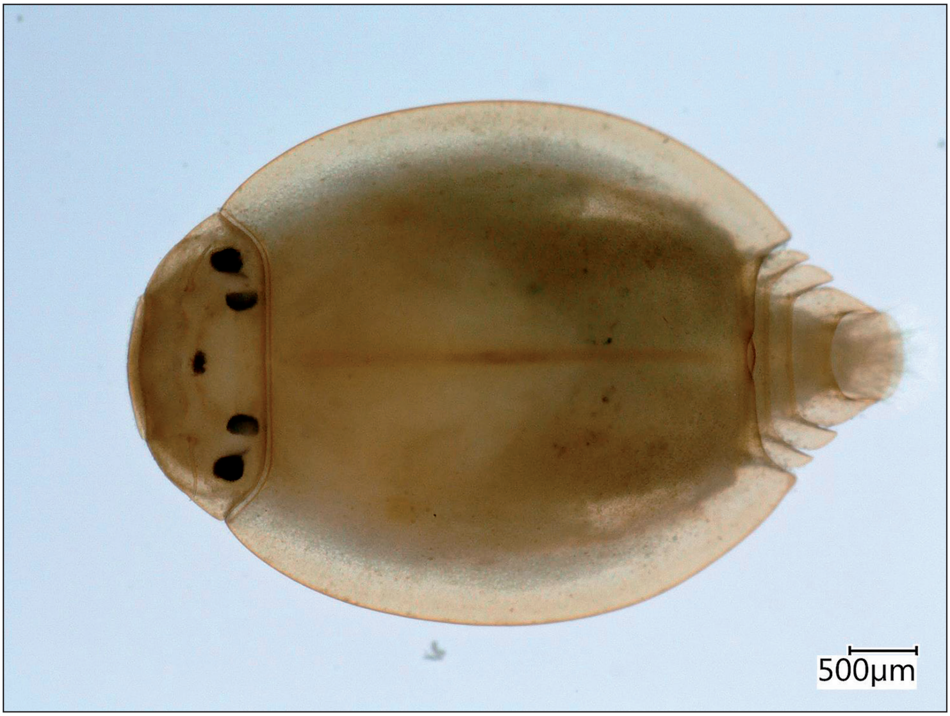

Fig. 10: *Prosopistoma pennigerum* (Ephemeroptera: Prosopistomatidae) from the Vjosa. – Abb. 10: *Prosopistoma pennigerum* (Ephemeroptera: Prosopistomatidae) aus der Vjosa.

damming would lead to extirpation of population density or extinction of these particular populations. At the Daugava River, for example, the species disappeared after the building of a power-plant dam (Schletterer & Kuzovlev 2007).

Schletterer & Füreder (2009) summarise the ecological situation of this Ephemeroptera family as follows: "the records are scattered and some species were only found once and not rediscovered after their description. Obviously Prosopistomatidae are a very rare and sensitive family, which underlines the need of a specific protection of all species i.e. the inclusion to the IUCN list (Schletterer & Füreder 2008). For example, the species *Prosopistoma pennigerum* became rare throughout Europe due to an increase of anthropogenic activities, i.e. habitat alternation and/or eutrophication, within the 20th century" (Schletterer & Füreder 2009).

As numerous specimens can be found at the Vjosa, the urgently needed studies on the ecology of *Prosopistoma pennigerum* could be conducted on this last persisting European population. Despite its small body-size, it has the potential to become a flag-ship species for natural lowland river systems.

Potamophilus acuminatus (Coleoptera: Elmidae) (Fig. 11)

Buczyński et al. (2011) state that "in many countries *Potamophilus acuminatus* is regarded as a species strongly endangered by extinction. In Austria, Czech Republic, Germany and Slovakia it has the status CR (critically endangered) (Boukal 2005, Geiser 1998, Holecová & Franc 2001, Jäch et al. 2005), due to strong decreases of national populations in relation to historical data, including regional extinction of the species

Fig. 11: *Potamophilus acuminatus* (Coleoptera: Elmidae) larva at its habitat, a dead trunk. – Abb. 11: Larve von *Potamophilus acuminatus* (Coleoptera: Elmidae) auf ihrem Habitat, ein Stück Totholz.

(Klausnitzer 1996) or its long-term absence in the whole country (Boukal 2005). The decline of *Potamophilus acuminatus* in Europe has many reasons, such as water pollution and degradation, and the development of banks (Klausnitzer 1996). Braasch (1995) for example, classified it in the highest sensitivity class regarding environmental degradation. Jäch et al. (2005) report, among others, this species' high requirements regarding water quality, and its low resistance to organic and toxic pollution: "Adverse changes of the environment result in the decrease of numbers and quality of habitats of *P. acuminatus* as well as their fragmentation (Ribera 2000)". "A specific threat is associated with trophic requirements of larvae: harmless removal of decaying wood (its main habitat) can result in the total vanishing of the species (Jäch et al. 2005). For the reasons described above, the authors postulate the inclusion of *Potamophilus acuminatus* in the Red List of IUCN in VU category (vulnerable species) (Jäch et al. 2005, Ribera 2000)".

Conclusion

The fauna of the Vjosa comprises typical elements of highly dynamic large rivers, all of which have lost large areas of their former distribution in Europe. These riverine faunal elements are highly sensitive to changes of the natural hydromorphology. Any anthropogenic alterations of this special habitat, like changes in discharge and flow regime or sediment budget, will affect this specialised assemblage. Most likely, these highly vulnerable taxa will decrease in population density, or will go extinct. Since the Albanian and the Balkan fauna and flora is poorly known regarding its benthic communities, no one can tell if this unique diversity occurs in other areas and how it will respond to large-scale hydromorphological changes. Yet, one thing is sure: any changes in this system that deprive it of its dynamic character will lead to a loss of biodiversity.

With the obliteration of the typical faunal community of this last undammed large European river, the unique opportunity to study such systems will be lost. In light of on-going restoration measures aimed at mitigating global change, the significance of such untamed rivers as models to guide restoration efforts cannot be undervalued. The Vjosa and her highly diverse floodplain in particular could serve as examples for large gravel-shifting rivers that once were common in Europe. Aside from the international relevance of this system as a reference site, local communities depend on the rich Vjosa floodplain for agriculture and as a setting for their specific cultural heritage.

The Vjosa represents a unique riverine ecosystem in Europe. The fauna and flora of this highly dynamic river represent the last inhabitants of a dwindling river refuge. Their survival depends on well-planned management of both catchment and the surrounding area. At the given pace of habitat modification in the wake of economic growth, the Vjosa and her catchment need to be included in international conservation and management schemes. As a model for restoration measures, cradle of biodiversity and natural heritage, this river and its community are too important to be lost.

Acknowledgment

The authors are grateful for the support of the Albanian colleagues, namely S. Beqiraj and A. Miho, and for the donation of specimens collected by G. Kunz. We thank B. Seaman for linguistic improvements of the manuscript and H. Malicky for taxonomical support.

Literature

AQEM consortium, 2002: Manual for the application of the AQEM system. A comprehensive method to assess European streams using benthic macroinvertebrates, developed for the purpose of the Water Framework Directive. Version 1.0. (www.aqem.de).

Barbour M.T., Gerritsen J., Snyder B.D. & Stribling J.B., 1999: Rapid bioassessment protocols for use in wadeable streams and rivers: periphyton, benthic macroinvertebrates and fish. (2nd Ed.) EPA 841-B-99-002. U.S. Environmental Protection Agency, Office of Water, Washington.

Barbour M.T. & Yoder C.O., 2000: The multimetric approach to bioassessment, as used in the United States of America. Freshwater Biological Association, Ambleside.

Bauernfeind E. & Soldán T., 2012: The Mayflies of Europe (Ephemeroptera). Apollo Books, Ollerup, Denmark, 1–781.

Beqiraj S., Liçaj P., Luotonen H., Adhami E., Hellsten S. & Pritzl G., 2008: Situation of benthic macroinvertebrates in Vjosa River, Albania, and their relationships with water quality andenvironmental state. Conference Proceedings "Balwois 2008", Ohrid, FYROM, 27–31 May 2008, 416–428.

Birk S., Bonne W., Borja A., Brucet S., Courrat A., Poikane S., Solimini A., Van De Bund W., Zampoukas N. & Hering D., 2012: Three hundred ways to assess Europe's surface waters: an almost complete overview of biological methods to implement the Water Framework Directive. Ecol. Indic. 18, 31–41.

Boukal D.S., 2005: Elmidae. In: Farkaè J., Král. D., Škorpík M. (Eds.), Červený seznam ohrožených druhù Èeské republiky.Bezobratlí – Red list of threatened species in the Czech Republic. Agentura ochrany pøírody a krajiny ÈR, Praha, 462–463.

Buczyński P., Przewoźny M., Zawal A. & Zgierska M., 2011: On the occurrence of *Potamophilus acuminatus* (Fabricius, 1772) (Coleoptera: Elmidae) in Poland. Baltic J. Coleopterol. 11(1), 45–56.

Braasch D., 1995: Zur Bewertung rheotypischer Arten in Fließgewässern des Landes Brandenburg. Naturschutz und Landschaftspflege in Brandenburg 3, 4–15.

Chatzinikolaou Y., Dakos V. & Lazaridou M., 2008: Assessing the Ecological Integrity of a Major Transboundary Mediterranean River Based on Environmental Habitat Variables and Benthic Macroinvertebrates (Aoos-Vjose River, Greece-Albania). International Review of Hydrobiology, 93, 73–87. doi:10.1002/iroh.20061093

Den Hartog C., van der Brink F. W.B. & Van der Velde G., 1992: Why was the invasion of the river Rhine by *Corophium curvispinum* and *Corbicula* species so successful? Journal of Natural History 26, 1121–1129.

Fochetti R. & Tierno de Figueroa J.M., 2008: Global diversity of stoneflies (Plecoptera; Insecta) in freshwater. Hydrobiol. 595, 365–377.

Fittkau E.I. & Reiss F., 1983: Versuch einer Rekonstruktion der Fauna europäischer Ströme und ihrer Auen. Arch. Hydrobiol., Stuttgart, 97,1, 1–6.

Geiser R., 1998: Rote Liste der Käfer (Coleoptera). In: Binot M., R Bless., Boye P., Gruttke H., Pretscher P. (Eds.), Rote Liste gefährdeter Tiere Deutschlands. Bundesamt f**ü**r Naturschutz, Bonn-Bad Godesberg, 168–230.

Graf W., Leitner P., Haidvogl G., Birk S., van Geest G., Buijse, T. & Pletterbauer F., 2016: MARS Deliverable 5-C: Report on legacy and tipping points in large rivers, MARS project- Funded by the European Union within the 7th Framework Programme, Grant Agreement 603378.

Graf W., Pauls S.U. & Vitecek S., 2018: *Isoperla vjosae* sp. n., a new species of the *Isoperla tripartita* group from Albania (Plecoptera: Perlodidae). Zootaxa 4370 (2),171–179.

Graf W. & Kovács T., 2002: The aquatic invertebrates of the Lafnitz-Rába river system in Austria and Hungary a natural heritage of the Central European potamocoen. Internat. Assoc. Danube Res. 34, 295–303, Tulcea.

Hering D., Johnson R.K., Kramm S., Schmutz S., Szoszkiewicz K. & Verdonschot P.F.M., 2006: Assessment of European streams with diatoms, macrophytes, macroinvertebrates and fish: a comparative metric-based analysis of organism response to stress. Freshwater Biol. 51, 1757–1785.

Holecová M. & Franc V., 2001: Červený (ekosozologický) zoznam chrobákov (Coleoptera) Slovenska (Red list of beetles (Coleoptera) of Slovakia). In: Baláž, D., Marhold, K. & Urban, P. (Eds.), Red list of plants and animals of Slovakia. Ochrana Prírody 20 (Suppl.), 111–128.

Jabłońska A., Vukić J., Šanda R., Zawal A., & Grabowski M., 2018: Report of Atyaephyra Thyamisensis Christodoulou, Antoniou, Magoulas & Koukouras, 2012 (Decapoda, Caridea, Atyidae) From Albania And The Republic Of Macedonia Confirmed By Dna Barcodes. Crustaceana 91 (5), 599–610.

Jäch M.A., Dietrich F. & Raunig B., 2005: Rote Liste der Zwergwasserkäfer (Hydraenidae) und Krallenkäfer (Elmidae) Österreichs (Insecta: Coleoptera). In: Zulka K.P. (Ed.), Rote Listen gefährdeter Tiere Österreichs. Checklisten, Gefährdungsanalyse, Handlungsbedarf. Part 1: Säugetiere, Vögel, Heuschrecken, Wasserkäfer, Netzflügler, Schnabelfliegen, Tagfalter (Grüne Reihe des Lebensministeriums, Vol. 14/1). Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wirtschaft.

Klausnitzer B., 1996: Käfer im und am Wasser. Westarp Wissenschaften, Spektrum Akademische Verlag, Magdeburg–Heidelberg–Berlin–Oxford,1- 237.

Kovács T. & Ambrus A., 2000: Two rare Plecopterans from Rába: *Agnetina elegantula* (Klapálek, 1905) and *Marthamea vitripennis* (Burmeister, 1839) (Plecoptera:Perlidae). Miscellanea Zoologica Hungaria, Tomus. 13, 77–80.

Lawton J.H. & May R.M. (Eds.), 1995: Extinction rates. Oxford University Press.

Lövei G.L., 1997: Global change through invasions. Nature 388, 627–628.

McArthur R.H. & Wilson E.O., 1967: The theory of island biogeography. Princeton, University Press, Princeton, New Jersey.

Mandaville S.M., 2002: Benthic Macroinvertebrates in Freshwaters – Taxa Tolerance Values, Metrics, and Protocols. Soil & Water Conservation Society of Metro Halifax.

Mey W., 2006: Ein Blick zurück: Köcherfliegen am Rhein bei St. Goarshausen im Jahre 1890 (Insecta, Trichoptera). – Lauterbornia (Dinkelscherben) 56, 155–167.

Ribera I., 2000: Biogeography and conservation of Iberian water beetles. Biological Conservation 92(2), 131–150.

Schiemer F., Drescher A., Hauer C. & Schwarz U.. 2018: The Vjosa River corridor: a riverine ecosystem of European significance. Acta ZooBot Austria 155, this volume.

Schletterer M. & Kuzovlev V.V., 2007: First record of Prosopistoma pennigerum from the Russian Federation (Ephemeroptera: Prosopistomatidae). Zoosystematica Rossica, 16(2), 169–172.

Schletterer M. & Füreder L., 2008: Entomological notes on all described species of the mayfly-family Prosopistomatidae (Insecta: Ephemeroptera) Ber. nat.-med. Verein Innsbruck 95, 67–75.

Schletterer M. & Füreder L., 2009: The family Prosopistomatidae (Ephemeroptera): a review on its ecology and distribution, with particular emphasis on the European species Prosopistoma pennigerum Müller, 1785. Aquatic Insects 31, Suppl. 1, 603–620.

Schletterer M., Bauernfeind E. & Lechthaler W., 2016: Larval redescription of Prosopistoma pennigerum (Müller, 1785) from the River Volga near Rzhev, Tver Region, Russia (Insecta: Ephemeroptera). DOI: 10.11646/zoosymposia.11.1.6

Schletterer M., Weiss S. & Graf W., 2018: Ecological and genetic considerations regarding *Prosopistoma pennigerum* (Müller, 1785) from the Volga (Russia) and Vjosa (Albania). Oral presentation at the XV International Conference on Ephemeroptera and XIX International Symposium on Plecoptera, Aracruz, Brazil.

Tzomos T. & Koukouras A., 2015: Redescription of *Palaemon antennarius* H. Milne Edwards, 1837 and *Palaemon migratorius* (Heller, 1862) (Crustacea, Decapoda, Palaemonidae) and description of two new species of the genus from the circum-Mediterranean area Zootaxa 3905 (1), 27–51.

Travis J.M.J., 2003: Climate change and habitat destruction: a deadly anthropogenic cocktail. Proc. R. Soc. London. B 270, 467–473.

Wright J.F., Sutcliffe D.W. & Furse M.T., 2000: Assessing the biological quality of fresh waters: RIVPACS and other techniques. F. B. A., Ambleside.

Žganec K., Gottstein S., Grabowski M. & Platvoet D., 2010: Distribution of the endemic amphipod species *Echinogammarus thoni* (Schäferna, 1922) in watercourses of the Balkan Peninsula. Lauterbornia 69, 41–50.

Zwick P., 1984: *Marthamea beraudi* (Navâs) and its European congeners (Plecoptera : Perlidae). Annals Limnol 20 (1–2), 129–139.

Zwick P., 1992: Stream habitat fragmentation – a threat to biodiversity. Biodiversity and Conservation 1, 80–97.

Received: 2018 06 16

Addresses:

Dr. Wolfram Graf, BOKU, University of Natural Resources and Life Sciences, Institute of Hydrobiology and Aquatic Ecosystem Management, Gregor Mendelstr. 33, 1180 Vienna, Austria.
E-mail: wolfram.graf@boku.ac.at

Dr. Michal Grabowski, University of Lodz, Department of Invertebrate Zoology & Hydrobiology, ul. Banacha 12/16, 90–237, Lodz, Poland.
E-mail: michal.grabowski@biol.uni.lodz.pl

Dipl. Biol. Monika Hess und Dipl. Biol. Ullrich Heckes, Büro H2 Ökologische Gutachten, Hess + Heckes GbR, Rumfordstr. 42, 80469 München, Germany.
E-mail: hess@buero-h2,heckes@buero-h2.de

Dr. Wolfgang Rabitsch, Environment Agency Austria, Spittelauer Lände 5, 1090 Vienna, Austria. E-mail: wolfgang.rabitsch@umweltbundesamt.at

PhD Simon Vitecek, WasserCluster Lunz, Biologische Station GmbH, Dr.-Carl-Kupelwieser Promenade 5, A-3293 Lunz am See, Austria. E-mail: simon.vitecek@wcl.ac.at