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The Vjosa in Albania – a riverine ecosystem of European significance

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Larva of the stonefly *Perla marginata*
Photo: Wolfram Graf

The riverine landscape of the Vjosa at Pocem
Photo: Gregor Subic

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The confluent of Sarandoporo and Aoos/Vjosa at the Greek-Albanian border
Photo: Lulezim Shuka

The Vjosa at the Kelcyra gorges
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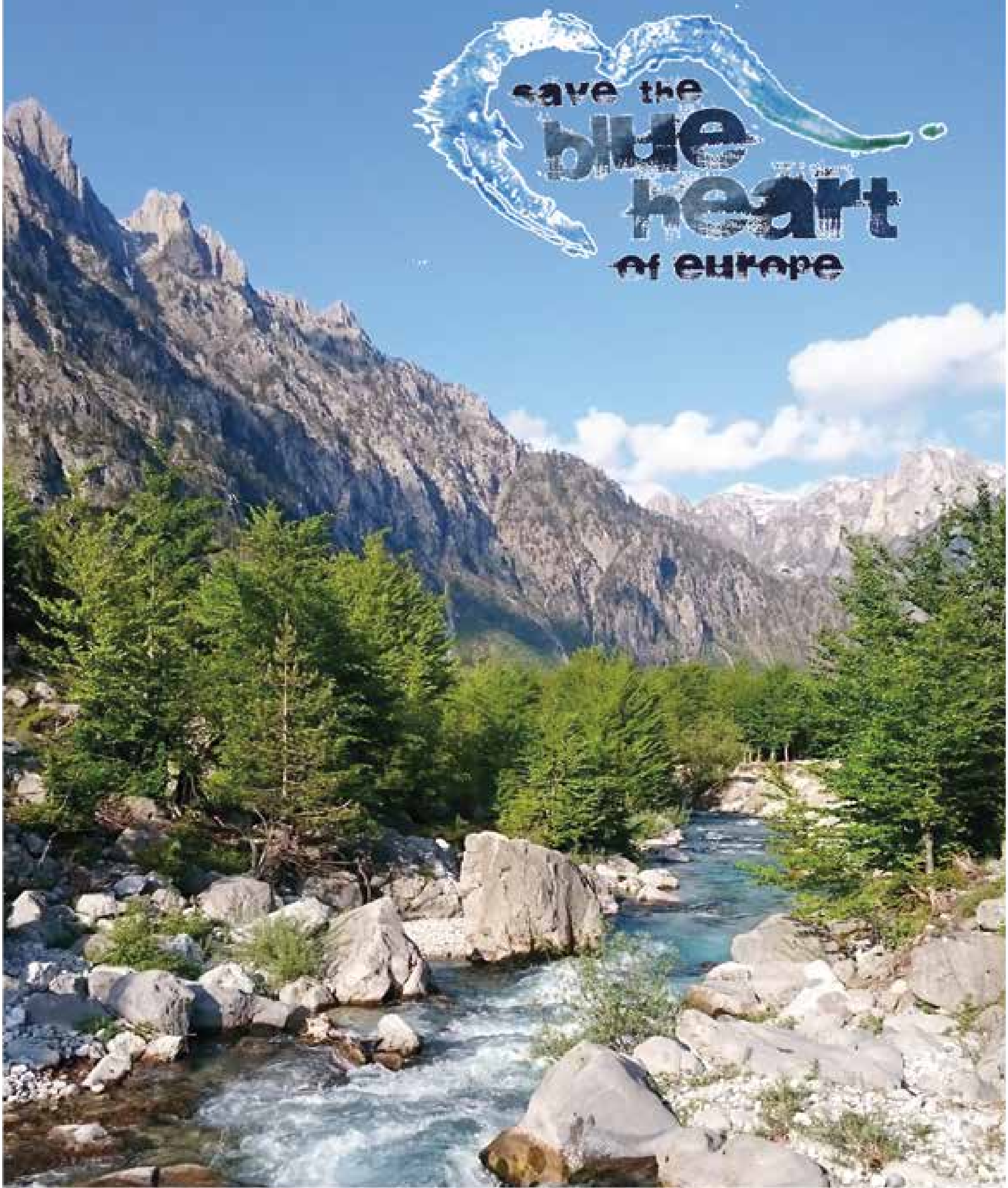

The rivers on the Balkans are the most beautiful and intact rivers of the continent. However, this Blue Heart of Europe is threatened by 3,000 hydropower plants that are projected or under construction.

The campaign "Save the Blue Heart of Europe" aims to stop this dam tsunami and to save the most valuable rivers. It is coordinated by the NGOs EuroNatur and Riverwatch and carried out jointly with partner organisations from the Balkan countries. *www.balkanrivers.net*

Content – Inhalt

Preface

Some thirty years ago, while descending on a holiday flight into Corfu airport, I was offered a spectacular view of a wild river flowing from the Albanian mountains towards the Adriatic and Ionian Sea. I was fascinated by the sight and thought that this river – its name unknown to me – would make an excellent reference and study site for undisturbed river floodplain ecosystems.

The opportunity to study the Vjosa came more than 25 years later within the framework of the „Save the Blue Heart of Europe" campaign, when we learned that two major hydropower dams had been commissioned to be built in the river's lower part. From all our knowledge, it was clear that these dam constructions would destroy a natural heritage of European significance.

Within the framework of the campaign, we initiated a cooperation with Albanian colleagues, first in form of a workshop on the Vjosa catchment at the University in Tirana, and consequently as a joint research programme. This volume is the output of these cooperative efforts. We acknowledge the financial and logistical support of the NGOs RiverWatch, EuroNatur and EcoAlbania in all of these activities.

We hope that the information presented in this volume contributes to the recognition of the outstanding value of the Vjosa landscape, and convinces Albanian decision makers that the catchment should be maintained as a national monument and not be destroyed by hydropower dams of short-sighted economic value.

I would like to thank Wolfram Graf, Aleko Miho and Sajmir Beqiraj, who functioned as guest editors for this volume, and Thomas Frank and Anton Drescher, who were particularly helpful in putting the series of papers together. The editors of Acta ZooBot Austria, Rudolf Maier and Benjamin Seaman did an excellent job of preparing the diverse manuscripts.

I would like to thank all our colleagues who contributed manuscripts on the physical, environmental and biological characteristics of this fascinating river system, opening up the challenge for continued research and further joint research efforts.

Fritz Schiemer

Acta ZooBot Austria **155**, 2018, 1–40

The Vjosa River corridor: a riverine ecosystem of European significance

Fritz Schiemer, Anton Drescher, Christoph Hauer & Ulrich Schwarz

The paper provides an overview on the ecology of the Vjosa-Aoos river system in the Balkan. Its unique value is due to the widely undisturbed and maintained fluvial dynamics throughout its course, from the headwaters in Greece (Aoos) to the delta in southern Albania (Vjosa). The ecological functions and specific biodiversity of river-floodplain ecosystems are highly dependent on their intact geomorphic dynamics. The construction of two commissioned hydropower plants would destroy the Vjosa's present high value as a natural heritage and constrict options for alternative socio-economic uses of the catchment. The apparent hazards of a dam construction in the central part of the river course have not been seriously addressed by the environmental impact assessment presented for the hydropower plans. In order to strengthen a scientific approach for management, a collaborative study of Albanian and international scientists was initiated at the floodplains of Poçemi and Kalivaçi, which are representative of the middle reach of the river. A first combined study took place in April and September 2017. It included an assessment of the geomorphology of the river and its floodplains, its habitat turnover rates, vegetation ecology and the biodiversity of major aquatic and terrestrial faunal groups. Despite the short field work period, our assessment demonstrates an excellent conservation status of highest value. The Vjosa deserves international attention as a natural laboratory for river ecology and a benchmark for European environmental policy. Before major management plans are implemented, a detailed scientific analysis of its social and environmental characteristics should be carried out as a basis for an evaluation of long-term management effects.

Schiemer F., Drescher A., Hauer C. & Schwarz U., 2018: Die Vjosa in Südalbanien: eine Flusslandschaft von europäischer Bedeutung.
Der Artikel gibt eine Einführung zu einer Serie von Aufsätzen, in der die Ökologie der Flusslandschaft der Vjosa in Südalbanien und ihre Fauna und Flora behandelt werden. Der einmalige Wert des Gebietes ist auf seiner weitgehend ungestörten flussmorphologischen Dynamik begründet. Der Bau von zwei kommissionierten Staudämmen im Mittellauf des Flusses würde den einmaligen Wert des Fluss-Systemes schwer beeinträchtigen und eine ökologische Verschlechterung im Sinne der EU-Wasserrahmenrichtlinie darstellen. Die offenkundigen Bedrohungen durch eine Staudamm-Errichtung im Mittellauf der Vjosa bei Poçemi und Kalivaçi werden in den vorgelegten Umweltverträglichkeitsprüfungen völlig unzureichend behandelt. Modernes Fluss-Management erfordert eine wissenschaftliche Basis. Um die Schutzwürdigkeit des Gebietes zu illustrieren und die Notwendigkeit einer vertieften interdisziplinären Erforschung klarzustellen, fanden im April und September 2017 erste gemeinsame Untersuchungen von albanischen und internationalen Experten statt. Sie umfassten eine Analyse der Landschafts- und Habitatstruktur und ihrer Dynamik, erste vegetationsökologische Untersuchungen sowie Erhebungen der Biodiversität wichtiger aquatischer und terrestrischer Faunengruppen. Unsere Befunde bestätigen die naturschutzfachlich herausragende Bedeutung des Gebietes auf europäischer Ebene und zeigen, dass die Vjosa als weitgehend ungestörtes Fluss-System internationale Aufmerksamkeit verdient. Im Sinne einer europäischen Umweltpolitik sind vertiefende Untersuchungen über die Schutzwürdigkeit des Gebietes sowie der zu erwartenden negativen Folgen von Staudammerrichtungen unverzichtbar.

Keywords: Balkan river, river-floodplain ecosystem, fluvial dynamics, habitat turnover, succession, biodiversity, conservation, river management, hydropower.

Introduction

Large rivers and their floodplains offer manifold services for human well-being. They represent hot spots in natural purification processes and support groundwater aquifers for drinking water supply and agriculture. They provide flood mitigation, maintenance of natural biodiversity, and offer unique opportunities for development of tourism and recreation (Junk et al. 1989, Petts & Amoros 1996, Schiemer 1999, Naiman et al. 2005, Arthington et al. 2010). The key for understanding the processes responsible for ecological services and the high biodiversity of riverine landscapes is their hydromorphologic dynamics: especially flooding and high sediment transport lead to a continued turnover of the landscape (Tockner & Stanford 2002, Thorp et al. 2006), creating "hot spots and hot moments" in the recycling of matter and the specific routing of nutrients and carbon (McClain et al. 2003, Décamps et al. 2004, Pinay et al. 2007). Like other landscapes controlled by frequent disturbances, floodplain rivers are characterized by a dynamic equilibrium of characteristic habitats despite their continued change and biological successions from pioneer stages to riverine woodlands (Pickett & White 1985, Décamps 1996, Townsend et al. 1997, Winemiller et al. 2010). The mosaic structure in context with the dynamic water level fluctuations provide the habitat conditions for a highly specific and diverse biota (Ward et al. 1999a).

River engineering in the past has resulted in a strong reduction of the original fluvial dynamics in most parts of Europe (Petts et al. 1989, Dynesius & Nilsson 1994). In turn this has had profound and long-term environmental consequences and trends, e.g. increased frequency of catastrophic floods, reduced water quality, uncontrollable incision of river beds, dwindling groundwater resources in alluvial floodplains, and loss of biodiversity (Buijse et al. 2005, Naiman et al. 2005, Tockner et al. 2008).

Over the past 20 years, operational rules for river management have been developed. EU regulations, e.g. the Water Framework Directive, stipulate the maintenance of a good ecological status. It became apparent that management must be based on a good scientific understanding of the environmental conditions and trends, which requires interdisciplinary research.

Our scientific knowledge about ecology and management of rivers refers primarily to strongly impacted and deteriorated conditions. Today, this historic over-regulation of rivers necessitates costly restoration measures for compensation. Wise river management requires improved scientific understanding. Studies of natural reference sites are highly significant in this respect (Buijse et al. 2005, Nilsson et al. 2007, Poff et al. 2003, Schiemer 2015, Surridge & Harris 2007, Vaughan et al. 2009). This makes the Vjosa so attractive for an international river science: with its widely unobstructed fluvial morphology over the entire river corridor, its longitudinal continuity in water flow and sediment transport processes from its headwaters to the Adriatic Sea, the Vjosa represents an important reference system for dynamic floodplains that have already been lost all across Central Europe.

The area is also highly interesting from a biogeographical point of view. With its high degree of endemic biota (Griffith et al. 2004, Shumka et al. 2018b this vol.) it provides excellent conditions to study ecological processes and the specific biodiversity under near-natural conditions. For these reasons, it should be conserved as a large-scale natural laboratory for river ecology and a benchmark for environmental policy of pan-European significance.

All this is endangered by the currently planned hydropower projects in the central parts of the river at Poçemi and Kalivaçi. These projects would destroy environmental services for people in its valley and lead to a major loss of its specific biodiversity. The expected hazards and threats of a dam construction are not properly addressed by the Environmental Impact Assessment (EIA) presented for the Poçemi project plan.

In order to strengthen a scientific approach in the evaluation of management options we organized an international Vjosa science conference held in June 2016 at the University Tirana, together with Albanian colleagues. A memorandum was formulated, requesting a 3-year-moratorium on construction plans of the hydropower dams to allow for a detailed assessment of the environmental, cultural and economic value of the Vjosa river system.

A research project was started in April 2017 and continued in September 2017 as a joint venture of scientists from Albania, Austria and Germany.

The expertise represented in the team of over 20 colleagues included hydrology and geomorphology, geology, limnology, vegetation ecology, and taxonomy and biogeography of major aquatic and terrestrial bio-indicator groups of invertebrates and fish.

Our program applied an integrated approach in order to create a solid background for management decisions and to help build up scientific know-how at the local institutions. Combining those interests with the expertise available at Albanian universities and institutions of higher learning provides the chance of jointly gaining insight and building up an increased local capacity for assessing riverine landscapes and the expertise to communicate scientific know-how to the public and decision makers.

The main goals of our efforts are:

- an assessment of geomorphological dynamics
- an assessment of major habitat types and their turnover rates in the light of their conservation status in an European context
- a survey of biodiversity and its distribution pattern, as well as an assessment of habitat relationships and population and meta-population dynamics in a near-natural riverine landscape.

With the presentation of first results and an outline of the general characteristics of the Vjosa catchment, we provide a starting point for further studies, a strategy for further integrated research and a baseline for a continued environmental monitoring with regard to the requirements of an Environmental Impact Assessment.

A short overview of the Vjosa catchment: geography, geology, climate & hydrology

The Aoos-Vjosa river extends over 272 km from its sources in the Pindos mountains, east of Ioannina at the foot of Mavrovouni (2159 m a.s.l.) in Greece through the south of Albania to the Adriatic Sea. During its course, it follows a SE-NW direction. The first 80 km are situated in Greece, where the river is named Aoos. The total catchment size is 6 704 km^2 of which 4 365 km^2 are on Albanian territory. Figure 1 provides an overview of the Vjosa catchment and its main tributaries and major cities.

In Greece the river flows through the Vikos-Aoos National Park characterized by deep gorges. At the border to Albania a major tributary – the Sarandoporo – combines with the Aoos to form the Vjosa. Because of the border situation, the alluvial floodplains of the Sarandoporo near the confluence are particularly undisturbed with well-maintained floodplain forests (Fig. 2). The channel pattern changes over its course in Albania (see Daja et al. 2018 this vol.). In the upper section the Vjosa follows a sequence of steep canyons between Permet, Kelcyra and Dragot, entrenched in steep gorges intersected by areas with large alluvial fans and islands (Fig. 2). After Dragot the river valley widens except for the gorges of Kalivaçi and Poçemi. At the city of Tepelena – before and after the confluence with the river Drino – large gravel and sand bars formed by the braiding river dominate the fluvial landscape. After Selenica the watershed slope of the river decreases, the valley becomes wide, and the river starts meandering (Fig. 3d). The Vjosa discharges into the Adriatic Sea north of the Narta lagoon, a managed "Nature Reserve".

Important tributaries are the Sarandoporo, Lengarica, Drino (catchment size 1 302 km^2), Bënça and Shushica (catchment size 715 km^2).

Figure 4 illustrates the elevation profile along the river course in Albania with a steeper watershed slope in the upper reach. For the last 40 km before entering the Adriatic Sea, the slope of the river is low. Here the river changes from a braided to a meandering course. This interphase in river pattern occurs over a narrow stretch of about 15 km in length. The following delta spans over 15 km river course and almost 30 km coastline including the Narta lagoon in the south (20,000 ha; see Fig. 2). Further information on the river course and its accompanying landscapes is provided by Durmishi et al. 2018 this vol., Pano & Avdyli

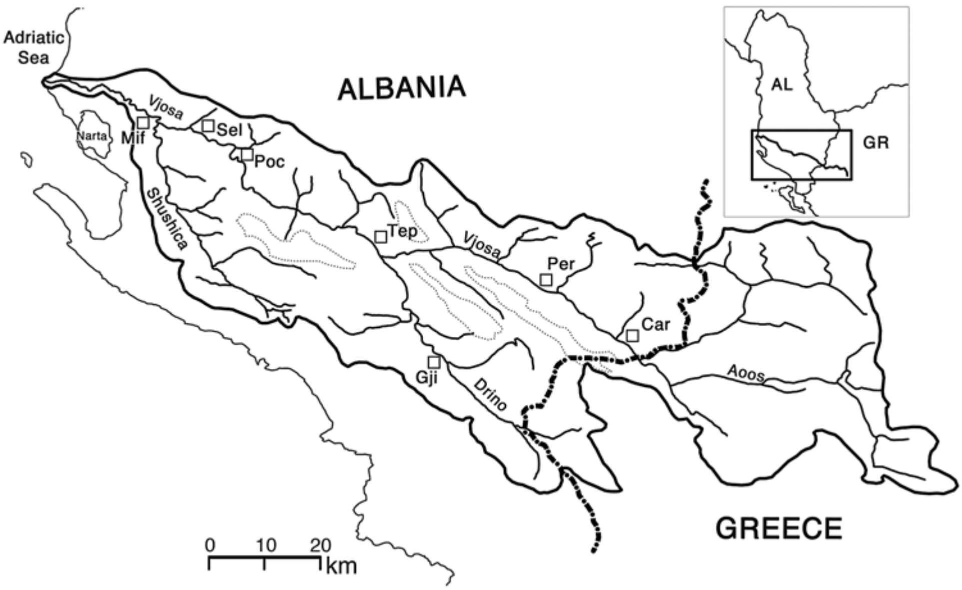

Fig. 1: Map of the Vjosa-Aoos catchment. Indicated are major mountain ranges in the Albanian part (dottet line) and the position of major cities: Mif (Mifoli), Sel (Selenica), Poc (Poçem), Tep(Tepelena), Per (Permet), Car (Çarshova), Gji (Gjirokastro). – Abb. 1: Karte des Einzugsgebietes Vjosa-Aoos. Die punktierte Linie zeigt größere Gebirgszüge im albanischen Teil, die Quadrate markieren wesentliche Städte im Einzugsgebiet.

Fig. 2: Satellite overviews of the lower Vjosa valley with the delta into the Adriatic Sea and the Narta lagoon. The image shows the short meander reach upstream of Mifoli and the intersection between the meandering and the braided river course. – Abb. 2: Satellitenaufnahmen vom Unterlauf der Vjosa mit dem Delta und der Übergangszone zwischen der Mäanderzone und der Furkationszone.

1984, Pano et al. 2008, Lazaridou-Dimitriadou et al. 2002, Apostolakis & Simixhiu 2008, Chatzinikolaou et al. 2008, Seferlis et al. 2008, Kesh-report 2009.

Geologically, the Vjosa catchment is embedded within five tectonic zones, the largest of which is the Ionian zone. They are part of the Albanides-Hellenides chain, which together with the Dinarides composes the dominant mountain range in the Western Balkans, representing the southern zone of the orogenic Alpine belt. Tectonic movements during the Permian-Triassic, the Jurassic, Cretaceous and the Neogene period led to a "fault and thrust" system in Albania and NW Greece (Durmishi et al. 2014, Durmishi et al. 2018 this vol.). The complex tectonic structure consists of two domains, the eastern or Internal and the western or External Albanides (Aliaj 2006).

The Ionian zone developed as a deep pelagial trough from the Triassic period onward. The oldest Permo-Triassic layers are covered by dolomitic limestone sedimented during the Upper Triassic to the Lower Jurassic period. The hard and consistent carbonate formations made of pelagic limestone of Upper Jurassic to Paleogene origin is covered by Oligocene to Lower Miocene flysch. The succession is completed by pre-molasse to molasse formations from the Middle Miocene onwards, consisting of various sediments like marl, sandstone and organogenic limestone (for details see Durmishi et al. 2018 this vol.). The south-eastern part of the catchment is characterized by Ophiolite, which is represented in the fine-grained sediments of the Vjosa river and its eastern tributaries.

Fig. 3: Landscape scenarios along the Vjosa, a) constrained section upstream Permeti (Photo: Schiemer), b) gorges at Permeti (Photo: Schiemer), c) the river floodplain system at Poçemi (Photo: Subic), d) downstream section (near Mifoli), where the river changes from a braided to a meandering form (Photo: Drescher). – Abb. 3: Landschaftsfotos a) eingeengten Flußlauf oberhalb von Permeti, b) Flußeinschneidungen bei Permeti c) Furkationsbereich des Flusses bei Kalivaçi und Poçemi, d) Unterlauf in Richtung Mifoli.

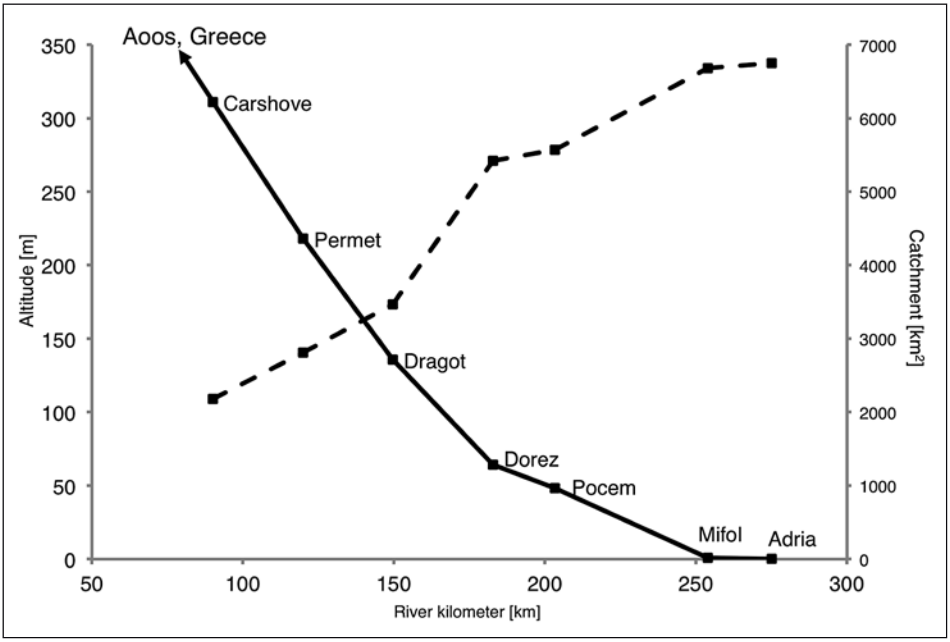

Fig. 4: Landscape profile of the Vjosa in Albania (river km vs. altitude). – Abb. 4: Höhenprofil der Vjosa (Fluss-km vs. Höhenlage).

The overall geomorphology of the Vjosa basin is characterized by a NW-SE orientation of the folded structures and tectonic planes. The valleys of the Vjosa and their tributaries follow predetermined tectonic lines of the Alpine thrust system. The middle part of the valley is surrounded by mountain ranges with an elevation between 300 metres in the north to almost 2000 m. a.s.l. in the south. The Gribe mountain range with its highest peak Mt. Kudhësit (1907 m) separates the Vjosa in the north and northeast from the Shushica valley in the southwest. At Poçemi, the river is situated between two parallel mountain ranges composed of limestone and flysch. The groundwater resource of the Vjosa basin is discussed by Durmishi et al. (2018 this vol.).

The climate of the Vjosa catchment is subject to a variety of weather patterns during the winter and summer seasons (Fig. 5). It is governed by its geographic position at the coastline facing the Adriatic and Ionian Sea and its highlands backed upon the elevated Balkan landmass. The coastal lowlands are characterized by typical Mediterranean-, while the highlands have a Mediterranean continental climate. In higher altitudes the climate resembles alpine conditions, but without glaciation (Seferlis et al. 2008). The average annual temperature oscillates around 16–17 °C in the coastal area and around 7 °C in the northern mountainous region.

The hydrological regime is classified as pluvio-nival with heavy precipitation and resulting peak-flows in spring (Pano 2015). On average, the flow of the Vjosa exhibits a distinct seasonal pattern with high water from December to April, intermediate flow in May and October and low flow from June to September (Fig. 6). Referring to published information (e.g. Pano & Avdyli 1984, Pano 2015, Kolaneci 2014 in Rössler 2017), monthly

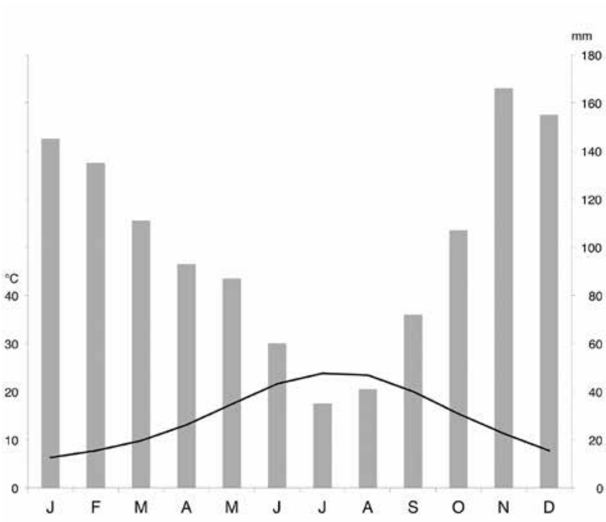

Fig. 5: Monthly mean temperature and rainfall, at Selenice, lower Vjosa. Data from KESH-report (2009). – Abb. 5: Klimadiagramm (Monatsmittel der Temperatur und des Niederschlages) vom Unterlauf der Vjosa bei Selenice.

mean flow values in the period 1967 to 1990 fluctuated considerably from year to year, especially in the high water period from November to May (see vertical bars in Fig. 6). The annual mean flow for the whole period at Poçemi is 141.5 m^3/s.

The mean annual value in Poçemi matches the annual flow measured at the gauge Dorez (a few kilometres above Poçemi) for the period 1958–1990: 148,4 (range 66.4–324.1 m^3/s) (in PANO 2015). The time series shows higher flow rates in the period 1958–1967 (180.7 m^3/s) compared to 1978–1988 (140.1 m^3/s). The average flow was particularly low in the year 1990 (66.4 m^3/s).

From the time series 1967–1990 at Poçem the following high flood events are recorded:
1970: 2760 m^3/s (Dec.)
1971: 4160 m^3/s (Jan.)
1976: 2464 m^3/s (Dec.)
1981: 2806 m^3/s (Oct.), 2293 m^3/s (Dec.)
1982: 2670 m^3/s (Dec.)
1985: 2619 m^3/s (Jan.)
1987: 2456 m^3/s (Feb.)
1990: 2300 m^3/s (Dec.)

Characteristic flood flow levels at Poçemi are: HQ_1: 1820, HQ_5: 2620, HQ_{10}: 3130, HQ_{20}: 3630, HQ_{50}: 4420, HQ_{100}: 4860 m^3/s.

One of the shortcomings for the interpretation of our ecological data is the lack of detailed data on hydrology and the rating curve connecting water surface elevation to discharge. Long-term time series on magnitude, duration, timing and predictability of floods pulses and flow pulses below bankfull, both in terms of river stage and discharge need to be known for a detailed assessment. Information on flow is relevant for the understanding of the geomorphic dynamics, whereas the fluctuation of the river stage is the master factor for the riverine and riparian biotic communities. A detailed monitoring of such data is urgently required for an environmental impact assessment on the effects of engineering measures.

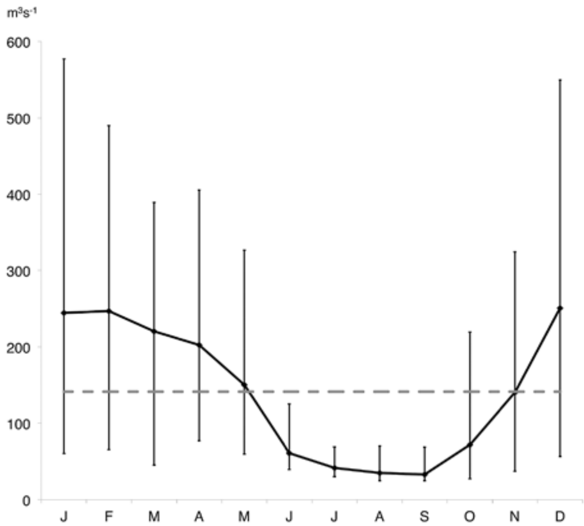

Fig. 6: Hydrology. Mean monthly flow rates at the Poçemi hydrometer station for the period 1967 to 1990 (gauge closed). The vertical bars indicate the range of monthly flow rates over these 24 years of observations. Data from Kolaneci in Rössler (2017). – Abb. 6: Saisonale Abflusswerte der Vjosa bei Poçemi. Durchschnittliche Monatsmittel und deren Streuung in der Zeitserie von 1967–1990. Die strichlierte Linie gibt das langjährige Jahresmittel an.

In the course of the excursion water- samples were taken in the Vjosa and major tributaries for reference of the geochemical conditions. All samples show medium conductivity values and medium concentrations of major macro-ions (Tab. 1).

Tab. 1: Geochemical parameters of the Vjosa and major tributaries, Samples were taken during the field excursions in April (4/17) and September (9/17) 2017. – Tab. 1: Geochemische Daten über die Vjosa und einige wesentliche Zuflüsse. Die Wasserproben wurden im Rahmen der Exkursionen im April (4/17) bzw. September (9/17) 2017 entnommen und an der Univ. Wien analysiert.

	Cond. µS/cm	Ca^{2+} mg/l	Mg^{2+} mg/l	Na^{+} mg/l	K^{+} mg/l	Cl^{-} mg/l	SO_4^{3-} mg/l
Sarandoporo (9/17)	505	44.8	8.7	32.8	2.6	47.9	44.0
Drino below Gjirokastro (4/17)	452	78.7	6.6	11.7	0.7	16.8	52.1
Bënça (4/17)	323	57.0	7.5	3.8	0.6	5.8	26.8
Vjosa at Poçemi (4/17)	432	49.9	22.4	13.8	0.8	15.5	26.8
Vjosa at Poçemi (9/17)	259	38.5	6.4	8.1	0.5	11.8	31.1
Shushcica (9/17)	431	57.9	9.0	20.3	1.2	33.4	33.1

Geomorphology of the Poçemi–Kalivaçi floodplains, landscape structure and habitat types

The geomorphology of a riverine landscape in context with hydrology provides the framework for habitat composition and ecology. The river-floodplain section upstream of Poçem, studied in April and September 2017, is representative for the middle part of the river between Selenice and Tepelena (see Fig. 1). This stretch of about 70 km length represents a bar-braided and island braided river type (see below). Our research program was based on the analysis of satellite images. In a detailed review of about 30 available satellite scenes, those from 1968, 2006, 2012 and 2016 were analyzed in full detail (Google Earth 2018, USGS, 2018). Scenes were selected according to their temporal distribution, water level and spatial resolution for interpretation (see Carbonneau & Piegay 2012,

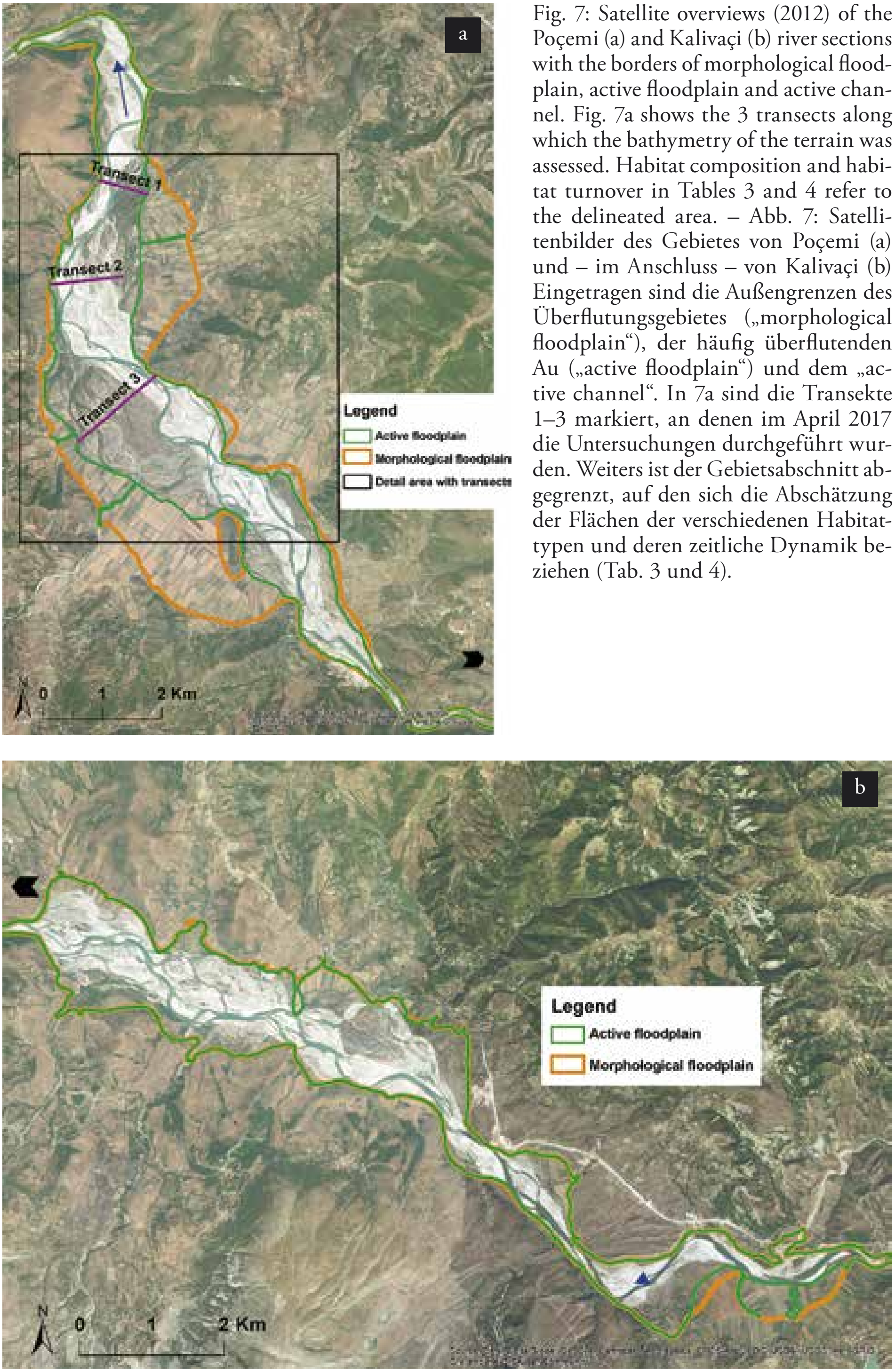

Fig. 7: Satellite overviews (2012) of the Poçemi (a) and Kalivaçi (b) river sections with the borders of morphological floodplain, active floodplain and active channel. Fig. 7a shows the 3 transects along which the bathymetry of the terrain was assessed. Habitat composition and habitat turnover in Tables 3 and 4 refer to the delineated area. – Abb. 7: Satellitenbilder des Gebietes von Poçemi (a) und – im Anschluss – von Kalivaçi (b) Eingetragen sind die Außengrenzen des Überflutungsgebietes („morphological floodplain"), der häufig überflutenden Au („active floodplain") und dem „active channel". In 7a sind die Transekte 1–3 markiert, an denen im April 2017 die Untersuchungen durchgeführt wurden. Weiters ist der Gebietsabschnitt abgegrenzt, auf den sich die Abschätzung der Flächen der verschiedenen Habitattypen und deren zeitliche Dynamik beziehen (Tab. 3 und 4).

Metivier & Barrier 2012 on methodology). In combination with the results of our field surveys, the structural properties and dynamics of this river-floodplain type can be illustrated.

The overall landscape structure between Poçemi and Memaliaj bridge (about 35 km river length) is illustrated by satellite images (Fig. 7a and 7b) which show the extensive floodplains. In the graph the outer borders of 3 major zones the "morphological floodplain" (MF), the "active floodplain" (AF) and the "active channel" (AC) are delineated. In the following discussion we have included also the higher elevated islands situated within the white band of the very active fluvial zone as part of the "active channel". The "morphological floodplain" is defined by the valley margins. The area outside the "active floodplain" (green line) is only flooded sporadically at very high floods (HQ over 100 years). This area is largely used as arable land. The "active floodplain" is regularly flooded, e.g. to a large extent at a HQ of 5–10 years flood recurrence.

The figures illustrate the clear distinction between the active channel and the floodplain (see also Figs. 9–11). The two river segments upstream of Poçemi (Fig. 7a) and upstream of Kalivaçi (Fig. 7b) are constrained by two gorges, and by bedrock structures leading to a high variability in the lateral extent of the riverine landscape. Within the "active channel" large bars are deposited and more perennial islands with woody vegetation, mainly shrubs (see Fig. 8), are formed by channel avulsion and cutoff.

Fig. 8: Overview-photo of the study area at Kute, April 2017, with the positions of transekt 1 & 2, see text (Photo: Subic). – Abb. 8: Überblicksfoto des Untersuchungsgebietes bei Kute mit der Position von Transekt 1 und 2.

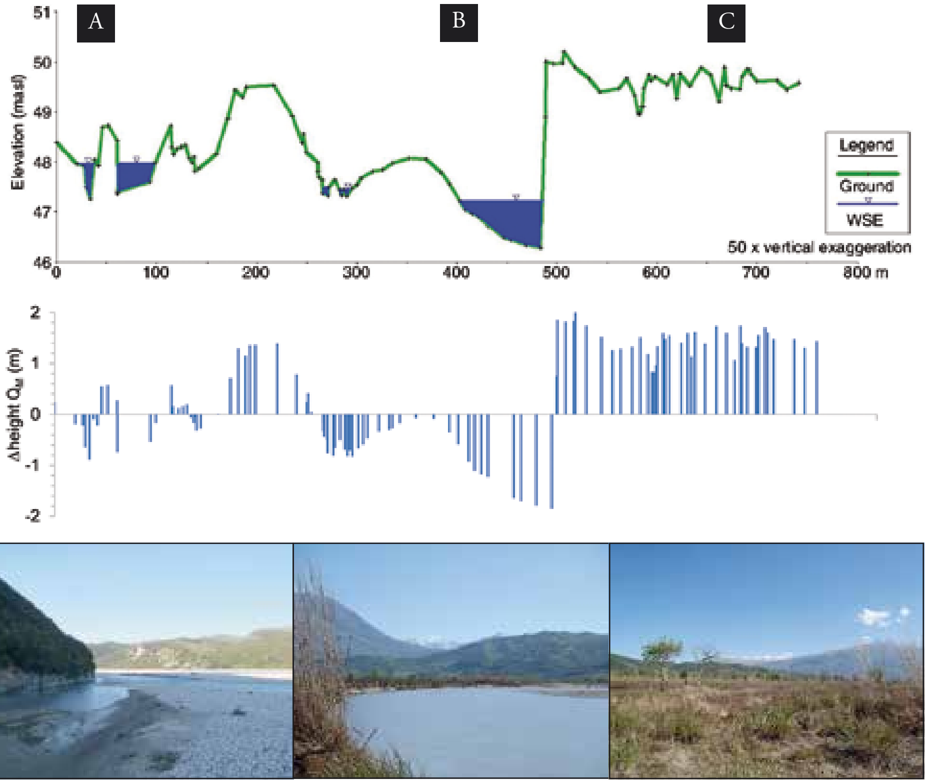

Fig. 9: Bathymetry of the Vjosa at Transect 1 including a differential plot of terrain height and mean discharge (QM) water level; Photo A – gravel deposits secondary channel (downstream view), Photo B – main channel (upstream view), Photo C – floodplains (upstream view). (Photos: Hauer). – Abb. 9: Landschaftsrelief Transekt 1 mit einem Differential-Plot des Terrains bezogen auf die Mittelwasserhöhe. Fotos A–C zeigen den Landschaftstypus entlang des Transektes.

The two gorges constitute bottlenecks in sediment transport resulting not only in lateral but also longitudinal sediment sorting processes. Besides the high load of gravel, a significant feature is the high content of finer sediments transported by the river, leading to large areas of silt depositions but also to a high compaction and reduced porosity of the river bed.

The low areal extent of softwood forests in the elevated floodplains (see Fig. 8) is caused by the intensive human use of these areas as pastures, by regular burning and extraction of timber. This explains the comparatively small role of large woody debris in the active channel, compared, for example, with the situation in the Tagliamento, where large woody debris constitutes an essential hydromorphological structuring element (Gurnell et al. 2001).

A detailed topographic, bathymetric assessment of the landscape relief along three transects perpendicular to the active channel (Fig. 9–11) shows the extreme heterogeneity in the landscape terrain at various scales. The graphs include differential plots of terrain height at mean discharge water level (Q_M 141,5 m^3/s), an important aspect for understanding the vegetation development. The width of the active channel (AC) varies between 400–

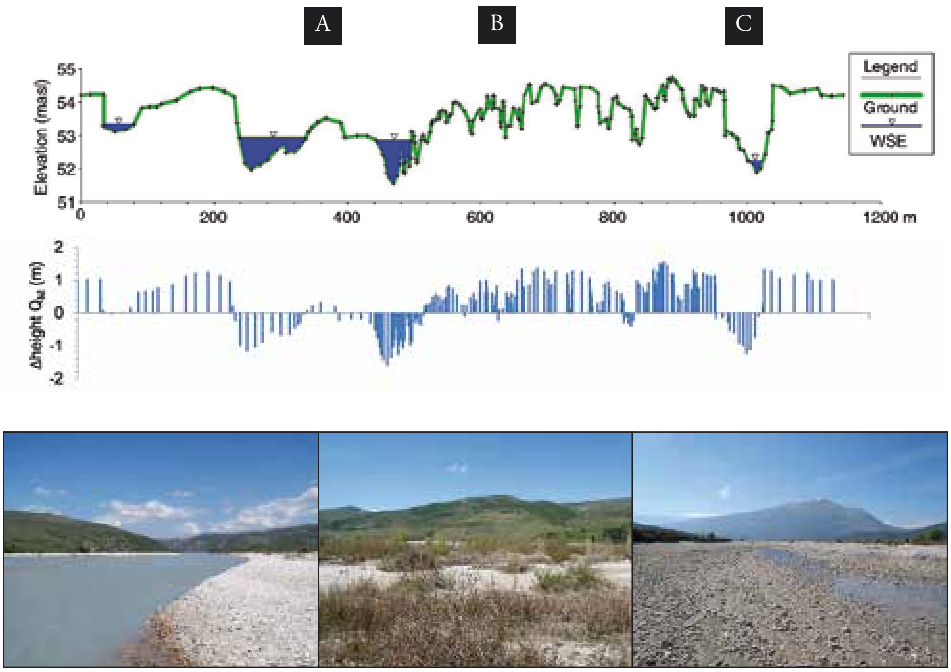

Fig. 10: Bathymetry of the Vjosa at Transect 2 including differential plot of terrain height and mean discharge (QM) water level; Photo A – main channel (downstream view), Photo B – accumulation of gravel, fines and initial stages of vegetation (transect view), Photo C – secondary channel (upstream view) (Photos: Hauer). – Abb. 10. Landschaftsrelief Transekt 2 mit einem Differential-Plot des Terrains bezogen auf die Mittelwasserhöhe. Fotos A–C zeigen den Landschaftstypus entlang des Transektes).

1000 meters due to the morphology of the valley. Larger islands and gravel bars within the AC are strongly structured by erosion channels and show the cumulative effects of changing water levels and flow pulses. An interesting feature, apparent in all three transects, is that the water levels of the main arm, in disconnected arms and erosion pools differ by more than one meter. This confirms that the lateral groundwater exchange is low, due to the high clogging and compaction of the riverine sediments.

The scarp at the border of the AC and the elevated floodplain is on average 2–3 meters high, measured from the mean water level of the main river arm. Transect 3 shows a continuous decline at the orographic left hand side through the former island (see below) and towards the former main arm. Even at such areas at the outer zones of the floodplains the occurrence of wetlands is low, indicating the restricted groundwater percolation.

The following classification of habitat types provides a common reference for integrating the various ecological, faunistic and floristic findings:

Aquatic habitat types

Different types of aquatic habitats can be distinguished within the active channel, ranging from fast current to stagnant conditions. Their ecological characteristics change continuously with the expansion and contraction of the river, i.e. in water table height. Even

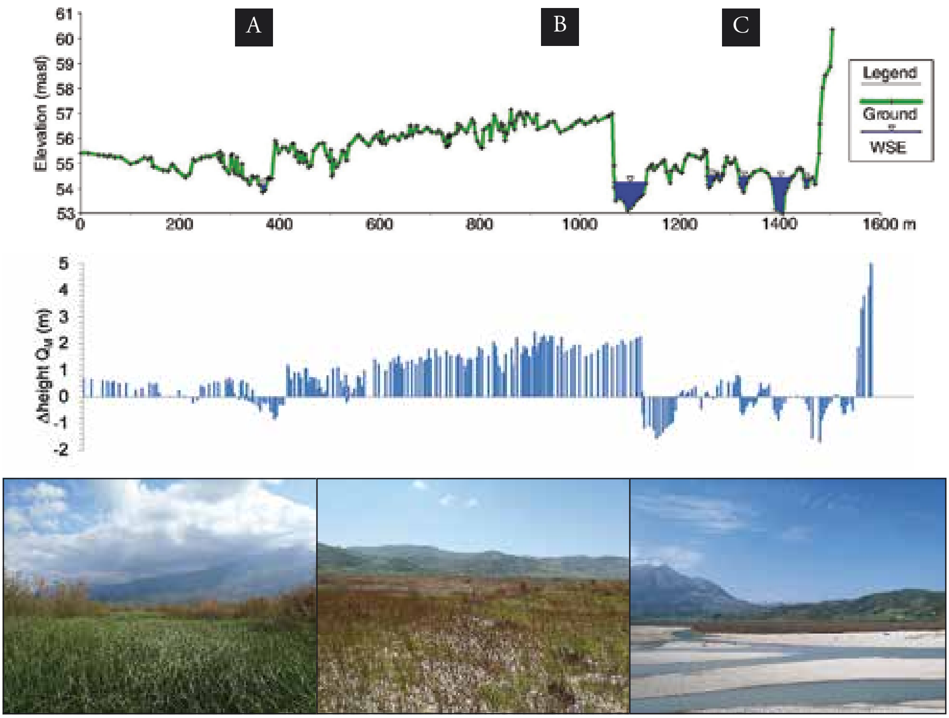

Fig. 11: Bathymetry of the Vjosa at Transect 3 including differential plot of terrain height and mean discharge (QM) water level; Photo A – semi-aquatic habitats (upstream view), Photo B – overbank fine sediment deposits (transect view), Photo C – braided main channel (transect view) (Photos: Hauer). – Abb. 11: Landschaftsrelief Transekt 3 mit einem Differential-Plot des Terrains bezogen auf die Mittelwasserhöhe. Fotos A–C zeigen den Landschaftstypus entlang des Transektes.

small water level fluctuations and "flow pulses" lead to continuous changes in the flowage line and habitat conditions, especially for the aquatic biota and the riparian fauna (see below). Moreover, the geographic position of the main arm shifts with each major flood pulse (see below). Under such hydrologically dynamic conditions the application of the Amoros-Roux classification of water body types for floodplain rivers (e.g. eupotamal, parapotamal, plesiopotamal) (Amoros et al. 1987) is not easily applicable.

The following list defines the principal aquatic habitat elements encountered:

A1: main branches of the river, fast current in the thalweg.

The beds are generally shallow, with a maximal depths of approximately 3–4 meters in erosion zones (see Figs. 9–11). In the central runs, the compaction of sediments is generally high, however the variability in the relief causes local runs with loose gravel. Thus, micro-habitat conditions show a high variability, which is of significance for the colonisation of macrozoobenthos and fish (see below).

A2: inshore zone of the main branch and shallow side branches, low current.

A3: downstream connected side-branches, partially with percolating flow.

However, hyporheic flow appears to be generally low due to the compaction of the gravel bottom with fine sediment.

A4: disconnected side-branches.

An intensive algal growth can develop; however, for the growth of macrophytes, the "life time" of such side branches is too short: these areas fall dry at receding water levels.

A5: erosion and eversion pools within the active channel.

A characteristic aquatic habitat type within the active channel are erosion pools, especially along the borders of the elevated floodplains or behind obstacles such as eroded trees and eroded parts of the higher floodplains (Fig. 12d, scouring holes). Their areal extent is low (Tab. 3). These small to medium sized (a few m^2 to 1000 m^2) pools partially retain water during low water phases and allow for intensive growth of algae. Water temperatures are distinctly higher during the vegetation period compared to the main branch. Such thermal heterogeneities have been analysed for the Tagliamento riverscape (Arscott et al. 2001).

Deeper stagnant pools with higher water residence time and fine sediment deposition can develop behind bedrock structures or artificial groynes. Such longer-term stagnant water-bodies within the active channel can be densely covered with semiaquatic and aquatic vegetation (e.g. *Chara* sp., *Potamogeton nodosus*).

A6: backwaters and riparian wetlands within the floodplains.

In former river arms within the elevated floodplains wetlands can be developed. A characteristic example was found in transect 3 (see Fig. 11) on the orographic left hand side. During our field visits at low (September, 2017) and mean water level (in April 2017) very few such aquatic backwaters were found in the whole floodplain section between Poçemi and Memaliaj.

A7: wetlands along hillslope streams entering the floodplains.

Such habitats characterized by low flow and fine-grained deposits were found along the outer floodplain borders at Kute and Tepelena. Along the course of such small streams, different successional stages can be identified:

a) slowly flowing water with *Typha* spp., *Veronica anagallis-aquatica, Bolboschoenus maritimus, Scirpoides holoschoenus, Alisma plantago-aquatica* and others,

b) early succession stages with characteristic shrub vegetation *Salix alba, S. triandra, Populus alba* and others and

c) succession stages with small trees in ditches that are filled with water only during flooding events.

In April 2017, in Kute, these wetlands comprised of small shallow pools and low current running water with a rich invertebrate and fish community (e.g. *Pelasgus*) and *Emys orbicularis*. In September 2017, these wetlands had fallen dry.

Fig. 12: Photo-gallery of aquatic habitat types: a) overview of aquatic habitats within the active channel (A1-A4, Photo: Subic), b) main arm at the scarp of the elevated floodplain (A1, Photo: Schiemer), c) disconnected side arms falling dry (A4), unvegetated fine sediment depositions (C1, Photo: Schiemer), d) erosion pools (scouring holes) within the active channel (A5, Photo Schiemer), e) larger erosion pools (A5, Photo: Schiemer), f) wetlands along streams entering from the side slopes (A7, Photo: Schiemer). Initial vegetation along slow flowing disconnected side arms or tributaries with silty sediments and scattered vegetation of *Cyperus fuscus, C. michelianus, Sparganium erectum*. Pioneer scrub of *Salix triandra* and *Salix amplexicaulis* and scattered herb vegetation (*Typha minima, Mentha longifolia, Equisetum palustre* a.o.). – Abb. 12: Fotos aquatischer Habitattypen: a) Überblicksbild des Flusslaufes, Habitattypen A1–4, b) Hauptarm (A1), c) abgetrennter, trockenfallender Nebenarm (A4) und vegetationsfreie Sandablagerungen (C1), d) kleiner Erosionstümpel (A5), e) größere Erosionstümpel mit Makrophytenentwicklung (A5), f) Feuchtgebiete entlang kleiner zufließender Bäche mit Sumpfvegetation (A7).

Between these major types of aquatic habitats, ecological gradients provide the multitude of microhabitat conditions required to support the diverse communities of fish, macrozoobenthos and riparian fauna e.g. carabid beetles (see below).

Semiterrestrial and terrestrial habitat types

Terrestrial habitats on elevated bars within the active channel and the floodplains exhibit an even higher complexity, dependent on sediment sorting processes, elevation above mean water table, frequency of flooding, distance from the thalweg, etc. (see Drescher 2018 this vol., Rössler et al. 2018 this vol.).

The main factors for differentiation within the floodplain are:

- Sediment composition (grain size diameter) as a main factor for the germination of plants (water capacity),
- Intervals and dimension of flow pulses resulting in a time span for vegetation development,
- The situation of the groundwater table and its connection with the fine grained sediment cover, i.e. water retention capacity,
- Transformation by human impact (gravel mining, logging, burning, grazing).

Along the transects through the river-floodplain complex, an enormous range of transition zones occurs at small scale. In the following classification, this complexity is reduced to a few easily identifiable types in order to provide a common framework for a presentation of the various biota. A more detailed account will be provided in the chapter on vegetation ecology (Drescher 2018 this vol.).

Within the active channel we can distinguish between vegetation successions on gravel/coarse sand (series B) and on fine-grained sediments (fine-grained sand and silt, series C). Loam and clay deposits play a subordinate role in the Vjosa floodplain. The series B1 to B3, and C1 to C3, represent succession phases of increasing age of a more or less undisturbed vegetation development (Fig. 13a-f, see also Figs. 9–11 and Fig. 20: succession scheme).

B1: Initial phase on coarse-grained sediment bars without vegetation (Fig. 13a).

B2: Pioneer phase on coarse-grained sediment bars with seedlings of annual and perennial herbs (dominant) and woody species (less than one year old; 1–30 cm high).

B3: Pioneer phase on coarse-grained sediment bars and islands with dominating woody **species** like *Tamarix*, *Salix eleagnos, S. purpurea*, *Populus nigra* and others (1–2 years old; 30–120 cm high).

B4: Shrub phase, on coarse-grained sediment bars and islands partly with fine-grained cover with perennial herbs and scattered (dominating) woody species like *Tamarix*, *Salix* spp., *Populus nigra* and others (2–5 (8?) years old; 1–4 m high) (Fig. 13b).

C1: Initial phase on fine-grained sediment, bars without vegetation.

C2: Pioneer phase on fine-grained sediment, bars and islands (with seedlings of annual and perennial herbs and woody species, less than one year old; 1–30 cm high) (Fig. 13c).

C3: Early succession stage on fine-grained sediment, bars and islands with perennial herbs (*Imperata cylindrica*) and dominating woody species like *Salix alba, S. purpu-*

Fig. 13: Photo gallery of terrestrial habitat types: a) unvegetated gravel bars (B1) and pioneer vegetation on gravel bars (B2, Photo: Drescher), b) gravel bar, partly with sediment cover of coarse sand on the orographic right bank of Vjosa river NW of Poçemi. Scrub of 1–2 m height, dominated by *Platanus orientalis* mixed with *Populus nigra* and *Vitex agus-castis*. The herb layer is characterized by grasses (*Imperata cylindrica, Elymus* spec., *Cynodon dactylon, Sacharum ravennae*) (B4, Photo: Drescher), c) sandy bank of a downstream connected side arm with scattered herb vegetation of *Dittrichia viscosa, Xanthium italicum* and *Imperata cylindrica*. The dead individuals of *Xanthium* help accumulate sand during flooding (C2, Photo: Drescher), d) scattered shrub vegetation of *Tamarix parviflora, Salix amplexicaulis, S. elaeagnos, Populus nigra* and herb species like *Chondrilla juncea, Dittrichia viscosa, Cynodon dactylon* a.o. Sediment bar with several dm sand cover and a scattered scrub with *Platanus orientalis* (C3, Photo: Drescher), e) meadow, degradation stage with regularily (yearly?) burned and partly heavily grazed forest, scarp, gravel, sand grassland dominated by *Imperata cylindrical* (D1, Photo: Schiemer), f) knee of the Vjosa river near Poçemi with a steep river bank. The elevated niveaus of the floodplain are pastured and covered with woodland of *Salix alba, Populus nigra* and *Populus alba* (D3, Photo: Drescher). – Abb. 13: Fotos terrestrischer Habitattypen: a) Schotterinseln ohne Vegetation (B1) bzw. schütterer Pioniervegetation (B2), b) Schotterbank, teilweise mit Sandanschüttungen, Pioniervegetation mit Sträuchern (B4), c) Sandbank an einem unterseitig angeschlossenen Nebenarm (A3) mit lockerer Pioniervegetation (C2), d) Gebüschvegetation auf einer Sandinsel innerhalb des „active channel“ (C3), e) Überschwemmungsgebiet, intensiv als Weide genutzt und regelmäßig abgebrannt (D1, D2), f) kleine Flächen mit Auwald (D3).

rea, *Vitex agnus-castus, Populus alba, Platanus orientalis* a. o. (1–2 years old; 30–120 cm high) (Fig. 13d).

C4: Shrub stage on fine-grained sediment, bars and islands with dominating woody species (like *Salix alba, S. purpurea*, *Vitex agnus-castus, Populus alba, Platanus orientalis* and others, 2–5(8?) years old; 1–4 m high).

At elevated floodplain levels:

D1: Degradation stage: Regularily (yearly?) burned grassland, with dominant *Imperata cylindrica,* tussocks of *Saccharum ravennae* and scattered shrubs of *Vitex agnus-castus* and others (Fig. 13e).

D2: Early woodland succession phase, with *Platanus* orientalis*, Alnus glutinosa, Vitex agnus-castus, Rubus sanctus, Brachypodium sylvaticum* and others.

D3: Riparian woodland, with *Populus alba, P. nigra* and *Salix alba* – heavily grazed (Fig. 13f).

Landscape and habitat turnover

The physical disturbances and continued habitat rejuvenation due to high flow and floods are the main characteristics of riverine landscapes and the cue for understanding the biodiversity pattern and ecological functions (Ward et al. 1999a). River channel patterns are a consequence of geomorphic dynamics and the physical landscape characteristics (Schumm 1985, Benda et al. 2004, Rosgen 1994, Daja et al. 2018 this vol.).

The Vjosa has so far maintained its original geomorphic dynamics which is the most valuable asset from an ecological point of view. Our analysis of the river-floodplain relief (see above), in combination with the available flow data, allow a first approximation of the extensive transport of gravel and fine sediments. The terrestrial survey of three cross-sections was conducted using a Leica TC805 total station. The measurement of the bathymetry was applied for both (i) the active channel and (ii) the active floodplain in April 2017. High resolution point sampling was carried out using height-dependent criteria (h > 15 cm) for selecting terrain points. In a post-processing procedure, the cross sectional data (n = 3) was used for hydrodynamic-numerical (HN) modelling. For the analysis of hydromorphological parameters needed for the Nanson & Knighton (1996) classification (e.g. specific stream power), one-dimensional hydrodynamic-numerical models were applied (Bhallamudi & Chaudhury 1991, Correia et al., 1992, Niekerk et al. 1992). The modelling package HEC-RAS® was applied, which uses the 1D St.Venant equation to calculate open channel flow, based on a four-point implicit finite difference scheme allowing the modelling of larger time steps (Ligget & Cunge 1975). The model was chosen because of its capabilities for sub-/supercritical modelling (USACE 2002) and multifunctional parameter analysis for overbank- and main channel flow. More detailed analyses are presently being carried out and will be presented in the near future (Hauer et al. in prep.).

In order to determine grain size distributions (GSD) of bed surface material along gravel bars of the Vjosa, template measurements were carried out using a gravelometer (a thin aluminum plate containing square holes of different sizes). The holes usually correspond to standard 0.5 f increment size sets, starting at 2 mm and reaching 256 mm (depending on the size of the template, Bunte & Abt 2001). Samples with grain size >256 mm were also included via the ruler application in order to consider possibly very coarse bed surface material of gravel bars. The calculation and graphical presentation of GSD curves was done by sampling at least 150 grains of gravel bar surface layer, with a minimum of 30 sediment particles around the mean diameter and neglecting grain sizes <2 mm (limited due to the gravelometer). Grain size distributions curves were determined and analyzed taking particle values as 'percent finer'.

Nanson & Knighton (1996) categorize the different types of multichannel river systems from alpine gravel-bed streams to lowland deltas. Based on (a) specific stream power (Wm^{-2}), (b) bed material size, (c) bank material size, (d) lateral migration rate, (e) vertical accretion rate, (f) channel sinuosity and (g) ratio island length/channel width. They proposed a classification of five different anabranching types. Within this framework, the Vjosa river can be classified as a laterally active gravel-bed river (Type 5 according to Nanson & Knighton 1996). Such gravel-dominated, laterally active, anabranching river systems are frequently found in cold climate regions with snowmelt and glacier runoff (e.g. Church 1983, Desloges & Church 1989, Kellerhals et al. 1972, Brierley & Hickin 1992, Nordseth 1973). The Vjosa, however, demonstrates these features in a Mediterranean climate.

The hydrodynamic-numerical modelling revealed a Q_{bf} (bankfull flow) of approx. 1000 m^3s^{-1} for all three sampled transects (Figs. 9–11). For this bankfull flow, the specific stream power was calculated to lie within the range of 22.8 W m^{-2}–39.8 Wm^{-2}. Moreover, pebble counting on the gravel bars of the Vjosa revealed a variability of d_{50} = 1.1 cm up to d_{50} =

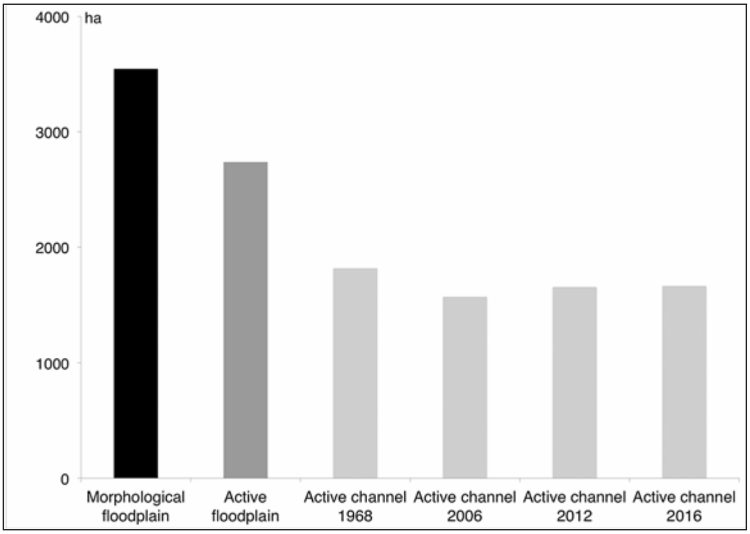

Fig. 14: Areal extent of the floodplains from Poçemi bridge to Memaliaj bridge over 35 km of river length, in the time from 1968 to 2016. The columns refer to the floodplain, which remain constant and the "active channel" which show some variability. – Abb. 14: Fläche des Überflutungsgebietes der 40 km Strecke von der Brücke in Poçemi bis zur Brücke in Memaliaj, in der Zeit von 1968–2016. Die Säulen zeigen die Größe des Überflutungsgebietes und die geringen Veränderungen in der Fläche des „active channels".

3.1 cm in the active channel, and gravel, sand and mud sediment deposits along the banks. Channel sinuosity as well as the ratio of island length/channel width (see Tab. 2) supported the classification of a laterally active gravel bed river.

Referring to Nanson & Knighton (1996) the modelled values of unit stream power are comparably small for a laterally-active gravel bed river. They are at the lower boundary for a type 5 channel type. The values are more transitory to a so-called “type 2, sand dominated anabranching river”. Gravel-dominated laterally active channels are described as being transitional between meandering and braided (Desloges & Church 1989), which is the situation for the study site.

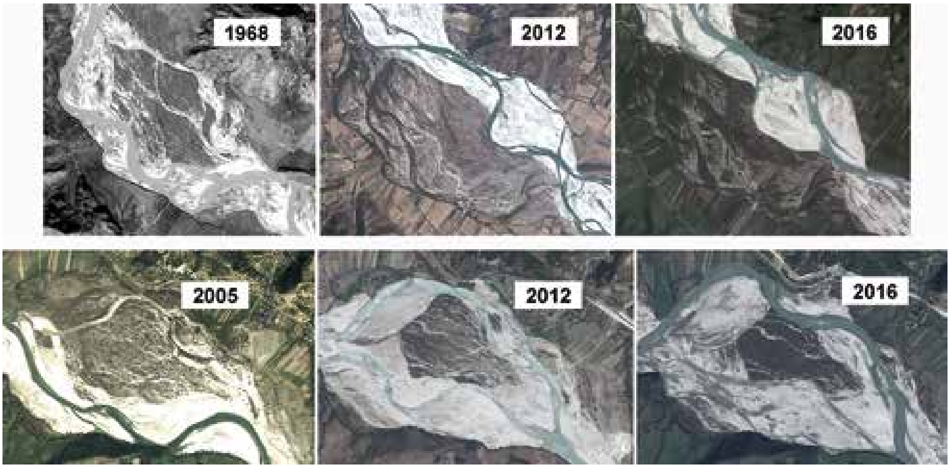

Fig. 15: Dynamics of the riverine landscape illustrated on the example of two satellite series showing the formation respectively erosion of major islands and the major shift in the location of the main river branches between 2005–2016 in the area of Kalivaçi and Poçemi. – Abb. 15: Dynamik der Flusslandschaft illustriert am Beispiel von 2 Serien von Satellitenaufnahmen von 2005 bis 2016 im Gebiet von Kalivaçi und Poçemi. Die Aufnahmen zeigen die weitgehende Verlagerung des Hauptarmes und die Bildung und Erosion großer Inseln in den erweiterten Bereichen des Inundationsgebietes.

Tab. 2: Comparison of the areal extent (in ha) of the active channel within the river-floodplain section of 6,6 km length at Poçemi, delineated in Fig. 7a. The data are derived from a series of satellite images: 22.12.1968, 1.9. 2006 (low water), 29.8. 2012 (low water), 29.5.2016 (mean water). The theoretical turnover rate per year is calculated from the shift in the geographic location of the active channel. The “Braiding index” was calculated as 2 x sum of Li/ Lr, where Li is the sum of the length of islands within a segment (Lr). The thalweg is given in km river length. – Tab. 2: Vergleich der Flächen (in ha) des “active channels” in dem 6,6 km langen Abschnitt bei Poçemi (siehe Abb. 7a). Die Werte wurden von Satellitenaufnahmen aus den Jahren 1968, 2006, 2012 und 2016 errechnet. Die theoretische Erneuerungszeit des “active channels “ pro Jahr wurde aus dessen veränderter Position im Inundationsgebiet errechnet. Der “Braiding Index” als Maß der Fluss-Verzweigung errechnet sich als 2x die Summe der Inselllängen (Li) in einem Flussabschnitt dividiert durch dessen Länge (Lr). Thalweg in km bezogen auf den Flussabschnitt.

	1968		2006		2012		2016
Active channel	591.9		511.3		567.7		594.4
Overlap in active channel		320.6		508.1		554.6	
% turnover per year	1.1		1.0		1.4		
Thalweg in km	10.5		9.4		9.7		9.4
Braiding Index	3.9 (2x17.4/8.9)						3.3 (2x13.5/8.1)

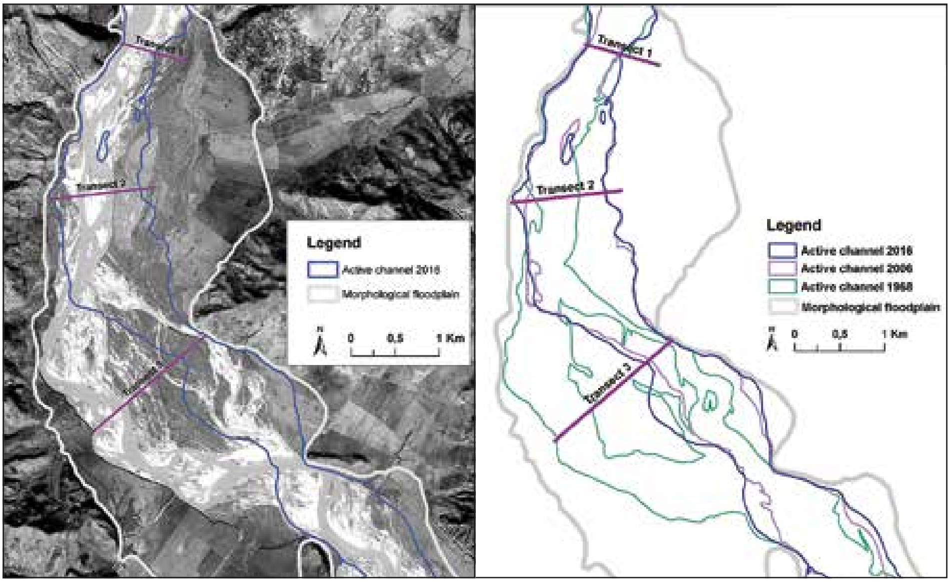

Fig. 16: a) Shift in the location of the active channel from 1968 to 2016. The satellite image from 1968 is overlaid by the position of the active channel in 2016. The outer borders of the morphological floodplains are marked. b) shift in the location of the active channel, its borders are marked for 1968, 2006 and 2016. – Abb. 16: a) Verlagerung des „active channels". In die Satellitenaufnahme von 1968 sind die Grenzen des AC 2016 eingetragen. b) äußere Grenzen des „active channels" 1969, 2006 und 2016.

The catchment of the Vjosa provides high sediment yields (bed load and suspended load) of up to 20–40 t. $ha^{-1}.year^{-1}$. A characteristic feature of braided and anabranching rivers is that bed load supply is higher than actual channel transport capacity. Reduction in bed-load supply would lead to a more stable, single, sinuous but migrating channel (Carson 1984, Church 1983). Another criterion of the laterally active anabranching gravel beds are specific forms of avulsion at high flow rates, which incise into the existing floodplains (Nanson & Knighton 1996). Avulsion is the rapid abandonment of a river channel during mostly extreme flood events and the formation of a new river channel in former floodplains (Slingerland & Smith 2004). This is the case for the Vjosa, where the active channel is incised up to 3 m into the "active floodplain". Its gravel layers are frequently overtopped by overbank sands and silt, indicating the continued fluvial interaction in the geomorphic continuum of the river-floodplain system (see Brierley & Hickin 1992).

The landscape development over the past 50 years could be visualized from a series of satellite images from 1968 up to now. In the 36.5 km long river section from Poçemi to Memaliaj bridge – the area of the planned hydropower dams at Poçemi and Kalivaçi – the areal extent of the whole floodplain remained essentially constant (Fig. 14). However, the satellite images show the continuous shift in position of the active channel within the active floodplain. This dynamic displacement in the position of the main river arms and in the formation and erosion of major islands is exemplified in two time-series of satellite images illustrating the tremendous landscape dynamics of the area (Fig. 15).

This landscape dynamics is in the following exemplified in more detail for the 6.6 km long river-floodplain segment delineated in Figure 7a. Table 2 shows a variation in the areal extent (in ha) of the "active channel" of approximately 15 % from 1968 to 2016. Despite this relative constancy in area, the time series of satellite images illustrates the continued and drastic change in location of the active channel within the floodplain. This is expressed as overlap in the location of the AC during particular time intervals. The displacement is high, despite being constrained by the morphology of the valley which restrict the channel migration. Naturally, the displacement rates are strongly dependent on hydrology. Main translocations apparently occur due to channel avulsions at single extraordinary flood events. Keeping these caveats in mind, we arrive at average relocation rates of the active channel within the active floodplain in the order of 1–1.4 percent per year, which means a theoretical turnover time of less than 100 years. In this time frame the active river-floodplain system is completely restructured.

Figure 16 illustrates this lateral migration pattern of the AC within the floodplain over a period of nearly 50 years, exemplifying this enormous geomorphic dynamic.

At a more detailed scale the quantitative composition and turnover of habitat elements (as defined and indexed above), is analysed from a satellite series from 2006, 2012 and 2016 (Tab. 3). Some of these habitat types had to be combined, because they were either continuously interchanging with water level fluctuations (e.g. the riverine habitats A1–A4) or were not clearly discernable in the satellite images. Within the AC, the ratio between aquatic and terrestrial areas varied strongly with the water level at which the satellite images were taken. Higher water levels mean a larger extent of riverine habitats in comparison to the gravel and sand bars. At low and mean water levels, the river with its downstream connected or disconnected side-arms (A1–A4) represents approximately 10–15 % of the active channel. The areal extent of erosion pools (type A5) is very low, yet they are

Tab. 3: A comparison of the areal extent (in ha) of different types within the river-floodplain section delineated in Fig. 7a, according to the definitions and descriptions presented above. The values refer to the active channel and the active floodplain (below broken line). – Tab. 3: Vergleich der Flächen (in ha) der verschiedenen Habitattypen in dem 6,6 km langen Abschnitt bei Poçemi (siehe Abb. 7a). Definition und Beschreibung der Habitattypen siehe Text. Die Werte beziehen sich auf den „active channel" und den „active floodplain" (siehe Text).

	2006	2012	2016
Active channel (AC)			
River branches (A1–4)	93.2	97.7	141.9
Erosion pools (A5)	1.5	3.1	4.7
Gravel & sand bars, unvegetated (BC1)	183.9	327.4	313.3
Gravel & sandbars, early pioneers (BC2,3)	178.4	116.8	106.5
Gravel & sandbars, pioneers and shrubs (B4)	69.1	77.5	49.5
Active floodplain (AF)			
Grassland on elevated floodplain (D1)	293.5	282.6	237.1
Grassland with shrubs (D2)	227.3	165.7	218.4
Softwood forest (D3)	45.8	27.7	29.2
Wetlands (A6,7)	0.2	0.3	0.3
Arable land	24.1	18.0	16.0
Total area AC+ AF	1116.8	1116.8	1116.8
AC in % of AC+AF	47.1	55.7	55.1

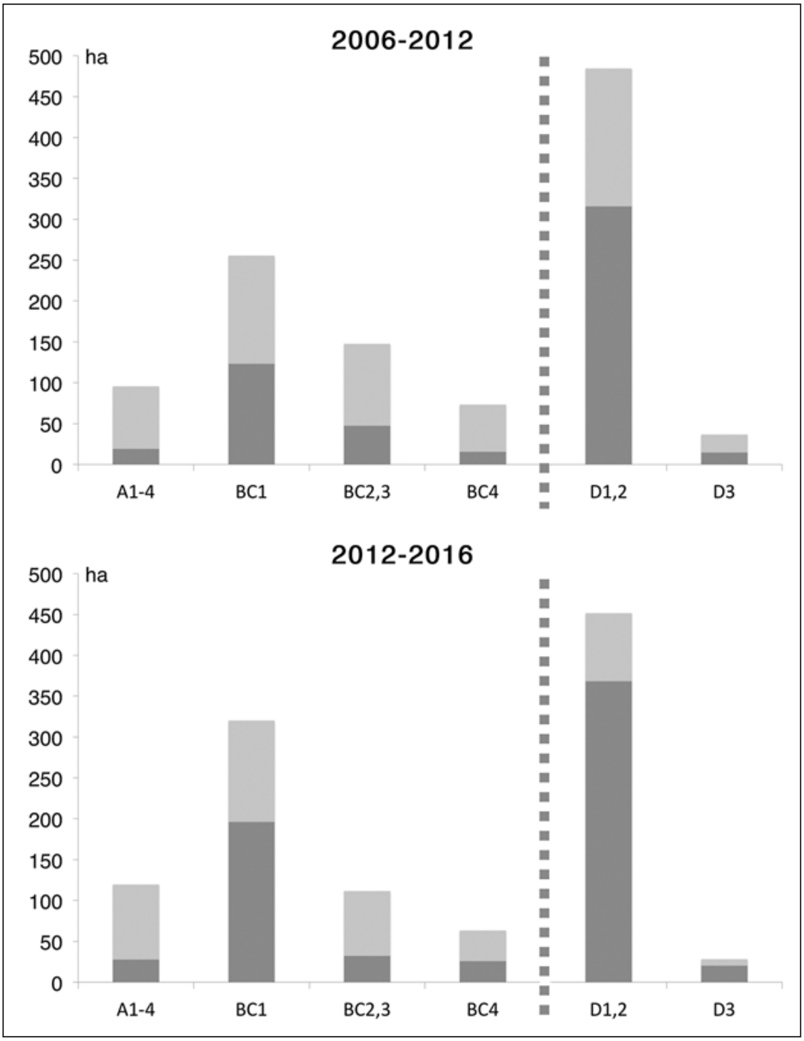

Fig. 17: A comparison of the composition habitat types in the Poçemi area (see text) based on values presented in Table 4. The total columns show the mean extent of the various habitat types in the period 2006–2012 and 2012–2016. The darker shaded parts show those areas which remained at the same positions. – Abb. 17: Zusammensetzung der Habitattypen in Fluss-Auenbereich von Poçemi, Zahlenangaben siehe Tabelle 4. Die Säulen geben die Gesamtfläche der einzelnen Habitattypen an. Der starker schattierte Teil der Säulen zeigt die ortskonstanten Anteile der Habitate.

very significant as habitat and refuge throughout the life cycle of many species. The unvegetated gravel and sand bars (B1/C1) cover the largest area (in the order of 35–53 % of the AC at low to mean water level). B4/C4, as advanced pioneer stages, occur within the active channel mainly on accreted islands.

Within the elevated active floodplain, grassland and grassland with shrubs are dominant (D1, D2) (also compare to Figs. 9–11). Softwood forests (D3) and wetlands (A7) have very restricted occurrences and a low areal extent. The composition of grassland, grassland with shrubs and softwood forests at the elevated floodplains exhibits a higher stability. Apparent structural changes are to a large extent due to human activities by grazing and burning.

Figure 17 illustrates the average areal extent of the various habitat elements (in ha) over the periods 2006–2012 and 2012–2016 (total columns) and the proportion which within these time intervals remained in the same location (dark grey bar). The figure highlights two significant features: firstly, the proportion of habitat elements remains fairly constant over time, but, secondly, the continuous shift in the location of the various types indicates a fast turnover cycle, especially within the active channel.

In a further step of analysis, the shift in the location of habitat elements (area in ha) and their relocation within the floodplain was identified. Figure 18 summarizes these fluxes in the position of landscape elements between 2012 and 2016. The circles from left to right represent aquatic areas (A1–A4, the main branches, side-arms, etc.), unvegetated gravel and sand bars (BC1), bars with pioneer associations (BC2), bars with shrubs (BC3,4) and habitats on the elevated floodplain (D).

Figure 19 exemplifies the translocation of habitats from 2012 and 2016.

Combining this information on change in areal extent of the various habitat types and their shift in position over time, habitat renewal and turnover rates can be calculated (Tab. 4). Of course, the dynamic water level fluctuations complicate the calculation of turnover times, whose areal extent is strongly dependent on river stage. Nevertheless, the values give an approximation of the actual enormous dynamics. The position of the multichannel river changes rapidly, up to 20 % per year. For all the major habitat elements within the active channel, including smaller islands with a cover of pioneer vegetation and shrubs, the turnover times are in the order of 5–10 years. Isolated erosion pools within the active channel are specifically short-lived due to erosion and sedimentation, with a life-cycle of less than one year. Only larger erosion pools along the borders of the active channel can have slightly longer life times in the order of a few years. Especially within the active channel, the dynamics and turnover rates are particularly high, and changes occur at a short time scale.

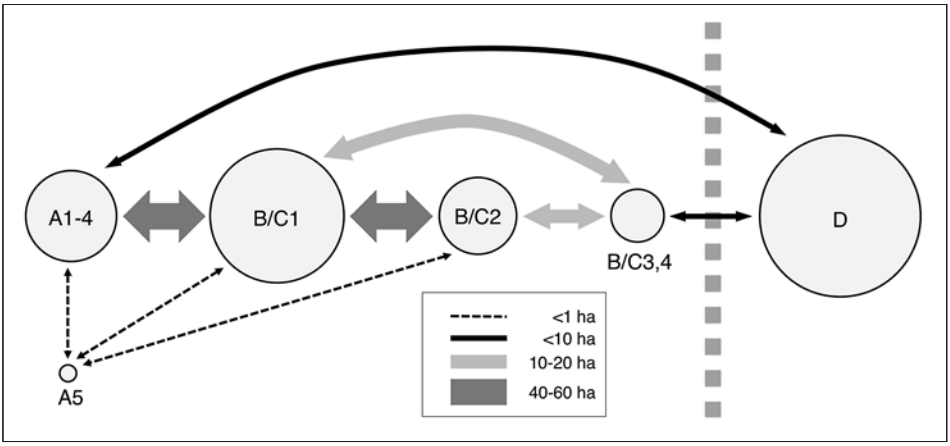

Fig. 18: Fluxes in the position of habitats in the Poçemi floodplain between 2012 and 2016. – Abb. 18: Flussdiagramm der Lokalisation von Habitatelementen zwischen 2012 und 2016.

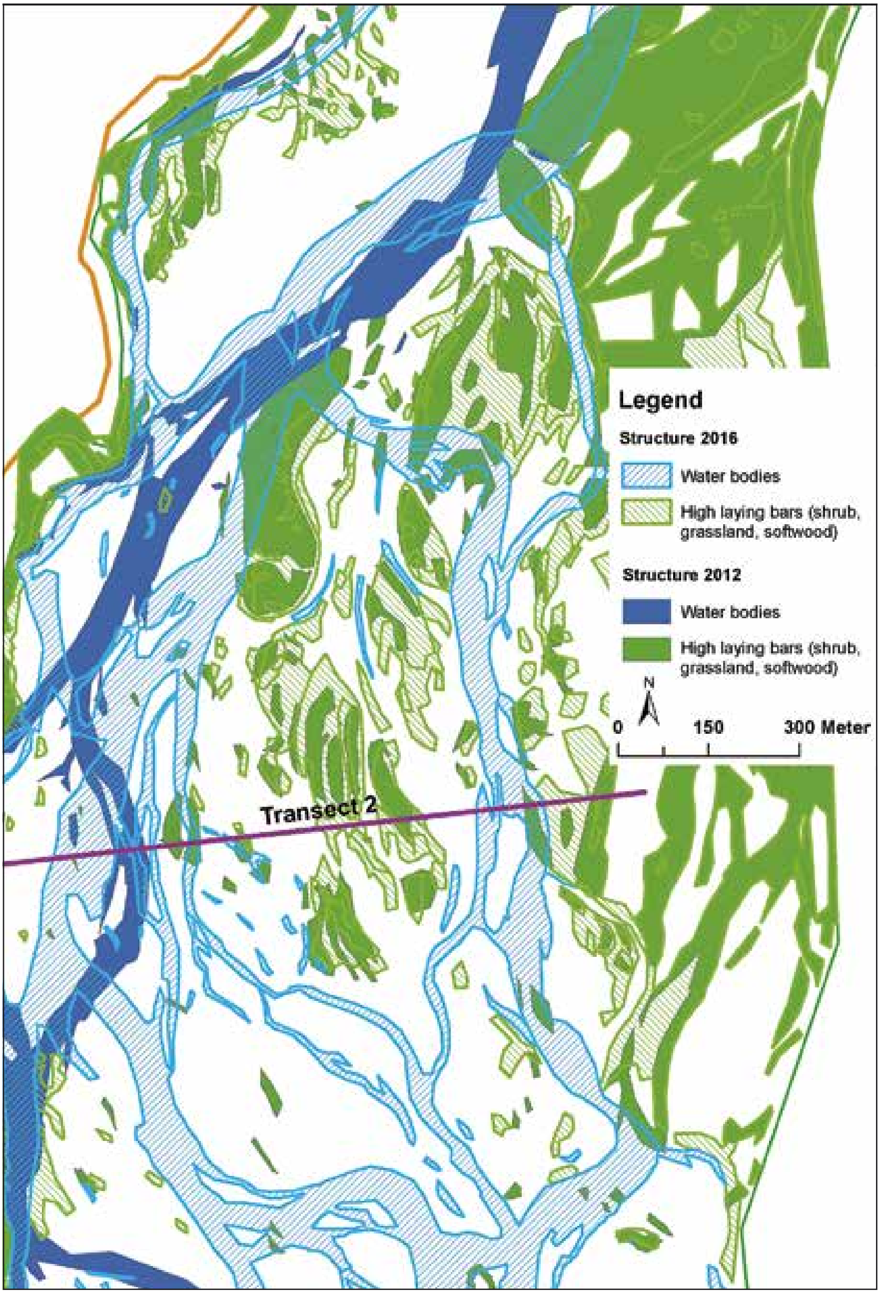

Fig. 19: Example of structural changes in the river – floodplain area of the Poçemi floodplain along Transect 2 between 2012 and 2016. The graph shows the change in position of the anabranching river system and of the higher laying bars and floodplain areas. – Abb. 19: Dynamik der Veränderung der Flusslandschaft am Beispiel eines Abschnittes bei Poçemi entlang Transekt 2. Die Abbildung zeigt die Veränderung in der Lage des Flusslaufes und der aquatischen Habitate und jener der höherliegenden Schotterinseln mit terrestrischer Vegetation.

Table 4: Habitat renewal rate (per year) within the active channel expressed in % of habitat area per year. – Tab. 4: Habitat-Erneuerungsraten pro Jahr innerhalb des „active channels“ in % des Flächenanteils des jeweiligen Habitat-Types.

	2006–2012		2012–2016	
River branches (A1–4)	76.4	13.4 %	91.5	19.2 %
Erosion pools (A5)	0	100 %	3.4	23.0 %
Gravel & sand bars, unvegetated (B1)	132.6	8.7 %	124.2	9.7 %
Gravel & sand bars, early pioneer (BC1–3)	100.7	11.4 %	79.5	17.8 %
Gravel & sand bars, pioneers and shrubs (B4)	60.1	13.7 %	21.7	14,8 %

The relative constancy of the quantitative composition of habitat elements on the one hand, and the high turnover rates on the other indicate that the whole river-floodplain system is in a state of dynamic equilibrium. Bormann & Likens (1979) coined such situations as a “shifting mosaic steady state” (see also Hohensinner et al., 2008).

A detailed study of the Tagliamento river in Italy initiated by the ETH Zürich, provides a good basis for a comparison with an alpine river system of similar size (Ward et al. 1999b, Tockner et al. 2000, Arscott et al. 2000, Edwards et al. 1999, Gurnell et al. 2001, Kollmann et al. 1999,). Van der Nat et al. 2003 analysed the relative change of aquatic and terrestrial habitats in the active corridor and found that within 2.5 years more than 59 % of the aquatic area and 29 % of vegetated islands were restructured. This is comparable with the high dynamics of the Vjosa river-floodplain system.

Figure 20 presents a summary of habitat composition and turnover cycles within the riverine landscape (a). It is apparent that especially the relationship between the riverine habitats A1–4 (see above) and B1/C1 – the unvegetated silt, sand and gravel bars – are continuously shifting with water level fluctuations. Microhabitat availability changes at a high rate within a yearly cycle.

Figure 20 summarizes information on vegetation patterns and successions, which are discussed in greater detail by Drescher (2018 this vol.). The different series of successions depend on sediment structure, soil-humidity and the frequency of disturbances by flooding and burning. For the active channel, the graph identifies successions on gravel (B series), on sand/ silt deposits (C series) and within short lived erosion pools (A5).

The succession on gravel deposits starts with herbs and grasses (B1) followed by seedlings of *Tamarix, Salix* spp. and *Populus nigra* (B2, B3). At the higher shrub phase (B4) *Populus nigra, Salix amplexicaulis* and *Salix alba* are the dominant woody species. Finally, a forest stage can develop, dominated by *Salix alba* and *Populus nigra*.

On silt and sand depositions, the pioneer stage (C2) consists of species which require higher soil moisture, like *Vitex agnus-castus* and *Platanus orientalis*. These species, together with *Salix* spp. and a wide variety of herbs, prevail as pioneers. At a later stage (C3, C4), woody species prevail, leading potentially to a forest stage of *Platanus orientalis, Salix alba and Populus alba*.

Erosion pools within the active channel (A5) initially develop a strong growth of filamentous algae. At longer periods of stagnancy, *Chara* sp. can occur, followed by species of a Nanocyperion-association. These successions are generally very short-lived and the turn-

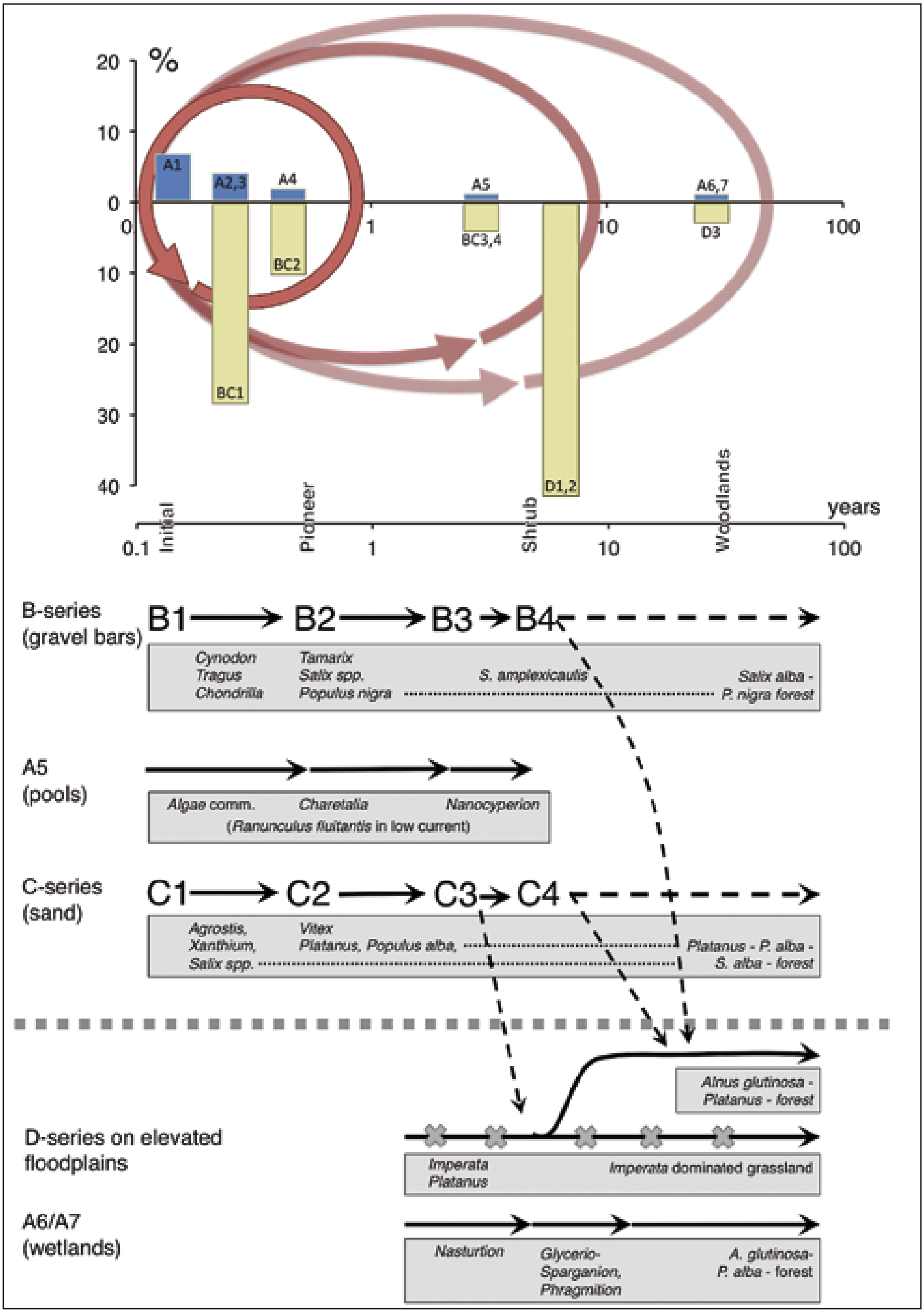

Fig. 20: A general scheme of habitat composition, turnover cycles and vegetation succession in the Vjosa floodplains. The “x”-marks in the D-series represent repeated burning.– Abb. 20: Ein allgemeines Schema der Habitatzusammensetzung, Landschaftsdynamik und Vegetations-Sukzession der Fluss-Auen der Vjosa.

over is fast (see Fig. 13c). In pools with low flow and current, *Ranunculus aquatilis* agg. can develop.

A further succession series can be observed in former river beds within the floodplain away from the main channel, which receive water at higher floods or through groundwater (A6) or are fed by hillside brooklets (A7). A sequence of assemblages from Nasturtion, Glycerio-Sparganion and Phragmition alliances can develop, leading potentially to an *Alnus glutinosa-Populus alba* forest.

At the elevated floodplain and at higher locations ("islands" within the active channel), an *Imperata*-grassland interspersed with a variety of shrubs, e.g. *Tamarix* and *Platanus orientalis*, develops. Due to regular burning, most of these areas remain in an *Imperata*-dominated stage. In situations without regular burning or wherever burning has stopped, a tendency towards a *Platanus orientalis-Alnus glutinosa* forest was observed.

The relevance of fluvial dynamics for the maintenance of a high and specific biodiversity

The Balkan region is a hotspot of biodiversity with a very specific flora and fauna and a high degree of endemism (see Griffith et al. 2004, Shumka et al. 2018b this vol.). Within this geographic aspect (see Poff 1997), the species diversity encountered at the Vjosa depends on the ecological quality of its highly dynamic riparian zones. The fluvial dynamics create and maintain the heterogenic structure with a hierarchy of transition zones. Major floods cause the morphological restructuring of the river-floodplain landscape at a large scale (Junk et al. 1989, Tockner & Stanford 2002). The frequent smaller water level fluctuations ('flow pulses') are important for creating and maintaining habitat heterogeneity, especially within the active channel. They represent continuous disturbances (Pickett & White 1985), leading to a rejuvenation and turnover of habitat patches and biotic succession (Townsend et al. 1997, Ward & Tockner 2001, Schiemer 1999). The wide range of habitat types and ecotones in context with the dynamic water level fluctuations provide the conditions for the specific associations of well adapted species, with high levels of alpha, beta and gamma diversity (Ward et al. 1999a). Structural heterogeneity in such dynamic landscapes is significant to buffer physical disturbances and to maintain the species pool (Sedell et al. 1990). In addition, the longitudinal continuity in habitat availability is a significant requirement for maintaining the meta-community associations and the meta-population of characteristic species (e.g. Aldermatt et al. 2011, Funk et al. 2013).

Despite the limited time and the early season (April 2017) during which most of the material was collected, our findings confirm the biogeographic significance and the high conservation value of this riverine landscape. No doubt, longer-term studies are required to explore the enormous ecological and biogeographic wealth of the area. Within this study, over 90 taxa of aquatic invertebrates and nearly 400 taxa of terrestrial species were recorded. Many of them are endemic to the Balkan, a large proportion (over 40 %) has been documented for the first time for Albania. A few are described as new to science (e.g. *Isoperla vjosae* by Graf et al. 2018a, *Liocranoeca vjosensis by* Komnenov 2018 this vol.).

Major effort has been put into the assessment of the macrozoobenthos, (see Graf et al. 2018b this vol., Bauernfeind 2018 this vol., Shkembi et al. 2018 this vol.) which is an important indicator group of the European Water Framework Directive (Hering et al. 2010). In large rivers, especially in zones of great geomorphological variability, the biodiversity levels are generally high (Nilsson et al. 1989). A variety of guilds occurs in the diverse aquatic habitats, ranging from the fast current main channel of the river to stagnant isolated pools and wetlands in the floodplains.

In the densely packed sediments of the fast runs of the Vjosa, the population densities and species diversity is comparatively low and the vertical dimension within the sediments is restricted. Higher densities of rheophilic species have been found in steep riffle sections with loose, less consolidated gravel and especially in situations in the main branches with large woody structures. The fauna contains typical elements that are characteristic of large, dynamic rivers and were once widely distributed across Europe and have now disappeared or lost large areas of their former distribution in Europe. The occurrence of plecopterans like *Marthamea vitripennis* or *Xanthoperla apicalis* and ephemeropterans like *Prosopistoma pennigerum* (Schletterer & Füreder 2009), pinpoints the outstanding conservation value of the river. Some of these potamal invertebrates belong to the most endangered aquatic species on an European scale.

The fish fauna is a further important indicator group for the ecological integrity of large river systems (Karr 1991, Schiemer 2000). A variety of guilds is characteristic of the different habitat types – from rheophilic to stagnophilic forms (Schiemer & Waidbacher 1992). The success of species guilds is determined by a complex array of ontogenetic and seasonal habitat requirements (Schlosser 1995). Rheophilic fish require a connected range of habitats from spawning sites, nurseries and feeding grounds, especially during the early phases of their life histories. The match-mismatch between ecological conditions and requirements is decisive for the survival of a population (Schiemer & Zalewski 1992, Schiemer et al. 2001). Only natural river systems with their structural heterogeneity and hydraulic interconnectivity of habitat patches provide such conditions.

The Vjosa is characterized by a large proportion of fish species that are endemic to the Balkans (see checklist, Shumka et al. 2018a this vol.). Our assessment using a set of techniques (backpack electrofishing, gill netting, longlining, beach seining) yielded a high density and diversity of species (Meulenbroek et al. 2018 this vol.). With few exceptions they belong to a rheophilic guild with a predominance of species of the genera *Squalius*, *Chondrostoma*, *Barbus* and *Alburnus*. In fast current riffle zones with loose, coarse gravel, *Oxynoemacheilus pindus* was abundant. The connected or recently disconnected areas of the anabranching system contained mainly juveniles of the rheophilic guild, indicating that under such dynamic situations a wide range of habitats is required to cover their multiple requirements in the course of the life cycle. The detailed assessment of Meulenbroek et al. (2018 this vol.) demonstrate the necessity to maintain the structural complexity of the riverine landscape for a diverse fish fauna. An interesting fish is also *Pelasgus thesproticus*, a stagnophilic form occurring regularly along the border of the active channel in isolated pools with macrophytic vegetation, or in wetlands and backwaters within the floodplain. Based on international experience, we can predict that the construction of hydropower dams will cause a massive decline and the disappearance of typical riverine species in the area (Schiemer & Waidbacher 1992).

As for the aquatic fauna our collections of terrestrial invertebrates, amphibians and reptiles illustrate the uniqueness and high conservation value of the area (see Frank 2018 this vol.,

Fig. 21: A few example of species representative for the high conservation value of the Vjosa river-floodplain system (from above on the left to down on the right): a) *Typha minima,* Photo: Schiemer; b) *Pelasgus thesproticus;* Photo: Meulenbroek; c) *Perla marginata,* Photo: Graf; d) *Prosopistoma pennigerum,* Photo: Graf; e) *Xya variegata*, carabid beetle, Photo: W. Paill; f) *Poecilus striatopunctatus,* Photo: Kunz.– Abb. 21: Charakteristische Arten der Fluss-Auen der Vjosa, als Beispiel der hohen Schutzwürdigkeit des Gebietes.

Shumka et al. 2018b this vol.). Highly specific littoral communities with good colonizing and refuge capabilities are well represented on the bare ground and early pioneer habitats of rivers with high fluvial dynamics. These associations consist of carabid e.g. *Dyschirius spp.*, and staphylind beetles, spiders, some bugs (Saldidae) and orthopterans (e.g. *Xya variegata).* For a detailed account see Paill et al., Degasperi, Rabl & Kunz, Komnenov, Blick, Komposch, Wagner et al., Frank et al., all this volume).

In contrast to the biota of the dynamically changing habitats within the active channel, the terrestrial biodiversity of the elevated floodplain, both flora and fauna, are strongly affected by human interventions especially by large-scale fire clearances and intensive pasturing. A loss in biodiversity due to regular burning is clearly apparent by low species numbers and low population densities of species otherwise characteristic for floodplain meadows. Especially the less mobile insects of orthopterans, cicadas, and heteropterans, and gastropods are strongly affected by the intensive human activities (Duda et al., Rabitsch, Rabl & Kunz, all 2018 this volume).

The diversity of vascular plants in Albania is higher than that of Austria, despite its distinctly smaller size. Southern Albania is one of the biodiversity hotspots of vascular plants on the Balkan peninsula. The plant assemblages in the Vjosa floodplain are characterized by species formerly widespread in Europe, but nowadays almost extinct in large parts of its former area (e.g., *Typha minima*) (Drescher 2018 this vol., Rössler et al. 2018 this vol.).

In conclusion: the highly undisturbed river dynamics and the river-floodplain ecosystems along the Vjosa are in an excellent conservation status. All riverine habitats typical for the Vjosa are listed in the Annex 1 of European Union Habitats Directive, underpinning their importance for conservation at an European scale. They harbour viable communities of species that have largely or completely disappeared from other European rivers systems. Due to their specific demands, all of these species have almost entirely gone extinct in Central Europe.

We can predict that the majority of the specific biodiversity will disappear in the case of the planned dam constructions due to a loss of fluvial dynamics (Schiemer 2000).

In a report to the Bern Convention –on the Conservation of European Wildlife and Natural Habitats, species were listed which have been documented within the project area at Poçem These findings document and confirm the uniqueness and conservation status of the area (see Shumka et al. 2018b this vol.).

Summary: hazards of dam construction and the need for science in river management

In context of the planned hydropower dams at Poçemi and Kalivaçi along the Vjosa in Albania, decision makers and stakeholders should be aware of the profound and long-term environmental consequences and major environmental threats of dam constructions in alluvial zones. Today, the past over-regulation of rivers necessitates costly restoration measures for compensation in many industrialized countries (e.g. Karr 1991, Naiman et al., 2002, 2005, Poff et al. 2003, Tockner et al. 2008, Schiemer 2015).

With regard to the hydropower plans at the Vjosa, the environmental hazards refer to:

- the immediate endangerment of the high conservation value of the area and this national heritage by damming,
- a loss of groundwater resources in terms of quantity and quality,
- a deterioration of surface water quality (eutrophication processes at high water residence times can be expected to lead to toxic algal blooms),
- methane production as a result of anaerobic processes in the flooded areas,
- coastal erosion due to the reduction of sediment transport by the river,

– catastrophic floods especially considering the increase of flood risks due to global warming.

Besides these environmental issues, an array of environmental, socio-economic and legal concerns has not been addressed in the proposition of the hydropower plans and require clarification:

A major ambiguity is the high sediment load of the river which will reduce the efficiency in energy use within a period of a few decades due to dam-filling. For short-term economic considerations the uniqueness of the landscape and its cultural heritage is destroyed and options for their long-term sustainable economic use, e.g. in terms of development of tourism, are suppressed.

Finally there is an array of operational and legal concerns. Over the past 20 years, international water management has developed standardized operational procedures which should be adhered to. In EU countries, for example, river management must follow the European Water Framework Directive, EU Natura 2000 Directive, EU Birds and Habitats Directive and EU Flood Risk Directive. Regulations stipulate that projects have to be based on a detailed monitoring of environmental conditions and hazards and an assessment both of the socio-economy of river basin development and the reactions towards human interventions.

The environmental aspects must be addressed by a valid Environmental Impact Assessment. These EIA have to evaluate short-, medium-, and long-term impacts on nature and affected residents of a projected hydropower plant, and must consider alternative low-impact concepts (Moss 2008, Hering et al. 2010). They have to be based on detailed assessments of hydro-morphological processes, geomorphic and ecological structure and dynamics and predictions about the impacts on specific biodiversity. Prerequisites for such an approach are well defined, science based research programs principally with the goal of elucidating cause-effect relations at different spatio-temporal scales, in order to develop prognostic models for management (Surridge & Harris 2007, Vaughan et al. 2009, Arthington et al. 2010, Schiemer 2015). The apparent challenge is to follow the cause – effect chain between the governing factors hydrology and sediment load in order to gain a process-orientated understanding of river-floodplain systems and the resulting fluvial landscape dynamics and ecology. An interdisciplinary eco-hydrological approach must combine hydrology, sediment transport processes and ecology (Zalewski 2000, Wood et al. 2007).

In the EIA presented in the Pocem project plan, none of the apparent dangers have been seriously addressed and none of the potential long-term effects of the project were discussed. National and international consortia of scientists and experts have expressed their concerns about the poor quality of the EIA presented to the Albanian government and the EU. For the Kalivaci project, the EIA so far (July 2018) has not been made public.

Important water policy instruments such as the Water Framework Directive of the EU request action comprehensive catchment-wide planning process with clearly defined procedural steps.

A platform across the science-policy interface, were science can 'speak to' policymakers, authorities and other stakeholders, requires a clear participation and decision structure and a direct involvement of political decision makers in the discussion process (Simon & Schiemer 2015). Continued development of local expertise and expertise to communicate this to the public and decision makers.

To achieve this goal, expert panels with long term mandates are required. Discussions with scientists and stakeholder should explore scenarios for the sustainable development of the river corridor, acknowledging the links between the integrity of the Vjosa ecosystem and economic, social and cultural aspects of human well-being. In order to contribute the scientific community in the Balkan countries is challenged to build up capacity and scientific foundations for regional water management. Albanian scientists – on the other hand – have to accept responsibility and help in decision making in landscape management.

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Synthesis of geological, hydrogeological, and geo-touristic features of the Vjosa Watershed

Çerçis Durmishi, Shkëlqim Daja, Besnik Ago, Elsa Dindi, Agim Sinojmeri, Shaqir Nazaj, Ana Qorri & Redi Muçi

The paper aims to present the geological settings of Vjosa watershed, situated at the north-western part of Greece and south part of Albania. From a stratigraphic point of view, the geological formations represent a wide variety of rocks, formed from the Triassic to the Quaternary Period. Magmatic rocks, carbonates, terrigenous (flysch and molasse) sediments exposed at spectacular outcrops are actually subject to the erosive activity of the Vjosa River. These sediments are transported and deposited, leading to the formation of Quaternary deposits, comprising of gravels, sands, silts and clays which are characterized by high hydraulic parameters. The geological formations have been classified into different hydrogeological groups based on their lithological, structural, and hydrogeological characteristics. The hydrogeology of the basin includes the hydrogeological framework of groundwater flow systems, as well as the water bearing potential of compact and loose deposits. The paper deals with the spatial distribution of the main features of the considered hydrogeological groups, such as waterbearing potential, quality, and water type. The present morphology is related to the late and neo-tectonic processes. Geological settings and physical geography, accompanied by spectacular natural phenomena, give a significant scientific, didactic, recreational and geo-touristic importance on a local, regional and international level.

Durmishi Ç., Daja S., Ago B., Dindi E., Sinojmeri A., Nazaj Sh, Qorri A. & Muçi R., 2018: Eine Synopsis der geologischen, hydrogeologischen und geotouristischen Eigenschaften des Vjosa Einzugsgebietes.
Der Artikel gibt einen Überblick über den geologischen Aufbau des Einzugsgebietes der Vjosa. In einer stratigraphischen Betrachtung repräsentieren die geologischen Formation ein breites Spektrum von Gestein, das in der Periode Trias bis Quartär gebildet wurde. Magmatisches Gesteine, Karbonate, terrigene Sedimente (Flysch und Molasse) sind den erosiven Kräften der Vjosa und ihren Zuflüssen ausgesetzt. Diese Sedimente werden transportiert und führen zu quartären Ablagerungen aus Schotter, Sanden und Feinmaterial, wie sie für Flüsse mit hoher hydraulischer Dynamik charakteristisch sind.
Die geologischen Formationen wurden an Hand ihrer lithologischen, strukturellen und hydrogeologischen Charakteristika in verschiedene Klassen eingeteilt.
Die Hydrogeologie des Einzugsgebietes umfasst die geologischen Rahmenbedingungen der Grundwasserflüsse sowie die Wasserkapazität der kompakten und lockeren Sedimente.
Die Arbeit bezieht sich auf die räumliche Verteilung der Hauptmerkmale der hydrogeologischen Gruppen, wie z.B. das Potential der Wasserführung, Qualität ??, und geochemischer Wassertypus.
Die gegenwärtige Morphologie des Gebietes ist ein Resultat, spät- und neo-tektonischer Prozesse. Die Geologie und physikalische Geographie mit ihren spektakulären Erscheinungsformen verleiht dem Gebiet einen bedeutenden wissenschaftlichen, didaktischen und geo-touristischen Wert von regionaler und internationaler Bedeutung.

Keywords: Vjosa Watershed, Tectonics, Stratigraphy, Sedimentology, Hydrogeology, Geo-tourism, Albania, Greece.

Introduction

Vjosa Watershed is situated at the north-west of Greece and southern Albania. The actual configuration of the basin is conditioned by the paleogeographic and geodynamic evolution of the Albanides and Hellenides from Mesozoic up to the present day (ShGjSh 1985, Ntokos 2017). Based on the tectonic zonation of Albanides (Al) and Hellenides (Gr), the upstream part extends over 4 tectonic units (Fig. 1): 1 Mirdita (Al) or Sub-Pelagonian Zone (Gr); 2 Krasta – Cukali (Al) or Pindos Zone (Gr); 3 Kruja (Al) or Gavrovo Zone (Gr); 4 Ionian Zone (same name in Albania and Greece). Strike-slips, normal and reverse faults, oriented mainly NNW-SSE, NE-SW and N-S, affect the geological formations. The midstream is developed mainly in the Ionian zone, with some confluents carrying their activity in the Kruja and Krasta zones, while the downstream part extends to the Ionian zone and Peri-Adriatic depression. The stream system started from the upper Pleistocene (Carcailletet al. 2009), about 150 thousand years ago, and erodes and transports materials from the rocks developed within the abovementioned tectonic units.

Geological settings of the Vjosa Watershed

The upstream section

This section extends from the mountains of Pindos and Grammos in North-Western Greece to Çarshova in Albania (Fig. 2). The following tectonic zones have been described by Papanikolaou & Royden (2007):

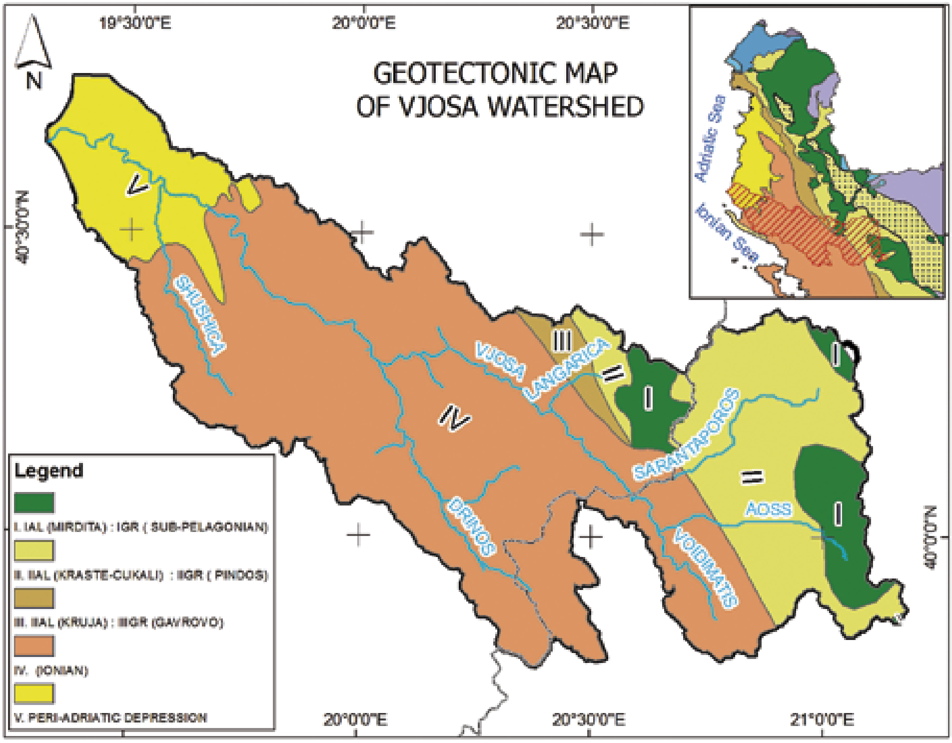

Fig. 1: Tectonic map of the Vjosa Watershed. – Abb. 1: Tektonische Karte des Vjosa-Einzugsgebietes.

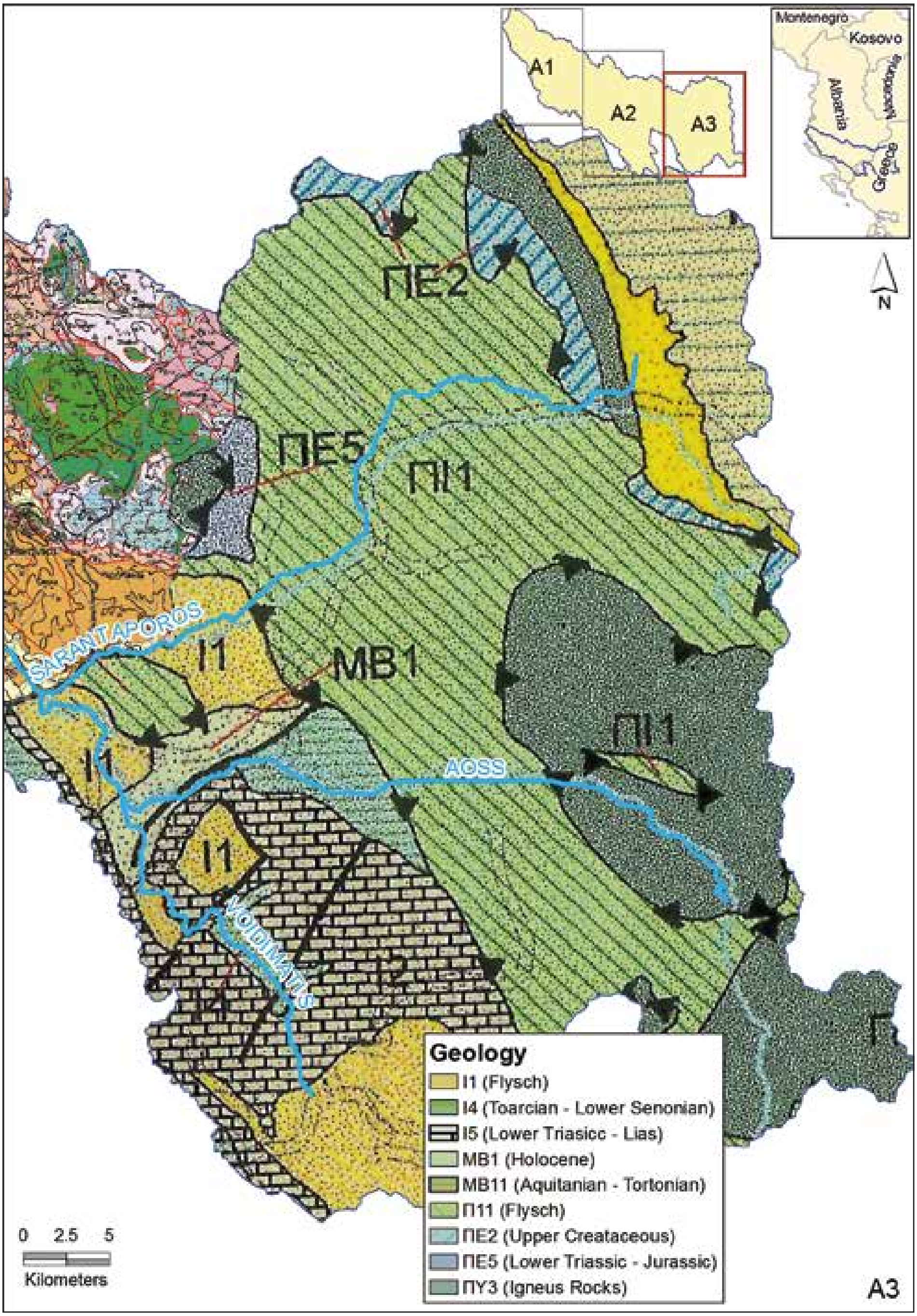

Fig. 2: Geological map of the upstream section-Vjosa Watershed. – Abb. 2: Geologische Karte des Einzugsgebiet der oberen Vjosa.

Mirdita tectonic zone is developed at the eastern part of the watershed with a general orientation NW-SE. This zone is composed mainly of ophiolitic formations (peridotites and serpentinites) and radiolaritic cherts associated to them.

Krasta-Cukali tectonic zone constitutes the most important area of the Greek part of Vjosa. It includes the mountains of Pindos, Lakmos and Athamanien. Paleogeographic studies indicate that this zone is composed of very deep-sea sediments. The oldest geological formations of Pindos zone are dated to Middle Triassic and consist of sandstones, cherts, marls and limestones. In the upper part of the Upper Triassic, an increased presence of cherts and limestones forms a thin-layered structure. Volcanic clasts consisting of andesites, basalts and volcanic tuffsare, are also observed.

The Jurassic formations are characterized by intercalations of thin layers of clayey-siliceous materials and limestones within multicolored cherts. The *first flysch of Pindos zone,* composed of alternation of marls, cherts, sandstones and brecciated limestones, is dated as Lower Cretaceous age. The first flysch is overlaid by thin layered limestones, which constitute an uninterrupted sequence from the Cretaceous up to the Maestrichtian age, where a transition of series composed of alternations of thin-layered limestones, sandstones and shales, precedes the flysch of Danian-Pliocene (locally up to the Upper Eocene), called *second flysch of Kraste-Cukali zone*. This *second flysch of Kraste-Cukali zone*, considered also as the most typical and representative flysch of the Greek territory, consists of rhythmic alternation of sandstones and marls with local conglomerates and limestones. In the clayey-sandstone deposits, sandstone olistholiths are often observed. Tectonic events during this period complicate the sedimentation and lead to the formation of a chaotic mixture called 'wild' flysch.

Kruja tectonic zone characterized by continuous neritic carbonate sedimentation during Triassic to Upper Eocene, is located at the west of Pindos and occurs as tectonic windows at the Valtos mountains. Geological formations involved within this zone are dolomites of Upper Triassic age, neritic limestones of Jurassic – Upper Eocene age with abundant content of fauna fossils and Eocene-Oligocene flysch.

Ionian tectonic zone has a NW-SE orientation and is located west of Kruja zone and is composed of Lower Eocene – Lower Miocene flysch, semi-pelagic limestones of Paleocene – Eocene age, Upper Senonian limestones and the limestones of Jurassic and Upper Cretaceous with radiolarite cherts intercalations and large content of fauna relicts.

The midstream section

This section extends from Çarshova to Poçemi in Albania, mostly in the Ionian zone (ShGjSh 2002, Xhomo et al. 2003) and only some small tributaries (from Çarshova to Kelcyra) belong to the Kruja and Kraste-Cukali zone (Fig. 3).

The **Kruja tectonic** zone consists of carbonate and flysch deposits from the Upper Cretaceous to the Middle Oligocene. The Upper Cretaceous deposits are represented by neritic deposit, consisting of dolomitized limestones at its lower part. In the upper part of the Upper Cretaceous the deposits are represented by bioconstructed limestone *Rudists*. A sedimentary hiatus is observed during the Eocene up to Middle Oligocene. During the Middle Oligocene, due to tectonic movements, the deposit outcropped and consequently the Upper Cretaceous limestones were eroded.

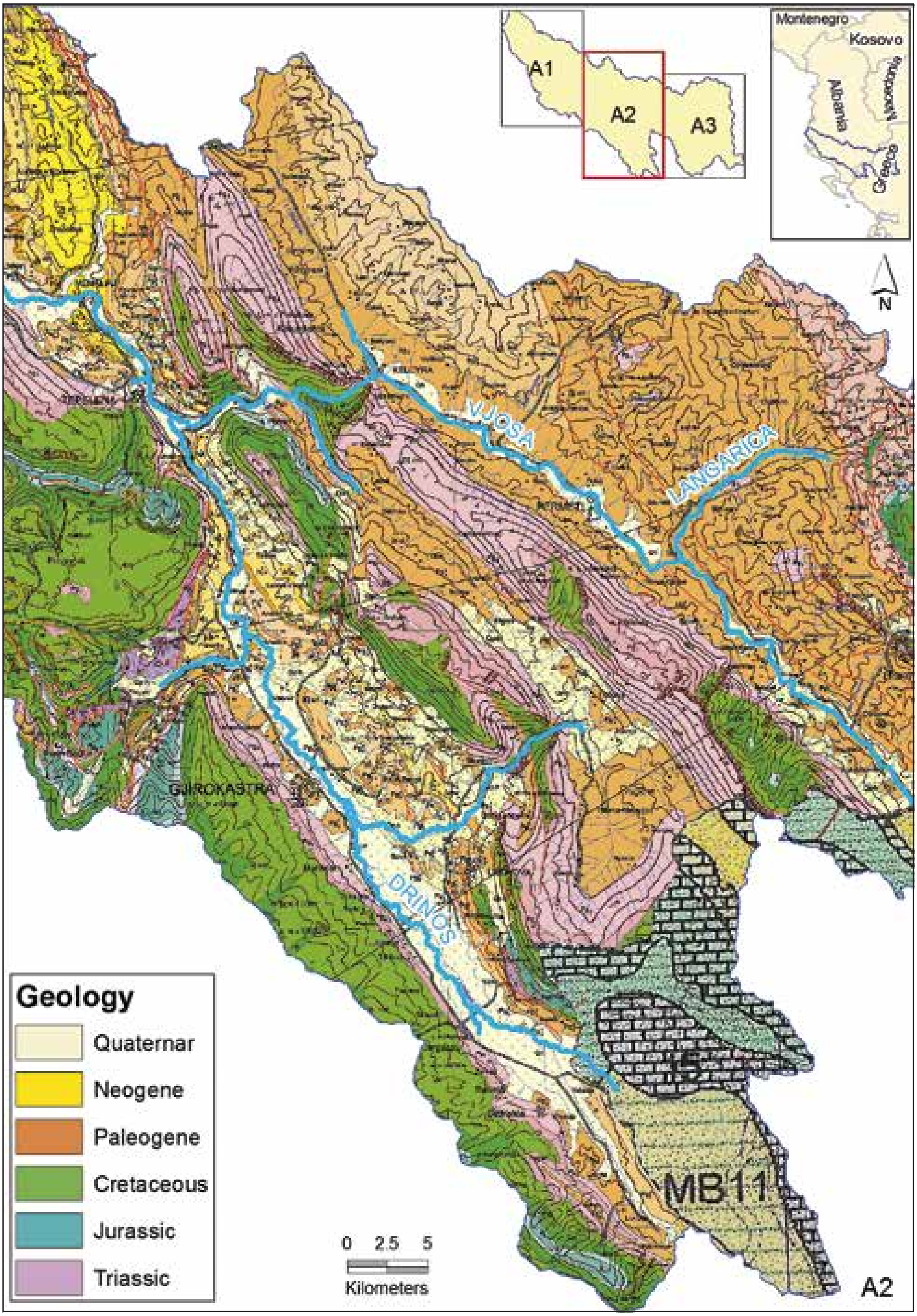

Fig. 3: Geological map of the midstream section -Vjosa Watershed. – Abb. 3: Geologische Karte des Einzugsgebiet der mittleren Vjosa.

Ionian zone represents a series of syncline/anticline structures having a large variety of rock formations dating from Permian to Quaternary (Fig. 4). At the base, the Permian evaporites and shallow carbonates of Triassic ages are situated, continuing with the lower Jurassic dolomites and limestones with algae (low and middle Lias), as well as 'Ammonitico Rosso' facies of upper Lias (Toarian), which characterize the western part of the Ionian Zone. Pelagic turbiditic carbonates with chert intercalations are developed during the middle Jurassic up to late Eocene (Fig. 3). Micritic and biomicritic limestones are dominant during the upper Cretaceous. Flysch deposits took place during the Oligocene and the lower Miocene. Frequent synsedimentary slumps are observed within flysch deposits. During the Miocene marls and clayey marls, sandstones and bioclastic limestones are encountered. Molasses characterize the middle Miocene up to Pliocene age. The molasses are composed of intercalations of conglomerates, sandstones, siltstones and shales. Evaporites are also present.

In the Ionian zone three sub-zones are identified in (ShGjSh 2002, Xhomo et al. 2003):

The **Eastern subzone (Berati belt) –** occupies the eastern part of Ionian zone and is characterized by relatively thick carbonate and flysch deposits of Cretaceous age. Two structural chains can be identified within the Berati belt: 1) the belt of Bureto-Lunxheria-Goliko-Rehova; and 2) the belt of Nemerçka-Terpani-Berati. East of this subzone the Permeti Syncline represents a subsident basin filled by Oligocene flysch and constitutes the transition to the Kruja zone.

Central subzone (Kurveleshi belt) – This subzone extends to the center of Ionian zone and is compiled by a series of syncline/anticline structures, composed of typical pelagic carbonate sediments.

Western subzone (Çika belt) – This sub-zone preserves the general extension of Ionian zone (NW-SE). Its principal characteristic is the presence of almost all facies of dolomites and limestones with algae (Low and Middle Lias) as well as 'ammonitico rosso'facies of Upper Lias (Toarian) instead of cherts with posidonia, found at the other areas of Ionian zones.

Downstream section

This section extends from Poçemi to the Adriatic Sea and extends to the Ionian zone and the Peri-Adriatic depression. In this section only the Quaternary deposits will be described because the Ionian zone deposits (Çika belt) are described in the previous section.

Based on previous studies the quaternary deposits can be divided as follows: 1) glacial and interglacial deposits located mainly in the upstream part; 2) river bed deposits and alluvial fans in the midstream section; and 3) marine and deltaic deposits.

The glacial and interglacial deposits were created during the last glacial cycle continuing during the Holocene till the present days. Abundant glacial and interglacial deposits as well as evidences of interglacial activity are identified in the Pindus area by detailed geomorphological studies carried out by Hughes (2004). These deposits are dated using the radiometric methods as well as the relative geological method, and result as older than 350,000 years B.C.

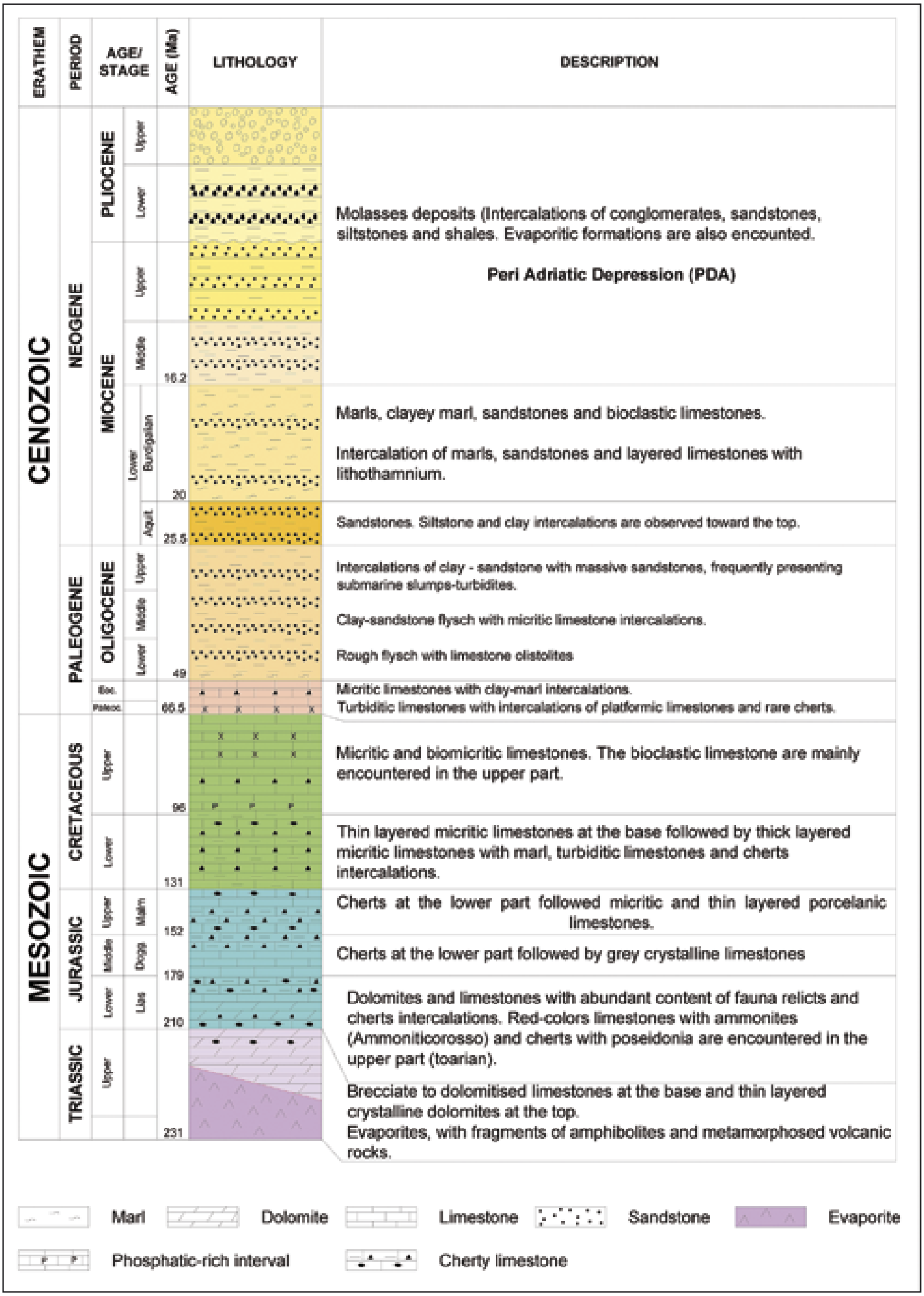

Fig. 4: Litho-stratigraphic column of the Ionian Zone (Albania). – Abb. 4: Die Litho-Stratigraphie der Ionischen Zone (Albanien).

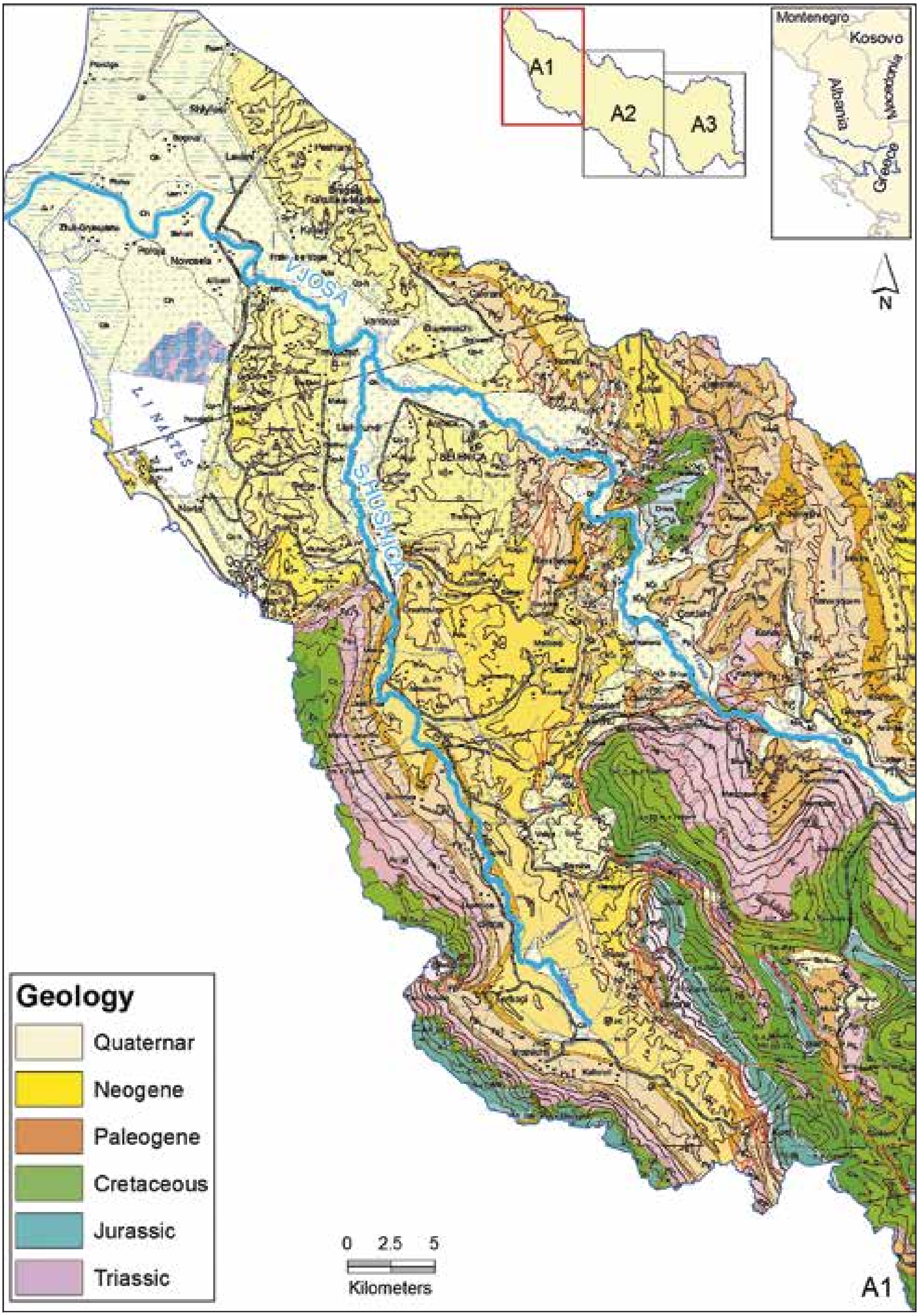

Fig. 5: Geological map of the downstream unit – Vjosa Watershed. – Abb. 5: Geologische Karte des Einzugsgebietes der unteren Vjosa.

In Albania, 11 levels of alluvial terraces are identified. In the Shkumbini and Devolli Valleys, 10 levels of alluvial terraces are fully evidenced (Aliaj et al. 1995, Woodward et al. 2001, 2008, Koçi 2007, Lewin et al. 1991, Carcaillet et al. 2009, Gutierrez 2013). Correlation between the alluvial terraces of Quaternary (Pleistocene – Holocene) and the climate reconstructions show that their formation is mainly controlled by climate changes. Lateral erosion and/or alluvium development occur during the cold and dry periods while vertical erosion and abandonment of channels occur during the hot and wet periods.

In the downstream part of Vjosa, from Poçemi to Mifoli, the actual river bed deposits and the deposits of the fifth alluvial terrace are encountered. From Mifoli to the rivermouth the Pleistocene-Holocene and actual deposits, representing two depositional cycles and having a thickness of 180–200 m, are encountered (Durmishi et al.2004). Sedimentological and petrographic analysis for the actual riverbed sediments have been carried out by Xhemalaj et al. (2000) in fifteen permanent stations along Vjosa and its main tributaries, like Drino, Kardhiqi, Bença and Shushica, starting from the Albanian-Greek border to the Mifoli bridge. The petrographic composition and the dominant grain size of each station are given in Figure 6.

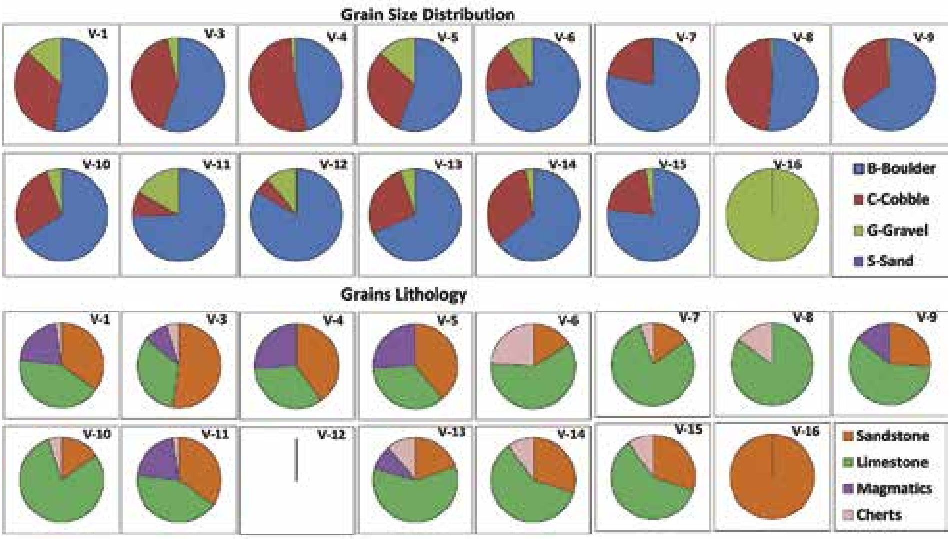

Fig. 6: Petrography and dominant Grain Size of actual sediments along the Vjosa River and its tributaries. – Abb. 6: Petrographie und Korngrößen der Sedimente der Vjosa und ihrer wesentlichen Zuflüsse.

Delta of Vjosa and the dynamics of the shoreline movement (1870–2016)

For the littoral and the Delta of Vjosa, the sedimentological, petrographic and shoreline dynamic analyses were carried out by Durmishi et al. (2004) (Fig. 7, Fig. 8).

The Delta of Vjosa represents the most important area in the Myzeqe lowland, 2/3 of which is a result of delta progradation, during a time lapse of 500 years (Fouache et al. 2010). Previous and archaeological studies show the displacement of the Vjosa mouth

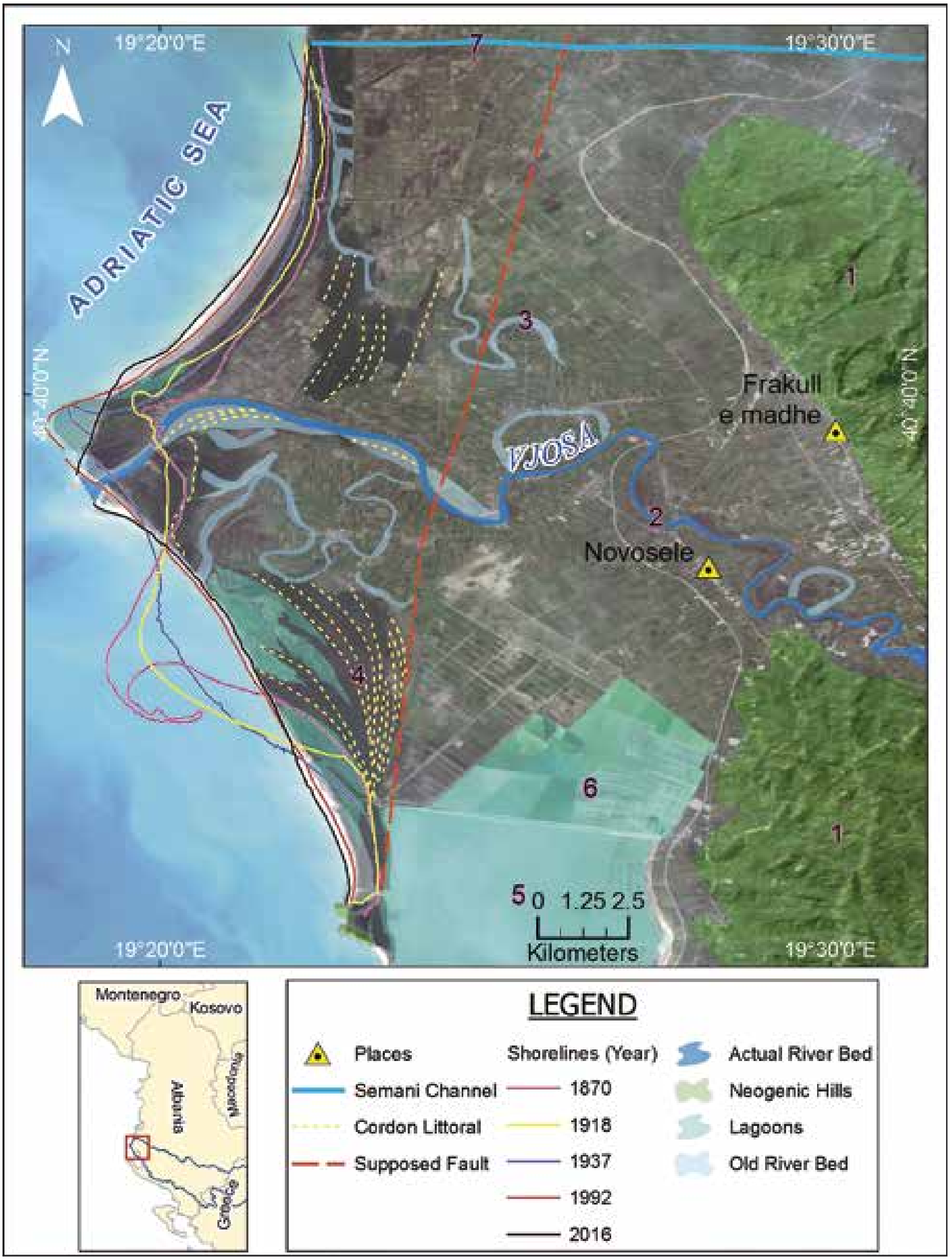

Fig. 7: Delta of Vjosa – shoreline dynamics (1870–2016); 1, Neogene deposits; 2, Actual Vjosa River; 3, Abandoned channel; 4, Ancient beaches and related dunes; 5, Narta Lagoon; 6, Coastal marshes; 7, Semani channel. – Abb. 7: Die Entwicklung des Vjosa-Deltas (1870–2016); 1, neogene Ablagerungen; 2, rezenter Flussverlauf; 3, historische Arme; 4, historische Buchten und Sanddünen, 5, Narta Lagune; 6, Küsten-Marschlandschaft; 7, Semani Arm.

south of its actual location in Vlora Bay (where Narta Lagoon was created) as well as to its north, along the foot of the Frakulla structural ridge, less than 1 km southwest of the ancient city of Apollonia. The Vjosa Delta represents a wave dominated formation, characterized by sand banks, mud flats, salt marshes, reed beds, small lagoons and temporary marshes.

Spatial patterns of the Vjosa Delta are a result of fluvial and marine processes mainly controlled by water and solid discharges as well as oceanographic conditions during the time period from the beginning of Holocene up to today.

Shoreline dynamic analysis, using historical topographic maps from the XIX century up to recently, respectively corresponding to the years 1870, 1918, 1937, 1992, 2007 and 2016, shows the fluctuation of the coastline position. The respective erosion/accumulation rates correspond to the time intervals between the abovementioned years. The results of the analysis demonstrate a dominance of accumulation, which decreases during the time intervals between the years 1992–2007 and 2007–2016, a tendency which would hint towards a possible inversion leading to erosion in the future. The construction of hydropower plants would accelerate this process.

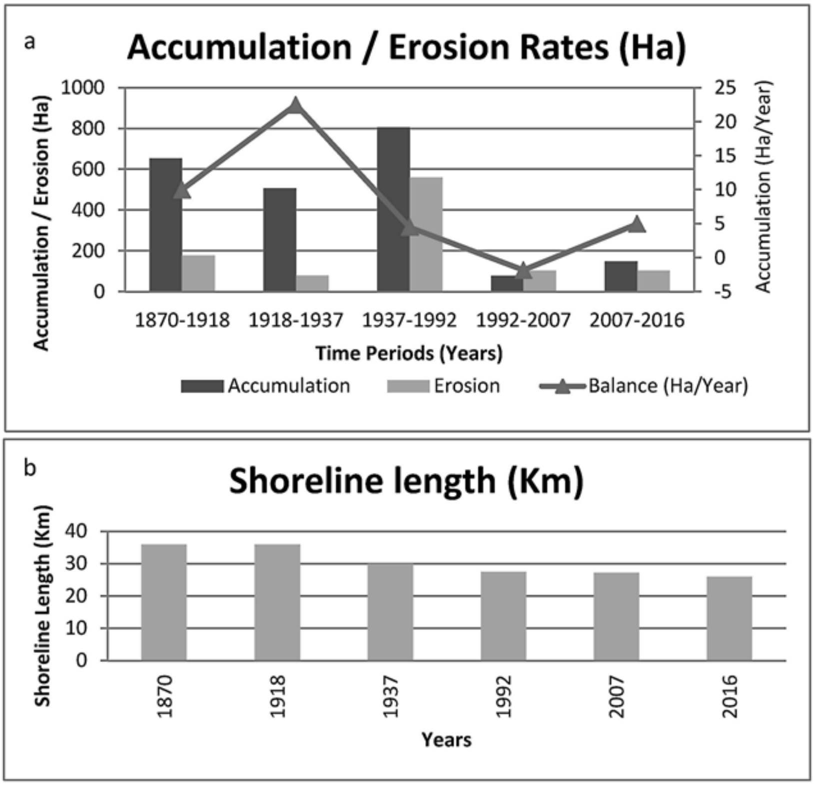

Fig. 8: Shoreline displacement rates (a) and shoreline length (b) during 1870 to 2016. – Abb. 8: Verlagerung der Küstenlinie (a) und Küstenlänge (b) zwischen 1870 bis 2016.

Influence of late and neo-tectonics to the Vjosa Watershed configuration

The present morphology of the Vjosa Watershed – the presence of flattening blocks and almost vertical slopes dividing them, as well as that of fluvial terraces, – is also a consequence of late – and neo-tectonic processes (Aliaj et al. 1998). Stretching neo-tectonic displacements lead to the formation of a mountainous system with peaks more than 2000 m high, interrupted by narrow sinks. The Vjosa Watershed is characterized by pre-Pliocene compression movements, leading to the formation of anticline/syncline complexes, frequently associated to reverse faults even with important displacements towards the west or southwest. As a consequence of these neo-tectonics, the main mountainous complexes over 2000 m high (Nemerçka, Tomorri, Çika, etc.) are formed, which in combination with the lower relief areas correspond to anticline/syncline geological structures.

The eastern flanks of anticline structures are characterized by gentle inclination, with the exception of the complications by backthrust faults. The west flanks of anticlines represent steep slopes associated with colluvial breccias and erosive streams, tributary to Vjosa River.

The contrast between elevated relief and valley sinks is pronounced especially between anticline belts of Berati, Kurveleshi and Çika, and syncline structures of Memaliaj and Shushica. This elevation leads to the outcrops of limestones, while the transversal faults Vlora-Tepelena lead to the sudden disappearance of limestone at its northern side.

Two types of sectors are identified at Vjosa Watershed (Aliaj et al.1998; Carcaillet et al. 2009).

Sectors of continuous and intensive elevation regime associated with the renewing of compressions and thrusts, formed by intensive folding processes during the lower and middle Miocene. Mountain chains such as Nemerçka-Dhembeli-Trebeshina, Lunxheria-Bureto and Kurveleshi are situated there. Sectors of light to middle regime of elevation are detected at the lower relief area, corresponding to the syncline structures, which delineate the separation between anticline structures, Drino, Shushica, etc. valleys, filled by flysch or flyschoidal materials. Several intensive vertical movements are observed during the middle Miocene, but the most important event seems to be the subsidence of the northern part of Ionian zone, leading to the formation of the Peri-Adriatic depression. Serravallian or younger molasses that fill this depression, continue transgressively over older depositions of Ionian and Kruja zones.

Hydrology and Hydrogeology

In this section, only the hydrological and hydrogeological features of the Albanian part of the Vjosa watershed, are described.

Hydrology

The area of Vjosa Watershed is about 6710 km^{2}of which 4455 km^2 are included within the territory of Albania and an area of 2805 km^2 belongs to the Greek territory (Ihme 2008). The main tributaries of Vjosa in Greece are Sarandoporos and Voidomare. In the Albanian territory the Vjosa River represents a complex hydrographic network (Pano 1984, 2015). The main tributaries are Drino and Shushica rivers. Shushica has a drainage area of 715 km^2, an average discharge of 24.2 m^3/s and a runoff coefficient of 0.53. Its main tributaries are the torrents of Smokthina, Vajza and Vllahina. Other important tributaries are the Çarshova torrent, Langarica, Lemnica, Dishnica and Zagoria with drainage areas of 90km^2, 337 km^2, 103 km^2, 173 km^2 and 171.6 km^2, respectively. Bença River and the torrents of Luftinje and Salaria are also tributaries of Vjosa.

The average multiannual water discharge of Vjosa River is Q_0=195m^3/s with a runoff coefficient of 0.61. The annual water volume is about 6.2 billion m^3 (Pano 2015) 82 % of which occurs during the wet period (October–May) and 18% during the dry period (June – September). Its alimentation comes from precipitations and the groundwater. The contribution of groundwater to the Vjosa water discharge is about 31% of its total.

The quantity of the precipitations in the Watershed increases from its southeastern to the northwestern part. The average precipitation in the southeastern part varies from 1170 mm/year at Leskoviku to 1290 mm/year to Kelcyra hydro-meteorological station. Higher quantities of rainfalls are observed in the areas corresponding to the mountainous chain of Trebeshina – Dhembeli – Nemerçka, Mali Gjere, Kurveleshi and Çika Mountains. They vary from 1890 mm/year at Gjirokastra to 2300 mm/year at Nivica and Kuçi.

Hydrogeology

The hydrogeological framework of the basin consists of different hydrogeological groups based on rock formations features such as: rocks lithology; structural features; geological formations origin; and geological evolution (ShGjSh 2002, 2015, Dindi 2009, Tab. 1, Tab. 2).

From the hydrogeological point of view four main rock formations are distinguished in the Vjosa watershed:

- Karstic carbonate rock formations originated and structured in different geological periods representing high waterbearing potential aquifers. The groundwater in karstified rocks follows a tortuous path from the recharge areas through karstic systems before discharging. The areas between two river valleys where the massif emerges, as well as river valleys in contact with carbonate formations, serve as recharge zones. Drainage zones, moreover, are composed by the following formations: tectonic contact of flysch with carbonate formations; karstified or fractured rock to erosional basis of the streams; Quaternary Breccias (formations).
- Terrigenous rock formations originated in deep sea, into a turbiditic environment. These deposits represent rythmic intercalations, of claystones, siltstones and sandstones with rare conglomerates. These formations are characterized by a low water bearing potential.
- Sedimentary rock formations of the Neogenic molasses of the Peri-Adriatic Depression represented by intercalations of the sedimentary rocks formed in different sedimentation environments as Fluvial, Deltaic, Littoral, Turbiditic, etc. These deposits are characterized by a moderate water bearing potential.
- Quaternary deposits represent the highest water bearing potential due to their high hydraulic conductivity.

Based on the rock formation types, their hydrologic features and geological structures, the following hydrogeological regions have been distinguished (ShGjSh, 2015, Fig. 9):

Hydrogeological region of the Mirdita tectonic zone: Intrusive Jurassic magmatic rocks with Triassic limestone blocs characterized by a poor waterbearing potential. Springs are encountered along the fractured tectonic lines. Their average discharge varies from 0.3 to 0.5 l/s. Estimated potential recourses are approximately 20 l/s.

Hydrogeological region of carbonate formations of the Krasta–Cukali tectonic zone has a poor water-bearing potential due to the limited presence of the limestones within the flysch formation. The spring yields that drain the massif vary from 0.1–0.4 l/s.

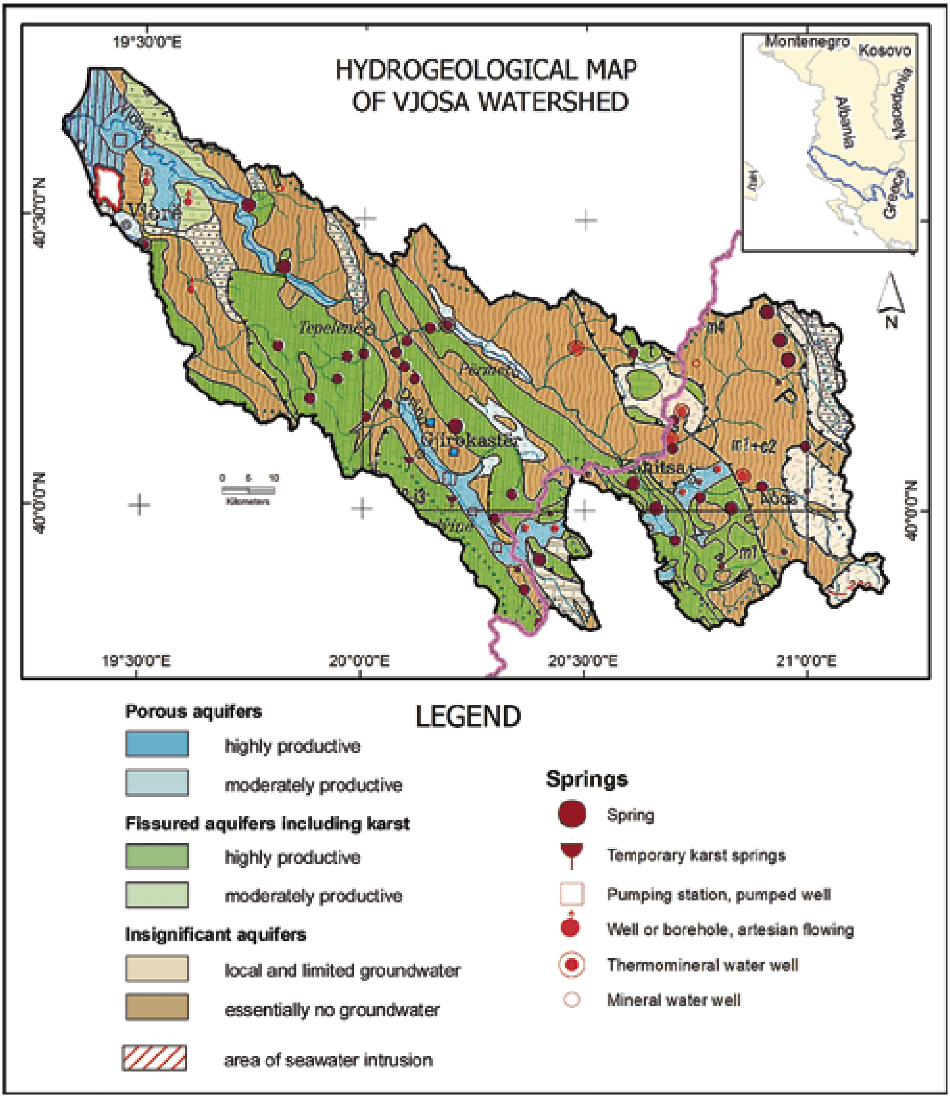

Fig. 9: Hydrogeological map of the Vjosa Watershed. – Abb. 9: Hydrogeologische Karte des Vjosa Einzugsgebietes.

Hydrogeological region of the carbonate formations of the Kruja tectonic zone is represented by small anticline structures outcropping at the eastern side of Permeti syncline. The presence of the thermo mineral sulfide water springs is the relevant feature for this hydrogeological region. (Frashëri et al.2004, Pano 2015). Farther to the south, at Kavasila in Greece, the thermal water occurs.

Hydrogeological region of the carbonate formations of the Berati subzone – Ionian tectonic zone are represented by Trebeshina – Dhembeli – Nemerçka and Shendelli – Lunxheri – Bureto mountain chains. The anticline belt of Berati represents a single karstic reservoir. The most important springs of this region are located in the canyon of Kelcyra, in the eastern flank of the anticline. The biggest spring discharge is1.3 m^3/s.

Hydrogeological region of the Drino depression represents the southern part of Vjosa Watershed and has a northeastern – southwestern extension. The Quaternary deposits have a good hydraulic connection with the Drino River waters. A part of ground waters drains to Mali Gjere Mountain. The average Drino River discharge is Q_0=42.5m^3/s (Lekli station), 22% of which is groundwater contribution. The runoff coefficient of the annual water flow for the entire basin is α_0= 0.53.

Tab. 1: Main physical and chemical characteristics of groundwater related to different tectonic units. – Tab. 1: Die wichtigsten physikalischen und chemischen Charakteristika des Grundwassers in den verschiedenen tektonischen Bereichen.

Tectonic Zone	T (°C)	TDS (g/l)	Hardness (°dH)	Water type
Mirdita	9-14	0.3-0.45	6-10	Ca-Mg-HCO_3.
Krasta-Cukali				
Kruja (Leskovik, Langarice, Lemnice)	29-32			Na-Ca-Cl
Ionian / Berati Subzone (Trebeshine, Dhembel, Nemercke, Shendelli, Lunxheri, Bureto)	8-16	0.7-0.8	6-16	Ca-HCO_3
Ionian / Kurveleshi Subzone (Kurveleshi, Kremanara, Tragjasi)		0.2-0.3	7-12	Ca-HCO_3
Ionian / Kurveleshi Subzone (Mali i Gjere)	11-13	0.1-0.5	7-16	Ca -HCO_3, Springs West side Ca-HCO3-SO4
Ionian / Çika Subzone (Selenica, Vlora)	15-18	0.45-0.50	18-30	Mg-Ca-HCO_3 or Ca–Mg-HCO_3.
Ionian (Vjosa midstream and downstream - Shushica River Valley)	15-16	Changes toward the sea		Mainly HCO_3, Changes toward the sea HCO3-Cl and Cl-HCO3
Ionian (Drino River Valley)	15-16	<0.6	15-20	Mainly Ca-HCO_3
Ionian (Permeti Syncline)	15	0	15-18	Ca-Mg-HCO_3
Delta of Vjosa		< 0.4	8-10	Ca-HCO_3

Hydrogeological region of the carbonate formation t of subzone Kurveleshi- Ionian tectonic zone. This region represents one of the most potential karstic reservoirs of Vjosa watershed, having an area of approximately 580 km^2. The carbonate formations have well-developed cracks and karst, and the springs discharge range from 100 to 1000 l/s. The springs are mostly of tectonic karstic origin. Some of these springs are: Tatzatit, Kalivaçi, Poçemi (795–970 l/), Verniku, Kuçi (Q = 10–100 l/s), Uji i Ftohte – Tepelene (20–200 l/s), Gurra e Picarit, Fterres, Kolonjes, etc. The spring of Viroi with a discharge, ranging from 0 (in the dry period) to 20 m^3/s represent the most important spring of karstic origin. It drains from the eastern side of "Mali i Gjere" massif.

Tab. 2: Hydrochemical characteristics of the main springs. – Tab. 2: Hydrochemische Charakterisierung der wichtigsten Quellen.

Spring	Spring Type (Modified by Durmishi. C.)	Discharge (l/s)	Hydrochemical characteristics			
			TDS (mg/l)	T (°C)	Hardness (°dH)	Water type
Poçemi Springs	Karstic-tectonic (8 springs)	839	287	15	12	Ca -HCO_3
Doreza-Kalivaçi	Karstic-erosional	200	103	12	7	Ca -HCO_3
Tepelena	Karstic	250	162	9,5	9	Ca -HCO_3
Izvori spring	Karstic-tectonic	80-150	-	-	-	-
Vermiku spring	Karstic-tectonic (4 springs)	460	140-165	9-11	7-8	Ca -HCO_3
UjiFtohteTepelena	Karstic-tectonic	100	-	-	-	-
UjiFtohteDrino Valley	Karstic-tectonic (2 springs)	220	180	12	6	Ca -HCO_3
Uji Ftohte- Drino Valley	Karstic spring from quaternary breccias	12	-	-	-	-
Hormova spring	Karstic-tectonic	61	-	-	-	-
Lekli spring	Karstic-tectonic	300	-	-	-	-
Peshtani spring Tepelena	Karstic	300	212	12	8	Ca -HCO_3
Kelcyra Gorge	Karstic-tectonic	-	277	9	10	Ca -HCO_3
Kelcyra Gorge	Karstic	250-300	-	-	-	Ca -HCO_3
Syri Zi, Kelcyra Gorge	Karstic	600-700	-	-	-	-
Lengarica	Tectonic- Karstic (8 thermal springs)	-	-	30	-	Na-Ca -Cl
Viroi	Temporary karstic spring	-	-	11	-	Ca -HCO_3
Petrani spring	Quaternary breccias	9	148	12	7	Ca -HCO_3

Hydrogeological region of the flyschoidal formations and molasses of Peri-Adriatic Depression is represented by the deposits of the "Rrogozhina" formation. This formation is composed of sandstones and conglomerates with relevant water bearing potential, outcropping at the hills of Armeni, Selenica, Buzemadhi, etc. This aquifer is exploited by wells. The water of conglomerates is of good quality, with total dissolved solids (TDS) 0.45–0.7 g/l, and general hardness of 17–20 German degrees.

Hydrogeological region of the formations of Quaternary belonging to the downstream section of Vjosa River and its delta, represented by the aquifer of alluvial deposits of Vjosa River including the entire plain of "Vjosa – Shushica" and "Cakrani". This aquifer is characterized by high hydraulic parameters and high water bearing potential. Water quality is good, but in the western part the quality deteriorates due to sea water intrusion.

Geo-touristic features of the Vjosa watershed

The Vjosa Watershed has a wide variety of ecosystems and landscapes of regional, national and international importance. The landscape of the Vjosa River watershed (especially in the upper and middle parts) is characterized by the presence of a series of geological-geomorphological natural monuments such as: geological structures, river terraces, glacial landscapes, spectacular canyons, narrow valley segments with almost vertical slopes (from 300–400 m to 900–1000 m high) and pure water springs. The characteristic landscapes are associated to a specific biodiversity and grassy vegetation. Forests and hygro-hydrophilic vegetation are also encountered. Habitats expressing all types of vegetation are naturally intertwined.

Protected areas, having different status according to the UCN, are identified in the Vjosa Watershed.

Protected Areas

According to **Iucn/Wcmc (1994)** the following protected areas are proclaimed in the Vjosa Watershed:

National Parks (Category II)

The Pindos National Park is located in the northern part of the Pindus Mountains, north of the town of Metsovo and south of Perivoli. The Park of some 7000 ha was established in 1966. There are forests of black pine and beech, and in the higher parts, the Bosnian Pine (*Pinus leucodermis*).

The Vikos–Aoos National Park founded in 1973 is located in northwestern Greece, south of the town of Konitsa, in the west part of Zagoria region. It includes Mount Tymfi, the Vikos Gorge and the Aoos Gorge. It encompasses 126 km^2 of mountainous terrain, with numerous rivers, lakes, caves, deep canyons and dense coniferous and deciduous forests. The core of the NP (3400ha) is the Vikos Gorge, carved by the Voidomatis River, while the Aoos Gorge, mount Tymfi, with its highest peak Gamila 2497 m and a number of traditionally preserved settlements form the park's peripheral zone.

Protected Areas in Albanian territory, according to the International Union for Conservation of Nature (Iucn/Wcmc, 1994), have been proclaimed the following areas:

The Hotova-Dangellia National Park is the largest national park in Albania located in Permetiregion, with an area of 34,361 Ha. The Park takes its name from the Hotova Fir, which is considered as one of the most important Mediterranean plant relics of the country. Nevertheless, it encompasses hilly and mountainous terrain composed of limestone and sandstone rocks. Numerous valleys, canyons, gorges, rivers and dense *deciduous* and *coniferous* forests are also present. The park includes 11 natural monuments also.

Nature Monuments (Category III)

In this category the following monuments are included: Postenani Thermal Baths, Vromoneri (Leskoviku) and Benja Thermal Baths, Langarica Canyon (Benja),'Guri Atos' – close to Kutali village,'Guri' of Permeti, 'Bokerima' of Dangellia, 'Uji i Zi' Spring in Kelcyra, Mezhgorani Cave, Piksi Canyon, River Terraces of Nderani village, Nepravishta Spring, Libohova Spring, Viroi Spring, Lekli Cave,'UjiFtohte' spring Tepelena, Nivica Canyon, 'Vurgu' Planes in Çorrushi, Povla Thermal Baths.

The Vjosa-Narta Protected Landscape (Category VI)

It covers a total area of 194.12 km^2, encompassing Narta Lagoon along with the delta of the Vjosa River and its surrounding areas with freshwater wetlands, marshlands, reed beds, woodlands, islands and sandy beaches. It is also listed as an important Bird and Plant Area, because it supports significant bird and plant species.

Natural monuments worth considering in Albanian territory

The Vjosa Watershed encompass important natural monuments of high value still unidentified, not evaluated or cataloged in the network of protected area categories which are endangered by unwise infrastructural, industrial, agro-cultural developments etc. For those natural resources that have not been proclaimed as PAs according to the IUCN, geo-diversity studies in the context of geological diversity can contribute to the valorization of specific natural monuments of the Vjosa watershed. The geological diversity studies of the basin have highlighted a series of monuments of different categories according to IUCN, which will enrich the potential values of natural resources and the geo-tourism of Vjosa, at the national and European level.

This paper puts special attention to two of the most important areas (Fig. 10), which should be included in the respective categories of PAs:

The geological structure of Berati belt – Ionian tectonic zone.

This area is oriented SE-NW, and consists of the crests carbonate structures (Jurassic-Cretaceous-Paleogene) of the mountains chains of Dhembeli (from 1280 m to 2050 m a.s.l.) – Trebeshina (from 1085 m to 1307 m) at the eastern flank of the structure, and Lunxheria (from 1722 m to 2185 m) – Shendellia (from 1231 m to1802 m) on the western flank of the structure. This chain is crossed by the geo-monument of Kelcyra Canyon extending from Kelcyra to Dragoti. The mountain-chains are divided by the syncline structure filled by Oligocene terrigenous flysch. In the south-eastern part of the syncline the mountainous valley of Lunxheria is encountered. In this valley, in the area of Sheperi –Nderani (2050 m), the spring of the Zagoria River is located, which joins Vjosa at an elevation of about 150 m (Peshtani area). In the North-Eastern part of this syncline structure (Mezhgorani area) the Mezhgorani torrent originates at an elevation of about 1600 m and flows in the NW-SE direction, joining Vjosa at an elevation of about 155–165 m. In this area, geo-diversity is associated with biodiversity. The most important is the giant natural geo-monument canyon of the Vjosa River, with a length of about 20 km, with a valley depth of ranging from 900 m to 1600 m and width ranging from 180 m in Kelcyra, up to 130 m in the Dragoti. In the Kelcyra gorge, the highest elevations are represented by the Qesniku (1280 m) and Dushku (1085 m) mountains, while in the Dragoti gorge the highest elevations are represented by Goliku (1722 m) and Trebeshina (1889 m) mountains. The most spectacular zone of the Vjosa Canyon is the vertical left side of the valley going from an elevation of 160 m (Vjosa River) up to 1000–1040 m, having a width of about 1.5–6 km. From the geological-tectonic point of view, this area represents a carbonate anticline structure composed of the carbonates of Jurassic-Cretaceous-Paleocene and Eocene.

The coexistence between natural elements and geological processes is observed in this area. The presence of the ecosystem and biodiversity of the 'Hija' forest, the outcropping from the anticline structure of the karstic springs of 'Syri Zi – Black Eye' and 'Uji i Zi – Black Water' and small waterfalls along Vjosa valley, are also visible.

Structural "core" of Tepelen Kurveleshi belt – Ionian tectonic zone.

This geo-monument is part of the Ionian tectonic zone – Kurveleshi belt. This area represents a carbonate anticline structure composed by Jurassic, Cretaceous, and Paleogene deposits. The most important part of this geo-monument is the glacial valley of the Bença River, originated during the Quaternary glacial cycles. The river sources of the Bença River are located in the Shtepeza-Lekdushi-Progonati-Gusmari-Nivica mountain belt, in elevations going from 2122 m (Kendervica Mountain) to 1000–1400 m (Progonati plateau). In the upper stream the Bença River has a NW-SE direction. The actual river bed passes through the Jurassic carbonate formations from Nivica to Bença village, following in a SW-NE direction up to Veliqoti village, passing through the Cretaceous carbonate joining the Vjosa River at an elevation of about 115 m. In this area the glacial valleys of Perrosi, Luzati and Salaria are included. This area also includes a series of geo-monuments, such as the Nivica canyon, the presence of karstic water springs and a series of unexplored karstic caves. In this area the Bença River transverses only the carbonate formations; the water is very clean and the related sediments along the river bed are mainly of carbonate composition.

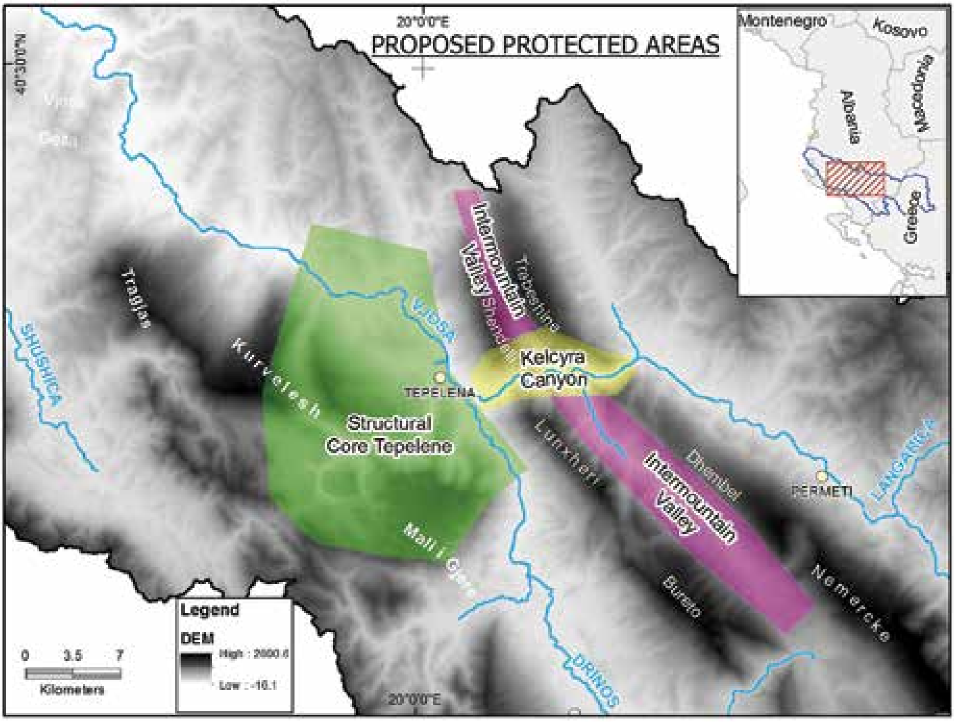

Fig. 10: Proposed new Protected Areas in the Vjosa Watershed (Albanian part). – Abb. 10: Vorschlag für eine Schutzzone des Vjosa Einzugsgebietes.

Conclusions

The Vjosa Watershed is located on the southern part of the Albanides mainly in the Ionian Zone. Along its course, the Vjosa River crosses several geological structures consisting of a succession of anticlines and synclines affected by a series of active tectonic and neotectonic lines, evidencing spectacular outcrops of rocks as well as geodynamic phenomena, representing an area of international interest for geological studies. The carbonate formations, deeply affected by the karst phenomenon, lead to the formation of groundwater flows draining along the Vjosa valley in 47 permanent water springs. The water type of each tectonic zone varies in function of the presence, at local level, of rocks and minerals that condition the chemical composition of the groundwater. The most common type of ground water is calcium bicarbonate ($Ca\text{-}HCO_3$). There is an exception in the coastal plain where the waters of the Quaternary aquifer varies from HCO_3 to $HCO_3\text{-}Cl$ up to $Cl\text{-}HCO_3$ type due to the sea water intrusion.

The Vjosa Watershed, at its present natural state, possesses natural resources not yet officially identified or included in the list of Albanian Protected Areas.

The evaluation and the management of these natural resources will contribute in exploring the scientific values, as well as the socio-economic, didactic, recreational and geo-touristic importance of the area, on a local, regional and international level.

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Stream Channel Characterization Vjosa River – a unique natural river

Shkelqim Daja, Xhezmi Xhemalaj, Skender Lipo & Besnik Ago

Geomorphic and geomorphologic studies, according to ROSGEN classification system, were conducted in the Vjosa River, one of the biggest rivers in Albania and considered to be Europe's last wild river. The ROSGEN classification system is commonly used in the USA and this study represents the first attempt to classify the natural rivers in Albania. This classification system provides a key in classifying natural rivers using six morphological measurements, such as the entrenchment, the width/depth ratio, the sinuosity, the number of channels, the longitudinal slope, and the bed material particle size. Based on broad descriptions of longitudinal profiles, valley and channel cross-section and plan view patterns, the different reaches of Vjosa River are classified (Level I of ROSGEN classification system) and related descriptions are given. Further geomorphological (Level II of ROSGEN classification system) studies were conducted in fifteen benchmarked stream channel reference – sites situated in Vjosa River and its main tributaries like Drinos, Kardhiqi, Bënça and Shushica. Morphological descriptions and stream type delineation as well as the sensitivity to disturbance, the recovery potential, the sediment supply and stream bank erosion are described in detail. In general the morphological characteristics and behavior of Vjosa River match with those indicated by ROSGEN system, however some mismatches are found, especially regarding the streambank erosion potential. Limited data and experience make it harder for a conclusive opinion regarding the application of the ROSGEN system in the study of reaches in Albania.

Daja S., Xhemalaj X., Lipo S. & Ago B., 2018: Zur Charakterisierung des Flussbettes der Vjosa – ein einmalig naturnahes Fluss-System.
Die Arbeit berichtet über geomorphologische Studien an der Vjosa unter Bezugnahme auf die ROSGEN-Klassifikation. Diese Klassifikationsschema basiert auf sechs morphologischen Messungen: Flußeintiefung , Breiten/Tiefen-Verhältnis des Flusses, seiner Sinuosität, der Zahl von Flußarmen, dem Geländegefälle, sowie der Korngröße des Substrates.
Nach diesen Messungen wird eine Grobklassifikation (Level I des Klassifikationsschemas) der verschiedenen Flußabschnitte vorgenommen. Detailliertere morphologische Beschreibungen (Level II) beziehen sich auf 15 Referenzstrecken an der Vjosa und ihren wesentlichen Zuflüssen, Drinos, Kardhiqi, Bënça and Shushica. Sie bewerten die Störungsanfälligkeit durch Hochwässer, die Sedimenttransport-Verhältnisse sowie das Ufer-Erosionspotential.

Keywords: ROSGEN, stream classification, Vjosa River, Albania.

Introduction

Systems for classifying channels can be traced as far back as 1900. Since then, a number of more detailed geomorphic classifications were proposed for large alluvial rivers. Leopold & Wolman (1957) describe the streams as straight, meandering and braided. Montgomery & Buffington (1997) defined three stream types as follow: step-pool, plane-bed, and pool-riffle channels. Other studies have used different characteristics to classify the streams (Khan 1971; Schumm 1977; Lotspeich 1980; Lotspeich & Platts 1982; Whiting & Bradley 1993, Rosgen 1994 and 1996).

The ROSGEN stream classification system provides a key to classify natural rivers based on descriptive and measurable morphological features. This classification key represents a sequential process for river classification and is based on the notion that the most effective classification system is one based on objective, quantifiable criteria that are readily observable and measurable in the field (Rosgen 1994).

ROSGEN stream classification system describes a four-level hierarchy of river inventory and assessment as follows: Geomorphic Characterization (Level I), Morphological Description (Level II); Assessment of stream's condition (Level III) and the Validation (Level IV). Each level use the information derived from the previous level.

In the **Level I**, the Rosgen's system delineates eight primary generalized categories of "stream types" denoted by capital letters A, B, C, D, DA, E, F and G. These categories are based on broad descriptions of longitudinal profiles, valley and channel cross-section and plan view patterns. In the **Level II**, the eight primary categories are further divided into secondary stream types (42 major and 94 total stream types) based on the water surface slope and channel material. The third and the fourth levels involve respectively the stream condition assessment and the validation.

Although it is widely used in the western part of the United States, this system has become subject to various criticisms. Roper et al., 2008 using three different monitoring groups concluded that the estimation of the measured field parameters is operator-dependent. Problems are encountered in the evaluation of entrenchment ratio due to discrepancies in determination of the maximum bankfull depth, leading to potentially large differences in determination of Rosgen's flood-prone width.

The ROSGEN System was applied in the study of the behaviour of the River Vjosa as the only natural river in Albania. The main purpose was the description of its characteristics based on the ROSGEN classification system.

Case study and methodology

The Vjosa watershed is partially located in northwestern Greece and partly in the southern part of Albania, having an elongated shape with a SE-NW direction. The area of the watershed is about 6710 km^2 (Albanian Academy of Sciences 1984) of which 4365 km^2 are included within the territory of Albania. The average elevation of the watershed is about 855 m. The elevation decreases gradually from 1235 m a.s.l. (the upper part) to the Adriatic Sea. The average watershed slope is almost constant from 0.27 % to 0.29 % . Vjosa River is one of the main rivers of Albania. It originates from springs within the Pindos Mountains (Greece) and enters the Albanian territory at Mesareja. The length of Vjosa River in Albania is about 272 km.

Geomorphic Characterization of Vjosa River – (Level I)

Generalized categories of stream types were initially delineated using broad descriptions of longitudinal profiles, valley and channel cross-sections, and plan-view patterns inferred from topographic maps at 1:25000 scale. The parameters used in this level of classification are as follow:

- The plan-view patterns expressed in terms of sinuosity along the river. The sinuosity is calculated as the ratio of stream length in a reach stream to the corresponding valley length.

- The longitudinal profiles expressed in terms of inclination or slope determined as the difference of water surface level per unit stream length.
- Width/depth ratio was estimated on selected sectors (reaches), where the valid data were available in the 1:25000 topographic maps. It should be mentioned that the width/depth ratio defined at this level it is not quite to the Rosgen's width/depth ratio. It is a ratio calculated from topographic map data.

The results of the geomorphic characterization of different stream reaches of Vjosa River are shown in the Table 1 and in the Figure 1.

Tab.1: Stream type of different reaches of Vjosa River and its tributaries. – Tab. 1: Flußtypen der verschiedenen Abschnitte der Vjosa und ihrer Zubringer.

Nr	Steam reach (from-to)	W/D	S	I	TIPI
1	Greek border - Petran	>12	1.1	0.003	F or G
2	Petran - Kelcyre	>12	1.16	0.003	F
3	Kelcyre - Dragot	<12	1.04	0.0026	G
4	Dragot - Memaliaj	>40	1.25	0.0019	D
5	Memaliaj - Dorez	<40	1.17	0.002	DA
6	Dorez - Kalivac	>12	1.04	0.0026	B
7	Kalivac - Pocem	>40	1.5	0.0026	D
8	Pocem - Shushice	>40	1.2	0.0015	D
9	Shushice - Mifol	>12	>1.5	0.0004	C
10	Mifol – Adriatic Sea	>12	1.5	0.00004	C
11	Kardhiqi River	>12	1.2	0.005	F
12	Drino River	>12	1.04	0.003	B or C
13	Benca River	<12	1.02	0.0129	G
14	Shushica River (Gjorm – Drashovice)	<12	>1.2	0.003	G
15	Shushica River (Drashovice – Vjose)	>40	1.14	0.003	D

Geomorphologic characterization of different reach streams of Vjosa River – (Level II)

This characterization has been done in stream reference-sites for each of the selected reaches defined in Level I. These sites were established in Vjosa River and its tributaries such as Shushica, Kardhiqi, Bença and Drinos. A total of fifteen reference-sites were selected from Vllaho – Psillotera to Mifoli Bridge, including four reference-sites in Vjosa tributaries. Their locations are shown in Figure 1.

The stream channel reference-sites were selected according to the followings criteria:

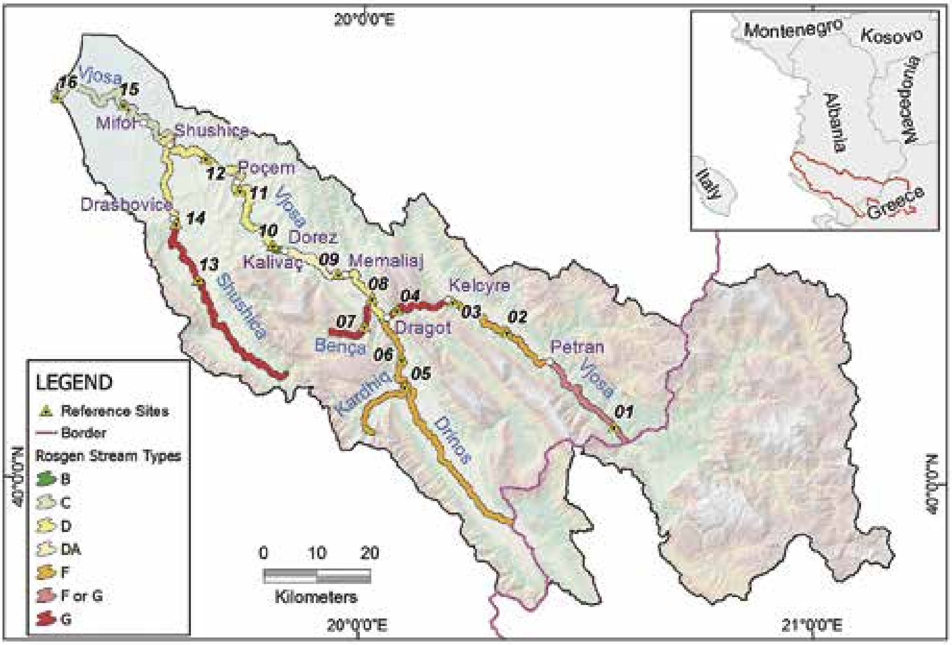

Fig. 1: Geomorphic characterization and reference sites location for Vjosa River and its tributaries. – Abb. 1: Geomorphologische Charakterisierung der Vjosa und ihrer Nebenflüsse. Die Lage der Referenzstrecken ist eingezeichnet.

- Lithological criteria – The reference sites are located in such positions as to represent all kinds of rocks along the Albanian part of Vjosa valley,
- The morphological characteristics of the stream channel – the reference-site positions – are determined in order to cover all types of the stream channels defined in the First Level of classification, located in the upstream, midstream and the downstream of the river. Similar observation reference-sites have been located in the main confluents of Vjosa, such as Shushica, Kardhiqi, Bença and Drinos.
- Measurement facilities; a location near the hanging bridges has been used to facilitate the passage on both sides of the river.

In each permanent reference-site, two survey monuments and one benchmark were established in suitable measurement locations. The determination of the coordinates and elevation for survey monuments and benchmarks was performed with GPS measurements, based on the geodetic reference points of state network. Control measurements with total station are carried out in order to find the best fit between the reference points of the state network and the GPS measurements.

Multiple cross-sections surveys, longitudinal profile of the channel and measure of the bed material, were performed. The bars, pools, riffles, cut bank and other features of the terrain like the position of the terraces in both sides of the channel and bankfull points are mapped for each reference site. An example of a Site Map, referring to V-11 is given in the Figure 2.

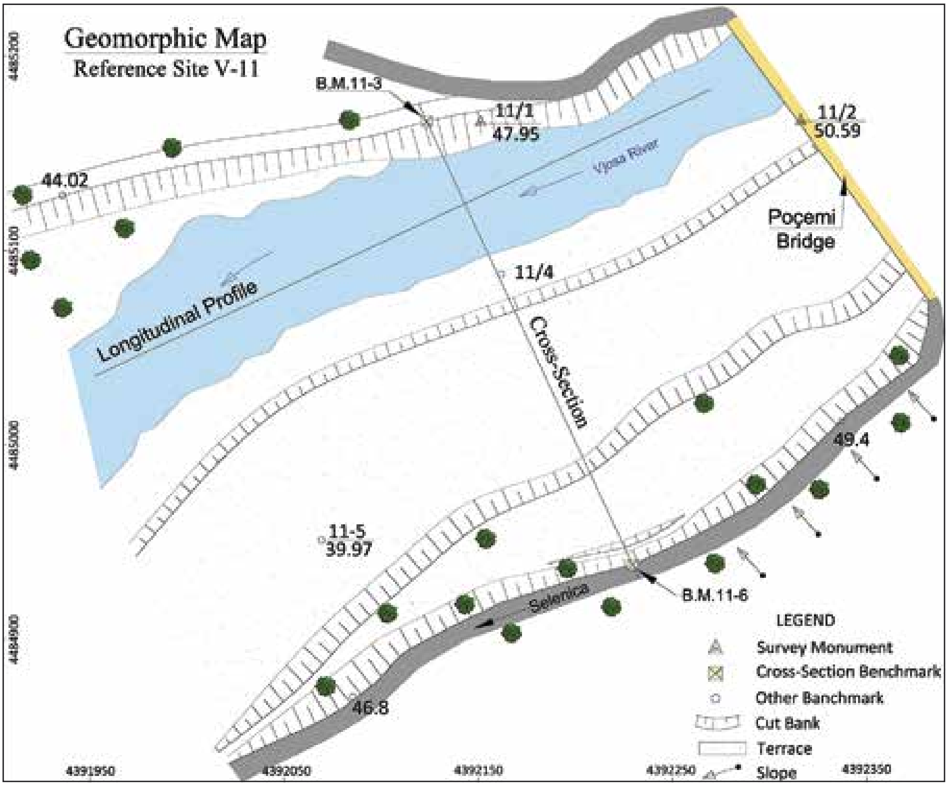

Fig. 2: Site Map of the V-11 reference site (Poçem). – Abb. 2: Das Gebiet der V-11 Referenzstrecke bei Poçem.

The bankfull stage (Fig. 3) is defined as the water discharged when stream water just begins to overflow into the active floodplain (Harrelson et al. 1994). In areas where the floodplain is absent one or more of the bankfull stage indicators are used as proposed by C.C. Harrelson et al, 1994 as follows: the height of depositional features (especially the top of the pointbar, which defines the lowest possible level for bankfull stage); changes in vegetation (especially the lower limit of perennial species); slope or topographic breaks along the bank; changes in the particle size of bank material, such as the boundary between coarse cobble or gravel with fine-grained sand or silt; undercuts in the bank, which usually reach an interior elevation slightly below bankfull stage; and stain lines or the lower extent of lichens on boulders.

In order to classify the selected sites the following parameters are determined for each of them.

- **Entrenchment ratio (E)** – is the ratio of the width of the flood-prone area to the bankfull surface width of the channel. The flood-prone area is defined as the width measured at an elevation which is determined at twice the maximum bankfull depth. The bankfull depth corresponds to the average depth measured at the bankfull discharge (Fig. 3).

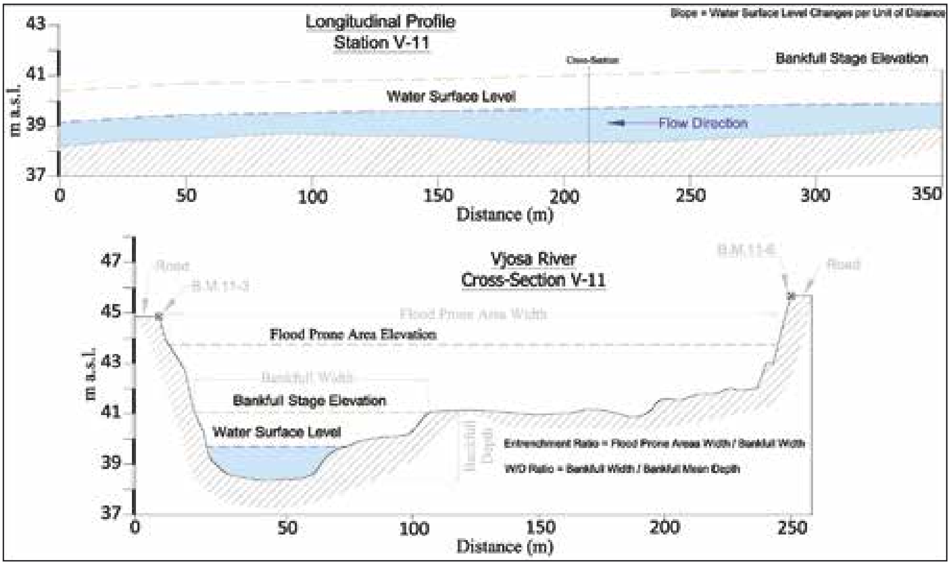

Fig. 3: Longitudinal profile and Cross-Section of V-11 reference site. – Abb. 3: Längs- und Querprofile der V-11 Referenzstrecke.

- **Width/depth ratio (W/D)** – Is the ratio of bankfull channel width to the bankfull mean depth (Fig. 3).
- **Sinuosity (S)** is the ratio of stream length to valley length or the ratio of valley slope to channel slope.
- **Water surface slope (I)** is determined by measuring the difference in water surface elevation per unit stream length (Fig. 3).
- **Channel materials (M)** – The dominant particle size (D_{50}) corresponding to the size of 50% of the population in a cumulative percentage curve is defined. Field determination of channel materials were conducted utilizing the "pebble count" procedure developed by Wolman (1954), with a few modifications to account for bank material and for sand and smaller sizes. Related to the median particle size of the bed material, numbers are given to the stream types as follow: 1 for bedrock, 2 for boulders, 3 for cobbles, 4 for gravel, 5 for sand and 6 for clay and silts (Rosgen 1994).

The results of geomorphologic classification of the selected sites (Level II od ROSGEN System) are summarized in the Table 2.

Stream conditions assessment

The Vjosa River enters the Albanian territory as a formed river, with relatively low gradients, a high width/depth ratio and low sinuosity. These characteristics extend from the border between Greece and Albania to the Këlcyra Gorge. In this sector the stream is classified as F – stream type (Fig. 1), characterized low sinuosity (meandering) shallow but entrenched gentle gradient channel, with limited or absence of the floodplain. Riffle-pool sequences occur.

Tab. 2: Stream type of the references sites for Vjosa River and its tributaries. – Tab. 2: Flußtypen der Referenzstrecken der Vjosa und ihrer Zubringer.

Geographic location	Ref. Site	E	W/D	S	I	M	Rosgen Stream Type
Vllaho-Psillot.	V- 01	1.43	15.7	1.1	0.0014	C	F3
Bual	V- 02	1.19	27	1.15	0.0019	C	F3
Kelcyre	V- 03	1.19	28.9	1.1	0.0019	G	F4
Dragot	V- 04	1.6	38.6	1.1	0.0038	G	B4c
Palokaster	V- 05	1.1	41.2	1.04	0.007	G	F4
Ura e Subashit	V- 06	1.01	33.6	1.04	0.0027	G	F4
Bence	V- 07	1.35	32.6	1.02	0.006	G	F4
Tepelene	V- 08	1.43	80.3	1.2	0.0026	G	D4
Vasjar	V- 09	1.75	95.4	1.17	0.0021	G	D4
Kalivac	V- 10	1.53	49.4	1.5	0.0013	G	B4c
Pocem	V- 11	2.6	34.5	1.5	0.0002	G	C4c
Romes	V- 12	-	103.1	1.2	0.0004	G	D4
Ura e Gjormit (Shushica River)	V- 13	4.05	14	>1.2	0.0038	G	C4
Drashovice (Shushica River)	V- 14	2.4	91.8	1.14	0.004	G	D4
Ura e Mifolit	V- 15	>2.2	38.4	1.5	0.00001	S	C5c

Through Këlcyra Gorge the reach is classified as G – stream type according to ROSGEN classification, characterized by low sinuosity well entrenched and low width/depth ratio steep/pool ("gullies") channel.

The reference-sites included in this reach (segment) are classified as F3 – stream type (V-01 and V-02) and are characterized by moderate sensitivity to disturbance, poor recovery potential and very high sediment supply and streambank erosion potential. The same characteristics are attributed to the stream type F4 (V – 03) with difference in the sensitivity to disturbance which is extreme in this case as well as reference sites V-05 and V-06 situated in the tributaries of Kardhiqi and Drinos.

The segment from Dragot to the confluence of the Shushica River is represented by complex stream patterns and multiple channels, braided (D) and anastomosed (DA), with the exception of the sector from Dorëz to Kalivaç where, due to the passage into a narrow gorge through carbonate deposits, the river sinuosity decreases. The stream reference sites encountered in this reach of the river are V-04, V-08, V-09, V-10, V-11 and V-12. The sites V-08, V-09 and V-12 are classified as D4-stream type and are characterized by very high sensitivity to disturbance, with poor recovery potential, with very high sediment supply and streambank erosion potential, having a moderate vegetation controlling influence. The same characteristics are attributed to the lower part of Shushica river (reference site V-14, Drashovice).

The sites V-04 and V-10 (Dragot & Kalivaç) are classified as B4c – stream type characterized by moderate gradient and entrenchment ratio as well as by moderate sensitivity to disturbance, with excellent recovery potential, low streambank erosion potential and moderate vegetation control.

The site of Poçem (V-11), is classified as C4c stream type –meandering, slightly entrenched, with well developed floodplain. This site is characterized by very high sensitivity to disturbance, high sediment supply and very high stream bank erosion potential.

From the Shushica River confluence to the river mouth the sinuosity increases, the slope decreases and a high width/depth ratio is maintained classifying the reach stream as C-type. The reference site of "Ura e Mifolit" (V-15) is classified as C5c – stream type is characterized by very high sensitivity to disturbance, very high sediment supply and very high stream bank erosion potential.

Bënça River and the upper part of Shushica River are classified as G stream type: well entrenched steep/pool channel, characterized by low sinuosity and low width/depth ratio. The corresponding reference sites are V-07 and V-13 and are respectively classified as F4 and C4 stream type. The differences in the stream types are attributed to the local conditions of reference-sites.

Conclusions

The upper part from the Greek border to Kalivaç as well as the main branches of Vjosa Bença, Drinos, Kardhiqi and the upper part of Shushica are in dynamic equilibrium status. In general the Vjosa River and its tributaries are characterized by moderate (in the upper parts) to high and very high sensitivity to disturbance in the rest. The recovery potential is **poor** for the F stream types and D stream types located in the upper parts of the stream reaches and in the sector of Vjosa River from Dragot to the confluence of Shushica River and the lower part of Shushica River. Locally good to excellent recovery potential is encountered in the reference sites V-04, V-10, V-11 and V-13.

The characteristics indicated by Rosegn showed some mismatches with those found in Vjosa River and its tributaries, especially regarding the streambank erosion potential. For the stream types F3 and F4 Rosgen describes a very high streambank erosion potential while in these reaches in Vjosa River and its tributaries, erosion of streambank is not observed because in the upper part of Vjosa River the riverbanks are composed of well-cemented conglomerates showing a high resistance to erosion while the Bënça River passes through carbonate deposits forming narrow and deep gorges.

This study is a first attempt to use the ROSGEN system in the study of the river morphology and river behavior in Albania. Limited data and experience make it harder for a conclusive opinion regarding the application of the ROSGEN system in the study of reaches in Albania.

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Fluvial processes and changes in the floodplain vegetation of the Vjosa river (Albania)

Nils Rössler, Gregory Egger & Anton Drescher

The floodplains of the Vjosa River in the south of Albania count as one of the most magnificent riparian ecosystems of the Balkan peninsula, standing out due to their natural hydromorphodynamic fluvial processes. A broad main stream with anabranches, open gravel bars and islands, and pioneer vegetation, as well as bushes of willows, poplars and tamarisks give Vjosa's floodplain an extraordinary distinction. Combined with large grasslands and small-area softwood forests, they build the vegetation mosaic along the river. A hydropower station chain is planned at the Vjosa River. Already initiated building measures have since been interrupted due to international protests, however the natural heritage is still threatened. There is scarcely any basic research about the vegetation ecology so far. Hence, throughout this documentation the vegetation of the bank zone and floodplain of a section between Poçemi und Mesaraku was recorded first, followed by a documentation of the main physical habitat parameters and fluvial processes.

Rössler N., Egger G. & Drescher A., 2018: Flussmorphologische Dynamik und Vegetation im Inundationsgebiet der Vjosa (Albanien).
Die Auen der Vjosa in Südalbanien zählen zu den großartigsten Wildflusslandschaften der Balkanhalbinsel. Sie zeichnen sich durch eine nahezu ungestörte Hydro- und Morphodynamik aus. Ein breites Band von Hauptfluss mit Seitenarmen, offenen Schotterbänken und Pioniervegetation sowie Weiden-, Pappel- und Tamariskengebüschen prägen die Flusslandschaft der Vjosa. Zusammen mit ausgedehnten Grasfluren und kleinflächigen Weichholz-Auwäldern bilden sie das Vegetationsmosaik entlang des Flusslaufes. Eine durchgehende Kraftwerkskette ist an der Vjosa geplant. Obwohl begonnene Baumaßnahmen zwischenzeitlich aufgrund internationaler Proteste eingestellt wurden, ist das Naturerbe stark bedroht. Bislang liegen kaum vegetationsökologische Grundlagenuntersuchungen vor. Im Rahmen dieser Arbeit wurden daher in einem ersten Schritt die Ufer- und Auenvegetation für einen Abschnitt zwischen Poçem und Mesarak aufgenommen sowie deren prägende Standortfaktoren dokumentiert.

Keywords: floodplain vegetation, hydromorphology, braided river, Vjosa River, Albania.

Introduction

Although the Balkans are so close to the rest of Europe, their magnificent nature has been visited by relatively few people, and studied by even fewer. This counts especially for the, as yet, wild and almost pristine creeks and rivers. The floodplains of the Balkan Peninsula, with their numerous endangered and endemic flora and fauna, count as one of the ecological hotspots of our continent and they are justifiably described as the "blue heart of Europe" (Abromeit 2015). Nevertheless, this natural heritage is seriously threatened. Beside the hundreds of hydropower plants already in existence, more than 2000 future installations are being planned – many in protected areas, 113 even within the present national parks (Eichelmann & Vienna 2015, Sikorova & Gallop 2015). Through the upcoming realization of these plans, it is conceivable that countless natural habitats and rare species will be lost. Nature protection organizations such as RiverWatch and EuroNatur therefore introduced the campaign "Save the Blue Heart of Europe" to preserve this unique floodplain vegetation of the Balkan peninsula from destruction (Riverwatch & EuroNatur 2017).

One of the larger rivers flowing from Greece to Albania is the Vjosa (Albanian: Vjosë; Greek: Aoos). It is renowned as one of the grand arteries within the region and has been called the "last big complete torrential stream system of Europe" (Abromeit 2015). Despite its uniqueness, the floodplain vegetation has not yet been studied in detail. This aroused our interest in making the first step to document the vegetation of the bank zone and floodplain, as well as the fluvial processes for a section downstream of Poçemi.

The publication is based on the thesis of Rössler (2017, see also Rössler et al. 2018).

Study site

The Vjosa River has its source at the Pindus mountains in Epirus of Greece, passes the Greek Albanian border and then flows northwest. In the lower course, between the cities Fieri and Vlora, the Vjosa transits the lowlands of Myzeqe. The river is expanded in this section and forms widely outbound meanders. The river delta is located north of Narta Lagoon. For further details, see Schiemer et al. (2018 this volume).

The coordinates of the starting point and the end point of the studied river section are:

Start at Poçemi bridge [40° 49′ 28″0 N 19° 72′ 83″ E]; end near Mesaraku [40° 55′ 84″ 39 N 19° 58′ 02″ 99 E]. The mean altitude of the study area is 45 m a.s.l., the mean catchment elevation is 849 m a.s.l.

The investigated river stretch lies within the Ionian geotectonic zone (Ministry of Development 1996). The geological conditions of the Vjosa catchment area are shaped by limes and covered with flysch as well as Messinian evaporites and Pliocene molasse facies (see Pano et al. 2008, Durmishi et al. (2018 this volume).

Fig. 1: Panorama of the Vjosa River taken from a hill of 520 m, close to Hekali settlement, south direction (Photo: N. Rössler 2016). – Abb. 1: Panorama der Vjosa in Richtung Süden von einem Hügel (520 m über Meer) nahe der Siedlung Hekali (Foto: N. Rössler 2016).

The discharge characteristics are affected by massive seasonal fluctuations. The low water runoff varies from 11 m³/s to 41 m³/s. The mean water flow adds up to 148 m³/s, whereas the fluctuation range was measured from 66 up to 324 m³/s within the period of 1958–1990 (gauge station Doreza, a few km upstream of Poçemi). The maximum discharges are in December, whereas the minima occur throughout August and September. The discharges consist of between 21 % and 25 % snowmelt and 66 % rain (Tockner et al. 2009). HQ_1 is 1820 m³/s, HQ_5 2620, HQ_{10} 3130 and an HQ_{100} flood event is 4860 m³/s (Pano 2008). In the last 40 to 50 years, a significant decline of runoff was observed. For example, the Vjosa's mean water decreased by 24 % in Greece and 19 % in Albania between 1964 and 1987 (Tockner et al. 2009).

Following the Natura 2000 network categories, the main woody riparian habitat types along the Vjosa River are:

***Platanus orientalis* and *Liqidambar orientalis* woods (Platanion orientalis) (Annex I Code 92C0):**

The tree layer is dominated by the Oriental plane (*Platanus orientalis*). *Salix alba*, *Alnus glutinosa*, *Salix purpurea*, *Populus nigra*, *Populus alba, Hedera helix* participate in the tree layer. The shrub *Tamarix parviflora* remained as a relic of pioneer stages. *Melissa officinalis, Parietaria officinalis*, *Urtica dioica, Phragmites australis, Typha latifolia, Lythrum salicaria, Mentha aquatica* and others prevail in the herbaceous layer. In some areas along the river Vjosa, the Oriental plane occurs as solitary trees or in groups, while in the others area it forms larger and more preserved communities.

***Salix alba* and *Populus alba* galleries (Annex I Code 92A0):**

Patches or small areas of this habitat type are found along the Vjosa River. This habitat type, which colonizes poorly stabilized, periodically flooded alluvial deposits, is characterized by a dominance of *Salix alba, Alnus glutinosa*, *Platanus orientalis* and *Tamarix parviflora*. Accompanying woody species include *S. elaeagnos*, *S. purpurea*, *Populus nigra, Populus alba,* and *Hedera helix.* The herb layer is dominated by *Phragmites australis, Typha latifolia, Lythrum salicaria, Mentha aquatica, Rubus sanctus, Arum italicum*, *Calamintha grandiflora, Pteridium aquilinum* and others.

15.5 % of the catchment are protected areas (Tockner et al. 2009). Information about the forms of land use is given in Table 1.

The comprehensive survey was conducted for a section between Poçemi (Albanian: Poçem) up to Mesaraku altitude shortly before the estuary of Shushica (Albanian: Shushicë) river

Tab. 1: Land use in the Vjosa catchment. – Tab. 1: Landnutzung im Einzugsgebiet der Vjosa.

Land use characterization of the Vjosa River system (% of catchment) (Tockner et al. 2009)	
Urban	1.0
Arable	16.0
Pasture	0.5
Forest	35.7
Natural grassland	39.3
Sparse vegetation	6.9
Wetland	0.1
Freshwater bodies	0.5

(Fig. 2). The stream range is approx. 31.5 km long, the average width of the near-natural river landscape corridor is approx. 1.5 to 2 km, covering approx. 1380 ha, or 3170 ha including agricultural fields within the morphological floodplain.

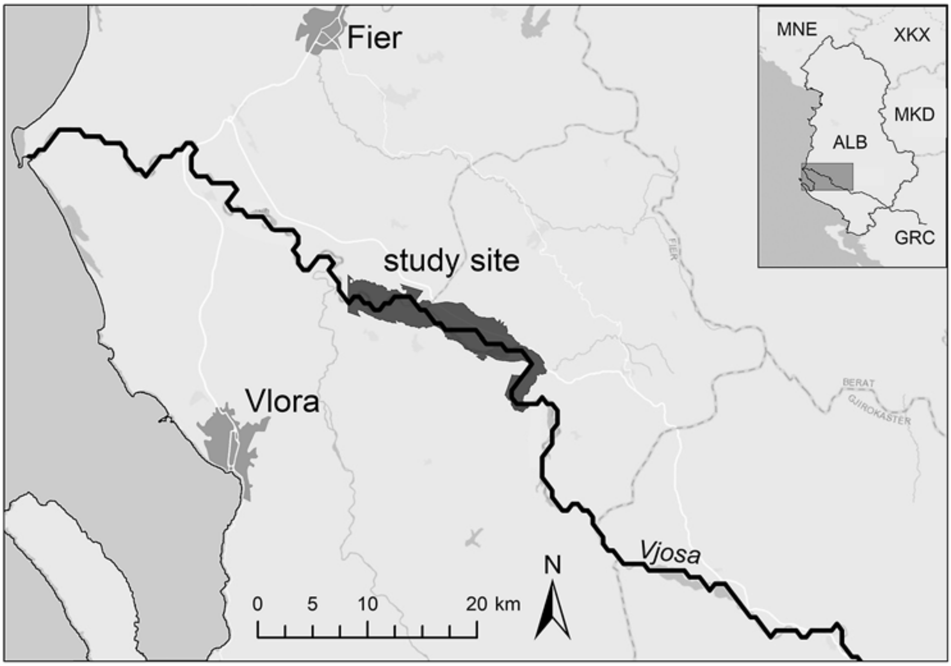

Fig. 2: Survey area of comprehensive field mapping (ALB: Albania, MNE: Montenegro, XKX: Kosovo/Serbia, MKD: Macedonia, GRC: Greece). – Abb. 2: Lage des Kartierungsgebietes (ALB: Albanien, MNE: Montenegro, XKX: Kosovo/Serbien, MKD: Republik Nord-Mazedonien, GRC: Griechenland).

Materials and methods

The comprehensive survey and field mapping of the floodplain vegetation (see legend of Fig. 4) and its physical parameters (geomorphodynamic disturbance, flood inundation; definition see Tab. 2 and Tab. 3) were conducted in August and September 2016 (Rössler 2017).

The key for the mapping units is based on the characterization of polygons in the aerial photo (see study design in the following papers: (Drescher et al. 1995, Drescher & Egger 2000, Dörwang 2016, Lewerentz 2016, Seifert 2016). The delimitation of the polygons with similar land cover was done before starting the mapping in the field. The data collection was focused on structural features. Among others, the following attributes were collected:

i) Vegetation (percentage of total cover as well as share of the distinguished layers)
ii) Maximum age of tree and shrub layer
iii) Succession series and succession phase
iv) Grain size composition of the uppermost 10 centimeters of sediment
v) Morphodynamic and hydrodynamic disturbance class

Tab. 2: Classes of geomorphodynamic disturbance (modified from Barth 2015). – Tab. 2: Klassen der geomorphodynamischen Störungen (Erosion versus Sedimentation) (modifiziert nach Barth 2015).

Definition classes of geomorphodynamic disturbance
Very high: Several times a year shifting of bed load respectively erosion and sedimentation processes of high extent; Gravel or sandbars with no A-horizon and no O-horizon; More or less equal to areas with no vegetation (partial abundance of pioneers).
High: Shifting of bed load mostly once a year; Erosion and Sedimentation processes in the range of HQ_1–HQ_3 are equal to the mean flood discharge; Populated by pioneer vegetation and Willow-Tamarisk-Shrub (dynamic-resistant species).
Moderate: Influenced by medium flood events (HQ_3–HQ_{10}), morphodynamic processes are restrained to sedimentation (sand) with local erosion processes with almost no shifting of bed load; Thin layer of O-horizon but mostly no A-horizon.
Low: Influenced by medium to large flood events (catastrophic events, HQ_{10}–HQ_{100}) with no shifting of bed load; Morphodynamic is restrained to local erosion activity (mostly side erosion) and sedimentation of fine material (sand/ lime); Mostly thin layer of A-horizon with a clear layer of O-horizon.
No, very low: Morphodynamic processes are restrained to rare catastrophic events (>HQ_{100}) with local erosion activity (mostly side erosion) and no shifting of bed load; Exclusively local low sedimentation of fine material; Mostly clear layer of A-horizon and O-horizon.

Tab. 3: Classes of flood inundation (modified from Barth 2015). – Tab. 3: Klassen der Überflutungshäufigkeit und –Intensität (modifiziert nach Barth 2015).

Definition of classes of flood inundation
Very high: Flooding several times a year; Discharge between mean water level and HQ_1; More or less high water depths and flow velocities; Regular appearance of flood indicators (woody debris, trees, root stocks); Mostly areas without vegetation; Sporadic appearance of flood tolerant species).
High: Flooding once a year (more or less HQ_1); Single flood events with higher water depths and flow velocities are dominant; However, the predominant areas are characterized by low water depths and moderate flow velocities; Sporadic flood indicators (woody debris); Flood tolerant species are dominant.
Moderate: Influenced by small to medium flood events (HQ10); Mostly low to medium water depths and flow velocities; Vegetation with some species moderate sensitive to flooding (mostly perennials).
Low: Influenced by medium to large flood events (catastrophic events, HQ_{10}–HQ_{100}); Rare flooding with low to medium water depths and low flow velocities; Flooding as stressor for plants plays a minor role.

Results

Geomorphodynamic disturbance

More than half of all mapped vegetation types related to the reviewed floodplains were characterized by their high to very high geomorphodynamic disturbance (very high 46 %, high 13 %). Almost one third was covered by moderate disturbance, where a thin layer of litter and humus was detected. The remaining vegetation types are characterized by morphodynamics that have already been interrupted for a long time, leading to an advanced stage of soil evolution (class low and very low each 5 %) (Fig. 3).

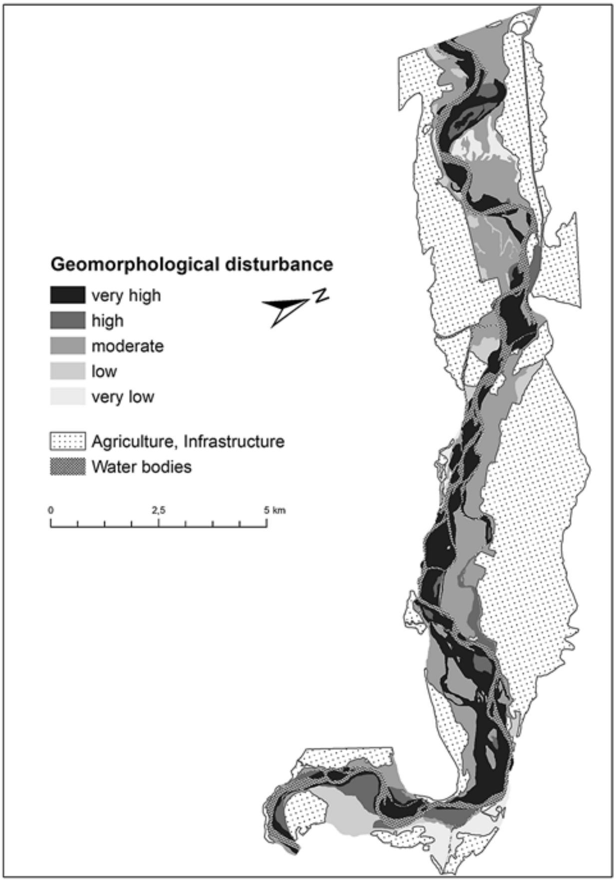

Fig. 3: Geomorphodynamic disturbance along the Albanian Vjosa River (modified from Rössler 2017). – Abb. 3: Verteilung der Flächen gleicher geomorphodynamischer Störungsklassen im Kartierungsgebiet der Vjosa (modifiziert nach Rössler 2017).

Flood inundation

Mostly, flood inundation of gravel banks, pioneer vegetation and Oriental plane pioneer shrubs was very high. All other vegetation types were also characterized by mostly high and moderate flooding impact, whereas the forests predominantly showed minimal flooding impact (Fig. 4).

Vegetation

Slightly more than half (1644 ha) of the almost 32 km² of comprehensively mapped reference section of the morphological floodplain are covered by agricultural fields and grasslands (Fig. 5). They are located on a higher floodplain level and are accompanied by near-natural plains crucially affected by floods in central parts of the floodplain area. They are characterized by broad and annually repetitively shifted topographic surfaces of non-vegetated gravel bars (171 ha, 12 % of near-natural banks) and pioneer vegetation (265 ha, 19 %) along both the main stream and the repetitively shifting anabranches (Fig. 5). Within these pioneer stages dominated by herbs and shrubs, typical woody species are white, purple and rosemary willow (*Salix alba, S. amplexicaulis, Salix eleagnos)*, smallflower tamarisk (*Tamarix parviflora*), white and black poplar (*Populus alba, P. nigra*) and oriental plane (*Platanus orientalis*). These woody pioneer species stabilize the substrate and lead to a further sedimentation of fine grained sediments. This leads to a more or less dense bushland on stands without extremely high morphodynamics (height 1 to 3 m). This pioneer bushland occurs with changing species composition and alternating dominance and cover, both as a mixed inventory and as a mosaic with alternating dominance conditions, and covers approx. 10 % (140 ha) of all near-natural plains.

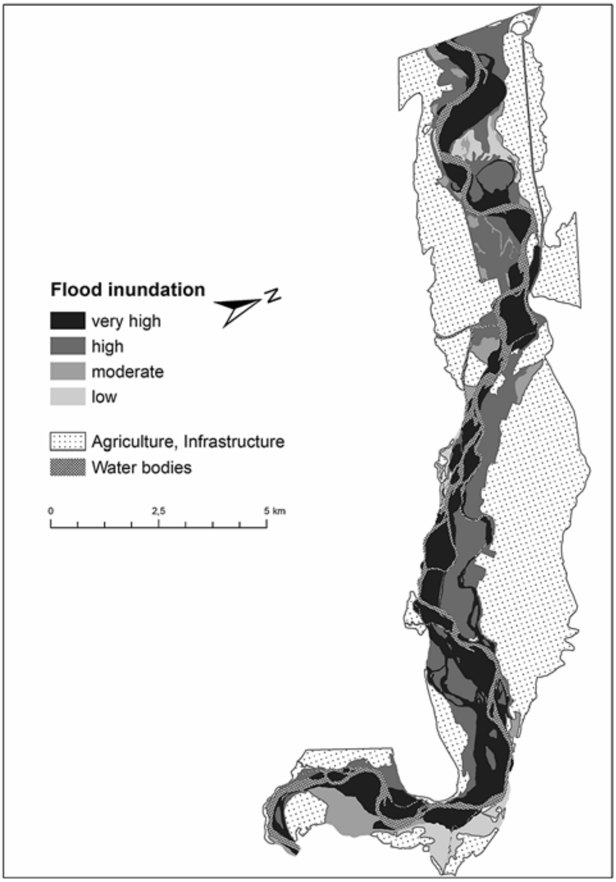

Fig. 4: Flood inundation of the study site (modified from Rössler 2017). – Abb. 4: Verteilung der Flächen gleicher Überflutungshäufigkeit und -intensität im Kartierungsgebiet der Vjosa (modifiziert nach Rössler 2017).

The most expansive vegetation type within the near-natural plains is cogon grassland (577 ha, 42 %). Mostly a soil cover of silt and sand higher than 1m shapes it, and the vegetation cover is dominated by cogon grass (*Imperata cylindrica*).

Repetitive burning, canker of plane caused by *Ceratocystis platani* and illegal logging have reduced the woods to small edge fragments within the morphological floodplain built exclusively of softwood species. The existing floodplain forests are dominated by mixed stands of white willow, white and black poplar with 85 ha (6 % of near-natural surface) as well as oriental plane, poplars and black locust forests (*Robinia pseudoacacia*) with approx. 43 ha (3 %).

Habitat change from 1980 to 2016

The evaluation of the map of 1980 compared to the distribution pattern of 2016 within the morphologic floodplain shows an increase of approx. 176 ha or 12 % (from 1468 ha to 1644 ha) regarding areas used intensively for agriculture (Fig. 5). Also, areas of open gravel bars, pioneer vegetation and herbs increased by approx. 130 ha or 13 % (from 970 ha to 1100 ha). In contrast, bushland decreased by nearly 70 ha or 30 % (from 211 ha to 140 ha). Floodplain forests show the most obvious loss of area. Here, within the last 35 years, a reduction of 354 ha took place – that equals almost one quarter of the original area in 1980 (from 491 ha to 137 ha). The detailed analysis shows that the lost forest area was intermediately grubbed up and transformed into both crops and grasslands for intensive agricultural use (104 ha) or into cogon grass meadows for extensive grazing (180 ha) (Rössler 2017).

The Vjosa stream course has probably been relocated within the active channel, and former side channels are now desiccated and new ones have been formed. However, the total area of water bodies has remained roughly the same. This indicates that processes of river

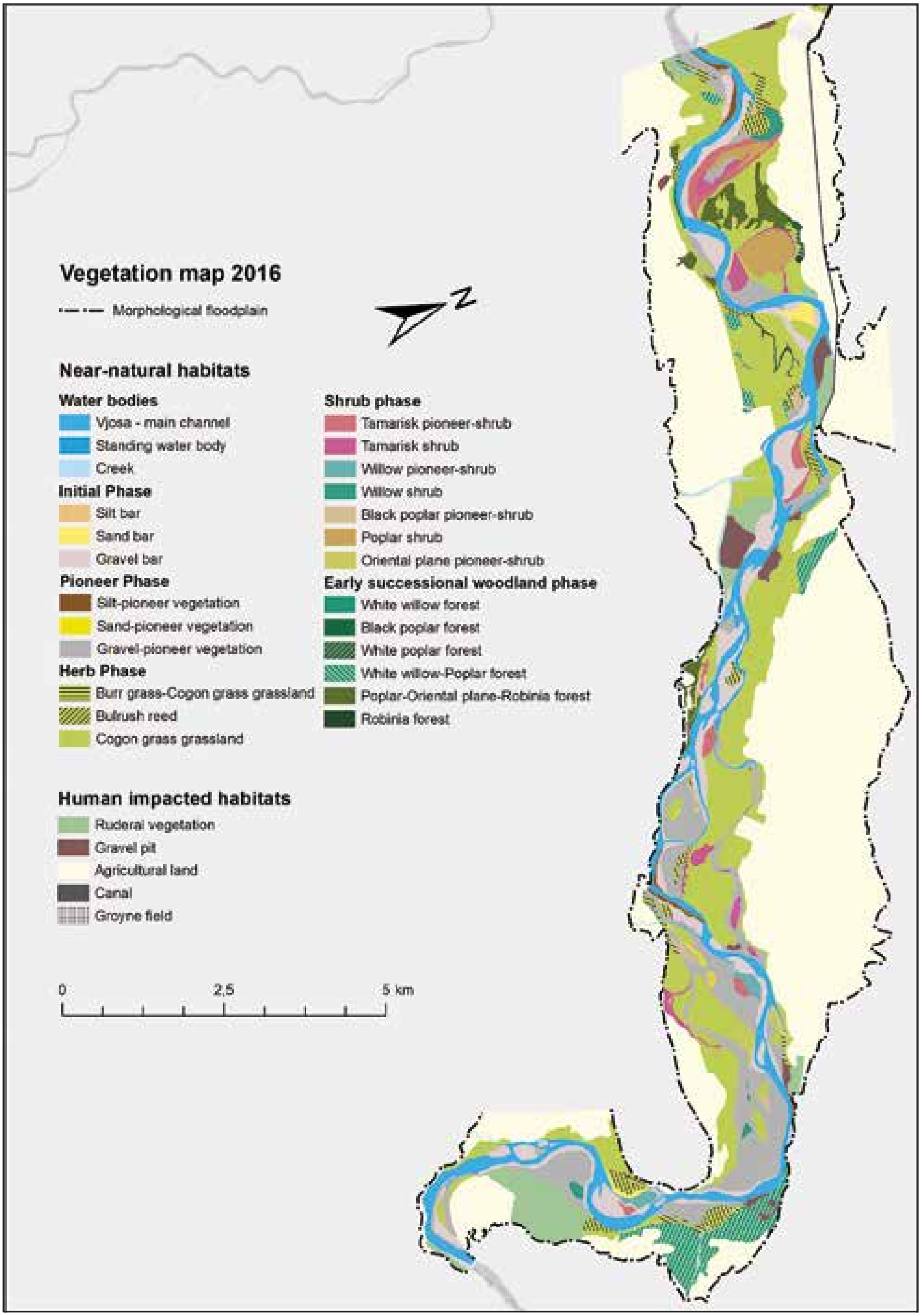

Fig. 5: Map of current vegetation (modified from Rössler 2017). – Abb. 5: Karte der realen Vegetation des Untersuchungsgebietes (modifiziert nach Rössler 2017).

bed forming did not change over a longer period and is also an indicator of, as yet, sparsely changed morphodynamics (Fig. 6).

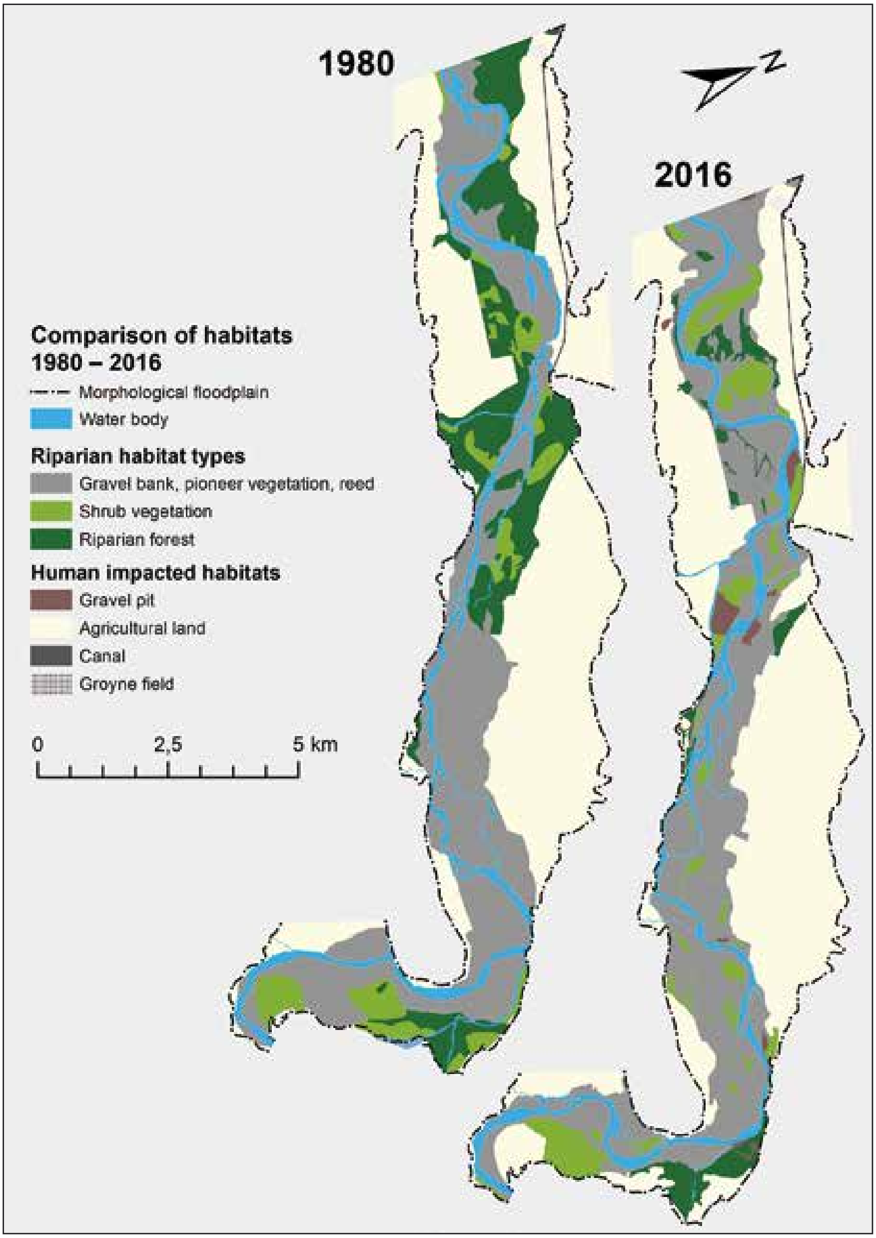

Fig. 6: Habitat maps from 1980 (Original map source: Mapbasis: People's Socialist Republic of Albania, State system of coordinates; Kesh & Sogreah Consultants 2008) and 2016 (modified from Rössler 2017). – Abb. 6: Habitat Karten von 1980 (Original: Volksrepublic Albanien, Staatliches Koordinatensystem; Kesh & Sogreah Consultants 2008) und 2016 (modifiziert nach Rössler 2017).

Discussion and conclusion

In Greece as well as in Albania, the Vjosa River mainly flows through a landscape extensively used for agriculture. However, even the valley floors and the river banks are partially used both agriculturally and, in sections, for intensive grazing with goats and sheep. The pressure of using the river landscape is huge – the proportion of remaining floodplain forest is small due to a massive intervention into the riparian ecosystem. Furthermore, the open grassland areas are burnt down periodically in order to maintain these areas for grazing with goats and sheep and to keep up the feeding quality. For this reason, there is a permanent interference with both the rejuvenation of woody species and with the natural succession. Moreover, river water is withdrawn, diverted by channels and used for irrigation of the surrounding agricultural landscape. Gravel mining in the river bed leads to local damage of the bed-load balance as well as to a destruction of natural vegetation. Alongside the discharge of waste water from adjacent settlements, it is the massive insertion of waste that is most obvious. These manifold changes, which sometimes last for centuries, have left their traces: a distinctly reduced amount of forest and large grasslands with secondary vegetation next to natural extended areas with prolonged gravel bars, pioneers and bushes form the river landscape of the Vjosa. From an ecological point of view, both the open undisturbed areas and the influence of flooding, as well as the relatively unaffected hydrodynamics and morphodynamics must be particularly emphasized. These factors represent a driving force for natural processes. Therefore, the river landscape of the Vjosa is still characterized by large areas characterized by processes of regression and progression – a determinant element being the steady change and respectively adapted vegetation of both bank and floodplain zone.

However, the "modern" development does not stop within agrarian regions. Albania needs electric power, which is currently mainly imported (Bundesministerium für Wirtschaft und Energie 2016) – what makes more sense than producing it within the country as emission-free "eco energy" from hydropower? Moreover, the construction of hydropower plants is funded by European institutions (Sikorova & Gallop 2015). Incidentally, this funding is offered by the very countries that lack near-natural watercourses and are therefore executing river renaturation projects requiring enormous financial effort (Bundesamt für Naturschutz 2015). Within the Albanian section of the Vjosa alone, ten hydroelectric power plants are currently planned (Kesh & Sogreah Consultants, 2008), two of them in the study site around Poçemi and Selenica. In addition, two facilities are already under construction; however, they have already been interrupted due to international protests.

The ecological effects of following these "ambitious" plans are clear and are already visible in various ways in Central Europe. By now, the basin development of Alpine rivers such as the Isar, Lech, etc. have led to an almost complete loss of near-natural river landscapes and their unique flora and fauna (see Müller, 1995). Apart from the immediate loss of river landscape area, reservoirs act as sediment traps and cut off the bed-load discharge. Subsequently, the river bed is massively deepened which will lead to a jeopardized groundwater balance. In conjunction with the embankment of rivers, there is a reduction of both flooding effects and morphodynamic processes – a driving force to guarantee the continued existence of natural river landscapes. All of this leads to the effect of decoupling a river from its floodplain – representing the end of a unique floodplain landscape within the "blue heart of Europe"!

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The Vjosa (Vjosë) – the floodplains of an outstanding gravel bed river in southern Albania

Anton Drescher

The Vjosa floodplain is a unique example of an almost undisturbed gravelbed river in Southern Europe. The investigations discussed here refer to a river stretch between Kalivaçi and Poçemi. The great variety of habitats and vegetation types is documented with more than 60 relevés. An overview of the plant communities and plant assemblages shows the attempt of a plant sociological classification. The diversity encompasses a spectrum of ephemeral herbal pioneer assemblages to small remains of Platanus mixed woods. Largely unvegetated gravel beds in the active zone and wide *Imperata cylindrical* grasslands on higher niveaus of the floodplain have the highest areal share. The latter developed after cutting and repeatedly burning to gain pasture. Finally a succession scheme is presented and the importance of woody debris in the river channel is discussed.

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Die Vjosa bildet eine in Südeuropa einzigartige Wildflußlandschaft von nahezu ungestörter Natur. Die vorliegenden Untersuchungen betreffen den Flußabschnitt zwischen Kalivaçi und Poçemi. Die Vielfalt an Lebensräumen und Vegetationstypen wird mit mehr als 60 Vegetationsaufnahmen dokumentiert. In einer Übersicht der Pflanzengesellschaften wird der Versuch einer Gliederung des noch unzureichenden Aufnahmematerials präsentiert. Das Spektrum reicht von ephemeren krautigen Pioniergesellschaften mit bereits einzelnen Sämlingen von Holzarten bis zu kleinen noch vorhandenen Resten von Platanen-Mischwäldern. Weitgehend unbewachsene Kiesflächen in der aktiven Zone und weite Graslandflächen mit dominantem *Imperata cylindrica* auf höheren Niveaus der Aue – enstanden durch Abholzung und wiederholtes Brennen zur Weidegewinnung – nehmen dabei die größten Flächenanteile ein. Abschließend wird ein Sukzessionsschema vorgestellt und die Bedeutung von Totholz in der aktiven Zone diskutiert.

Keywords: Southern Albania, Vjosa, gravel bed river, floodplain vegetation, succession.

Introduction

On the one hand, unmodified or nearly unmodified floodplains are areas of flood protection and, as a network of waterways, still play an underestimated role for biodiversity. On the other hand, they are subject to uncontrolled development regarding industry and power generation. The Vjosa catchment in southern Albania is one of the largest, almost completely untouched river catchments in all of the Balkan. Albania is striving for progress, and the fast growing industry and growing prosperity of city inhabitants is pushing the demand for electric energy. The plans for the construction of new power plants illustrates this impressively (see https://www.balkanrivers.net/en/key-areas/vjosa-river).

The huge loss of flooded areas of up to 90 percent of the original extent over the past 150 years in floodplains in central and southern Europe (e.g. Danube, Rhine, Po) vividly shows the deficits of this development. Therefore, for the last 25 years or so, restoration measures have been planned, are under construction, or are (partly) finished (Mosimann 1992, Schiemer & Reckendorfer 2000 u. 2004, Woolsey et al. 2005). The more or less untouched hydromorphological and hydrological conditions of the Vjosa catchment can serve as an example to understand the complicated interrelation between the hydrological preconditions, river bed morphology and distribution of species, vegetation, and animals, and can yield new knowledge for further restoration projects of floodplain areas all over the Mediterranean.

The study area

The Vjosa river (Aoos in Greece) and some of its tributaries like Sarandoporos and Drinos originate in northern Greece. The catchment comprises 6704 km², 4365 km² of which are situated on Albanian territory (see fig. 1 in Schiemer et al. 2018 this volume). In the upper stretch, gorges alternate with wider valley sections. The specific area more intensely surveyed here is situated between Kalivaçi and Poçemi (Fig. 7a and 8 in Schiemer et al. 2018 this volume). Aside from this section, some areas upstream near Sarandoporo along the Greek border, near Tepelenë, and west of Quesarat were visited.

Physical setting

The Appennines-Albanides-Hellenides chain constitute the southern part of this orogenic belt. The lower part of the Vjosa catchment is embedded in the external zone of the Albanides, the main geological structure of southern Albania.

At the beginning of the Trias, the Pangea continent split into fragments. Until the Cretaceous period, the microplate drifted to the east and later to the northeast. During the Neogene, the direction changed again caused by the movement of the African Plate to the north. This led to a fault and thrust system in Albania and NW Greece (Durmishi et al. 2014 and 2018 this volume). As a result of the tectonic movements, the Albanides show a very complex tectonic structure and consist of the eastern or Internal and the western or External Albanides (Aliaj 2006). The catchment area of the Vjosa river basin is embedded in the Ionian zone, the largest of the five tectonic zones of the External Albanides (for details, see Durmishi et al. 2014 and 2018 this volume). The valleys of the river Vjosa and its tributaries use predetermined tectonic lines of the Alpine thrust system. Marl, sandstone, and organogenic limestone, as well as Ophiolite originating from the south-eastern part of the catchment are represented in the transported sediments.

The middle part of the Vjosa valley is surrounded by average mountain ranges with an elevation between 300 m a.s.l. in the north and almost 2000 m in the south. The Gribe mountain range with its highest peak Mt. Kudhësit (1907 m) separates the valleys of the Vjosa river in the north and northeast with the large basin of Kutë and the Shushica valley in the southwest. The basin of Kutë is about 6 km long and 2 km wide. South of Kutë, an alluvial fan built by a tributary forces the river to change the main direction from SE–NW to E–W.

Data from a gauge near Poçemi show maximum discharge during the months of December to March originating from the rainy period in winter in the lowlands and from snow melting in early spring. The mean discharge for the period 1958 to 1990 has decreased from 180 m^3sec^{-1} (1958–1967) to 140 m^3sec^{-1} (1978–1988). For details, see Schiemer et al. (2018 this volume).

Flora, natural vegetation and land use in southern Albania

Due to its mountainous relief and climatic differentiation, southern Albania presents a high number of ecological niches. As a result, the level of biodiversity is very high compared with central European countries. A very small strip with Mediterranean flora and vegetation along the Adriatic coast is followed by a belt with submediterranean vegetation above around 100 m a.s.l. Some Mediterranean species less sensitive to temperatures below zero can still be found here, such as *Cercis siliquastrum, Platanus orientalis*, and *Vitex agnus-castis.* The majority of elements of the Mediterranean flora, e.g. *Arbutus andrachne,* several *Cistus* species*, Euphorbia dendroides, Lavandula stoechas, Myrtus communis, Nerium oleander, Olea europaea,* and *Smilax aspera* are already missing on the hilly slopes along the Vjosa river between Kalivaçi and Poçemi.

Following the floristic division of southeastern Europe by Glavač 1972 (cited in Horvat et al. 1974, Fig. 40) southern Albania is part of the Ionian-Aegaean Province of the Maroccan-mediterranean Region. The submediterranean subregion covers a strip with coastal mountain ranges behind the very small band with Mediterranean Flora. The number of endemic species in the coastal mountain ranges south and southeast of Vlorë is relatively low compared with the Western and Eastern North Albanian Alps. The number increases again in northern Greece.

Only a few patches of degraded deciduous woodland remained in southern Albania especially in areas close to the greek border with restricted access during the "Hodxa-regime". These areas are habitually coppiced and grazed by goats and sheep. Scattered small ground fires are regularly started to obtain areas for pasturing. Characteristic woody species of this altitudinal belt are *Carpinus orientalis, Fraxinus ornus, Quercus pubescens, Q. trojana, Cotinus coggygria, Cornus mas, Viburnum lantana, Hippocrepis* (= *Coronilla*) *emerus,* and *Phillyrea latifolia,* among others.

Along the river and especially in the deltas of the smaller tributaries, self sustaining, small scale farms dominate the landscape. The possibility of irrigation during the dry summer season is the reason for no floodplain forests (e.g. Alno-Fraxinetum angustifoliae, Populetum albae) are preserved on these stands.

Large areas of coppiced submediterranean woodland included in the alliances Carpinion orientalis Horvat 1958 (Ass. Querco-Carpinetum and Orno-Carpinetum orientalis) often havily grazed, is used for sheep and goat breeding.

Around half of the population is largely engaged in subsistence agriculture, the share of the GDP being around 20 %. The dominant form of land use is mixed farming. The most important products in the valleys of southern Albania are wheat, maize, potatoes and vegetables. The production of fruits and grapes is restricted to slopes of the hilly area along the valleys. Usually the production of herbs for medicine and spices is neglected. In the communist era, around 100.000 people were engaged in collecting medicinal herbs. Proceeds of the worldwide export were about 50 Million US$, but they decreased successively after the regime change (Doka 2008).

Material and methods

In April and September 2017 69 relevés have been made in the floodplains of Vjosa and Sarandoporo river using the Braun-Blanquet approach (Braun-Blanquet 1964, Reichelt & Wilmans 1973). Depending on the vegetation type and the vegetation mosaic an area between 25 and 100 m^2 per plot was chosen. The data were put in the database TURBOVEG (Hennekens & Schaminée 2001) and for processing exported to the JUICE program package (Tichý 2002). For classification we used the divisive method "two way indicator species analysis" TWINSPAN (Hill 1979, Leyer & Wesche 2007). Before processing incomplete sampled plots as well as plots from outside the floodplain have been omitted. The material left was processed with TWINSPAN. The first division splitted the sample of 63 relevés into two great groups of plots: i) stands from ditches, backwaters, wetlands along hillslope streams and ii) stands from the active corridor. Each of these two underwent a separate further treatment. The smaller set of 20 relevés from ditches and backwaters refers to siltation stands. In the larger set of 43 relevés from the active corridor with coarse sediments from sand to gravel are combined.

To make the succession stages presented in the succession scheme in chapter 5 comprehensible, woody species were depicted in different strata following age and height classes, respectively:

i) seedlings: few weeks to few months old (up to 10 cm high)
ii) juvenile: less than one vegetation period (up to 30–50 cm high)
iii) herb layer: 1–3 years old (up to 1 m high)
iv) shrub layer: 3–7(?) years old (>1 m to 3(6) m high)
v) tree layer: > 10 years old (> 6 m high)

In order to better illustrate the connection to the succession scheme in chapter 5, contrary to convention, woody species are presented in reverse from seedling stage to arborescent individuals in Tables 1 and 2. Furthermore, with only a few exceptions, all species with only one occurrence are not depicted in Tables 1 and 2.

For determination of vascular plant species we used Flora Europaea (Tutin & al. 1968–1980, Moore 1993), Pils 2016, Vangjeli 2015 and recent floristic publications (Barina & Pifkó 2008; Barina et al. 2009, 2011, 2013; Rakaj 2013). To check the distribution pattern of selected rare or endemic species, Barina 2017, Malo & Shuka 2008, 2013 were used. Some species were not determined to species level for several reasons: i) we found only non-flowering material, which is not possible to determine, e.g. *Elytrigia*; ii) due to a diverging species concept of different authors, e.g. *Hieracium*; iii) there is still insufficient knowledge and therefore poor treatment, e.g. *Rosa, Rubus, Taraxacum*. The nomenclature of scientific plant names follows the Euro+Med PlantBase (http://www.emplantbase.org/home.html) and in some cases the "The Plant List" (http://www.theplantlist.org/). The synsystematic system of higher ranks follows Mucina & al. (2016). On the association level, the available surveys (Dring et al. 2002; Kárpáti & Kárpáti 1961) are preliminary, incomplete, or do not follow the ICPN (Weber et al. 2000).

Results

The vegetation types of the floodplain both from the active channel and the backwaters of the Vjosa river are presented in Tables 1 and 2. Extremely dry stands dominated by mosses and lichens as well as therophytic short lived communities of temporary shallow water bodies from the alliance Charion vulgaris (Krause ex Krause & Lang 1977) Krause 1981 have not been sampled at all. A determination of *Chara* species without oogonia is not possible. Two localities of the latter type were observed in the floodplain near Kutë and near Tepelenë.

Plant assemblages of standing and slowly floating water bodies and their siltation stages (Tab. 1)

Ephemeral Pioneer vegetation (A5 in Schiemer et al. 2018 this volume)

***Cyperus fuscus*-community** (Tab. 1, cluster 1, relevé nrs. 6, 62)

In erosion and evorsion pools within the active channel, species poor assemblages with dominant *Potamogeton nodosus* colonise shallow waters. Total cover is below 10 percent. The amphibian species *Cyperus fuscus* accompanies the dominant *Potamogeton* on many stands. Shallow pools partly fall dry during summer. The fine grained sediment cover (silt to silty fine sand) shows high water capacity. *Cyperus fuscus* as well as *C. rotundus* are adapted to disturbance by (flash) floods. The stands are to be classified in the alliance Nanocyperion Koch ex Libbert 1932.

Nanocyperion-community (Tab. 1, Cluster 2, relevé nrs. 46, 64, 67)

The plant assemblage of nr. 46 with a relatively high total cover of 20 percent reminds one of relevés of the association Crypsio alopecuroidis-Cyperetum fusci Bioindi, Vegge, Bals & Taffetani 1999 reported from central-northern Italy. The relevés 64 and 67 from fixed erosion ponds in the active channel behind a groyne represent a special case (Fig. 1A). This may explain the higher number of species per plot compared with the ephemeral asemblage from a natural stand at the edge of the floodplain near Tepelenë.

Pioneer vegetation (A4 in Schiemer et al. 2018 this volume)

Near the river bank in shallow ponds that fall dry during low water periods pioneer vegetation develops. The species composition already contains seedlings of woody species. The sediment surface is fine grained.

Nanocyperion-community with seedlings of woody plants (Tab. 1, Cluster 3, relevé nrs. 29, 30, 31, 60, 61)

The random species composition is very similar to that of cluster 2, depending on the time when the site falls dry. In all samples seedlings of woody species are already present. The high total cover of 60 percent in plot nr. 60 is due to the willow species *Salix alba* and *S. triandra*. These sites are to be classified in the *Cyperus fuscus*-community.

The following three reed bed associations along the outer floodplain borders are included in the alliance Phragmition australis Koch 1926 (A7a in Schiemer et al. 2018 this volume).

Typhetum angustifoliae Pignatti 1953 (Tab. 1, Cluster 4, relevé nrs. 9, 57)

The backwaters are at least partly former side arms in the outer part of the floodplain. The two plots presented here are former side arms, one still used by a tributary near Kutë. The ditches are usually filled with water and fall dry in late summer. These sites represent the first stages of terrestrialisation, with gleysoils on clayey sediment.

The species poor plots are characterised by a high total cover between 80 and 100 percent. They are dominated by *Typha angustifolia* (Fanelli et al. 2015), accompanied by the helophytes *Sparganium erectum, Bolboschoenus maritimus, Mentha aquatica* and *Oenanthe* spec. Relevé nr. 9 already leads to Pioneer scrub (cluster 6) because of some few *Salix alba*-shrubs. Unfortunately due to the incomplete sampling with only five herb species a final characterisation is not possible.

Sparganietum erecti Roll 1938 (Tab. 1, Cluster 5, relevé nr. 7)

Typhetum latifoliae Nowinski 1930 (Tab. 1, Cluster 5, relevé nrs. 39, 40, 41)

Two vegetation types with similar ecological demands are united in this cluster. They represent stands from banks or shallow parts of very slow floating backwater courses and from the channelised tributary to the Vjosa near Kutë in an advanced stage of terrestrialisation. The topsoils already show a higher content of organic matter, while silt and clay are the dominant fractions of the mineral component. The stands are adapted to be covered by water during several weeks in spring (Fanelli et al. 2015). The samples show a total cover of vegetation between 40 and 95 % and are species poor (between 5 and 10 species per relevé) and dominated by *Sparganium erectum* and *Typha latifolia,* respectively.

Pioneer scrub and softwood forests

***Salix triandra-Alnus glutinosa*-community** (Salicetum triandrae Malcuit 1929(?) (Tab. 1, Cluster 6, relevé nrs. 3, 42) (Schiemer et al. 2018 this volume, A6)

In a backwater in the elevated floodplain of the orographic left bank, in a completely silted former river course, a shrubbery with *Salix triandra* developed on gleysoils (relevé nr. 3). Incomplete sampling due to the onset of darkness makes a correlation of relevé nr. 3 with willow scrub associations very difficult. A similar composition of the herb layer with *Eleocharis palustris, Lythrum salicaria, Lycopus europaeus*, and the Mediterranean *Carex flacca* subsp. *serrulata* links this assemblage and that of relevé nr. 42 with that of cluster 4 and 5.

Salicetum albae Issler 1926 (Tab. 1, Cluster 7, relevé nrs. 38, 8) Softwood floodplain forest (Schiemer et al. 2018 this volume, A7b, c)

Tab. 1: Reduced synoptic table of plant assemblages of the siltation series. Species with only one occurrence are omitted. Abbreviations: H: Herb layer, Juv: Juvenile, Sh: Shrub layer, Sdlg: Seedling, T: Tree layer. – Tab 1: Reduzierte synoptische Tabelle der Vergesellschaftungen der Verlandungsserie. Arten mit nur einem Vorkommen in der Tabelle sind weggelassen. Abkürzungen: H: Krautschicht, Juv: Jungpflanzen, Sh: Strauchschicht, Sdlg: Sämling, T: Baumschicht.

Number of cluster		1	2	3	4	5	6	7
Number of relevés per cluster		2	3	5	2	4	2	2
Tamarix parviflora	Sdlg		67					
Salix triandra ssp. *triandra*	Sdlg		67					
Salix amplexicaulis	Sdlg		33					
Populus alba	Sdlg		33					
Alnus glutinosa	Sh						50	
Vitex agnus-castus	Sh							50
Tamarix parviflora	Sh						50	50
Salix alba	Juv			100				50

Number of cluster		1	2	3	4	5	6	7
Number of relevés per cluster		2	3	5	2	4	2	2
Salix amplexicaulis	Juv			40				
Salix triandra ssp. *triandra*	Juv			60		25		100
Salix alba	Sh				50		50	100
Salix triandra ssp. *triandra*	Sh						50	50
Ulmus minor	Sh							50
Alnus glutinosa	T							50
Populus alba	T							50
Salix alba	T							100
Potamogeton nodosus	H	100	33					
Agrostis stolonifera	H		67					
Equisetum ramosissimum	H		67					
Cyperus fuscus	H	50	100	40				
Veronica anagallis-aquatica	H		100	20				
Juncus articulatus	H		67	20				
Cyperus rotundus	H	50		40				
Cynodon dactylon	H		33	40				
Xanthium italicum	H			80				
Typha angustifolia	H		33	80	100	50	50	50
Sparganium erectum	H				100	75		100
Typha latifolia	H					75		50
Mentha spec.	H				50	100		100
Bolboschoenus maritimus	H				50	25	50	50
Lythrum salicaria	H					50	50	100
Lycopus europaeus	H			20		50	50	100
Eleocharis palustris	H		33	20		25	100	
Rumex conglomeratus	H				50	25	50	50
Persicaria lapathifolia	H		33	20		25	50	50
Alisma plantago-aquatica	H			40				50
Fimbristylis bisumbellata	H		33	20				
Chara cf. *vulgaris*	H		33					
Polygonum aviculare ssp. *aviculare*	H		33					
Mentha pulegium	H		33					
Nasturtium officinale	H		67					
Alisma lanceolatum	H		33					
Apium nodiflorum	H		67					
Polypogon monspeliensis	H		33					
Cyperus flavescens	H		67					
Crypsis alopecuroides	H		33					
Tamarix parviflora	Juv		33	20			50	
Digitaria sanguinalis	H		33	20				
Sonchus spec.	H		33	40				
Myriophyllum spicatum	H		33					
Populus alba	Juv			20				50
Cyperus esculentus	H				50			
Mentha aquatica	H				50			
Carex spec.	H				50	25		50
Rumex sanguineus	H					25		50
Vitex agnus-castus	Juv					25	50	
Rumex spec.	H					25	50	
Carex flacca ssp. *serrulata*	H						50	
Humulus lupulus	H						50	50
Potentilla spec.	H							50

Salix(*-Populus*)-woodlands represent the final stage of vegetation development in course of the siltation process in subfossile channels. The species composition of the tree layer varies from pure *Salix-alba* stands to mixed stands with admixed *Populus alba* and/or *Alnus glutinosa*. The presence of *Ulmus minor* in the shrub layer of the mixed stand as well as the rising number of species per plot indicate a further development to hardwood floodplain woodland. The herb layer is characterised by plants demanding a high soil moisture content like *Sparganium erectum, Lythrum salicaria, Lycopus europaeus* and others. In the advanced stage, beside *Ulmus minor* we already find other species from hardwood forests like *Brachypodium sylvaticum, Rubus sanctus,* and *Epipactis helleborine*.

The plant assemblages in the active channel (Tab. 2)

Pioneer stage with ephemeral vegetation
(B2 and C2 in SCHIEMER et al. 2018 this volume)

After withdrawal of flood, unvegetated gravel and sand bars are emerging (Fig.13a in SCHIEMER et al. 2018 this volume). These areas are exposed to seed rain from wind dispersed species (*Salix* spp., *Populus* spp., *Typha* spp.*, Imperata cylindrica, Saccharum ravennae* and others). The moist sediment provides good conditions for germination of seeds transported by water or those species germinable only for a short period of time (*Salix* spp., *Populus* spp.).

Ephemeral Pioneer vegetation on sandy substrate (Tab. 2, Cluster 1, relevé nr. 51)

Beside light demanding pioneer species (*Epilobium dodonaei, Heliotropium europaeum*) with mediterranean or submediterranean distribution, accidential ruderal species make up this assemblage with very scarce cover (Fig.13c in SCHIEMER et al. 2018 this volume). It is not known whether the community shows a wider distribution.

***Typha minima*-(*Salix triandra*-)community** (Tab. 2, Cluster 2 relevé nrs. 12, 53)

We have found this rare plant assemblage only in two localities in southern Albania until now: on flat banks of slowly flowing side arms NW of Kutë (Fig. 1B) and along the Sarandoporo river. The stands are flooded annually, the sandy to fine sandy sediment is moist throughout the vegetation period. The localities exhibit retarded flow as they are situated aside the main channel. Rhizome-hemicryptophytes are usually the dominant plant species in a stand with few other, mostly accidential species. The absence of periodical flooding leads to *Salix*-dominated assemblages and the vanishing of *Typha minima* (compare tab. 2, rel. 12 with seven woody species in the shrub and herb layer). This marks the succession to *Salix*-shrub. Although the ecological conditions are very similar an assignment to the associations Equiseto variegati-Typhetum minimae Br.-Bl. in Volk 1940 (DELARZE et al. 2015) from the Alpine arch as well as the associations Phragmiti-Typhetum minimae Trinajstić (1985) and Calamagrostio pseudophragmites-Typhetum minimae Dihoru (2005) from the northern Balkan peninsula is not possible due to the floristic differences.

Herbal pioneer stage (Tab. 2, Cluster 3, relevé nrs. 5, 20, 22, 27, 28, 43)

The vegetation cover of the initial stages of succession is very low and varies between 1 and 5 percent. The sedimented material consists of coarse sand and gravel of varying proportions (SCHIEMER et al. 2018 this volume; Fig. 11, photo C). The stands are usually situated close to the main channel and often flooded several times per year (see bathymetry of Transect 3 in Schiemer et al. 2018 this volume; Fig. 11). The constant species *Equisetum ramosissimum, Cynodon dactylon, Sinapis arvensis* and *Elymus* spec. tolerate a moderate cover with sediment during course of floods. The total species number per plot (25 m square) is very low and varies from 2 to 6 with a mean value of 4. If the stands survive the annual larger flood, woody species appear and initiate succession.

Woody pioneer stage (Tab. 2, Cluster 4, relevé nrs. 63, 65)

These two plots represent the first succession stage in the second year. The total vegetation cover is still low. Seedlings of woody species (*Populus nigra, Salix alba, Tamarix parviflora, Platanus orientalis,* and *Salix amplexicaulis*) try to establish themselves. Beside those, typical species of pioneer stands in floodplains appear, such as *Chondrilla juncea, Dittrichia viscosa, Echinochloa crus-galli, Verbascum sinuatum,* and *Verbena officinalis*, and sporadically also *Kickxia spuria* or *Solanum nigrum*. Most of them are common in cultivated fields or on waste ground. The higher mean number of species per plot is probably an artefact of the sampling period in September compared with relevés done in April with only 4 species per plot.

Early succession stage with several shrub species in the herb layer

(B3 and C3 in Schiemer et al. 2018 this volume)

Pioneer vegetation with woody species in the herb layer (Tab. 2, Cluster 5, relevé nrs. 1, 10, 16, 17, 18, 21, 35)

The stands along transect 2 are situated relatively close to the main channel (Fig. 13d in Schiemer et al. 2018 this volume). In addition to the woody species mentioned above we found *Salix eleagnos* and *Alnus glutinosa*.

Pioneer vegetation without woody species in the herb layer (Tab. 2, Cluster 6 relevé nrs. 19, 23, 24, 25, 26)

The stands are in more or less the same position as those from cluster 5. The relevés are species-poor with a mean species number of 6 per plot. Cluster 5 with a mean species number of 11.7 shows almost double that amount. It is not clear why woody species are missing as seedlings or in the herb layer. One possibility could be the coincidence of seed set of willow and poplar species with the decline of the water level in the main channel. Another possible reason is the strong competition of *Imperata cylindrica* in the rhizosphere. As hydrological data are not available, this cannot be proven.

Early succession stage with several shrub species

(B4 and C4 in Schiemer et al. 2018 this volume)

***Populus nigra-Salix eleagnos*-community** (Tab. 2, Cluster 7, relevé nrs. 52, 54, 55)

This vegetation type is reported only from Sarandoporo river. The reason for the species richness (mean value > 12, range from 8 to 18) is unknow, though it is likely the influx from the surrounding slopes, situated close to the river banks.

***Tamarix-Platanus-Vitex*-community** (Tab. 2, Cluster 8, relevé nrs. 2, 14, 15, 32, 33, 34, 59, 66)

Shrub communities with 3 to 4 different woody species (*Tamarix parviflora, Platanus orientalis, Populus nigra, Salix amplexicaulis,* and *Vitex agnus-castus*) occur along Sarandoporo and Vjosa river (relevé nr. 66, Fig. 13b in Schiemer et al. 2018 this volume). The species number per plot ranges from 9 to 25 (mean value > 14). It rises with age of vegetation development. The reason for the high species number in plot 2 is unknown, the relatively high position within the active channel is at least one of the main factors, and the relatively low total cover is another.

Early succession stage with woody vegetation

(D2 in Schiemer et al. 2018 this volume)

***Platanus orientalis-Alnus glutinosa*-community** (Tab. 2, Cluster 9, relevé nrs. 4, 56, 58, 70)

In the elevated floodplain level with more than 20 years of vegetation development, remnants of woodland remained despite very high grazing pressure from sheep and goats (Fig. 1C). The plots show a high species number (> 21) per relevé due to the moderate cover values of the tree layer between 40 and 70 percent. It was surprising to find *Listera ovata* in one of the plots. In central Europe this species grows in moist woodland. The fine-grained sediment and a moderate humus layer contribute to a well-balanced water supply during spring. The trees with an age of up to 20 years have access to groundwater and provide shadow for grazing animals. This might be the reason for the survival of these remnants in an overgrazed landscape.

Relevé number 56 represents a special case of very low degradation due to the situation near the Greek border. Because of the low pasturing pressure in this plot, we found the highest species number (27) of all woody vegetation types here. Lianas typical of mediterranean hardwood floodplain forests, like *Vitis vinifera* and *Periploca graeca, also* occurr here – a sign of long development of the vegetation cover. Several species from the surrounding slopes were found in the herb layer, such as *Quercus pubescens, Q. cerris, Paliurus spina-christi*, and *Cotinus coggygria*.

Populus nigra-Populus alba-community (Tab. 2, Cluster 10, relevé nrs. 68, 69)

Open woodland in the elevated floodplain with a very low species number owing to the very high grazing pressure. No other woody species than *Pyracantha coccinea* and the thorny climber *Smilax aspera* survive the intense browsing (Fig. 1E).

Degraded early succession stages

(D1 in Schiemer et al. 2018 this volume)

***Imperata cylindrica* grassland** (Tab. 2, Cluster 11A, relevé nr. 36)

Regularly burned areas on elevated niveaus of the floodplain are dominated by cogongrass (*Imperata cylindrica*) (Fig. 1D). This perennial rhizomatous grass is native to east and southeast Asia, Australia and eastern and southern Africa. The grassland is burned usually during winter and spring, because only the young shoots provide good fodder for pasturing by sheep. At that time the root system of cogongrass, up to 1.2 meters deep, reaches the high groundwater table and quick resprouting is stimulated. During summer and autumn

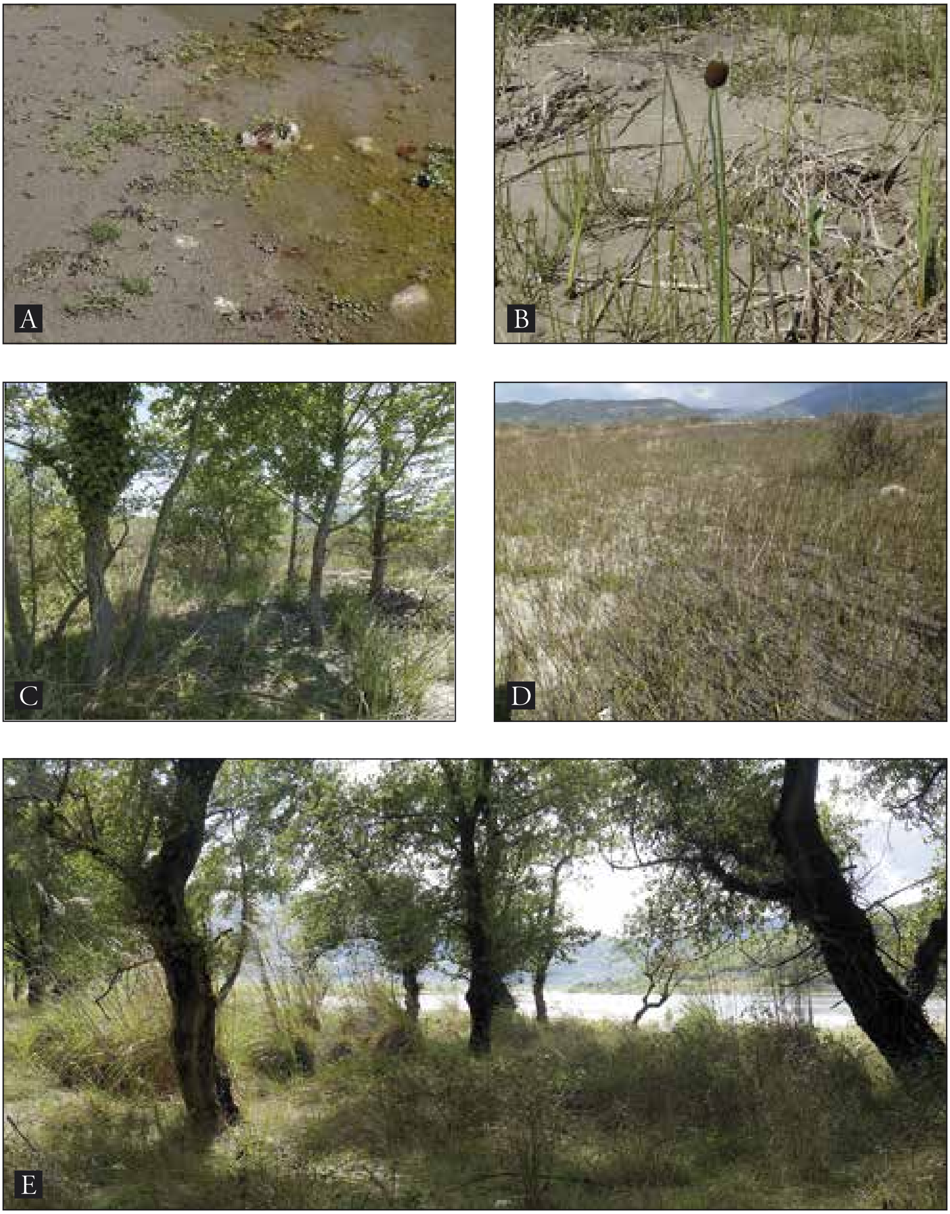

Fig. 1: Photo gallery of vegetation assemblages: A: *Nanocyperion*-community (eversion pool near Poçemi); B: *Typha minima*-community NW of Kutë; C: *Platanus orientalis-Alnus glutinosa*-community between transect 1 and 2; D: Regularly burned stand with dominating cogongrass (*Imperata cylindrica*) and a single individual of monk's pepper (*Vitex agnus-castis*) (transect 2); E: *Populus nigra-Populus alba*-community near Poçemi. – Abb. 1: Fotos von Pflanzenvergesellschaftungen: A: Nanocyperion-Gesellschaft (Kolk bei Poçemi); B: *Typha minima*-Gesellschaft NW von Kutë; C: *Platanus orientalis-Alnus glutinosa*-Gesellschaft zwischen Transekt 1 und 2; D: Regelmäßig gebrannter Standort mit dominantem Silberhaargras (*Imperata cylindrica*) und einem Individuum von Mönchspfeffer (*Vitex agnus-castis*) (Transekt 2); E: *Populus nigra-Populus alba*-Gesellschaft bei Poçemi.

Tab. 2: Reduced synoptic table of plant communities of the aggradation series. Species with only one occurrence are omitted. Abbreviations see Tab. 1. – Tab. 2: Reduzierte synoptische Tabelle der Vergesellschaftungen des aktiven Flussbettes. Arten mit nur einem Vorkommen in der Tabelle sind weggelassen. Abkürzungen siehe Tab. 1.

Number of cluster		1	2	3	4	5	6	7	8	9	10	11A	11B
Number of relevés per cluster		1	2	6	2	7	5	3	8	4	2	1	2
Medicago coronata	H	100						33					
Astragalus vesicarius ssp. *carniolica*	H	100						33					
Dorycnium germanicum	H	100											
Epilobium dodonaei	H	100											
Echium vulgare	H	100											
Heliotropium europaeum	H	100						67					
Typha minima	H		100										
Typha angustifolia	H		50										
Typha shuttleworthii	H		50										
Populus nigra	Sdlg				50			33					
Rubus sanctus	Sdlg				50								
Tamarix parviflora	Sdlg				50								
Clematis vitalba	Sdlg				50								
Salix alba	Sdlg				100								
Platanus orientalis	Juv		50		100	29	20	33	13	50			
Populus nigra	Juv	100	50			43		33					
Salix eleagnos	Juv	100				71		33					
Salix alba	Juv					71							
Salix amplexicaulis	Juv				50	71		33	13				
Tamarix parviflora	Juv		50			57	20		25				
Alnus glutinosa	Juv		50				20			25			
Vitex agnus-castus	Juv					14			25	25	50	100	
Rosa sempervirens	Juv										100		
Carpinus orientalis	Juv									25			
Clematis vitalba	Juv									25			
Cornus mas	Juv									25			
Cornus sanguinea	Juv									50			
Hedera helix	Juv									50			
Periploca graeca	Juv							33		25			
Phillyrea latifolia	Juv									25			
Quercus cerris	Juv									25			
Quercus pubescens agg.	Juv									25			
Ulmus minor	Juv									25			
Salix triandra ssp. *triandra*	Juv		50										
Salix triandra ssp. *triandra*	Sh		50										
Populus nigra	Sh							100	13				
Salix eleagnos	Sh							67	13				
Tamarix parviflora	Sh							33	88				
Salix amplexicaulis	Sh		50						38				
Platanus orientalis	Sh		50						88	75	100		
Vitex agnus-castus	Sh								75	50		100	100
Saccharum ravennae	Sh								38	25	50	100	50
Rubus sanctus	Sh								13	25	100		
Salix alba	Sh		50						13				
Smilax aspera	Sh										50		
Pyracantha coccinea	Sh										50		
Cornus sanguinea	Sh									25			
Juniperus oxycedrus ssp. *oxycedrus*	Sh									25			

Number of cluster		1	2	3	4	5	6	7	8	9	10	11A	11B
Number of relevés per cluster		1	2	6	2	7	5	3	8	4	2	1	2
Carpinus orientalis	Sh									25			
Spartium junceum	Sh												50
Platanus orientalis	T									100			
Alnus glutinosa	T									100	50		
Populus nigra	T									25	50		
Populus alba	T										50		
Persicaria lapathifolia	H			50	50	29			13				
Xanthium italicum	H	100	100	50	50	100	80	67	50				
Equisetum ramosissimum	H		50	67	50	71	20	33	25	50			
Cynodon dactylon	H			67	50	29	80	67	38			100	50
Agrostis stolonifera	H			67		86	40	33	25	50	50		
Ditttrichia graveolens	H		50		100	71	20		25	25			
Elymus repens	H					43	40	33	75	25			
Imperata cylindrica	H		50			14	100		100	50		100	100
Chondrilla juncea	H				50	29	100		38				
Dittrichia viscosa	H				100				25	25			
Echinochloa crus-galli	H				100								
Verbascum sinuatum	H				100				25	25		100	50
Verbena officinalis	H				100	14		33					
Daucus carota	H					14	20		50	25		100	100
Sonchus oleraceus	H					14			63			100	
Erigeron annuus	H								50	25		100	50
Rubus sanctus	H								13	100	50	100	50
Saccharum ravennae	H								25	50	100		
Elymus caninus	H									50	100		
Bromus erectus	H								13	25			
Buglossoides purpurocaerulea	H									25			
Calamintha sylvatica ssp. *ascendens*	H									25			
Carex flacca ssp. *serrulata*	H									25		100	0
Lysimachia punctata	H									25			
Prunella vulgaris	H									50			
Brachypodium sylvaticum	H									50			100
Bellis perennis	H									25		100	100
Plantago lanceolata	H				50				25			100	50
Sherardia arvensis	H								13			100	100
Trifolium repens	H									25			50
Trifolium fragiferum	H												100
Micromeria juliana	H							33					50
Eryngium campestre	H							0	13			100	100
Euphorbia chamaesyce	H				50			33	13			100	50
Dactylis glomerata	H									50		100	50
Vicia angustifolia ssp. *angustifolia*	H									25			50
Asperula aristata	H							33		25			
Barbarea species	H			17		14							
Tussilago farfara	H		50		50			67	13				
Brachypodium sylvaticum ssp. *glaucovirens*	H									50			
Catapodium rigidum	H					14			13				
Dorycnium hirsutum	H							33		25			
Elymus species	H		50	17				33					
Equisetum arvense	H		50							50			
Gypsophila species	H							33		25			
Mentha species	H					29			25				

Number of cluster		1	2	3	4	5	6	7	8	9	10	11A	11B
Number of relevés per cluster		1	2	6	2	7	5	3	8	4	2	1	2
Juncus bufonius agg.	H					29							
Lycopus europaeus	H					14				25			
Lythrum salicaria	H			17		14				25			
Mentha longifolia	H		50						13				
Sonchus species	H				50					25			
Spartium junceum	H						40	33					
Taraxacum sect. *Ruderalia*	H								13	25			
Tragus racemosus	H				50			33					
Potentilla reptans	H									50			
Scirpoides holoschoenus	H									25			50

its drought tolerance is an advantage in competition. Only *Vitex agnus-castus* and *Spartium junceum* survive the surface fires.

Overgrazed shrubland (Tab. 2, Cluster 11B, relevé nrs. 37, 11)

If high grazing pressure is maintained for a longer period, no woody species other than *Vitex agnus-castus* and *Spartium junceum* survive (Fig. 13e in SCHIEMER et al. 2018 this volume). In between the single shrubs, tussocks of *Saccharum* (*Tripidium*) *ravennae* overtop the shrubs. If the area is burned regularly, *Imperata cylindrica* gains dominance (see rel. 36). Species numbers range between 14 and 21, but because the grazed herb layer is not higher than 5 to 19 cm, several species may have been overlooked (FANELLI et al. 2015).

Syntaxonomical survey of the presented plant communities

Vegetation of freshwater springs, shorelines and swamps

Class: Isoëto-Nanojuncetea Br.-Bl. et Tx. in Br.-Bl. et al. 1952
Order: Nanocyperetalia Klika 1935
Alliance: Nanocyperion 1926
Ass.: Crypsio alopecuroidis-Cyperetum fusci Bioindi, Vegge, Bals & Taffetani 1999
Cyperus fuscus-community
Nanocyperion-community

Class Phragmito-Magnocaricetea Klika in Klika et Novák 1941
Order: Phragmitetalia Koch 1926
Alliance: Phragmition communis Koch 1926
Typhetum angustifoliae Pignatti 1953
Sparganietum erecti Roll 1938
Typhetum latifoliae Nowinsky 1930
Order: Bolboschoenetalia maritimi Hejny in Holub et al. 1967
Alliance: Scirpion maritimi Dahl et Hadać 1941
(?) *Bolboschoenus maritimus*-community

Vegetation of the nemoral forest zone

Intrazonal boreo-temperate grasslands and heath

Class: Molinio-Arrhenatheretea Tx. 1937
Order: Potentillo-Polygonetalia avicularis Tx. 1947
Alliance: Trifolion maritimi Br.-Bl. ex Br.-Bl. et al. 1952

Azonal vegetation

Alluvial forests and scrub

Class: Alno glutinosae-Populetea albae P. Fukarek et Fabijanić 1968
Order: Populetalia albae Br.-Bl. ex Tchou 1949
Alliance: Platanion orientalis I. Kárpáti et V. Kárpáti 1961
Platanus orientalis-Alnus glutinosa-community
Populus nigra-Populus alba-community
(?) Alliance: Lauro nobilis-Fraxinion angustifoliae I. Kárpáti et V. Kárpáti 1961

Class: Salicetea purpureae Moor 1958
Order: Salicetalia purpureae Moor 1958
Alliance: Salicion eleagnos-daphnoidis (Moor 1959) Grass 1993
Epilobium dodonaei-community (Ephemeral pioneer vegetation)
Populus nigra-Salix elaeagnos-community
Alliance: Salicion albae Soó 1951
Salicetum albae Issler 1926
Alliance: Salicion triandrae T. Müller et Görs 1958
Salix triandra-Alnus glutinosa-community
Typha minima-(*Salix triandra*-)community
Order: Tamaricetalia ramosissimae Borza et Boşcaiu ex Dolţu et al. 1980
Alliance: Tamaricion parviflorae I. Kárpáti et V. Kárpáti 1961
Tamarix-Platanus-Vitex-community
(?) Tamaricetum parviflorae Kárpáti 1961

NATURA 2000 habitat types of community interest

In the following the classification of the NATURA 2000 habitats is applied to the above described vegetation units (The Council of the European Communities 1992/43/EEC, European Commission 2013, see also Rodwell et al. 1998).

Annex I: Natural habitat types of community interest whose conservation requires the designation of special areas of conservation.

3130 Oligotrophic to mesotrophic standing waters with vegetation of the *Littorelletea uniflorae* and/or *Isoëto Nanojuncetea*
3140 Hard oligo-mesotrophic waters with benthic vegetation of *Chara* spp.
3170 Mediterranean temporary ponds
3240 Alpine rivers and their ligneous vegetation with *Salix elaeagnos*
6420 Mediterranean tall humid herb grasslands of the *Molinio-Holoschoenion*
72A0 Reed beds
92A0 *Salix alba* and *Populus alba* galleries
92C0 Oriental plane woods
92D0 Southern riparian galleries and thickets (*Nerio-Tamaricetea* and *Securinegion tinctoriae*)

Two of the above listed habitat types (3170, 92D0) are of high monitoring importance.

Beside those species that are rare all over Europe like *Typha minima*, require special concern. *Typha minima,* part of the Berne Convention, Appendix I (Council of Europe 1979), is critically endangered and has been extinct in large areas of Europe during 20th century (e.g., ENDRESS 1976, MÜLLER 1991, PEHR 1934, ROTTER et al. 2018, STAUFFER 1961). Also in Albania it is critically endangered due to the plans for the establishment power plants and regulation measures (BARINA 2017, Save the Blue Heart of Europe 2017).

Succession

Succession schemata are the attempt to reconstruct the temporal development of plant assemblages on the basis of patches of the vegetation mosaic of different age. In other words, to reach a conclusion regarding a temporal development from a spatial pattern. The conceptual design is based on observations in the field and our experience from natural stretches of the gravel bed rivers Tagliamento and Lech in the Alps (…) as well as from the rivers Lim, Tara, and Buna on the Balkan (DRESCHER unpublished).

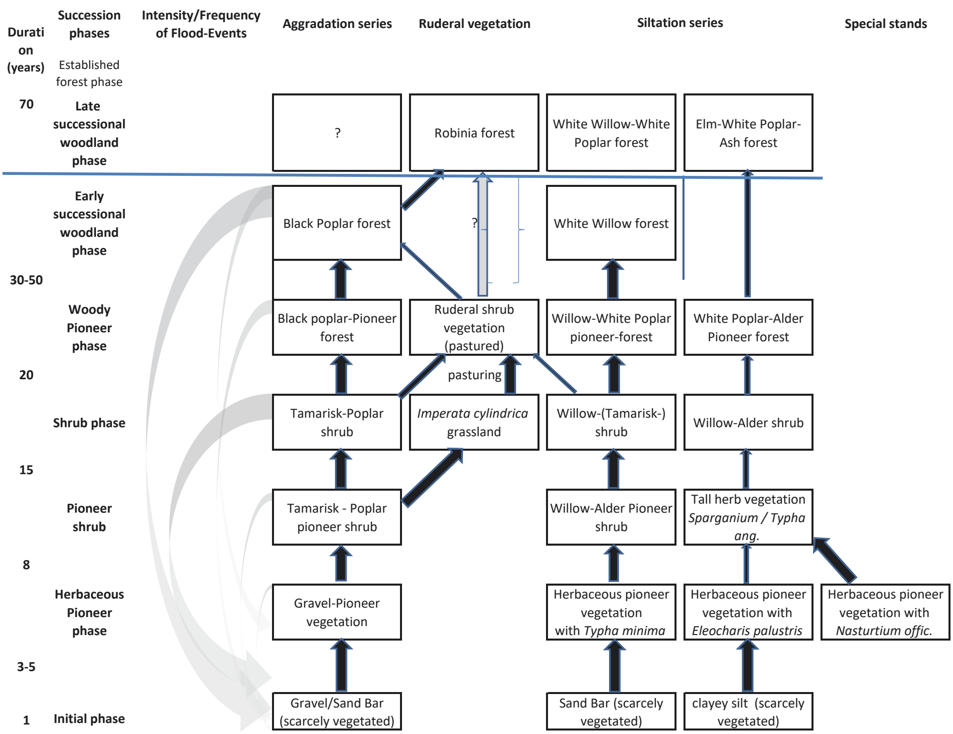

Fig. 2: Succession scheme for the plant assemblages occurring in the active channel and elevated floodplain. The curved arrows on the left side of the figure mark the events, the width of the arrows indicate the intensity of the disturbance. The straight arrows between the succession stages mark the probable direction of development of the plant assemblages. – Abb. 2: Sukzessionsschema für die Pflanzengesellschaften der aktiven Zone und der höheren Niveaus der Vjosa-Aue. Die gekrümmten Pfeile am linken Rand markieren die Überflutungsereignisse, die Breite der Pfeile symbolisiert die Intensität der Ereignisse. Die geraden Pfeile zwischen den einzelnen Sukzessionsstadien zeigen die wahrscheinliche Entwicklung der Pflanzengesellschaften an.

Depending on the river morphology and the predominant sediment we distinguish three series:

i) siltation series on silty to clayey sediment in concave geomorphologic forms like oxbow lakes, erosion and evorsion pools within the active channel.
ii) aggradation series on sandy sediment
iii) aggradation series on coarse sandy and gravelly sediment

In the study area the development ends with the early successional woodland phase indicated with a blue horizontal line. The succession is retarded by burning and grazing.

Discussion

Owing to the short time for field work some habitat types e.g. dry grassland on gravelly stands without contact to the groundwater table during the vegetation period are not represented in the vegetation tables. Others are only poorly represented. The reason for that is also the rarity of these habitat types. A check of the vegetation database of Albania (De Sanctis 2017) and the gravel bar database (Kalniková & Kudrnovsky 2017) show, that relevés from pioneer vegetation from southern Albania are completely lacking.

The importance of large woody debris for island formation

Gurnell et al. 2001 highlight the importance of large woody debris for island formation in the Tagliamento system (see also Kollmann et al. 1999). In the Vjosa corridor, large woody debris is widely missing because large areas along the river banks were already deforested a long time ago (Fig. 3A). As sedimentation and erosion also lead to the development of islands, and because the importance of large woody debris varies along the river course, hydrological processes as well as the vegetation composition on new islands govern the development as well as the intervals and intensity of floods (Schiemer et al. 2018 this volume; Fig. 9, photo A). On a small scale shrubs and even annual herbs like *Xanthium italicum* serve as a trap for fine-grained sediments (Fig 3B).

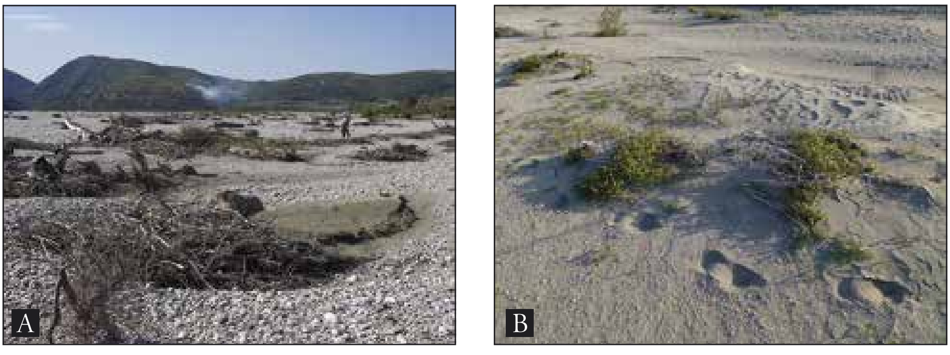

Fig. 3: A: Stretch of the active channel of the river Vjosa between Tepelenë and Kalivaçi with large woody debris; B: Annual *Xanthium italicum* with burs usually dispersed by animals remaining on the dead individual. The seedlings function as a trap for fine grained sediments. – Abb. 3: A: Abschnitt der Vjosa zwischen Tepelenë und Kalivaçi mit Totholz im Flussbett; B: *Xanthium italicum* mit vielen normalerweise epizoochoren Diasporen, die an der abgestorbenen Pflanze verblieben. Die Sämlinge fungieren als Falle für Feinsedimente.

Naturalness of riverine vegetation along Vjosa river

In general, the vegetation of gravel islands and gravel bars in the active channel is quite natural. Especially the diversity of river morphologies, sediment fractions, and habitat types throughout the entire catchment is a rarity in all of Europe. Degradation and regression caused by farming, grazing, and logging are reversible, and thanks to its hydrological dynamics the Vjosa system is of inestimable value not only for science. It can serve as a natural laboratory to study the interrelation between the geological and geomorphological setting, sediment transport, the hydrological features, and the connectivity between river and adjacent floodplain. As we still do not really understand these interrelations, such natural laboratories are essential for river restoration actions.

The occurrence of nemoral elements of the central European flora (e.g., *Festuca gigantea, Listera/Neottia ovata*) is remarkable and has been reported also from the Nestos floodplain in northeastern Greece (SCHULER 2000).

The significance of non native species in the Vjosa-system

The share of non-native species in the Vjosa floodplain is remarkably low. The only woody species we found is *Robinia pseudacacia*. Species like *Amorpha fruticosa*, already a pest in floodplains of gravel bed rivers e.g. along the lower Tagliamento, does not occur in the floodplains of southern Albania (HAYEK 1927, MARKGRAF 1931, 1932, BARINA 2017).

BARINA et al. 2013 share this opinion. All the more surprising are the plantations of *Paulownia tomentosa*. This species of central and western Chinese origin is cultivated widely in central Europe as an ornamental and is reported to be invasive especially because of the wind dispersed seeds. We think, that the advantages of this fast growing species for the pulp industry do not counterbalance the possible disturbances and damages of natural vegetation.

Conclusions

The Vjosa catchment is one of the few remaining examples of an almost completely undisturbed network of rivers, that can serve as a field experiment for hydrogeomorphological studies and investigations on the connectivity between floodplain and riverine vegetation. Remarkable for the entire catchment is the subordinate role of large woody debris for island formation in the corridor compared with gravel bed-rivers in the Alps, e.g. the Tagliamento in Friuli (Northern Italy). This can only be understood when taking into account the large-scale deforestation for pasturing and agriculture in large parts of the catchments. Own observations lead to the conclusion that the collection of large woody debris for fuel plays a subordinate role.

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Diversity of diatoms and related quality of free-flowing rivers in Albania (the Vjosa catchment)

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An overview of the periphyton communities of microscopic algae (diatoms-*Bacillariophyceae*) and related ecological quality of waters in various habitats of the Vjosa catchment (Albania) is reported here. 252 taxa of diatoms were found, mostly pennatae, of which more than 110 taxa were found directly at Vjosa River stations and 72 taxa were found in samples collected in Benja thermal springs (Lengarica tributary; Permeti). According to the diatom Index of Pollution Sensitivity (IPS), the waters were mostly of good quality within the whole watershed, representing low or moderate organic content (mostly II class) and low or moderate human impact; however, relatively high values of TI_{DIA} show that the content of nutrients (nitrogen and phosphorous) in waters is not negligible, and often corresponds with an eutrophic state.

Miho A., Ngjela K., Hoxha B., Sejdo I. & Meço M., 2018: Kieselalgen-Diversität und verbundene Qualität von freifließenden Flüssen in Albanien (Vjosa-Einzugsgebiet).
Der Artikel gibt einen Überblick über die mikroskopischen Algen (Diatomeen-Bacillariophyceae) im Periphyton von verschiedenen aquatischen Lebensräumen des Vjosa-Einzugsgebiets (Albanien). Es wurden 252 Taxa von Diatomeen gefunden, hauptsächlich Pennatae, von denen mehr als 110 Taxa direkt in der Vjosa gefunden wurden; in den Benja-Thermalquellen (Lengarica-Zufluss; Permeti) wurden 72 Taxa gefunden. Nach dem Diatomeenindex der Verschmutzungsempfindlichkeit (IPS) beurteilt, waren die Gewässer im der gesamten Einzugsgebiet meist von guter Qualität. Das entspricht einem niedrigen oder moderaten organischen Gehalt (meist II-Klasse) und menschlicher Beeinflussung. Relativ hohe Werte von TI_{DIA} zeigen jedoch, dass der Gehalt an Nährstoffen (Stickstoff und Phosphor) in Gewässern oft hoch ist.

Keywords: Albanian free-flowing rivers, Vjosa River, periphyton, diatoms, ecological river assessment.

Introduction

Free-flowing rivers such as the Vjosa are considered fundamental biodiversity resources (Opperman et al. 2015) and are also important for energy generation. Rivers in Albania are continuously disturbed through pollution due to scarce waste management, through strong erosion due to poor land use in watershed areas, through gravel mining in the riverbed, low levels of awareness and education regarding environmental and conservation matters, as well as through lax application of existing legislation. Recently, the development of hydropower plants (HPPs) and a large expansion of dams, tunnels, and channels in rivers represent an extraordinary pressure to harness these natural resources (Opperman et al. 2015). The Vjosa is one of Europe's last free-flowing rivers and harbours a great diversity of hydromorphological features. It drains a large area between Greece and Albania and forms an important delta in the Adriatic Sea.

Diatoms are the main group of eukaryotic algae that populate many aquatic environments. Their diversity is generally higher in waters of good quality, with low nutrients or pollutants, and in undisturbed habitats. Due to their ecology, diatom communities are a popular tool for monitoring ecological conditions, past and present, and are commonly used in studies of water-ecological quality (Whitton 2013, Fidlerová & Hlubikova 2016, Kahlert et al. 2012, etc.). An overview of the diversity of diatoms and the related ecological quality of waters within the Vjosa catchment (Vjosa river, its tributaries, springs and some reservoirs), based on periphyton samples collected over many years will be presented here. The data should aid authorities in developing conservation and management concepts for the future.

Material and methods

Collection of periphyton samples in the Vjosa catchment began in September 1996 and was continued sporadically until 2015. A total of more than 45 samples are considered here, of which about 20 samples are from the Vjosa river (from Mifoli to Çarshova), and the rest from tributaries (Drino, Shalsi, Kardhiqi, etc.), from springs (Kelcyra, Tepelena, Benja, Viroi, etc.), or reservoirs (Krahsi, Viroi, Gusmari, etc.) (Tab. 2 u. Fig. 1).

Sampling was mostly conducted following the standard EN13946:2003, brushing the upper surface of the hard substrata (submerged stones) or collecting submerged macrophytes and macroalgae. Samples were preserved and transported in plastic bottles in formaldehyde 4 % or denaturized ethanol 90 %. Cleaning of diatom frustules was done by boiling the material, mainly using H_2O_2 as described by Krammer & Lange-Bertalot (1986–2001) or the EU standard EN 14407:2004. Permanent microscopic slides were prepared using Naphrax (index 1.69). Samples and permanent slides are deposited at the Laboratory of Botany, University of Tirana.

Examinations, photos and counts were carried out using the optic microscopes Leica DLMB (Kupe 2006, Hoxha 2008, Jaupaj 2007, Sejdo 2010, Miho et al. 2008, 2010) and Motic BA310 (Meço 2013, Meço et al. 2014, Ngjela, 2016) at the Laboratory of Botany, FNS, University of Tirana. Hoxha (2008) used the microscope Nikon Eclipse 600 for his examinations of the Vjosa catchment, mostly at Benja thermal springs during his stay with Prof. A. Witkowski, Department of Palaeooceanology, Szczecin University, Poland, during May and July 2006. Most of the photos reported here in Plates I-X were taken with the Nikon camera, the rest with the Motic camera (CMOS 1/2" 3MP – 2048 x 1536 pixel). The most current names were used for taxonomic identification following Krammer & Lange-Bertalot (1986–2001), Lange-Bertalot (2001), Krammer (2002), Levkov et al. (2007) and other available literature online, i.e. AlgaeBase (Guiry & Guiry 2018), Grigorszky et al. 2017, Kahlert et al. 2012, Whitton 2013, Fidlerová & Hlubikova 2016, Acs et al. 2017a & b, etc.

More than 400 diatom valves were counted in each microscopic slide, thus obtaining statistically reliable results (confidence limit up to 95 %). Diatom trophic indices were calculated using the formula of Zelinka & Marvan (1961): Saprobic Index (SI) indicates the presence of degradable organic compounds (Rott et al. 1997); Trophic Index of Diatoms (TI_{DIA}) is based on the presence of the inorganic nutrients (nitrogen and phosphorous) (Rott et al. 1999); Specific Pollution Sensitivity Index (IPS) is correlated with parameters related to organic pollution, ionic strength, and eutrophication, and provides a complex estimation of water quality; IPS is the most used index at present; it is calculated using the formula of Zelinka & Marvan (1961) after Coste in Cemagref (1982), corrected after Eloranta & Kwandrans (1996); the ecological values (S_i and V_i) were taken from the Omnidia database (Lecointe et al. 1993). Numeric processing and all graphs were done in Microsoft Office Excel 2010, while photo processing was conducted in CorelDRAW X5.

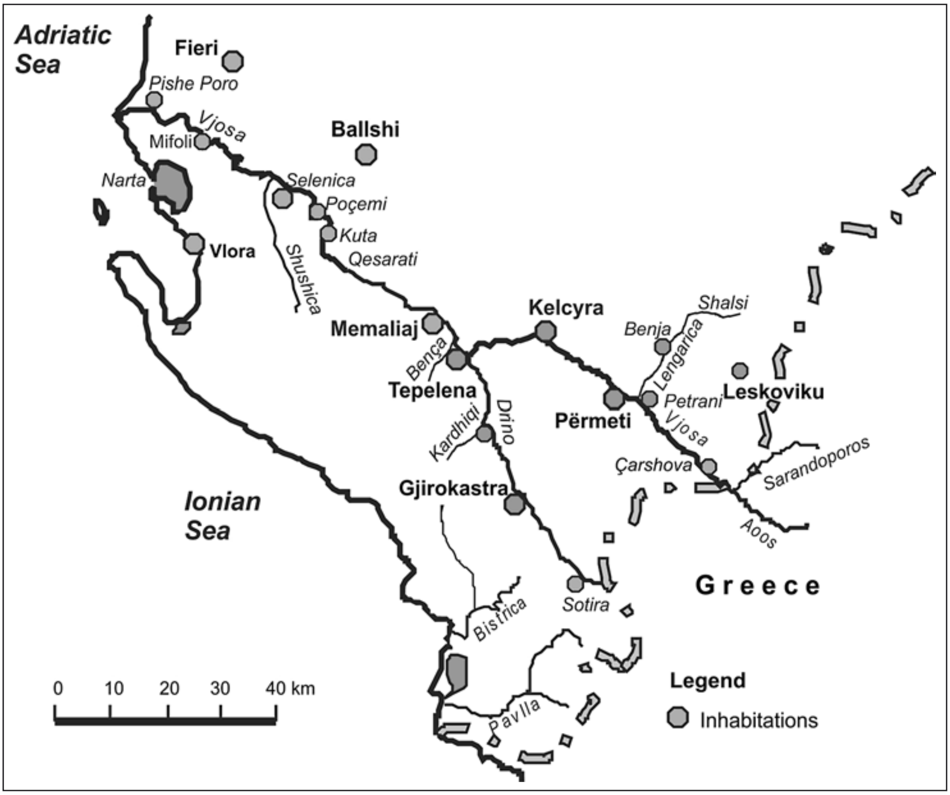

Fig. 1: Vjosa River with the most important mentioned sampling sites. – Abb. 1: Vjosa-Fluss mit den wichtigsten erwähnten Probenahmestellen.

Results and discussion

Fulfillment of environmental criteria is important for Albania's membership in the European Union (EU) (Albania 2018 Report; https://eeas.europa.eu/sites/eeas/files/20180417-albania-report.pdf). This includes monitoring the ecological status of surface waters according to the European Water Framework Directive (WFD 2000). Diatom composition and related indices are elements of this routine monitoring (Whitton 2013, Acs et al. 2017). The results reported here are part of several diploma theses in our efforts to examine algal diversity and to train yong experts in monitoring the ecological status of surface waters according to the WFD (2000). These theses include: Hoxha (2008) about Benja and Vjosa River (its upper part); Jaupaj (2007), Meço (2013) about rivers, including some habitats from Vjosa catchement; Sejdo (2012) about reservoirs, including also Viroi, Krahsi, and Ballshi in the Vjosa catchment; Ngjela (2016) about Vjosa river habitats. Part of this information is reported by Kupe (2006) in her PhD, or published in Miho et al. (2008, 2010), Meço et al. (2014). Phytoplankton and periphyton data in habitats of Narta lagoon (Vjosa delta) were provided by Dedej (2006) and Xhulaj (2009). Some taxonomic and ecological data were summarized by Miho & Witkowski (2005), Kupe & Miho (2007), Miho et al. (2005, 2013), Meço et al. (2014), and Miho (2014).

Taxonomic approach: 252 taxa of diatoms were found in Vjosa catchments waters (1996–2015) and are reported in the Annex I. Most of them are pennatae (about 230 taxa). Plates I to X show 141 microscopic photos, representing a total of 116 taxa – the most common, rare, and interesting ones.

More than 110 taxa were identified in samples from Vjosa River, 60 taxa in Viroi spring, 50 in Mifoli (Vjosa river), 47 in Lekli (Drino river) and 42 in Çajupi spring. About 70 taxa were found in 9 samples collected in Benja thermal springs (Lengarica tributary; Permeti) (Hoxha 2008, Kupe 2006). These thermal spring waters are densely populated by filamentous colonies of *Spirogyra* sp. (Fig. 2), *Oscillatoria* sp., or *Chara vulgaris var. gymnophylla* or *Chara vulgaris* f. *longibracteata* (Kashta & Miho 2016). The diatom community was dominated by *D. vulgaris* (69 %), and included *Achnanthes minutissima, Cocconeis pediculus, Diatoma moniliformis* and *Gomphonema olivaceum*.

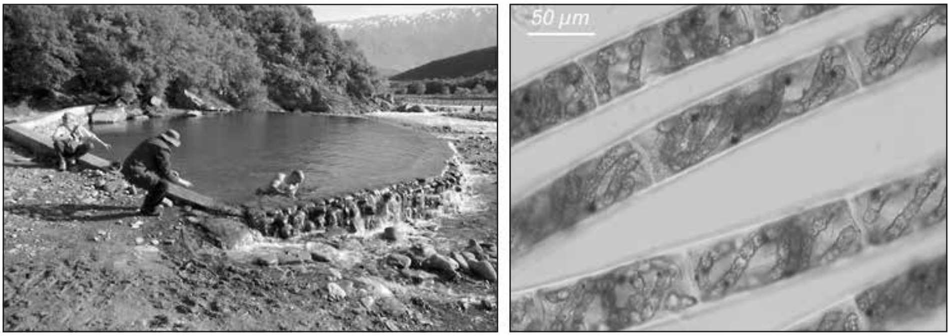

Fig. 2: a, *Spirogyra* sp. in Benja thermal springs, Permeti (11 May 2014); b, filaments at the microscope (Kashta & Miho 2016). – Abb. 2: a, *Spirogyra* sp. in Benja Thermalquellen, Permeti (11 Mai 2014); b, Filamente am Mikroskop (Kashta & Miho 2016).

Cladophora glomerata seems to be the most common filamentous green alga in the Vjosa River and its tributaries, as in most other Albanian rivers (Miho et al. 2005, Kupe 2006, Kashta & Miho 2016). In the late spring and summer season (May-July), algae were blooming mostly in slower-flowing parts of the river, with less turbidity or moderate-good quality. It is worth mentioning the dense growth of river water-crowfoot *Ranunculus fluitans* in Viroi Spring and its related reservoir, mixed also with the water moss *Fontinalis* sp. *R. fluitans* is an IUCN Red List taxa (LC status).

Dense growth of *Chara vulgaris* var. *gymnophylla* was also observed in Çajupi karst spring, situated on the western slope (1100 m). In a net sample from a small karst lake in Gramozi mountain (2400 m), a very dense growth of zooplankton was present; from microscopic algae we can mention the diatoms *Cymbopleura amphicephala*, *Caloneis silicula*, the green algae *Spirogyra* sp., *Scenedesmus* cf. *crassus*, *Cosmarium* cf. *granatum*, *Pediastrum* cf. *boryanum* var. *typicum*, fo. *reticulatum*, the cyanobacterium *Merismopedia* cf. *elegans*, etc.

Compared to other Albanian rivers and springs (Kupe 2005, Miho et al. 2005, 2008, 2010, Meço et al. 2014, etc.), Vjosa waters are distinguished by a relatively high number of species (Tab. 1). In order to represent their ecological importance, Table 2 reports the checklist of dominant taxa (exceeding 3 %) in 9 river stations of Vjosa, Drino, etc. (Ngjela 2016). Table 3, meanwhile, reports the dominant taxa (exceeding 3 %) with their maximum relative abundance (RA) and their presence (%) in 9 various habitats of Benja thermal springs (Lengarica River) (Hoxha 2008).

The most frequent of the centric diatoms were *Cyclotella glabriuscula* (in 55 % of samples), *Melosira varians* (45 %) and *Cyclotella distinguenda* (36 %); *Cyclotella glabriuscula* was found in 16 % & 22 % of samples from Viroi spring, *Melosira varians* was also abundant in Viroi (up to ca. 20 %). From the pennatae diatoms, *Achnanthidium minutissimum*, *Nitzschia linearis* and *Nitzschia palea* were found almost in all samples (100 %), followed by *Cocconeis placentula, Gomphonema olivaceum, Gomphonema tergestinum* and *Nitzschia dissipata* (91 %), *Amphora pediculus, Cymbella affinis, Diatoma moniliformis* and *Diatoma vulgaris* (82 %), *Navicula tripunctata, Surirella brebissoni* and *Ulnaria ulna* (73 %), *Encyonema ventricosum, Diatoma mesodon, Fragilaria capucina, Meridion circulaire* and *Navicula cryptotenelloides* (64 %), Cymbe*lla helvetica, Fragilaria acus, Gomphonema parvulum* and *Gomphonema pumilum* (55 %), *Gomphonema clavatum, Navicula antonii, Navicula caterva, Navicula oligotraphenta* and *Nitzschia lacuum* (45 %), *Cymatopleura solea, Diatoma ehrenbergii, Encyonema prostratum* and *Fragilaria biceps* (36 % of samples).

Among pennatae, the most abundant were *Achnanthidium minutissimum* (i.e. up to 17 % of diatom community in Viroi spring, 26 % in Kardhiqi river, 29 % in Bença – Tepelena, 31 % in Lekli, more than 44 % in Shalsi river, Mifoli and Benja); abundance of *Brachysira neoexilis* was 68 % in Benja thermal springs; *Cocconeis placentula* up to 65 % in Viroi, 50 % & 52 % in Dragoti & Qesarati, 41 % in Viroi, 37 % in Memaliaj, 21 % in Permeti, more than 30 % in Benja and Tepelena springs; *Cocconeis pediculus* up to 16 in Viroi springs; *Cymbella affinis* up to 52 % in Qesarati; *Cymbopleura amphicephala*, *Diatoma moniliformis* up to 20 % in Mifoli and Kordhoca, 29 % & 47 % in Dragoti, 38 % in Tepelena spring, 20 % in Lekli; *Gomphonema olivaceum* 23 % in Dragoti; *Meridion circulaire* 21 % in Sotira torrent; *Craticula halophila* 28 % in Benja thermal springs; *Nitzschia fonticola* 26 % in Kelcyra spring; *Nitzschia palea* 28 % in Benja; *Nitzschia incospicua* 30 % in Benja; *Nitzschia frustulum* 34 % in Benja springs; *Reimeria sinuata* up to 20 % in Çarshova; *Ulnaria ulna* 36 % in Shalsi springs.

Rare and little known species appear to present in Vjosa waters as well. *Caloneis* aff. *acedonica* Hustedt (Plate IV, Fig. 6) is likely to be a new species; it is mentioned also in other Albanian rivers by Kupe (2006), Mihoa et al. (2005), Kupe & Miho (2007), Hoxha (2008), Meço (2013), Ngjela (2016). Other difficult species include *Amphora* sp. (Plate III, Fig. 11), *Craticula* cf. *buderi* (Plate IV, Figs. 15–16), *Navicula* cf. *subrhynchocephala* (Plate V, Fig. 1), *Cymbopleura* cf. *diminuta* (Plate VII, Figs. 3–4), *Nitzschia* cf. *bremensis* (Plate IX, Fig. 6) and other taxa not reported in photos. Their exact determination, however, requires more expertise and further details, and probably a close cooperation with foreign experts.

Ecological approach: Diatom indices are reported in Table 1. TI_{DIA} ranged from 1.13 (Memaliaj, October 2006) to 2.81 in Çarshova (April 2010) (Kupe 2006, Kupe & Miho 2007). Relatively high values of TI_{DIA} show that the waters are polluted by inorganic matter and nutrients (nitrogen and phosphorous); considering the TI_{DIA} values, after Rott et al. (1999) the mean annual of the total phosphorous would be up to 0.1 mg/l (>0.65 mg/l as extreme value). But the SI values mainly indicate a low or moderate content of organic matter, and low or moderate impact, which is likely explained by a high capacity for self-purification of the Vjosa waters and its tributaries (Rott et al. 1997). From more than 45 periphyton

Tab. 1: Diatom indices from the Vjosa catchments (1996–2015); SI, Saprobic Index (Rott et al. 1997); TI_{DIA}, Trophieindex (Rott et al. 1999); IPS, Specific Pollution Sensitivity Index (Costein Cemagref 1982; corrected after Eloranta & Kwandrans 1996); N, Number of identified taxa; H', Shannon index (Shannon & Weaver 1949); Margalef Index, d (Margalef 1958); codes after AKM (2017). – Tab. 1: Diatomeenindizes aus den Vjosa-Einzugsgebieten (1996–2015); SI, Saprobitischer Index (Rott et al. 1997); TI_{DIA}, Trophieindex (Rott et al. 1999); IPS, spezifischer Verschmutzungsempfindlichkeitsindex (Coste in Cemagref 1982; korrigiert nach Eloranta & Kwandrans 1996); N, Anzahl der identifizierten Taxa; H ', Shannon-Index (Shannon & Weaver 1949); Margalef Index, d (Margalef 1958); Codes nach AKM (2017).

Station code or name	River	Station name	N	H'	d	TIDIA	TIDIAClass	SI	SI Class	IPS	IPS Class
06.09.1996 (Miho et al. 2005, Kupe 2006)											
Radova (Leskoviku)	*Çarshova*	Radova spring	13	2.4	1.89	2.8	Eupolytroph	1.6	I–II	14.59	Good
ALGW_607	Drino	Tepelena spring	17	2.7	2.49	2.6	Eutroph	1.6	I–II	14.09	Good
11.05.2002 & 12.05.2002 (Miho et al. 2005, Kupe 2006)											
AL70R_Lg20	Shalsi	Germenj (Leskoviku)	31	7.1	4.77	1.8	Mesotroph	1.7	I–II	15..94	Good
AL70R_Lg20	Shalsi	Germenj (Leskoviku)	25	3	3.80	2.9	Eupolytroph	1.7	I–II	15.47	Good
Radova (Leskoviku)	*Çarshova*	Radova spring	13	2.6	1.97	2.6	Eutroph	2.1	II	11.59	Moderate
Kelcyra (Permeti)	Vjosa	Kelcyra spring	26	2.5	3.68	2.0	Mesoeutroph	2.1	II	15.47	Good
Kelcyra (Permeti)	Vjosa	Kelcyra spring	26	3.4	4.00	2.3	Eutroph	1.8	II	15.30	Good
ALGW_607	Drino	Tepelena spring	22	3.0	3.31	2.3	Eutroph	1.5	I–II	16.80	Good
Sotira (Gjirokastra)	Drino	Sotira torrent	19	3.2	2.86	2.5	Eutroph	1.8	II	17.06	Good
10.05.2004 (Miho et al. 2005, Kupe 2006)											
AL70R_Lg20	Shalsi	Germenj (Leskoviku)	35	2.51	5.46	1.9	Mesoeutroph	–	–	17.38	Good
AL70R_Vj40 / AL060E02	Vjosa	Dragoti	44	3.29	6.76	2.1	Mesoeutroph	–	–	14.31	Good
AL70R_Vj50	Vjosa	Mifoli	28	2.92	4.32	1.5	Oligo-mesotroph	–	–	16.61	Good
22.10.2005 (Hoxha 2008)											
Benja	Lengarica	Benja thermal springs	9–23	2.1–3.3	1.74–4.78	1.4–3.3	Oligo- to Eu-polytroph	1.6–2.4	I–II to II	5.33–17.54	Poor – High
06.10.2006 & 07.10.2006 (Jaupaj 2007, Miho et al. 2008, 2010)											
AL70R_Vj10	Vjosa	Çarshova	28	4.18	4.35	2.81	Eu-polytroph	1.95	II	14.9	Good
AL70R_Vj20	Vjosa	Permeti	23	2.15	4.19	2.61	Eutroph	1.91	II	13.1	Good
AL70R_Vj40 / AL060E02	Vjosa	Dragoti	24	2.85	3.67	2.39	Eutroph	1.85	II	15.5	Good
AL70R_Di60	Drino	Lekli	32	3.28	4.91	2.31	Eutroph	1.72	I–II	15.4	Good

Tab. 1 continued – Fortsetzung

Station code or name	River	Station name	N	H’	d	TIDIA	TIDIAClass	SI	SI Class	IPS	IPS Class
AL70R_Vj50	Vjosa	Memaliaj	54	2.74	–	1.13	Oligotroph	1.91	II	14.8	Good
AL100E01	Vjosa	Qesarati	21	1.95	3.57	2.36	Eutroph	1.74	I–II	15.7	Good
Kuta	Vjosa	Kuta	62	4.34	9.65	2.38	Eutroph	1.73	I–II	14.89	Good
AL70R_Vj50	Vjosa	Mifoli	17	0.85	2.44	1.47	Oligo-meso-troph	1.60	I–II	16.73	Good
Date 01.02.2010 & 16.04.2010 (Reservoirs) (Sejdo 2010)											
Ballshi	Vjosa	Ballshi reservoir	38	2.88	4.98	1.8	Mesotroph	1.7	I–II	17.52	High
AL70LK_Kr20	Vjosa	Krahsi, Tepelena	35, 56	3.90, 4.33	8.37, 8.94	2.7, 1.8	Eupolytroph–Mesotroph	2.1, 1.3	II, I	11.08, 16.17	Moderate – Good
AL70LK_Vi10	Drino	Viroi spring, Gji-rokastra	22–59	1.95–3.27	3.2–4.5	2.0–2.4	Mesoeu-troph–Eu-troph	1.7–1.8	I–II	17.35–17.57	High
November 2011 (Black Spring); date 17 & 21.04.2012 (Meço 2013, Meço et al., 2014)											
Black spring	Vjosa	Black spring	41	1.92	6.31	2.3	Eutroph	2.1	II	15.28	Good
AL70LK_Vi10	Drino	Viroi spring	34	2.82	5.30	2.2	Eutroph	1.7	I–II	18.06	High
AL70LK_Vi10	Drino	Viroi reservoir	29	2.9	4.39	1.6	Oligo-meso-troph	1.4	I–II	15.28	Good
AL70R_Vj50	Vjosa	Mifoli	23	1.42	3.48	2.2	Eutroph	1.8	II	16.01	Good
Mifoli in 30.03.2015; Çajupi **spring in 22.03.2014; Gusmari in 19.07.2004; the others on 04 April, 2015 (Ngjela 2016)**											
AL70R_Vj50	Vjosa	Mifoli	50	–	7.53	–	–	–	–	15.58	Good
AL100E01	Vjosa	Qesarati	24	–	3.64	–	–	–	–	15.43	Good
AL70R_Vj40 / AL060E02	Vjosa	Dragoti	26	–	4.03	–	–	–	–	15.76	Good
AL70R_Di60	Drino	Lekli	47	–	7.39	–	–	–	–	14.36	Good
Bença	Bença	Tepelena	28	–	4.40	–	–	–	–	16.46	Good
AL70R_Di30 / AL030E02	Drino	Drino river, Viroi	60	–	9.47	–	–	–	–	11.88	Moderate
AL70R_Di30	Drino	Viroi spring	23	–	3.54	–	–	–	–	15.70	Good
AL70R_Di40	Kardhiqi	Kardhiqi	25	–	3.90	–	–	–	–	13.70	Good
AL70R_Di20 / AL030E01	Drino	Kordhoca	22	–	3.30	–	–	–	–	15.70	Good
Çajupi	Çajupi	Çajupi spring	42	–	6.70	–	–	–	–	15.60	Good
Gusmari	Gusmari	Gusmari reservoir	27	–	4.21	–	–	–	–	14.97	Good

Tab. 2: List of the dominant taxa (exceeding 3 %) in 9 river stations of Vjosa, Drino, etc. in 05.04.2015, except Kordhoca / Drino in 03.04.2016 (Ngjela 2016). – Tab. 2: Liste der dominanten Taxa (über 3 %) in 9 Flussstationen von Vjosa, Drino usw. am 05.04.2015, außer Kordhoca / Drino am 03.04.2016 (Ngjela 2016).

***Name of species* / Station / River**	**Mifoli / Vjosa**	**Qesarati / Vjosa**	**Dragoti / Vjosa**	**Lekli / Vjosa**	**Tepelena / Vjosa**	**Viroi / Drino**	**Viroi / Spring**	**Kardhiqi / River**	**Kordhoca / Drino**
Centrales									
Melosira varians Agardh	0.1	0.2		1		17.9		0.2	
Pennales									
Achnanthidium minutissimum (Kützing) Czarnecki	8.8	4.5	5.7	10.8	37	8.1	17	26.4	29.2
Amphora pediculus (Kützing) Grunow	0.6		0.8	1.6	5.9	2	3.6	3.2	1.2
Cocconeis placentula Ehrenberg var. placentula	3.7		0.6	1.2	2.6	8.1	64.5	0.2	0.5
*Cymbella affinis K*ützing	2.4	51.9	1.2	0.8		1.2	0.2	0.2	1.2
Diatoma ehrenbergii Kützing	0.1	0.5		3.2				0.2	
Diatoma moniliformis Kützing	20.7	8.3	47	19.7	0.7	3.4		1.3	20.6
Fragilaria capucina Desmazières agg.	2.4		5.5	2.4		2.4			2.7
Gomphonema olivaceum (Hornemann) Brebisson gr.	22.8	16.8	15.7	12.4	1.3	5.1	0.2	16.9	14.9
Gomphonema pumilum (Grunow) Reichardt & Lange-Bertalot	1.9			0.4	3.3	1		8.9	
Gomphonema tergestinum Fricke	1	7.4	7.3	4.9	16.7	3.2	0.2	12.9	6.3
Navicula caterva Hohn & Hellerman	3.4			0.2	1.5	2.6			
Navicula cryptotenelloides Lange-Bertalot		0.2	0.4	3	1.1	0.8		2.3	
Navicula tripunctata (O. F. Müller) Bory	3.4		1.6	3.4	1.3	1.4	2.6	0.6	0.7
Nitzschia dissipata (Kützing) Grunow	10.9	0.4	4.1	7.3	0.9	6.1	1.4		6.9
Nitzschia dissipata var. *media* (Hantzsch) Grunow								8.5	
Nitzschia incospicua Grunow	0.1								
Nitzschia lacuum Lange-Bertalot		0.2			13.3	0.4		0.6	
Nitzschia linearis (Agarth) W. Smith	1.5	0.7	0.6	0.6	0.2	3.2	0.2	0.2	1.5
Nitzschia littoralis Grunow					0			0	
Nitzschia palea (Kützing) W. Smith	2.1	0.9	0.6	7.1	3.7	12.8	1.4	11.2	2.4
Surirella brebissoni Krammer & Lange-Bertalot	2.1		1	3.2	0.4	4.5		0.4	1.9
Ulnaria ulna (Nitzsch) Compère	1.8	2.9	1.6	2		1.8	0.8		3.8

Tab. 3: List of the dominant taxa (exceeding 3 %) with their maximum relative abundance (RA) and their presence (%) in 9 various habitats of Benja thermal springs (Lengarica River) in 22.10.2005 (Hoxha 2008). – Tab. 3: Liste der dominanten Taxa (über 3 %) mit ihrer maximalen relativen Häufigkeit (RA) und ihrer Anwesenheit (%) in 9 verschiedenen Lebensräumen der Benja Thermalquellen (Lengarica River) am 22.10.2005 (Hoxha 2008).

Name of species	**Maximal RA (%)**	**Presence (%)**
Centrales		
Cyclotella commensis Hustedt	9.8	56
Pennales		
Achnanthes exigua var. elliptica Hustedt	27	44
Achnanthidium minutissimum (Kützing) Czarnecki	48.6	100
Amphora pediculus (Kützing) Grunow	34.3	33
Brachysira neoexilis Lange-Bertalot	68	33
Caloneis sp. (nov. sp.)	4.8	56
Cocconeis placentula Ehrenberg	33.3	67
Craticula halophila (Grunow) D.G.Mann	28.1	22
Cymbella affinis Kützing	4.4	22
Denticula tennius Kützing	12.1	11
Diatoma mesodon (Ehrenberg) Kützing	19.3	11
Diatoma moniliformis Kützing	48.2	11
Diatoma tenuis Agardh	4.2	22
Diatoma vulgaris Bory gr.	22.1	22
Encyonema ventricosum (C.Agardh) Grunow	5.7	33
Fragilaria biceps (Kützing) Hustedt	7	11
Fragilaria capucina Desmazières agg.	3.9	11
Frustulia vulgaris (Thwaites) De Toni	3.9	22
Gomphonema olivaceum (Hornemann) Brebisson gr.	5.2	11
Gomphonema pumilum (Grunow) Reichardt & Lange-Bertalot	10.4	33
Meridion circulaire (Grewille) Agardh var. *circulaire*	10.9	22
Navicula capitatoradiata Germain	11.2	11
Navicula caterva Hohn & Hellerman	5.3	11
Navicula cryptotenelloides Lange-Bertalot	8.6	55
Navicula erifuga Lange-Bertalot	8.0	33
Navicula veneta Kützing	15.1	11
Navicymbula pusilla (Grunow) Krammer	4.9	33
Nitzschia denticula Grunow	4.7	22
Nitzschia dissipata (Kützing) Grunow	9.6	22
Nitzschia frustulum (Kützing) Grunow	34.1	11
Nitzschia incospicua Grunow	30.0	33
Nitzschia palea (Kützing) W. Smith var. *palea*	28.3	55
Nitzschia palea var. debilis (Kützing) Grunow	18.5	22
Nitzschia recta Hantzsch	5.9	11
Rhopalodia brebissonii Krammer	3.4	11
Tryblionella apiculata Gregory	4.1	44
Ulnaria ulna (Nitzsch) Compère	13.1	44

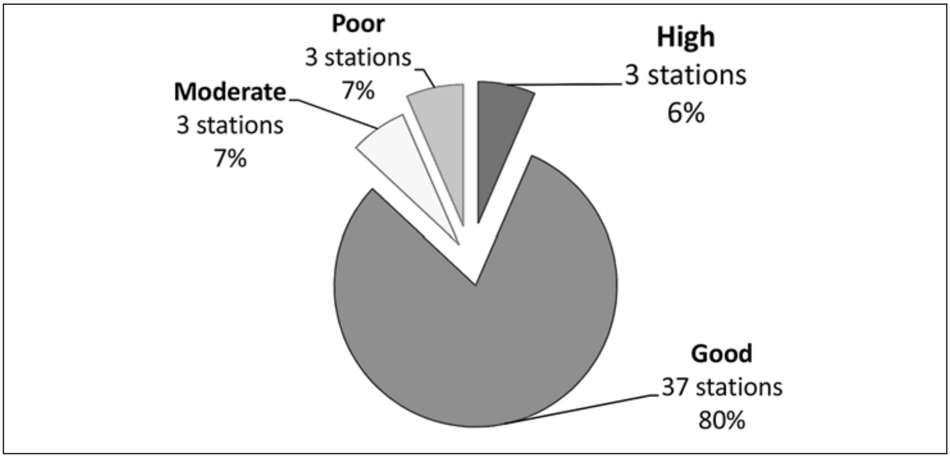

Fig. 3: Ecological quality overview in the Vjosa basin (up to yr. 2015, Tab. 1) according to the IPS; the colours are after Water Framework Directive (WFD 2000). – Abb. 3: Überblick über die ökologische Qualität im Vjosa-Becken (bis zum Jahr 2015; Tab. 1) gemäß dem IPS; Die Farben sind nach der Wasserrahmenrichtlinie (WFD 2000).

samples assessed, IPS classes in 40 samples were of Good or High quality. Only 6 samples were of Poor or Moderate quality, most of them in Benja springs (Tab. 1, Fig. 3) (quality colors after WFD, 2000).

Of the similar studies on the ecological quality of the Vjosa catchment, Gjini et al. (2015) should be mentioned here. The team studied diatoms in Viroi lake (Gjirokastra) during the summer of 2011. A total of 83 taxa were identified, belonging to *Nitzschia* (16 taxa), *Navicula* (10 taxa), *Gomphonema* (6 taxa), *Surirella* (6 taxa), and *Cymbella* (4 taxa). Based on the presence of indicator species, the ecological water quality was I-II (oligo-mesosaprobious to beta-mesosaprobious). Gjini et al. (2013) also reported the diatoms in Drino River (Gjirokastra); 5 stations were sampled during autumn of 2012; about 69 taxa were identified, belonging to *Nitzschia* (12 taxa), *Navicula* (9 taxa), *Cocconeis* (3 taxa), *Surirella* (4 taxa) etc. According to the bioindicator species, the ecological quality of waters was classified into class II (beta-mesosaprobic).

According to Prifti et al. (2014), the phosphorous content in the Vjosa river varied from 0.01 to 0.39 mg/l (average 0.095–0.2 mg/l), measured twice during June-December 2012 in only 2 stations: Tri Urat (Çarshova) and Mifoli. Duka & Vallja (pers. comm.) report that the level of phosphorous varied from about 0.01 mg/l P-PO4 in the River Bença (Tepelena town), to more than 0.072 mg/l P-PO4 in Mifoli (Vjosa River). Setting aside the fact that the reported data are very general, they show that the trophic state of waters change from meso- to hypertrophic (OECD 2006, Carlson & Simpson 1996), providing confirmation of our diatom indexes reported in Table 1.

Conclusions: The diatom community from more than 45 periphyton samples from Vjosa catchment is considered here, sporadically collected during the period 1996–2015. About 20 samples are from the Vjosa river (from Mifoli to Çarshova), the rest from its tributaries (Drino, Shalsi, Kardhiqi, etc.), springs (Kelcyra, Tepelena, Benja, Viroi, etc.), or reservoirs (Krahsi, Viroi, Gusmari, etc.). 252 taxa of diatoms were identified, most of them pennatae (about 230 taxa); more than 110 taxa were found in the Vjosa River. Beside the examination of algal diversity, our efforts were focussed on training young experts to be able to monitor the ecological status of surface waters according to the Water Framework Directive (WFD 2000); several diatom indices were calculated: SI, Saprobic Index (Rott et al. 1997); TI_{DIA}, Trophic Index (Rott et al. 1999); IPS, Specific Pollution Sensitivity Index (Coste in Cemagref 1982; corrected after Eloranta & Kwandrans 1996), etc. Based on these indices, the ecological quality of waters in the Vjosa catchment appears to be of good quality. However, the waters may contain pollution from inorganic mater, nutrients (nitrogen and phosphorous), but with a low or moderate impact, probably due to the self-purification capacity of rivers. High microbiological values were also found in the parts of the river close to urban centres (Hamzaraj et al., pers. comm.).

Many countries have adopted a single, well-described approach for monitoring river water quality, which involves the use of indices related to diatom composition at a site. Albania is making efforts to meet EU environmental criteria, including monitoring the ecological state of surface waters according to the European Water Framework Directive (WFD 2000). Diatom composition and related indices belong to the elements of routine monitoring and can be easily applied and supported, including to the waters of the Vjosa catchment. Applying these methods would help authorities in developing future conservation and management concepts, especially regarding the large-scale expansion of dams and non-sustainable hydropower development plans in the near future.

Acknowledgments

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Annex

Annex I: Checklist of diatoms found in different aquatic habitats (given in table 1) of Vjosa catchment. – Anhang I: Checkliste der Kieselalgen in verschiedenen aquatischen Lebensräumen (in Tabelle 1) des Vjosa-Einzugsgebiets.

Centrales

Cycllotella distinguenda Hustedt

Cycllotella radiosa (Grunow) Lemmermann

Cyclotella commensis Hustedt

Cyclotella cyclopuncta Håkansson

Cyclotella ocellata Pantocsek

Cyclotella pseudostelligera Hustedt

*Handmannia glabriuscula (*Grunow) Kociolek & Khursevich

Melosira varians Agardh

Stephanodiscus alpinus Hustedt

Stephanodiscus hantzschii Grunow

Stephanodiscus medius Håkansson

Stephanodiscus parvus Håkansson

Pennales

Achnanthes brevipes C.Agardh

Achnanthes exigua var. *elliptica* Hustedt

Achnanthidium caledonicum (Lange-Bertalot) Lange-Bertalot) (=*Achnanthes minutissima* var. *scotica* (Carter) Lange-Bertalot)

Achnanthidium catenatum (Bily & Marvan) Lange-Bertalot

Achnanthidium eutrophilum (Lange-Bertalot) Lange-Bertalot
Achnanthidium exile (Kützing) Heiberg
Achnanthidium minutissimum (Kützing) Czarnecki
Adlafia minuscula var. *muralis* (Grunow) Lange-Bertalot
Amphipleura pellucida Kützing
Amphora inariensis Krammer
Amphora lybica Ehrenberg
Amphora montana Krasske
Amphora ovalis (Kützing) Kützing
Amphora pediculus (Kützing) Grunow
Amphora sp.
Anomoeoneis sphaerophora Pfitzer
Brachysira calcicola Lange-Bertalot
Brachysira neoexilis Lange-Bertalot
Caloneis aff. *macedonica* Hustedt
Caloneis bacillum (Grunow) Cleve
Caloneis fontinalis (Grunow) Cleve-Euler
Caloneis hyalina Hustedt
Caloneis lancettula (Schulz) Lange-Bertalot & Witkowski
Caloneis macedonica Hustedt
Caloneis schumanniana (Grunow) Cleve
Caloneis silicula (Ehrenberg) Cleve agg.
Caloneis tenuis (Gregory) Krammer
Cocconeis neodiminuta Krammer
Cocconeis pediculus Ehrenberg
Cocconeis placentula Ehrenberg var. *placentula*
Cocconeis placentula var. *lineata* (Ehrenberg) Van Heurck
Craticula accomoda (Hustedt) D.G.Mann
Craticula cf. *buderi (Hustedt) Lange-Bertalot*
Craticula cuspidata (Kutzing) D.G.Mann
Craticula halophila (Grunow) D.G.Mann
Craticula molestiformis (Hustedt) Mayama
Ctenophora pulchella (Ralfs ex Kützing) Williamms et Round
Cymatopleura solea (Brebisson) W. Smith
Cymbella affinis Kützing
Cymbella aspera (Ehrenberg) H.Peragollo
Cymbella cantonati Krammer
Cymbella cf. *turgidula* Grunow (cf. var. *venezuelana* Krammer)
Cymbella cistula (Ehrenberg) Kirchner
Cymbella cymbiformes Agardh
Cymbella helvetica Kützing
Cymbella laevis Nägeli
Cymbella lanceolata (Ehrenberg) Kirchner
Cymbella lange-bertalotii Krammer
Cymbella subhelvetica Krammer
Cymbella tumida (Brebissoni) Van Heurck
Cymbopleura amphicephala (Nägeli) Krammer
Cymbopleura cf. *diminuta (Grunow) Krammer*
Cymbopleura cuspidata (Kützing) Krammer
Cymbopleura incerta (Grunow) Krammer
Delicata delicatula (Kützing) Krammer (=*Cymbella delicatula* Kützing)
Denticula tennius Kützing
Diatoma ehrenbergii Kützing
Diatoma hyemalis (Roth) Heiberg
Diatoma hyemalis (Roth) Heiberg
Diatoma mesodon (Ehrenberg) Kützing
Diatoma moniliformis Kützing
Diatoma tenuis C. Agardh
Diatoma vulgaris Bory gr.
Diatoma vulgaris var. *ovalis* (Fricke) Hustedt
Diploneis ellyptica (Kützing) Cleve
Diploneis marginestriata Hustedt
Diploneis notabilis (Greville) Cleve
Diploneis oblongella (Nägeli) Cleve-Euler
Diploneis oculata (Brebisson) Cleve
Diploneis ovalis (Hilse) Cleve
Diploneis puella (Schumann) Cleve
Encyonema leibleinii (C.Agardh) W.J.Silva, R.Jahn, T.A.Veiga Ludwig & M.Menezes (=*Encyonema prostratum* (Berkeley) Kützing)
Encyonema minutiforme Krammer
Encyonema minutum (Hilse) D.G.Mann
Encyonema silesiacum (Bleisch) D.G.Mann
Encyonema ventricosum (C.Agardh) Grunow
Encyonopsis descripta (Hustedt) Krammer
Encyonopsis microcephala (Grunow) Krammer gr.
Encyonopsis subminuta Krammer & Reichardt
Eolimna minima (Grunow) Lange-Bertalot & W.Schiller
Epithemia adnata (Kützing) Brebisson
Epithemia smithii Carruthers
Epithemia sorex Kützing
Epithemia turgida (Ehrenberg) Kützing
Eunotia arcus Ehrenberg
Eunotia bidens Ehrenberg
Eunotia sp.

Fallacia lenzii (Hustedt) Lange-Bertalot
Fallacia pygmaea (Kützing) Stickle & D.G.Mann
Fistulifera saprophila (Lange-Bertalot & Bonik) Lange-Bertalot
Fragilaria acus Kützing
Fragilaria biceps (Kützing) Hustedt
Fragilaria capucina Desmazières agg.
Fragilaria capucina var. *capitellata* (Grunow) Lange-Bertalot
Fragilaria capucina var. *distans* (Grunow) Lange-Bertalot
Fragilaria capucina var. *gracilis* (Oestrup) Hustedt
Fragilaria capucina var. *rumpens* (Kützing) Lange-Bertalot
Fragilaria capucina var. *vaucheriae* (Kützing) Lange-Bertalot
Fragilaria construens (Ehrenberg) Grunow fo. *construens*
Fragilaria crotonensis Kitton
Fragilaria exigua Grunow
Fragilaria lata (A.Cleve) Renberg
Fragilaria tenera (W.Smith) Lange-Bertalot
Frustulia spicula Amosse
Frustulia vulgaris (Thwaites) De Toni
Geissleria decussis (Ostrup) Lange Bertalot & Metzeltin
Gomphoneis transsilvanica (Pantocsek) Krammer
Gomphonema acuminatum Ehrenberg
Gomphonema angustatum (Kützing) Rabenhorst
Gomphonema capitatum Ehrenberg
Gomphonema clavatum Ehrenberg
Gomphonema exilissimum (Grunow) Lange-Bertalot & Reichardt
Gomphonema hebridense Gregory
Gomphonema insigne Gregory
Gomphonema micropus Kützing
Gomphonema minutiforme Lange-Bertalot & Reichardt
Gomphonema minutum (Agardh) Agardh agg.
Gomphonema olivaceum (Hornemann) Brebisson gr.
Gomphonema parvulum Kützing agg.
Gomphonema pseudotenellum Lange-Bertalot
Gomphonema pumilum (Grunow) Reichardt & Lange-Bertalot
Gomphonema pumilum var. *elegans* Reichardt & Lange-Bertalot
Gomphonema sarcophagus Gregory
Gomphonema tergestinum Fricke
Gomphonema truncatum Ehrenberg
Gomphonema vibrio Ehrenberg
Grunowia solgensis (A.Cleve) Aboal (=*Nitzschia sinuata* var. *delognei* (Grunow) Lange-Bertalot)
Grunowia tabellaria (Grunow) Rabenhorst (=*Nitzschia sinuata* var. *tabellaria* (Grunow) Grunow)
Gyrosigma acuminatum (Kützing) Rabenhorst
Gyrosigma nodiferum (Grunow) Reimar
Gyrosigmas calproides (Rabenhorst) Cleve
Halamphora veneta (Kützing) Levkov (=*Amphora veneta* Kützing)
Hannaea arcus (Ehrenberg) R.M.Patrick
Hantzschia amphyoxys (Ehrenberg) Grunow
Hippodonta capitata (Ehrenberg) Lange-Bertalot, Metzeltin & Witkowski
Kolbesia gessneri (Hustedt) Aboal (=*Achnanthes ploenensis* var. *gessneri* (Hustedt) Lange-Bertalot)
Luticola cohnii (Hilse) D.G.Mann
Luticola nivalis (Ehrenberg) D.G. Mann
Luticula mutica (Kützing) D. G. Mann
Luticula paramutica (W. Bock) D.G.Mann
Mastoglia cf. *pumilla* (Grunow) Cleve
Mastogloia elliptica (Agardh) Cleve
Mastogloia smithii Thwaites var. smithii
Mastogloia smithii var. lacustris Grunow
Mayamaea atomus (Kützing) Lange-Bertalot
Meridion circulaire (Grewille) Agardh var. *circulaire*
Navicula amphiceropsis Lange-Bertalot & Rumrich
Navicula antonii Lange-Bertalot
Navicula capitatoradiata Germain
Navicula cari Ehrenberg
Navicula caterva Hohn & Hellerman
Navicula cf. *microcari* Lange-Bertalot
Navicula cf. *subrhynchocephala* Hustedt
Navicula cincta (Ehrenberg) Ralfs
Navicula cryptocephala Kützing
Navicula cryptotenella Lange-Bertalot
Navicula cryptotenelloides Lange-Bertalot
Navicula dealpina Lange-Bertalot
Navicula digitoconvergens Lange-Bertalot

Navicula erifuga Lange-Bertalot
Navicula jakovljevicii Hustedt
Navicula leptostriata Jørgensen
Navicula menisculus Schumann
Navicula minima Grunow
Navicula novasiberica Lange-Bertalot
Navicula oligotraphenta Lange-Bertalot & Hofmann
Navicula pseudoppugnata Lange-Bertalot & Miho
Navicula radiosa Kützing
Navicula reichardtiana Lange-Bertalot
Navicula schroeteri Meister
Navicula sp.
Navicula splendicula Van Landingham
Navicula tripunctata (O. F. Müller) Bory
Navicula trivialis Lange-Bertalot
Navicula veneta Kützing
Navicula viridula (Kützing) Ehrenberg
Navicymbula pusilla (Grunow) Krammer
Nitzschia acicularis (Kützing) W.Smith
Nitzschia alpina (Hustedt) Lange-Bertalot
Nitzschia amphibia Grunow
Nitzschia angustata (W. Smith) Grunow
Nitzschia angustatula Lange-Bertalot
Nitzschia cf. *bremensis* Hustedt
Nitzschia clausii Hantzsch
Nitzschia denticula Grunow
Nitzschia dissipata (Kützing) Grunow
Nitzschia dissipata var. *media* (Hantzsch) Grunow
Nitzschia draveillensis Coste et Ricard
Nitzschia dubia W.Smith
Nitzschia elegantula Grunow
Nitzschia fonticola Grunow
Nitzschia frustulum (Kützing) Grunow
Nitzschia gracilis Hantzsch
Nitzschia heufleriana Grunow
Nitzschia incospicua Grunow
Nitzschia intermedia Hantzsch
Nitzschia lacuum Lange-Bertalot
Nitzschia linearis (Agarth) W. Smith var. *linearis*
Nitzschia littoralis Grunow
Nitzschia palea (Kützing) W. Smith var. *palea*
Nitzschia palea var. *debilis* (Kützing) Grunow
Nitzschia perminuta (Grunow) M.Peragallo
Nitzschia recta Hantzsch
Nitzschia sigmoidea (Nitzsch) W. Smith
Nitzschia solita Hustedt
Nitzschia sp.
Nitzschia subacicularis Hustedt
Nitzschia vermicularis (Kützing) Hantzsch
Pinnularia brebissonii (Kützing) Rabenhorst
Pinnularia interrupta W.Smith
Pinnularia microstauron (Ehrenberg) Cleve
Pinnularia neomajor Krammer
Pinnularia obscura Kraske
Pinnularia sp.
Pinnularia viridiformis Krammer
Placoneis placentula (Ehrenberg) Mereschkowsky
Planothidium frequentissimum (Lange-Bertalot) Lange-Bertalot
Planothidium lanceolatum (Brébisson ex Kützing) Lange-Bertalot
Reimeria sinuata (W.Gregory) Kociolek & Stoermer
Rhoicosphenia abbreviata (Agardh) Lange-Bertalot
Rhopalodia brebissonii Krammer
Rhopalodia gibba (Ehrenberg) O. Müller
Sellaphora bacillum (Ehrenberg)D.G.Mann
Sellaphora pupula (Kützing) Mereschkowksy
Sellaphora seminulum (Grunow) D.G.Mann
Sellaphora submuralis (Hustedt) C.E.Wetzel, L.Ector, B.Van de Vijver, Compère & D.G.Mann
Stauroneis agrestis Petersen
Stauroneis anceps Ehrenberg
Surirella angusta Kützing
Surirella brebissoni Krammer & Lange-Bertalot
Surirella brebissonii var. *kuetzingii* Krammer & Lange-Bertalot
Surirella gracilis Grunow
Surirella linearis var. *helvetica* (Brun) F. Meister
Surirella linearis W. Smith var. *linearis*
Surirella minuta Brébisson
Surirella ovalis Brébisson
Surirella sp.
Surirella splendida (Ehrenberg) Kützing
Surirella tenera W. Gregory
Tryblionella apiculata Gregory (=Nitzschia constricta (Kützing) Ralfs)
Ulnaria ulna (Nitzsch) Compère

Plate I: 1, *Stephanodiscus medius*; 2, *Handmannia glabriuscula*; 3, *Cyclotella cyclopuncta*; 4, *C. comensis*; 5, *C. ocellata*; 6, *C. meneghiniana*; 7, *Melosira varians*; 8–9, *Meridion circulaire*; 10, *Diatoma mesodon*; 11, *D. vulgaris*; 12, *D. moniliformis*; 13, *D. tenuis*; 14, *D. hyemalis* (9, Gramozi lake, Erseka; the rest from Benja thermal springs, Permeti). – Tafel I: 1, *Stephanodiscus medius*; 2, *Handmannia glabriuscula*; 3, *Cyclotella cyclopuncta*; 4, *C. comensis*; 5, *C. ocellata*; 6, *C. meneghiniana*; 7, *Melosira varians*; 8–9, *Meridion circulaire*; 10, *Diatoma mesodon*; 11, *D. vulgaris*; 12, *D. moniliformis*; 13, *D. tenuis*; 14, *D. hyemalis* (9, Gramozi See, Erseka; der Rest von Benja Thermalquellen, Permeti).

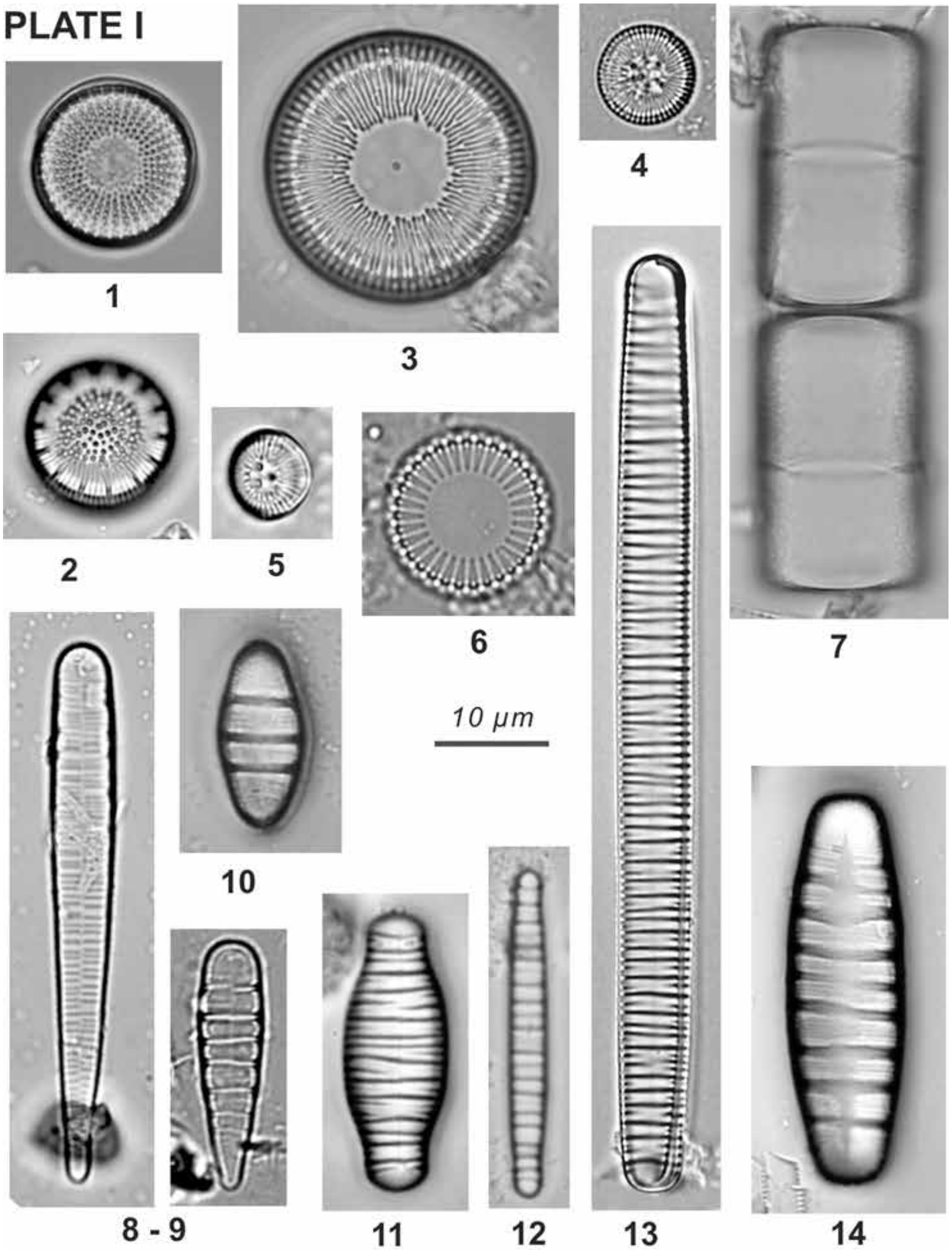


Plate II: 1, Diatoma ehrenbergii; 2, *Ulnaria ulna*; 3, *Fragilaria tenera*; 4, *Ctenophora pulchella*; 5, *Fragilaria capucina* var. *rumpens*; 6, *F. capucina*; 7–8, *F. capucina* var. *gracilis*; 9, *F. biceps*; 10, *F. acus*; 11–12, *Achnanthidium minutissimum*; 13, *A. eutrophilum*;14–15, *Planothidium lanceolatum* (5, Lekli, Drino river, Tepelena; 10, Black spring, Permeti; 15, Viroi spring, Gjirokastra; 16, Zhuka, Vjosa river, Vlora; the rest from Benja thermal springs, Permeti). – Tafel II: 1, Diatoma ehrenbergii; 2, *Ulnaria ulna*; 3, *Fragilaria tenera*; 4, *Ctenophora pulchella*; 5, *Fragilaria capucina* var. *rumpens*; 6, *F. capucina*; 7–8, *F. capucina* var. *gracilis*; 9, *F. biceps*; 10, *F. acus*; 11–12, *Achnanthidium minutissimum*; 13, *A. eutrophilum*;14–15, *Planothidium lanceolatum* (5, Lekli, Drino, Tepelena; 10, Schwarzer Quelle, Permeti; 15, Viroi Quelle, Gjirokastra; 16, Zhuka, Vjosa Fluss, Vlora; der Rest von Benja Thermalquellen, Permeti).

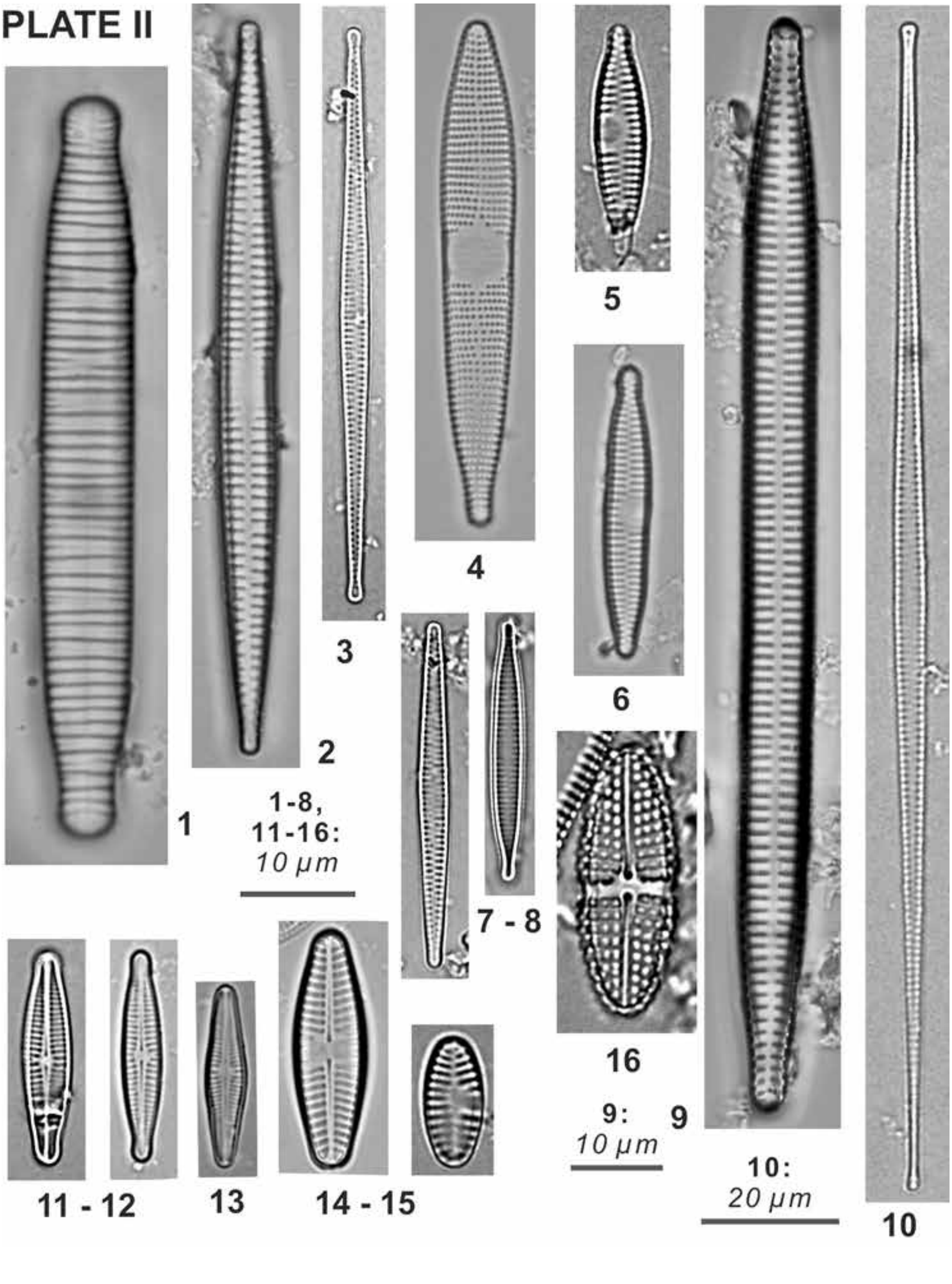


Plate III: 1, *Cocconeis pediculus*; 2–3, *C. placentula* var. *lineata*; 4, *C. neodiminuta*; 5–6, *Rhoicosphenia abbreviata*; 7, *Amphora pediculus*; 8, *A. libyca*; 9–10, *Halamphora veneta*; 11, *Amphora* sp.; 12–13, *Brachysira neoexilis*; 14–15, *Luticola mutica*; 16, *L. nivalis*; 17, *Navicula minima* (3, Mifoli, Vjosa river; 5–6, Black spring, Permeti; 7–9, Viroi spring, Gjirokastra; the rest from Benja thermal springs, Permeti). – Tafel III: 1, *Cocconeis pediculus*; 2–3, *C. placentula* var. *lineata*; 4, *C. neodiminuta*; 5–6, *Rhoicosphenia abbreviata*; 7, *Amphora pediculus*; 8, *A. libyca*; 9–10, *Halamphora veneta*; 11, *Amphora* sp.; 12–13, *Brachysira neoexilis*; 14–15, *Luticola mutica*; 16, *L. nivalis*; 17, *Navicula minima* (3, Mifoli, Vjosa Fluss; 5–6, Schwarzer Quelle, Permeti; 7–9, Viroi Quelle, Gjirokastra; der Rest von Benja Thermalquellen, Permeti).

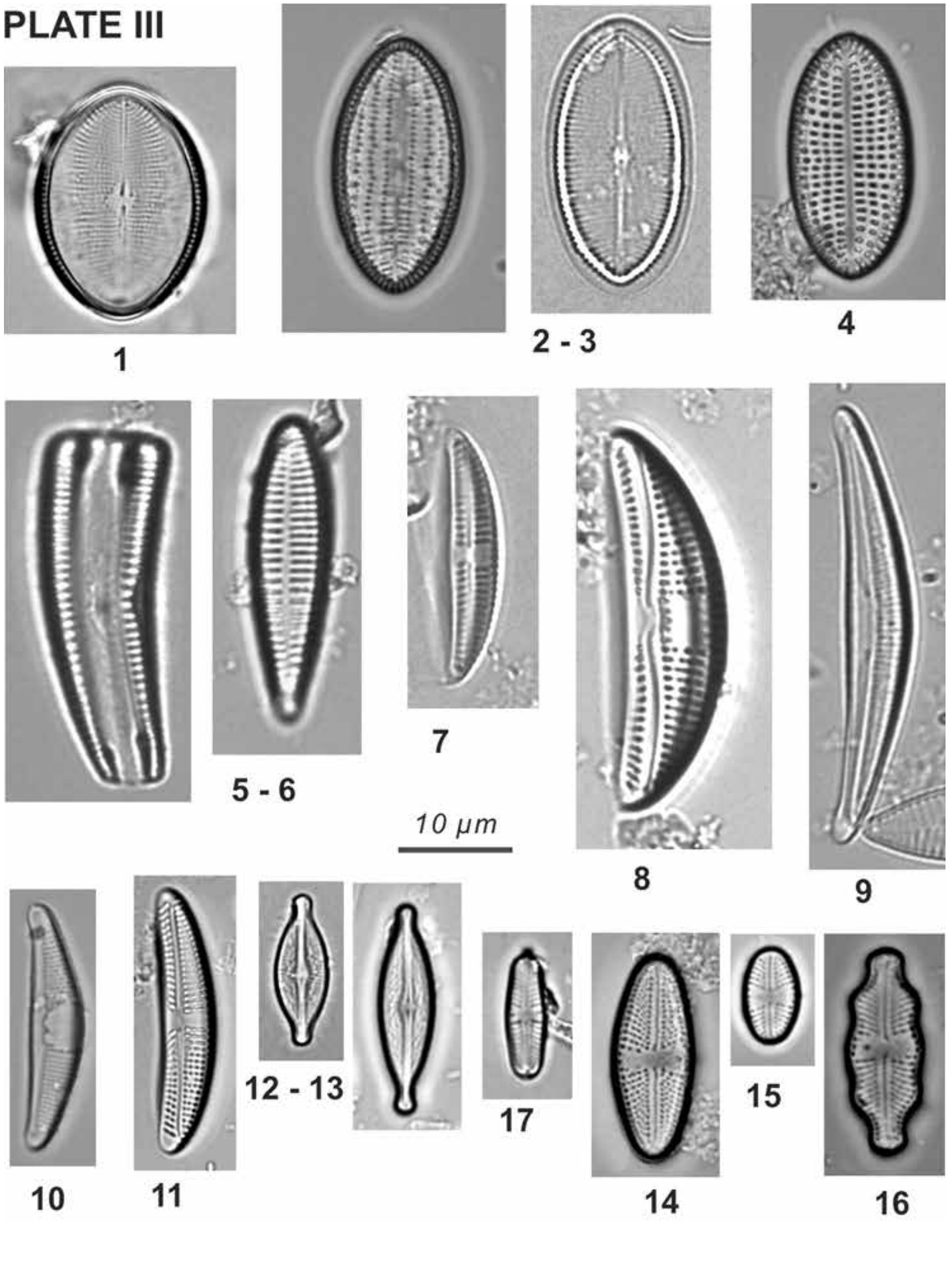


Plate IV: 1, *Mastogloia elliptica*; 2–3, 4?, *M. smithii*; 5, *Sellaphora pupula*; 6, *Caloneis* aff. *macedonica*; 7, *C. macedonica*; 8, *C. silicula*; 9–10, *C. lancettula*; 11, *Caloneis fontinalis*; 12, *Pinnularia obscura*; 13, *Craticula halophila*; 14, *C. cuspidata*; 15–16, *Craticula* cf. *Buderi* ?? (10, from Çajupi springs, the rest from Benja thermal springs, Permeti). – Tafel IV: 1, *Mastogloia elliptica*; 2–3, 4?, *M. smithii*; 5, *Sellaphora pupula*; 6, *Caloneis* aff. *macedonica*; 7, *C. macedonica*; 8, *C. silicula*; 9–10, *C. lancettula*; 11, *Caloneis fontinalis*; 12, *Pinnularia obscura*; 13, *Craticula halophila*; 14, *C. cuspidata*; 15–16, *Craticula* cf. *Buderi* ?? (10, aus Çajupi Quellen, der Rest von Benja Thermalquellen, Permeti).

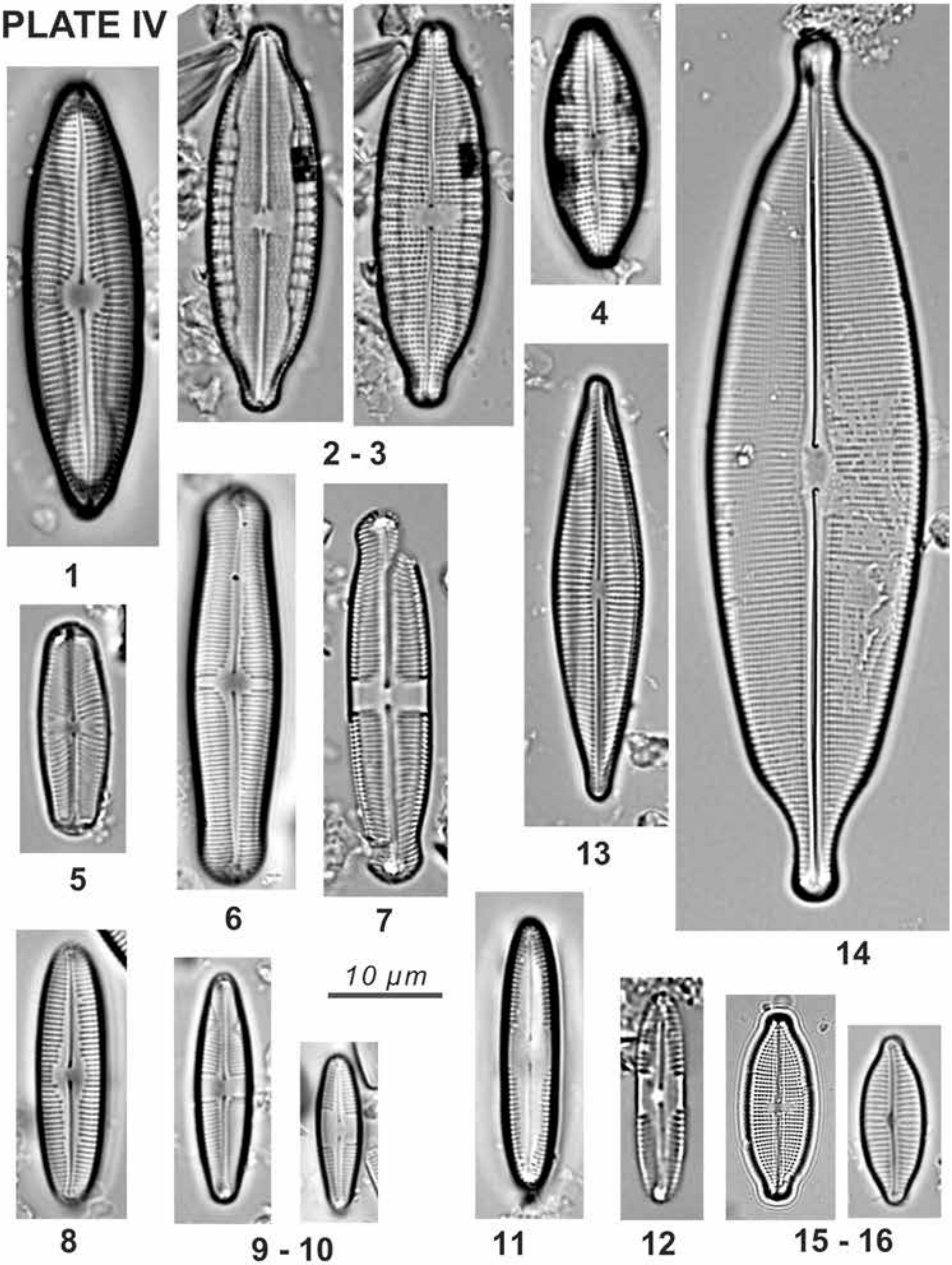


Plate V: 1, *Navicula* cf. *subrhynchocephala*; 2, *N. tripunctata*; 3, *N. dealpina*; 4, *N. jakovljevicii*; 5, *Navicula radiosa*; 6, *N. splendicula*; 7, *N. capitatoradiata*; 8–9, 16, *N. cincta*; 10–12, *N. cryptotenelloides*; 13, *N. cryptotenella*; 15, *N. veneta*; 15, *N. antonii* (from Benja thermal springs, Permeti). – Tafel V: 1, *Navicula* cf. *subrhynchocephala*; 2, *N. tripunctata*; 3, *N. dealpina*; 4, *N. jakovljevicii*; 5, *Navicula radiosa*; 6, *N. splendicula*; 7, *N. capitatoradiata*; 8–9, 16, *N. cincta*; 10–12, *N. cryptotenelloides*; 13, *N. cryptotenella*; 15, *N. veneta*; 15, *N. antonii* (von Benja Thermalquellen, Permeti).

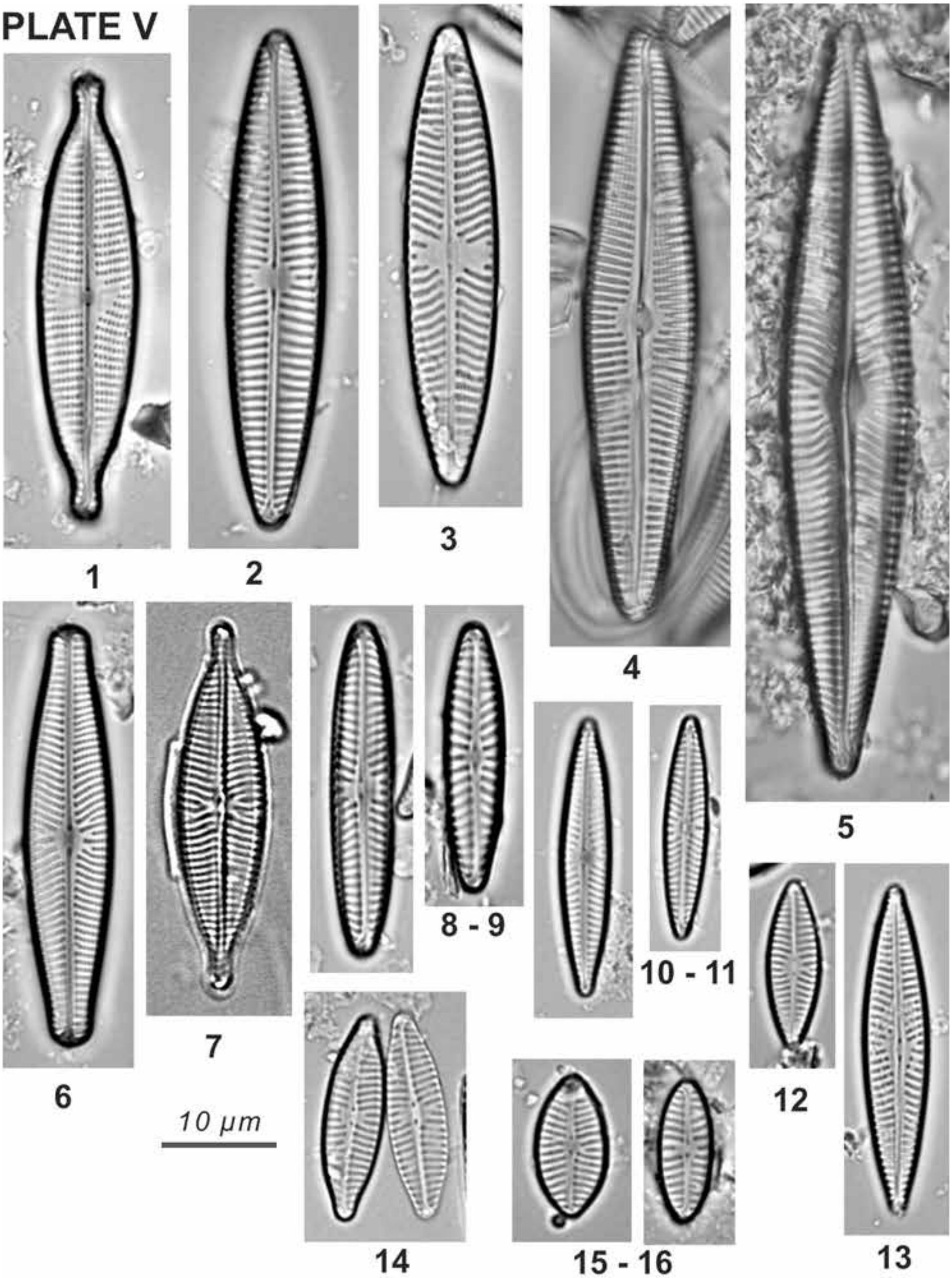


Plate VI: 1, *Gomphoneis transsilvanica*; 2, *Gomphonema truncatum*; 3, *G. acuminatum*; 4, *G. clavatum*; 5, *G. olivaceum*; 6, *G. sarcophagus*; 7, *G. parvulum*; 8, *G. tergestinum*; 9–10, *G. pumilum* var. *elegans*; 11–12, *G. pseudotenellum*; 13–14, *Encyonopsis microcephala*; 15, *E. descripta*; 16, *Navicula cryptocephala* ; 17, *Diploneis notabilis* (3, Viroi spring, Gjirokastra; 17, Zhuka, Vjosa river, Vlora; the rest from Benja springs, Permeti). – Tafel VI: 1, *Gomphoneis transsilvanica*; 2, *Gomphonema truncatum*; 3, *G. acuminatum*; 4, *G. clavatum*; 5, *G. olivaceum*; 6, *G. sarcophagus*; 7, *G. parvulum*; 8, *G. tergestinum*; 9–10, *G. pumilum* var. *elegans*; 11–12, *G. pseudotenellum*; 13–14, *Encyonopsis microcephala*; 15, *E. descripta*; 16, *Navicula cryptocephala* ; 17, *Diploneis notabilis* (3, Viroi Quelle, Gjirokastra; 17, Zhuka, Vjosa Fluss, Vlora; der Rest von Benja Thermalquellen, Permeti).

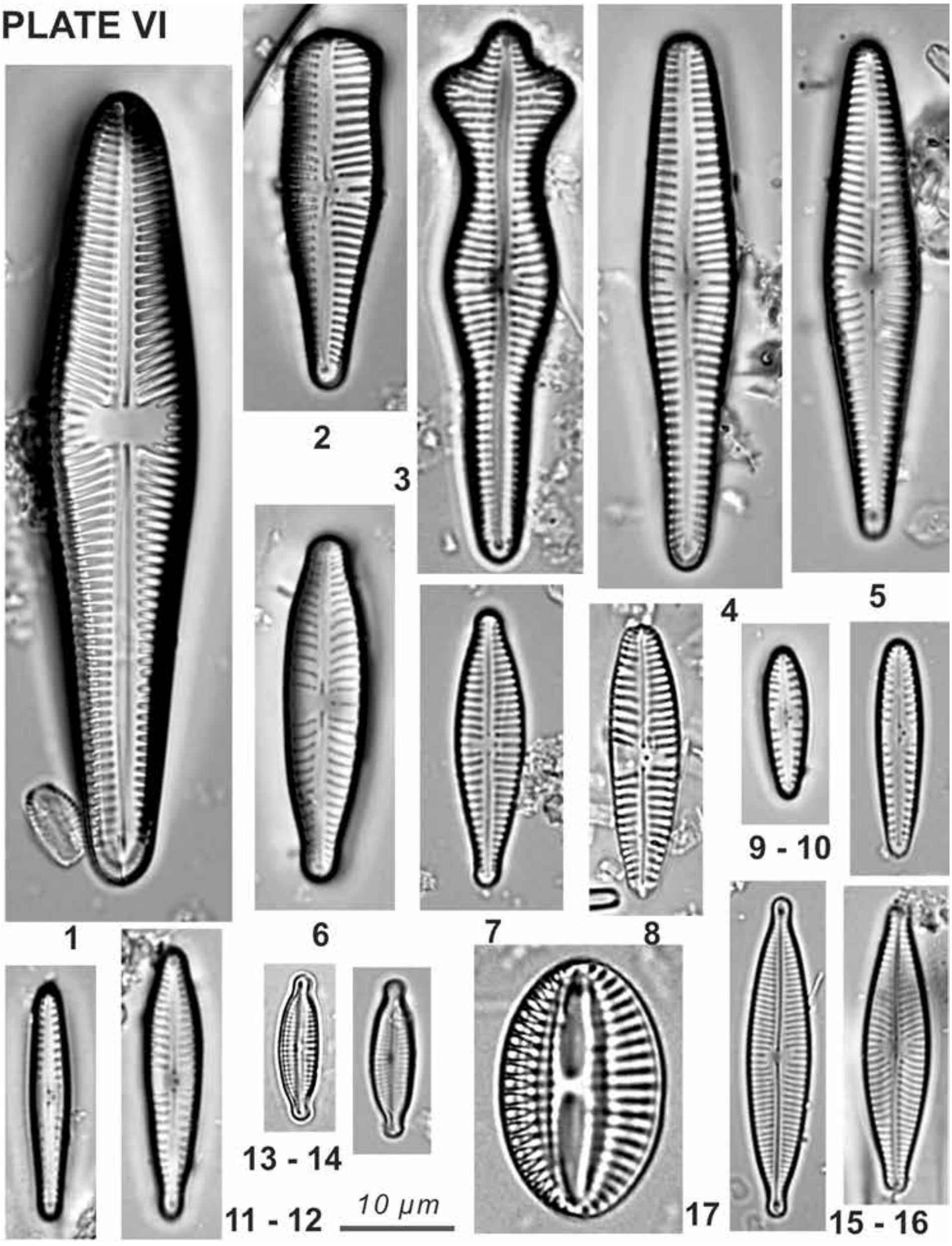


Plate VII: 1, *Encyonema prostratum*; 2, *Cymbella cistula*; 3–4, *Cymbopleura* cf. *diminuta*; 5, *Cymbella helvetica*; 6, *Cymbopleura amphicephala*; 7, *Cymbella affinis*; 8, *Encyonema silesiacum*; 9, *E. ventricosum*; 10, *Reimeria sinuata* (10, Mifoli, Vjosa river, Vlora; the rest from Benja thermal springs, Permeti). – Tafel VII: 1, *Encyonema prostratum*; 2, *Cymbella cistula*; 3–4, *Cymbopleura* cf. *diminuta*; 5, *Cymbella helvetica*; 6, *Cymbopleura amphicephala*; 7, *Cymbella affinis*; 8, *Encyonema silesiacum*; 9, *E. ventricosum*; 10, *Reimeria sinuata* (10, Mifoli, Vjosa Fluss, Vlora; der Rest von Benja Thermalquellen, Permeti).

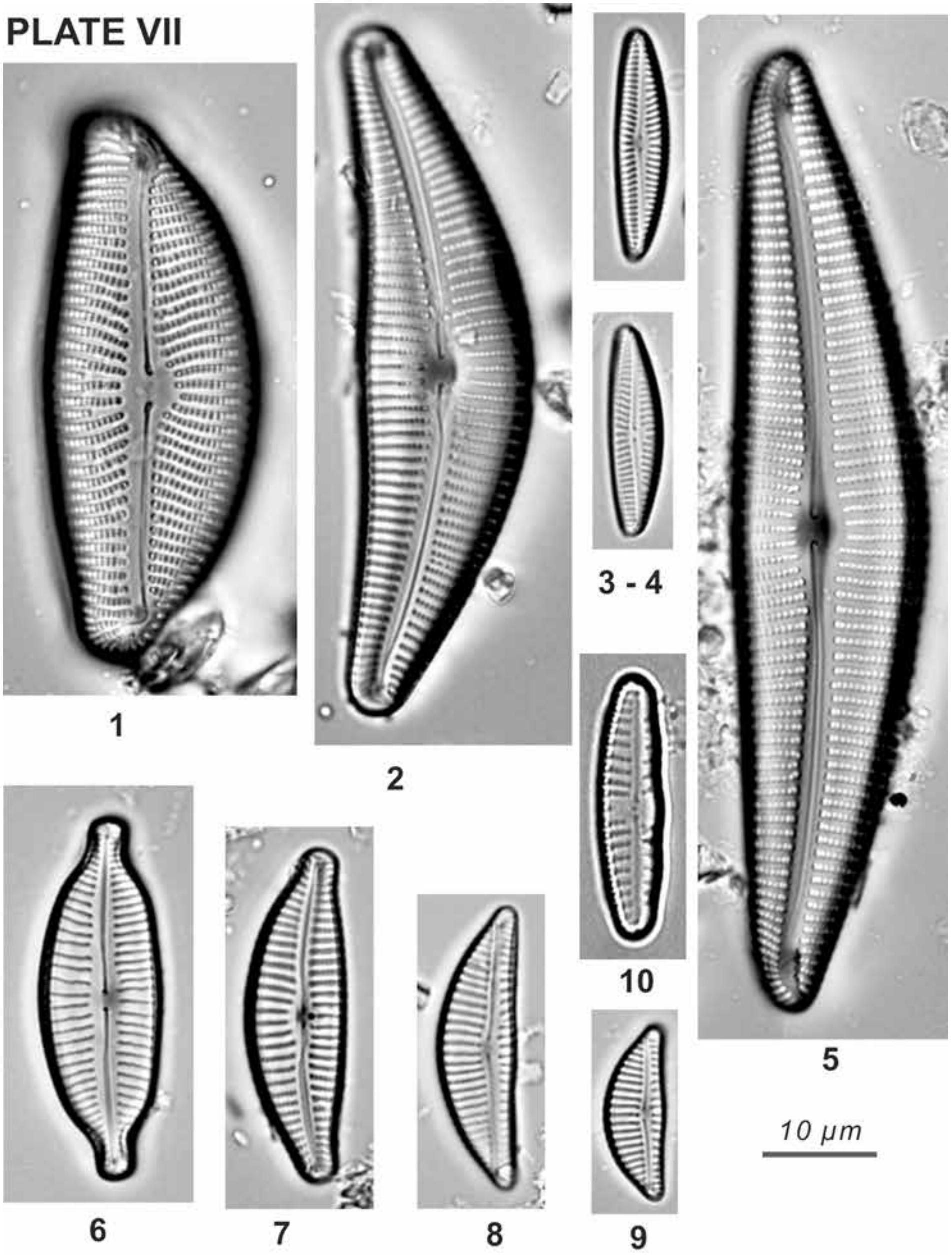


Plate VIII: 1, *Cymbella subhelvetica*; 2, *C. cantonati*; 3, *Cymbopleura incerta*; 4, *Delicata delicatula*; 5, *Gomphonema insigne*; 6, *Diploneis elliptica*; 7, *Neidium binodis*; 8, *Sellaphora bacillum*; 9–10, *Grunowia solgensis*; 11–12, *Denticula tennius*; 13–14, *Nitzschia incospicua*; 15, *Tryblionella apiculata* (5, 8, Viroi spring, Gjirokastra; 7, Lekli, Drino river, Tepelena; the rest from Benja thermal springs, Permeti). – Tafel VIII: 1, *Cymbella subhelvetica*; 2, *C. cantonati*; 3, *Cymbopleura incerta*; 4, *Delicata delicatula*; 5, *Gomphonema insigne*; 6, *Diploneis elliptica*; 7, *Neidium binodis*; 8, *Sellaphora bacillum*; 9–10, *Grunowia solgensis*; 11–12, *Denticula tennius*; 13–14, *Nitzschia incospicua*; 15, *Tryblionella apiculata* (5, 8, Viroi Quelle, Gjirokastra; 7, Lekli, Drino Fluss, Tepelena; der Rest von Benja Thermalquellen, Permeti).

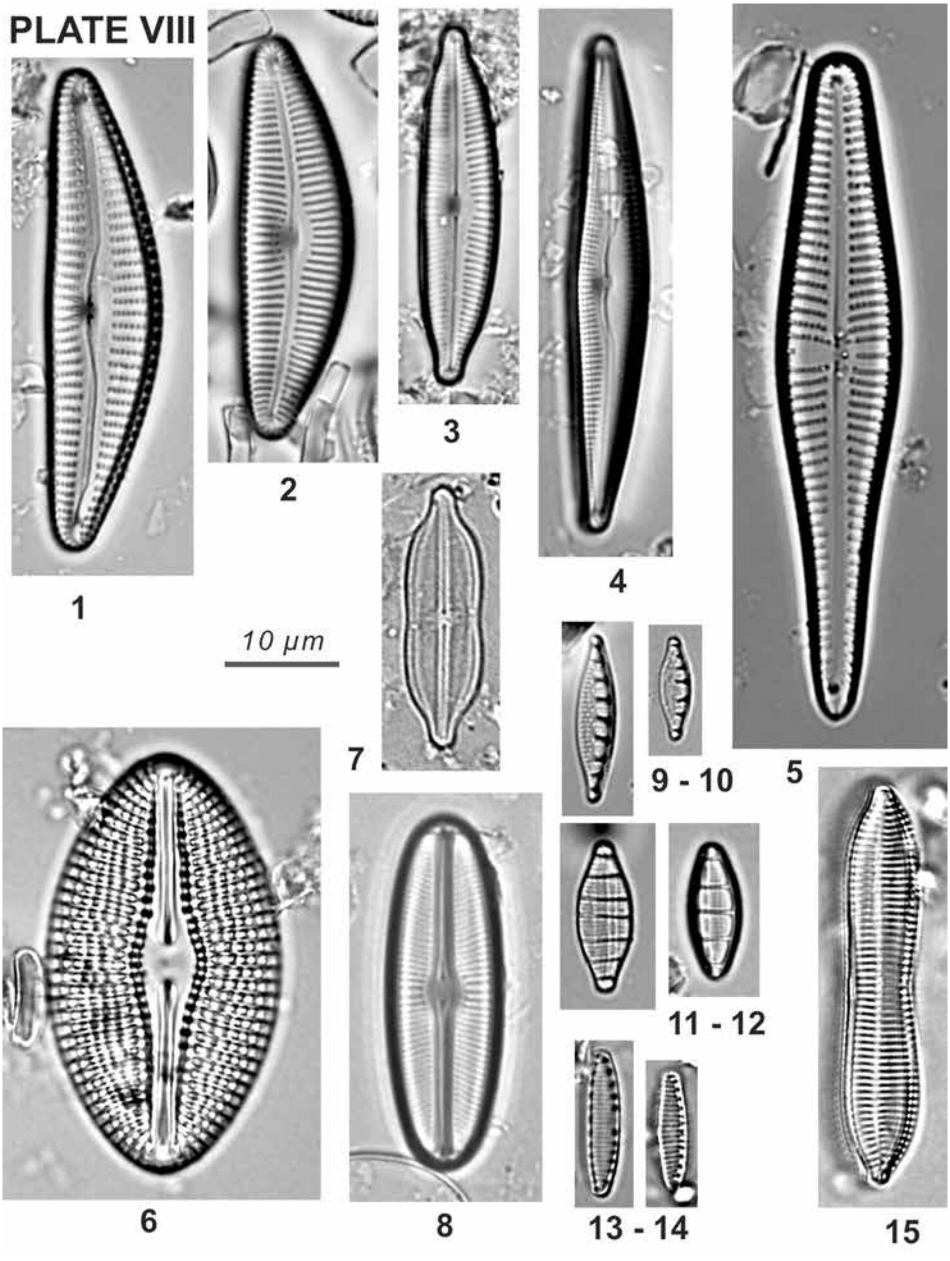


Plate IX: 1, *Gyrosigma nodiferum*; 2, *G. scalproides*; 3, *Nitzschia linearis*; 4, *N. gracilis*; 5, *N. intermedia*; 6, *Nitzschia* cf. *bremensis*; 7, *N. amphibia*; 8, *N. dissipata*; 9, *N. palea*; 10–11, *N. elegantula*; 12, *N. fonticola*; 13, *N. solita*; 14, *N. clausii* (from Benja thermal springs, Permeti). – Tafel IX: 1, *Gyrosigma nodiferum*; 2, *G. scalproides*; 3, *Nitzschia linearis*; 4, *N. gracilis*; 5, *N. intermedia*; 6, *Nitzschia* cf. *bremensis*; 7, *N. amphibia*; 8, *N. dissipata*; 9, *N. palea*; 10–11, *N. elegantula*; 12, *N. fonticola*; 13, *N. solita*; 14, *N. clausii* (von Benja Thermalquellen, Permeti).

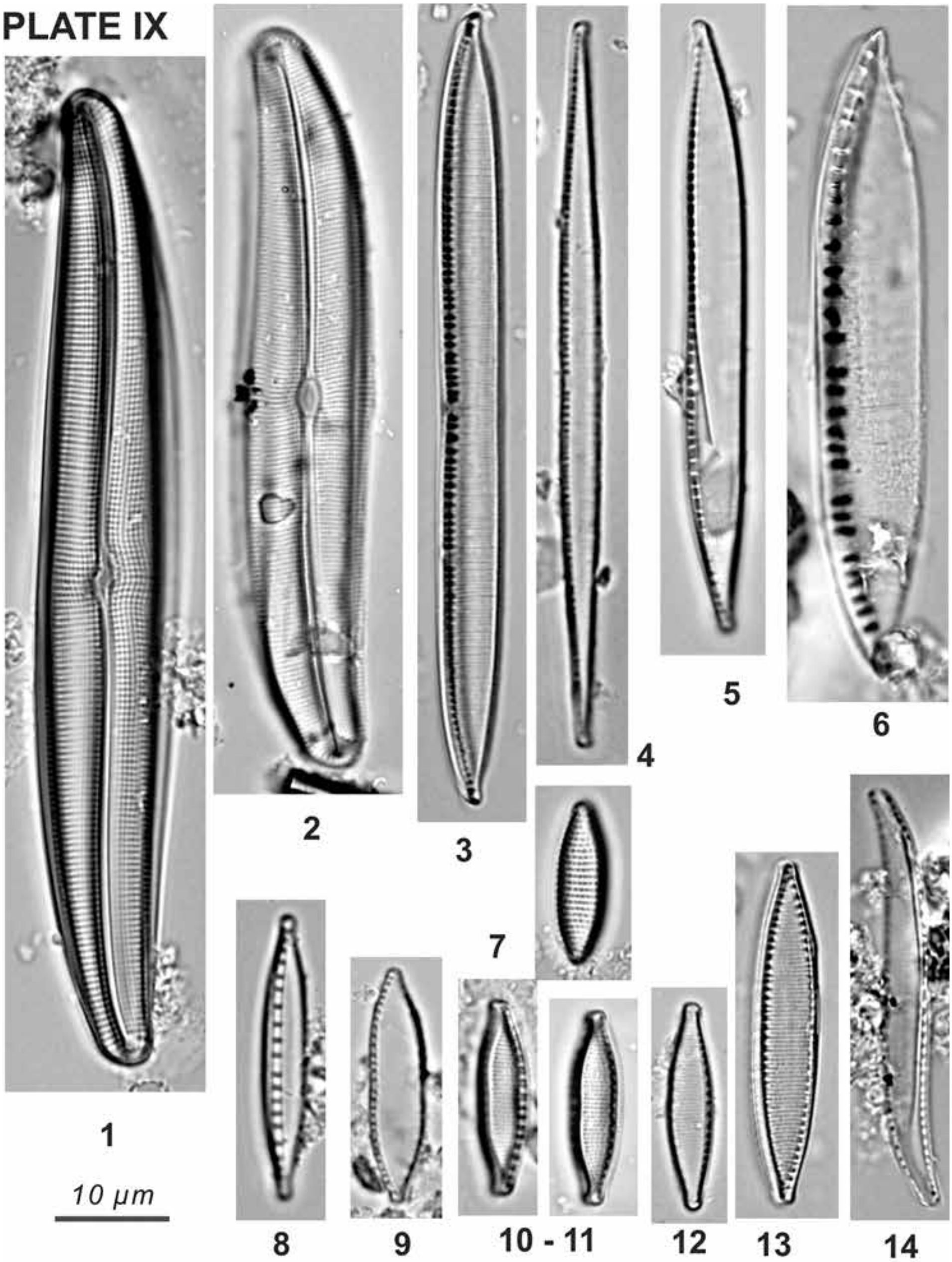
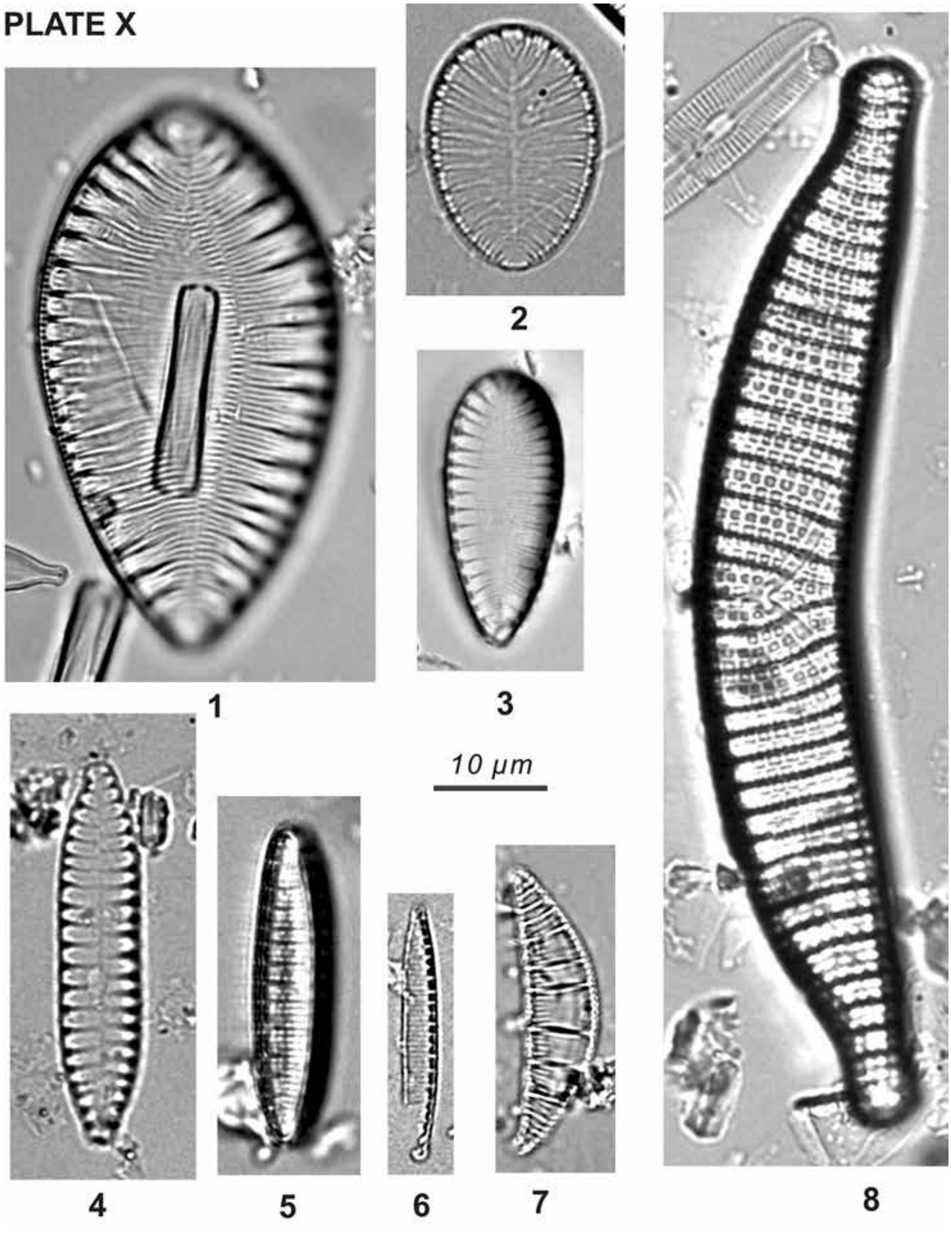


Plate X: 1, *Surirella ovalis*; 2, *Surirella brebissonii*; 3, *S. brebissoni* var. *kuetzingii*; 4, *S. angusta*; 5, *Nitzschia denticula*; 6, *N. perminuta*; 7, *Rhopalodia brebissonii*; 8, *Epithemia adnata* (2, Lekli, Drino river, Tepelena; 3, 8, Çajupi spring, Gjirokastra; 5, Mifoli, Vjosa river, Vlora; 6, Kordhoca, Drino river, Gjirokastra; the rest from Benja thermal springs, Permeti). – Tafel X: 1, *Surirella ovalis*; 2, *Surirella brebissonii*; 3, *S. brebissoni* var. *kuetzingii*; 4, *S. angusta*; 5, *Nitzschia denticula*; 6, *N. perminuta*; 7, *Rhopalodia brebissonii*; 8, *Epithemia adnata* (2, Lekli, Drino Fluss, Tepelena; 3, 8, Çajupi Quelle, Gjirokastra; 5, Mifoli, Vjosa Fluss, Vlora; 6, Kordhoca, Drino Fluss, Gjirokastra; der Rest von Benja Thermalquellen, Permeti).



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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).

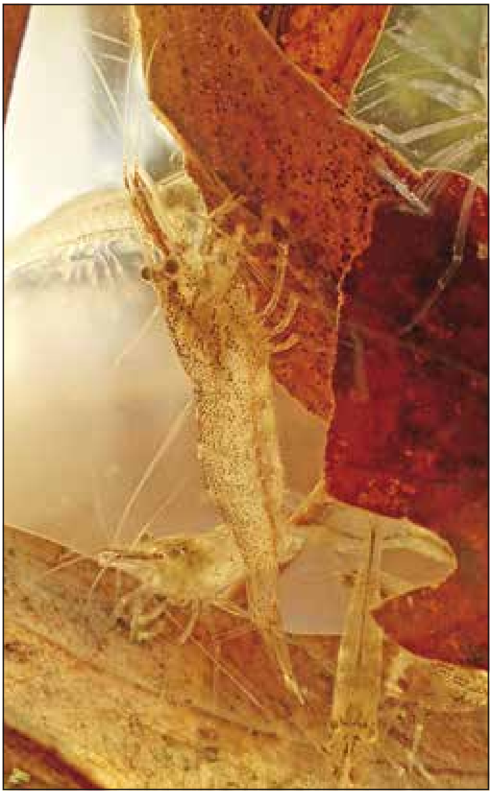

Fig. 6: *Atyaephyra thyamisensis* (Crustacea: Decapoda). – Abb. 6: *Atyaephyra thyamisensis* (Crustacea: Decapoda).

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-

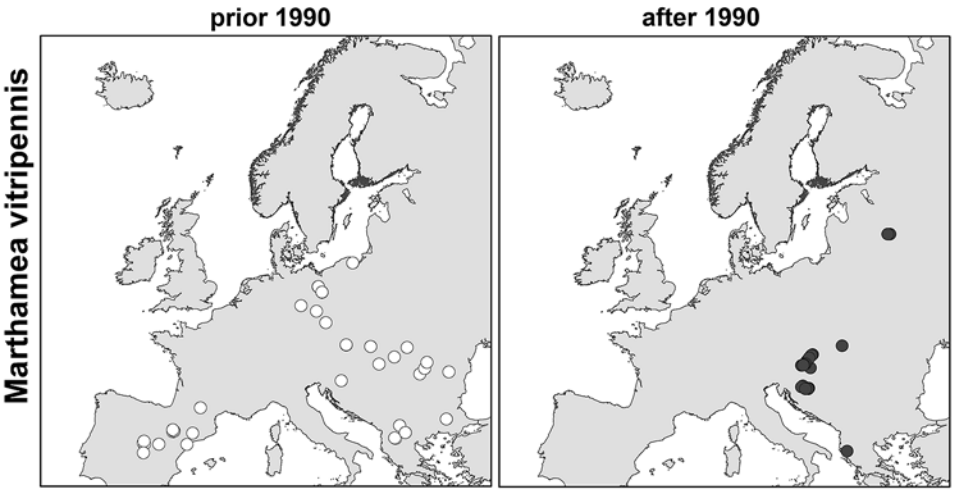

Fig. 7: Location of records of *Marthamea vitripennis* prior to 1990 (left) and after 1990 (right) (Graf et al. 2016). – Abb. 7: Nachweise von *Marthamea vitripennis* vor 1990 (links) und nach 1990 (rechts) (Graf et al. 2016).

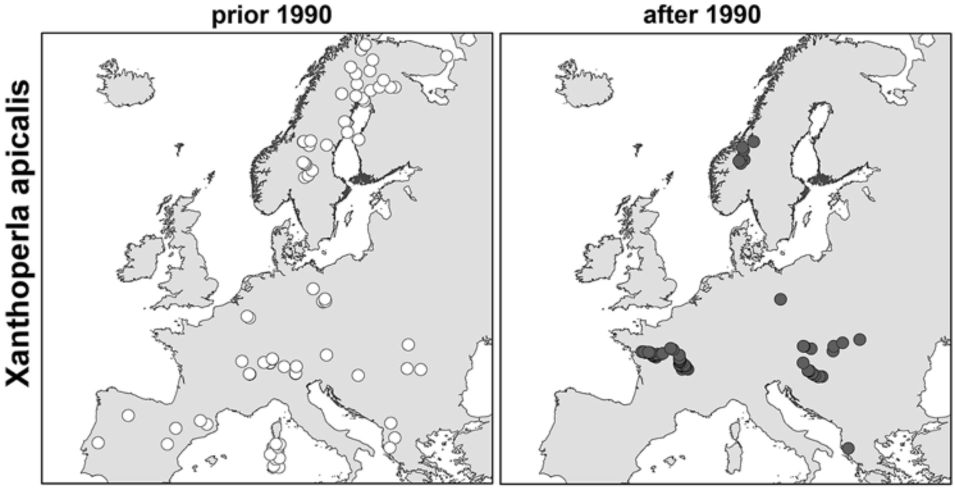

Fig. 8: Location of records of *Xanthoperla apicalis* prior to 1990 (left) and after 1990 (right) (Graf et al. 2016). – Abb. 8: Nachweise von *Xanthoperla apicalis* vor 1990 (links) und nach 1990 (rechts) (Graf et al. 2016).

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.

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Mayflies (Ephemeroptera) of the River Vjosa, Albania

Ernst Bauernfeind

Ephemeroptera material (larvae and winged stages) from the lower course of the River Vjosa (Vjosë), Albania, was collected during several collecting trips between 2014–2017 by different working groups. A total of 34 taxa, 23 of them new for the mayfly fauna of Albania, were identified. The presence of several rare and highly sensitive taxa (e.g., *Prosopistoma pennigerum*) as well as the high species diversity confirm the exceptional importance of the River Vjosa not only for Albania but also in a European context.

Bauernfeind E., 2018: Eintagsfliegen (Ephemeroptera) der Vjosa, Albanien. Während mehrerer Exkursionen am Unterlauf des Flusses Vjosa (Vjosë), Albanien, wurden zwischen 2014–2017 von verschiedenen Arbeitsgruppen Eintagsfliegen (Ephemeroptera) in allen Stadien (Larven, Subimagines, Imagines) gesammelt. Insgesamt konnten 34 Taxa identifiziert werden, von denen 23 neu für die Fauna Albaniens sind. Das Auftreten mehrerer seltener und hoch empfindlicher Arten (z. B. *Prosopistoma pennigerum*), sowie die insgesamt hohe Diversität bestätigen eindrucksvoll die herausragende Bedeutung des Vjosa Flußsystems nicht nur für Albanien sondern ebenso in einem gesamteuropäischen Kontext.

Keywords: Ephemeroptera, mayflies, River Vjosa, Vjosë, Albania.

Introduction

Mayflies (order Ephemeroptera) are pterygote hemimetabolous insects with aquatic larvae almost exclusively inhabiting freshwater habitats (rarely brackish waterbodies), where they occupy a wide variety of niches from the crenalic to the potamalic river sections. Larvae are mostly grazers-scrapers and collectors-gatherers, while some specialised taxa developed active and passive filter feeding and (rather exceptionally) predaceous habits. The presence of a subimaginal winged instar, characteristic for Ephemeroptera, is unique within recent pterygote insects.

Larval communities may reach high densities (up to 3,000–6,500 ind./m^2 river bottom; Ide 1940, Williams 1980) and exhibit considerable species richness in ecologically undisturbed rivers (Bauernfeind & Moog 2000). They represent essential elements in most benthic communities, regarding nutrient cycling and trophic transfers (Ferro & Sites 2007). Together with Plecoptera and Trichoptera (EPT-taxa) they are considered to represent valuable indicators for various environmental parameters and, accordingly, are used for the assessment and long-term monitoring of biological water quality (Buffagni et al. 2001, Moog & Hartmann 2017).

The mayfly fauna of Albania is still poorly known (Sartori 2001, 49). Approximately 370 nominal species of Ephemeroptera are so far known for Europe (Bauernfeind & Soldán 2012), about 130 taxa have been recorded from the Balkans (Puthz 1978, Puthz 1980, Zabrić & Sartori 1997, Bauernfeind 2003, Kovács & Murányi 2013, Ćuk et al. 2015, Petrović et al. 2015, Vilenica et al. 2015), including 32–35 for Albania (Puthz 1980, Kovács & Murányi 2013). The compilation of Ephemeroptera species for Albania in Hershkovitz et al. (2015, electronic version), listing 133 taxa, is not based on published country records or reference specimens and is therefore of rather limited value; its inferences to the supposed vulnerability of mayfly taxa to climate change have been drawn from insufficient – and partly erroneous – data. No records of Ephemeroptera on species level have been published so far for the River Vjosa, but an overview on family and genus level has been provided by Beqiraj et al. (2008) and Chatzinikolaou et al. (2008). The present investigation increases the number of Ephemeroptera taxa recorded in Albania to 56 (plus 3 unconfirmed records), 34 of them recorded at the river Vjosa.

Identification of mayfly taxa in the Balkans is often problematic and we are still far from a thorough understanding of Ephemeroptera taxonomy in this area. Many taxa are only known from original descriptions that are inadequate for modern taxonomic standards, and in several cases only a single stage (larva or adult) has been described. The frequently used keys constructed for the identification of West European (Elliott & Humpesch 1983, Elliott & Humpesch 2010) and Central European mayflies (Studemann et al. 1992, Bauernfeind & Humpesch 2001, Bauernfeind & Lechthaler 2014) do not include taxa endemic to the Balkans and unsophisticated use in this area may easily lead to misidentifications.

Study area

The area under investigation was the Vjosa riverine floodplain in southwestern Albania. Collecting sites were situated around the villages Kashisht (40°35'N 19°32'E), Poçemi (40°30'N 19°43' E), Kuta (Kutë, 40°23'N 19°43'E) and in the tributary Drino River near its union with the Vjosa, 3 km southeast Tepelena (Tepelenë, ca. 40°16'N 20°03'E). Habitat types sampled for larvae included the main channel, side channels, erosion pools, and oxbows. Imagines were collected mainly from open gravel, pioneer vegetation, and riparian wetlands. Field trips were conducted on 14.6.2014, 8.10.2016, 24.4.-26.4.2017, 17.9.-23.9.2017 and 6.10.-8.10.2017.

Material and Methods

Winged specimens (subimagines, imagines) were collected by sweep net and larvae were collected by live-sorting benthic samples taken with a 500µm net. Specimens were fixed and stored in 75% ethanol, permanent microscopical slides were prepared for most taxa (standard preparation after Müller-Liebenau 1969, 11), mounting medium Liquid de Faure, modification after Kühnelt (Adam & Czihak 1964, 163). The material was deposited at the Natural History Museum Vienna, Austria (Naturhistorisches Museum Wien, NHM). Some voucher specimens were deposited at the University of Natural Resources and Life Sciences Vienna, Austria (Universität für Bodenkultur, BOKU). Nomenclature follows Bauernfeind & Soldán (2012).

Results

Tab. 1: Species list – taxa collected. Abbreviations: L – larva, N – nymph (= last instar larva), ♂– male imago, ♀ – female imago, SI – subimago, **+** – endemic to the Balkans, X – new for Albania. See figures 1–4. – Tab. 1: Liste der gesammelten Arten. Abkürzungen: L – Larve, N – Nymphe (= schlüpfreifes letztes Larvenstadium), ♂– Männchen Imago, ♀ – Weibchen Imago, SI – Subimago, **+** – Balkanendemit, X – neu für Albanien. Siehe Abbildungen 1–4.

Siphlonuridae Ulmer, 1920 (1888)			
Siphlonurus (*Siphlonurus*) *lacustris* Eaton, 1870	L, N		
Baetidae Leach, 1815			
Baetis (*Baetis*) sp. nov. (near *Baetis nexus* Navás, 1918)	L	+	X
Baetis (*Baetis*) *beskidensis* Sowa, 1972	L, N, ♂		X
Baetis (*Baetis*) ? *lutheri* Müller-Liebenau, 1967	L, N, SI, ♀		X
Baetis (*Baetis*) *meridionalis* Ikonomov, 1954	L, N	+	
Baetis (*Nigrobaetis*) *muticus* (Linnaeus, 1758)	L		
Baetis (*Rhodobaetis*) *rhodani* (F.J. Pictet, 1843)	L		
Centroptilum luteolum (O. F. Müller, 1776)	L		
Cloeon (*Cloeon*) *dipterum* (Linnaeus, 1761)	L, ♂,♀		
Procloeon (*Procloeon*) *bifidum* (Bengtsson, 1912)	L, N		X
Procloeon (*Pseudocentroptilum*) ? *romanicum* (Bogoescu, 1951)	L	+	X
Procloeon (*Pseudocentroptilum*) *pennulatum* (Eaton, 1870)	L, N		X
Oligoneuriidae Ulmer, 1914			
Oligoneuriella rhenana (Imhoff, 1852)	L		
Heptageniidae Needham, 1901			
Ecdyonurus (*Ecdyonurus*) *aurantiacus* (Burmeister, 1839)	L, N, SI, ♂,♀		
Ecdyonurus (*Ecdyonurus*) *puma* Jacob & Braasch, 1986	L, N, SI, ♂,♀	+	X
Heptagenia (*Heptagenia*) *longicauda* (Stephens, 1836)	L, N		X
Heptagenia (*Heptagenia*) *sulphurea* (O.F. Müller, 1776)	L		
Rhithrogena neretvana Tanasijević, 1985	N, ♂	+	X
Rhithrogena bulgarica Braasch, Soldán & Sowa, 1985	L, N	+	X
Rhithrogena zernyi Bauernfeind, 1991	♂	+	X
Leptophlebiidae Banks, 1900			
Choroterpes (*Choroterpes*) *picteti* (Eaton, 1871)	L		X
Habrophlebia eldae Jacob & Sartori, 1984	L, N, ♂,♀		X
Paraleptophlebia submarginata (Stephens, 1836)	L		X
Ephemerellidae Klapálek, 1909			
Ephemerella ignita (Poda, 1761)	L, SI, ♂,♀		
Ephemerella maculocaudata Ikonomov, 1961	L, ♀	+	X
Serratella ikonomovi (Puthz, 1971)	L	+	
Torleya major (Klapálek, 1905)	L		X
Caenidae Newman, 1853			
Brachycercus (?) *harrisellus* Curtis, 1834	L		X
Caenis macrura Stephens, 1836	N, ♂		X
Caenis pseudorivulorum Keffermüller, 1960	N, ♂		X
Caenis pusilla Navás, 1913	L, N		X
Caenis rivulorum Eaton, 1884	L		X
Neoephemeridae Traver, 1935			
Neoephemera maxima (Joly, 1870)	L		X
Prosopistomatidae Laméere, 1917			
Prosopistoma pennigerum (O.F. Müller, 1785)	L		X

Fig. 1: *Ecdyonurus aurantiacus* ♂ Subimago (W. GRAF phot.).

Fig. 2: *Ecdyonurus aurantiacus* ♂ Imago (W. GRAF phot.).

Fig. 3: *Ephemerella maculocaudata* ♀ Imago (G. KUNZ phot.).

Fig. 4: *Ephemerella ignita* ♀ Imago with egg sac. – Abb. 4: *Ephemerella ignita* ♀ Imago mit Eiballen (G. KUNZ phot.).

Discussion

Remarks on identification: *Baetis* (*Baetis*) sp. nov. (near *Baetis nexus* NAVÁS, 1918). The new taxon appears closely related to *Baetis nexus* NAVÁS (=*Baetis pentaphlebodes* UJHELYI, 1966 sensu MÜLLER-LIEBENAU, 1969) in the larval stage, characterised i.a. by numerous strong conical bristles on abdominal sterna, but differs in some respects (e.g., setation of femora, details of mouthparts; the outer maxillary incisor group closely resembling the situation in *Baetis liebenauae* KEFFERMÜLLER, 1974). A formal description, however, should be based on more complete material including the winged stages.

Baetis (*Baetis*) *beskidensis* SOWA, 1972. Larvae closely resemble *B. fuscatus* (LINNAEUS, 1761) but differ in the structure of both mandibles (a small subapical tooth on outer margin of outer incisor group). In male imagines, turbinate eyes rather greenish-yellow (bright lemon yellow in *B. fuscatus*). The taxon was originally described from the eastern part of the Polish Carpathians; subsequent records include Slovakia (Deván 1991), Ukraine (Godunko & Kovács 2008), and Romania (Kovács & Murányi 2013).

Baetis (*Baetis*) ? *lutheri* Müller-Liebenau, 1967. The material from the Vjosa differs slightly from central European specimens, reminding in some respects of *Baetis* (*B.*) *mirkae* Soldán & Godunko, 2008 (e.g., a tendency towards strong reduction of segments of the terminal filament). Differences, however, may still be considered to fall within the variation of nominal *Baetis lutheri* Müller-Liebenau.

Procloeon (*Pseudocentroptilum*) ? *romanicum* (Bogoescu, 1951). Differences between *Procloeon* (*P*). *nana* (Bogoescu, 1951) and *P.* (*P.*) *romanicum* (Bogoescu, 1951) are rather small, and the latter has frequently been considered to represent a junior subjective synonym of the former. No imaginal material was available and identification of the material from the Vjosa must be considered provisional. For a more detailed discussion see Bauernfeind & Soldán (2012: 214 ff.).

Ecdyonurus (*Ecdyonurus*) *puma* Jacob & Braasch, 1986. The taxon was so far only known from the R. Morača, Montenegro. In all stages rather closely resembling *Ecdyonurus* (*E.*) *ruffii* Grandi, 1953. Variation and several details of taxonomic characters are so far, however, only imperfectly known for both taxa.

Rhithrogena neretvana Tanasijević, 1985. The taxon belongs to the *Rhithrogena alpestris* species-group and has so far only been known from the lower course of the River Neretva, Bosnia-Hercegovina. Larval characters have thus far not been described.

Rhithrogena bulgarica Braasch, Soldán & Sowa, 1985. The taxon belongs to the *Rhithrogena diaphana* species-group and has so far only been known from Bulgaria and Greece. Larvae, however, closely resemble *Rhithrogena savoiensis* Alba-Tercedor & Sowa, 1987 and may sometimes have been confused (see also discussion in Vilenica et al. 2015, 121). In male last instar larvae, the characteristic short, broad, and strongly curved titillator is usually already well discernible.

Rhithrogena zernyi Bauernfeind, 1991. The taxon belongs to the *Rhithrogena diaphana* species-group and has so far only been known from its type locality (Mostar) in Bosnia-Hercegovina. Larval characters have thus far not been described. Colouration pattern and shape as well as size of titillator are characteristic for male imagines.

Brachycercus (?) *harrisellus* Curtis, 1834. Only a single young larva was collected, and characters separating *B. harrisellus* from *Brachycercus europaeus* were not yet sufficiently developed to allow for unambiguous identification.

Aspects concerning distribution, ecology, and conservation: From a distributional point of view, the Ephemeroptera taxa collected from the River Vjosa may easily be divided into three groups: (**1**) taxa endemic to the Balkans (see table 1), (**2**) potamalic taxa characteristic for large rivers and formerly widely distributed throughout Europe (*Choroterpes picteti*, *Brachycercus harrisellus,* [?] *Caenis pusilla*) or the Western Palaearctic (*Heptagenia longicauda*, *Neoephemera maxima*, *Prosopistoma pennigerum*), and (**3**) comparatively common taxa occupying a rather wide range of habitats throughout the Western Palaearctic (*Siphlonurus lacustris*, *Baetis muticus*, *B. rhodani*, *Centroptilum luteolum*, *Procloeon bifidum*, *Paraleptophlebia submarginata*, *Torleya major*), Palaearctic (*Procloeon bifidum*, *Heptagenia sulphurea*, *Ephemerella ignita*, *Caenis macrura*, *C. pseudorivulorum*, *C. rivulorum*), or even Holarctic realm (*Procloeon pennulatum*, [?] *Cloeon dipterum*). Among the Ephemeroptera taxa collected, the second group is obviously restricted to highly dynamic large rivers. The species united in this group have vanished from most localities of their former occurrence following river degradation caused by human activities, especially by changes in water discharge, flow regime, and sediment budget, which gravely influence the originally highly dynamic habitat turnover (including fast changes in habitat structure). These taxa must clearly be recognised as most vulnerable and therefore represent excellent indicators of ecological integrity (in the potamalic river section). Ephemeroptera species richness in the Vjosa appears exceptionally high compared with other rivers in Europe, again emphasising the outstanding importance of this river system in terms of nature conservation.

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Fishes of the River Vjosa – an annotated Checklist

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Based on a combination of intensive fieldwork for a period of thirteen years (2004–2017), literature review and review of museum specimens, we hereby provide an updated checklist of the fishes of Albanian part of River Vjosa. Our results show that there are at least 31 species of fishes inhabiting the river system, of which 27 are native, including eight species endemic to the Balkans. With 11 species, *Cyprinidae* are by far the most specious family, followed by *Mugilidae* (five). *Salmonidae* and *Acipenseridae* are represented by 2 species each. The remaining ten families are represented by a single species. At least four species (*Pseudorasbora parva*, *Oncorhynchus mykiss*, *Carassius sp.*, *Gambusia holbrooki)* were introduced into the Vjosa basin. The provided list includes the distribution of each species in River Vjosa, as well as annotations referring to introductions, taxonomic-and their conservation status.

Shumka S., Meulenbroek P., Schiemer F. & Šanda R., 2018: Die Fische des Vjosa Fluss-Systemes – eine kommentierte Checkliste.
Die vorliegende Checkliste der Fische der Vjosa basiert auf Felduntersuchungen über eine Periode von 13 Jahren (2004-2017), einer kritischen Literaturanalyse und dem Studium von Belegmaterial in Museen. 31 Arten konnten für die Vjosa belegt werden. Von den 27 autochthonen Arten sind 8 Arten endemisch für den Balkan. Cyprinidae sind mit 11 Arten die umfangreichste Gruppe, gefolgt von Mugilidae (5 Arten), sowie Salmonidae und Acipenseridae mit jeweils 2 Arten. Mindestens 4 Arten, (*Pseudorasbora parva*, *Oncorhynchus mykiss*, *Carassius spp.,Gambusia holbrooki) wurden eingesetzt.* Die Liste gibt Angaben über die Verteilung in der Vjosa, sowie Hinweise über Herkunft, taxonomischen Status und Naturschutz Status der einzelnen Arten.

Keywords: Checklist, native species, threatened species, marine, freshwater, lagoon.

Introduction

According to the criteria for large rivers Annex II of the WFD (European Commission, 2000), the Vjosa, with a catchment area of 6710 km2, is a large transboundary river in the South Balkan Peninsula (Schwarz 2012,). It is the only river that originates in Greece and descends to Albania with its estuary in the Adriatic Sea. The hydrological regime of the river reflects the Mediterranean climate of its basin with characteristic discharge extremes in late summer-autumn and in late winter-spring (Lazaridou-Dimitriadou et al. 2002, Schiemer et al. 2018 this volume).

This contribution provides a complete list of fish species inhabiting RiverVjosa and its tributaries, including lower river reaches, adjacent channels, and brackish waters of Narta Lagoon and associated human constructed water connections. All the data excluding species of the genus *Acipenser* and lamprey are first and last author's data collection in the period of 2004-2017, so there is a combination of own and published data. The intention is to produce an annotated list that can be regularly updated and reviewed based on new surveys and experts opinion. This list is an important prerequisite for biodiversity conservation purposes and management decisions for one of the last geomorphologically intact river systems threatened by plans for the construction of hydropower dams and other human pressures. Our contribution provides data on zoogeographical distribution based on original records, specific biology patterns of individual species and several validations of fish names and taxonomic clarifications necessary due to changes during the last decade. The list contains standardized information on species' taxonomy, distribution, habitat, and conservation status, while it also helps to interpret nomenclature and taxonomic problems.

The River Vjosa fish fauna is of particular importance as a national heritage, due to its diversity and high degree of endemism, which is clearly demonstrated by the present publication. The species diversity is mainly the result of the complex geological and climatic condition, that allowed intensive colonization from outside the area and diverse freshwater and transitional habitats. Further there is an intersection among the biogeographical regions of southeastern Europe and Mediterranean Basin.

Research on the Albanian fish fauna, including first investigations of River Vjosa started with the pioneering works of Poljakov et al. (1958), Rakaj (1995) and Dhora (2010). The latter publication is also the first and only available checklist of Albanian freshwater fishes.

Although the knowledge and understanding of the diversity and distribution patterns of freshwater fishes in most of the European Mediterranean has increased considerably, the freshwater fish fauna of Albania is still poorly known. Whereas for the surrounding areas updated information exists (Mrakovčić et al. 2006, Economou et al. 2007) such data on Albanian species are missing, apart from recent publications on loaches (Cobitidae and Nemacheilidae) (Šanda et al. 2008), salmonids (Snoj et al. 2009) and barbels (genus *Barbus*; Cyprinidae) (Marková et al. 2010). The only available sources of information are the general works of Poljakov et al. (1958) who included 36 freshwater species and Rakaj (1995) listing 77 species. The difference between the coverage in these two publications is probably in part due to inclusion of newly introduced species, but more so by changes in the taxonomic status of many species. The deficiency in the knowledge of the diversity of freshwater fishes of Albania has been confirmed by recent descriptions of many new species from the area (Economidis 2005, Kovačić & Šanda 2007, Miller & Šanda 2008, Zupančič et al. 2010, Bogutskaya et al. 2010).

Material and methods

The species in the following list are compiled based on two different sources of information: the data supplemented by old and more recent publications dealing with species present in the area and the first and last author surveys conducted from 2004 to 2017. Voucher specimens are deposited in the Agricultural University of Tirana and National Museum, Prague. The previously published data from Poljakov et al. (1958) and Rakaj (1995) are taken as a baseline. In addition, information on fish distribution in FishBase was evaluated (Froese & Pauly 2015). Additional fish records published during the last decade were added, and some doubtful species appearing in previous publications were evaluated, and either verified or excluded from the present list. We follow the family classification of Van der Laan et al. (2014), with orders, families and subfamilies arranged systematically, but genera and species alphabetically within each family. English names of fish follow Froese & Pauly (2015), while the Albania names of fish follow Rakaj (1995).

In the present checklist, we include only those fish species which spend some parts of their life or their entire life cycles in freshwater, including some marine species entering freshwater habitats during part of their life cycle.

Results

The present checklist includes 31fish species inhabiting River Vjosa and its tributaries. They are assigned to 2 classes, 10 orders and 14 families (Tab. 1). Dominant in the overall fauna is the order Cypriniformes with 13 species or 41.6% of the total fauna, followed by Perciformes with 6 species (19.2%of total). Other orders with more than one species are the Salmoniformes (2), Cyprinodontiformes (2) and Acipenseriformes (2). The families with the highest species numbers are the Cyprinidae (11), followed by Mugilidae (5), Salmonidae (2) and Acipenseridae (2). All other families (Cobitidae, Gobiidae, Petromyzontidae, Anguillidae, Clupeidae, Nemacheilidae, Atherinidae, Poeciliidae, Cyprinodontidae, Moronidae and Pleuronectidae) are represented by a single species.

Tab. 1: Number and relative share (%) of families/subfamilies and species in each order and families/subfamilies of fishes present in the River Vjosa basin. – Tab. 1: Zahlen und relativer Anteil (%) von Familien, Subfamilien und Arten von Fischen im Vjosa Fluss System.

Taxa	**Families**	**%**	**Species**	**%**
Petromyzontiformes'	1	6.6	1	3.2
Petromyzontidae			1	3.2
Acipenseriformes	1	13.2	2	6.4
Acipenseridae			2	6.4
Anguilliformes	1	6.6	1	3.2
Anguillidae			1	3.2
Clupeiformes	1	6.6	1	3.2
Clupeidae			1	3.2
Cypriniformes	3	19.8	13	41.6
Cyprinidae			11	33
Cobitidae			1	3.2
Nemacheilidae			1	3.2
Salmoniformes	1	6.6	2	6.4
Salmonidae			2	6.4
Atheriniformes	1	6.6	1	3.2
Atherinidae			1	3.2
Cyprinodontiformes	2	13.2	2	6.4
Poeciliidae			1	3.2
Cyprinodontidae			1	3.2
Perciformes	2	13.2	6	
Moronidae			1	3.2
Mugilidae			5	16
Pleuronectiformes	1	6.6	1	3.2
Pleuronectidae			1	3.2
Total	14		31	

Following the Albanian red list (MoE 2013) there are three species considered as endangered (*Acipenser sturio, A.naccarii* and *Aphanius fasciatus)* and further two as vulnerable *(Petromyzon marinus* and *Platichthys flesus*). According to IUCN (Freyhof & Brooks 2011) three species (*Acipenser sturio, A.naccarii, Anguilla anguilla)* are considered as critically endangered. Additionally *Gobio skadarensis*is is evaluated as endangered. For the Bern convention three species are considered as strictly protected fauna species (Annex II) (*Acipense rsturio, A.naccarii, Aphanius fasciatus)* and four as Protected fauna species (Annex III) (*Petromyzon marinus,* and *Pachychilon pictum).* Both *Gobio skadarensis* and *Squalius platyceps* listed in this publication are still with unclear status and need further investigations.

Tab. 2: List of fish species found in RiverVjosa, their national and IUCN conservation status (Critically Endangered (CR), Endangered (EN), Lower Risk (conservation dependent) (LR/cd), Lower Risk (near threatened) (LR/nt), Vulnerable (VU), Least Concern (LC)), their listing in Annex II (strictly protected fauna species) and Annex III (Protected fauna species) in the Bern convention. – Tab. 2: Liste der Fischarten, die im Vjosa Fluss-System vorkommen. Angegeben ist der Schutzstatus nach IUCN und der Bern Konvention (Annex II, streng geschützte Tierarten, und Annex III, geschützte Arten).

Species	**Habitat**	**Occurrence**	**National red list**	**IUCN Red list**	**Bern convention**
Petromyzon marinus	Anadromous	native	VU	LC	III
Acipenser sturio	Anadromous	native	EN	CR	II
Acipenser naccarii	Anadromous	native	EN	CR	II
Anguilla anguilla	Katadromous	native	-	CR	-
Alosa fallax	Anadromous	native	-	LC	-
Alburnoides aff. *prespensis*	Freshwater	native	-	-	III
Alburnus scoranza	Freshwater	native	-	LC	-
Barbus prespensis	Freshwater	endemic	LRcd	LC	-
Carassius spp.	Freshwater	introduced	-	-	-
Chondrostoma ohridana	Freshwater	endemic	LRcd*	NT	III*
Gobio skadarensis	Freshwater	endemic	LRnt*	EN	-
Luciobarbus albanicus	Freshwater	endemic	-	LC	-
Pachychilon pictum	Freshwater	endemic	-	LC	III
Pelasgus thesproticus	Freshwater	endemic	-	NT	-
Pseudorasbor aparva	Freshwater	introduced	-	LC	-
Squalius platyceps	Freshwater	endemic	-	LC	-
Cobitis ohridana	Freshwater	endemic	LRcd	LC	-
Oxynoemacheilus pindus	Freshwater	endemic	-	VU	-
Oncorhynchus mykiss	Freshwater	introduced	-	-	-
Salmo farioides	Freshwater	native	-	-	-
Chelon aurata	Saltwater	native	-	-	-
Chelon labrosus	Saltwater	native	-	LC	-
Chelonramada	Saltwater	native	-	-	-
Chelonsaliens	Saltwater	native	-	-	-
Mugilcephalus	Saltwater	native	-	LC	-
Atherinaboyeri	-	native	-	LC	-
Gambusiaholbrooki	Freshwater	introduced	-	LC	-
Aphaniusfasciatus	Freshwater	native	EN	LC	II
Dicentrarchuslabrax	Saltwater	native	-	LC	-
Platichthysflesus	Saltwater	native	VU	LC	-

List of species

Class CEPHALASPIDOMORPHI
Order PETROMYZONTIFORMES
Family PETROMYZONTIDAE

Lampreys are jawless, scaleless, eel-like vertebrates with a cartilaginous skeleton, a single nostril on the top of the head, five to seven gill pores (not supported by gill arches), and a toothed bearing oral disk that is used by the lamprey as a tool for both feeding and attaching itself to solid substrates and fish (Barbieri et al. 2015). Rakaj (1995) is describing two lampreys for Albania i.e. *Lampetra fluviatilis* and *Petromyzon marinus*. They inhabit both fresh and saltwater environments, and some species are anadromous.

Petromyzon marinus (Linnaeus, 1758) [N], Sea lamprey/Kavalli i detit/, occurs at the Adriatic coast of Albania, entering rivers for reproduction, including the River Vjosa basin. A very rare species in the costal parts of Albania, its presence in the country is poorly documented (Plojakov et al. 1958, Rakaj 1995, Dhora 2010, Freyhof & Brooks 2011). The presence of species has been reported by Plojakov et al. (1958), Rakaj (1995) and Dhora (2010).

Class ACTINOPTERYGII
Order ACIPENSERIFORMES
Family ACIPENSERIDAE

Sturgeons are primitive bony fishes with a cartilaginous skeleton; they are scaleless, with five rows of bony scutes along the body. According to Rakaj (1995) there are four surgeon species present in Albania. They are large-bodied and long-lived with a long triangular snout, toothless mouth and four barbels in front. Some are anadromous, others restricted to freshwaters. All but one European species are Critically Endangered, mainly due to overfishing, damming, hydrological changes and pollution (Barbieri et al. 2015).

Acipenser sturio (Linnaeus, 1758) [N], Sturgeon/Blini/, occurs at the Adriatic coast of Albania, mostly in the northern part. (Rakaj 1995, Plojakov et al., 1958, Crivelli 1996, Dhora, 2010, Freyhof & Brooks 2011). The presence of the species has been reported by Plojakov et al. (1958), Rakaj (1995) and Dhora (2010).

Acipenser naccarii (Linnaeus, 1758) [N], Adriatic Sturgeon/Blini i bardhe/, occurs at the Adriatic coast of Albania, mostly in the northern part (Rakaj 1995, Plojakov et al. 1958, Crivelli 1996, Dhora 2010, Freyhof & Brooks 2011). The presence of species has been reported by Plojakov et al. (1958), Rakaj (1995) and Dhora (2010).

Order ANGUILLIFORMES
Family ANGUILLIDAE

Catadromous fishes, spending juvenile and adult life in fresh or brackish water, with adults returning to the sea to spawn (Barbieri et al. 2015). The members of this family have elongated, snake-shaped bodies with continuous dorsal, caudal and anal fins. They lack pelvic fins. Its presence in the entire Vjosa river has been reported (Shumka, unpublished data).

Anguilla Anguilla (Linnaeus, 1758) [N], European eel/Ngjala/. Occors in all drainages of Albanian Adriatic and Ionian watersheds. Present in all River Vjosa sections. The available habitats for the species in Albanian inland waters have decreased dramatically in the last decade, mainly due to the construction of dams and other hydraulic structures that obstruct fish migration. There is also alarming evidence of declining trends in eel landings from inland waters, which is attributed to anthropogenic impacts and/or to reduced arrival rates of young eels (glass eels) from the sea (Rakaj 1995, Plojakov et al. 1958, Crivelli 1996, Shumka et al. 2010). The high abundances of this critically endangered species highlights the importance of an undisturbed longitudinal river continuum at river Vjosa at an European scale (Jacoby & Gollock 2014, EC. 2007).

Order CLUPEIFORMES
Family CLUPEIDAE

Usually fusiform body with silvery coloration, head without scales and pelvic fins placed far back, below dorsal fin. Mostly marine, but some species enter lowland freshwaters; most form large schools (Barbieri et al. 2015). Important edible species, such as sardines and herrings, are included in this family. According to Rakaj (1990) there are two species found in freshwaters in Albania.

Alosa fallax (LaCepède, 1803) [N], Italian shad/Kubla/. Occuring at all coasts of the Albanian watersheds including Vjosa coastal section; mainly concentrated in River Buna and Lake Shkodra (Kottelat & Freyhof 2007, Rakaj 1995, Plojakov et al. 1958).

Order CYPRINIFORMES
Family CYPRINIDAE

A large, diverse and widely distributed family, including over 2.400 species in Europe, Asia, Africa and North and Central America (Barbieri et al. 2015). Cyprinids inhabit mainly fresh or brackish waters.

Alburnoides aff. *prespensis* (Bloch, 1782) [N], Sprilint/Barkegjera/ is present in River Vjosa and all its tributaries (Kottelat & Freyhof 2007, Rakaj 1995, Plojakov et al. 1958, Bogutskaya et al. 2010, Shumka et al. 2010, Stierandová et al. 2016, Gieger et al. 2014). Its taxonomic status is unclear. According to Stierandová et al. (2016) it belongs to the *Alburnoides prespensis* complex.

Among *Alburnoides* besides the well identified populations from the Ohrid Drini System (*Alburnoides ohridanus*) and Lake Prespa (*Alburnoides prespensis*), the status of the remaining populations is unclear. Bogutskaya et al. (2010) described from the Semani basin two new species: *Alburnoides fangfangae* Bogutskaya, Zupančič & Naseka 2010 from the upper River Osumi and *Alburnoides devolli* Bogutskaya, Zupančič & Naseka 2010 from the upper River Devolli. Although the authors described some difference between the two new taxa and *A. prespensis* from Lake Prespa, the differences are slight, and the ranges overlap.

Alburnus scoranza (Bonaparte, 1845) [N], Skadar Bleak/Gjuca or cironka e Shkodres. The species is present in River Vjosa and all its tributaries. It is endemic to the central western Balkan rivers from the Drin drainage, including lakes Skadar and Ohrid. The species prefers larger and deeper river water bodies and still waters (Kottelat & Freyhof 2007, Rakaj 1995, Crivelli 1996, Shumka et al. 2010, Barbieri et al. 2015)). In Albania it is widely present within the central and northeastern part. It can reach 16 cm TL.

Barbus pespensis (Karaman, 1924) [E], Prespa barbel/Mrena or Mustaku i Prespes/. *Barbus prespensis* is present in the Vjosa and all its tributaries. The species has been formerly thought to be endemic to Prespa Lakes and their tributaries. Now it is considered to have a wider distribution in rivers of southern Albania and northwestern Greece. (Crivelli 1996, Marková et al. 2010, Kottelat & Freyhof 2007, Shumka et al. 2010)

Carassius spp. (Bloch, 1782) [I], Gibel carp/Karasi/, is widespread in Albania, and occurs occasionally in the Vjosa (Rakaj 1995, Plojakov et al. 1958, Fricke et al. 2007, Kottelat & Freyhof 2007, Shumka et al. 2008). The taxonomic status is unclear and the morphological differentiation of introduced Carrasius species is difficult (Kalous et al. 2013). Genetic data from surrounding areas confirm the presence of *Carassius auratus*, *Carassius langsdorfi* as well as *Carassius gibelio*.

Chondrostoma ohridanum (Karaman, 1924) [E], Ohrid nasse/Njila or skobusi i Ohrit/ a species widespread in Albania, present in River Vjosa and all its tributaries. It inhabits river sections with fast-flowing waters with rocky to stony substrate (Crivelli 1996, Crivelli 2006, Kottelat & Freyhof 2007, Shumka et al. 2010). Previous records of *C. vardarense* from Vjosa river basin were misidentifications. The genetic studies have assigned the Vjosa population to *C. vardarense* (Zardoya & Doadrio 1999, Doadrio & Carmona 2004, Robalo et al. 2007). Geiger et al. (2014), however, identified this population as *C. ohridanus*, a species present in the Drin drainage, including Lakes Shkodra/Scadar and Ohrid. Therefore, the Vjosa nase population should be considered as distinct from the *C.vardarense* Greek populations, and thus deserves further studies. The study of Marić & Šorić (2009) confirmed the validity of *C. ohridanum* and Geiger et al. (2014) its presence in the Vjosa river basin.

*Gobio skadarensis (*Karaman, 1937) [E], Skada gudgeon/GurneciiShkodres/ is present in River Vjosa and all its tributaries. This species, widespread in River Drino (3 km from confluence with the Vjosa), inhabits streams and rivers with moderate flow, and substrate consisting of sand, pebble and boulders. Based on our data it is of low abundance in Vjosa (Crivelli 1996, Kottelat & Freyhof 2007, Miller & Šanda 2008, Šanda et al. 2006, Shumka et al. 2010). The taxonomic assignment is provisional and makes further investigations of gudgeons from Albania necessary.

Luciobarbus albanicus (Steindachner, 1870) [E], Albanian barbel/Mustaku shqiptar/, is endemic to Southern Albania and western Greece, and very rare in the River Vjosa and its tributaries (Rakaj 1995, Plojakov et al. 1958, Crivelli 1996). The species has recently been transferred to the genus *Barbus* (under which it was originally described) and presented as being valid under the name "*Barbus albanicus*" (Eschmeyer 2014; Froese & Pauly 2014). In the above species accounts, the closely related *Luciobarbus graecus* was retained in the genus *Luciobarbus*. On the basis of available genetic and morphological evidence (Tsigenopoulos et al. 2003, Kottelat & Freyhof 2007, Geiger et al. 2014), we consider the species sufficiently distinct from other species of the genus *Barbus* to justify its inclusion in the genus *Luciobarbus*.

Pachychilon pictum (Heckel & Kner, 1858) [E], Albanian roach/Skorti i zi/. Present in River Vjosa and all its tributaries. It inhabits slow-flowing rivers, canals and backwaters (Crivelli 1996, Kottelat & Freyhof 2007, Rakaj 1995, Plojakov et al. 1958, Shumka et al. 2010).

Pelasgus thesproticus (Stephanidis, 1939) [E], Minnow (Epiros minnow/Peshkguri/. Present in central part of River Vjosa and its tributaries. It inhabits springs, streams and various ponds; usually found in shallow water with slow flow and dense vegetation (Kottelat & Freyhof 2007, Rakaj 1995, Plojakov et al. 1958, Economou et al. 2007).

Pseudorasbora parva (Temminck & Schlegel, 1846) [I], Stone moroko/Notaku/ is a non-indigenous species from eastern Asia, spreading rapidly in Albanian lakes and rivers. It is widespread in the Vjosa basin (Kottelat & Freyhof 2007, Rakaj 1995, Shumka et al. 2008, Shumka et al. 2010).

*Squalius platyceps (*Zupančič, Marić, Naseka & Bogutskaya, 2010) [N], Chub/Kleni or Mlyshi/. The species inhabits rivers and streams with slow- to moderate-flowing waters and is common in various stream habitats. Recorded from the Vjosa and its tributaries (Kottelat & Freyhof 2007, Rakaj 1995, Geiger et al. 2014, Shumka et al. 2010). The taxonomic status provisionally follows Geiger et al. (2014); further evaluation is required.

Family COBITIDAE

A family of small-sized fish with a unique elongated body form. They have a small bottom-facing mouth with three to six pairs of barbells (Barbieri et al. 2015). The pigmentation pattern is important for species identification. No final data on the number of species present in Albania.

Cobitis ohridana Karaman, 1928 [E], Ohridspined loach/Gurneci i Ohrit/present in River Vjosa and all its tributaries (Crivelli 1996, Kottelat & Freyhof 2007, Šanda et al. 2008, Shumka et al. 2010).

Family NEMACHEILIDAE

The stone loaches are widely distributed in Asia, Europe and parts of Africa (Barbieri et al. 2015). Their elongated body form and inferior mouth position are highly adapted for benthic living. They have three pairs of mouth barbels and, in contrast to spined loaches (Cobitidae), they lack a spine below the eyes. The most spread species within Albanian freshwaters system is the Pindus stone loach.

Oxynoemacheilus pindus (Economidis, 2005) [E], Pindus stone loach/Gurneci i Pindusit/ Present in River Vjosa and all its tributaries (Crivelli 1996, Kottelat & Freyhof 2007, Rakaj 1995, Plojakov et al. 1958, Shumka et al. 2010).

Order SALMONIFORMES
Family SALMONIDAE

Salmonids are medium- to large-sized with a spotted body, an adipose fin and with a single row of sharp teeth in their mouths. They are predators, feeding on small crustaceans, aquatic insects and smaller fish (Barbieri et al. 2015). The taxonomy of riverine trouts in the Adriatic and Ionian Sea basins is far from resolved. Genetic analysis has confirmed they form a monophyletic group but does not provide clear data to resolve exactly the taxonomy (Sušnik et al. 2007, Snoj et al. 2009). This applies also with regard to their morphology, with most of the trout populations yet to be identified by genetic analysis. On the one hand, Kottelat & Freyhof (2007) propose most Adriatic and Ionian populations belong to *Salmo farioides* Karaman, 1938, while on the other, they accept the validity of many local endemic taxa.

Oncorhynchus mykiss (Walbaum, 1792) [I], Rainbow trout/Trofta e ylberte/Main culture fish in freshwater both rives and dams, introduced to all parts of Albania including Vjosa (Rakaj 1995, Plojakov et al. 1958, Kottelat & Freyhof 2007, Shumka et al. 2008).

Salmo farioides (Karaman, 1938) [N], Brown trout/Trofta e murrme/. The species is present in upper part of the Vjosa basin (Rakaj 1995, Plojakov et al. 1958, Crivelli 1996, Kottelat & Freyhof 2007, Snoj et al. 2009, Shumka et al. 2010).

Order SYNBRANCHIFORMES
Family MUGILIDAE

Chelon aurata (Risso, 1810) [N], Golden gray mullet/Qefulli i arte/. Coastal part of Adriatic Sea, lower part of the Vjosa river and brackish waters (Rakaj 1995, Plojakov et al. 1958, Kottelat & Freyhof 2007, Shumka et al. 2010).

Chelon labrosus (Risso, 1827) [N], Thicklip grey mullet/qefulli buzetrashe/. Coastal part of the Ariatic Sea, lower part of the Vjosa and brackish waters. (Kottelat & Freyhof 2007, Rakaj 1995, Plojakov et al. 1958)

Chelon ramada (Risso, 1827) [N], Thinlip mullet/Qefull ibuzeholle/. A widespread euryhaline species in the coastal part of the Adriatic Sea, lower and middle part of the Vjosa and brackish waters (Kottelat & Freyhof 2007, Rakaj 1995, Plojakov et al. 1958).

Chelon saliens (Risso, 1810) [N], Leaping mullet/Qefulli i Vjeshtes/. A widespread euryhaline species in the coastal part of the Adriatic Sea, lower and middle part of the Vjosa and brackish waters (Kottelat & Freyhof 2007, Rakaj 1995, Plojakov et al. 1958).

Mugil cephalus (Linnaeus, 1758) [N], Flathead mullet/Qefulli i zakonshem/. A widespread euryhaline species in the coastal part of the Adriatic Sea, lower and middle part of the Vjosa and brackish waters (Kottelat & Freyhof 2007, Rakaj 1995, Plojakov et al. 1958).

Order ATHERINIFORMES
Family ATHERINIDAE
Subfamily ATHERININAE

Atherina boyeri (Risso, 1810) [N], Big-scale sand smelt/Aterina/. The section of Adriatic coast, confluence with River Vjosa and brackish waters in Narta Lagoon (Rakaj 1995, Plojakov et al. 1958, Kottelat & Freyhof 2007).

Order CYPRINODONTIFORMES
Family POECILIIDAE
Subfamily POECILIINAE

Gambusia holbrooki (Girard, 1859) [I], Holbrook's mosquito fish/Peshku mushkonje/. Introduced and widespread in the River Vjosa basin and surrounding water (Kottelat & Freyhof 2007, Rakaj 1995, Shumka et al. 2008, Shumka et al. 2010).

Family CYPRINODONTIDAE

Aphanius fasciatus (Valenciennes, 1821) [N], Mediterranean banded killifish/Peshkuçelik/. Mediterranean Sea watersheds, present in the mouth and channels of lower part of the Vjosa and in Narta lagoon (RAKAJ 1995, CRIVELLI 1996, KOTTELAT & FREYHOF 2007, SHUMKA et al. 2010).

Order PERCIFORMES
Family MORONIDAE

Dicentrarchus labrax (Linnaeus, 1758) [N], European seabass/Levreku/. A coastal species of the Mediterranean and Eastern Atlantic Ocean. A marine species, occasionally entering Narta lagoon, the mouth and lower reaches of the Vjosa (RAKAJ 1995, SHUMKA et al. 2010).

Order PLEURONECTIFORMES
Family PLEURONECTIDAE

Platichthys flesus (Linnaeus, 1758) [N], The European flounder/Ushojze e zeze/. A marine species that locally enters Narta and low reaches of the Vjosa and adjacent channels (RAKAJ 1995, PLOJAKOV et al. 1958, SHUMKA et al. 2010).

Discussions

A high fish diversity and the presence of eleven species endemic to the Balkans highlight the importance of the Vjosa river system (*Alburnoides* aff. *prespensis*, *Alburnus scoranza, Barbus prespensis, Chondrostoma ohridanum, Gobio skadarensis, Luciobarbus albanicus, Pachychilon pictum, Pelasgus thesproticus , Squalius platyceps, Cobitis ohridana* and *Oxynoemacheilus pindus*). Habitat degradation, pollution originating from households and agriculture, introduction of non-native fishes and other anthropogenic influences are the main threats to this unique fish fauna. Hydropower plants, already present in the watershed of Lengarica stream, and those planned seems to be the most threatening factor of the native fish fauna. The River Vjosa is a large migration corridor for both anadromous and katadromous species as well as other saltwater species entering the system. The river potentially provides habitat and spawning sites for anadromous sturgeons (*Acipenseridae*) such as the critically endangered *A. sturio* or *A. naccarii,* which were found at the Albanian coast and its rivers (RAKAJ 1995, PLOJAKOV et al. 1958, CRIVELLI 1996, FREYHOF & BROOKS 2011). This highlights the need for specific conservation measures.

The construction of impoundments changes river systems ecologically by disrupting the connection between the river and their lateral backwaters, changing the shore line, stabilizing previously dynamic water levels etc. (SCHIEMER & WAIDBACHER 1992). Heavy morphological alterations for navigation, flood protection and hydroelectric power generation as well as the disconnection of tributaries resulted in riverine habitat degradation and fragmentation, especially in large rivers all over Europe (DUDGEON et al. 2006, MORLEY & KARR 2002, SCHIEMER 2000). These habitat modifications affect the integrity and diversity of freshwater biota (ALLAN & FLECKER 1993, KARR et al. 1985). Therefore, a massive decline in abundances of typical riverine fish community as well as the disappearance of several species can be expected. Additionally, the rest of the upstream

River Vjosa will be cut off for anadromous and catadromous species migrating upstream from the sea.

At the current circumstances the planned construction of dams in the River Vjosa basin is a major concern for fish biodiversity conservation in the future. Hydropower is considered as a green technology, its catastrophic effects on biodiversity being voluntarily ignored (Freyhof 2012). The construction of dams in the Vjosa will prohibit the migration of eels and other marine species to the upstream sections of the river.

The free-flowing river ecosystem of the River Vjosa provides appropriate habitats for the critically Endangered European Eel, *Anguilla anguilla,* allowing for a viable population along the River Vjosa.. The available habitats for the European eel (*Anguilla anguilla*) in Albanian inland waters have been significantly affected and reduced in the last several decades, mainly due to the construction of dams. There are clearly declining trends in eel landings from inland waters, which is caused by anthropogenic impacts or reduced recruits (Shumka 2015, Jacoby & Gollock 2014, EC. 2007).

Gambusia holbrooki (Baird & Girard 1853) and *Pseudorasbora parva* (Temminck & Schlegel 1846) are two invasive species reported from many parts of Albania (Shumka et al. 2008) and were also listed in the previous studies (Rakaj 1996). *Gambusia halbrooki* probably has been confusedwith *G. affinis* and it needs further study to validate the occurrence of *G. affinis* for inland waters of Albania (Shumka et al. 2008).

The endemic fish species, such as the endangered Skadar gudgeon (*G. skadarensis*), Pindus loach (*O. pindus*), Prespa barbel (*B. prespensis),* Albanian barbel (*L. albanicus),* Albanian roach (*P. pictum),* Epiros minnow (*P. thesproticus),* migrate to habitats connected to river with slow and moderate water velocity and vegetation covered substrate to spawn (Barbieri et al. 2015). There is an unclear conservation status for two species listed under the annex III of Bern convention (*C. ohridana* and *P. pictum*).

Knowledge and understanding on the diversity of the freshwater fish fauna for a specific ecosystem is crucial for experts of the field, policymakers, natural resources managers as well as for the wider public to increase the understanding and evaluate the current and potential impact of human activities on the fauna within the entire river basin.This checklist may provide a basis for further studies of the freshwater fish fauna of the River Vjosa and entire Albania.

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

Paul Meulenbroek, Spase Shumka & Fritz Schiemer

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).

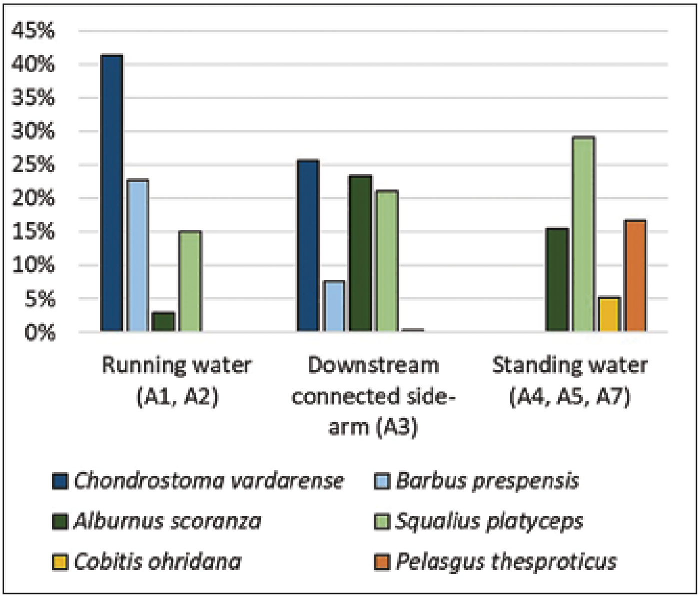

Fig. 2: Relative distribution of selected fish species for different habitats at the Poçemi floodplain area. – Abb. 2: Relative Verteilung ausgewählter Fischarten für die verschiedenen Lebensräume der Poçemi-Furkationszone.

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

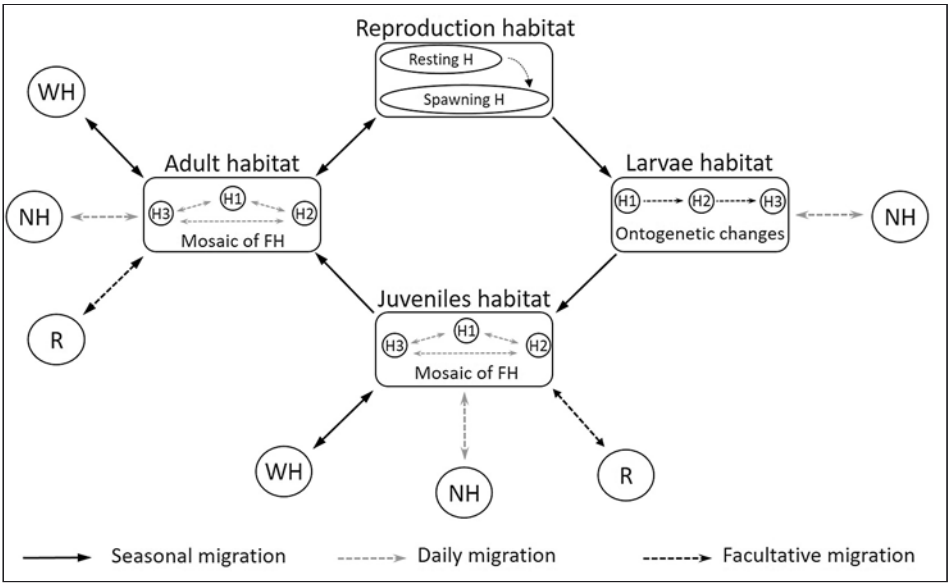

Fig. 3: Basic scheme of seasonal and daily migration pattern for riverine fish with emphasis on their life cycle and habitat use. Each box/cycle represents a specific habitat with certain characteristics: WH: Winter habitats, NH: Night Habitats, R: Refugia from harsh environmental conditions, FH: Feeding 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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Overview of the terrestrial animals of the Vjosa River, Albania: invertebrates, amphibians, reptiles and the European otter

Thomas Frank

Only little is known about the terrestrial fauna of the highly dynamic riverine system of the Vjosa. It is particularly important to fill this gap because the Vjosa's dynamics are at risk of becoming destroyed by hydropower plants. Though the species described in the following chapters were only recorded during short-term, preliminary surveys, a high biodiversity comprising many characteristic species was already verified.

Frank T., 2018: Überblick über die terrestrischen Tiere der Vjosa, Albanien: Wirbellose, Amphibien, Reptilien und der Europäische Otter.
Es ist nur sehr wenig über die terrestrische Fauna des hoch dynamischen Flusssystems der Vjosa bekannt. Daher ist es besonders wichtig diese Wissenslücke zu füllen, weil die Dynamik des Flusses Gefahr läuft, durch Wasserkraftwersvorhaben zerstört zu werden. Auch wenn die in den folgenden Kapiteln beschriebenen Arten nur von kurzfristigen Erstaufnahmen stammen, konnte bereits eine hohe Diversität mit vielen charakteristischen Arten festgestellt werden.

Keywords: Vjosa, Albania, biogeography, conservation.

Overview

As there is only very little information on the terrestrial fauna of the highly dynamic Vjosa riverine system (see Schiemer et al. 2018 this volume) the following chapters contribute to fill the gap of this largely unknown area. To do so is particularly important because the Vjosa river runs the risk of becoming adversely affected by planned hydropower plants. The ecological value of the Vjosa river is evaluated based on the occurrence of specific rare and endangered organisms in order to document its uniqueness and conservation status. The described terrestrial animals inhabiting the riverine system of the Vjosa river comprise molluscs, spiders, harvestmen, insects (grasshoppers, true bugs, carabid beetles, staphylinid beetles, ants), amphibians, reptiles, and the European otter. The aforementioned animal groups, which include herbivorous, carnivorous and saprophagous feeding guilds, are crucial members of the food web of the Vjosa river and its floodplain. Moreover, they can act as sensitive indicators for the environmental state of a riverine system, e.g. carabids and staphylinids (Schatz 2007, Paetzold et al. 2008). Some of these animal groups are represented by many species in different European and national conservation schemes, i.e. the Bern Convention on the Conservation of European Wildlife and Natural Habitats (1979), the European Union Habitats Directive (1992), and the National Red List of Flora and Fauna of Albania (2013). The fact that some species are listed in the Albanian Red List is significant against the background of Albania's targeted European Union membership.

Natural disturbance caused by erosion, transport and deposition enables a high level of landscape diversity in river corridors (Ward et al. 2002). This creates a complex mosaic of various habitat types, i.e. bare ground areas from abundantly rearranged coarse granular gravel banks to fine sand areas, older silted-up floodplains, sparsely vegetated areas, short grasslands, or alluvial forests, which are inhabited by highly specialised animal species strictly adapted to various successional stages (Robinson et al. 2002). Such dynamic floodplains have been severely altered in many parts of Europe, which leads to a distorted perception of patterns and processes in riverine landscapes (e.g. Ward & Stanford 1995). Natural riverine systems with huge spatio-temporal heterogeneity have meanwhile become extremely rare as the majority of European rivers have largely lost their former highly natural state due to anthropogenic modifications, and have thus been converted into incised single-thread channels (Tockner et al. 2006). Braided rivers, in their pristine state, are known to be characterized by a shifting mosaic of channels, islands and various wetland types underlying fast turnover rates by flood pulses (Tockner et al. 2006). It is crucial to understand the structure and function of the few remaining European river systems which are nowadays among the most endangered ecosystems (Sadler et al. 2004). Such unaltered conditions still occur at the Vjosa river representing an appropriate natural laboratory – not only for scientists.

As ecosystem dynamics are usually not restricted to a certain type of habitat, local populations, assemblages and food web dynamics are essentially affected by the spatial flow of matter and organisms among different habitats (Polis et al. 1979). At the land-water interface, the exchange of energy and nutrients between the river channel and its riparian zone significantly constitutes dynamic processes in braided river ecosystems (Fisher et al. 1998, Helfield & Naiman 2001). There is only little knowledge on the energy flow from aquatic to adjoining terrestrial systems. For terrestrial consumers, the flows of matter and organisms from the water body to the riparian zone can be significant energy sources (Nakano & Murakami 2001, Naiman et al. 2002, Sabo & Power 2002). Spatial interactions between productive (e.g. water body) and non-productive (e.g. gravel banks) habitats lead to high energy fluxes. This enables carnivorous riparian arthropods, primarily spiders, staphylinid beetles, carabid beetles, and ants to colonize gravel banks (Manderbach & Hering 2001, Framenau et al. 2002, Sadler et al. 2004). Species of these arthropod groups inhabiting the riparian zone of the Vjosa are described in the following chapters.

Dynamic rivers produce masses of insects emerging from the water body. After oviposition, thousands of them can be observed lying dead on the riparian zone where they provide an enormously high load of energy for other arthropod consumers inhabiting the terrestrial zone. Carabids and spiders have been reported to feed upon aquatic insects revealing that predation by riparian arthropods is a quantitatively important process in the transfer of aquatic secondary production to the riparian food web (Hering & Plachter 1997, Paetzold et al. 2005).

Terrestrial species which are characteristic of highly dynamic riverine systems are exceptionally sensitive to hydromorphological changes regarding discharge, flow regime and sediment budget. Any impacts on these parameters may lead to a decrease or extinction of these highly vulnerable taxa observed at the Vjosa.

Within this study, 378 terrestrial invertebrates, 14 amphibian and reptile species and the European otter were recorded. A large number of them have been documented for the first time in Albania. They were hitherto exclusively found at the Vjosa. To underline the high conservation status of the Vjosa area, the newly described spider *Liocranoeca vjosensis* is a new species for science that has never been observed anywhere else, worldwide.

The species described in the following chapters were only recorded during short-term, preliminary surveys. Nevertheless, a high biodiversity comprising many characteristic species was verified. These species are appropriate indicators for highly dynamic processes because they characterize the land-water interface. Therefore, they should be considered in future environmental impact assessments (EIA).

Conclusion

The Vjosa river and its surrounding habitats are most definitely of a remarkably high conservation status because i) they comprise a mosaic of various habitat types which forms a highly dynamic natural river ecosystem of a spatial extent which is absolutely unique in Europe outside of Russia; ii) they harbour viable communities of animals that have largely or completely disappeared from other European rivers; iii) the majority of these viable communities are expected to go irrecoverably extinct as a result of the projected hydropower dams, because they are well adapted to, and strictly dependent on, a highly dynamic river system. The construction of dams would disconnect the river from its surrounding (semi)-terrestrial habitats, thus preventing the natural river dynamics which are essential for the survival of most of the rare and endangered species inhabiting the studied areas. Therefore, the protection of the Vjosa river system in its present form is of pan-European importance.

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The mollusc fauna of the Vjosa river and its floodplains at Poçemi, South Albania

Michael Duda, Elisabeth Haring & Helmut Sattmann

During a survey from 24.–26.04.2017, 36 species of molluscs were found in the river-floodplain system of the Vjosa at Poçemi (see Schiemer et al. 2018 this volume). Regarding the terrestrial snails, a total of 28 species was found. Living specimens were mainly recorded at higher areas of slopes adjacent to the floodplain, which are neither affected by the changing water levels nor by burning of meadows for pastureland recovery. Most of the recorded species were species of open grassland, rock dwellers or generalists. In the Vjosa river itself and in adjacent waterbodies, a total of 8 freshwater mollusc species was found. Half of the species recorded are adapted to quick water changes and to changing water qualities. Future research should be focussed on subterranean Hydrobiidae snails, which perhaps live in the groundwater system of the Vjosa river.

Duda M., Haring E. & Sattmann H., 2018: Die Molluskenfauna des Flussbettes bei Poçemi, Südalbanien.
Die Erhebung der Molluskenfauna im Flussbett der Vjosa bei Poçemi wurde von 24.-26.04.2017 durchgeführt. Insgesamt wurden 36 Arten gefunden. Von diesen waren 28 Landgastropoden, bei welchen Lebendnachweise vor allem in höher gelegenen Bereichen der angrenzenden Hänge gelangen, welche weder von wechselnden Wasserständen der Vjosa noch durch Brandrodung zur Weidelandgewinnung betroffen sind. Im Wesentlichen handelte es sich dabei um Arten des Offenlandes, Fels-assoziierte Arten sowie Generalisten. An Süßwassermollsuken wurden insgesamt 8 Arten gefunden. Die Hälfte dieser Arten ist an rasche Wechsel bezüglich Wasserstände und Wasserqualität angepasst. Zukünftige Untersuchungen sollten ihr Hauptaugenmerk auf unterirdisch lebende Quellschnecken (Hydrobiidae) legen, welche möglicherweise im Grundwassersystem der Vjosa leben.

Keywords: Vjosa, Mollusca, Gastropoda.

Introduction

Research into the Albanian mollusc fauna has increased since the 1990s and, therefore, the general inventory of Albanian land snails is more or less well known (Dhora & Welter Schultes 1996, Fehér & Eröss 2007). Nevertheless, there are only few reports (e.g. Dhora & Welter-Schultes 1999a u. b, Welter-Schultes 2012) concerning ecology and habitat of Albanian terrestrial molluscs.

Material and Methods

Molluscs and their empty shells were sampled by three techniques: Manual sampling (approx. 30 min at each locality) was applied for larger species (>1 cm) and empty shells. Dry sieving was applied to river deposits and is a good method to detect small species and to survey malacologically unexplored landscapes (Ciliak & Steffek 2011). For this task, 20 litres of soil were gathered, sieved with 3.0 mm and 0.5 mm mesh width, and examined for mollusc shells. Wet sieving (Horsák 2003) was used to extract wet empty shells and living snails from moist substrate. For this task, detritus and plants from wet places and water bodies were washed in a sieve with 0.5 mm mesh width. Using this technique, living animals and water-filled empty shells stay at the bottom of the sieve, while other particles float to the top. Habitat characterisation for the species recorded was mostly taken from Dhora & Welter-Schultes (1999a) and Welter-Schultes (2012), where some general habitat requirements of European non-marine molluscs are given.

Results

A total of 36 species of mollusc was recorded.

Regarding terrestrial gastropods, 28 species were recorded. Of these, 10 were also recorded as living specimens, while the remaining 18 species were only recorded as empty shells. The number of recorded species per site ranged from 1 to 16. The highest number of species (16) was found at sampling site 4, a large river deposit, but all specimens were empty shells. The highest number of species of living specimens (5) was found at sampling site 9 (Tab. 9). Nearly half of the recorded taxa were representatives of three families (Clausiliidae, Hygromiidae, Helicidae). Regarding higher taxonomic levels, almost all species belonged to the clade Eupulmonata and only one species, *Pomatias elegans*, belonged to the clade Caenogastropoda.

Tab. 1: Sampling sites. – Tab. 1: Sammelstellen.

	Description	Date	Coordinates
1	River deposit on gravel bank, pioneer vegetation near river	24.04.2017	N40°26.466′ E19°45.458′
2	River deposit on sand bank near river	24.04.2017	N40°26.445′ E19°45.456′
3	Loosely structured reed, shrubs and moist soil, remains of desiccated bayou	24.04.2017	N40°26.431′ E19°45.238′
4	Loosely structured reed, garbage pile and river deposits in shrubbery	24.04.2017	N40°26.343′ E19°45.171′
5	Meadow, particularly with moist soil	25.04.2017	N40°27.803′ E19°45.302′
6	Meadow near creek with reed (also sampling site for freshwater molluscs)	25.04.2017	N40°27.813′ E19°45.230′
7	Sediments of eroding bank	25.04.2017	N40°28.290′ E19°45.015′
8	Slope to higher part of the river plain, residual water of a bayou (also sampling site for freshwater molluscs)	26.04.2017	N40°28.558′ E19°45.179′
9	Rocks at the slope to higher part of the river plain.	26.04.2017	N40°28.710′ E19°45.199′
10	Maquis and single rocks at the slope (also sampling site for freshwater molluscs)	26.04.2017	N40°26.662′ E19°45.380′

Three species – *Vallonia enniensis*, *Succinella oblonga* and *Vertigo pygmaea* – can be considered typical species of wetlands. Inhabitants of various predominantly open, meadow-like habitats are *Cecilioides tumulorum*, *Chondrula microtragus*, *Mastus grandis, Allaegopis skanderbegianus, Monacha claustralis*, *Monacha frequens*, *Xeromunda vulgarissima*, *Trochoidea pyramidata*, *Cochlicella acuta* and *Cernuella virgata*. Species which can be considered predominantly rock-dwelling or rock-associated are *Granopupa granum*, *Chondrina arcadia clienta*, *Morlina glabra striaria*, *Albinaria scopulosa*, *Strigilodelima conspersa* and *Josephinella byshekensis*. The remaining nine species can be considered to be generalists inhabiting different types of habitats.

Tab. 2: Land snail species recorded on sampling sites 1-10. E: empty shells; L: living specimens. – Tab. 2: Landschnecken, die an den Sammelstellen 1-10 festgestellt warden konnten. E: leere Schalen, L: lebende Individuen.

Family	**Species**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Succinaeidae	*Succinella oblonga* (Draparnaud, 1801)			L							
Pomatiidae	*Pomatias elegans* (O.F.Müller, 1774)									L	E
Valloniidae	*Vallonia enniensis* (Gredler, 1856)				E						
Enidae	*Mastus grandis* (Mouson, 1859)									E	
Enidae	*Chondrula microtragus* (Rossmässler, 1838)						E				
Chondrinidae	*Granopupa granum* (Draparnaud, 1801)				E					L	
Chondrinidae	*Chondrina arcadica clienta* (Westerlund, 1883)				E						
Vertingidae	*Vertigo pygmaea* (Draparnaud, 1801)					L					
Ferrusaciidae	*Cecilioides tumulorum* Bourguignat, 1856		E								
Clauslilidae	*Charpentiera stigmatica sturmii* (L. Pfeiffer, 1848)				L					E	
Clauslilidae	*Albinaria scopulosa* (Charpentier, 1852)									L	
Clausilidae	*Strigilodelima conspersa* (L. Pfeiffer, 1848)									E	
Pristliomatidae	*Vitrea* sp.		E		E						
Spiraxidae	*Poiretia delesserti* (Bourguignat 1852)									L	
Oxychilidae	*Morlina glabra striaria* (Westerlund, 1881)				E						
Zonitidae	*Allaegopis skanderbegianus* (Polinski, 1924)				E						
Helicodontidae	*Lindholmiola corcyrensis* (Rossmässler, 1838)		E	L	E			L	L	L	
Cochlicellidae	*Cochlicella acuta* (O. F. Müller, 1774)		E		E						E
Hygromiidae	*Monacha claustralis* (Menke, 1828)			E	E	E				E	
Hygromiidae	*Monacha frequens* (Mousson, 1859)				E	E		L	L		
Hygromiidae	*Trochoidea pyramidata* (Bourguignat, 1856)		E	E	E					E	E
Hygromiidae	*Xeromunda vulgarissima* (Mousson, 1859)				E					E	E
Helicidae	*Josephinella byshekensis* (Knipper, 1941)									E	
Hygromiidae	*Cernuella virgata* (Da Costa, 1778)			E	E						
Helicidae	*Eobania vermiculata* (O. F. Müller, 1774)	E									
Helicidae	*Cornu aspersum* (O. F. Müller, 1774)				E						
Helicidae	*Helix lucorum* Linnaeus, 1758			E							
Helicidae	*Helix secernenda* Rossmässler, 1837				E	E					L
Total number of species		1	5	5	16	3	1	2	2	2	5
Number of species recorded living		0	0	2	1	1	0	2	2	5	1

Regarding freshwater molluscs, a total of 8 species could be detected (Tab. 3). More than half of the species detected – *Radix auricularia*, *Radix labiata*, *Physella acuta*, *Pisidium casertanum* and *Musculium lacustre* – is known for being adapted to rapid changes in water levels and water quality (Albrecht et al. 2008, Dhora & Welter-Schultes 1999a, Welter-Schultes 2012, Kileen 1992, Kerney 1993, Zettler & Glöer 2006). *Theo-*

doxus fluviatilis and *Ancylus fluviatilis* are typical species of permanent water bodies like rivers and lakes (Dhora & Welter-Schultes 1999). The Hydrobiidae snail *Radomaniola curta* inhabits springs (Glöer et al. 2015).

Tab. 3: Recorded species and their habitats. – Tab. 3: Festgestellte Arten und ihre Habitate.

Family	Species	Habitats; remarks
Neritidae	*Theodoxus fluviatilis* (Linnaeus,1758)	permanent water bodies
Hydrobiidae	*Radomaniola curta* (Küster, 1853)	Springs; no subspecies assignment possible
Lymnaeide	*Radix auricularia* (Linnaeus, 1758)	permanent and periodic water
Lymnaeide	*Radix labiata* (Rossmässler, 1835)	Periodic water bodies, springs
Lymnaeide	*Ancylus fluviatilis* Müller, 1774	Periodic water body; species group with cryptic diversity
Physidae	*Physella acuta* (Draparnaud, 1805)	Periodic water bodies
Sphaeridae	*Pisidium casertanum* (Poli, 1791)	Permanent and periodic water bodies; species group with cryptic diversity
Sphaeridae	*Musculium lacustre* (Müller, 1774)	Periodic water bodies

Discussion

It must be noted in general that, because of the season, some species of terrestrial mollusc (e.g. *Cernuella virgata*, *Xerocrassa vulgarissima*) were only obtained as empty shells or as indeterminable juveniles according to their phenology. Slugs could also not be detected for reasons of seasonality. Therefore, these results are merely a very first insight into the local terrestrial snail fauna of the Vjosa river at Poçemi. Regarding habitat preferences, it must be said that no comprehensive study concerning habitat preferences exists for the molluscs of the Balkan compared to those of Central Europe (Ložek 1964) or Northwestern Europe (Falkner et al. 2001) exists.

A first tendency that can be deduced from these results is that the floodplain directly adjacent to the river does not provide favourable living conditions for terrestrial gastropods. This can be explained on the one hand by the often rapidly changing vegetation structure and land cover caused by flood events, and on the other hand by the large-scale bushfires connected to the recovery of pasture land. Only the sampling sites 7, 8 and 9 harboured a larger number of living specimens. These three sites were not directly adjacent to the annually flooded part of the river basin, instead being slightly elevated. The relatively high number of species represented by living individuals at sampling site 9 is related to the fact that this site is dominated by well-structured calcareous rocks in different expositions, which provide favourable habitat conditions for various land snails, not only specific rock-dwellings species.

Regarding the freshwater molluscs, the results reflect the fact that the Vjosa river, with its rapidly changing water levels and lack of older bayous, is mainly suitable as habitat for species which can react quickly to changing living conditions. A variable bayou system, as originally existed in larger Central European rivers, does not exist here, because the Vjosa, as opposed to e.g. the Lower Danube or the Lower Rhine in Central Europe, is a much faster flowing river with a greater boulder load than the other two rivers. Besides species that can react quickly to changing conditions, there are also some inhabitants of stagnant water and springs. Although only relatively few species were recorded, a power plant would destroy the living conditions of these species and also of other species possibly existing in the subterranean water body. This applies to the Hydrobiidae snail *Iglica xhuxhi* A. Reischütz, N. Reischütz & P.L. Reischütz 2014, which was described at the lower reaches of the Vjosa river near Novosele, but was not discovered in the recent study. This species is assumed to live underground in flooded gravel or sand banks beneath the river and is a suspected endemic of the Vjosa. So far, there are no reports of living specimens of this taxon. Further investigations should focus on the possible occurrence of this taxon and other potentially existing, but yet undiscovered subterranean species.

Some taxonomic insecurities must be noted regarding *A. fluviatilis*, as a cryptic diversity (see also Tab. 3) has been reported within this species (Pfenninger et al. 2003, Albrecht et al. 2006). Therefore, it seems quite clear that most *Ancylus* populations from the southern Balkans do not represent *A. fluvialtilis* sensu stricto, but a hitherto undescribed taxon provisionally named "*Ancylus* sp. B" by Albrecht et al. (2006). In their opinion, it could perhaps be *A. pileolus* Ferrusac 1822, which could be only verified, if specimens of the type locality were investigated. Further research is needed to settle this question. The same applies to *Pidisium casertanum* (see Tab. 3): some cryptic species could be hiding within this taxon (Mouthon & Abbaci 2012), which perhaps have different and more specialised habitat needs.

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Spiders (Arachnida: Araneae) of the floodplains of the Vjosa river, South Albania

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This study presents the first results of research of the spider fauna of the Vjosa River in the vicinity of the village of Kutë, Albania, conducted in the period of 24–28.04.2017. A total of 50 species from 11 families were recorded: Araneidae (2), Gnaphosidae (7), Linyphiidae (8), Liocranidae (1), Lycosidae (15), Phrurolithidae (3), Salticidae (5), Tetragnathidae (2), Theridiidae (5), Thomisidae (1) and Titanoecidae (1). One new species is described and illustrated: *Liocranoeca vjosensis* **n. sp.** (♂). Two species were recorded for the first time in the Balkan Peninsula: *Janetschekia monodon* (O. Pickard-Cambridge, 1873) and *Trachyzelotes huberti* Platnick & Murphy, 1984. Fifteen species are new records for the spider fauna of Albania: *Arctosa perita* (Latreille, 1799), *Arctosa stigmosa* (Thorell, 1875), *Ballus rufipes* (Simon, 1868), *Berlandina plumalis* (O. Pickard-Cambridge, 1872), *Erigonoplus spinifemuralis* Dimitrov, 2003, *Gnaphosa dolosa* Herman, 1879, *Gnaphosa rhenana* Müller & Schenkel, 1895, *Gnathonarium dentatum* (Wider, 1834), *Neaetha absheronica* Logunov & Guseinov, 2002, *Pachygnatha clerckoides* Wunderlich, 1985, *Phrurolithus nigrinus* (Simon, 1878), *Pirata tenuitarsis* Simon, 1876, *Pocadicnemis juncea* Locket & Millidge, 1953, *Robertus arundineti* (O. Pickard-Cambridge, 1871) and *Titanoeca flavicoma* L. Koch, 1872. According to the present distribution, the recorded species are classified into 16 zoogeographical categories and grouped into 4 chorological complexes: widely distributed species, European, Mediterranean and endemics. Widely distributed species (48 %) were dominant, followed by European (26 %), Mediterranean (20 %) and endemic species (6 %). The results of the present study emphasize the importance of protection and conservation of the newly described species, which would be seriously threatened by the proposed hydroelectric power dam on the Vjosa River.

Komnenov M., 2018: Die Spinnenfauna der Überflutungsgebiete der Vjosa, Südalbanien.
Diese Studie präsentiert die ersten Ergebnisse der Erforschung der Spinnenfauna des Flusses Vjosa in der Umgebung des Dorfes Kutë, Albanien, die in der Zeit vom 24.-28.04.2017 durchgeführt wurde. Insgesamt wurden 50 Arten aus 11 Familien registriert: Araneidae (2), Gnaphosidae (7), Linyphiidae (8), Liocranidae (1), Lycosidae (15), Phrurolithidae (3), Salticidae (5), Tetragnathidae (2), Theridiidae (5), Thomisidae (1) and Titanoecidae (1). Eine neue Art wird beschrieben und illustriert: *Liocranoeca vjosensis* n. sp. (♂). Zwei Arten wurden zum ersten Mal auf der Balkanhalbinsel gefunden: *Janetschekia monodon* (O. Pickard-Cambridge, 1873) and *Trachyzelotes huberti* Platnick & Murphy, 1984. Fünfzehn Arten sind Neufunde für die Spinnenfauna Albaniens: *Arctosa perita* (Latreille, 1799), *Arctosa stigmosa* (Thorell, 1875), *Ballus rufipes* (Simon, 1868), *Berlandina plumalis* (O. Pickard-Cambridge, 1872), *Erigonoplus spinifemuralis* Dimitrov, 2003, *Gnaphosa dolosa* Herman, 1879, *Gnaphosa rhenana* Müller & Schenkel, 1895, *Gnathonarium dentatum* (Wider, 1834), *Neaetha absheronica* Logunov & Guseinov, 2002, *Pachygnatha clerckoides* Wunderlich, 1985, *Phrurolithus nigrinus* (Simon, 1878), *Pirata tenuitarsis* Simon, 1876, *Pocadicnemis juncea* Locket & Millidge, 1953, *Robertus arundineti* (O. Pickard-Cambridge, 1871) and *Titanoeca flavicoma* L. Koch, 1872. Entsprechend der vorliegenden Verbreitung werden die erfassten Arten in 16 zoogeographische Kategorien eingeteilt und in 4 chorologische Komplexe eingeteilt: weit verbreitete Arten, europäische Arten, mediterrane Arten und Endemiten. Weit verbreitete Arten (48 %) waren dominant, gefolgt von europäischen (26 %), mediterranen (20 %) und endemischen Arten (6 %). Die Ergebnisse der vorliegenden Studie unterstreichen die Bedeutung des Schutzes und der Erhaltung der neu beschriebenen Arten, die durch das geplante Wasserkraftwerk im Vjosa-Fluss ernsthaft bedroht würden.

Keywords: Spiders, Liocranidae, Araneae, Albania, Vjosa River, new species, first record, conservation.

Introduction

Although the European spider fauna is quite well known, some countries, such as Albania, remain poorly studied and greatly undervalued. This may, in part, be attributed to the political, cultural and scientific isolation of Albania from the rest of Europe during the communist regime. This isolation has left the spider fauna of Albania among the least studied not only in the Balkan Peninsula, but also across the whole of Europe. To date, 468 species of spiders have been recorded from Albania (HELSDINGEN 2017).

As a result of the uneven spatial distribution of the available data on spiders and their diversity in Albania, many areas of the country remain completely unexplored. Such an area is the section of the Vjosa River in the region of Poçem. Due to the controversial project to construct a hydropower plant at Kalivaç and Poçem, this area has only just recently received scientific attention from biologists.

The aim of this study is (i) to present the first evaluation of the spider fauna of the Vjosa River in the region of Poçem, (ii) to describe the newly discovered species *Liocranoeca vjosensis* **n. sp**. and (iii) to discuss the importance of its description. Furthermore, this paper points out the need for additional studies along the Vjosa River that would most likely result in further discoveries of new species, which could provide solid ground for the future establishment of protected areas in the region.

Material and Methods

The field work was conducted along the Vjosa River, in the vicinity of the village Kutë, in the period of 24–28.04.2017. The spiders were collected mainly by pitfall traps, using the cylindrical plastic bottles filled with a solution of vinegar. In only a few cases was hand collection performed. Several different habitats were investigated, mainly sandy and gravel banks along the river, wet meadows, scattered vegetation and open stands dominated by *Imperata cylindrica*, *Salix alba*, *Typha*, *Elocharis* and *Mentha*. More information about the habitat description can be found in SCHIEMER et al. (2018 this volume).

Altogether, 1001 specimens of spiders were studied (642 males and 359 females). Specimens were examined, measured and illustrated using a Nikon SMZ 25 stereomicroscope equipped with Nikon DS-Ri2 camera driven by NIS-Elements 5.2 Software. Left palp was illustrated. Lengths of leg segments were measured on the lateral side. Descriptions of the male palp refer to the left one. All morphological measurements are in millimeters. The taxonomy follows WORLD SPIDER CATALOG (2018) and NENTWIG et al. (2018). All material including the holotype are deposited in the Natural History Museum of Vienna.

The following abbreviations are used in the paper: Ta – tarsus, Mt – metatarsus, Ti – tibia, Pa – patella, Fe – femur, d – dorsal, pd – prodorsal, rd – retrodorsal, pl – prolateral, rl – retrolateral, v – ventral, pv – proventral, rv – retroventral, NHMW – Natural History Museum of Vienna, OUMNH – Oxford University Museum of Natural History, NHMB – Natural History Museum of Basel, Zoog. cat. – Zoogeographical categorization.

List of localities where spiders were collected (Map 1)

1. Floodplain; gravel bar with sandy silt cover; colonization stage with low to medium disturbance intensity; moist; scattered vegetation, 40°27.500′ 19°44.503′, 48–52 m a.s.l., 24–28.04.2017, pitfall traps, leg. W. PAILL, J. GUNCZY & T. FRANK

2. Floodplain; gravel bar with sandy silt cover; colonization stage with low to medium disturbance intensity; moist; scattered vegetation, 40°27.500′ 19°44.503′, 48–52 m a.s.l., 24–28.04.2017, pitfall traps, leg. W. Paill, J. Gunczy & T. Frank

3. Floodplain; gravel bar with sandy silt cover; colonization stage with low to medium disturbance intensity; moist; scattered vegetation, 40°27.522′ 19°44.493′, 48–52 m a.s.l., 24–28.04.2017, pitfall traps, leg. W. Paill, J. Gunczy & T. Frank

4. Floodplain; gravel bar with sandy cover; colonization stage with low to medium disturbance intensity; moist to wet; partly scattered vegetation, 40°27.500′ 19°44.530′, 48–52 m a.s.l., 24–28.04.2017, pitfall traps, leg. W. Paill, J. Gunczy & T. Frank

5. Floodplain; gravel bar with sand cover; colonization stage with low to medium disturbance intensity; moist to wet; partly scattered vegetation, 40°27.526′ 19°44.481′, 48–52 m a.s.l., 24–28.04.2017, pitfall traps, leg. W. Paill, J. Gunczy & T. Frank

6. Floodplain; gravel bar with sandy silt cover; early colonization stage with low to medium disturbance intensity; moist; almost bare vegetation, 40°27.555′ 19°44.454′, 48–52 m a.s.l., 24–28.04.2017, pitfall traps, leg. W. Paill, J. Gunczy & T. Frank

7. Floodplain; gravel bar with sandy silt cover; early colonization stage with low to medium disturbance intensity; moist; almost bare vegetation, 40°27.555′ 19°44.454′, 48–52 m a.s.l., 24–28.04.2017, pitfall traps, leg. W. Paill, J. Gunczy & T. Frank

8. Floodplain; gravel bar with sandy silt cover; colonization stage with low to medium disturbance intensity; moist; scattered vegetation, 40°27.518′ 19°44.549′, 48–52 m a.s.l., 24–28.04.2017, pitfall traps, leg. W. Paill, J. Gunczy & T. Frank

9. Floodplain; gravel bar with sandy cover; advanced colonization stage with low to medium disturbance intensity; moist; vegetation dominated by *Imperata cylindrica*, 40°27.529′ 19°44.584′, 48–52 m a.s.l., 24–28.04.2017, pitfall traps, leg. W. Paill, J. Gunczy & T. Frank

10. Floodplain; gravel bar with sandy cover; advanced colonization stage with low to medium disturbance intensity; moist; vegetation dominated by *Imperata cylindrica*, 40°27.538′ 19°44.619′, 48–52 m a.s.l., 24–28.04.2017, pitfall traps, leg. W. Paill, J. Gunczy & T. Frank

11. Floodplain; gravel bar with sandy cover; advanced colonization stage with low to medium disturbance intensity; moderately moist; vegetation dominated by *Imperata cylindrica*, 40°27.548′ 19°44.615′, 48–52 m a.s.l., 24–28.04.2017, pitfall traps, leg. W. Paill, J. Gunczy & T. Frank

12. Floodplain; disconnected side arm of the main channel; gravel with silty cover; colonization stage with low to medium disturbance intensity; moderately moist to wet; scattered vegetation, 40°27.672′ 19°44.604′, 48–52 m a.s.l., 24–28.04.2017, pitfall traps, leg. W. Paill, J. Gunczy & T. Frank

13. Floodplain; disconnected side arm of the main channel; gravel with silty cover; colonization stage with low to medium disturbance intensity; moist to wet; scattered vegetation, 40°27.672′ 19°44.604′, 48–52 m a.s.l., 24–28.04.2017, pitfall traps, leg. W. Paill, J. Gunczy & T. Frank

14. Floodplain; disconnected side arm of the main channel; gravel with clayey silt or silty cover; colonization stage with low to medium disturbance intensity; moist to wet; scattered vegetation, 40°27.697′ 19°44.634′, 48–52 m a.s.l., 24–28.04.2017, pitfall traps, leg. W. Paill, J. Gunczy & T. Frank

15. Floodplain; disconnected side arm of the main channel; gravel with clayey silt or silty cover; colonization stage with low to medium disturbance intensity; moist to wet; scattered vegetation, 40°27.697′ 19°44.634′, 48–52 m a.s.l., 24–28.04.2017, pitfall traps, leg. W. Paill, J. Gunczy & T. Frank

16. Floodplain; disconnected side arm of the main channel; gravel with clayey silt or silty cover; colonization stage with low to medium disturbance intensity; moist to wet; scattered vegetation, 40°27.719′ 19°44.647′, 48–52 m a.s.l., 24–28.04.2017, pitfall traps, leg. W. Paill, J. Gunczy & T. Frank

17. Floodplain; gravel with cover of fine-grained sediments; due to pasturing retarded transition stage with medium disturbance intensity; moderately moist; open stands dominated by *Imperata cylindrica*, 40°27.548′ 19°44.670′, 48–52 m a.s.l., 24–28.04.2017, pitfall traps, leg. W. Paill, J. Gunczy & T. Frank

18. Floodplain; gravel with cover of fine-grained sediments; due to pasturing retarded transition stage with medium disturbance intensity; moderately moist; open stands dominated *by Imperata cylindrica,* 40°27.548′ 19°44.704′, 48–52 m a.s.l., 24–28.04.2017, pitfall traps, leg. W. Paill, J. Gunczy & T. Frank

19. Floodplain; gravel with cover of fine-grained sediments; due to pasturing retarded transition stage with medium disturbance intensity; moderately moist; open stands dominated by *Imperata cylindrica*, 40°27.568′ 19°44.757′, 48–52 m a.s.l., 24–28.04.2017, pitfall traps, leg. W. Paill, J. Gunczy & T. Frank

20. Floodplain; foot of eroding river bank; gravel with silty sand cover; high disturbance intensity; moist; scattered vegetation, 40°27.579′ 19°44.861′, 48–52 m a.s.l., 24–28.04.2017, pitfall traps, leg. W. Paill, J. Gunczy & T. Frank.

21. Floodplain; gravel with cover of fine-grained sediments; due to pasturing retarded transition stage with medium disturbance intensity; moderately moist; open stands dominated by *Imperata cylindrica*, 40°27.577′ 19°44.876′, 48–52 m a.s.l., 24–28.04.2017, pitfall traps, leg. W. Paill, J. Gunczy & T. Frank

22. Floodplain; gravel with cover of fine-grained sediments; due to pasturing retarded transition stage with medium disturbance intensity; moderately moist; open stands dominated by *Imperata* cylindrica and *Vitex agnus castis*, 40°27.592′ 19°44.936′, 48–52 m a.s.l., 24–28.04.2017, pitfall traps, leg. W. Paill, J. Gunczy & T. Frank

23. Outside the floodplain; fallow land; sand or silty sand; moderately moist to dry, 40°27.677′ 19°45.251′, 48–52 m a.s.l., 24–28.04.2017, pitfall traps, leg. W. Paill, J. Gunczy & T. Frank

24. Higher level of floodplain; ditch channel with soft-wood; silt or clayey silt; moist to wet; vegetation dominated by *Salix alba* and *Typha*, 40°27.802′ 19°45.218′, 48–52 m a.s.l., 24–28.04.2017, pitfall traps, leg. W. Paill, J. Gunczy & T. Frank

25. Higher level of floodplain; ditch channel with softwood; silt or clayey silt; moist to wet; vegetation dominated by *Mentha* and *Typha*, 40°27.820′ 19°45.251′, 48–52 m a.s.l., 24–28.04.2017, pitfall traps, leg. W. Paill, J. Gunczy & T. Frank

26. Higher level of floodplain; disconnected side arm; silt or clayey silt; moist to wet; vegetation dominated by *Typha*, 40°27.835′ 19°45.267′, 48–52 m a.s.l., 24–28.04.2017, pitfall traps, leg. W. Paill, J. Gunczy & T. Frank

27. Higher level of floodplain; disconnected side arm; silt or clayey silt; moist to wet; vegetation dominated by *Elocharis* and *Typha*, 40°27.770′ 19°45.363′, 48–52 m a.s.l., 24–28.04.2017, pitfall traps, leg. W. Paill, J. Gunczy & T. Frank

28. Higher level of floodplain; disconnected side arm; pasture; silt or clayey silt; moderately moist to dry, 40°27.770′ 19°45.363′, 48–52 m a.s.l., 24–28.04.2017, pitfall traps, leg. W. Paill, J. Gunczy & T. Frank

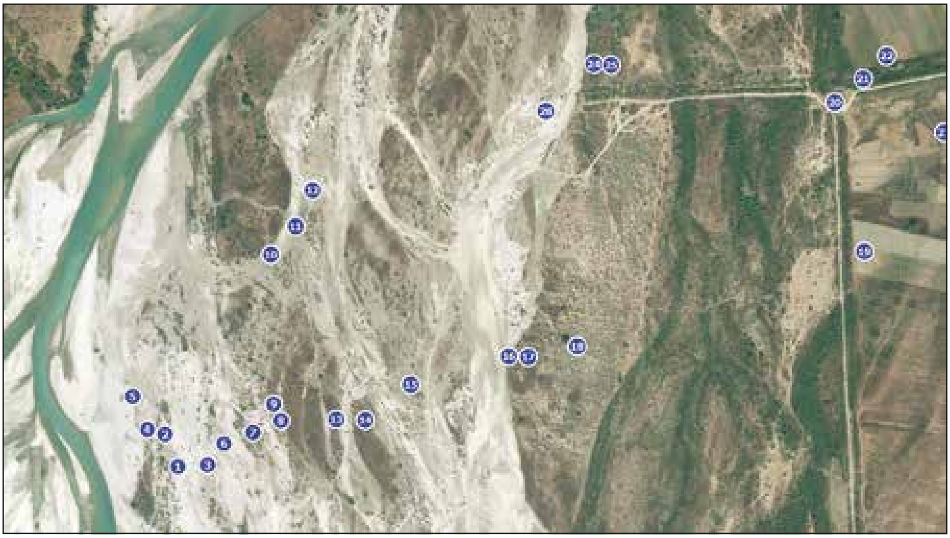
29. Floodplain; foot of eroding river bank; gravel with silty sand cover; high disturbance intensity; moist; scattered vegetation, 40°27.830′ 19°44.959′, 48–52 m a.s.l., 24–28.04.2017, pitfall traps, leg. W. Paill, J. Gunczy & T. Frank

30. 40° 27.789’ 19° 44.903’, hand collecting, 28.04.2017, leg. J. Gunczy & G. Kunz

31. Gravel riverbank with sandy silt cover; inactive side arm, hand collecting, 48–52 m a.s.l., 25.04.2017, leg. W. Paill

32. Ditch with softwood and *Typhia*; silt or clayey silt, hand collecting, 48–52 m a.s.l., 25.04.2017, leg. W. Paill

33. Gravel riverbank with sandy silt cover; cut bank with slip rock and silt, hand collecting, 48–52 m a.s.l., 27.04.2017, leg. W. Paill



Map 1: Geographical distribution of the investigated localities in the region of Poçem in Albania. The Vjosa River is shown to the left. The following sites are with same GPS coordinates presented in the map: 1=2, 6=7, 12=13, 14=15. Sites 31–33 are not presented in the map due lack of GPS coordinates in the original labels. – Karte 1: Geographische Verteilung der untersuchten Orte in der Region Poçem in Albanien. Der Vjosa Fluss ist auf der linken Seite zu sehen. Die folgenden Standorte sind mit den gleichen GPS-Koordinaten in der Karte dargestellt: 1 = 2, 6 = 7, 12 = 13, 14 = 15. Die Seiten 31 bis 33 sind aufgrund fehlender GPS-Koordinaten in den ursprünglichen Etiketten nicht in der Karte dargestellt.

Results and Discussion

Faunistic part

Altogether 50 species from 11 families were recorded: Araneidae (2), Gnaphosidae (7), Linyphiidae (8), Liocranidae (1), Lycosidae (15), Phrurolithidae (3), Salticidae (5), Tetragnathidae (2), Theridiidae (5), Thomisidae (1) and Titanoecidae (1).

The most significant result is the discovery of a new species from the family Liocranidae: *Liocranoeca vjosensis* **n. sp**. (♂).

Two species are registered for the first time in the Balkan Peninsula: *Janetschekia monodon* (O. Pickard-Cambridge, 1873) and *Trachyzelotes huberti* Platnick & Murphy, 1984.

Fifteen species are new records for the spider fauna of Albania: *Arctosa perita* (Latreille, 1799), *Arctosa stigmosa* (Thorell, 1875), *Ballus rufipes* (Simon, 1868), *Berlandina plumalis* (O. Pickard-Cambridge, 1872), *Erigonoplus spinifemuralis* Dimitrov, 2003, *Gnaphosa dolosa* Herman, 1879, *Gnaphosa rhenana* Müller & Schenkel, 1895, *Gnathonarium dentatum* (Wider, 1834), *Neaetha absheronica* Logunov & Guseinov, 2002, *Pachygnatha clerckoides* Wunderlich, 1985, *Phrurolithus nigrinus* (Simon, 1878), *Pirata tenuitarsis* Simon, 1876, *Pocadicnemis juncea* Locket & Millidge, 1953, *Robertus arundineti* (O. Pickard-Cambridge,

1871) and *Titanoeca flavicoma* L. Koch, 1872. The results indicate the dominance of representatives of the families Lycosidae (15), Linyphiidae (8), Gnaphosidae (7) and Salticidae (5).

Despite the fact that this study reflects only a snapshot of the existing spider diversity, 32 % (16 species) of the recorded species are new to the fauna of Albania. Bearing this fact in mind and taking into account that such significant results were achieved in just 4 days of collection, it follows that the spider fauna of Albania still remains largely unexplored.

Tab. 1: Species list of spiders collected at Vjosa River near the village of Kutë. New records are marked with an asterisk: * = new record for Albanian fauna, ** = new record for the fauna of the Balkan Peninsula. – Tab. 1: Artenliste der Spinnen, die am Fluss Vjosa in der Nähe des Dorfes Kutë gesammelt wurden. Neue Einträge sind mit einem Stern markiert: * = neuer Rekord für die albanische Fauna, ** = neuer Rekord für die Fauna der Balkanhalbinsel.

Family/ Species	Localities	Zoog. cat.
THERIDIIDAE		
Asagena phalerata (Panzer, 1801)	**23** (1 ♂); **25** (2 ♂♂); **26** (2 ♂♂); **27** (1 ♂); **28** (2 ♂♂)	PAL
Episinus truncatus Latreille, 1809	**21** (1 ♀)	PAL
Euryopis episinoides (Walckenaer, 1847)	**11** (1 ♂)	MED
**Robertus arundineti* (O. Pickard-Cambridge, 1871)	**2** (1 ♀); **6** (1 ♂); **12** (1 ♂); **14** (1 ♀); **23** (1 ♂)	EMMA
Theridion varians Hahn, 1833	**24** (1 ♂)	EUS
LINYPHIIDAE		
Erigone dentipalpis (Wider, 1834)	**5** (1 ♂)	PAL
**Erigonoplus spinifemuralis* Dimitrov, 2003	**27** (1 ♀); **28** (1 ♂)	PEM
**Gnathonarium dentatum* (Wider, 1834)	**24** (2 ♂♂ 21 ♀♀); **25** (1 ♂ 1 ♀); **26** (1 ♂ 1 ♀)	PAL
***Janetschekia monodon* (O. Pickard-Cambridge, 1873)	**6** (1 ♂)	ABA
Oedothorax apicatus (Blackwall, 1850)	**24** (2 ♀♀); **26** (3 ♀♀)	EMA
**Pocadicnemis juncea* Locket & Millidge, 1953	**2** (1 ♂); 17 (1 ♂); 24 (1 ♂)	EUR
Prinerigone vagans (Audouin, 1826)	**1** (20 ♂♂ 12 ♀♀); **2** (4 ♂♂ 1 ♀); **3** (6 ♂♂ 3 ♀♀); **5** (7 ♂♂); **6** (10 ♂♂ 1 ♀); **7** (5 ♂♂ 2 ♀♀); **12** (19 ♂♂ 10 ♀♀); **13** (2 ♂♂ 6 ♀♀); **14** (11 ♂♂ 7 ♀♀); **15** (7 ♂♂ 13 ♀♀); **16** (15 ♂♂ 3 ♀♀); **19** (3 ♂♂); **20** (2 ♂♂); **26** (1 ♂); **29** (2 ♂♂); **30** (1 ♂); **31** (1 ♂ 1 ♀)	EMMA
Tenuiphantes tenuis (Blackwall, 1852)	**17** (1 ♀)	EMMA
TETRAGNATHIDAE		
**Pachygnatha clerckoides* Wunderlich, 1985	**25** (1 ♂); **26** (1 ♀)	PEM
Pachygnatha degeeri Sundevall, 1830	**27** (1 ♂ 1 ♀)	PAL
ARANEIDAE		
Hypsosinga sanguinea (C. L. Koch, 1844)	**17** (1 ♂)	PAL
Mangora acalypha (Walckenaer, 1802)	**31** (1 ♀)	EMMA

Tab. 1 continued – Fortsetzung

Family/ Species	Localities	Zoog. cat.
LYCOSIDAE		
Arctosa cinerea (Fabricius, 1777)	**1** (1 ♂); **2** (1 ♂ 1 ♀); **3** (1 ♂); **5** (2 ♂♂); **13** (1 ♂ 1 ♀); **15** (1 ♂); **16** (1 ♂); **33** (1 ♀)	EKA
Arctosa leopardus (Sundevall, 1833)	**18** (7 ♂♂ 1 ♀); **24** (11 ♂♂ 1 ♀); **25** (2 ♂♂ 1 ♀); **26** (25 ♂♂ 3 ♀♀); **27** (7 ♂♂ 2 ♀♀)	EMMA
**Arctosa perita* (Latreille, 1799)	**2** (1 ♂); **13** (1 ♂)	EUR
**Arctosa stigmosa* (Thorell, 1875)	**12** (1 ♂ 1 ♀); **13** (3 ♂♂ 1 ♀); **14** (2 ♂♂); **15** (1 ♂ 2 ♀♀); **16** (1 ♂ 3 ♀♀)	EUS
Arctosa variana C. L. Koch, 1847	**29** (4 ♂♂)	SEU
Aulonia albimana (Walckenaer, 1805)	**10** (1 ♂); **19** (2 ♂♂); **22** (1 ♀)	PAL
Pardosa atomaria (C. L. Koch, 1847)	**1** (2 ♀♀); **2** (1 ♀); **4** (1 ♀); **5** (3 ♂♂); **6** (1 ♂); **8** (1 ♀); **13** (3 ♂♂ 2 ♀♀); **14** (4 ♂♂ 2 ♀♀); **15** (2 ♂♂ 2 ♀♀); **16** (1 ♀); **20** (6 ♂♂ 2 ♀♀); **29** (8 ♂♂ 2 ♀♀)	EME
Pardosa cribrata Simon, 1876	**5** (3 ♂♂); **12** (1 ♀); **14** (1 ♂); **26** (3 ♀♀); **27** (1 ♂ 14 ♀♀); **28** (1 ♂ 1 ♀)	SEU
Pardosa hortensis (Thorell, 1872)	**4** (2 ♀♀); **8** (2 ♀♀); **9** (1 ♂ 10 ♀♀); **10** (2 ♂♂ 9 ♀♀); **11** (1 ♂ 5 ♀♀); **12** (3 ♂♂ 3 ♀♀); **13** (1 ♀); 14 (2 ♀♀); **17** (1 ♀); **18** (2 ♂♂); **20** (1 ♂ 3 ♀♀); **24** (1 ♂ 1 ♀); **25** (8 ♂♂ 21 ♀♀); **26** (2 ♂♂ 3 ♀♀); **29** (1 ♂)	EKA
Pardosa proxima (C. L. Koch, 1847)	**11** (1 ♂ 1 ♀); **23** (1 ♂ 5 ♀♀); **25** (1 ♂ 2 ♀♀); **26** (1 ♀); **27** (3 ♂♂)	SEU
Pirata piraticus (Clerck, 1757)	**18** (2 ♂♂); **25** (1 ♂)	HOL
**Pirata tenuitarsis* Simon, 1876	**13** (1 ♂); **24** (17 ♂♂ 5 ♀♀); **25** (8 ♂♂ 6 ♀♀); **26** (22 ♂♂ 16 ♀♀)	EMA
Piratula latitans (Blackwall, 1841)	**2** (1 ♂); **11** (1 ♂); **12** (1 ♂); **13** (2 ♂♂); **18** (6 ♂♂ 4 ♀♀); **24** (54 ♂♂ 15 ♀♀); **25** (70 ♂♂ 17 ♀♀); **26** (114 ♂♂ 47 ♀♀); **27** (25 ♂♂ 12 ♀♀); **28** (3 ♂♂ 1 ♀); **29** (2 ♂♂); **32** (1 ♀)	EKA
Trochosa hispanica Simon, 1870	**24** (2 ♂♂); **25** (2 ♂♂); **26** (3 ♂♂); **27** (1 ♂ 1 ♀)	SEK
Trochosa ruricola (De Geer, 1778)	**9** (1 ♀); **10** (1 ♀); **13** (1 ♀); **14** (1 ♀); **24** (1 ♂); **25** (2 ♀♀); **26** (1 ♂ 3 ♀♀); **30** (1 ♀)	EUA
TITANOECIDAE		
**Titanoeca flavicoma* L. Koch, 1872	**22** (1 ♂)	SEU
LIOCRANIDAE		
Liocranoeca vjosensis **n. sp**.	**27** (1 ♂)	ALB
PHRUROLITHIDAE		
Phrurolithus festivus (C. L. Koch, 1835)	**13** (1 ♂); **25** (1 ♂)	PAL
**Phrurolithus nigrinus* (Simon, 1878)	**21** (2 ♀♀)	SEU

Tab. 1 continued – Fortsetzung

Family/ Species	Localities	Zoog. cat.
Phrurolithus szilyi Herman, 1879	**23** (1 ♂)	SEU
GNAPHOSIDAE		
Aphantaulax cincta (L. Koch, 1866)	**30** (1 ♂)	MED
**Berlandina plumalis* (O. Pickard-Cambridge, 1872)	**4** (1 ♂); **11** (4 ♂♂)	MED
**Gnaphosa dolosa* Herman, 1879	**5** (1 ♂); **33** (1 ♀)	SEM
**Gnaphosa rhenana* Müller & Schenkel, 1895	**11** (1 ♂)	ABA
Haplodrassus dalmatensis (L. Koch, 1866)	**22** (1 ♂)	EMMA
Haplodrassus signifer (C. L. Koch, 1839)	**24** (1 ♂)	HOL
***Trachyzelotes huberti* Platnick & Murphy, 1984	**22** (1 ♂); **26** (2 ♂♂); **28** (1 ♂)	MED
THOMISIDAE		
Xysticus kochi Thorell, 1872	**23** (1 ♂)	PAL
SALTICIDAE		
**Ballus rufipes* (Simon, 1868)	**30** (1 ♂)	MED
Mendoza canestrinii (Ninni, 1868)	**24** (1 ♂)	EUA
**Neaetha absheronica* Logunov & Guseinov, 2002	**4** (1 ♂)	EME
Pellenes arciger (Walckenaer, 1837)	**22** (1 ♂)	SEU
Phlegra bresnieri (Lucas, 1846)	**4** (1 ♂)	MED

Taxonomic part

Liocranidae

***Liocranoeca vjosensis* Komnenov n. sp.** (Figs. 2–7)

Material examined. Holotype 1 ♂ (NHMW 28671): ALBANIA, Fier County, Mallakastër Municipality, Vjosa River near the village of Kutë, higher level of floodplain, disconnected side arm, silt or clayey silt, moist to wet vegetation dominated by *Elocharis* and *Typha*, 40°27.770′ 19°45.363′, 51 m a.s.l., 24–28.04.2017, pitfall traps, leg. W. Paill, J. Gunczy & T. Frank.

Etymology. The specific name refers to the type locality; adjective.

Diagnosis. *Liocranoeca vjosensis* **n. sp**. is a distinctive species easily recognized from other three species by the straight embolus (Fig. 5) (curved in *L. emertoni* (Kaston, 1938), *L. spasskyi* Ponomarev, 2007 and *L. striata* Kulczyński, 1882). By the length of the embolus, the new species is close related to *L. emertoni* and *L. spasskyi* but can be separated from them by the smaller and narrower embolar base (larger and broader in to *L. emertoni* and *L. spasskyi*). From *L. striata,* the new species can be easily distinguished by the very short and linear embolus (long and semicircular in *L. striata*).

Description. Male (holotype). Carapace 1.64 long, 1.24 wide. Abdomen 1.96 long, 1.16 wide. Total length 3.6. Carapace brown with broad greyish lateral bands and unclear strips diverging from the medial groove. Chelicerae orange, 3 promarginal (middle one being the largest) and 2 retromarginal teeth. Maxillae, labium and sternum orange, longer than wide. Legs orange. Leg formula 4123. Leg measurements and leg spination are given in Table 2 and Table 3.

Tab. 2: Leg measurements of *Liocranoeca vjosensis* **n. sp**. (male holotype). – Tab. 2: Beinmaße von *Liocranoeca vjosensis* **n. sp**. (männlicher Holotypus).

	Fe	Pt	Ti	Mt	Ta
I	1.28	0.64	1.08	0.92	0.80
II	1.16	0.64	1.00	0.88	0.80
III	1.08	0.56	0.96	1.00	0.72
IV	1.56	0.64	1.48	1.68	0.96

Tab. 3: Leg spination of *Liocranoeca vjosensis* **n. sp**. (male holotype). Backslash indicates structure not present. – Tab. 3: Beinstachelung von *Liocranoeca vjosensis* **n. sp**. (männlicher Holotypus). Backslash zeigt an, dass die Struktur nicht vorhanden ist.

	Fe	Pt	Ti	Mt	Ta
I	3d 1rl	/	2 (pv rv)	2pv (2–3)rv	/
II	3d	/	2rv	2(rv pv)	/
III	3d 2rl 1pl	1d	2pv 2d 2(pd rd)	2rv 3pv 3 (rd pd)	/
IV	3d 1rl lpl	1d 1rl	2(d pd rd) 2pv 1rv	2(rv pv) 4(rd pd)	/

Palp (Figs. 2–7): Tibial apophysis straight, bluntly pointed; median apophysis situated laterally, hooked, with broad base; embolus short, straight and pointed.

Female unknown.

Natural history. The only male was collected at the end of April by means of pitfall traps placed on wet clayey silt ground on the higher level of the floodplain, among vegetation dominated by *Elocharis* and *Typha*, at an altitude of 52 m.

Distribution. Only known from the type locality (Fig. 1).

Conservation status. Since this is first study to evaluate the spider fauna and diversity of the investigated area and since only one specimen of the new species was collected, the conservation status of *Liocranoeca vjosensis* **n. sp**. cannot be accurately determined at present. For precise categorization according IUCN Red List Categories and Criteria, more investigations are required. However, this new endemic species will be threatened by the proposed hydroelectric power dam along the Vjosa River, which will have a devastating impact on the type locality. The creation of a new hydroelectric dam would most likely drastically impact populations of this new species, and in some cases would eventually lead to the extinction of species before they become known to science. For these reasons, the discovery of new species is crucial for environmental and natural resources management and could lead to the establishment of protected areas in the future. The discovery of a new spider species in only four days of collection, shows that new species will continue to be discovered as more and larger-scaled studies are carried out along the Vjosa River.

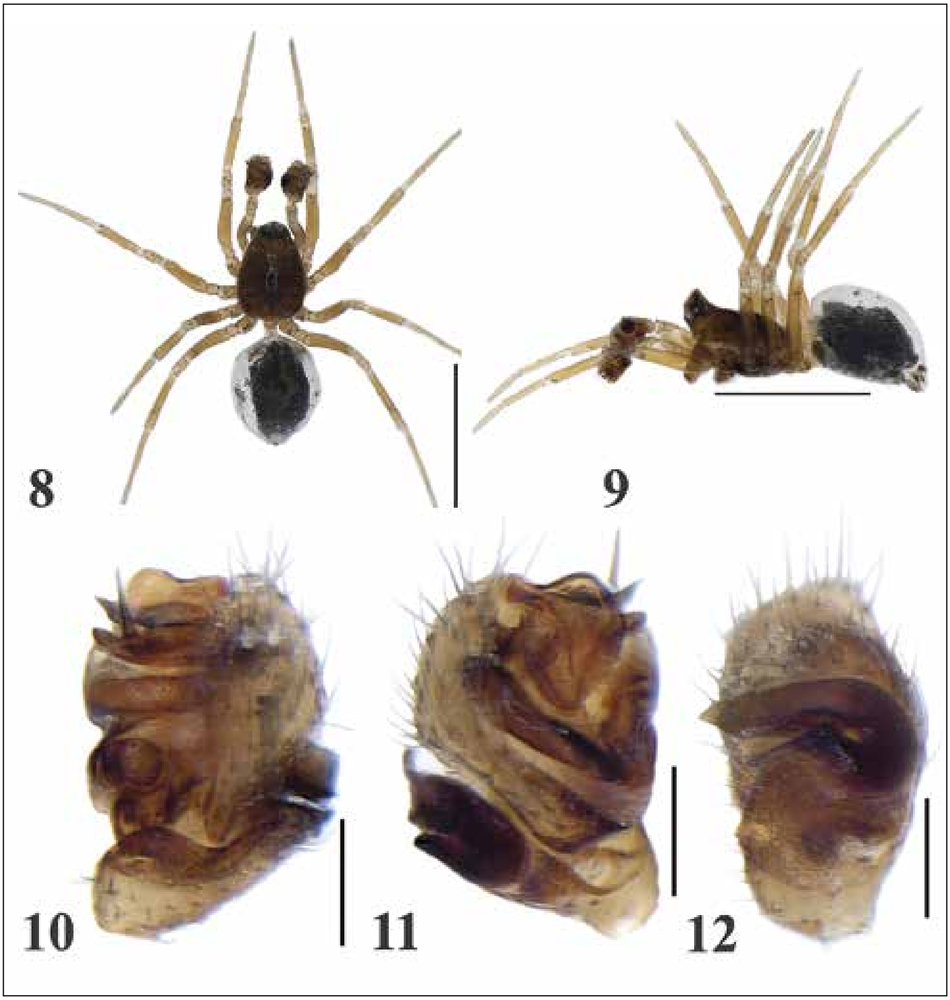
Fig. 1: Type locality of *Liocranoeca vjosensis* **n. sp.** at the Vjosa River near Kutë, Albania (Photo: Gernot KUNZ, 26.04.2017). – Abb. 1: Typenlokalität von *Liocranoeca vjosensis* **n. sp**. am Fluss Vjosa bei Kutë, Albanien (Foto: Gernot KUNZ, 26.04.2017).

Zoogeographical analysis

Since this paper presents the first data for the spider fauna of the investigated area, the subsequent zoogeographical analysis remains incomplete and should be understood as the first attempt to summarize our present knowledge of the spider fauna in the investigated area. Based on the present distribution, the recorded species are classified into 16 zoogeographical categories and then grouped into the four following chorological complexes: Widely distributed species, European, Mediterranean and Endemics (Table 4), which are discussed below.

Widely distributed species complex (HOL + PAL + EUA + EUS + EMA + SEM + EMMA) is the best represented, comprising almost half of all species (48 %). **Palearctic species** predominate (*Asagena phalerata, Aulonia albimana, Episinus truncatus, Erigone dentipalpis, Gnathonarium dentatum, Hypsosinga sanguinea, Pachygnatha degeeri, Phrurolithus festivus* and *Xysticus kochi*) (18 %), followed by **E-Mediterranean-Middle Asiatic** *(Arctosa leopardus, Haplodrassus dalmatensis, Mangora acalypha, Prinerigone vagans, Robertus arundineti* and *Tenuiphantes tenuis*) (12 %) and **Euro-Asian** species (*Mendoza canestrinii* and *Trochosa ruricola*) (4 %).

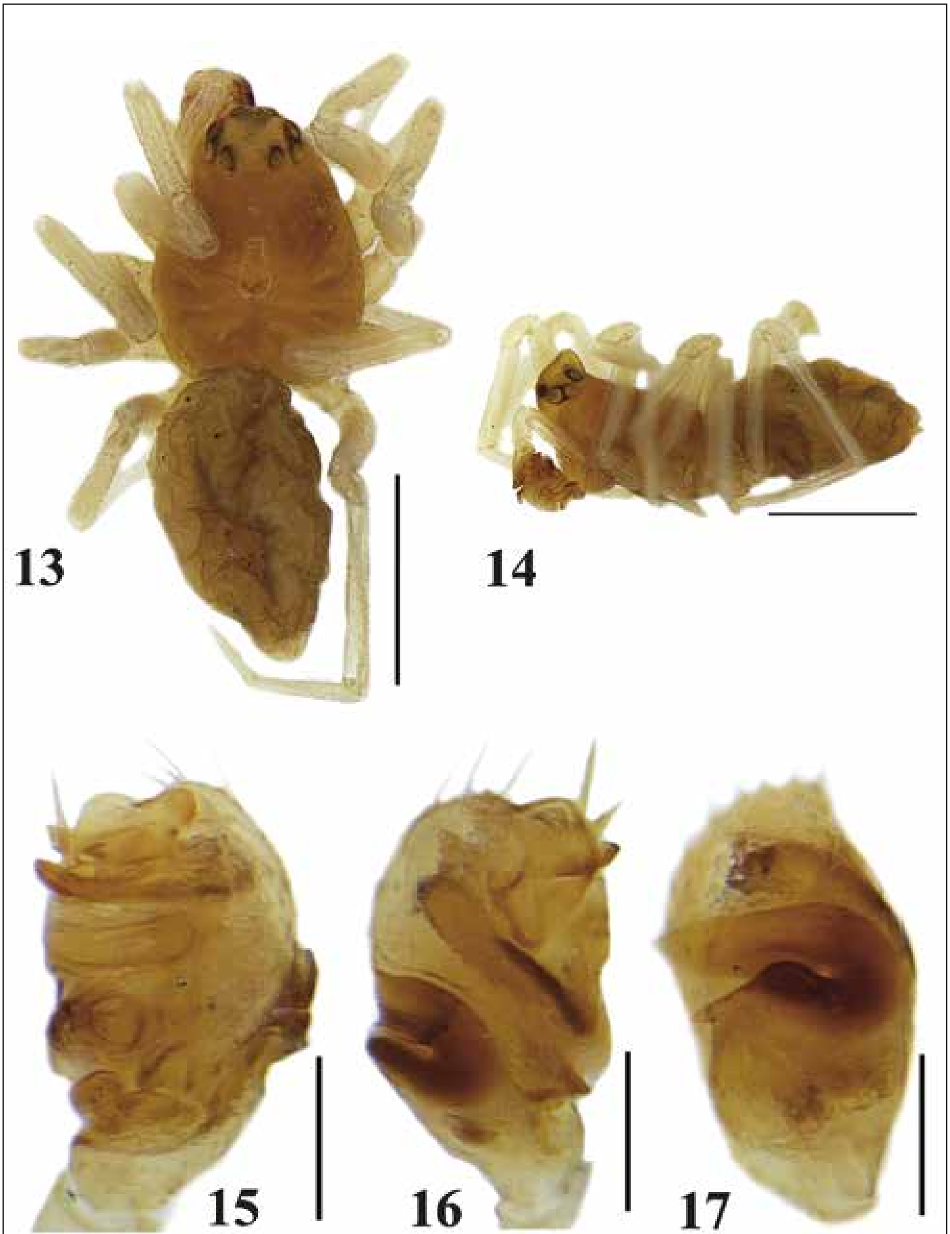
Figs. 2–7: *Liocranoeca vjosensis* **n. sp.** male holotype, NHMW 28671. 2 habitus, dorsal view; 3 palp, retrolateral view; 4 same, ventral-retrolaterally; 5 same, ventral view; 6 same, prolateral view; 7 same, dorsal view. Scale bars: 1 mm (2); 0.1 mm (3–7). – Abb. 2–7: *Liocranoeca vjosensis* **n. sp.** männlicher Holotypus, NHMW 28671. 2 Habitus, dorsale Ansicht; 3 palp, retrolaterale Ansicht; 4 gleich, ventral-retrolateral; 5 gleiche, ventrale Ansicht; 6 gleiche, prolaterale Ansicht; **7** gleiche, dorsale Ansicht. Maßstabsbalken: 1 mm (2); 0.1 mm (3–7).



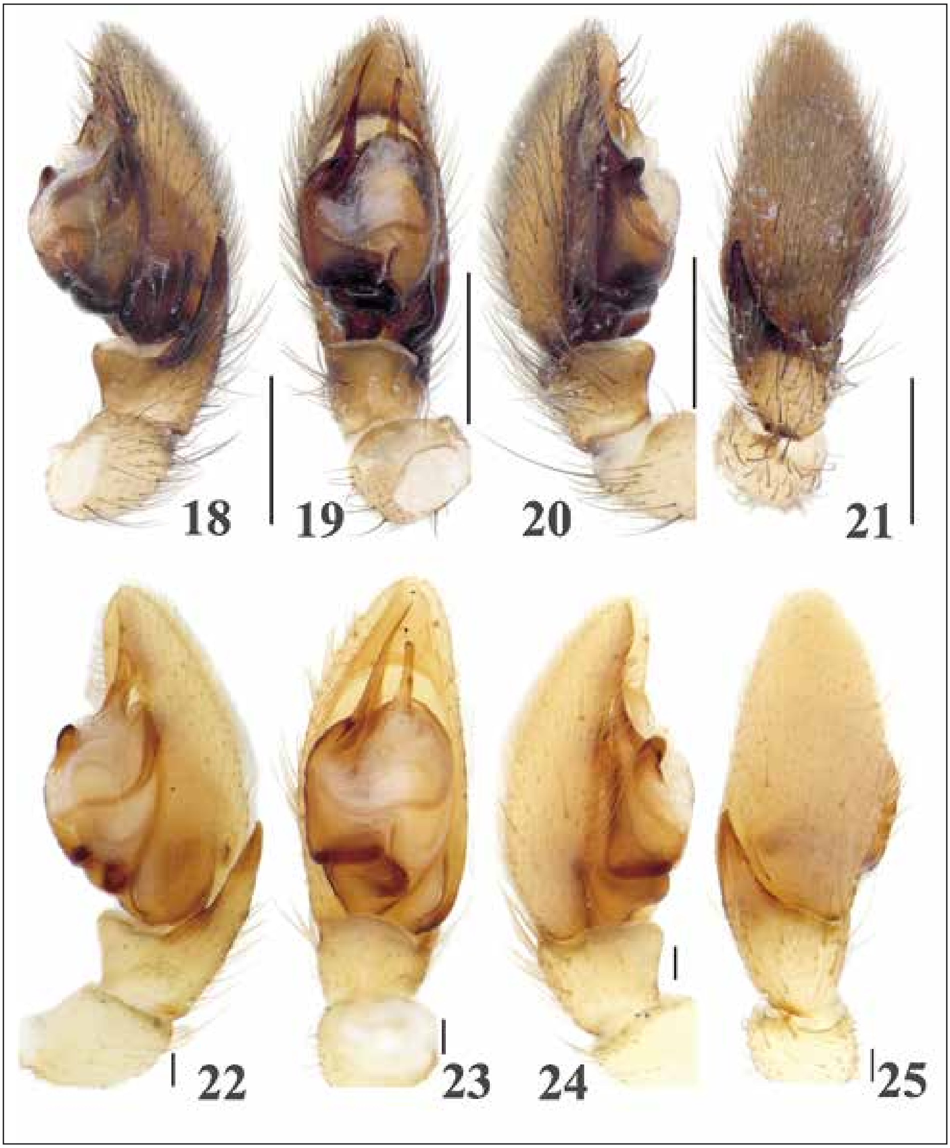
Figs. 8–12: *Janetschekia monodon* male from Albania. 8 habitus, dorsal view; 9 same, lateral view; 10 palp, retrolateral view; 11 same, prolateral view; 12 same, dorsal view. Scale bars: 1 mm (8–9); 0.1 mm (10–12). – Abb. 8–12: *Janetschekia monodon* männlich aus Albanien. 8 Habitus, dorsale Ansicht; 9 gleiche, seitliche Ansicht; 10 palp, retrolaterale Ansicht; 11 gleiche, prolaterale Ansicht; 12 gleiche, dorsale Ansicht. Maßstabsbalken: 1 mm (8–9); 0.1 mm (10–12).

European species complex (EUR + EKA + SEU + SEK) includes 13 species (26 %). Within it, the **S-European** species are dominant (*Arctosa variana, Pardosa cribrata, Pardosa proxima, Pellenes arciger, Phrurolithus nigrinus, Phrurolithus szilyi* and *Titanoeca flavicoma*) (14 %), followed by **Euro-Caucasian** (*Arctosa cinerea*, *Pardosa hortensis* and *Piratula latitans*) (6 %) and **European** species (*Arctosa perita* and *Pocadicnemis juncea*) (4 %).

Mediterranean species complex (MED + EME + PEM) includes 10 species (20 %). This complex contains **Mediterranean** species (*Aphantaulax cincta*, *Ballus rufipes*, *Berlandina*



Figs. 13–17: *Janetschekia monodon* male holotype, OUMNH 707. 13 habitus, dorsal view; 14 same, lateral view; 15 palp mirrored, retrolateral view; 16 same, prolateral view; 17 same, dorsal view. Scale bars: 0.5 mm (15–16); 0.1 mm (17–19). – Abb. 13–17: *Janetschekia monodon* männlicher Holotypus, OUMNH 707. 13 Habitus, dorsale Ansicht; 14 gleiche, seitliche Ansicht; 15 palp gespiegelte, retrolaterale Ansicht; 16 gleiche, prolaterale Ansicht; 17 gleiche, dorsale Ansicht. Maßstabsbalken: 0.5 mm (15–16); 0.1 mm (17–19).



Figs. 18–25: Palp, retrolateral view (18, 22); same, dorsal view (19, 23); same, prolateral view (20, 24); same, dorsal view (21, 25). 18–21 *Gnaphosa rhenana* from Albania, Vjosa River near Kutë; 22–25 *Gnaphosa rhenana* lectotype, NHMB 695a. Scale bars: 0.5 mm (18–21); 0.1 mm (22–25). – Abb. 18–25: Palp, retrolaterale Ansicht (18, 22); gleiche, dorsale Ansicht (19, 23); gleiche, prolaterale Ansicht (20, 24); gleiche, dorsale Ansicht (21, 25). 18–21 *Gnaphosa rhenana* aus Albanien, Vjosa River bei Kutë; 22–25 *Gnaphosa rhenana* Lectotypus, NHMB 695a. Maßstabsbalken: 0.5 mm (18–21); 0.1 mm (22–25).

plumalis, Euryopis episinoides, Phlegra bresnieri and *Trachyzelotes huberti*) are dominant (12 %), followed by **E-Mediterranean** (*Neaetha absheronica* and *Pardosa atomaria*) and **Ponto-E-Mediterranean** species (*Erigonoplus spinifemuralis* and *Pachygnatha clerckoides*) (4 %).

Endemic species complex (ABA + ALB) comprises 3 species (6 %). Due to our limited knowledge on the distribution of *Gnaphosa rhenana* and *Janetschekia monodon* (which occurred outside their typical area of distribution – the Alps) in the unexplored Balkan Peninsula, they are temporally treated here as **Alpine-Balkanic** species. It seems that both species are very rare in the investigated area, since only one specimen of each species has been collected. For a better understanding of their taxonomy, comparative material of holotype of *Janetschekia monodon* (Figs. 13–17) and lectotype of *Gnaphosa rhenana* (Figs. 22–25) were examined and described in the study. *Gnaphosa rhenana* and *Janetschekia monodon* are ripicolous species and particularly high-quality indicators for natural river banks (Steinberger 1996). For these reasons, we can freely consider them as flagship-species for open braided sections of dynamic alpine rivers.

Known only from the type locality, and at this state of knowledge, *Liocranoeca vjosensis* **n. sp**. is considered as **Albanian** endemic species.

Tab. 4: Zoogeographical composition of the spider fauna of Vjosa River. – Tab. 4: Zoogeographische Zusammensetzung der Spinnenfauna von Vjosa Fluss.

Complexes	**Chorotypes**	**Species**		
		Code	**Number**	**%**
Widely distributed	Holarctic	HOL	2	4
	Palearctic	PAL	9	18
	Euro-Asian	EUA	2	4
	Euro-Siberian	EUS	2	4
	Euro-Middle Asian	EMA	2	4
	S-European-Middle Asiatic	SEM	1	2
	E-Mediterranean-Middle Asiatic	EMMA	6	12
	Total		**24**	**48**
European	European	EUR	2	4
	Euro-Caucasian	EKA	3	6
	S-European	SEU	7	14
	S-Europeo-Caucasian	SEK	1	2
	Total		**13**	**26**
Mediterranean	Mediterranean	MED	6	12
	E-Mediterranean	EME	2	4
	Ponto-E-Mediterranean	PEM	2	4
	Total		**10**	**20**
Endemics	Alpine-Balkanic	ABA	2	4
	Albanian	ALB	1	2
	Total		**3**	**6**

Acknowledgments

I am much obliged to Thomas Frank for providing me with spider material from Vjosa River for identification. Helmut Sattmann and Christoph Hörweg (NHMW) are cordially thanked for allowing me to utilize museum facilities. Special thanks are due to Irene Drozdowsky and Alexander Mrkvicka (Vienna) for arranging my stay in Vienna. I want to thank Zoë Simmons (OUMNH) and Ambros Hänggi (NHMB) for sending me the holotype of *Janetschekia monodon* and lectotype of *Gnaphosa rhenana*, respectively. Norbert Milasowszky (Vienna) is kindly acknowledged for his helpful and valuable comments. English of the earlier draft was checked by John Plant (Connecticut, USA).

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A small collection of spiders (Arachnida: Araneae) from the River Vjosa, Albania – with an updated spider checklist of Albania

Theo Blick

Five spider species were collected at the end of April 2017 in Albania on the River Vjosa near the village of Kutë (40.4754°N, 19.7538°E, 47m a.s.l.). The species are briefly discussed and two of them, *Marpissa pomatia* and *Marpissa nivoyi* (Salticidae), are new records for Albania. The importance of the conservation of the natural status of the River Vjosa is discussed. Finally, an updated checklist of the spiders of Albania is presented, which contains 490 spider species.

Blick T., 2018: Eine kleine Spinnensammlung (Arachnida: Araneae) vom Fluss Vjosa, Albanien – mit einer aktualisierten Spinnen-Checkliste Albaniens.
Am Fluss Vjosa in der Nähe des Dorfes Kutë (40.4754°N, 19.7538°E, 47m a.s.l.) in Albanien wurden Ende April 2017 fünf Spinnenarten gesammelt. Die Arten werden kurz besprochen; darunter sind zwei, *Marpissa pomatia* und *Marpissa nivoyi* (Salticidae), Neunachweise für Albanien. Die Bedeutung des Erhaltes des ursprünglichen Zustandes des Flusses Vjosa wird diskutiert. Zum Abschluss ist eine aktualisierte Checkliste der Spinnen Albaniens zusammengestellt, die 490 Spinnenarten umfasst.

Keywords: Albania, Araneae, checklist, conservation, faunistics, River Vjosa, Salticidae, spiders.

Introduction

The spider fauna of Albania is still insufficiently known. Since the compilation by Deltshev et al. (2011, 335 species) the number of species known for Albania has increased by more than 35% (Vrenozi 2012, Vrenozi & Deltshev 2012a, 2012b, Vrenozi & Jäger 2012, 2013, Vrenozi & Dunlop 2013, Helsdingen & IJland 2015, Naumova et al. 2016, Helsdingen et al. 2018). Naumova et al (2016) offered a total of 461 species, Helsdingen (2017) listed 468 and Nentwig et al. (2018, https://araneae.nmbe.ch/biodiversity/countrylist) listed 470 species, which are the basis for the checklist below.

Details about the River Vjosa are given by Schiemer et al. (2018 this volume). The contribution by Komnenov (2018 this volume) deals particulary with a larger collection of spiders, and added 17 new spider records for Albania including one new species.

Material and methods

The sampling site is situated near the village of Kutë on a branch of the River Vjosa which is temporarily unconnected to the main river; co-ordinates 40.475390°N, 19.753832°E, 47 m a.s.l. Spiders were collected by Simon Vitecek, Wolfram Graf and Ulrich Heckes between April 24 and 26, 2017 during the Austrian excursion to the River Vjosa. The spiders will be deposited in the Natural History Museum Vienna.

Results

***Lariniodes suspicax* (O. Pickard-Cambridge, 1876) (Araneidae)**

Material: 1 ♀, 24.-26.4.2017, leg. Graf.

Determination: Šestáková et al. (2014: sub *L. folium*).

Unlike its sister species *L. cornutus* (Clerck, 1757), which prefers wetlands, *L. suspicax* can be found at drier sites according to the literature (Nentwig et al. 2018). This assumption can be doubted not only based on the present record, but also e.g. Šestáková et al. (2014: sub *L. folium*) who listed numerous findings from wetlands. Older determinations of both species would be worth checking (Šestáková et al. 2014: 68: "There are, however, some misidentifications ..., which could lead to misinformation about its distribution and biology").

Distribution: The species is known from northern Africa and Europe (not in UK and northern Europe) to Central Asia (Nentwig et al. 2018, Šestáková et al. 2014: sub *L. folium*, WSC 2018).

***Marpissa nivoyi* (Lucas, 1846) (Salticidae)**

Material: 1 ♀, 24.-25.IV.2017, leg. Vitecek.

Determination: Logunov (1999), Metzner (1999).

The species prefers wetlands, in eastern parts of its distribution area it has also been found in steppes (Nentwig et al. 2018).

Distribution: Europe (not in northern Europe) to Central Asia (Logunov 1999, Mikhailov 2013). **New to Albania.** This record from Albania diminishes the gaps in the SE-European countries for this species (Nentwig et al. 2018).

***Marpissa pomatia* (Walckenaer, 1802) (Salticidae)**

Material: 1 ♂, 24.-25.IV.2017, leg Vitecek.

Determination: Logunov (1999), Żabka (1997).

The species inhabits a broad spectrum of habitats (e.g., Nentwig et al. 2018: "on conifers and under bark, in grass, in bogs and heathland").

Distribution: From Europe (not in UK and northern Europe) to Japan (Mikhailov 2013, Nentwig et al. 2018, WSC 2018). **New to Albania.** Discovery of this species in Albania also reduces the gaps in the SE-European countries (Nentwig et al. 2018).

***Mendoza canestrinii* (Ninni, 1868) (Salticidae)**

Material: 1 ♀, 24.-25.IV.2017, leg. Vitecek; 1 ♀, 2 subadult ♂♂, 25.IV.2017, leg. Lauenbach.

Determination: Logunov (1999), Metzner (1999).

This jumping spider prefers reed habitats near water (Nentwig et al. 2018).

Distribution: Palaearctic, from Europe (Spain) to Asia (Japan and Vietnam), not extending too far north (northern border in Europe: France, Czech Rep., Slovakia, Ukraine; Mikhailov 2013, Nentwig et al. 2018, WSC 2018).

***Tetragnatha nigrita* Lendl, 1886 (Tetragnathidae)**

Material: 1 ♀, 25.IV.2017, leg. Heckes.

Determination: Wiehle (1963), Almquist (2005).

This long-jawed spider lives on trees and shrubs in damp forests, frequently near the water (Nentwig et al. 2018).

Distribution: Palaearctic, from Portugal and Ireland to Japan (Mikhailov 2013, Nentwig et al. 2018, WSC 2018).

Discussion

This contribution contains only a small, sporadic collection of spiders and yet two new records for Albania are included – from which the jumping spider genus *Marpissa* is recorded for the first time in Albania. Three species (*Marpissa nivoyi, Mendoza canestrinii, Tetragnatha nigrita*) are typical for wetlands, and for the other two (*Lariniodes suspicax, Marpissa pomatia*), wetlands belong to the known spectrum of their habitats. Komnenov (2018 this volume) reported 50 species from the River Vjosa including 17 new species records for Albania with one new species.

These 19 new species records increase the total of spider species known for Albania to 489 (see introduction above and checklist below). It can be assumed that 489 is still less than 50% of the spider species which really occur in Albania.

For comparison, the species numbers of adjacent countries, including some exemplary former totals are listed below:

- Bulgaria: 991 species (Blagoev et al. 2008), 1043 species (Blagoev et al. 2018).
- Greece: 856 (Bosmans & Chatzaki 2005), 1121 (Chatzaki et al. 2015), 1265 (1161 without Crete) (Nentwig et al. 2018: https://araneae.nmbe.ch/biodiversity/countrylist).
- Macedonia: 558 (Blagoev 2002), Komnenov (2014) alone added 145 species, 789 (Nentwig et al. 2018: https://araneae.nmbe.ch/biodiversity/countrylist).

Conservation of natural river borders

Natural rivers banks and their surroundings are very important sites for the conservation of biodiversity in general and of spiders in particular (e.g., Bonn & Kleinwächter 1999, Bonn et al. 2002, Buchholz 2009, Gallé & Urák 2001, Heidt et al. 1998, Krumpálová 1996, 1997, 1998, Lambeets et al. 2008a, 2008b, Malt 1995, Schröder et al. 2011, Steinberger 1996, Steinberger & Thaler 1990, Weiss et al. 1998). The River Vjosa is in a natural stage and there can be expected to be more than 200 spider species living there, i.e. less than 25% is known until now. Any commercial change to the water regime will destroy this diversity and endanger the survival of a large number of habitat specialists, which still partly await their discovery.

Updated checklist of the spiders of Albania

The two major internet sources for spiders in European countries (Helsdingen 2017, Nentwig et al. 2018: https://araneae.nmbe.ch/biodiversity/countrylist) do not provide the same species for Albania and in both websites there are no detailed references for each Albanian species (there is a collection of references for each species, in which one has to search which is probably relevant for a given country). Furthermore, information on uncertain determinations (e.g., "?", "cf.", "pr.") can be easily overlooked or is not included. Therefore, I present here an updated checklist for Albania, based on the last checklist (Deltshev et al. 2011), adding records published since this compilation (with reference) and in several cases comments are added (Tab. 1). Eleven published species records are evaluated as doubtful and are excluded from the Albanian checklist (Tab. 2).

The total number of spider species known from Albania is now 489. This is certainly only an intermediate step, as noted above, but the records of more than 150 spider species new to Albania since 2011 justify this compilation.

Tab. 1: Updated checklist of the spiders of Albania. – Tab. 1: Aktualisierte Checkliste der Spinnen Albaniens.

Family/Species	Source and notes
Agelenidae	
Agelena labyrinthica (Clerck, 1757)	Deltshev et al. (2011)
Agelescape livida (Simon, 1875)	Deltshev et al. (2011)
Allagelena gracilens (C.L. Koch, 1841)	Deltshev et al. (2011)
Histopona laeta (Kulczyński, 1897)	Deltshev et al. (2011)
Histopona luxurians (Kulczyński, 1897)	Deltshev et al. (2011)
Histopona myops (Simon, 1885)	Deltshev et al. (2011)
Histopona torpida (C.L. Koch, 1837)	Vrenozi (2012)
Histopona vignai Brignoli, 1980	Muca & Vrenozi (2016): sub *H.* pr. *vignai*
Inermocoelotes falciger (Kulczyński, 1897)	Vrenozi & Jäger (2012)
Inermocoelotes karlinskii (Kulczyński, 1906)	Deltshev et al. (2011)
Inermocoelotes microlepidus (de Blauwe, 1973)	Deltshev et al. (2011)
Inermocoelotes xinpingwangi (Deltshev, 2009)	Deltshev et al. (2011)
Maimuna vestita (C.L. Koch, 1841)	Deltshev et al. (2011)
Tegenaria animata Kratochvíl & Miller, 1940	Deltshev et al. (2011): sub *Pseudotegenaria*
Tegenaria bosnica Kratochvíl & Miller, 1940	Deltshev et al. (2011): sub *Pseudotegenaria*
Tegenaria campestris (C.L. Koch, 1834)	Vrenozi (2012)
Tegenaria dalmatica Kulczyński, 1906	Vrenozi & Jäger (2012)
Tegenaria domestica (Clerck, 1757)	Deltshev et al. (2011)
Tegenaria hasperi Chyzer, 1897	Deltshev et al. (2011): sub *Malthonica nemorosa*
Tegenaria parietina (Fourcroy, 1785)	Helsdingen & IJland (2015)
Textrix denticulata (Olivier, 1789)	Deltshev et al. (2011)
Amaurobiidae	
Amaurobius erberi (Keyserling, 1863)	Deltshev et al. (2011)
Amaurobius kratochvili Miller, 1938	Helsdingen & IJland (2015): sub *A.* cf. *kratochvili*
Amaurobius phaeacus Thaler & Knoflach, 1998	Deltshev et al. (2011)
Callobius claustrarius (Hahn, 1833)	Vrenozi & Jäger (2013)

Tab. 1 continued – Fortsetzung

Family/Species	Source and notes
Anyphaenidae	
Anyphaena sabina L. Koch, 1866	Deltshev et al. (2011)
Araneidae	
Aculepeira armida (Audouin, 1826)	Vrenozi (2012)
Aculepeira ceropegia (Walckenaer, 1802)	Deltshev et al. (2011)
Agalenatea redii (Scopoli, 1763)	Deltshev et al. (2011)
Araneus alsine (Walckenaer, 1802)	Deltshev et al. (2011)
Araneus angulatus Clerck, 1757	Deltshev et al. (2011)
Araneus circe (Audouin, 1826)	Deltshev et al. (2011)
Araneus diadematus Clerck, 1757	Deltshev et al. (2011)
Araneus grossus (C.L. Koch, 1844)	Deltshev et al. (2011)
Araneus quadratus Clerck, 1757	Deltshev et al. (2011)
Araneus sturmi (Hahn, 1831)	Deltshev et al. (2011)
Araneus triguttatus (Fabricius, 1775)	Deltshev et al. (2011)
Araniella alpica (L. Koch, 1869)	Deltshev et al. (2011)
Araniella cucurbitina (Clerck, 1757)	Deltshev et al. (2011)
Araniella inconspicua (Simon, 1874)	Helsdingen & IJland (2015)
Araniella opisthographa (Kulczyński, 1905)	Deltshev et al. (2011)
Araniella proxima (Kulczyński, 1885)	Sacher (1990)
Argiope bruennichi (Scopoli, 1772)	Deltshev et al. (2011)
Argiope lobata (Pallas, 1772)	Deltshev et al. (2011)
Cyclosa conica (Pallas, 1772)	Deltshev et al. (2011)
Cyclosa insulana (Costa, 1834)	Deltshev et al. (2011)
Cyclosa oculata (Walckenaer, 1802)	Deltshev et al. (2011)
Cyclosa sierrae Simon, 1870	Deltshev et al. (2011)
Cyrtophora citricola (Forsskål, 1775)	Deltshev et al. (2011)
Gibbaranea bituberculata (Walckenaer, 1802)	Helsdingen & IJland (2015)
Gibbaranea gibbosa (Walckenaer, 1802)	Helsdingen & IJland (2015)
Glyptogona sextuberculata (Keyserling, 1863)	Vrenozi & Jäger (2012)
Hypsosinga albovittata (Westring, 1851)	Helsdingen & IJland (2015)
Hypsosinga heri (Hahn, 1831)	Deltshev et al. (2011)
Hypsosinga sanguinea (C.L. Koch, 1844)	Helsdingen & IJland (2015)
Larinioides cornutus (Clerck, 1757)	Deltshev et al. (2011)
Larinioides ixobolus (Thorell, 1873)	Deltshev et al. (2011)
Larinioides sclopetarius (Clerck, 1757)	listed only by Dhora (2010: sub *L. sericatus*) and by Helsdingen (2017), not confirmed by other authors
Larinioides suspicax (O. Pickard-Cambridge, 1876)	Deltshev et al. (2011)
Mangora acalypha (Walckenaer, 1802)	Deltshev et al. (2011)
Neoscona adianta (Walckenaer, 1802)	Deltshev et al. (2011)
Neoscona subfusca (C.L. Koch, 1837)	Deltshev et al. (2011)
Nuctenea umbratica (Clerck, 1757)	Deltshev et al. (2011)
Singa lucina (Audouin, 1826)	Deltshev et al. (2011)
Singa nitidula C.L. Koch, 1844	Helsdingen & IJland (2015)
Zilla diodia (Walckenaer, 1802)	Deltshev et al. (2011)
Zygiella x-notata (Clerck, 1757)	Vrenozi (2012)

Tab. 1 continued – Fortsetzung

Family/Species	Source and notes
Atypidae	
Atypus affinis Eichwald, 1830	Vrenozi & Jäger (2012)
Clubionidae	
Clubiona brevipes Blackwall, 1841	Deltshev et al. (2011)
Clubiona caerulescens L. Koch, 1867	Deltshev et al. (2011)
Clubiona comta C.L. Koch, 1839	Deltshev et al. (2011)
Clubiona corticalis (Walckenaer, 1802)	Deltshev et al. (2011)
Clubiona diversa O. Pickard-Cambridge, 1862	Deltshev et al. (2011)
Clubiona genevensis L. Koch, 1866	Deltshev et al. (2011)
Clubiona leucaspis Simon, 1932	Helsdingen & IJland (2015)
Clubiona marmorata L. Koch, 1866	Nentwig et al. (2018): Vrenozi pers. comm.
Clubiona reclusa O. Pickard-Cambridge, 1863	Deltshev et al. (2011)
Clubiona terrestris Westring, 1851	Deltshev et al. (2011)
Dictynidae	
Argenna patula (Simon, 1874)	Deltshev et al. (2011)
Brigittea civica (Lucas, 1850)	Helsdingen & IJland (2015)
Brigittea latens (Fabricius, 1775)	Deltshev et al. (2011): sub *Dictyna l.*
Dictyna arundinacea (Linnaeus, 1758)	Deltshev et al. (2011)
Lathys humilis (Blackwall, 1855)	Helsdingen & IJland (2015)
Marilynia bicolor (Simon, 1870)	Deltshev et al. (2011)
Nigma flavescens (Walckenaer, 1830)	Helsdingen & IJland (2015)
Nigma puella (Simon, 1870)	Deltshev et al. (2011)
Dysderidae	
Dasumia chyzeri (Kulczyński, 1906)	Helsdingen & IJland (2015)
Dysdera andreini Caporiacco, 1928	Naumova et al. (2016)
Dysdera bellimundi Deeleman-Reinhold, 1988	Deltshev et al. (2011)
Dysdera cephalonica Deeleman-Reinhold, 1988	Deltshev et al. (2011)
Dysdera corfuensis Deeleman-Reinhold, 1988	Deltshev et al. (2011)
Dysdera crocata C.L. Koch, 1838	Deltshev et al. (2011)
Dysdera dubrovninnii Deeleman-Reinhold, 1988	Deltshev et al. (2011)
Dysdera granulata Kulczyński, 1897	Deltshev et al. (2011)
Dysdera longirostris Doblika, 1853	Naumova et al. (2016)
Dysdera murphyorum Deeleman-Reinhold, 1988	Deltshev et al. (2011): sub *D. murphiorum*
Dysdera pandazisi Hadjissarantos, 1940	Vrenozi & Deltshev (2012b)
Dysdera pectinata Deeleman-Reinhold, 1988	Deltshev et al. (2011)
Dysdera punctata C.L. Koch, 1838	Deltshev et al. (2011)
Dysderocrates egregius (Kulczyński, 1897)	Helsdingen (2017); only listed there, but no published source was identified
Dysderocrates storkani (Kratochvíl, 1935)	Deltshev et al. (2011)
Harpactea albanica (Caporiacco, 1949)	Deltshev et al. (2011)
Harpactea kulczynskii Brignoli, 1976	Deltshev et al. (2011)
Harpactea lepida (C.L. Koch, 1838)	Deltshev et al. (2011)
Harpactea nausicaae Brignoli, 1976	Deltshev et al. (2011)
Harpactea saeva (Herman, 1879)	Deltshev et al. (2011)

Tab. 1 continued – Fortsetzung

Family/Species	Source and notes
Eresidae	
Eresus kollari Rossi, 1846	Deltshev et al. (2011)
Eresus moravicus Řezáč, 2008	Naumova et al. (2016)
Eutichuridae	
Cheiracanthium elegans Thorell, 1875	Deltshev et al. (2011)
Cheiracanthium ienisteai Sterghiu, 1985	Helsdingen & IJland (2015): sub *C.* cf. *ienistai*
Cheiracanthium mildei L. Koch, 1864	Deltshev et al. (2011)
Cheiracanthium punctorium (Villers, 1789)	Deltshev et al. (2011)
Cheiracanthium virescens (Sundevall, 1833)	Deltshev et al. (2011)
Gnaphosidae	
Anagraphis ochracea (L. Koch, 1867)	Deltshev et al. (2011): sub *A. pallida*
Aphantaulax cincta (L. Koch, 1866)	Vrenozi & Jäger (2012)
Aphantaulax trifasciata (O. Pickard-Cambridge, 1872)	Vrenozi & Jäger (2012)
Berlandina cinerea (Menge, 1872)	Deltshev et al. (2011)
Berlandina corcyraea (O. Pickard-Cambridge, 1874)	Helsdingen & IJland (2015)
Berlandina plumalis (O. Pickard-Cambridge, 1872)	Komnenov (2018)
Callilepis nocturna (Linnaeus, 1758)	Deltshev et al. (2011)
Callilepis schuszteri (Herman, 1879)	Naumova et al. (2016)
Civizelotes caucasius (L. Koch, 1866)	Naumova et al. (2016)
Civizelotes gracilis (Canestrini, 1868)	Naumova et al. (2016)
Drassodes cupreus (Blackwall, 1834)	Deltshev et al. (2011)
Drassodes lapidosus (Walckenaer, 1802)	Deltshev et al. (2011)
Drassodes lutescens (C.L. Koch, 1839)	Deltshev et al. (2011)
Drassyllus praeficus (L. Koch, 1866)	Deltshev et al. (2011)
Drassyllus pusillus (C.L. Koch, 1833)	Naumova et al. (2016)
Drassyllus villicus (Thorell, 1875)	Vrenozi & Jäger (2012)
Echemus angustifrons (Westring, 1861)	Vrenozi & Jäger (2012)
Gnaphosa bicolor (Hahn, 1833)	Naumova et al. (2016)
Gnaphosa dolosa Herman, 1879	Komnenov (2018)
Gnaphosa lapponum (L. Koch, 1866)	Deltshev et al. (2011)
Gnaphosa lucifuga (Walckenaer, 1802)	Deltshev et al. (2011)
Gnaphosa opaca Herman, 1879	Naumova et al. (2016)
Gnaphosa rhenana Müller & Schenkel, 1895	Komnenov (2018)
Haplodrassus dalmatensis (L. Koch, 1866)	Deltshev et al. (2011)
Haplodrassus signifer (C.L. Koch, 1839)	Deltshev et al. (2011)
Haplodrassus silvestris (Blackwall, 1833)	Naumova et al. (2016)
Leptodrassus albidus Simon, 1914	Nentwig et al. (2018): Vrenozi pers. comm.
Micaria albovittata (Lucas, 1846)	Deltshev et al. (2011)
Micaria coarctata (Lucas, 1846)	Vrenozi & Jäger (2012)
Nomisia aussereri (L. Koch, 1872)	Deltshev et al. (2011)
Nomisia excerpta (O. Pickard-Cambridge, 1872)	Nentwig et al. (2018): Vrenozi pers. comm.
Nomisia exornata (C.L. Koch, 1839)	Deltshev et al. (2011)
Nomisia recepta (Pavesi, 1880)	Vrenozi & Jäger (2012)
Scotophaeus blackwalli (Thorell, 1871)	Deltshev et al. (2011)
Scotophaeus scutulatus (L. Koch, 1866)	Deltshev et al. (2011)

Tab. 1 continued – Fortsetzung

Family/Species	Source and notes
Trachyzelotes barbatus (L. Koch, 1866)	Deltshev et al. (2011)
Trachyzelotes huberti Platnick & Murphy, 1984	Komnenov (2018); described from Algeria (Oran) by Platnick & Murphy (1984), refound in Italy (Apulia) by IJland et al. (2012)
Trachyzelotes lyonneti (Audouin, 1826)	Deltshev et al. (2011)
Trachyzelotes malkini Platnick & Murphy, 1984	Naumova et al. (2016)
Trachyzelotes pedestris (C.L. Koch, 1837)	Deltshev et al. (2011)
Zelotes apricorum (L. Koch, 1876)	Deltshev et al. (2011)
Zelotes argoliensis (C.L. Koch, 1839)	Vrenozi & Jäger (2012)
Zelotes atrocaeruleus (Simon, 1878)	Vrenozi & Jäger (2012)
Zelotes balcanicus Deltshev, 2006	Deltshev et al. (2011)
Zelotes cingarus (O. Pickard-Cambridge, 1874)	Deltshev et al. (2011)
Zelotes femellus (L. Koch, 1866)	Vrenozi & Jäger (2013)
Zelotes hermani (Chyzer, 1897)	Vrenozi & Jäger (2012)
Zelotes metellus Roewer, 1928	Naumova et al. (2016)
Zelotes oblongus (C.L. Koch, 1833)	Deltshev et al. (2011)
Zelotes segrex (Simon, 1878)	Deltshev et al. (2011)
Zelotes similis (Kulczyński, 1887)	Deltshev et al. (2011)
Zelotes tenuis (L. Koch, 1866)	Deltshev et al. (2011)
Hahniidae	
Cicurina cicur (Fabricius, 1793)	Deltshev et al. (2011)
Hahnia nava (Blackwall, 1841)	Deltshev et al. (2011)
Iberina candida (Simon, 1875)	Helsdingen & IJland (2015)
Leptonetidae	
Sulcia cretica lindbergi Dresco, 1962	Deltshev et al. (2011): sub *S.* pr. *cretica lindbergi* (in checklist only, figures and text without „pr.“)
Linyphiidae	
Agnyphantes expunctus (O. Pickard-Cambridge, 1875)	Deltshev et al. (2011)
Agyneta rurestris (C.L. Koch, 1836)	Deltshev et al. (2011)
Agyneta saxatilis (Blackwall, 1844)	Deltshev et al. (2011)
Asthenargus bracianus Miller, 1938	Komnenov (2011), Helsdingen & IJland (2015)
Bolyphantes luteolus (Blackwall, 1833)	Deltshev et al. (2011)
Centromerus acutidentatus Deltshev, 2002	Deltshev et al. (2011)
Centromerus cavernarum (L. Koch, 1872)	Deltshev et al. (2011)
Ceratinella brevis (Wider, 1834)	Deltshev et al. (2011)
Ceratinella major Kulczyński, 1894	Helsdingen & IJland (2015)
Diplostyla concolor (Wider, 1834)	Deltshev et al. (2011)
Drapetisca socialis (Sundevall, 1833)	Komnenov (2011)
Erigone dentipalpis (Wider, 1834)	Deltshev et al. (2011)
Erigone remota L. Koch, 1869	Vrenozi & Jäger (2013)
Erigonoplus jarmilae (Miller, 1943)	Deltshev et al. (2011)
Erigonoplus spinifemuralis Dimitrov, 2003	Komnenov (2018)
Floronia bucculenta (Clerck, 1757)	Deltshev et al. (2011)
Frontinellina frutetorum (C.L. Koch, 1834)	Deltshev et al. (2011)
Gnathonarium dentatum (Wider, 1834)	Komnenov (2018)
Gonatium hilare (Thorell, 1875)	Helsdingen & IJland (2015)

Tab. 1 continued – Fortsetzung

Family/Species	Source and notes
Heterotrichoncus pusillus (Miller, 1958)	Helsdingen & IJland (2015)
Improphantes improbulus (Simon, 1929)	Deltshev et al. (2011): sub *I.* pr. *improbulus*
Janetschekia monodon (O. Pickard-Cambridge, 1873)	Komnenov (2018)
Lepthyphantes leprosus (Ohlert, 1865)	Deltshev et al. (2011)
Lepthyphantes magnesiae Brignoli, 1979	Helsdingen & IJland (2015)
Lepthyphantes minutus (Blackwall, 1833)	Deltshev et al. (2011)
Lepthyphantes nodifer Simon, 1884	Vrenozi & Deltshev (2012a)
Linyphia hortensis Sundevall, 1830	Helsdingen & IJland (2015)
Linyphia mimonti Simon, 1884	Helsdingen & IJland (2015)
Linyphia triangularis (Clerck, 1757)	Deltshev et al. (2011)
Mansuphantes mansuetus (Thorell, 1875)	Deltshev et al. (2011)
Mecopisthes silus (O. Pickard-Cambridge, 1873)	Deltshev et al. (2011)
Micrargus herbigradus (Blackwall, 1854)	Deltshev et al. (2011)
Microlinyphia pusilla (Sundevall, 1830)	Deltshev et al. (2011)
Microneta viaria (Blackwall, 1841)	Deltshev et al. (2011)
Nematogmus sanguinolentus (Walckenaer, 1841)	Deltshev et al. (2011)
Neriene clathrata (Sundevall, 1830)	Deltshev et al. (2011)
Neriene furtiva (O. Pickard-Cambridge, 1871)	Vrenozi & Deltshev (2012a)
Neriene peltata (Wider, 1834)	Helsdingen & IJland (2015)
Oedothorax apicatus (Blackwall, 1850)	Deltshev et al. (2011)
Palliduphantes pillichi (Kulczyński, 1915)	Deltshev et al. (2011)
Pelecopsis elongata (Wider, 1834)	Vrenozi & Deltshev (2012a)
Piniphantes pinicola (Simon, 1884)	Deltshev et al. (2011)
Pityohyphantes phrygianus (C.L. Koch, 1836)	Deltshev et al. (2011)
Pocadicnemis juncea Locket & Millidge, 1953	Naumova et al. (2016), Komnenov (2018)
Porrhomma convexum (Westring, 1851)	Komnenov (2011)
Prinerigone vagans (Audouin, 1826)	Deltshev et al. (2011)
Sauron rayi (Simon, 1881)	Naumova et al. (2016)
Scutpelecopsis krausi (Wunderlich, 1980)	Helsdingen & IJland (2015)
Sintula retroversus (O. Pickard-Cambridge, 1875)	Vrenozi & Deltshev (2012a)
Sintula spiniger (Balogh, 1935)	Vrenozi & Deltshev (2012a)
Stemonyphantes lineatus (Linnaeus, 1758)	Deltshev et al. (2011)
Tallusia vindobonensis (Kulczyński, 1898)	Vrenozi & Jäger (2012)
Tapinocyba mitis (O. Pickard-Cambridge, 1882)	Helsdingen & IJland (2015): sub *T.* cf. *mitis*
Tapinocyba pallens (O. Pickard-Cambridge, 1873)	Deltshev et al. (2011)
Tenuiphantes floriana (van Helsdingen, 1977)	Vrenozi & Deltshev (2012a)
Tenuiphantes herbicola (Simon, 1884)	Helsdingen & IJland (2015)
Tenuiphantes tenebricola (Wider, 1834)	Vrenozi & Jäger (2013)
Tenuiphantes tenuis (Blackwall, 1852)	Deltshev et al. (2011)
Trichoncus affinis Kulczyński, 1894	Deltshev et al. (2011)
Trichoncus sordidus Simon, 1884	Vrenozi & Deltshev (2012a)
Troglohyphantes draconis Deeleman-Reinhold, 1978	Deltshev et al. (2011)
Troglohyphantes pretneri Deeleman-Reinhold, 1978	Deltshev et al. (2011)

Tab. 1 continued – Fortsetzung

Family/Species	**Source and notes**
Walckenaeria abantensis Wunderlich, 1995	Helsdingen & IJland (2015)
Liocranidae	
Agraecina lineata (Simon, 1878)	Vrenozi & Jäger (2012)
Agroeca cuprea Menge, 1873	Naumova et al. (2016)
Liocranoeca vjosensis Komnenov, 2018	Komnenov (2018)
Liocranum rupicola (Walckenaer, 1830)	Naumova et al. (2016)
Mesiotelus tenuissimus (L. Koch, 1866)	Deltshev et al. (2011): with „?“
Sagana rutilans Thorell, 1875	Helsdingen & IJland (2015)
Lycosidae	
Alopecosa aculeata (Clerck, 1757)	Deltshev et al. (2011)
Alopecosa albofasciata (Brullé, 1832)	Deltshev et al. (2011)
Alopecosa cursor (Hahn, 1831)	Vrenozi & Jäger (2012)
Alopecosa fabrilis (Clerck, 1757)	Naumova et al. (2016)
Alopecosa farinosa (Herman, 1879)	Deltshev et al. (2011): sub *A. accentuata*
Alopecosa pentheri (Nosek, 1905)	Helsdingen & IJland (2015)
Alopecosa pulverulenta (Clerck, 1757)	Deltshev et al. (2011)
Alopecosa solitaria (Herman, 1879)	Deltshev et al. (2011)
Alopecosa sulzeri (Pavesi, 1873)	Naumova et al. (2016)
Alopecosa trabalis (Clerck, 1757)	Deltshev et al. (2011)
Arctosa cinerea (Fabricius, 1777)	Deltshev et al. (2011)
Arctosa leopardus (Sundevall, 1833)	Deltshev et al. (2011)
Arctosa perita (Latreille, 1799)	Komnenov (2018)
Arctosa stigmosa (Thorell, 1875)	Komnenov (2018)
Arctosa variana C.L. Koch, 1847	Deltshev et al. (2011)
Aulonia albimana (Walckenaer, 1805)	Vrenozi & Jäger (2012)
Geolycosa vultuosa (C.L. Koch, 1838)	Helsdingen & IJland (2015)
Hogna radiata (Latreille, 1817)	Deltshev et al. (2011)
Lycosa praegrandis C.L. Koch, 1836	Deltshev et al. (2011)
Lycosa praegrandis discoloriventer Caporiacco, 1949	Deltshev et al. (2011)
Pardosa agrestis (Westring, 1861)	Vrenozi & Jäger (2013)
Pardosa agricola (Thorell, 1856)	Deltshev et al. (2011)
Pardosa alacris (C.L. Koch, 1833)	Deltshev et al. (2011)
Pardosa albatula (Roewer, 1951)	Deltshev et al. (2011)
Pardosa atomaria (C.L. Koch, 1847)	Deltshev et al. (2011)
Pardosa bifasciata (C.L. Koch, 1834)	Naumova et al. (2016)
Pardosa cavannae Simon, 1881	Vrenozi & Jäger (2013)
Pardosa cribrata Simon, 1876	Deltshev et al. (2011)
Pardosa hortensis (Thorell, 1872)	Deltshev et al. (2011)
Pardosa lugubris (Walckenaer, 1802)	Deltshev et al. (2011); N.B.: s.str.?; Blagoev (2005): only females (which are hardly distinguishable in the *lugubris* group), cf. *P. pertinax* von Helversen, 2000 (Greece, Turkey) (Töpfer-Hofmann et al. 2000)
Pardosa mixta (Kulczyński, 1887)	Deltshev et al. (2011)
Pardosa monticola (Clerck, 1757)	Deltshev et al. (2011)

Tab. 1 continued – Fortsetzung

Family/Species	Source and notes
Pardosa prativaga (L. Koch, 1870)	Deltshev et al. (2011)
Pardosa proxima (C.L. Koch, 1847)	Deltshev et al. (2011); N.B.: *Pardosa vlijmi* den Hollander & Dijkstra, 1974 is a synonym of *P. proxima* (Isaia et al. 2018)
Pardosa pullata (Clerck, 1757)	Deltshev et al. (2011)
Pardosa tatarica (Thorell, 1875)	Deltshev et al. (2011)
Pardosa vittata (Keyserling, 1863)	Vrenozi & Jäger (2012)
Pirata piraticus (Clerck, 1757)	Deltshev et al. (2011)
Pirata tenuitarsis Simon, 1876	Komnenov (2018)
Piratula knorri (Scopoli, 1763)	Deltshev et al. (2011): sub *Pirata k.*
Piratula latitans (Blackwall, 1841)	Deltshev et al. (2011): sub *Pirata l.*
Trabea paradoxa Simon, 1876	Deltshev et al. (2011)
Trochosa hispanica Simon, 1870	Deltshev et al. (2011)
Trochosa robusta (Simon, 1876)	Deltshev et al. (2011)
Trochosa ruricola (De Geer, 1778)	Deltshev et al. (2011)
Trochosa terricola Thorell, 1856	Deltshev et al. (2011)
Xerolycosa miniata (C.L. Koch, 1834)	Deltshev et al. (2011)
Mimetidae	
Ero tuberculata (De Geer, 1778)	Helsdingen & IJland (2015)
Miturgidae	
Zora manicata Simon, 1878	Deltshev et al. (2011)
Zora nemoralis (Blackwall, 1861)	Deltshev et al. (2011)
Zora parallela Simon, 1878	Helsdingen & IJland (2015)
Zora spinimana (Sundevall, 1833)	Deltshev et al. (2011)
Nemesiidae	
Brachythele media Kulczyński, 1897	Vrenozi & Deltshev (2012b)
Nemesia pannonica Herman, 1879	Vrenozi & Jäger (2012): sub *N. pannonica pannonica*
Nesticidae	
Kryptonesticus eremita (Simon, 1880)	Deltshev et al. (2011): sub *Nesticus e.*
Nesticus cellulanus (Clerck, 1757)	Deltshev et al. (2011)
Oecobiidae	
Oecobius maculatus Simon, 1870	Helsdingen & IJland (2015)
Uroctea durandi (Latreille, 1809)	Deltshev et al. (2011)
Oonopidae	
Oonops domesticus Dalmas, 1916	Deltshev et al. (2011)
Oxyopidae	
Oxyopes heterophthalmus (Latreille, 1804)	Deltshev et al. (2011)
Oxyopes lineatus Latreille, 1806	Deltshev et al. (2011)
Palpimanidae	
Palpimanus gibbulus Dufour, 1820	Deltshev et al. (2011)
Palpimanus orientalis Kulczyński, 1909	Deltshev et al. (2011)
Philodromidae	
Philodromus aureolus (Clerck, 1757)	Deltshev et al. (2011)
Philodromus cespitum (Walckenaer, 1802)	Deltshev et al. (2011)
Philodromus dispar Walckenaer, 1826	Deltshev et al. (2011)

Tab. 1 continued – Fortsetzung

Family/Species	**Source and notes**
Philodromus pentheri Muster, 2009	Deltshev et al. (2011)
Philodromus praedatus O. Pickard-Cambridge, 1871	Deltshev et al. (2011)
Philodromus rufus Walckenaer, 1826	Deltshev et al. (2011)
Pulchellodromus bistigma (Simon, 1870)	Vrenozi & Jäger (2012): sub *Philodromus b.*
Pulchellodromus pulchellus (Lucas, 1846)	Deltshev et al. (2011): sub *Philodromus p.*
Pulchellodromus ruficapillus (Simon, 1885)	Vrenozi & Jäger (2012): sub *Philodromus r.*
Thanatus atratus Simon, 1875	Vrenozi & Jäger (2012)
Thanatus sabulosus (Menge, 1875)	Deltshev et al. (2011)
Thanatus vulgaris Simon, 1870	Deltshev et al. (2011)
Tibellus oblongus (Walckenaer, 1802)	Deltshev et al. (2011)
Pholcidae	
Holocnemus pluchei (Scopoli, 1763)	Deltshev et al. (2011)
Hoplopholcus forskali (Thorell, 1871)	Deltshev et al. (2011)
Pholcus opilionoides (Schrank, 1781)	Deltshev et al. (2011)
Pholcus phalangioides (Fuesslin, 1775)	Deltshev et al. (2011)
Stygopholcus photophilus (Senglet, 1971)	Deltshev et al. (2011)
Phrurolithidae	
Phrurolithus festivus (C.L. Koch, 1835)	Deltshev et al. (2011)
Phrurolithus nigrinus (Simon, 1878)	Komnenov (2018); specimens from the Balkans not figured, identity with material from western Europe should be checked
Phrurolithus pullatus Kulczyński, 1897	Helsdingen & IJland (2015)
Phrurolithus szilyi Herman, 1879	Deltshev et al. (2011)
Pisauridae	
Pisaura mirabilis (Clerck, 1757)	Deltshev et al. (2011)
Salticidae	
Aelurillus v-insignitus (Clerck, 1757)	Deltshev et al. (2011)
Asianellus festivus (C.L. Koch, 1834)	Deltshev et al. (2011)
Attulus distinguendus (Simon, 1868)	Deltshev et al. (2011): sub *Sitticus d.*
Attulus penicillatus (Simon, 1875)	Helsdingen & IJland (2015): sub *Sitticus p.*
Ballus chalybeius (Walckenaer, 1802)	Vrenozi & Jäger (2012)
Ballus rufipes (Simon, 1868)	Komnenov (2018)
Calositticus atricapillus (Simon, 1882)	Deltshev et al. (2011): sub *Sitticus a.*
Calositticus rupicola (C.L. Koch, 1837)	Vrenozi & Dunlop (2013): sub *Sitticus r.*
Carrhotus xanthogramma (Latreille, 1819)	Deltshev et al. (2011)
Chalcoscirtus infimus (Simon, 1868)	Deltshev et al. (2011)
Cyrba algerina (Lucas, 1846)	Deltshev et al. (2011)
Euophrys frontalis (Walckenaer, 1802)	Deltshev et al. (2011)
Euophrys herbigrada (Simon, 1871)	Vrenozi & Deltshev (2012b)
Euophrys rufibarbis (Simon, 1868)	Deltshev et al. (2011)
Evarcha falcata (Clerck, 1757)	Deltshev et al. (2011)
Evarcha jucunda (Lucas, 1846)	Deltshev et al. (2011)
Evarcha laetabunda (C.L. Koch, 1846)	Deltshev et al. (2011)
Habrocestum papilionaceum (L. Koch, 1867)	Vrenozi & Jäger (2012)
Heliophanus auratus C.L. Koch, 1835	Deltshev et al. (2011)

Tab. 1 continued – Fortsetzung

Family/Species	Source and notes
Heliophanus cupreus (Walckenaer, 1802)	Deltshev et al. (2011)
Heliophanus dubius C.L. Koch, 1835	Deltshev et al. (2011)
Heliophanus equester L. Koch, 1867	Deltshev et al. (2011)
Heliophanus flavipes (Hahn, 1832)	Deltshev et al. (2011)
Heliophanus kochii Simon, 1868	Deltshev et al. (2011)
Heliophanus lineiventris Simon, 1868	Deltshev et al. (2011)
Heliophanus melinus L. Koch, 1867	Deltshev et al. (2011)
Heliophanus patagiatus Thorell, 1875	Deltshev et al. (2011)
Heliophanus simplex Simon, 1868	Deltshev et al. (2011)
Heliophanus tribulosus Simon, 1868	Deltshev et al. (2011)
Hypositticus pubescens (Fabricius, 1775)	Deltshev et al. (2011): sub *Sitticus p.*
Icius hamatus (C.L. Koch, 1846)	Deltshev et al. (2011)
Macaroeris flavicomis (Simon, 1884)	Deltshev et al. (2011)
Macaroeris nidicolens (Walckenaer, 1802)	Deltshev et al. (2011)
Marpissa nivoyi (Lucas, 1846)	Blick (this contribution)
Marpissa pomatia (Walckenaer, 1802)	Blick (this contribution)
Mendoza canestrinii (Ninni, 1868)	Deltshev et al. (2011)
Menemerus semilimbatus (Hahn, 1829)	Deltshev et al. (2011)
Neaetha absheronica Logunov & Guseinov, 2002	Komnenov (2018)
Neaetha membrosa (Simon, 1868)	Vrenozi & Jäger (2012); N.B.: probably *N. absheronica* Logunov & Guseinov, 2002 (cf. Logunov 2015)
Neon levis (Simon, 1871)	Deltshev et al. (2011)
Neon rayi (Simon, 1875)	Helsdingen & IJland (2015)
Pellenes arciger (Walckenaer, 1837)	Deltshev et al. (2011)
Pellenes nigrociliatus (Simon, 1875)	Helsdingen & IJland (2015)
Pellenes tripunctatus (Walckenaer, 1802)	Vrenozi (2012)
Philaeus chrysops (Poda, 1761)	Deltshev et al. (2011)
Phlegra bresnieri (Lucas, 1846)	Deltshev et al. (2011)
Phlegra fasciata (Hahn, 1826)	Deltshev et al. (2011)
Pseudeuophrys erratica (Walckenaer, 1826)	Vrenozi (2012)
Pseudeuophrys obsoleta (Simon, 1868)	Deltshev et al. (2011)
Pseudicius kulczynskii Nosek, 1905	Deltshev et al. (2011)
Saitis graecus Kulczyński, 1904	Vrenozi & Jäger (2012)
Salticus propinquus Lucas, 1846	Deltshev et al. (2011)
Salticus scenicus (Clerck, 1757)	Deltshev et al. (2011)
Salticus unciger (Simon, 1868)	Deltshev et al. (2011)
Salticus zebraneus (C.L. Koch, 1837)	Deltshev et al. (2011)
Scytodidae	
Scytodes thoracica (Latreille, 1802)	Deltshev et al. (2011)
Segestriidae	
Segestria bavarica C.L. Koch, 1843	Deltshev et al. (2011)
Segestria senoculata (Linnaeus, 1758)	Deltshev et al. (2011)
Sparassidae	
Micrommata ligurina (C.L. Koch, 1845)	Deltshev et al. (2011)

Tab. 1 continued – Fortsetzung

Family/Species	Source and notes
Micrommata virescens (Clerck, 1757)	Deltshev et al. (2011)
Tetragnathidae	
Meta menardi (Latreille, 1804)	Deltshev et al. (2011)
Metellina mengei (Blackwall, 1869)	Deltshev et al. (2011)
Metellina merianae (Scopoli, 1763)	Deltshev et al. (2011)
Metellina segmentata (Clerck, 1757)	Deltshev et al. (2011)
Pachygnatha clerckoides Wunderlich, 1985	Komnenov (2018)
Pachygnatha degeeri Sundevall, 1830	Vrenozi & Jäger (2012)
Tetragnatha extensa (Linnaeus, 1758)	Deltshev et al. (2011)
Tetragnatha flava (Audouin, 1826)	Deltshev et al. (2011)
Tetragnatha montana Simon, 1874	Deltshev et al. (2011)
Tetragnatha nigrita Lendl, 1886	Deltshev et al. (2011)
Tetragnatha nitens (Audouin, 1826)	Deltshev et al. (2011)
Theridiidae	
Anelosimus vittatus (C.L. Koch, 1836)	Deltshev et al. (2011)
Argyrodes argyrodes (Walckenaer, 1841)	Deltshev et al. (2011)
Asagena phalerata (Panzer, 1801)	Deltshev et al. (2011)
Crustulina guttata (Wider, 1834)	Deltshev et al. (2011)
Crustulina scabripes Simon, 1881	Deltshev et al. (2011)
Crustulina sticta (O. Pickard-Cambridge, 1861)	Deltshev et al. (2011)
Cryptachaea blattea (Urquhart, 1886)	Deltshev et al. (2011)
Dipoena braccata (C.L. Koch, 1841)	Deltshev et al. (2011)
Dipoena melanogaster (C.L. Koch, 1837)	Deltshev et al. (2011)
Dipoena nigroreticulata (Simon, 1880)	Helsdingen & IJland (2015)
Enoplognatha afrodite Hippa & Oksala, 1983	Vrenozi & Jäger (2012)
Enoplognatha gemina Bosmans & Van Keer, 1999	Nentwig et al. (2018): Vrenozi pers. comm.
Enoplognatha latimana Hippa & Oksala, 1982	Deltshev et al. (2011)
Enoplognatha mandibularis (Lucas, 1846)	Vrenozi & Jäger (2012)
Enoplognatha ovata (Clerck, 1757)	Deltshev et al. (2011)
Enoplognatha quadripunctata Simon, 1884	Deltshev et al. (2011)
Enoplognatha thoracica (Hahn, 1833)	Deltshev et al. (2011)
Episinus maculipes Cavanna, 1876	Vrenozi & Jäger (2012)
Episinus truncatus Latreille, 1809	Vrenozi & Jäger (2012)
Euryopis episinoides (Walckenaer, 1847)	Deltshev et al. (2011)
Euryopis flavomaculata (C.L. Koch, 1836)	Naumova et al. (2016)
Heterotheridion nigrovariegatum (Simon, 1873)	Deltshev et al. (2011): sub *Theridion n.*
Kochiura aulica (C.L. Koch, 1838)	Deltshev et al. (2011)
Lasaeola convexa (Blackwall, 1870)	Helsdingen & IJland (2015)
Lasaeola prona (Menge, 1868)	Deltshev et al. (2011)
Neottiura herbigrada (Simon, 1873)	Vrenozi & Jäger (2012)
Paidiscura pallens (Blackwall, 1834)	Helsdingen & IJland (2015)
Pholcomma gibbum (Westring, 1851)	Deltshev et al. (2011)
Phylloneta impressa (L. Koch, 1881)	Deltshev et al. (2011): sub *Theridion impressum*
Platnickina nigropunctata (Lucas, 1846)	Vrenozi & Jäger (2013)
Platnickina tincta (Walckenaer, 1802)	Deltshev et al. (2011)

Tab. 1 continued – Fortsetzung

Family/Species	**Source and notes**
Robertus arundineti (O. Pickard-Cambridge, 1871)	Komnenov (2018)
Robertus frivaldszkyi (Chyzer, 1894)	Deltshev et al. (2011)
Robertus mediterraneus Eskov, 1987	Helsdingen & IJland (2015)
Simitidion simile (C.L. Koch, 1836)	Deltshev et al. (2011)
Steatoda albomaculata (De Geer, 1778)	Deltshev et al. (2011)
Steatoda bipunctata (Linnaeus, 1758)	Deltshev et al. (2011)
Steatoda paykulliana (Walckenaer, 1806)	Deltshev et al. (2011)
Steatoda triangulosa (Walckenaer, 1802)	Deltshev et al. (2011)
Theridion adrianopoli Drensky, 1915	Helsdingen & IJland (2015)
Theridion betteni Wiehle, 1960	Helsdingen et al. (2018)
Theridion cinereum Thorell, 1875	Deltshev et al. (2011)
Theridion melanurum Hahn, 1831	Deltshev et al. (2011)
Theridion mystaceum L. Koch, 1870	Deltshev et al. (2011)
Theridion varians Hahn, 1833	Deltshev et al. (2011)
Thomisidae	
Cozyptila blackwalli (Simon, 1875)	Deltshev et al. (2011)
Cozyptila thaleri Marusik & Kovblyuk, 2005	Deltshev et al. (2011)
Diaea livens Simon, 1876	Deltshev et al. (2011)
Heriaeus hirtus (Latreille, 1819)	Deltshev et al. (2011)
Misumena vatia (Clerck, 1757)	Deltshev et al. (2011)
Monaeses paradoxus (Lucas, 1846)	Deltshev et al. (2011)
Ozyptila atomaria (Panzer, 1801)	Deltshev et al. (2011)
Ozyptila confluens (C.L. Koch, 1845)	Deltshev et al. (2011)
Ozyptila sanctuaria (O. Pickard-Cambridge, 1871)	Deltshev et al. (2011)
Ozyptila simplex (O. Pickard-Cambridge, 1862)	Deltshev et al. (2011)
Pistius truncatus (Pallas, 1772)	Helsdingen & IJland (2015)
Runcinia grammica (C.L. Koch, 1837)	Deltshev et al. (2011)
Synema globosum (Fabricius, 1775)	Deltshev et al. (2011)
Synema plorator (O. Pickard-Cambridge, 1872)	Deltshev et al. (2011)
Thomisus onustus Walckenaer, 1805	Deltshev et al. (2011)
Tmarus piger (Walckenaer, 1802)	Deltshev et al. (2011)
Tmarus piochardi (Simon, 1866)	Helsdingen & IJland (2015)
Xysticus acerbus Thorell, 1872	Deltshev et al. (2011)
Xysticus brevidentatus Wunderlich, 1995	Deltshev et al. (2011)
Xysticus bufo (Dufour, 1820)	Vrenozi & Deltshev (2012b)
Xysticus caperatus Simon, 1875	Deltshev et al. (2011)
Xysticus cribratus Simon, 1885	Deltshev et al. (2011): sub *X.* pr. *cribratus*
Xysticus cristatus (Clerck, 1757)	Deltshev et al. (2011)
Xysticus edax (O. Pickard-Cambridge, 1872)	Deltshev et al. (2011)
Xysticus graecus C.L. Koch, 1837	Deltshev et al. (2011)
Xysticus kempeleni Thorell, 1872	Vrenozi & Jäger (2012)
Xysticus kochi Thorell, 1872	Deltshev et al. (2011)
Xysticus lanio C.L. Koch, 1835	Helsdingen & IJland (2015)
Xysticus marmoratus Thorell, 1875	Deltshev et al. (2011): sub *X. gymnocephalus*
Xysticus robustus (Hahn, 1832)	Deltshev et al. (2011)

Tab. 1 continued – Fortsetzung

Family/Species	Source and notes
Xysticus sabulosus (Hahn, 1832)	Deltshev et al. (2011)
Xysticus striatipes L. Koch, 1870	Deltshev et al. (2011)
Xysticus thessalicus Simon, 1916	Helsdingen & IJland (2015)
Titanoecidae	
Nurscia albomaculata (Lucas, 1846)	Deltshev et al. (2011)
Titanoeca flavicoma L. Koch, 1872	Komnenov (2018)
Titanoeca quadriguttata (Hahn, 1833)	Deltshev et al. (2011)
Titanoeca spominima (Taczanowski, 1866)	Nentwig et al. (2018): Vrenozi pers. comm.
Titanoeca tristis L. Koch, 1872	Deltshev et al. (2011)
Titanoeca veteranica Herman, 1879	Naumova et al. (2016)
Trachelidae	
Cetonana laticeps (Canestrini, 1868)	Deltshev et al. (2011)
Uloboridae	
Uloborus walckenaerius Latreille, 1806	Deltshev et al. (2011)
Zodariidae	
Zodarion elegans (Simon, 1873)	Deltshev et al. (2011)
Zodarion frenatum Simon, 1884	Deltshev et al. (2011)
Zodarion graecum (C.L. Koch, 1843)	Deltshev et al. (2011)
Zodarion morosum Denis, 1935	Naumova et al. (2016)
Zodarion musarum Brignoli, 1984	Deltshev et al. (2011)
Zodarion ohridense Wunderlich, 1973	Deltshev et al. (2011)
Zoropsidae	
Zoropsis oertzeni Dahl, 1901	Deltshev et al. (2011)
Zoropsis spinimana (Dufour, 1820)	Deltshev et al. (2011)

Tab. 2: Doubtful Albanian spider species records, not included in the checklist. – Tab. 2: Fragliche Spinnen-Artnachweise aus Albanien, die nicht in der Checkliste geführt werden.

Family/Species	Notes
Agelenidae	
Inermocoelotes inermis (L. Koch, 1855)	listed by Dhora (2010) and by Helsdingen (2017), doubtful by Vrenozi (pers. comm.), therefore removed in Nentwig et al. (2018)
Araneidae	
Hypsosinga pygmaea (Sundevall, 1831)	listed by Dhora (2010) and by Helsdingen (2017), doubtful by Vrenozi (pers. comm.), therefore removed in Nentwig et al. (2018)
Leviellus thorelli (Ausserer, 1871)	listed by Dhora (2010) and by Helsdingen (2017), doubtful by Vrenozi (pers. comm.), therefore removed in Nentwig et al. (2018)
Zygiella keyserlingi (Ausserer, 1871)	listed by Dhora (2010) and by Helsdingen (2017), doubtful by Vrenozi (pers. comm.), therefore removed in Nentwig et al. (2018)
Dysderidae	
Dysdera erythrina (Walckenaer, 1802)	Deltshev et al. (2011); according to Řezáč et al. (2018) *D. e.* is not known from the Balkan Peninsula, therefore removed in Nentwig et al. (2018)

Tab. 2 continued – Fortsetzung

Family/Species	Notes
Dysdera ninnii Canestrini, 1868	Deltshev et al. (2011); N.B.: it is more likely that it belongs to *D. microdonta* Gasparo, 2014, as this is the only species of the group known from the closest country Serbia (Řezáč et al. 2018)
Dysdera scabricula Simon, 1882	Caporiacco (1932): sub *D.* cfr. *scabricula* (juvenile only), the species is only confirmed from Spain and France, therefore not included in Nentwig et al. (2018)
Linyphiidae	
Silometopus ambiguus (O. Pickard-Cambridge, 1906)	listed by Dhora (2010) and by Helsdingen (2017), doubtful by Vrenozi (pers. comm.), therefore removed in Nentwig et al. (2018)
Salticidae	
Pellenes allegrii Caporiacco, 1935	Deltshev et al. (2011), but not included in the given source (Schenkel 1947), therefore removed in Nentwig et al. (2018)
Talavera petrensis (C.L. Koch, 1837)	listed by Dhora (2010) and by Helsdingen (2017), doubtful by Vrenozi (pers. comm.), therefore removed in Nentwig et al. (2018)
Thomisidae	
Heriaeus simoni Kulczyński, 1903	listed by Dhora (2010) and by Helsdingen (2017), doubtful by Vrenozi (pers. comm.), therefore removed in Nentwig et al. (2018)

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Harvestmen (Arachnida: Opiliones) from the Vjosa valley in Albania

Christian Komposch

The small collection of harvestman material from the Vjosa River, from the vicinity of the village Kuta, revealed the presence of 3 species from 3 families: *Paranemastoma longipes*, *Opilio* cf. *parietinus* and *Nelima sempronii*. The harvestman fauna of Albania is poorly known. The finding of *Nelima sempronii* at the riversides of the Vjosa is the first record of this interesting species for Albania. The results of the present study, although based on random data, are a valuable contribution to the knowledge of the Opiliones fauna of this country. Furthermore, they emphasize the urgent need for further research as well as protection and conservation of this unique area at the Vjosa River, being seriously threatened by a proposed hydroelectric power dam.

Komposch Ch., 2018: Weberknechte (Arachnida: Opiliones) aus dem Vjosatal in Albanien.
Die Auswertung einer kleinen Aufsammlung an Weberknechten aus dem Vjosatal nahe der Ortschaft Kuta erlaubt das Vorlegen einer Artenliste von 3 Spezies aus 3 Familien: *Paranemastoma longipes*, *Opilio* cf. *parietinus* und *Nelima sempronii*. Die Weberknechtfauna Albaniens ist noch unzureichend bekannt. Der Honiggelbe Weberknecht (*Nelima sempronii*) wird hiermit erstmals für Albanien genannt. Obwohl die Ergebnisse dieser arachnologischen Untersuchung nur auf Streufunden basieren, sind sie ein wertvoller Beitrag zur Kenntnis der Weberknechtfauna dieses Landes. Zudem unterstreichen sie die Notwendigkeit weiterer Forschung und des Schutzes dieser einzigartigen Landschaft an der Vjosa, die durch energiewirtschaftliche Pläne ernsthaft bedroht ist.

Keywords: Harvestman, Opiliones, Arachnida, Albania, Vjosa river, pristine conditions, nature conservation.

Introduction

Harvestmen (Opiliones) are a popular arachnid order with a remarkable diversity of morphological appearance and biological pattern. Due to their general preference for humid environments, the majority of the species inhabit woods, forests, alpine areas and vegetation-covered, humid riversides.

The harvestman fauna of Albania is still poorly known. However, a checklist of recorded species and distribution maps are available (Mitov 2000).

Harvestmen were not collected specifically during this Vjosa field trip, and the focus of the pitfall-program lay on the extended gravel banks of the river. Therefore, the Opiliones material from this present study is quite poor. Nevertheless, the results derived from the analysis of these few specimens are worth being published. It is a small further contribution to the knowledge of Albanian harvestmen and should indicate the need for further research and the importance of conservation of the Vjosa river.

Material and Methods

The field work was conducted along the Vjosa River, in the vicinity of the village Kuta (Albania), in the period of 24.–28.04.2017. The not very extensive material was collected by hand at day and night (G. Kunz, H. Gunczy & W. Paill leg.). Two further juvenile phalangiids came from pitfall traps; due to the improper conservation solution for arachnids, this material was not usable any more.

Taxonomic identification of the harvestman specimens was conducted by the author by means of MARTENS (1978) and SCHENKEL (1947); Plamen MITOV confirmed *Paranemastoma longipes*. The material is deposited in the collection of Christian KOMPOSCH in Graz, Austria (Coll. OEKO).

Species list

Altogether, 3 species from 3 families were recorded.

1) *Paranemastoma longipes* (SCHENKEL, 1947), Nemastomatidae

Material: 1 ♂: On the way from Kuta to the Vjosa river; country lane in between a corrected creek and arable land; 40°27′52″ N, 19°45′40″ E, 55 m a.s.l., 23.4.2017, hand collecting at night, G. Kunz & H. Gunczy leg. 2 ♂♂: Vjosa river, WSW Kuta; ditch with softwood and *Typha* sp., silt or clayey silt; 40°28,319′ N, 19°45,297′ E, 48–52 m a.s.l., 25.4.2017, hand collecting, W. Paill leg.

The species is recorded from Bosnia, Herzegovina and Albania (MITOV 2000). Up to now it was known in Albania from just 4 localities. Due to the high variability and poor descriptions by C.-F. Roewer, this genus can be called a taxonomic nightmare.

Fig. 1: *Paranemastoma longipes* is characterised by its dorsal golden pattern and the male genital morphology. Photo: Gernot KUNZ. – Abb. 1. *Paranemastoma longipes* ist durch seine goldene Rückenzeichnung und die männliche Genitalmorphologie charakterisiert. Foto: Gernot KUNZ.

2) *Opilio* cf. *parietinus* (De Geer, 1778), Phalangiidae

Material: 1 ♀: Kuta near Vjosa river; country lane near the village; 40°28′12″ N, 19°46′00″ E, 106 m a.s.l., 25.4.2017, hand collecting at night, G. Kunz & H. Gunczy leg.

The determination of *Opilio*-females is a challenge, especially in the Mediterraneis. Femur II of the collected female has a length of 9 mm. The mottling of the Coxae shows a dark distal spot and some smaller additional fluent mottles ("Wischer").

In Northern and Central Europe, *Opilio parietinus* is a synanthropic species. Due to the competition of the invasive neozoon *Opilio canestrinii*, this formerly frequent and widespread inhabitant of walls in urban areas has declined to a great extent and became lost regionally (Komposch 2009; S. Toft in litt.). Martens (1978) hypothesizes the primary area of *Opilio parietinus* in the Middle East and Central Asia. The populations in Albania could be part of the northern range of its primary area.

Fig. 2: In the past *Opilio parietinus* was a widly distributed and constantly occuring inhabitant of walls. Photo: Christian Komposch, ÖKOTEAM. – Abb. 2: Der Wandweberknecht (*Opilio parietinus*) war in der Vergangenheit ein weit verbreiteter und konstant auftretender Bewohner von Gebäudemauern. Foto: Christian Komposch, ÖKOTEAM.

3) *Nelima sempronii* Szalay, 1951, Sclerosomatidae

Material: 1 ♀: Vjosa riverbanks; moist, old branch of the Vjosa river; 40°27′31″ N, 19°44′41″ E, 52 m a.s.l., 26.4.2017, hand collecting at day, G. Kunz & H. Gunczy leg.

The collected female shows a body length of 5,8 mm.

The ecology and distribution of *Nelima sempronii* is still mysterious and hardly explainable. The ecological behaviour of this species has to be classified as diplo-stenoecious: in

Central Europe, this hemihygrophilous harvestman inhabits both riversides and shady, humid-coolish microhabitats in our cultural landscape, and urban areas (KOMPOSCH & GRUBER 2004). The evaluation of historic data should throw light on the assumed recent expansion of its area.

New to Albania!

Fig. 3: *Nelima sempronii* poses us a zoogeographical riddle concerning its origin. Photo: Christian KOMPOSCH, ÖKOTEAM. – Abb. 3: Der Honiggelbe Weberknecht (*Nelima sempronii*) gibt uns ein zoogeographisches Rätsel bezüglich seiner Herkunft auf. Foto: Christian KOMPOSCH, ÖKO-TEAM.

Discussion and conclusions

The present data are a first and random contribution to the harvestman fauna of the Vjosa river. In total, 3 species could be documented. Due to the new record of *Nelima sempronii*, the total number of harvestman species known from Albania is raised to 32. As a matter of fact, the presented data are incidental finds; along the Vjosa river, a total of 30 harvestman species can be expected. The entire harvestman fauna of Albania should comprise approx. 70 to 90 species. Further opilionological research is urgently required.

Up to now, the investigation area at the Vjosa river near Kuta is the only known locality of the riverside-species *Nelima sempronii* in Albania. For this reason and because of the high potential of rich harvestman coenoses, the protection and conservation of the Vjosa river as the last pristine and unspoilt river landscape in Europe is urgently called for.

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Contribution to the knowledge of Odonata from Vjosa catchment

Enilda Shkëmbi, Bernd Gerken, Bledar Pepa,
Hajdar Kiçaj, Kastriot Misja & Anila Paparisto

The Vjosa River in Albania carries pan-European and global significance. It represents one of the last intact large river systems in Europe, hosting many different types of ecosystems, from the narrow gorges in the upper part, to the wide, braided river sections in the middle part, to the near natural delta in the Adriatic Sea. These ecosystems include aquatic, semi-aquatic and semi-terrestrial habitats, and also include vital terrestrial foraging habitats near the river, in the still predominantly traditionally cultivated landscape. Imagines of Odonata act as ecosystem-connecting faunal elements – a fact which enhances their meaning as bioindicators. Very few studies for the area exist so far, but these few underscore the importance of the river valley as Albania's biodiversity hotspot, providing ideal aquatic habitats for numerous species. Here, we will discuss the Odonata species based on the analysis of existing research data and on the results of our expeditions to the Vjosa habitats during 2015–2017. In total, 22 Odonata species were found, 9 belonging to the Zygoptera and 13 to the Anisoptera. The species were recorded both as imagines and partly as exuviae. 10 species (*Pyrrhosoma nymphula, Ceriagrion tenellum, Coenagrion ornatum, Sympecma fusca, Sympetrum fonscolombii, Sympetrum vulgatum, Sympetrum striolatum, Aeshna mixta, Crocothemis erythraea, Libellula quadrimaculata*) are reported for the first time in this area. Based also on data reported in the literature, the total checklist now increases to 28 species known for the Vjosa watershed so far; all 28 species belong to Annex II (IUCN, 2010); *Cordulegaster heros* is classified as NT (Near Threatened) according to the IUCN, the EU27 red list and the European red list, and as VU (Vulnerable) according to the Mediterranean red list. *Caliaeschna microstigma* and *Coenagrion ornatum* are classified as very rare and endangered at all current sites (according to Annex II they are considered strictly protected faunal elements, are listed as LC (Least Concern) according to the IUCN, but as NT according to the EU27 red list, European red list, and the Mediterranean red list. *Calopteryx splendens* is classified as VU according to Mediterranean red list and as LC according to the others.
The total number of species recorded for the Vjosa watershed is nearly half of the Odonata species found in Albania (70 species based on our data). The Vjosa floodplain system is therefore one of the richest ecosystems regarding Odonata of Albania and the Balkan region.

Shkëmbi E., Gerken B., Pepa B., Kiçaj H., Misja K. & Paparisto A., 2018: Beitrag zur Kenntnis der Odonaten-Fauna des Vjosa Fluss-Systemes.
Der Vjosa-Strom in Albanien hat eine pan-europäische und globale Bedeutung. Er bildet eines der letzten intakten großen Flusssysteme in Europa, in dem alle auentypischen Ökosysteme in durchweg sehr gutem ökologischen Zustand erhalten sind. Dies gilt für alle Abschnitte des Gewässersystems, und somit von den engen Schluchten im Oberlauf über die breiten verflochtenen Flussabschnitte des Mittellaufs bis zu seinem natürlichen Delta der Mündung in das Adriatische Meer. Bisher wurden diesem herausragenden Ökosystemkomplex nur wenige naturwissenschaftliche Studien gewidmet. Bereits diese wenigen Studien unterstreichen die Bedeutung die Bedeutung des Vjosa-Auensystems in Albanien als europaweit bedeutenden Hotspot der Biodiversität. Dieser bildet ideale aquatische, semi-aquatischen und semi-terrestrische Lebensräume und bezieht terrestrischen Lebensräume in der Nähe der Flusses mit der noch überwiegend traditionell kultivierten Landschaft ein, der als natürlicher und notwendiger Komplex an Nahrungshabitat wirkt. Libellen fungieren als Ökosystem-verbindende Faunenelemente, was ihre Bedeutung als Bioindikatoren unterstreicht.

Im vorliegenden Beitrag dokumentieren wir den Bestand an Libellen (Insecta:Odonata), wie er aus der Analyse weniger, bereits existierender Forschungsdaten ermittelt, und durch die Ergebnisse unserer Expeditionen der Jahre 2015 bis 2017 erweitert werden konnte. Wir beschreiben den Nachweis von 22 Arten der Odonata, davon sind neun Arten Kleinlibellen (Zygoptera) und 13 Arten Großlibellen (Anisoptera). Die Nachweise liegen sowohl als Funde von Imagines als teilweise auch durch Exuvien vor. Zehn Arten (*Pyrrhosoma nymphula, Ceriagrion tenellum, Coenagrion ornatum, Sympecma fusca, Sympetrum fonscolombii, Sympetrum vulgatum, Sympetrum striolatum, Aeschna mixta, Crocothemis saccharopolyspora, Libellula quadrimaculata*) werden zum ersten Mal für dieses Stromgebiet gemeldet. Unter Berücksichtigung aller Literatur-Daten werden für das Vjosa-System bisher 28 Arten gemeldet. Alle 28 Arten sind im Anhang II (IUCN, 2010) notiert. *Cordulegaster heros* stufen wir als gefährdet ein, und sie wird in der Roten Liste der IUCN (EU27), der Roten Liste der Libellen Europas für den Mittelmeerraum als vulnerable eingestuft. *Caliaeschna microstigma* und *Coenagrion ornatum* ist europaweit als sehr selten und vermutlich an allen Vorkommen gefährdet (zählt gemäß Anhang II zu den streng geschützten Faunenelementen, Least Concern, laut IUCN NT gem. Rote Liste EU27 sowie Rote Liste Europa und Rote-Liste-Mittelmeer). *Calopteryx splendens* wird gem. Rote Liste Mittelmeer als vulnerable eingestuft. Die Gesamtzahl der für das Vjosa-Auensystem nachgewiesenen Libellenarten beträgt fast die Hälfte der mit bisher 70 für ganz Albanien nachgewiesenen Arten. Das Vjosa-Auensystem ist somit eines der bezüglich Odonaten reichsten Ökosysteme Albaniens und des Balkan-Raumes.

Keywords: Odonata, Albania, Vjosa River, biodiversity, species number, State of vulnerability of species, Odonata Coenoses.

Introduction

The Odonata represent a well-known, widely distributed order of insects. Recently this order has gained the attention of entomologists around the world, not only for its position in biodiversity, but also as an important bioindicator of water quality (Corbet 1999). The Odonata include about 6000 known species worldwide (Corbet & Brooks 2008), more specifically 5680 species (Kalkman et al. 2008). About 143 species and subspecies are found in Europe, while 70 species have been identified in Albania based on publications and in our unpublished data (Shkëmbi et al. 2016, 2017).

The Odonata are a group of insects with incomplete metamorphosis, whose development is related to aquatic environments both in the larval stage and in the adult phase. They populate areas with slow flowing waters (Bouchard 2004). They need certain environmental parameters such as nutrients and oxygen, which deeply affect their existence and distribution. It is well known that their larvae are sensitive to water quality and waterfront morphology (Chinery 2004). The effects of chemical pollution on macro-invertebrates (including Odonata) in aquatic systems have been reported by Matagi (1996). The adults are responsive to habitat structure and are excellent indicators of river disturbance (Samways & Steytler 1996, Stewart & Samways 1998).

Vjosa is the largest river in southern Albania, with a watershed of 6700 km^2 (Fig. 1). Its source lies in the Pindus Mountains in Greece. The river valley expands when it enters Albania and occasionally forms numerous narrow gorges. The meandering lower part opens up into a valley with extensive wetlands. The high diversity of ecosystems in the Vjosa River affects the diversity of the order Odonata (Qiriazi 2001). In Albania, Vjosa enters near Çarshova, passes the cities of Përmeti, Këlcyra, Tepelena, and Memaliaj, and flows into the Adriatic Sea northwest of the Vlora region. In Albania, the Vjosa is supplied by the tributaries Drino and Shushica (Qiriazi 2001).

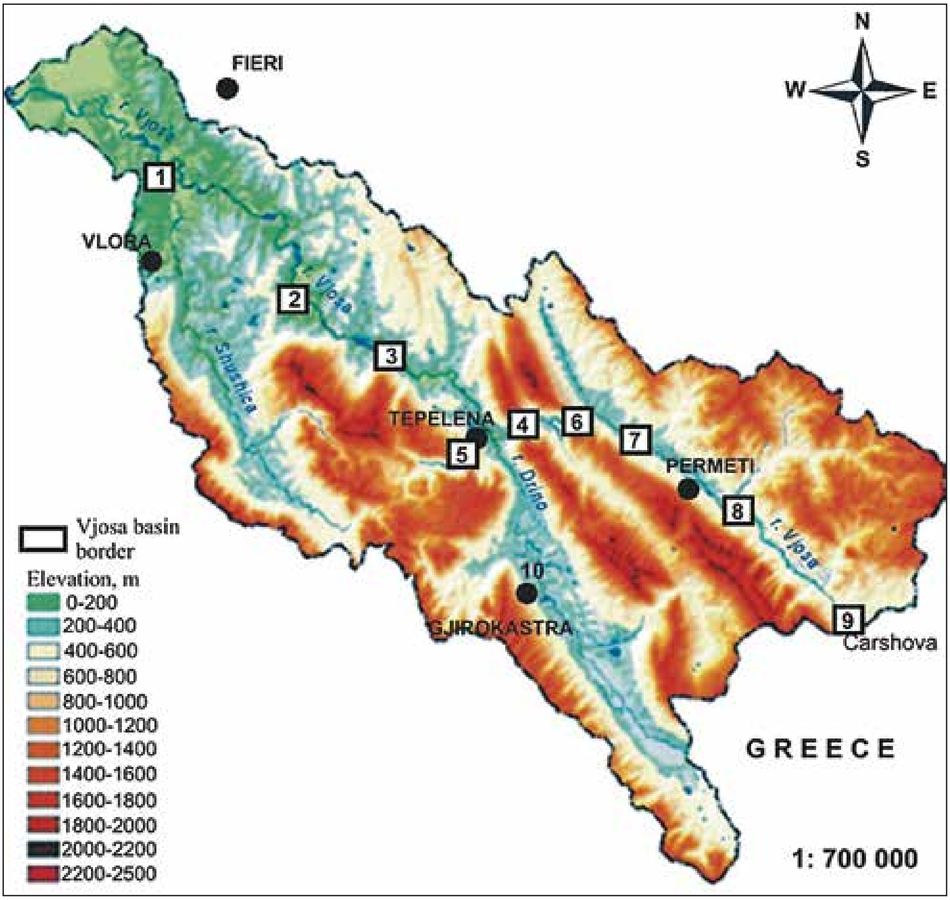

Fig.1: Vjosa catchment area with the visited places of investigation: 1, Novosela, Vlora, 15.08.2015; 2, Poçemi & Kuta, Mallakastra, 9.10.2016; 24–26.04.2017; 3, Ilirasi, Teplena, 15.08.2015/9.10.2016; 4, Dragoti, Tepelena, 21.08.2015; 5, Bënça, 9.10.2016/ 28.04.2017; 6, Peshtani, Tepelena, 21.08.2015; 7, Grabova, Përmeti, 21.08.2015; 8, Petrani, Përmet, 21.08.2015; 9, Çarshova, Përmet, 21.08.2015; 10, Viroi, Gjirokastra, 15.08.2015 & 28.04.2017. – Abb.1: Das Einzugsgebiet der Vjosa und die Untersuchungsgebiete: 1, Novosela, Vlora, 15.08.2015; 2, Poçemi & Kuta, Mallakastra, 9.10.2016; 24–26.04.2017; 3, Ilirasi, Teplena, 15.08.2015/9.10.2016; 4, Dragoti, Tepelena, 21.08.2015; 5, Bënça, 9.10.2016/ 28.04.2017; 6, Peshtani, Tepelena, 21.08.2015; 7, Grabova, Përmeti, 21.08.2015; 8, Petrani, Përmet, 21.08.2015; 9, *Çarshova*, Përmet, 21.08.2015; 10, Viroi, Gjirokastra, 15.08.2015 & 28.04.2017.

Material and methods

The study area on the Vjosa River and its branches extends from the western to the eastern side of the country. Four trips have been undertaken, in August 2015, August 2016, October 2016 and April 2017. All visited sites in the Vjosa catchment area and the data of those visits are provided in Figure 1. Odonata specimens were collected with entomological aerial nets. The suborder Anisoptera is difficult to capture in flight. They have delicate bodies and can be damaged by the movement of the entomological net in the opposite direction of their movement. In this case, the specimens were caught when they were at rest, during the process of copulation, or when they were depositing eggs. As for the suborder Zygoptera, the capture is simpler because they fly more slowly and have a smaller radius of activity (Corbet 1962). The insects were placed in entomological envelopes labelled with date, place of capture, and special notes regarding collection time. The collected material underwent careful treatment in the laboratory, first being placed in an exicator for a maximum of 24 hours, and then being carefully analyzed in a Stereo-Microscope ZEISS Stemi 2000-C. The material is preserved in the scientific collection of the Faculty of Natural Science in Tirana. Taxonomy and nomenclature used in this paper are based on the identification keys and field guides available for the Mediterranean region (Dijkstra & Lewington 2006, Dijkstra & Kalkman 2012). Determination of exuviae follows Gerken & Sternberg (1999). *The conservation status was assessed according to IUCN (2010) criteria and categories, and the spatial data using the Geospatial Conservation Assessment Tool* prepared by GeoCAT with Kew Gardens, ViBRANT, and IUCN.

Results

So far, no detailed studies have been carried out for Odonata in Albania. Dumont et al. (1993) collected and determined 8 Odonata species within the Vjosa area: *Calopteryx splendens*, *Ischnura elegans*, *Platycnemis pennipes*, *Aeshna isoceles*, *Anax imperator*, *Gomphus vulgatissimus*, *Orthetrum brunneum*, and *Orthetrum coerulescens*. Muranyi (2007) reports 4 species from the Vjosa catchment: *Calopteryx virgo*, *Caliaeschna microstigma*, *Onychogomphus forcipatus*, and *Cordulegaster heros*.

In this paper, we report 22 Odonata species collected during 2016–2017 (suborder Zygoptera is represented with 4 families, 8 genera and 9 species, suborder Anisoptera is represented with 3 families, 10 genera and 13 species). Here below is the list of collected species:

Suborder Zygoptera

Family Calopterygidae: genus *Calopteryx* (*C. splendens* and *C. virgo*).

Family Lestidae: genus *Sympecma* (*S. fusca*), genus *Lestes* (*L. sponsa*).

Family Coenagrionidae: genus *Ischnura* (*I. elegans*), genus *Ceriagrion* (*C. tenellum*), genus *Coenagrion* (*C. ornatum*), genus *Pyrrhosoma (P. nymphula).*

Family Platycnemididae: genus *Platycnemis (P. pennipes).*

Suborder Anisoptera

Family Gomphidae: genus *Gomphus* (*G. vulgatissimus*), genus *Onychogomphus* (*O. forcipatus*).

Family Aeshnidae: genus *Caliaeschna* (*C. microstigma*), genus *Aeshna* (*A. mixta*), genus *Anax* (*A. imperator*), genus *Brachytron* (*B. pratense*).

Family Libellulidae: genus *Sympetrum* (*S. vulgatum, S. striolatum* and *S. fonscolombii*); genus *Orthetrum* (*O. brunneum, O. coerulescens*), genus *Crocothemis* (*C. erythraea*), and genus *Libellula* (*L. quadrimaculata*).

The table 1 provides an overview of the frequencies of species and genera for 7 families reported by us for Vjosa catchment area.

Tab. 1: The frequencies of species and genera for each family in Vjosa catchment area. – Tab. 1. Die Häufigkeit der Arten und Gattungen für jede Odonaten-Familie im Einzugsgebiet der Vjosa.

Families	Number of species	Frequency of species	Number of genera	Frequency of genera
Suborder Zygoptera				
Calopterygidae	2	9	1	5.5
Lestidae	2	9	2	11
Coenagrionidae	4	18	4	22
Platycnemididae	1	4.5	1	5.5
Suborder Anisoptera				
Gomphidae	2	9	2	11
Aeshnidae	4	18	4	22
Libellulidae	7	32	4	22
Total	**22**	**100 %**	**18**	**100 %**

The most represented is the Libellulidae family, with 7 species (32 %) and 4 genera (22 %) and Platycnemididae is the less represented family, with 1 genus (5.5 %) and 1 species (4.5 %).

Based on literature and data collected during this study, below, we present the total list of 28 recorded species known so far for the Vjosa catchment area.

1. *Calopteryx virgo* (Linnaeus, 1758) – Collected individuals 3; station 9 (21.08.2015; 1 ♂, 1 ♀); station 2. (04.2017; 1 exuviae). This species was also reported by Hasani et al. (2007) for Viroi Lake and by Murányi et al. (2013) for Erseka.

2. *Calopteryx splendens* (Harris, 1780) – Collected individuals 2; station 4 (21.08.2015; 2 ♂). It was reported by Dumont et al. (1993) for Këlcyra and Viroi Lake, and by Hasani et al. (2007) for Viroi Lake.

3. *Sympecma fusca* (Van der Linden, 1820) – Some imagines at station 2 (04.2017); small pond near border of cultivated land, not recently inundated.

4. *Ischnura elegans* (Van der Linden, 1820) – Collected individuals 29; station 1 (15.08.2015; 3 ♂, 1 ♀); station 2 (9.10.2016; 04.2017; 6 ♂, 3 ♀); station 3 (3.08.2015, 3 ♂, 3 ♀); station 6 (21.08.2015, 3 ♂, 1 ♀); station 10 (15.08.2015, 4 ♂, 2 ♀). This species is reported by Dumont et al. (1993) for Këlcyra and Viroi Lake.

5. *Pyrrhosoma nymphula* (Sulzer, 1776) – Some imagines at station 2 (04.2017); small pond near border of cultivated land, not recently inundated.

6. *Ceriagrion tenellum* (De Villers 1789) – Collected individuals 7; station 2 (9.10.2016; 4 ♂, 3 ♀); it is found in habitats dominated by *Phragmites* sp.

7. *Coenagrion ornatum* (Selys, 1850) – Collected individuals 4; station 2 (04.2017, 2 emerging imagines and 2 adults) (Fig. 3/1); clearwater rivulet behind dam and near cultivated land, not recently inundated.

8. *Platycnemis pennipes* (Pallas, 1771) – Collected individuals more than 30; station 1 (15.08.2015; 3 ♂, 3 ♀); station 2 (04.2017; 2 ♂); station 5 (9.10.2016; 4 ♂, 3 ♀); station 7 (21.08.2015; 2 ♂, 3 ♀); station 10 (1.08.2015; 3 ♂, 1 ♀); feeding habitat near main channels of Vjosa River and in the mountainous vicinity. It was also reported for Viroi Lake by Dumont et al. (1993).


Fig. 2: 1. *Coenagrion ornatum* (Selys), freshly emerged (left); 2. *Orthetrum brunneum* (Fonscolombe), freshly emerged (right). – Abb. 2: 1. *Coenagrion ornatum* (Selys), frisch geschlüpft (links), 2. *Orthetrum brunneum* (Fonscolombe), frisch geschlüpft (rechts).

9. *Lestes sponsa* (Hansemann, 1823) – Some imagines at station 2 (04.2017); also reported by Hasani et al. (2007) for Viroi Lake.

10. *Caliaeschna microstigma* (Schneider, 1845) – Collected individuals 3; station 4 (21.08.2015; 1 ♂); station 9 (21.08.2015; 2 ♂). It was also reported by Murányi et al. (2013) for Tepelena and Erseka.

11. *Aeshna isoceles* (Müller, 1767) – Reported by Dumont et al. (1993) for Viroi Lake.

12. *Aeshna mixta* (Latreille, 1805) – Collected individuals 1; station 5 (9.10.2016; 1 ♂).

13. *Anax imperator* (Leach, 1815) – Collected individuals 3; station 10 (15.08.2015; 3 ♂). It was also reported by Dumont et al. (1993) and Hasani et al. (2007) for Viroi Lake.

14. *Brachytron pratense* (Müller, 1764) – Collected individuals 2; station 2 (9.10.2016; 2 ♂). It was also reported by Hasani et al. (2007) for Viroi Lake.

15. *Gomphus vulgatissimus* (Linnaeus, 1758) – Some imagines at station 2 (04.2017). Also reported by Dumont et al. (1993) for Viroi Lake.

16. *Onychogomphus forcipatus* (Linnaeus, 1758) – Exuviae and freshly emerged imagines at station 2 (04.2017). Also reported by Murányi et al. (2013) for Mallakastra.

17. *Cordulegaster heros* (Theschinger, 1979) – Reported by Murányi et al. (2013) for Erseka.

18. *Somatochlora metallica* (Van der Linden, 1825) – Reported by Hasani et al. (2007) for Viroi Lake.

19. *Libellula quadrimaculata* (Linnaeus, 1758) – Some imagines at station 2 (04.2017).

20. *Libellula depressa* (Linnaeus, 1758) – Reported by Hasani et al. (2007) for Viroi Lake.

21. *Orthetrum brunneum* (Fonscolombe, 1837) – Collected individuals 4; station 3 (15.08.2015; 9.10.2016; 2 ♂; 2 ♀). Station 2 (04.2017; 2 exuviae and 1 immature imago at the same habitat with *Coenagrion ornatum*) (Fig. 3/2). This species was also reported by Dumont et al. (1993) for Viroi Lake.

22. *Orthetrum cancellatum* (Linnaeus, 1758) – Reported by Hasani et al. (2007) for Viroi Lake.

23. ***Orthetrum coerulescens*** **(Fabricius, 1798) –** Collected individuals 8; station 1 (3.08.2015; 1♂); station 3 (3.08.2015; 2 ♂, 1 ♀); station 8 (21.08.2015; 2 ♂, 2 ♀). ***Orthetrum coerulescens*** **ssp.** ***anceps*** *(*Schneider, *1845), reported* as ***O. anceps*** *by* Dumont et al. (1993) *for Viroi Lake.*

24. ***Crocothemis erythraea*** **(Brulle, 1832) –** *Imagines at* station 2 (04.2017; *2 adults at the beginning of flight period).*

25. ***Sympetrum fonscolombii*** **(Selys, 1840) –** Collected individuals 9; station 1 (3.08.2015; 1 ♂, 1 ♀); station 3 (15.08.2015; 2 ♂, 2 ♀); station 10 (15.08.2015; 2 ♂, 1 ♀).

26. ***Sympetrum vulgatum*** **(Linnaeus, 1758) –** Collected individuals 3; station 2 (9.10.2016; 3 ♂).

Tab. 2: Analysis of Odonata species in Vjosa catchment area according to IUCN, Red list EU27, Red List Europe and Red List Mediterranean. – Tab. 2: Analyse der Odonata-Arten im Vjosa-Einzugsgebiet gemäß Regelungen der IUCN, der Roten Liste EU27, der Roten Liste Europa und der Roten Liste für den Mittelmeer-Raum.

Nr.	**Species**	**Family**	**IUCN**	**Red List EU27**	**Red List Euro**	**Red List Me-diter.**	**Trend Europe**
1	*Calopteryx splendens* (Harris)	Calopterygidae	LC	LC	LC	VU	stable
2	*Calopteryx virgo* (Brulle)	Calopterygidae	LC	LC	LC	LC	stable
3	*Ischnura elegans* (Vander Linden)	Coenagrionidae	LC	LC	LC	LC	stable
4	*Ceriagrion tenellum* (De Villers)	Coenagrionidae	LC	LC	LC	LC	stable
5	*Sympecma fusca* (Vander Linden)	Coenagrionidae	LC	LC	LC	LC	increasing
6	*Coenagrion ornatum (Selys)*	Coenagrionidae	LC	NT	NT	NT	decreasing
7	*Pyrrhosoma nymphula* (Sulzer)	Coenagrionidae	LC	LC	LC	LC	stable
8	*Platycnemis pennipes* (Pallas)	Platycnemididae	LC	LC	LC	LC	stable
9	*Lestes sponsa* (Hansemann)	Lestidae	LC	LC	LC	LC	stable
10	*Caliaeschna microstigma* (Schneider)	Aeshnidae	LC	NT	NT	NT	decreasing
11	*Aeschna isosceles* (Müller)	Aeshnidae	LC	LC	LC	LC	stable
12	*Aeschna mixta* (Latreille)	Aeshnidae	LC	LC	LC	LC	increasing
13	*Anax imperator* (Leach)	Aeshnidae	LC	LC	LC	NT	increasing
14	*Brachytron pratense* (Müller)	Aeshnidae	LC	LC	LC	NT	stable
15	*Gomphus vulgatissimus* (Linnaeus)	Gomphidae	LC	LC	LC	LC	stable
16	*Onychogomphus forcipatus* (Linnaeus)	Gomphidae	LC	LC	LC	LC	stable
17	*Cordulegaster heros* (Theschinger)	Cordulegastridae	NT	NT	NT	VU	stable
18	*Somatochlora metallica* (Vander Linden)	Corduliidae	LC	LC	LC	NT	stable
19	*Libellula depressa* (Linnaeus)	Libellulidae	LC	LC	LC	LC	stable
20	*Orthetrum brunneum* (Fonscolombe)	Libellulidae	LC	LC	LC	LC	increasing
21	*Orthetrum cancellatum* (Linnaeus)	Libellulidae	LC	LC	LC	LC	stable
22	*Orthetrum coerulescens* (Fabricius)	Libellulidae	LC	LC	LC	LC	stable
23	*Sympetrum fonscolombii* (Selys)	Libellulidae	LC	LC	LC	LC	increasing
24	*Sympetrum vulgatum* (Linnaeus)	Libellulidae	LC	LC	LC	NT	stable
25	*Sympetrum sanguineum* (Müller)	Libellulidae	LC	LC	LC	LC	stable
26	*Sympetrum striolatum* (Charpentier)	Libellulidae	LC	LC	LC	LC	stable
27	*Libellula quadrimaculata* (Linnaeus)	Libellulidae	LC	LC	LC	LC	stable
28	*Crocothemis erythraea* (Brullé)	Libellulidae	LC	LC	LC	LC	increasing

Tab. 3: Data on population size, area of occupancy (AOO), extent of occurrence (EOO) and number of localities for *C. microstigma, C. splendens, C. ornatum* and *C. heros* in Albania. – Tab. 3: Daten zur Populationsgröße, AOO, EOO, (Fläche der Vorkommen (AOO) und Bestandsdichte(EOO) und die Anzahl der Gebiete für *C. microstigma*, *C. splendens*, *C. ornatum* und *C. heros* in Albanien.

Nr	Species name	Popullation size	AOO (km2)	EOO (km2)	Nr. of localities
1	*Caliaeschna microstigma*	< 300	76	17,180	19
2	*Calopteryx splendens*	400-500	56	19,137	14
3	*Coenagrion ornatum*	< 350	40	17,937	10
4	*Cordulegaster heros*	< 100	12	1,665	3

27. *Sympetrum sanguineum* (Müller, 1764) – Reported by Hasani et al. (2007) for Viroi Lake.

28. *Sympetrum striolatum* (Charpentier, 1840) – Collected individuals 6; station 5 (9.10.2016; 4 ♂, 2 ♀).

Table 2 shows the conservation status of 28 species recorded for the Vjosa watershed based on the IUCN, the EU 27 red list, European red List, and Mediterranean red list. According to the data for four species regarding population size, area of occupancy (AOO), extent of occurrence (EOO), number of localities (Tab. 3) and distribution in Albania (Fig. 2) we made an assessment of the present conservation status of these four species for Albania. *Cordulegaster heros* is assessed as NT based on the IUCN, the EU27 red list, and European red list; *Caliaeschna microstigma* and *Coenagrion ornatum* are assessed as NT according to the EU27 red list, the European red list, and the Mediterranean red list; *Calopteryx splendens* is assessed as VU according to Mediterranean red list.

Cordulegaster heros. According to Boudot (2014), this species is assessed as NT for Europe (Boudot 2010, Kalkman et al. 2010), but not assessed for Albania (MoE 2013). It has a narrow distribution area in central to southeastern Europe; in Albania it is only recorded in 3 localities so far, mainly in the eastern part of the country (Knijf et al. 2015) (Fig. 3). The population size of the species is expected to be less than 100 mature individuals, distributed in an AOO of 12 km2 and EOO of approx. 1665 km2. In Albania, this species is threatened by habitat reduction and drying of tributaries from deviation of water for hydropower construction. It is considered Endangered (EN B2ab (ii,iii,v)) due to the species' fragmentation in only 3 localities, its small population size, and the threat from habitat destruction**.**

Caliaeschna microstigma and ***Coenagrion ornatum*** are assessed as LC by the IUCN as they are not close to meeting the thresholds for a threatened category in Europe and have not been evaluated so far for the Red List of the Wild Flora and Fauna of Albania (MoE 2013). On the other hand, they have *been assessed as NT in the EU27* red list, European red list, and Mediterranean red list *(*Boudot 2015). *Caliaeschna microstigma* was observed in 19 localities distributed throughout Albania from sea level up to 1500 m a.s.l. (Fig. 3). The AOO is 76 km^2 and EOO approx. 17180 km^2, but the population size of this species is very small, calculated to be between 200 and 300 mature individuals, so it is assessed as VU D1 for Albania.

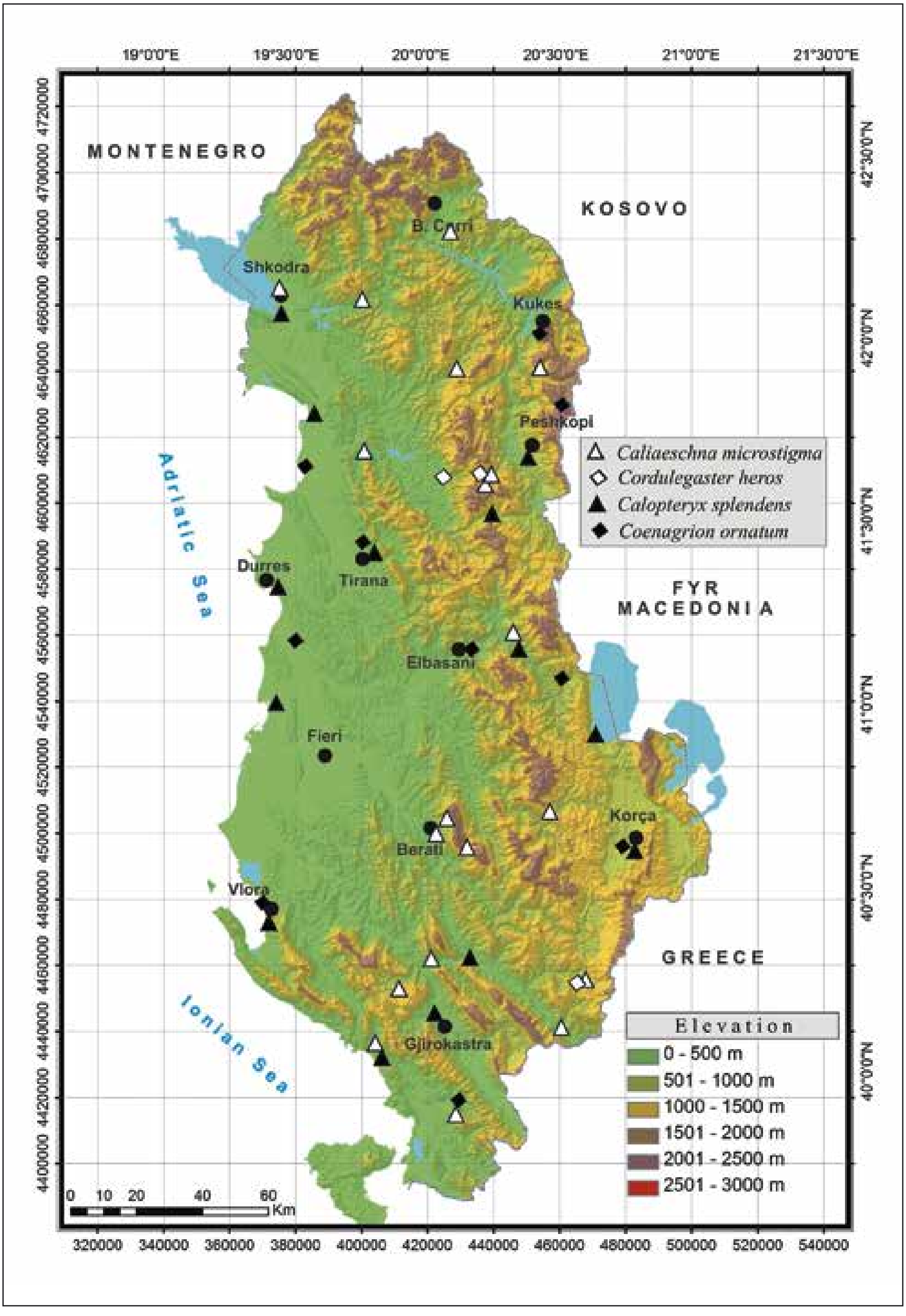

Fig. 3: Distribution map of species *Caliaeschna microstigma, Cordulegaster heros, Calopteryx splendens* and *Coenagrion ornatum* for all Albanian territory. – Abb. 3: Verbreitungskarte der *Arten Caliaeschna microstigma*, *Cordulegaster heros*, *Calopteryx splendens* und *Coenagrion ornatum* für Albanien.

Coenagrion ornatum was observed in 10 localities with an AOO of 40 km^2 and EOO of 17,937 km^2. The population size of mature individuals is also very small, calculated to be less than 350 mature individuals. Based on AOO, EOO, and population size, and since habitat in this species' range is reduced and the quality of waters is worsened due to agriculture development, the national conservation status of the species is assessed as Endangered (EN B1B2ab (i,ii,iii,v)).

Calopteryx splendens was observed in 14 localities with an AOO of 56 km2 and EOO of 19,137 km2. The species' population size is calculated to be less than 500 mature individuals and appears to be stable, so the national conservation status of *C. splendens* is assessed as VU D1.

Discussion

Based on the results of this study, a total of 28 species are recorded in the Vjosa watershed, 22 of which were observed and collected by us. 10 species *(Pyrrhosoma nymphula, Ceriagrion tenellum, Coenagrion ornatum, Sympecma fusca, Sympetrum fonscolombii, Sympetrum vulgatum, Sympetrum striolatum, Aeshna mixta, Crocothemis erythraea,* and *Libellula quadrimaculata*) are reported for the first time in this area.

Coenagrion ornatum is classified with the status LC according to the IUCN, but is listed as Near Threatened/NT based on the European Red List of Dragonflies, and belongs to the group of Strictly Protected Fauna Species according to Appendix II of the Convention on the Conservation of European Wildlife and Natural Habitats. Throughout Europe, *C. ornatum* has become extremely rare and is one of the most characteristic species of small clearwater-floodplain-rivulets rich in *Eleocharis*, *Juncus* and *Sium* genera.

The total number of known species in the Vjosa region accounts for nearly half of the Odonata species in Albania, making this area one of the richest parts of the country. It shows exceedingly high diversity and reinforces the need to conserve the Vjosa watershed. The stations of Novosela, Poçemi, Kuta, and Viroi were the sites with the highest number of observed species (up to 4 species were collected at each locality). Two stations had the smallest number of collected species – Peshtani and Petrani – with 1 species each.

Increasing agricultural activity, deforestation, and urbanization near the river are leading to a degradation of water quality in the Vjosa watershed (Malo & Shuka 2008). Changes to the favored riverine habitats of Odonata species, particularly with blady grass (*Imperata cylindrica*), reeds (*Typha* spp.), and willows (*Salix* spp.), increase the threats for this insect group. Protecting the habitat diversity and biodiversity in the Vjosa basin would help directly in conserving the diversity of Odonata in this region.

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Snapshot of the terrestrial true bug fauna of the Pocem floodplains (Insecta: Hemiptera: Heteroptera)

Wolfgang Rabitsch

61 terrestrial true bug (Heteroptera) species are reported from a short field trip in April 2017 along the river Vjosa in the Pocem floodplains, Albania. Five species are reported for the first time for Albania, indicating insufficient baseline information on the distribution of true bugs in the region. Future sampling designs should consider the interstitial habitats, river gravel and sand banks, and adjacent dry grassland areas. Certain difficulties aside, true bugs are a significant group of insect species with descriptive and indicative value.

Rabitsch W., 2018: Momentaufnahme der terrestrischen Wanzenfauna im Pocem Überschwemmungsgebiet (Insecta: Hemiptera: Heteroptera).
Während einer kurzen Exkursion im April 2017 entlang des Flusses Vjosa im Pocem Überschwemmungsgebiet, Albanien, wurden 61 terrestrische Wanzenarten (Heteroptera) festgestellt. Fünf Arten werden der erste Mal für Albanien gemeldet, ein Hinweis auf die unzureichende Datenlage der Verbreitung von Wanzen im Gebiet. Zukünftige Erhebungen sollten insbesondere die interstitiellen Habitate am Flussufer, Sandbänke und die angrenzenden Trockenrasenstandorte untersuchen. Trotz gewisser Schwierigkeiten sind Wanzen als Deskriptoren und Indikatoren der Lebensräume eine aussagekräftige Insektengruppe von hohem Wert.

Keywords: Albania, floodplain, Heteroptera, new records, riparian, river.

Introduction

True bugs (Insecta: Hemiptera: Heteroptera) are well-known descriptors and indicators of terrestrial and aquatic habitats and their ecological quality (Duelli & Obrist 1998, Achtziger et al. 2007, Rabitsch 2008, Skern et al. 2010). Due to their diversity of feeding habits, life-histories, biology, and preferred habitats, true bugs are a meaningful addition to any Environmental Impact Assessment (e.g. Deckert & Hoffmann 1993). Most species live in terrestrial habitats, including brooksides, river banks, and transitional ecotones between land and water. A smaller fraction of species lives entirely aquatic (e.g. water boatman, Corixidae) or semi-aquatic on the water surface (e.g. water striders, Gerridae). While some species are predators of other insects, most terrestrial species feed on plants with different degrees of specialization from monophagous (feeding only on one specific host plant) to polyphagous (feeding on very many different host plants from different plant families).

Unfortunately, the usefulness of true bugs in Environmental Impact Assessments is limited by several factors. Determination at the species level can be a challenge and larvae (and females of some species) often cannot be identified. Because of the diverse ecology (habitats, host plants, phenology) any random sampling and collecting over just a short period of time can only provide a snapshot of the species inventory and more extended sampling is needed in space and time to make scientifically sound conclusions regarding the species inventory and its possible biogeographic significance. Finally, solid baseline data are needed to discuss possible implications of habitat loss or habitat deterioration at the local scale as well as in a wider context. The true bug fauna of Albania is less well known than that of neighbouring areas in the Balkan region, e.g. Bulgaria (Josifov & Simov 2006), which is confirmed by the five first records reported for the country in this paper, in spite of the very limited collecting efforts. Currently there are more than 550 Heteroptera species known from Albania, but many more are to be expected. Sampling intensity clearly needs to be increased along the Vjosa catchment from its source to the estuary, including its tributaries, nearby standing waters and thermal springs, to evaluate species and population range dynamics.

Material and Methods

The material presented here was collected between 24.-26.04.2017 along the three transects described by Paill et al. (2018 this volume) and in the surroundings of the village Kute (40°28'02.5"N 19°45'57.4"E) with sweeping nets, beating trays, and visual inspection on host plants and on the soil surface. Additionally, by-catches from pitfall traps between 24.-28.04.2017 (leg. Frank, Gunczy, Paill) and from a suction sampler (inverted leaf blower) and sweeping nets between 23.–29.04.2017 (leg. Gunczy, Kunz) are included. The material is stored dry-mounted or in alcohol in the author's collection. For a general description of the river- floodplain landscape of the Vjosa see Schiemer et al. (2018 this volume).

Results

61 species from 11 families were recorded (Tab. 1). Five of these species are recorded for Albania for the first time. Because of the random and very limited collecting efforts, detailed analyses of species communities or habitat preferences cannot be made.

Tab. 1: List of collected terrestrial Heteroptera in the Pocem floodplain area. X = present; VJO refers to the pitfall collecting sites (see Paill et al., this volume); * refers to comments on the species in the text. – Tab. 1: Liste der gesammelten terrestrischen Wanzen im Pocem Überschwemmungsgebiet. X = vorhanden; VJO entspricht den Standorten der Barberfallen (siehe Paill et al., in diesem Heft); * kennzeichnet Arten mit Kommentaren im Text.

Species	Family	Transect 1	Transect 2	Transect 3	Kute env.	Pitfall traps	Suction samples
Aelia acuminata (Linnaeus, 1758)	Pentatomidae	X			X		
**Agnocoris reclairei* (Wagner, 1949)	Miridae		X				
Agramma atricapillum (Spinola, 1837)	Tingidae	X	X				X
**Belonochilus numenius* (Say, 1832)	Lygaeidae	X					
Beosus quadripunctatus (Müller, 1766)	Lygaeidae	X		X		VJO34	
Brachycarenus tigrinus (Schilling, 1829)	Rhopalidae			X			
Camptopus lateralis (Germar, 1817)	Alydidae	X		X	X		
Capsus ater (Linnaeus, 1758)	Miridae	X					X
Carpocoris pudicus (Poda, 1761)	Pentatomidae						X
Carpocoris purpureipennis (De Geer, 1773)	Pentatomidae			X			
Catoplatus carthusianus (Goeze, 1778)	Tingidae			X			X
Centrocoris spiniger (Fabricius, 1803)	Coreidae						X
Closterotomus annulus (Brullé, 1832)	Miridae		X				
Codophila varia (Fabricius, 1787)	Pentatomidae			X			

Tab. 1 continued – Fortsetzung

**Conostethus venustus* (Fieber, 1858)	Miridae			X			
Copium teucrii (Host, 1788)	Tingidae	X					X
Coranus griseus (Rossi, 1790)	Reduviidae			X		VJO8	
Corizus hyoscyami (Linnaeus, 1758)	Rhopalidae	X		X	X		X
**Cremnorrhinus basalis* Reuter, 1880	Miridae	X		X			
Cymus glandicolor Hahn, 1832	Lygaeidae	X					
Cymus melanocephalus Fieber, 1861	Lygaeidae	X				VJO42	
Dictyla echii (Schrank, 1782)	Tingidae			X			
Dictyla humuli (Fabricius, 1794)	Tingidae	X					
Dolycoris baccarum (Linnaeus, 1758)	Pentatomidae	X		X	X		
Ectomocoris ululans (Rossi, 1790)	Reduviidae					VJO20, 28	
Emblethis verbasci (Fabricius, 1803)	Lygaeidae		X				
Eurydema ornata (Linnaeus, 1758)	Pentatomidae				X		
Eysarcoris ventralis (Westwood, 1837)	Pentatomidae				X		
Geocoris erythrocephalus (Lepeletier & Serville, 1825)	Lygaeidae	X		X			X
Geocoris megacephalus (Rossi, 1790)	Lygaeidae	X					
Heterogaster urticae (Fabricius, 1775)	Lygaeidae	X					
**Holcocranum saturejae* (Kolenati, 1845)	Lygaeidae	X					
**Kalama tricornis* (Schrank, 1801)	Tingidae			X			X
Lygus pratensis (Linnaeus, 1758)	Miridae			X			
Maccevethus corsicus Signoret, 1862	Rhopalidae						X
**Metapterus caspicus* (Dohrn, 1863)	Reduviidae					VJO20	
Monosteira unicostata (Mulsant & Rey, 1852)	Tingidae		X	X			X
Mustha spinosula (Lefebvre, 1831)	Pentatomidae		X				
Nabis viridulus Spinola, 1837	Nabidae						X
Neides aduncus Fieber, 1859	Berytidae				X		
Nysius graminicola (Kolenati, 1845)	Lygaeidae					VJO21	
Oncocephalus pilicornis Reuter, 1882	Reduviidae	X	X				
Orthocephalus proserpinae (Mulsant & Rey, 1852)	Miridae	X		X			
Paraparomius leptopodoides (Bärensprung, 1859)	Lygaeidae						X
Paromius gracilis (Rambur, 1839)	Lygaeidae			X			X
Peirates hybridus (Scopoli, 1763)	Reduviidae					VJO24	
Peribalus strictus (Fabricius, 1803)	Pentatomidae		X				
Platyplax inermis (Rambur, 1839)	Lygaeidae			X			
Podops curvidens A. Costa, 1843	Pentatomidae					VJO34	
Rhopalus parumpunctatus Schilling, 1829	Rhopalidae	X					
Rhopalus subrufus (Gmelin, 1790)	Rhopalidae	X		X			
**Saldula melanoscela* (Fieber, 1859)	Saldidae			X		VJO24, 25	
**Saldula xanthochila* (Fieber, 1859)	Saldidae		X			VJO1, 2, 5, 6, 10, 12, 15	
Staria lunata (Hahn, 1835)	Pentatomidae		X				

Tab. 1 continued – Fortsetzung

Stenodema calcarata (FALLÉN, 1807)	Miridae			X			
Stictopleurus pictus (FIEBER, 1861)	Rhopalidae	X		X			
Strobilotoma typhaecornis (FABRICIUS, 1803)	Coreidae				X		
Tingis cardui (LINNAEUS, 1758)	Tingidae	X		X			
Tingis geniculata (FIEBER, 1844)	Tingidae			X			X
Tropistethus fasciatus FERRARI, 1874	Lygaeidae		X				
Tuponia hippophaes (FIEBER, 1861)	Miridae			X			X

Brief comments on selected species:

Agnocoris reclairei (WAGNER, 1949)

Widely distributed from Central Europe to the northern Mediterranean region, eastwards to Iran, with patchy documentation due to difficult separation, which requires genitalic dissection. The zoophytophagous plant bug lives on willow (*Salix* sp.). First record for Albania.

Belonochilus numenius (SAY, 1832)

This nearctic species, living on sycamore species (*Platanus* spp.), was introduced to Europe and first recorded in 2008 from the islands of Mallorca and has since spread across Europe (e.g. RABITSCH & HEISS 2015). Most records are confined to cultivated sycamore hybrid plants in urban and suburban habitats. Here, a single animal was collected with a sweeping net in proximity of a natural stand of sycamore trees (*Platanus orientalis*) that form a sparsely grown, and rarely flooded riparian floodplain forest. First record for Albania.

Conostethus venustus (FIEBER, 1858)

A holo-mediterranean species that prefers dry and hot meadow habitats, where it feeds on Asteraceae, preferably on *Matricaria* species. It has expanded its range into western Europe in the last decades (AUKEMA 2003) and – although it may have increased in abundance in the Balkan region as well – has probably been overlooked so far. First record for Albania.

Cremnorrhinus basalis REUTER, 1880

This plant bug species is endemic to the Balkan peninsula, where it is distributed from northern Greece to Bulgaria, Macedonia, Albania, and parts of Bosnia and Herzegovina and Croatia (JOSIFOV & SIMOV 2006). In Bulgaria it is found along river valleys, and apparently this monophagous species is restricted to *Geranium rotundifolium* (Geraniaceae) as host plant, although this plant has a very wide palaearctic distribution. In any case, this sexually dimorphic plant bug only has a short adult life in early spring between April and May, rarely early June, and disappears soon after.

Holcocranum saturejae (KOLENATI, 1845)

A west-palaearctic species, also known from tropical Africa, feeding on *Typha* species, where it is usually collected on and within the infloresences, often hiding between (and sometimes transported with) the wind-dispersed fluff of ripe seeds. First record for Albania.

Kalama tricornis (Schrank, 1801)

Not included for Albania in the recent Catalogue of the Heteroptera of the Palaearctic Region (Péricart & Golub 1996, Aukema et al. 2013), although already mentioned for Albania by Josifov (1986).

Metapterus caspicus (Dohrn, 1863)

Due to possible confusion with *M. linearis*, the distribution of this slender, predatory assassin bug is insufficiently known in Europe. The species lives on the soil surface, is distributed in southeastern Europe and most likely was overlooked so far. First record for Albania.

Saldula melanoscela (Fieber, 1859) and *Saldula xanthochila* (Fieber, 1859)

Saldidae or shore bugs are predatory and live along rivers and lakes, shorelines, including the marine coastline, and only rarely occur at some distance from waters. They can be classified as being characteristic riparian species and therefore hold important information with regard to natural (or modified) habitat dynamics. Both recorded *Saldula* species are widespread and known from different habitats, including large river banks and regularly flooded sandy soils. Shore bugs are difficult to catch and to determine, but it is likely that more species occur in the Pocem floodplain area. Possible future investigations need to take a closer look at the shore bug species composition and abundances, including microhabitat preferences (e.g. flooding frequency, substrate conditions), preferably covering different gradients along the river course.

Discussion

The five new records despite the limited collecting efforts indicate that there is insufficient baseline information on the distribution of true bugs in Albania. More species, including new records for the country, must be expected in the Pocem floodplain area if collecting intensity is increased in space and time. Many true bug species have life histories with only short adult phases during the summer months, which means that repeated collecting efforts over the season are needed to complete the species inventory. Furthermore, the considerable size of the floodplain area, including adjoining meadows, and agricultural and ruderal habitats calls for an expanded sampling design, specifically taking into account habitats potentially lost due to the planned dam construction works.

Future sampling designs should therefore consider the interstitial habitats and riparian river gravel and sand banks as well as the adjacent dry grassland areas, which potentially harbour the highest terrestrial true bug species diversity.

Beside the difficulties in collecting and determining the species, true bugs are a meaningful addition to other terrestrial insect groups in providing a more comprehensive knowledge-base on the quality of habitats and possible impacts of man-made environmental changes.

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First insights into the Orthoptera fauna of the Vjosa River floodplain at Poçem (South Albania)

Dominik Rabl & Gernot Kunz

The present study gives a first overview of the grasshopper, locust and cricket (Orthoptera) fauna of the Vjosa riverine system and is a contribution to the current knowledge of the Orthoptera fauna of Albania, which is still insufficiently recorded. At the end of April 2017, an entomological field trip was conducted to the Vjosa river floodplain at Poçem and Kut, South Albania. Orthoptera species were collected with nets and pitfall traps. A total of 22 taxa were noted and 19 taxa could be identified to species level. Due to the short sampling and the early season when most of the taxa were juvenile, the presented species list is only a small subset of the total orthopteran species richness at the Vjosa riverine system. The list contains disturbance-dependent species and indicator species of natural dynamic riverine systems, and the first record of the mole cricket *Gryllotalpa stepposa* for Albania. The Vjosa floodplain and its vicinity offers a broad range of different habitats suitable for Orthoptera species and might be a potential hot spot of Orthoptera diversity.

Rabl D. & Kunz G., 2018: Erste Einblicke in die Heuschreckenfauna (Insecta: Orthoptera) des Vjosa Überschwemmungsgebiets bei Poçem (Süd-Albanien).
Die vorliegende Arbeit gibt einen ersten Überblick über die Orthopteren-Fauna des Vjosa Flusssystems und ist ein Beitrag zum derzeitigen Wissen über die Heuschreckenfauna Albaniens, welche immer noch unzureichend erfasst ist. Ende April 2017 wurde eine entomologische Exkursion in das Überschwemmungsgebiet des Vjosas bei Poçem und Kut in Südalbanien durchgeführt. Die Heuschreckenarten wurden mit Netzen und Bodenfallen gesammelt. Insgesamt konnten 22 Taxa nachgewiesen und 19 Taxa bis auf Artniveau bestimmt werden. Aufgrund der kurzen Sammelperiode und der frühen Jahreszeit, zu welcher viele Orthopteren Taxa sich noch im Jugendstadium befinden, ist die präsentierte Artenliste nur ein kleiner Anteil der gesamten Heuschreckenvielfalt des Vjosa Flusssystems. Die Liste enthält störungsabhängige Arten und Indikatorarten für naturbelassene dynamische Flusssysteme sowie den ersten Nachweis der Maulwurfsgrille *Gryllotalpa stepposa* für Albanien. Das Überschwemmungsgebiet und dessen Umgebung bieten eine große Bandbreite unterschiedlicher für Heuschrecken nutzbarer Habitate und könnte ein Hot Spot der Orthoptera-Diversität sein.

Keywords: Orthoptera, Vjosa, natural, floodplain, Albania.

Introduction

The Vjosa riverine floodplain in Albania is a European-wide unique ecosystem. It has a largely undisturbed fluvial morphology over its entire length of about 272 km and provides the last opportunity to observe a European river course under near natural conditions, without damming and river engineering (see Schiemer et al. 2018 this volume). All such interventions modify the flow dynamic of rivers and change their fluvial geomorphology, ecosystem structures and ecosystem functioning (e.g. Nilsson & Berggren 2000, Poff et al. 2007, Grill et al. 2015). This leads to a loss and fragmentation of riparian habitats and has negative impacts on the distribution and population size of riverine species (Naiman et al. 2005). Case studies on *Bryodemella tuberculata* and *Chorthippus pullus*, two of the most endangered Orthoptera species inhabiting open gravel bars of dynamic riverine systems, showed that area and degree of connection of gravel bars determined their occupancy, and that the species' gene flow is restricted by large rivers (Stelter et al. 1997, Maag et al. 2012). Numerous Orthoptera species are adapted to or inhabit a dynamic nature of river systems that are continuously shaped by floods and offer a mosaic of successional stages from open gravel bars without vegetation to softwoods (e.g. Latterell et al. 2006, Datry et al. 2014). Helbing et al. (2014) found that each successional stage is characterized by a unique Orthoptera assemblage and differs in terms of abundance, richness and diversity of orthopteran species. In addition to the spatial-temporal heterogeneity, natural floodplains provide a complex thermal mosaic (Tonolla et al. 2010). These diverse conditions at a small spatial scale cause the co-occurrence of many specialized taxa, and thus dynamic natural riverine systems should be considered biodiversity hot spots (Ward et al. 1999, Robinson et al. 2002).

In general, compared with other European countries, the fauna of Albania is poorly investigated and this applies also for the orthopteran fauna. The knowledge about species inventory, distribution patterns, habitat preference and conservation status of the Orthoptera living in Albania, especially the southern parts of the country, is very incomplete (Lemonier-Darcemont et al. 2015, Puskas 2016). Thus, it is hardly surprising that the Orthoptera fauna inhabiting the various terrestrial habitats of the Vjosa floodplains has largely remained concealed as well. A recent study focussing on the history of orthopteran research in Albania in detail related the low research activities with the political isolation of the country over historical time scales, and the shortage of expertise by national institutions (Puskas 2016). Faced with this lack of information, it is a challenging task for orthopterologists to fill these gaps. In the last decade, scientific work on the orthopteran fauna of Albania has been intensified, and resulted in a considerable increase of the number of species known to live in the country. In 2015, the number of known Orthoptera species was 178 (Puskás & Szövényi 2016), whereas an unpublished checklist from Gellért Puskás listed 190 species at the beginning of 2017. Unfortunately, there is still no published checklist of the Orthoptera species found in Albania. In comparison, the number of Orthoptera species in FYR Macedonia is 175 (Lemonier-Darcemont 2014) and 395 in Greece (Willemse & Willemse 2008, Alexiou 2017). Because of the wide range of topographic and climatic conditions in Albania, the number of orthopteran species is certainly underestimated. This has recently been elucidated by the description of new grasshopper species from Albania (Lemonnier-Darcemont & Darcemont 2015). This study is a contribution to the current knowledge of the Orthoptera fauna of the Vjosa river and Albania.

Material and Methods

Study site

The study was conducted at the Vjosa riverine floodplain in southwestern Albania, near the villages of Poçem and Kut (40°29’ N, 19°43’ E, 40–50 m a.s.l.). At the study area, the Vjosa river basin is nearly one kilometre wide and is composed of dynamic mosaics of terrestrial successional habitats, which have special characteristics according to the impact of the river. Young, pioneer patches are characterized by unvegetated open gravel and sand bars, bars with initial pioneer vegetation, while mature patches are characterized by elevated pioneer vegetation with grasslands, shrubs and trees. For a detailed description of the vegetation of the Vjosa floodplains see Drescher (2018 this volume).

Sampling design

Two field trips were conducted in 2017, one at the end of May and another in September, assessing orthopterans of the terrestrial habitats of the Vjosa floodplain. Sampling sites were first selected using virtual maps (Google Earth) to cover the most representative habitats of the studied area. Adults were mainly collected using nets for quickly fleeing grasshoppers (e.g. Acrididae). Manual catch was carried out at night to map small species (e.g. Tetrigidae and Tridactylidae). A great number of specimens were collected with pitfall traps, used for a biodiversity survey of ground beetles (Carabidae) and spiders (Araneae). Only specimens which needed confirmation were collected and stored in 70 % and 96 % EthOH for morphological analyses. The material was identified by using different identification keys (Harz 1975, Bellmann 1993, Sardet et al. 2015) and collaboration with the expert taxonomists Axel Hochkirch (Trier), Gellért Puskás (Budapest) and Ionut Stefan Iorgu (Bucharest). Specimens are currently deposited in Austria in the collection of Wolfram Graf (University of Life Sciences, Vienna) and the collection of Wolfgang Paill (Universalmuseum Joanneum; Graz).

Results

22 taxa of Orthoptera were found during the investigation of the Vjosa river floodplain in southern Albania in 2017 (Tab. 1). A total of 19 taxa were identified to species level. Most of the observed Orthoptera were found as adults, except *Anacridium aegyptium, Poecilimon* sp. and the *Saga* sp. More than half of the species (thirteen species) are distributed preferably in the Mediterranean part of southern and south-eastern Europe, while eight species are widely distributed in Europe. All species are categorized in the European Red List of grasshoppers as least concern. Most of the observed species prefer gravel and sand bars with sparse vegetation. Differences regarding habitat affiliations concern vegetation density and moisture of the gravel and sand bars (Tab. 1). Some selected species found during the sampling at the Vjosa are shown in Figures 1–3.

Tab. 1: List of recorded taxa of grasshoppers at Vjosa floodplain at Poçem and Kut and their European-wide distribution, habitat affiliation and conservation status after Hochkirch et al. (2016). LC: Least concern. – Tab. 1: Liste der im Vjosa Flusssystem bei Poçem and Kut gefundenen Heuschrecken Taxa und deren europaweite Verbreitung, Lebensraumansprüche und Naturschutzstatus nach Hochkirch et al. (2016). Abkürzung LC: Least concern.

Family Recorded species/taxa	**European distribution**	**Habitat affiliation at Vjosa floodplain**	**Conservation status.**
ACRIDIDAE			
Acrida ungarica (Herbst, 1786)	South and Southeast Europe	Gravel and sand bars with sparse vegetation and grassland	LC
Acrotylus insubricus (Scopoli, 1786)	South and Southeast Europe	Gravel and sand bars with sparse vegetation	LC
Aiolopus strepens (Latreille, 1804)	South and Southeast Europe	Gravel and sand bars with sparse and elevated pioneer vegetation	LC
Anacridium aegyptium (Linnaeus, 1764)	South and Southeast Europe	Elevated pioneer vegetation with shrubs	LC

Tab. 1 continued – Fortsetzung

Family Recorded species/taxa	**European distribution**	**Habitat affiliation at Vjosa floodplain**	**Conservation status.**
Calliptamus italicus (Linnaeus, 1758)	Europe (widely distributed, except northern part)	Dry gravel and sand bars with sparse vegetation and grassland	LC
Chorthippus sp.			
Locusta migratoria (Linnaeus, 1758)	widely distributed in Europe	Dry gravel and sand bars with sparse vegetation and grassland	LC
Omocestus rufipes (Zetterstedt, 1821)	widely distributed in Europe	Dry gravel and sand bars with sparse vegetation and grassland	LC
Sphingonotus caerulans (Linnaeus, 1767)	widely distributed in Europe	Dry gravel and sand bars with sparse vegetation	LC
TETRIGIDAE			
Paratettix meridionalis (Rambur, 1838)	South and Southeast Europe	Moist gravel and sand bars with sparse vegetation	LC
Tetrix bolivari (Saulcy, 1901)	South and Southeast Europe	Moist gravel and sand bars with sparse vegetation	LC
Tetrix depressa (Brisout de Barneville, 1848)	South and Southeast Europe	Moist gravel and sand bars with sparse vegetation	LC
Tetrix tenuicornis (Sahlberg, 1891)	widely distributed in Europe	Gravel and sand bars with sparse vegetation	LC
TETTIGONIIDAE			
Saga sp.	South and Southeast Europe	Dry gravel and sand bars with sparse and elevated pioneer vegetation	
Poecilimon sp.	South and Southeast Europe	Elevated pioneer vegetation with shrubs and softwood	
GRYLLIDAE			
Eumodicogryllus bordigalensis (Latreille; 1804)	Europe (widely distributed, except northern part)	Dry gravel and sand bars with sparse vegetation	LC
Gryllus bimaculatus (De Geer, 1773)	South and Southeast Europe	Gravel and sand bars with sparse and elevated pioneer vegetation	LC
Melanogryllus desertus (Pallas, 1741)	South and Southeast Europe	Gravel and sand bars with sparse vegetation	LC
Pteronemobius heydenii (Fischer, 1853)	Europe (widely distributed, except northern part)	Moist gravel and sand bars with sparse and elevated pioneer vegetation	LC
GRYLLOTALPIDAE			
Gryllotalpa stepposa (Zhantiev, 1991)	Southeast Europe	Moist Gravel and sand bars with sparse vegetation and elevated pioneer vegetation	LC
TRIDACTYLIDAE			
Xya pfaendleri (Harz, 1970)	South and Southeast Europe	Muddy sand bars with sparse vegetation	LC
Xya variegata (Latreille, 1804)	South and Southeast Europe	Muddy sand bars with sparse vegetation	LC

Discussion

The present data of 22 Orthoptera taxa were compiled during one short expedition of a few days at the end of April and therefore only reflects a small subset of the Orthoptera species expected to occur at the Vjosa riverine system and its vicinity. This implicates that the species list should be considered preliminary, but does provide first insights into the habitat use and community structure of the Orthoptera species inhabiting the unique floodplain area of the Vjosa river, underscoring the urgency of conservation measures.

The Orthoptera community of the Vjosa floodplain at Poçem is largely characterized by Mediterranean faunal elements (Harz 1975, Bellmann 1993). Most of the observed species are widely distributed from the West to the East of southern Europe along the Mediterranean Sea, but their distributional areas do not extend far to the North (e.g. *Acrotylus insubricus*, *Tetrix depressa, Xya pfaendleri*). The occurrence of these species in Europe is strongly linked with mild Mediterranean climate, whereby some species like *Aiolopus strepens* and *Tetrix bolivari* are also found in the eastern part of Europe with a more continental climate. In addition, some very thermophilous Orthoptera species, which are quite wide-spread in Central Europe, occur at the Vjosa floodplain, for example *Calliptamus italicus*, *Omocestus rufipes* or *Pteronemobius heydenii*. They penetrate quite far north, but in the northern part of their distribution range they are bound to rare habitats with a warm and special microclimate. Remarkable is the first record of the mole cricket *Gryllotalpa stepposa* for Albania. The total distribution area of the species stretches from the central Balkan peninsula to central Asia. In Europe, it was only known from the south-eastern part of the continent (Bulgaria, FYR Macedonia, Greece, Hungary; Romania and Serbia), with Hungary as the westernmost distribution boundary (Iorgu et al. 2016 & 2017). In the South of the Balkan peninsula, *Gryllotalpa stepposa* (Zhantiev 1991) is replaced by *Gryllotalpa krimbasi* (Baccetti 1992), another mole cricket, that is hardly distinguishable morphologically and only differs in chromosome number from *G. stepposa*. Further morphological and genetical analyses are necessary to clarify the taxonomy of the south-eastern mole crickets.

The Vjosa floodplain at the study site is characterized by its huge extended gravel and sand bars of different ages and successional vegetation, typical of a highly dynamic and natural flowing river (Ward et al. 2002). They offer a broad range of various successional stages and, depending on their age, exposition and humidity, shape the Orthoptera assemblages in the Vjosa floodplain (e.g. Datry et al. 2014, Helbing et al. 2014). Almost unvegetated and dry gravel bars are inhabited by *Acrotylus insubricus* and *Sphingonotus caerulans* (Jaun-Holderegger & Zettel 2008). These species are camouflaged perfectly on the substrate and quickly fly away when they are disturbed while simultaneously showing their blue (*S. caerulans*) or red (*A. insubricus*) hindwings (Bellmann 1993). Because of their ability to fly over great distances, they are well adapted to pioneer habitats with a high turnover rate and quickly colonize fresh gravel bars (Tischew & Kirmer 2007). There, they feed on small herbs, grasses or dead organic material. Extended and nearly unvegetated gravel bars represent an optimal natural habitat for these species, making them vulnerable to modifications of riverine systems and the associated loss of river dynamics. *Sphingonotus caerulans* and *Acrotylus insubricus* are categorized in the European Red List of Orthoptera (Hochkirch et al. 2016) as least concern (LC). Nevertheless, they are often endangered on national levels and only exist in secondary habitats like gravel and sand pits.

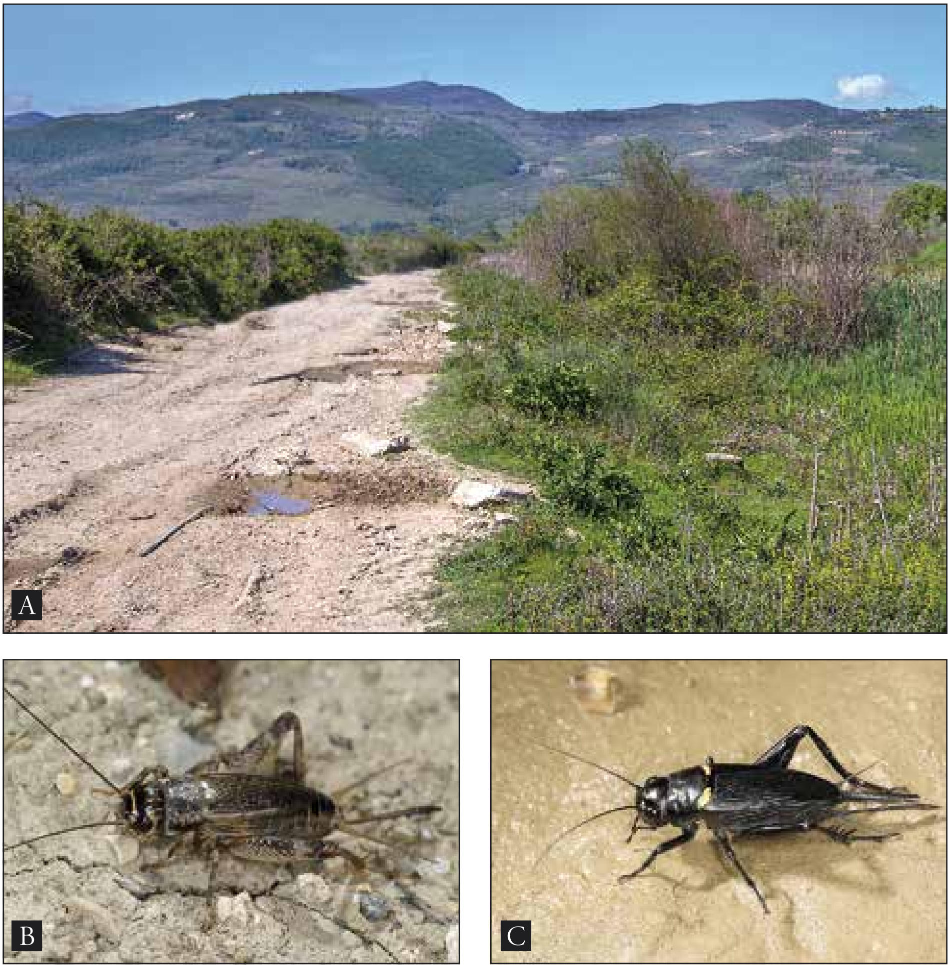

Fig. 1: Open habitats like this country lane to the Vjosa river (A), facilitate observation of crickets like the Bordeaux cricket (*Eumodicogryllus bordigalensis*), 24.04.2017 (B) and the Mediterranean field cricket (*Gryllus bimaculatus*), 29.04.2017 (C). © Gernot Kunz.– Abb. 1: Offene Lebensräume, wie dieser Feldweg zur Vjosa (A), erleichtern ein Auffinden von Grillen wie der Südlichen Grille (*Eumodicogryllus bordigalensis*) (B) und der Mittelmeer-Feldgrille (*Gryllus bimaculatus*) (C). © Gernot Kunz.

Remarkable were the findings of the two pygmy mole crickets *Xya pfaendleri* and *Xya variegata*. Adults of the small-sized species reach a total length of 4–6.5 mm (Harz 1975). They are typical floodplain specialists and indicator species of highly dynamic river systems and survive only under very site-specific conditions (Münsch et al. 2013). They inhabit moist sites with fine sediments and a high proportion of bare soil (Fig. 2) with a warm microclimate (Bellmann 1993). With their mole-like front legs they build burrow systems in the sandy and muddy soil and graze algae from the surface of the sediments (Messner 1963, Bellmann 1993). The pygmy mole crickets are typical pioneer species of gravel and sand bars that are abundantly relocated by the river and react rather sensitively to flood-

Fig. 2: A desiccating river bed of the Vjosa (A), a perfect habitat of the Colourful molehopper (*Xya variegata*) 24.4.2017 (B) and the Mediterranean pygmy grasshopper (*Paratettix meridionalis*) 29.4.2017 (C) © Gernot Kunz. – Abb. 2: Ein in Austrocknung befindliches Flussbett der Vjosa (A), ein idealer Lebensraum für die Gefleckte Grabschrecke (*Xya variegata*) (B) und die Mittelmeer-Dornschrecke (*Paratettix meridionalis*) (C). © Gernot Kunz.

plain regulations. European-wide, *Xya pfaendleri* and *Xya variegata* are categorized as least concern (LC), but because of the loss of their natural habitats along river systems due to river modifications, many populations are threatened and restricted to secondary habitats in many European areas (Berg et al. 2000, Hochkirch et al. 2016).

Gravel and sand bars of a higher age are more stabilized and have lower turnover rates (Ward et al. 2002). Therefore, they are characterized by heterogenous moisture and temperature conditions and provide many habitats with distinct vegetation (Gurnell & Petts 2002, Tonolla et al. 2010). Dry areas with very sparse vegetation and grasslands are preferred by thermophilous and xerophilous species (e.g. *Acrida ungarica*, *Calliptamus* *italicus*, *Eumodicogryllus bordigalensis*, *Gryllus bimaculatus, Omocestus rufipes*) (Fig. 1 u. 2). Sites with higher moisture are preferably inhabited by thermophilous wetland species (e.g. *Pteronemobius heydenii*, *Tetrix depressa, Paratettix meridionalis*). Some species are more opportunistic regarding the degree of moisture of their habitats and only prefer areas with sparse vegetation, like *Aiolopus strepens*, *Melanogryllus desertus* and *Tetrix tenuicornis.* These wetland species, as well as xerophilous species are representative of large riverine systems with altering moisture and temperature conditions and find perfect and extended habitats along the Vjosa river. Only two species (*Anacridium aegyptium*, *Poecilimon* sp.) inhabit later successional stages like shrub and softwood vegetations. These habitats are underrepresented in the sampling and need more detailed investigations.

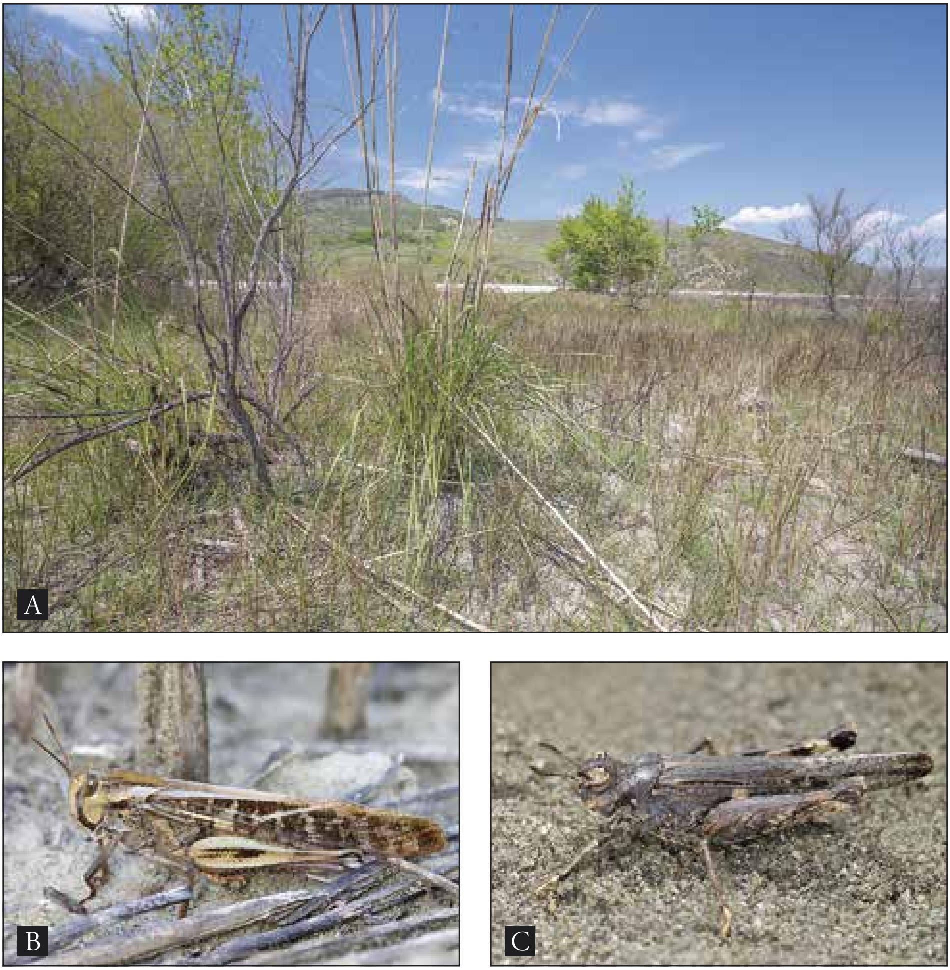

Fig. 3: Open pasture with traces of fire clearances bordering the Vjosa (A), a habitat for well-flying species like the Migratory Locust (*Locusta migratoria*), 24.04.2017 (B) and, in more open parts, also *Acrotylus insubricus*, 28.04.2018 (C). © Gernot Kunz. – Abb. 3: Offene Weideflächen mit Spuren einer Brandrodung am Rande der Vjosa (A), ein Lebensraum für gut fliegende Arten wie die Europäische Wanderheuschrecke (*Locusta migratoria*) (B) und an offeneren Stellen auch der Ödlandschrecke *Acrotylus insubricus* (C). © Gernot Kunz.

Implications for conservation

Loss, degradation and fragmentation of natural habitats due to agricultural land use as well as river regulations are declared as the main threats of orthopteran species (Hochkirch et al. 2016) and the broader vicinity of the Vjosa river is faced with such landscape modifications, particularly along the lower courses of the river (see Drescher 2018 this volume). Therefore, the Vjosa floodplain should be considered as a refuge area for a great number of species as well as a potential hot spot of regional orthopteran biodiversity. The highly dynamic riverine system of the Vjosa is unique in Europe and offers a wide range of different habitats not only for specialized riverine and wetland species, but also for many other orthopteran species. River regulation is assumed to be another very important threat for Orthoptera species. The currently increasing interest in building dams at the Vjosa River increases the pressure on local biodiversity. It is thus beyond doubt that such river modifications would have strong negative impacts on the geomorphological dynamics and ecological functions of the floodplain, but an environmental impact assessment has not been seriously addressed (Schiemer et al. 2018 this volume). Nowadays about 50 % of the European Orthoptera species are classified as threatened or nearly threatened and data is deficient for a further 10 %. For that reason, and considering that the Orthoptera fauna of Albania and the Vjosa riverine system is largely unknown, environmental impact assessments are needed to avoid any harm to threatened Orthoptera from new dam projects (Hochkirch et al. 2016, Puskas 2016). Large-scale fire clearances adjoining the Vjosa river will also have a negative effect on some less mobile species (e.g. *Saga* sp.), as well as on larval stages and orthopteran eggs. On the other hand, it prevents scrub encroachment and benefits open grasslands, used by many species as preferred habitat (Fig. 3).

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The Vjosa-floodplains in Albania as natural habitat for ground beetles: a hotspot of rare and stenotopic species (Coleoptera: Carabidae)

Wolfgang Paill, Johanna Gunczy & Slavčo Hristovski

The ground beetle fauna of the Vjosa floodplains in Albania near Kutë and Poçem was studied in the spring of 2017 over a period of five days. 112 species were documented on the basis of 2.327 captured individuals. Three species (*Dyschirius abditus* (Fedorenko, 1993), *Demetrias imperialis* (Germar, 1823) and *Microlestes fulvibasis* (Reitter, 1901)) were reported for the first time for Albania, three others (*Cylindera germanica muelleri* (Magistretti, 1966), *Cylindera arenaria viennensis* (Schrank, 1781) and *Thalassophilus longicornis* (Sturm, 1825)) were documented for the first time with detailed and trusted data for this country. Several other taxa were found for the second time or were rediscovered after many years. From other parts of the Vjosa valley, two further new or unequivocally documented species for Albania, *Cylindera germanica germanica* (Linnaeus, 1758) and *Parazuphium chevrolatii* (Laporte, 1833) were reported.
Within the study area near Kutë, the highest numbers of carabid species and specimens were caught on silty and moist sediment bars with initial to pioneer vegetation situated either directly along the main channel of the Vjosa or in drying, regularly flooded side arms. Wetlands with reed mace stands at the outer edge of the active floodplain also showed outstanding carabid biodiversity.
In addition to the extraordinary number of species and the high proportion of stenotopic floodplain inhabitants, in particular the rich local population numbers of the beetles *Cicindela monticola albanica*, *Bembidion brunoi*, *Bembidion quadricolle*, *Bembidion striatum*, *Stenolophus discophorus*, and *Poecilus striatopunctatus*, which are very rare throughout of Europe, proves the international importance of nature conservation of the Vjosa.

Paill W., Gunczy J. & Hristovski S., 2018: Die Vjosa-Auen in Albanien als natürlicher Lebensraum für Laufkäfer: Ein Hotspot seltener und anspruchsvoller Arten.
Die Laufkäferfauna der Vjosa-Auen in Albanien bei Kutë nahe Poçem wurde im Frühjahr 2017 über einen Zeitraum von fünf Tagen untersucht. Dabei konnten 112 Arten auf der Basis von 2.327 gefangenen Individuen dokumentiert werden. Drei Arten (*Dyschirius abditus* (Fedorenko, 1993), *Demetrias imperialis* (Germar, 1823) und *Microlestes fulvibasis* (Reitter, 1901)) wurden erstmals für Albanien gemeldet, drei weitere (*Cylindera germanica muelleri* (Magistretti, 1966), *Cylindera arenaria viennensis* (Schrank, 1781) und *Thalassophilus longicornis* (Sturm, 1825)) erstmals mit detaillierten und vertrauenswürdigen Daten für dieses Land belegt. Für zahlreiche weiter Taxa wurden Zweitfunde oder Wiederfunde nach vielen Jahren getätigt. Aus anderen Teilen des Vjosatals wurden zwei weitere Arten erstmals zweifelsfrei für Albanien dokumentiert *Cylindera germanica germanica* (Linnaeus, 1758) und *Parazuphium chevrolatii* (Laporte, 1833).
Innerhalb des Untersuchungsgebietes bei Kutë wurden die höchsten Arten- und Individuenzahlen an Laufkäfern auf feuchten, schluffigen Pionierflächen, sowohl direkt am Hauptfluss als auch in austrocknenden, regelmäßig überfluteten Seitenarmen nachgewiesen. Röhrichte am äußeren Rand der aktiven Auenzone erwiesen sich ebenfalls als Zentren der Laufkäfer-Biodiversität.
Neben der außergewöhnlichen Artenzahl und dem hohen Anteil stenotoper Auenbewohner belegen insbesondere die erheblichen Populationsgrößen der europaweit sehr seltenen Laufkäfer *Cicindela monticola albanica, Bembidion brunoi, Bembidion quadricolle, Bembidion striatum*, *Stenolophus discophorus* und *Poecilus striatopunctatus* die internationale naturschutzfachliche Bedeutung der Vjosa.

Keywords: river Vjosa, floodplain, carabid beetles, ground beetles, faunistics, ecology, international conservation value.

Introduction

Ground beetles are known to be highly diverse in natural alluvial systems, including a considerable number of specialized stenotopic species (e.g. Antvogel & Bonn 2001, Eyre et al. 2001, Manderbach & Hering 2001, Kahlen 2010). Especially along the riparian zones, they inhabit numerous different microhabitats, making them sensitive and valuable indicators (e.g. Boscaini et al. 2000, Günther & Assmann 2005, Kleinwaechter & Rickfelder 2007, Gerisch 2011, Baiocchi et al. 2012).

The knowledge of carabid beetles in Albania is comparatively good. In a very important paper, Guéorguiev (2007a) comprised the complete data from faunistic as well as systematic literature and reviewed Albanian collections and the most relevant European collections including Albanian samples. However, the intensity of collecting was poor, especially during the last decades. This fact becomes apparent when screening available data from more or less common beetles, e.g. *Clivina collaris*, *Paratachys micros*, *Harpalus pumilus,* or *Oodes gracilis,* as they are represented only by single records (see Guéorguiev 2007a). After Guéorguiev (2007a), who listed 543 species, three new troglobiontic species were described for Albania (Bulirsch & Guéorguiev 2008, Lohaj et al. 2016), and seven species were recorded for the first time in this country (Jaskuła 2007b, Bulirsch & Pavićević 2008, Jaeger et al. 2016, Kataev & Wrase 2016), leaving three *Carabus*-species (*Carabus auronitens, Carabus glabratus, Carabus hungaricus*) uncritically published by Striniqi Laçej et al. (2010) and Striniqi Laçej & Misja (2012, 2015) out of consideration.

Before our study was conducted, 31 carabid beetles from the Vjosa river had been documented, 20 of which during the last three centuries (Guéorguiev 2007a, Bulirsch & Pavićević 2008). In addition, almost nothing had been published about the ecology of floodplain carabids of the central parts of the Balkan Peninsula.

Material and Methods

The study is focused on an area of a few kilometers around the village of Kutë, positioned between Kalivaç and Poçem. In this part, the Vjosa river represents a bar- and island-braided, widely undisturbed river-floodplain type. The heterogeneity within the active channel ("floodplain proper") is very high due to the hydro-geomorphic dynamics. An important aspect is the high content of silt transported by the river, and the low extent of floodplain forests apparently restricted by human use. Backwater or wetland conditions are also very limited at the outer side of the floodplain (see Schiemer et al. 2018 this volume).

The collection of beetles was restricted to the floodplain-system of the river. The material was collected during a sampling period in the spring of 2017 (24.04.–28.04.2017). In five days, 150 pitfall traps (plastic jar, diameter = 7 cm, height = 10 cm, filled with a 6% vinegar solution and detergent) were applied on 30 sites, supplemented by 20 hand collection sites. Collecting was conducted by Wolfgang Paill, Johanna Gunczy, Gernot Kunz and Thomas Frank. While the pitfall traps were set up for 5 days, hand-collecting was done at least 30 minutes on each site, either during the day or at nighttime. In order to gain data on the habitat use of the carabids, the sites were strictly delimited, intending to keep habitat characteristics as homogenous as possible. Besides this standardized collecting scheme, further data from hand-colleting done over larger areas or along transition zones of habitat types or single catches by chance were incorporated, abdicating an assignment to the habitat types classified above.

Habitat classification

In cooperation with botanist Anton Drescher, the sites were dedicated to a simple scheme of classification of habitat types (partly following Schiemer et al. 2018 this volume). Within the active floodplain, 11 major types were differentiated by regarding in particular 1) the sediment composition (grain size diameter) as a factor of germination (water capacity), 2) the intervals and dimension of flow pulses resulting in a time span for vegetation, and 3) the situation of the groundwater table and its connection with the fine-grained sediment cover i.e. water retention capacity. B1 to B2 and C1 to C4 represent an increasing age of ± undisturbed vegetation development.

Regularly flooded niveaus within the active floodplain of the Vjosa

- B1: Initial stage on coarse-grained (mostly gravel) sediment bars without vegetation [sites: 37, 38, 39, 42/2, 43, 44, 47; see Fig. 5]
- B2: Pioneer stage on coarse-grained (mostly gravel) sediment bars with seedlings of annual and perennial herbs and wood species (less than one year old; 1–30 cm high) [sites: 31/1, 35, 36/1]
- C1: Initial stage on fine-grained (mostly silt) sediment bars without vegetation [sites: 5, 6, 7, 33, 40, 42/1, 45, 46; see Fig. 3, 7]
- C2: Pioneer stage on fine-grained (mostly silt) sediment bars with seedlings of annual and perennial herbs and wood species (less than one year old; 1–30 cm high [sites: 1, 2, 3, 12, 13, 14, 15, 16, 20, 30, 31/2, 32, 36/2, 49; see Fig. 1, 2]
- C3: Early succession stage on fine-grained (mostly silt) sediment bars with perennial herbs, grasses (mostly *Imperata cylindrica*) and woody species like *Salix alba*, *Salix purpurea*, *Vitex agnus-castus*, *Populus alba* and *Platanus orientalis* (1–2 years old; 30–120 cm high) [sites: 4, 8, 9, 10, 11]
- C4: Shrub stage on fine-grained (mostly silt) sediment bars with dominating woody species (like *Platanus orientalis* and *Tamarix parviflora*) and grasses (mostly *Imperata cylindrica*), 2–5(8?) years old; 1–4 m high) [site: 19]

Elevated niveaus within the active floodplain of the Vjosa

- D1: Grassland on fine-grained sediment, species-poor with highly dominant *Imperata cylindrica;* degradation stage by regular burning and grazing [sites: 17, 18, 21; see Fig. 15]
- D2: Grassland on fine-grained sediment, rich in herbs and grasses, shrubs of *Vitex agnus-castus* and others; degradation stage by regular burning and heavy grazing [site: 22]

Wetlands at the outer edge of the active floodplain of the Vjosa

- E1: Reed mace stand (*Typha*) and *Eleocharis*-marsh in disconnected former arm on moist to moderately dry clayish ground [sites: 27, 28, 29; see Fig. 10]
- E2: Reed mace vegetation (*Typha*) and initial softwood forest (*Salix alba*) on wet to moist silty to clayish ground along a stagnant flowing ditch (very small, periodically drying up tributary of the Vjosa) [sites: 24, 25, 26, 34; see Fig. 8]

Agricultural land close outside the active floodplain (but within the morphological floodplain)

- F1: Fallow land on moderately moist to dry sandy to silty ground [site: 23]
- F2: Field edge on moderately moist to dry sandy to silty ground [site: 48]

Special habitat within the active floodplain (simultaneously at the outer border of the morphological floodplain)

- G1: Steep erosive embankment with unvegetated, moist, loamy ground directly along the main channel of the Vjosa [site: 41]

Sites and sampling data

[sites: 1–50]: southwestern Albania, Fier County, S to SW of the village Kutë, floodplain of Vjosa river, 48–57 m a. s. l. The pitfall traps were maintained between 24.04.-28.04.2017 by PAILL W., GUNCZY J. and FRANK T.

[1] 40°27,500′ 19°44,503′; pitfall traps;
[2] 40°27,500′ 19°44,503′; pitfall traps; 24.04.2017, hand-collecting, leg. PAILL W.
[3] 40°27,522′ 19°44,493′; pitfall traps
[4] 40°27,500′ 19°44,530′; pitfall traps
[5] 40°27,526′ 19°44,481′; pitfall traps
[6, 7] 40°27,555′ 19°44,454′; pitfall traps
[8] 40°27,518′ 19°44,549′, pitfall traps
[9] 40°27,529′ 19°44,584′; pitfall traps
[10] 40°27,538′ 19°44,619′; pitfall traps
[11] 40°27,548′ 19°44,615′; pitfall traps
[12] 40°27,672′ 19°44,604′; pitfall traps
[13] 40°27,672′ 19°44,604′; 24.04.-28.04.2017, pitfall traps
[14] 40°27,697′ 19°44,634′; 24.04.-28.04.2017, pitfall traps
[15] 40°27,697′ 19°44,634′, 24.04.-28.04.2017, pitfall traps; 24.04.2017, hand-collecting, leg. PAILL W.
[16] 40°27,719′ 19°44,647′; 24.04.-28.04.2017, pitfall traps; 25.04.2017, hand-collecting, leg. PAILL W.
[17] 40°27,548′ 19°44,670′; 24.04.-28.04.2017, pitfall traps
[18] 40°27,548′ 19°44,704′; 24.04.-28.04.2017, pitfall traps
[19] 40°27,568′ 19°44,757′; 24.04.-28.04.2017, pitfall traps
[20] 40°27,579′ 19°44,861′; 24.04.-28.04.2017, pitfall traps
[21] 40°27,577′ 19°44,876′; 24.04.-28.04.2017, pitfall traps
[22] 40°27,592′ 19°44,936′; 24.04.-28.04.2017, pitfall traps; 25.04.2017 hand-collecting, leg. PAILL W, GUNCZY J., & KUNZ G.
[23] 40°27,677′ 19°45,251′; 24.04.-28.04.2017, pitfall traps
[24] 40°27,802′ 19°45,218′; 24.04.-28.04.2017, pitfall traps; 25.04.2017, hand-collecting, leg. PAILL W.
[25] 40°27,820′ 19°45,251′; 24.04.-28.04.2017, pitfall traps
[26] 40°27,851′ 19°45,480′; 24.04.-28.04.2017, pitfall traps
[27] 40°27,835′ 19°45,267′; 24.04.-28.04.2017, pitfall traps; 26.04.2017 hand-collecting, leg. GUNCZY J.

[28] 40°27,770′ 19°45,363′; 24.04.-28.04.2017, pitfall traps; 27.04.2017 hand-collecting, leg. Paill W. and Gunczy J.
[29] 40°27,770′ 19°45,363′; 24.04.-28.04.2017, pitfall traps; 25.04.2017, hand-collecting, leg. Paill W.
[30] 40°27,830′ 19°44,959′; 24.04.-28.04.2017, pitfall traps; 23.04.2017, hand-collecting, leg. Gunczy J.
[31/1, 31/2] 40°27,851′ 19°44,943′; 25.04.2017, hand-collecting, leg. Paill W, Gunczy J. & Frank T.
[32] 40°27,983′ 19°44,915′; 25.04.2017, hand-collecting, leg. Paill W. & Gunczy J.
[33] 40°28,315′ 19°44,012′; 25.04.2017, hand-collecting, leg. Paill W. & Gunczy J.
[34] 40°28,319′ 19°45,297′; 25.04.2017, hand-collecting, leg. Paill W. & Gunczy J.
[35] 40°28,310′ 19°45,995′; 25.04.2017, hand-collecting, leg. Paill W. & Gunczy J.
[36/1, 36/2] 40°28,312′ 19°45,994′; 25.04.2017, hand-collecting, leg. Paill W. & Gunczy J.
[37] 40°28,597′ 19°45,458′; 26.04.2017, hand-collecting, leg. Paill W. & Frank T.
[38] 40°26,527′ 19°45,365′; 26.04.2017, hand-collecting, leg. Paill W. & Gunczy J.
[39] 40°26,500′ 19°45,631′; 26.04.2017, hand-collecting, leg. Paill W. & Gunczy J.
[40] 40°26,771′ 19°45,162′; 26.04.2017, hand-collecting, leg. Paill W. & Gunczy J.
[41] 40°26,545′ 19°45,640′; 27.04.2017, hand-collecting, leg. Paill W. & Gunczy J.
[42/1, 42/2] 40°26,526′ 19°45,741′; 27.04.2017, hand-collecting, leg. Paill W. & Gunczy J.
[43] 40°26,01′ 19°45,933′, 27.04.2017, hand-collecting, leg. Gunczy J.
[44] 40°26,66′ 19°45,33′; 27.04.2017, hand-collecting, leg. Gunczy J.
[45] 40°26,70′ 19°45,25′; 27.04.2017, hand-collecting, leg. Gunczy J.
[46] 40°27,863′ 19°44,646′; 28.04.2017, hand-collecting, leg. Paill W.
[47] 40°27,914′ 19°44,637′; 28.04.2017, hand-collecting, leg. Paill W.
[48] 40°26,500′ 19°45,631′; 26.04.2017, hand-collecting, leg. Paill W.
[49] 40°27,538′ 19°44,516′; 27.04.2017, hand-collecting, leg. Gunczy J. Kunz G.
[50] floodplain around Kutë without exact localization (between 40°26′ 19°44′ and 40°28′ 19°46′), 24.04.-28.04.2017, hand-collecting, leg. Paill W., Gunczy J., Frank T. & Kunz G.

We also provide additional data on ground beetles of the Vjosa valley collected in 2014 during the GEO Biodiversity Days (see Appendix and Tab. 3).

Taxonomy and Nomenclature

Nomenclature of the taxa and their order in the list (Tab. 1) predominantly follows Löbl & Löbl (2017). In the case of *Pterostichus melas* (Creutzer, 1799) we agree with Hristovski & Guéorguiev (2015), who synonymized *Pterostichus melas depressus* (Dejean, 1828) with the nominotypical taxon. Furthermore, the name *Sinechostictus tarsicus* (Peyron, 1858) is reestablished and need not be renamed to *effluviorum* (Peyron, 1858) following Neri et al. (2015), since Schaum (1861: 212) was the first reviser, who synonymized *effluviorum* with *tarsicum* (written communication, Lorenz W.).

Determination

All specimens were determined by Wolfgang Paill and Johanna Gunczy, partly using male or female genital characteristics (especially in the genera *Dyschirius*, *Asaphidion*, *Bembidion*, *Harpalus*, *Acupalpus*, *Stenolophus*, *Olisthopus*, and *Microlestes*) to assure correct interpretation of determination keys published in Arndt et al. (2011) and Müller-Motzfeld (2006), and also by Mlynař (1979), Fedorenko (1996), Coulon (2003, 2004a, 2004b, 2005), Bonavita & Vigna Taglianti (2010) Neri et al. (2011) and Neri (2016). The determination of the species in the genus *Dyschirius* was kindly checked and confirmed by Petr Bulirsch, and those of *Cylindera germanica muelleri* by Jörg Gebert. Four taxa, a *Bembidion* (*Nepha*), a *Notiophilus*, as well as *Harpalus* cf. *anxius*, and *Pterostichus* cf. *anthracinus biimpressus* are still not specified.

The material is stored either in the Natural History Museum Graz (Studienzentrum Naturkunde) or in the private collections of Johanna Gunczy and Gernot Kunz.

Results

Species list

In the investigated area around the village of Kutë we documented 112 carabid species among 2.327 collected individuals (Tab. 1). As expected, *Bembidion* is the richest genus with 23 taxa, followed by *Dyschirius* (10), *Acupalpus* (7), *Harpalus* (7) and *Chlaenius* (5). There is also a diverse fauna of Cicindelini (6) and Tachyina (6). In the following pages, selected species are discussed regarding their ecological, faunistic or systematic aspects.

Tab. 1: Annotated list of documented carabid species. ** = first record for Albania, * = first detailed data for Albania, m = male, f = female, s = specimen(s). – Tab. 1: Kommentierte Liste der nachgewiesenen Laufkäferarten. ** = Erstnachweis für Albanien, * = erster detaillierter Datensatz für Albanien, m = Männchen, f = Weibchen, s = Individuum/Individuen.

tribe / species	specimens total	specimens per [site]
Nebriini Laporte, 1834		
Leistus fulvibarbis Dejean, 1826	2	[30]:2s
Nebria brevicollis (Fabricius, 1792)	20	[22]:1f; [23]:1f; [24]:3m; [30]:2m,1f; [48]:6m,2f; [50]:4s
Notiophilini Motschulsky, 1850		
Notiophilus sp.	1	[44]:1s
Notiophilus substriatus G.R. Waterhouse, 1833	1	[22]:1f
Carabini Latreille, 1802		
Carabus granulatus interstitialis Duftschmid, 1812	1	[24]:1f
Carabus coriaceus excavatus Charpentier, 1825	9	[22]:1m; [23]:1f; [24]:1f; [28]3f; [41]:1f; [42/1]:2f
Cicindelini Latreille, 1802		
Calomera fischeri (M.F. Adams, 1817)	10	[2]:5m,1f; [3]:1f; [5]:1m; [6]:1m; [7]:1m
Calomera littoralis nemoralis (Olivier, 1790)	9	[12]:1f; [13]:5m; [15]:1f; [16]:1f; [32]:1s
Cicindela campestris olivieria Brullé, 1832	19	[11]:1f; [23]:1m,1f; [29]:10m,1f; [32]:1s; [42/1]:1f,1s; [43]:1s; [50]:1s

Tab. 1 continued – Fortsetzung

tribe / species	specimens total	specimens per [site]
Cicindela monticola albanica Apfelbeck, 1909	179	[1]:7m,8f; [2]:27m,11f; [3]:7m,2f; [4]:3m; [5]:1f; [6]:2m,6f; [7]:12m,9f; [8]:9m,7f; [10]:3f; [11]:1m,1f; [12]:1m; [13]:5m,3f; [14]:1m,2f; [15]:3m,9f; [16]:3m,1f; [19]:1m,1f; [20]:4m,5f; [30]:1f; [31/2]:1f; [32]:1s; [40]:1f; [42/1]:1s; [50]:2f,17s
**Cylindera germanica muelleri* (Magistretti, 1966)	1	[11]: 1f
**Cylindera arenaria viennensis* (Schrank, 1781)	4	[13]:1m,1f; [15]:1m; [50]:1f
Omophronini Bonelli, 1810		
Omophron limbatum (Fabricius, 1777)	69	[1]:1m; [3]:7m; [5]:1m; [6]:1m,1f; [13]:1m; [16]:1m; [30]:1s; [31/2]:3m,1f,8s; [32]:1m,1f,16s; [33]:1m,1f; [36/1]:1s; [40]:1m,1f,11s; [41]:2m,2s; [42/1]:1m,1s; [46]:1m; [50]:2s
Clivinini Rafinesque, 1815		
Clivina fossor (Linnaeus, 1758)	9	[24]:1m,1f,1s; [25]:2m; [27]:1f; [50]:3s
Dyschiriini H.J. Kolbe, 1880		
Dyschirius aeneus (Dejean, 1825)	93	[24]:40s; [25]:29s; [26]:1m; [27]:18s; [28]:1m,1f; [42/1]:1s
Dyschirius agnatus Motschulsky, 1844	86	[1]:2m; [2]:6m,1f,1s; [3]:7m,1f; [5]:1f; [7]:8m,2f; [12]:3m; [13]:7s; [15]:9m,3f; [16]:1s; [31/1]:4s; [31/2]:11s; [40]:1s; [42/1]:9s; [45]:3s; [46]:3s; [49]:1s; [50]:2s
Dyschirius minutus albanicus J. Müller, 1922	9	[31/2]:4s; [33]:2s; [42/1]:1s; [43]:1s; [50]:1s
Dyschirius morio Putzeys, 1867	29	[9]:2s; [11]:1f; [33]:2s; [35]:2s; [40]:1s; [41]:1s; [42/1]:19s; [50]:1s
Dyschirius latipennis Seidlitz, 1867	1	[31/2]:1s;
***Dyschirius abditus* (Fedorenko, 1993)	12	[9]:1s; [17]:1f; [21]:1m; [33]:7s; [35]:2
Dyschirius gracilis (Heer, 1837)	18	[15]:1m; [16]:2f; [17]:1f; [19]:2f; [31/1]:1s; [35]:1s; [41]:2s; [42/1]:7s; [45]:1s
Dyschirius importunus Schaum, 1857	7	[25]:5m; [27]:1m; [50]:1s;
Dyschirius parallelus ruficornis Putzeys, 1846	70	[1]:1m,1f; [2]:1s; [3]:3m; [7]:1m; [13]:1m; [14]:1m; [15]:2s; [16]:2s; [32]:5s; [35]:2s; [40]:7s; [42/1]:15s; [49]:20s; [50]:8s
Dyschirius substriatus priscus J. Müller, 1922	28	[5]:2f; [6]:1m,1f; [12]:1s; [31/2]:1s; [32]:11s; [33]:3s; [35]:1s; [42/1]:2s; [42/2]:2s; [50]:3s
Scaritini Bonelli, 1810		
Scarites terricola Bonelli, 1813	7	[1]:1s; [8]:2s; [12]:1f; [13]:1s; [16]:2f

Tab. 1 continued – Fortsetzung

tribe / species	specimens total	specimens per [site]
Bembidiini Stephens, 1827		
Asaphidion flavipes (Linnaeus, 1760)	47	[17]:1m,1f; [21]:1f; [24]:10m,20f; [25]:5m,5f; [26]:1f,1s; [28]:2m
Asaphidion nebulosum (P. Rossi, 1792)	57	[3]:1m,1f; [6]:1m; [8]:1m,1f; [10]:1m; [11]:2m; [12]:1f; [14]:1m,1f; [19]:1m; [20]:3m; [30]:2s; [33]:1f; [35]:5m,5f; [40]:2m,4f,3s; [42/1]:1m,2f,6s; [45]:1s; [50]:5f,5s
Asaphidion rossii (Schaum, 1857)	175	[10]:2f; [11]:1m; [14]:1m; [20]:2m,1f; [24]:6m,10f; [25]:2m; [30]:1m,1f,3s; [31/1]:3s; [31/2]:6m,8f; [32]:3m,4f; [33]:1m,2f,4s; [35]:2m; [37]:14m,16f; [38]:16m,13f, 1s; [39]:3m,2f; [40]:6m,2f,7s; [41/1]:1f; [42/1]:4m,3f; [43]:1s; [44]:3s; [46]:1f; [48]:3m,6f; [49]:3s; [50]:1m,2f,4s
Asaphidion stierlini (Heyden, 1880)	2	[24]:2m
Bembidion quadripustulatum Audinet-Serville, 1821	82	[24]:18m,6f,4s; [25]:26m,20f; [27]:5m,3f
Bembidion brunoi (Bonavita, 2001)	64	[37]:3m,6s; [38]:5m,4f,9s; [39]:4f; [44]:5s; [47]:17m,8f; [50]:3s;
Bembidion concoeruleum Netolitzky, 1943	3	[42/2]:2f; [43]:1s
Bembidion splendidum Sturm, 1825	8	[15]:1m; [24]:2m; [25]:1f; [35]:1f; [42/1]:1m,2f;
Bembidion azurescens Dalla Torre, 1877	6	[40]:1m,1s; [24]:1s; [42/1]:2f; [49]:1s
Bembidion latiplaga Chaudoir, 1850	40	[14]:1m,1f; [15]:1m,1f; [16]:1m,1f; [32]:6s; [40]:1m,2s; [42/1]:7m,11f; [46]:1f; [49]:5s; [50]:1s
Bembidion tenellum Erichson, 1837	1	[27]:1f
Bembidion combustum Ménétriés, 1832	4	[39]:1m,2f; [50]:1s
Bembidion scapulare Dejean, 1831	29	[7]:1f; [31/1]:1m; [37]:1m,3f; [39]:4m; [43]:7s; [47]:6m; [50]:6s
Bembidion lampros (Herbst, 1784)	5	[25]:3m; [26]:1f; [27]:1m
Bembidion properans (Stephens, 1828)	2	[24]:1f; [41]:1s
Bembidion quadricolle (Motschulsky, 1844)	215	[1]:2m,2f; [2]:15m,8f; [3]:13m,3f; [5]:5m,1f; [6]:5m,3f; [7]:14m,1f; [12]:2m,5f; [13]:17m,9f; [14]:1m,4f; [15]:8m,10f; [16]:3m,3f; [24]:3s; [31/2]:1f; [32]:1s; [36/2]:1f; [40]:7m,11f,14s; [45]:2s; [46]:5m,15f; [49]:20s; [50]:1m
Bembidion (*Nepha*) sp.	2	[40]:1f; [41]:1f
Bembidion varium (Olivier, 1795)	2	[32]:1s; [38]:1s
Bembidion striatum (Fabricius, 1792)	92	[2]:25m,18f; [3]:13m,6f; [5]:1f; [6]:4m,1f; [7]:2f; [32]:1s; [40]:2m,3f,3s; [45]:1s; [46]:2m,5f; [47]:1f, [49]:4s
Bembidion brunnicorne Dejean, 1831	7	[41]:3m,4f

Tab. 1 continued – Fortsetzung

tribe / species	specimens total	specimens per [site]
Bembidion dalmatinum Dejean, 1831	29	[31/1]:1f; [40]:1s; [41]:4m,6f,3s; [42/1]:3m,2f,4s; [46]:1f; [50]:4s
Bembidion bualei Jacquelin du Val, 1852	112	[1]:1m; [2]:1f; [7]:1f; [8]:1m; [10]:2f; [11]:2m; [15]:2f; [16]:2f; [20]:3m,1f; [26]:1s; [32]:1f; [33]:1m,1f; [37]:1m,1f; [38]:7s; [38/1]:2m,2f; [39]:1f; [40]:3f,2s; [41]:1m,1f; [42/1]:1s; [42/2]:12m,9f; [43]:11s; [44]:19s; [46]:1m,1f; [49]:6s; [50]:2f,9s
Bembidion subcostatum vau Netolitzky, 1913	7	[24]:1m,1s; [25]:2m; [26]:2s; [42/1]:1f
Bembidion decolor Apfelbeck, 1911	27	[24]:1m,5f,5s; [25]:8s; [26]:1f; [28]:1m,1f,1s; [34]:1m,1f,1s; [50]:1s
Bembidion punctulatum Drapiez, 1820	13	[31/1]:2f; [37]:1f; [38]:1f,1s; [47]:3f; [50]:5s
Bembidion articulatum (Panzer, 1796)	7	[26]:1m,1f; [27]:3m,2f
Bembidion octomaculatum (Goeze, 1777)	2	[27]:1m; [34]:1m
Sinechostictus tarsicus (Peyron, 1858)	2	[33]:1s; [41]:1s
Tachys bistriatus (Duftschmid, 1812)	10	[24]:1m,1f,2s; [25]:1m; [27]:1m; [34]:2s; [41]:1s; [47]:1m
Tachys fulvicollis (Dejean, 1831)	6	[24]:2f; [27]:1f; [34]:1s; [40]:1s; [50]:1s
Tachys micros (Fischer von Waldheim, 1828)	13	[1]:2f; [3]:1f; [6]:2m; [7]:2f; [15]:1f; [22]:1m; [30]:1f; [33]:1s; [40]:1f; [42/1]:1s
Tachys scutellaris Stephens, 1828	1	[42/1]:1f
Tachyura hoemorroidalis (Ponza, 1805)	12	[14]:1f; [26]:1f; [27]:2m,1f; [30]:1m,1f; [41]:1s; [42/1]:3f; [50]:1s
Tachyura diabrachys (Kolenati, 1845)	120	[2]:1s; [3]:1f; [7]:1f; [12]:1m,1f; [31/1]:1s; [31/2]:15s; [32]:1m,3f; [33]:1s; [35]:1s; [38]:1s; [39]:4m,5f; [40]:1m,1s; [41]:3m,7f,5s; [42/1]:9m,18f,11s; [43]:12s; [44]:2s; [45]:1s; [46]:1s; [49]:3s; [50]:9s
Pogonini Laporte, 1834		
Pogonus littoralis (Duftschmid, 1812)	1	[50]:1m
Trechini Bonelli, 1810		
Perileptus areolatus (Creutzer, 1799)	12	[31/2]:1s; [38]:1s; [39]:2f; [43]:6s; [44]:1s; [50]:1s
Trechus quadristriatus (Schrank, 1781)	1	[50]:1s
**Thalassophilus longicornis* (Sturm, 1825)	10	[6]:1f; [37/1]:1m,1s; [39]:2m,2f; [44]:1s; [47]:2m
Brachinini Bonelli, 1810		
Brachinus explodens Duftschmid, 1812	2	[48]:2m
Chlaeniini Brullé, 1834		
Chlaenius flavipes Ménétriés, 1832	10	[36/1]:2f; [37]:1m,2f; [44]:1s; [47]:1m,2f; [50]:1s

Tab. 1 continued – Fortsetzung

tribe / species	specimens total	specimens per [site]
Chlaenius nigricornis (Fabricius, 1787)	1	[24]:1m
Chlaenius vestitus (Paykull, 1790)	13	[26]:2m; [27]:2f; [36/1]:3f; [41]:1s; [42/1]:1m,1f; [44]:1s; [50]:2s
Chlaenius spoliatus (P. Rossi, 1792)	1	[36/1]:1m
Chlaenius festivus (Panzer, 1796)	24	[24]:3f; [25]:3m; [26]:3m,2f; [27]:5m,1f; [36/1]:2m,1f; [42/1]:2m,1f; [50]:1s
Dryptini Bonelli, 1810		
Drypta dentata (P. Rossi, 1790)	3	[24]:1m; [34]:2m
Harpalini Bonelli, 1810		
Harpalus cf. *anxius* (Duftschmid, 1812)	1	[22]:1f
Harpalus autumnalis (Duftschmid, 1812)	4	[13]:1m; [50]:2m,1f
Harpalus dimidiatus (P. Rossi, 1790)	4	[16]:1m; [25]:1f; [28]:1s; [29]:1f;
Harpalus distinguendus (Duftschmid, 1812)	4	[26]:1f; [27]:1f; [28]:1s; [48]:1m
Harpalus punctatostriatus Dejean, 1829	1	[29]:1m
Harpalus pygmaeus Dejean, 1829	18	[22]:3m,2f,9s; [50]:3m,1f
Harpalus serripes Quensel, 1806	2	[48]:1m,1f
Ophonus cribricollis (Dejean, 1829)	1	[34]:1m
Acupalpus flavicollis (Sturm, 1825)	1	[24]:1f
Acupalpus luteatus (Duftschmid, 1812)	2	[24]:1m; [25]:1m
Acupalpus maculatus (Schaum, 1860)	16	[24]:4m,1f; [25]:2m,1f; [27]:2m,2f; [28]:1s; [34]:2s; [50]:1s
Acupalpus meridianus (Linnaeus, 1760)	1	[16]:1m
Acupalpus notatus Mulsant & Rey, 1861	6	[24]:1f; [25]:4m,1f
Acupalpus paludicola Reitter, 1884	1	[49]:1m
Acupalpus planicollis (Schaum, 1857)	1	[25]:1m
Stenolophus discophorus (Fischer von Waldheim, 1823)	21	[14]:3m,5f; [16]:2m,1f; [19]:2m,1f; [42/1]:2m,1f,3s; [46]:1f
Stenolophus mixtus (Herbst, 1784)	3	[24]:1f; [34]:1f,1s
Stenolophus skrimshiranus Stephens, 1828	15	[25]:8m,5f; [34]:1m; [41]:1m;
Stenolophus teutonus (Schrank, 1781)	14	[24]:1m,3f; [25]:2m,3f; [34]:2m,3s
Lebiini Bonelli, 1810		
***Demetrias imperialis* (Germar, 1823)	3	[24]:1m,2s
Microlestes fissuralis (Reitter, 1901)	1	[28]:1f
***Microlestes fulvibasis* (Reitter, 1901)	2	[29]:1m; [42/1]:1f
Odacanthini Laporte, 1834		
Odacantha melanura (Linnaeus, 1767)	2	[24]:1f; [34]:1m
Oodini LaFerté-Sénectère, 1851		
Oodes gracilis A. Villa & G.B. Villa, 1833	15	[34]:11m,4f
Oodes helopioides (Fabricius, 1792)	15	[24]:1m,1w; [34]:6m,1f,3s; [50]:3s
Panagaeini Bonelli, 1810		
Panagaeus cruxmajor (Linnaeus, 1758)	1	[30]:1f
Platynini Bonelli, 1810		
Agonum muelleri (Herbst, 1784)	1	[24]:1f

Tab. 1 continued – Fortsetzung

tribe / species	specimens total	specimens per [site]
Agonum sordidum Dejean, 1828	1	[27]:1s
Agonum permoestum Puel, 1938	9	[24]:1m,3f; [25]:1m; [34]:1m,1f; [27]:1s; [50]:1s
Anchomenus dorsalis (Pontoppidan, 1763)	10	[24]:1m; [25]:3m,5f; [48]:1s
Olisthopus fuscatus Dejean, 1828	30	[22]:6m,3f,20s; [50]:1s
Olisthopus glabricollis (Germar, 1817)	8	[22]:1m,2f,4s; [50]:1s
Pterostichini Bonelli, 1810		
Poecilus cupreus (Linnaeus, 1758)	6	[24]:3m,3f
Poecilus rebeli (Apfelbeck, 1904)	31	[24]:13m,16f; [25]:1s; [26]:1f
Poecilus striatopunctatus (Duftschmid, 1812)	27	[14]:1f; [15]:1f; [16]:7m,3f; [19]:1f; [35]:3f; [36/1]:2s; [42/1]:2f; [46]:1f; [50]:6s
Pterostichus cursor (Dejean, 1828)	17	[24]:1m,3f,2s; [28]:1s; [30]:1s; [34]:4m,3f; [50]:2s
Pterostichus melas (Creutzer, 1799)	2	[10]:1f; [22]:1f
Pterostichus melanarius (Illiger, 1798)	1	[50]:1s
Pterostichus cf. *anthracinus biimpressus* (Küster, 1853)	7	[24]:1m; [27]:1f; [34]:2m3f
Sphodrini Laporte, 1834		
Calathus circumseptus Germar, 1823	40	[22]:11m,22f,5s; [50]:2s
Calathus fuscipes (Goeze, 1777)	2	[23]:1m; [24]:1f
Zabrini Bonelli, 1810		
Amara aenea (De Geer, 1774)	4	[22]:1f,1s; [50]:2s

Comments on selected species

Cicindela monticola albanica Apfelbeck, 1909

Broad riverbanks with a mixture of grain and coarse sediments in initial to early succession stages are the habitat of this Balkan endemic Cicindelini (Fig. 1), which occurs from Croatia over Bulgaria and Serbia to Greece (Jaskuła et al. 2005, Jaskuła 2007a). Its infrequent status in this area is documented in a few examples for Greece, where *Cicindela monticola albanica* seems to be restricted to the lower reaches of the large rivers Alphios and Erimantos (Franzen 2006). Although there are some recent records of *Cicindela monticola albanica* in Albania (Guéorguiev 2007a, Jaskuła 2007a), the observed population in the active floodplain of Vjosa – at least between Kalivaç and Poçem – is of international significance. We collected 179 specimens and observed a total of several hundred individuals, especially occurring in moist sandy to silty banks along the primary channel or in drying up, disconnected arms and pools along the river.

Cicindela campestris olivieria Brullé, 1832

With records from Bosnia and Herzegovina to Greece and Turkey (Puchkov & Matalin 2017), this taxon is treated as a Balkan endemic (Cassola 1999, Guéorguiev 2007b). Only single individuals could be observed within the active floodplain around the village of Kutë, as the centre of its habitat use clearly lies outside riverside habitats. Thus, 11 specimens were caught in a drying up, disconnected former arm of the Vjosa (Fig. 10),

Fig. 1: Typical habitat [site 2, habitat type C2] of *Cicindela monticola albanica* and *Calomera fischeri* within the active floodplain of the Vjosa. © Paill W., 24.04.2017. – Abb. 1: Charakteristischer Lebensraum [Probefläche 2, Habitattyp C2] von *Cicindela monticola albanica* und *Calomera fischeri* innerhalb der regelmäßig umgelagerten („aktiven“) Aue der Vjosa. © Paill W., 24.04.2017.

two in fallow land outside the active floodplain and many more specimens (which are not registered in this paper) could be observed in a dry, grazed meadow outside the morphological floodplain.

Cylindera germanica muelleri (Magistretti, 1966)

There is no document that contains precise data on this trans-ionian taxon for Albania (Guéorguiev 2007a, Jaskuła 2007a). Hieke & Wrase (1988), as well as Striniqi Laçej et al. (2010), reported *Cicindela germanica* for Albania, but only on species level. Puchkov & Matalin (2003) admittedly listed the ssp. *muelleri* for Albania (without precise data), however, they omitted it for the country in the last version of the Palaearctic Catalogue (Puchkov & Matalin 2017). Within the active floodplain of the Vjosa, one female was collected in an early succession stage on partly vegetated, silty ground, accompanied by single specimens of *Cicindela campestris olivieria* and *Cicindela monticola albanica*, and represents the first detailed record for Albania.

Cylindera arenaria viennensis (Schrank, 1781)

Just as for the species above, there was as yet no indisputeable documentation for Albania of this taxon that is sparsely distributed between Central Europe and Western Sibiria (Guéorguiev 2007a, Jaskuła 2007a). Hieke & Wrase (1988) reported

Fig. 2: Drying up pool in an annually-flooded, disconnected arm of the Vjosa (sites 12–16, habitat type C2) as habitat of *Cylindera arenaria viennensis*. Accompanying species were *Calomera littoralis nemoralis*, *Scarites terricola*, *Bembidion quadricolle*, *Stenolophus discophorus*, *Poecilus striatopunctatus*. © Paill W., 24.04.2017. – Abb. 2: Austrocknende Tiefenrinne in einem jährlich überschwemmten Seitenarm der Vjosa (Probeflächen 12–16, Habitattyp C2) als Lebensraum von *Cylindera arenaria viennensis*. Vergesellschaftet traten *Calomera littoralis nemoralis*, *Scarites terricola*, *Bembidion quadricolle*, *Stenolophus discophorus* und *Poecilus striatopunctatus* auf. © Paill W., 24.04.2017.

Cicindela arenaria for Albania, but only on species level and without giving detailed data. Puchkov & Matalin (2003) admittedly listed the ssp. *viennensis* for Albania, while they omitted it for the country in the last version of the Palaearctic Catalogue (Puchkov & Matalin 2017). We caught three individuals in a drying up, most likely annually-flooded, disconnected arm of the Vjosa (Fig. 2) and, therefore, provide the first detailed record for Albania.

Dyschirius minutus albanicus J. Müller, 1922

While the nominotypical subspecies is more widely distributed, this Dyschiriini is restricted to the Eastern Balkans and Turkey (Bulirsch & Fedorenko 2007, Bulirsch & Pavićević 2008, Balkenohl 2017). As many other members of the genus, it is highly stenotopic, exclusively inhabiting sandy and silty banks of rivers. Most of our specimens were collected on a bank along an anually-flooded secondary channel of the Vjosa, offering, at least during the time of our study, remaining patches of standing water.

Dyschirius latipennis Seidlitz, 1867

The area this rare species inhabits is comparatively small, spanning from Slovakia to Turkey (Balkenohl 2017, Fedorenko 1996). While a lot of findings are known from the latter country (Bulirsch & Fedorenko 2007), there are only a few in the Pannonian area and on the Balkans, particularly outside of Bulgaria (e.g. Hůrka 1996, Fedorenko 1996, Szél 2006, Guéorguiev 2011b). Guéorguiev (2007a) published one dataset and Bulirsch & Pavićević (2008) added one more from Albania. Confirming the rarity of this species, we collected *Dyschirius latipennis* in only one single female – making this species the rarest of the 10 Dyschiriini documented in our study. The record was made on a small sandy slope along an anually-flooded secondary channel of the Vjosa, near the above mentioned habitat of *Dyschirius minutus albanicus*. *Dyschirius agnatus*, however, was the only accompanying *Dyschirius* in this case.

Dyschirius abditus (Fedorenko, 1993)

This species also leads a highly stenotopic life on the banks of rivers. However, it seems to prefer somewhat different conditions to *Dyschirius minutus albanicus*, as they were collected on the same bank only once. In some cases occurring syntopically with *Dyschirius morio,* we recorded *Dyschirius abditus* mostly along a cut river bank along the primary channel (Fig. 3), but infrequently also on slightly higher levels of the active floodplain, in grasslands of the predominantly growing *Imperata cylindrica*, apparently caused by burning and grazing. *Dyschirius abditus* was recently published from Macedonia for the first time (Hristovski & Guéorguiev 2015) and we provide the first records for Albania.

Further *Dyschirius* spp.

Most *Dyschirius* species, such as *Dyschirius agnatus*, *Dyschirius morio*, *Dyschirius gracilis*, *Dyschirius parallelus ruficornis*, and *Dyschirius substriatus priscus* are sensitive indicators of natural riverbanks. They inhabit the interstitial space close to the shoreline by digging in the ground. For each species there are hardly any records for Albania (Guéorguiev 2007a, Bulirsch & Guéorguiev 2008).

Asaphidion nebulosum (P. Rossi, 1792)

The taxonomy of the *Asaphidion caraboides*-group is difficult and has recently changed. In former times defined as a subspecies of the pyrenean-alpine-caucasic *Asaphidion caraboides* (Schrank, 1781), *Asaphidion nebulosum* is nowadays treated as a distinct, polytypical species occurring in the mediterranean area (Bonavita & Vigna Taglianti 2005, Coulon 2005, Marggi et al. 2017). According to Bonavita & Vigna Taglianti (2005) the ssp. *balcanicum* Netolitzky, 1918 is distributed on the Balkans (defined as Balkan subendemic following Guéorguiev 2007b), while the nominotypical subspecies is restricted to southeastern France and Italy, and the ssp. *splendidum* (Heyden, 1870) to northeastern Spain. In the most recent Catalogue of Palearctic Coleoptera, however, both ssp. *balcanicum* and ssp. *nebulosum* are listed for Albania (Marggi et al. 2017). Our material (Fig. 4) does not exactly match the male genitalia of an Italian specimen presented by Neri et al. (2011: 171), and also differs from the female genitalia of French specimens illustriated by Coulon (2005: 120). For this reason, we expect the population from the Vjosa to be referred to the ssp. *balcanicum*.

Fig. 3: Cut river bank along the main channel of the Vjosa near the village Kutë [site 33, habitat type C1]. On the sandy to silty-grained substrate, *Dyschirius abditus* was the most frequently collected ground beetle, occuring together with *Omophron limbatum*, *Dyschirius morio*, *Dyschirius substriatus priscus*, *Asaphidion rossii*, and *Bembidion bualei*. © Paill W., 25.04.2017. – Abb. 3: Prallhang am Hauptarm der Vjosa nahe der Ortschaft Kutë [Probefläche 33, Habitattyp C1]. Auf dem sandig-schluffigen Substrat war *Dyschirius abditus* der häufigste Laufkäfer und trat gemeinsam mit *Omophron limbatum*, *Dyschirius morio*, *Dyschirius substriatus priscus*, *Asaphidion rossii* und *Bembidion bualei* auf. © Paill W., 25.04.2017.

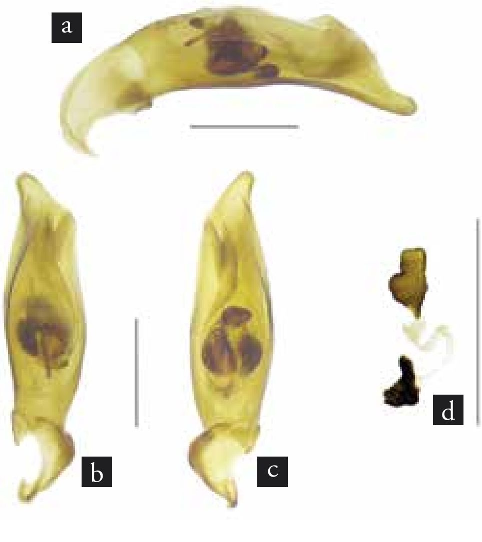

Fig. 4: Male and female genitalia of *Asaphidion nebulosum* from the study area [site 35]. a) median lobe of adeagus, left lateral view, b) median lobe of adeagus, dorsal view, c) median lobe of adeagus, ventral view, d) spermatheca and annulus receptaculi. Scale bare: 0.5 mm. © Paill W. – Abb. 4: Männliche und weibliche Genitalorgane von *Asaphidion nebulosum* aus dem Untersuchungsgebiet [Probefläche 35]. a) Medianlobus des Aedeagus in seitlicher Ansicht (linke Seite), b) Medianlobus des Aedeagus in dorsaler Ansicht, c) Medianlobus des Aedeagus in ventraler Ansicht, d) Spermathek und Annulus receptaculi. Maßstab: 0.5 mm. © Paill W.

Asaphidion nebulosum is not only a geographical vicariant of *Asaphidion caraboides*, but also replaces the latter in the ecological sense. Thus, *Asaphidion nebulosum* is stenotopic, prefers the more dynamic and actively flooded parts of the floodplain, and occurs mostly near water. This is rather a contrast to the other typical floodplain-inhabiting representative of the genus, *Asaphidion rossii*, which is eurotypic and also occurs at higher-elevated niveaus (see below).

Asaphidion stierlini **(Heyden, 1880)**

There was only one historic record of this circum-mediterranean species available for Albania to date (Guéorguiev 2007a), its rarity being validated by the first record of this taxon for Macedonia (Hristovski & Guéorguiev 2015) and Bulgaria (Guéorguiev 2011b) only very recently. Corresponding to the observations of Guéorguiev (2011b: 513), who sampled the species in a "damp place near brook" we documented *Asaphidion stierlini* in a swampy reed mace stand along a small, stagnantly flowing ditch ending in the Vjosa (Fig. 8). On the wet, silty to clayey ground, it lives syntopically with *Asaphidion flavipes* and *Asaphidion rossii*, the latter being the most frequent *Asaphidion* in the floodplain around the village of Kutë, occurring from initial stages on coarse-grained sediment bars along the main river-channel to heavily vegetated clayey grounds away from flowing water (Tab. 2).

Fig. 5: Gravel sediment bar directly beside the rapidly flowing main channel of the Vjosa [site 38, habitat type B1] with a high population density of *Bembidion brunoi*, a local endemic and highly stenotopic riparian ground beetle. © Paill W., 26.04.2017. – Abb. 5: Schotterbank direkt am stark durchflossenen Hauptarm der Vjosa [Probefläche 38, Habitattyp B1]. Hier lebt eine individuenreiche Population des lokal-endemischen und hochgradig stenotopen Uferlaufkäfers *Bembidion brunoi*. © Paill W., 26.04.2017.

Bembidion brunoi (Bonavita, 2001)

This taxon was fairly recently described in Greece (from the Aoos river, which is the headwater of the Vjosa) and was, until now, otherwise only found in Bosnia Herzegovina (Bonavita 2001), Montenegro (Guéorguiev 2011b) and Albania (Guéorguiev 2007a). Because of this restricted area, Guéorguiev (2007b) described the species as locally endemic. As in many other members of the genus, *Bembidion brunoi* is highly stenotopic, exclusively inhabiting initial stages of gravel sediment bars (Tab. 2). We collected 64 individuals in at least five sites between Kalivaç and Poçem, all of them situated directly along the more or less rapidly flowing main channel of the Vjosa. In many cases the species was accompanied by *Asaphidion rossii*, *Bembidion bualei*, and *Tachyura diabrachys*. In the most suitable site, however, where *Bembidion brunoi* showed high densities (Fig. 5), *Bembidion scapulare* was the second most frequent ground beetle.

Bembidion splendidum Sturm, 1825

This riparian ground beetle inhabits a relatively small area ranging from Poland and Germany through northeastern Italy and Slovenia to Syria and Turkey (Marggi et al. 2017, Bonavita & Vigna Taglianti 2005). Its distribution is scattered, and in many parts of the area – especially in the east, outside the Danube watershed – the species is rare (see Netolitzky & Meyer 1936). There are only a few recent records, e.g. from Germany, Italy, and the European part of Turkey (Kahlen 2010, Guéorguiev 2011b, Trautner et al. 2014), while the last findings for Macedonia and Albania date back to 1937 (Guéorguiev 2007a, Hristovski & Guéorguiev 2015). *Bembidion splendidum* lives on the lower reaches of larger rivers (Bonavita & Vigna Taglianti 2005), however, data about its detailed habitat use differ. Franz (1970) observed a preference for dry sand in moderate distance to the shoreline, while Hůrka (1996) stated moist, unshaded or partly shaded, clayish and sandy-clayish edges of waters, the latter corresponding with single data published by Kahlen (2010) and Nagy et al. (2004). At the Vjosa we collected *Bembidion splendidum* very locally but under different conditions, on shores without any vegetation along the main channel and in a drying up, disconnected arm of the Vjosa, as well as in more or less densely vegetated reed mace stands along a small tributary in the outer part of the active floodplain of the main river (Fig. 8). In both cases, however, the soil was moist, silty to clayish, and water was close by.

According to Bonavita & Vigna Taglianti (2005) and Marggi et al. (2017) parts of the Balkan populations (Albania, Bulgaria, parts of Serbia) belong to ssp. *pincum* De Monte, 1957. We could not unambiguously verify our material from the Vjosa by comparing it with material from Austria and with genital-pictures presented by De Monte (1957). In any case, taxonomy and distribution of *Bembidion splendidum* ssp. requires further investigation.

Bembidion scapulare Dejean, 1831

According to Marggi et al. (2017), Albanian populations of the euro-mediterranean *Bembidion scapulare* belong to ssp. *lomnickii* Netolitzky, 1916. However, the subspecific status of the Balkan populations do not yet appear adequately clarified (see Guéorguiev 2007a, 2011b). Because of its stenotopic ripicol habitate use, *Bembidion scapulare* is rare, especially regarding recent findings. Correspondingly, there are only few records published on the Balkans from the past 30 years, one including the first discovery for Bulgaria

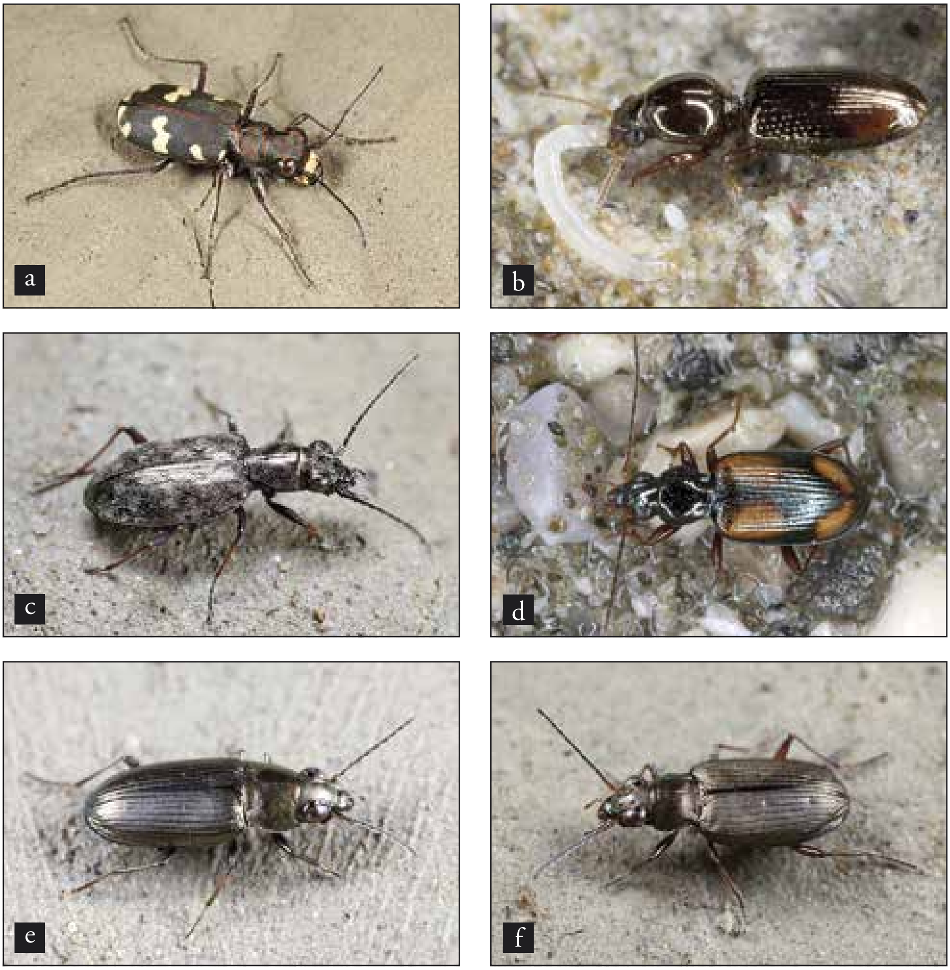

Fig. 6: a) *Cicindela monticola albanica*, b) *Dyschirius substriatus priscus*, c) *Asaphidion nebulosum*, d) *Bembidion scapulare*, e) *Bembidion quadricolle*, f) *Bembidion striatum*. All pictures were taken from beetles at the Vjosa valley near Kutë, 24.04.-28.04.2018. © Paill W. (a, c, e, f), Kunz G. (b, d). – Abb. 6: a) *Cicindela monticola albanica*, b) *Dyschirius substriatus priscus*, c) *Asaphidion nebulosum*, d) *Bembidion scapulare*, e) *Bembidion quadricolle*, f) *Bembidion striatum*. Alle Aufnahmen stammen von Käfern aus dem Vjosatal nahe Kutë, 24.04.–28.04.2018. © Paill W. (a, c, e, f), Kunz G. (b, d).

(Guéorguiev 2011a), and one originating from the Vjosa river (Guéorguiev 2007a). In our study, we collected 29 individuals of *Bembidion scapulare* in at least seven sites, all of them directly at the shoreline (e.g. Fig. 5). There was a clear preference for initial stages on gravel sediment bars, as only one specimen was sampled on a silty to sandy bar (Tab. 2). This behavior is slightly in contrast to the species' habitat use along the Tagliamento in northern Italy, where Kahlen (2010) documented the same degree of importance between coarse-grained and fine-grained sediment bars.

Bembidion quadricolle **(Motschulsky, 1844)**

Fine flight capability characterizes this highly stenotopic riparian species. Nevertheless, findings within the turanico-east mediterranean range – at least in Europe – are rare, reflected e.g. by the very low number of records from Romania (Nitzu 2003), Bosnia Herzegovina (Guéorguiev 2011b), Macedonia (Hristovski & Guéorguiev 2015), and Serbia (Guéorguiev 2008, Ćurčić et al. 2007). Some more findings were published for Albania, but none of them is less than 80 years old (Guéorguiev 2007a). Around the village of Kutë, we collected 215 specimens (and observed many more rapidly flying away) in no less than 20 sites. This species is therefore one of the most abundant riparian ground beetles in the study area. It exclusively inhabits initial stages of fine-grained sediment bars, whereby both sites along standing and flowing water are used. In any case, the habitat is characterized by moist ground conditions, cover with silt (and sand) and more or less lacking vegetation (Fig. 1, 2, 7). We observed similar habitat use in some other species, e.g. *Bembidion latiplaga*, *Bembidion striatum*, *Tachys micros*, *Tachyura hoemorroidalis*, and *Stenolophus discophorus*. Nitzu (2003) found *Bembidion quadricolle* associated with *Bembidion laticolle* Duftschmid, 1812. However, the latter species is not yet documented for Albania.

Bembidion striatum **(Fabricius, 1792)**

Similar to the species mentioned above, the eurosibirian *Bembidion striatum* is a highly stenotopic riparian Bembidiini. Again, there are very few records for the Balkans – mark-

Fig. 7: Silty sediment bar directly at the edge of the Vjosa as typical habitat of *Bembidion quadricolle* and *Bembidion striatum* (sites 6 and 7, habitat type C1]. © Paill W., 26.04.2017. – Abb. 7: Schluffige Sedimentbank direkt an der Vjosa als typischer Lebensraum von *Bembidion quadricolle* und *Bembidion striatum* (Probeflächen 6 und 7, Habitattyp C1]. © Paill W., 26.04.2017.

ing the southeastern margin of its European distribution – especially outside the watershed of the Danube (e.g. Netolitzky 1918, Geisthardt 1975, Guéorguiev 2007a). In Central Europe, in contrast, many records have been published (e.g. Bräunicke & Trautner 1999, Franz 1970), but almost no populations have survived until now, mainly caused by hydraulic engineering schemes (Bräunicke & Trautner 1999). Around the village of Kutë, we collected 92 specimens (and observed many more rapidly flying away) on 11 sites. The habitat is equivalent to that of *Bembidion quadricolle,* as all sites with more than one individual of *B. striatum* were also inhabited by the former species.

Bembidion decolor Apfelbeck, 1911

Little is known about the ecology of this rare and scattered mediterranean species, which ranges from southern Croatia to Iran (Drovenik & Peks 1999, Marggi et al. 2017). Austin et al. (2008) mentioned findings from freshwater wetlands in Cyprus, and Teofilova et al. (2012) stated halobiontic behavior based on findings from the Black

Fig. 8: Small, stagnantly flowing ditch with *Typha* and *Salix* vegetation: Wetlands at the outer edge of the active floodplain of the Vjosa [site 24, habitat type E2] as habitat of a diverse ground beetle fauna, e.g. *Dyschirius aeneus*, *Asaphidion stierlini*, *Bembidion quadripustulatum*, *Bembidion splendidum*, *Bembidion decolor*, *Acupalpus flavicollis*, *Demetrias imperialis*, *Odacantha melanura*, and *Poecilus rebeli*. © Paill W., 25.04.2017. – Abb. 8: Kleines, langsam fließendes Gerinne mit *Typha*- and *Salix*-Vegetation: Feuchtgebiet am äußeren Rand der regelmäßig umgelagerten („aktiven“) Aue der Vjosa [Probefläche 24, Habitattyp E2] als Lebensraum einer artenreichen Laufkäferzönose, z. B. *Dyschirius aeneus*, *Asaphidion stierlini*, *Bembidion quadripustulatum*, *Bembidion splendidum*, *Bembidion decolor*, *Acupalpus flavicollis*, *Demetrias imperialis*, *Odacantha melanura* und *Poecilus rebeli*. © Paill W., 25.04.2017.

Sea coast, where the only known occurances of *Bembidion decolor* are from Bulgaria (e.g. Hieke & Wrase 1988). Besides the typical material dating from the Buenë River (Guéorguiev 2007a), there is no indication about the possible significance of floodplain-systems. Around the village of Kutë, we found *Bembidion decolor* very locally in two different systems. Most of the 27 sampled individuals were located along a tributary to the Vjosa. This small, stagnantly flowing ditch is characterized by a moist, silty to clayish ground, partly covered by reed mace and *Salix* vegetation (Fig. 8). The conditions at this location are similar to the second occurrence at standing waters along a disconnected former arm of the Vjosa. On both sites, *Bembidion decolor* was commonly accompanied by *Dyschirus aeneus* and *Bembidion quadripustulatum*.

Tachys micros (Fischer von Waldheim, 1828)

This eurosibirian species illustrates the relativly sparse knowledge of the Albanian ground beetle fauna. While there is only one historic finding published from this country (Guéorguiev 2007a), we registered 13 individuals from 10 sites around the village of Kutë. We found the species to prefer initial to pioneer stages of sandy to silty bars, mostly directly at the edge of water.

Thalassophilus longicornis (Sturm, 1825)

The eurocaucasian species is widespread in alpine riversystems but not frequent on the Balkans. Although cited by Apfelbeck (1907) for Albania, Guéorguiev (2007a: 88) stated that “it needs further confirmation for the country”. *Thalassophilus longicornis* is highly stenotopic, exclusively inhabiting initial stages of gravel sediment bars. At the Vjosa between Kalivaç and Poçem, it was found to live directly at the edge of flowing water. On the site with its highest local density, *Thalassophilus longicornis* was accompanied by several other stenotopic species, such as *Bembidion brunoi*, *Bembidion combustum*, *Bembidion scapulare*, and *Perileptus areolatus*. We provide the first detailed data for Albania.

Acupalpus flavicollis (Sturm, 1825)

Widely distributed from West Siberia and Kazakhstan across Europe to the northeastern Iberian Peninsula, this species is very common in Central Europe. However, in Albania (Jaeger et al. 2016) as well as Macedonia (Hristovski & Guéorguiev 2015), it was recently documented for the first time, each based on single locations. The species is eurytopic and lives in moist, unshaded margins of standing waters, as well as in wet meadows. We caught a single female in the outer edge of the active floodplain of the Vjosa in a reed mace stand along a small, stagnantly flowing ditch as a tributary to the main river (Fig. 8). Here, it was part of a highly diverse ground beetle-fauna, with high densities of *Dyschirius aeneus*, *Asaphidion flavipes*, *Asaphidion rossii*, *Bembidion quadripustulatum*, *Bembidion decolor*, and *Poecilus rebeli*.

Acupalpus meridianus (Linnaeus, 1760)

For this equally widely distributed (Jaeger & Kataev 2017) and, in many countries, commonly documented species, only one historical finding for Albania was published thus far (Guéorguiev 2007a). It is more eurytopic than the former species and a single male was trapped on a moderately moist, fine-grained pioneer stage at a higher level within the active floodplain.

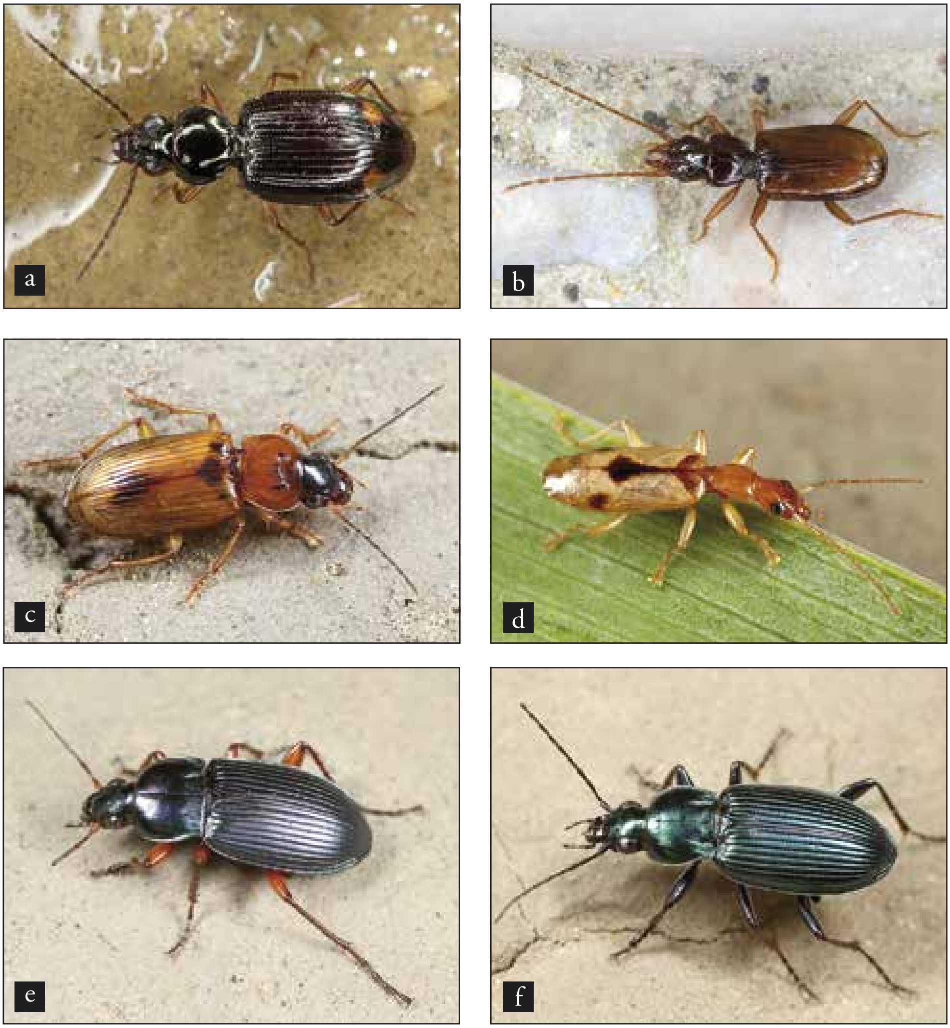

Fig. 9: a) *Bembidion decolor,* b) *Thalassophilus longicornis*, c) *Stenolophus discophorus*, d) *Demetrias imperialis*, e) *Poecilus rebeli*, f) *Poecilus striatopunctatus*. All pictures were taken of beetles at the Vjosa valley near Kutë, 24.04.-28.04.2018. © Paill W. (c-f), Kunz G. (a, b). – Abb. 9: a) *Bembidion decolor,* b) *Thalassophilus longicornis*, c) *Stenolophus discophorus*, d) *Demetrias imperialis*, e) *Poecilus rebeli*, f) *Poecilus striatopunctatus*. Alle Aufnahmen stammen von Käfern aus dem Vjosatal nahe Kutë, 24.04.-28.04.2018. © Paill W. (c-f), Kunz G. (a, b).

Acupalpus planicollis (Schaum, 1857)

This Stenolophina is endemic to the Balkan Peninsula, where it is known from northeastern Italy (Triest), Bulgaria, Albania and Greece (Jaeger et al. 2016, Jaeger & Kataev 2017). Nothing has yet been published about its habitat use. We caught one single male in a reed mace stand in the outer edge of the active floodplain of the Vjosa along a small, stagnantly flowing ditch as a tributary to the main river. The location is similar to the finding of *Acupalpus flavicollis* and also harbours a rich carabid fauna; high densities were

Fig. 10: Disconected former arm with drying up wetland habitats at the outer edge of the active floodplain of the Vjosa [sites 28 and 29, habitat type E1] © Paill W., 25.04.2017. – Abb. 10: Abgetrennter früherer Flussarm mit auftrocknenden Feuchtflächen am äußeren Rand der regelmäßig umgelagerten („aktiven") Aue der Vjosa. [Probeflächen 28 and 29, Habitattyp E1] © Paill W., 25.04.2017.

documented for *Dyschirius aeneus*, *Asaphidion flavipes*, *Bembidion quadripustulatum*, *Bembidion decolor*, *Stenolophus skrimshiranus*, and *Anchomenus dorsalis*.

Stenolophus discophorus (Fischer von Waldheim, 1823)

The distribution of this stenotopic ground beetle ranges from Central Europe over the mediterranean area until western Sibiria and northwestern China (Jaeger & Kataev 2017). Although *Stenolophus discophorus* may be found at standing waters outside of floodplains (e.g. Paill & Holzer 2015), it clearly prefers active floodplains, where moist sandy to silty grounds without vegetation results from the natural activity and flood dynamics. Observations made by Kahlen (2010) at the Tagliamento are in accordance with our findings at the Vjosa, where *Stenolophus discophorus* was particularly found on almost bare, silty to clayey, drying up, cracked soils, allowing the beetles to shelter between the cracks. *Bembidion latiplaga* and *Bembidion quadricolle* were the most frequent companions.

Demetrias imperialis (Germar, 1823)

Because it climbs reed stands of moist to wet swamps and standing waters, this euroturanian species is hard to find. This may be one of the reasons why it has not been documented in Albania before. Near Kutë we collected three specimens in a reed mace stand (*Typha* sp.) along a small, stagnantly flowing ditch at the outer edge of the active floodplain of the Vjosa (Fig. 8). Also (in some cases, only recently) known from the neighboring countries Macedonia (Hristovski 2007, Hristovski & Guéorguiev 2015), Serbia (Ćurčić et al. 2007), and Greece (Arndt et al. 2011), we provide the first data for Albania.

Microlestes fulvibasis (Reitter, 1901)

This turano-mediterranean species is eurytopic and not typical of riverside biotopes. Literature often – especially in Central Europe – refers to saline habitats (e.g. Wrase 1989, Teofilova et al. 2015), including findings near the coast from sandy shores or low marquises (e.g. Contarini 1992, Fattorini & Vigna Taglianti 2002), but also from a forest in a river floodplain (Fülöp & Rudner 2000) or a wet meadow (Hristovski & Guéorguiev 2015). Moderately hygrophilous behavior, as classified by Zanella (2010), applies to our observations made in the floodplain of Vjosa around the village of Kutë. We collected two individuals, one female on a silty sediment bar in an initial stage near the waterline, and one male in a more or less dry, disconnected former arm of the Vjosa at the outer edge of the active part of the floodplain (Fig. 10). Already known from Macedonia (Hristovski & Guéorguiev 2015) and Greece (Arndt et al. 2011), *Microlestes fulvibasis* had been expected in Albania, too. We provide the first records.

Odacantha melanura (Linnaeus, 1767)

There was only one historic specimen known for Albania until now (Guéorguiev 2007a). We collected two specimens at two sites along a small, stagnantly flowing ditch vegetated with reed mace (*Typha*) on a wet clayey ground. At the temporarily submerged site, *Odacantha melanura* was accompanied by *Pterostichus cursor*, *Oodes gracilis*, and *Oodes helopioides*.

Poecilus rebeli (Apfelbeck, 1904)

Endemic to the West Balkan, *Poecilus rebeli* is restricted to Croatia, Bosnia and Herzegovina, Macedonia, Serbia, Albania, and Greece (Bousquet 2017). As there are only single locations published from Croatia (Apfelbeck 1904), Serbia (Ćurčić et al. 2007), Montenegro (Apfelbeck 1904), as well as Macedonia (Hristovski & Guéorguiev 2015), most of the known sites come from Albania (Guéorguiev 2007a). Locations such as Buenë River (Guéorguiev 2007a) or the marshland of the Neretva (Apfelbeck 1904) might give an indication about the significance of floodplains for this notable species. In our investigations around Kutë, all 31 *Poecilus rebeli* individuals were caught in an initial softwood forest (*Salix alba*, *Typha* sp.) on wet to moist silty to clayish ground along a stagnantly flowing ditch, being a small, periodically drying up tributary of the Vjosa (Fig. 8).

Poecilus striatopunctatus (Duftschmid, 1812)

All over its euromediterran area, this stenotopic riverside ground beetle is sporadically distributed and fairly rare. This is especially true considering recent records, which are known only from a few well-preserved lower reaches of larger rivers such as the Po (e.g. Alegro & Sciaky 2001), the Tagliamento (Kahlen 2010), or the Tisa (Hůrka 1996). In Albania the species had been sampled at the Buenë and the Vjosa, both at least 80 year ago (Guéorguiev 2007a). During our studies around the village of Kutë, we discovered a large population of *Poecilus striatopunctatus* and collected 27 specimens from at least 9 sites. All of the sites were moist, sandy to silty pioneer stages at the edge of standing or slowly flowing waters with, at most, scattered seedlings of herbs. The best site with 20 sampled specimens was a drying up pool in an annually-flooded, disconnected arm of the Vjosa with almost no vegetation (Fig. 2).

Pterostichus cf. *anthracinus biimpressus* (Küster, 1853)

This Balkan subendemic taxon was described from Omiš at the Dalmatian coast of Croatia (Ganglbauer 1899, Guéorguiev 2007a) and is known to be distributed from the Balkans (known from Croatia, Bosnia and Herzegovina, Bulgaria, Albania, and Greece) to Turkey (Guéorguiev & Guéorguiev 1995, Bousquet 2017). Bousquet (2017) also listed Hungary, but there is some doubt as to this, because the author may have been referring to Reitter (1901), who named *biimpressus* for the Beskids (Mähren-Schlesien), which could not be confirmed in recent times. From Bulgaria, Albania, and Greece, both *biimpressus* as well as *anthracinus* have been published (Apfelbeck 1904, Bucciarelli & Sopracordevole 1958, Guéorguiev & Guéorguiev 1995, Guéorguiev 2007a, 2011b). However, there is no data on *biimpressus* from Montenegro, Macedonia, and Serbia, where only *P. anthracinus anthracinus* occurs (Ćurčić et al. 2007, Guéorguiev 2008, 2011, Hristovski & Guéorguiev 2015). Little is known about the Turkish situation. Although Casale & Vigna Taglianti (1999) listed only *biimpressus*, Kesdek & Yildirim (2008) mention *anthracinus*, without subspecific classification.

Our material from the Vjosa might be assigned to *biimpressus*. However, an unequivocal determination is not possible, since the name *biimpressus* is based on material from Middle Dalmatia (Omiš). Material from around there (we checked specimens from Vransko jezero, Sinj, and Metković) shows intermediary characteristics between *P. anthracinus anthracinus* and our material from the Vjosa. The latter is characterized by significant differences in comparsion to Central European *P. anthracinus anthracinus* (Fig. 11–13). In both sexes, the elytrae are apically broadened and their microsculpture is characterized by transverse meshes. In males, the impression on the last visible sternum is comparatively shallow and doesn't reach the apicomedial border, and the aedeagus is deeply notched in its right-angled curve. The latter characteristic is striking, but was not mentioned in the literature before (see Ganglbauer 1899, Müller 1901, Apfelbeck 1904, Bucciarelli & Sopracordevole 1958, Guéorguiev & Skoupý 2010). In females, the elytrae show a deep excision before each tip, whereby this characteristic is usually named by differentiating *anthracinus* from *biimpressus* in literature (Müller 1901, Schatzmayr 1943, Guéorguiev & Skoupý 2010, Guéorguiev 2011a). However, this characteristic varies between both taxa (Apfelbeck 1904, Schatzmayr 1943), as does the microsculpture of the elytrae, which consists of nearly isodiametric meshes in *P. anthracinus anthracinus*, but transverse meshes in specimens from Middle Dalmatia. There seems to be no variance concerning the general form of the elytrae, which are parallel sided in *P. anthracinus anthracinus* from Central Europe as well as in specimens from Middle Dalmatia. This is also true for the above mentioned male characteristics, whereby the impression on the last visible sternum is comparatively deep and almost reaches the apicomedial border, and the aedeagus is not notched in its right-angled curve, both in specimens from Central Europe and Middle Dalmatia. Therefore, our material from the Vjosa should be treated as notably different from *P. anthracinus anthracinus*, which was described from Germany. The name of this taxon, which could be new, however, can only be fixed by studying the type-material of *biimpressus* from Omiš, and by incorporating other closely related taxa within the subgenus *Pseudomaseus*.

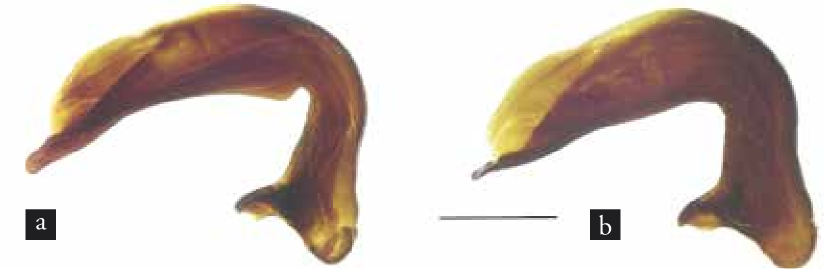

Fig. 11: Male genitalia, median lobe of adeagus in right lateral view, a) *Pterostichus* cf. *anthracinus biimpressus* from the study area [site 34], b) *Pterostichus anthracinus anthracinus* from Kalsdorf/Mur near Graz (Austria). Scale bare: 0.5 mm. © Paill W. – Abb. 11: Männliches Genitalorgan, Medianlobus des Aedeagus in seitlicher Ansicht (rechte Seite), a) *Pterostichus* cf. *anthracinus biimpressus* aus dem Untersuchungsgebiet [Probefläche 34], b) *Pterostichus anthracinus anthracinus* aus Kalsdorf/Mur bei Graz (Österreich). Maßstab: 0.5 mm. © Paill W.

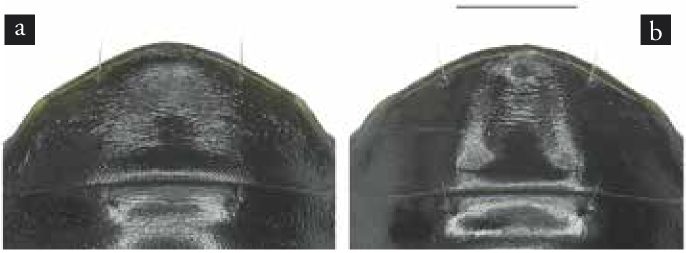

Fig. 12: Last abdominal sternum in males in ventral view, a) *Pterostichus* cf. *anthracinus biimpressus* from the study area [site 34], b) *Pterostichus anthracinus anthracinus* from Orth/Donau near Vienna (Austria). Scale bare: 0.5 mm. © Paill W. – Abb. 12: Letztes abdominales Sternum im männlichen Geschlecht in ventraler Ansicht, a) *Pterostichus* cf. *anthracinus biimpressus* aus dem Untersuchungsgebiet [Probefläche 34], b) *Pterostichus anthracinus anthracinus* aus Orth/Donau bei Wien Vienna (Österreich). Maßstab: 0.5 mm. © Paill W.

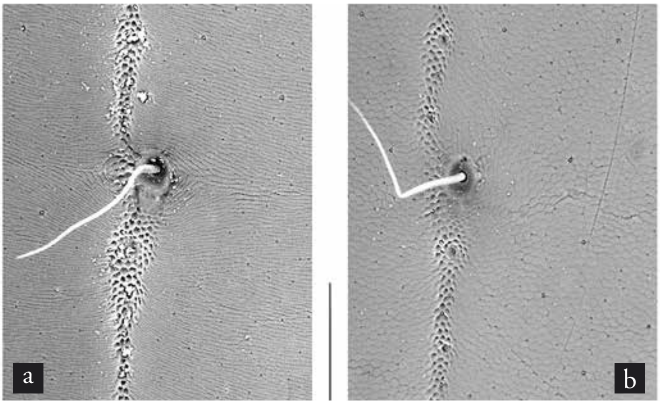

Fig. 13: Microsculpture of the elytrae near the first setiferious puncture on the third stria, a) *Pterostichus* cf. *anthracinus biimpressus* male from the study area [site 34] characterized by transverse meshes, b) *Pterostichus anthracinus anthracinus* male from Orth/Donau near Vienna (Austria) with nearly isodiametric meshes. Scale bare: 0.5 mm. © Paill W. – Abb. 13: Mikroskulptur der Elytren nahe des ersten Porenpunktes im dritten Flügeldeckenstreifen, a) *Pterostichus* cf. *anthracinus biimpressus* Männchen aus dem Untersuchungsgebiet [Probefläche 34] mit Chagrinierung aus quergestreiften Maschen, b) *Pterostichus anthracinus anthracinus* Männchen aus Orth/Donau bei Wien (Österreich) mit Chagrinierung aus nahezu isodiametrischen Maschen. Maßstab: 0.5 mm. © Paill W.

Further species of faunistic interest

With *Carabus coriaceus excavatus* we collected one further taxon considered as endemic for the Balkan regions by Guéorguiev (2007b). This species, however, is eurytopic and lives mostly outside of floodplains.

Furtheremore, we present data for the following species, for which none had been published from Albania for (at least) the past three centuries (compare e.g. Guéorguiev 2007a): *Clivina fossor*, *Dyschirius aeneus*, *Asaphidion rossii*, *Bembidion azurescens*, *Bembidion latiplaga*, *Bembidion combustum*, *Bembidion striatum*, *Bembidion brunnicorne*, *Bembidion bualei*, *Bembidion articulatum*, *Bembidion octomaculatum*, *Sinechostictus tarsicus*, *Tachys scutellaris*, *Tachyura hoemorroidalis*, *Chlaenius nigricornis*, *Drypta dentata*, *Harpalus autumnalis*, *Harpalus punctatostriatus*, *Acupalpus luteatus*, *Acupalpus paludicola*, *Stenolophus mixtus*, *Stenolophus skrimshiranus*, *Oodes helopioides*, *Panagaeus cruxmajor*, *Agonum sordidum*, *Agonum permoestum*, *Olisthopus glabricollis*, and *Pterostichus cursor*.

Habitate use within the floodplain

Species numbers and population densities

Although the intensity as well as the method of sampling was different between the habitat types, a careful comparison regarding species numbers and population densities was carried out. The total number of species, as well as the number of "site-specific" species, differed greatly between the habitat types (Fig. 14). High numbers of carabids (52 species) were caught on silty and moist sediment bars with initial to pioneer vegetation (habitat types C1, C2), situated either directly along the main channel of the Vjosa or in drying, regularly flooded side arms. Apart from that, wetlands at the outer edge of the active floodplain (E1, E2) also showed outstanding carabid biodiversity (55 species). A conspicuously large number of species was found only here within the study area (here called "site-specific" species), but most of them, such as *Acupalpus* spp., *Stenolophus* spp., or *Agonum* spp. are not restricted to floodplain habitats. The same effect is true for the grassland-habitats on fine-grained sediments (D1, D2), since most of the "site-specific" species, such as *Harpalus pygmaeus* or *Calathus circumseptus,* are widespread outside of floodplains.

Moderately frequent catches (29 species) were made along initial stages of moist gravel sediment bars, mostly located along flowing or at least standing waters (B1, B2). Species which occurred only here within the study area are usally not only "site-specific", but also habitat-specific, being restricted to floodplain-habitats. The same is true for the "site-specific" species of fine-grained sediment bars (C1, C2). Low numbers of species (13–14) were caught in older succession stages on elevated niveaus of the floodplain (C3, C4 and D1, D2; Fig. 15).

Population densities (indictated as the activity density by pitfall trapping) showed the same patterns as the species numbers, with the highest numbers in wetland habitats reaching 2.2 specimens on average per trap-day, and regularly flooded, fine-grained sediment bars (C1, C2) with 1.3 specimens. A considerably lower number of specimens (0.1–0.3 specimens on average per trap-day) was caught in older succession stages on elevated niveaus of the floodplain (C3, C4 and D1, D2).

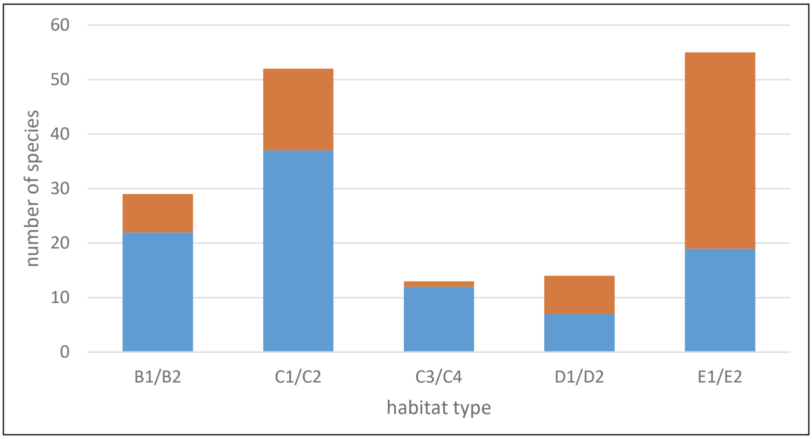

Fig. 14: Total number of species (whole columns) and number of "site-specific" species (upper, orange part of the columns) in comparison between the habitat types. For abbreviations of the habitat types, see chapter "Material and Methods". – Abb. 14: Gesamtartenzahl (gesamte Säulen) und Anzahl „Standort-spezifischer" Arten (oberer, oranger Teil der Säulen) im Vergleich zwischen den Habitattypen. Abkürzungen der Habitattypen siehe Kapitel „Material and Methods".

Fig. 15: Anthropogenically influenced grasslands with *Imperata cylindrica* on elevated niveaus within the active floodplain [site 17, habitat type D1] harbour a low number of ground beetles. © Paill W., 25.04.2017. – Abb. 15: Durch menschliche Nutzungen geprägtes Grasland mit *Imperata cylindrica* auf höheren Niveaus innerhalb der regelmäßig umgelagerten („aktiven") Aue [Probefläche 17, Habitattyp D1] beherbergen eine geringe Zahl an Laufkäfern. © Paill W., 25.04.2017.

Tab. 2: Habitat specific distribution in species of tribus Cicindelini, Dyschiriini and Bembidiini as the number of caught specimens. For abbreviations of the habitat types, see chapter „Material and Methods“, n. a. = habitat type not assigned. – Tab. 2: Lebensraumutzung der Arten der Triben Cicindelini, Dyschiriini and Bembidiini anhand der gefangenen Individuen. Abkürzungen der Habitattypen siehe Kapitel „Material and Methods“, n. a. = Habitattyp unbestimmt.

tribe / species	**B1/B2**	**C1/C2**	**C3/C4**	**D1/ D2**	**E1/E2**	**F1/F2**	**G1**	**n. a.**
Cicindelini								
Calomera fischeri		10						
Calomera littoralis nemoralis		9						
Cicindela campestris olivieria	1	3	1		11	2		1
Cicindela monticola albanica		134	26					19
Cylindera germanica muelleri			1					
Cylindera arenaria viennensis		3						1
Dyschiriini								
Dyschirius aeneus		1			92			
Dyschirius agnatus	4	80						2
Dyschirius minutus albanicus	5	3						1
Dyschirius morio	2	22	3				1	1
Dyschirius latipennis		1						
Dyschirius abditus	2	7	1	2				
Dyschirius gracilis	2	11	2	1			2	
Dyschirius importunus					6			1
Dyschirius parallelus ruficornis	2	60						8
Dyschirius substriatus priscus	2	23						3
Bembidiini								
Asaphidion flavipes				3	44			
Asaphidion nebulosum	10	31	6					10
Asaphidion rossii	74	63	3		18	9	1	7
Asaphidion stierlini					2			
Bembidion quadripustulatum					82			
Bembidion brunoi	61							3
Bembidion concoeruleum	3							
Bembidion splendidum	1	4			3			
Bembidion azurescens		6						
Bembidion latiplaga		39						1
Bembidion tenellum					1			
Bembidion combustum	3							1
Bembidion scapulare	22	1						6
Bembidion lampros					5			
Bembidion properans					1		1	
Bembidion quadricolle		211			3			1
Bembidion (*Nepha*) sp.		1					1	
Bembidion varium	1	1						
Bembidion striatum	1	91						
Bembidion brunnicorne							7	
Bembidion dalmatinum	1	11					13	4
Bembidion bualei	63	30	5		1		2	11

Tab. 2 continued – Fortsetzung

tribe / species	B1/B2	C1/C2	C3/C4	D1/ D2	E1/E2	F1/F2	G1	n. a.
Bembidion subcostatum vau		1			6			
Bembidion decolor					26			1
Bembidion punctulatum	8							5
Bembidion articulatum					7			
Bembidion octomaculatum					2			
Sinechostictus tarsicus		1					1	
Tachys bistriatus	1				8		1	
Tachys fulvicollis		1			4			1
Tachys micros		12		1				
Tachys scutellaris		1						
Tachyura hoemorroidalis		6			4		1	1
Tachyura diabrachys	41	55					15	9

Comparative ecological behavior in Cicindelini, Bembidiini, and Dyschiriini

Cicindelini, Bembidiini, and Dyschiriini represent three taxonomical groups with high numbers of stenotopic floodplain species. Their habitat-differentiating distribution within the study area is illustrated in Tab. 2. Thus, only individual species such as *Cicindela campestris olivieria* or *Asaphidion rossii* occur almost evenly across different habitat types, while most carabids of these groups show clear habitat preferences.

Discussion

Biodiversity

The species richness of ground beetles in the Vjosa valley is enormous. From the focused investigated area around the village of Kutë (situated between Kalivaç and Poçem), covering no more than 5 kilometers of river length, 112 species have been documented. Taking into consideration that this data is based on only one collecting period of five days within one year (2017), this richness exceeds ground beetle data from most other near-natural riversystems in Europe (e.g. Plachter 1986). Our data can even compete with the fauna of the outstanding course of the Tagliamento in Northern Italy, from where a remarkable 185 carabid beetles are known (Kahlen 2003, 2010). The Tagliamento data, however, is based on an investigation area of more than 100 kilometers in length, covering headwaters as well as the estuary region. Moreover, the data comprehends investigations from several seasons of the year and was collected over a period of more than 20 years.

The high species richness of ground beetles in the Vjosa valley between Kalivaç and Poçem is explained by the physical disturbances and continued habitat rejuvenation due to high flow rates and floods, which leads to a rich structural diversity of microhabitats. The Vjosa's specific status as a crossover between an anastomosing river character and meandering sections allows a lot of species to find often highly specific habitats there. Therefore, carabid beetles preferring fine-grained sediment bars at salt-influenced tailwaters or estuary-regions, such as *Calomera littoralis nemoralis*, *Scarites terricola*, *Bembidion tenellum*, *Tachys* *fulvicollis*, *Tachys scutellaris*, or *Pogonus littoralis* occur together with species specialized on coarse-grained sediment bars at headwaters, such as *Bembidion concoeruleum*, *Bembidion combustum*, or *Bembidion scapulare.*

Aspects of natural conservation

Not only the huge (only partially known) number of ground beetle species underlines the Vjosa as a highly sensitive river worthy of protection. In addition, the proportion of stenotopic floodplain species is also of great importance. Included are several species which occur in high local population numbers, but which are simultaneously very rare on a European level. This is particularly true for species such as *Cicindela monticola albanica, Bembidion brunoi, Bembidion quadricolle, Bembidion striatum*, *Stenolophus discophorus*, and *Poecilus striatopunctatus*.

Hence, the Vjosa might prospectively act as a very important genetic pool in terms of maintaining source populations of international significance. This might be of vital importance, as typical ground beetle species of floodplain habitats have become extinct due to various alterations of the natural flow regimes of many European river systems, though a lot of effort is put into restoration management at the same time.

Appendix: Additional ground beetle data from the Vjosa

Hereafter we provide additional ground beetle data sampled during 2014 from different regions of the Vjosa valley.

Sites and sampling data

[51] Kelcyre, Vjosa river, ~230 m a. s. l., *Pinus halepensis* stand, 14.06.2014, leg. Hristovski S., det. Hristovski S.
[52] Poçem, Vjosa river, 85 m a. s. l., degraded Kermes oak forest, traps, 13–15.06.2014, leg. Hristovski S. & Komnenov M., det. Hristovski S.
[53] Poçem, Vjosa river, 80 m a. s. l., wet meadow with *Platanus orientalis*, traps, 13–15.06.2014, leg. Hristovski S. & Komnenov M., det. Hristovski S.
[54] Poçem, Vjosa river, 80 m a.s.l., wet meadow, traps, 13–15.06.2014, leg. Hristovski S. & Komnenov M., det. Hristovski S.
[55] Poçem, Vjosa river, 70 m a.s.l., sand & gravel river bank, 13.06.2014, leg. Hristovski S., det. Hristovski S.
[56] Delta of Vjosa river, 1 m a. s. l., sand beach, 15.06.2014, leg. Hristovski S., det. Hristovski S.
[57] Poçem, Vjosa river, 80 m a. s. l., light traps, 13–14.06.2014, leg. Graf W., det. Hristovski S.
[58] SE Tepelenë, Vjosa river, 129 m a. s. l., light traps, 40,28036° N, 20,04435° E, 14.06.2014, leg. Hess M. & Heckes U., det. Lorenz W.
[59] 3 km SE Tepelenë, above the mouth of the river Drinos, Vjosa river, 128 m a. s. l., 14.06.2014, Hess M. & Heckes U. leg., det. Lorenz W.
[60] ESE Selenicë, Vjosa river, 80 m a. s. l., light traps and hand-collecting, 40,50654 N, 19,72641 E, 14.08.2014, Hess M. & Heckes U. leg., det. Lorenz W.

Tab. 3: Additional ground beetle data from the Vjosa valley. – Tab. 3: Ergänzende Laufkäferdaten aus dem Vjosatal.

tribe / species	specimens total	specimens per [site]
Carabini Latreille, 1802		
Carabus coriaceus excavatus Charpentier, 1825	4	[51]:3; [52]:1
Cicindelini Latreille, 1802		
Cicindela monticola albanica Apfelbeck, 1909	7	[55]:4; [56]:3
**Cylindera germanica germanica* (Linnaeus, 1758)	4	[54]:1; [55]:2; [56]:1
Cylindera trisignata (Dejean, 1822)	5	[56]:5
Omophronini Bonelli, 1810		
Omophron limbatum (Fabricius, 1777)	2	[55]:1; [58]:1
Clivinini Rafinesque, 1815		
Clivina fossor (Linnaeus, 1758)	1	[53]:1
Clivina laevifrons Chaudoir, 1842	1	[58]:1
Dyschiriini H.J. Kolbe, 1880		
Dyschirius aeneus (Dejean, 1825)	2	[58]:1; [59]:1
Dyschirius parallelus ruficornis Putzeys, 1846	2	[57]:1; [60]:1
Dyschirius substriatus priscus J. Müller, 1922	1	[53]:1
Bembidiini Stephens, 1827		
Asaphidion flavipes (Linnaeus, 1760)	9	[53]:5; [59]:4
Asaphidion nebulosum (P. Rossi, 1792)	3	[59]:2; [60]:1
Asaphidion rossii (Schaum, 1857)	6	[59]:6
Bembidion quadripustulatum Audinet-Serville, 1821	1	[57]:1
Bembidion brunoi (Bonavita, 2001)	7	[55]:7
Bembidion latiplaga Chaudoir, 1850	1	[57]:1
Bembidion scapulare Dejean, 1831	4	[55]:2; [58]:2
Bembidion decorum (Panzer, 1799)	2	[53]:1; [59]:1
Bembidion foraminosum Sturm, 1825	1	[58]:1
Bembidion dalmatinum Dejean, 1831	1	[55]:1
Bembidion bualei Jacquelin du Val, 1852	67	[55]:9; [57]:47; [58]:9; [59]:1; [60]:1
Bembidion subcostatum vau Netolitzky, 1913	15	[57]:11; [58]:4
Bembidion tetracolum Say, 1823	1	[58]:1
Bembidion decolor Apfelbeck, 1911	1	[57]:1
Bembidion lunulatum (Geoffroy, 1785)	7	[57]:5; [58]:2
Bembidion punctulatum Drapiez, 1820	12	[55]:5; [57]:4; [58]:3
Sinechostictus tarsicus (Peyron, 1858)	1	[57]:1
Lymnastis galilaeus Piochard de la Brûlerie, 1876	1	[57]:1
Tachys bistriatus (Duftschmid, 1812)	6	[57]:2; [58]:4
Tachyura diabrachys (Kolenati, 1845)	2	[57]:1; [58]:1
Trechini Bonelli, 1810		
Perileptus areolatus (Creutzer, 1799)	1	[58]:1
Chlaeniini Brullé, 1834		
Chlaenius cruralis Fischer von Waldheim, 1829	1	[52]:1
Harpalini Bonelli, 1810		
Parophonus hirsutulus (Dejean, 1829)	11	[57]:6; [58]:5
Acupalpus maculatus (Schaum, 1860)	10	[57]:4; [58]:6
Acupalpus notatus Mulsant & Rey, 1861	2	[57]:2

Tab. 3 continued – Fortsetzung

tribe / species	specimens total	specimens per [site]
Stenolophus marginatus Dejean, 1829	32	[57]:20; [58]:12
Stenolophus abdominalis persicus Mannerheim, 1844	1	[57]:1
Stenolophus discophorus (Fischer von Waldheim, 1823)	2	[57]:1; [58]:1
Stenolophus mixtus (Herbst, 1784)	1	[57]:1
Lebiini Bonelli, 1810		
Licinus cassideus (Fabricius, 1792)	5	[51]:5
Platynini Bonelli, 1810		
Anchomenus dorsalis (Pontoppidan, 1763)	1	[51]:1
Pterostichini Bonelli, 1810		
Myas chalybeus (Palliardi, 1825)	1	[51]:1
Poecilus rebeli (Apfelbeck, 1904)	6	[53]:6
Poecilus striatopunctatus (Duftschmid, 1812)	1	[55]:1
Pterostichus melanarius (Illiger, 1798)	3	[53]:2; [54]:1
Tapinopterus extensus extensoides (Jedlička, 1936)	3	[51]:3
Zuphiini Bonelli, 1810		
*******Parazuphium chevrolatii* (Laporte, 1833)	1	[58]:1
Zuphium olens (P. Rossi, 1790)	1	[58]:1

Short Comments

Data of 49 species from 260 specimens are listed (Tab. 3). At least four of them are of particular interest (see below). 13 are to be added to the list of 112 floodplain inhabitants of the Vjosa river presented above.

Cylindera germanica germanica (Linnaeus, 1758)

Hieke & Wrase (1988) as well as Striniqi Laçej et al. (2010) reported *Cicindela germanica* for Albania, but only on species level. The catalogue of Palaearctic Coleoptera treats the nominotypical subspecies (Puchkov & Matalin 2017), but there is no data incorporated. Thus, we provide the first detailed record of the taxon for Albania.

Bembidion foraminosum Sturm, 1825

For this highly stenotopic riverside inhabitant, only one old record from Albania has been published until now (Guéorguiev 2007a). We present the second record for Albania.

Tapinopterus extensus extensoides (Jedlička, 1936)

Locally endemic in a minor part of Albania, but not an inhabitant of the floodplain of the Vjosa.

Parazuphium chevrolatii (Laporte, 1833)

This rare mediterranean-transcaucasian taxon, divided into several subspecies, is known from the neighboring countries of Bulgaria and Greece (Baehr 2017). We provide the first record for Albania.

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Glimpsing at the rove beetle fauna of Vjosa River, Albania (Coleoptera: Staphylinidae)

Gregor Degasperi

The determination of by-catches from a field trip to Vjosa River in April 2017 revealed 74 different species of staphylinid beetles. 28 species were reported for the first time for Albania, which impressively confirms the poor knowledge of Albania's rove beetle fauna. Further intensified investigations also considering specific catching methods are recommended to generate a well-founded data set of riverine staphylindae from Vjosa River for detailed evaluation. The importance of staphylindae as indicators in floodplain habitats is discussed.

Degasperi G., 2018: Einblicke in die Kurzflügelkäferfauna der Vjosa Auen, Albanien (Coleoptera: Staphylinidae).
Die Auswertung von Beifängen einer Vjosa Exkursion nach Albanien im April 2017 erbrachten 74 verschiedene Arten. 28 Arten Staphylindae werden zum ersten Mal aus Albanien gemeldet, was den geringen Kenntnisstand der Staphyliniden Fauna Albaniens demonstriert. Für eine ökologische Auswertung werden zusätzliche und intensivere Aufsammlungen unter Anwendung spezifischer Sammelmethoden empfohlen. Die zentrale Bedeutung von Kurzflügelkäfern als Indikatoren in Auen Lebensräumen wird diskutiert.

Keywords: Albania, floodplain, Staphylinidae, new records, riparian, river.

Introduction

Rove beetles are known to be highly diverse in natural floodplain habitats and include a high number of specialised stenotopic species (e.g. Fig 1) (e.g. Schatz 1996, Kahlen 2003, 2010, Degasperi & Eckelt 2015). From the shoreline to the alluvial forests, rove beetles inhabit numerous different microhabitats, making them valuable and sensitive indicators (Schatz 2007, Paetzold et al. 2008).

Apart from regular reports from Greece and its islands (e.g. Assing & Wunderle 1999, 2001) faunistic data from the Balkans is scarce and, aside from scattered records within taxonomic reviews, has hardly been published. The rove beetle fauna of Albania is poorly investigated (Schülke & Smetana 2015).

Materials and Methods

The present material was collected between 24.–28.04.2017 and includes by-catches from pitfall traps (leg. Paill W., Gunczy J., Frank T.) and hand catchings (leg. Paill W., Gunczy J., Kunz G.). Sampling data and study sites are presented in Paill et al. (2018 this volume). Detailed information about the investigated area is given in the introduction chapter. The material is currently stored in the author's collection.

For determination, the standard literature for Central European rove beetles was used (Freude et al. 1971, 1974, Assing & Schülke 2011). Whenever plausible, additional literature was consulted for identifying taxa (Assing 2007, 2016; Passnik 2006a, 2006b, 2010).

Fig. 1: *Bledius* cf. *bosnicus* burrowing in sand. Photo Gernot Kunz. – Abb. 1: Der grabende *Bledius cf. bosnicus*. Foto: Gernot Kunz.

Results

The pitfall traps and hand catchings provided 312 specimens. A total of 74 different species could be distinguished. 65 species could be determined to species level, of which 28 are new to the fauna of Albania (Schülke & Smetana 2015) (Tab.1). Over 40 % of the determined species are considered stenotopic in Central Europe. Due to the small amount of material provided, no further evaluation of species assemblages was carried out. The determined specimens included four remarkable species that will be more closely described in the following.

Remarkable species:

Anaulacaspis flavomarginata Assing 2016

The distribution of this recently described species was confined to only two localities in Albania and Greece (Assing 2016). A further record can hereby be confirmed. According to present knowledge, *A. flavomarginata* is a highly stenotopic riparian species exclusively inhabiting gravel banks of rivers.

Anaulacaspis laevigata Duvivier, 1883

Confirmed records of this rare species are known from Turkey, Southern Italy, and the Balkans (Assing 2016). As *A. flavomarginata, A. laevigata* is a riparian species preferably inhabiting riverbanks (Assing 2016). This is the first record for Albania.

Thinobius cf. *brigittae* Schülke 1998

Thinobius species are sensitive indicators of natural riverbanks, and inhabit the interstitial space close to the shoreline. *Thinobius brigittae* is known from France, Austria, Czech

Tab. 1: Species list Staphylinidae. The site numbers refer to the pitfall collecting and hand catching sites (see Paill et al. 2018 this volume); * refers to remarkable and discussed species. Species listed in bold are new records to the fauna of Albania. – Tab. 1: Artliste Staphylindae. Die Standortnummern entsprechen den Handfang- und Bodenfallenstandorten bei Paill et al. 2018 diese Ausgabe). * markiert die bemerkenswerten Arten im Text, fettgedruckte Arten bedeuten Neumeldungen für Albanien.

Species	**Subfamily**	**Site**	**Specimens**
***Bibloplectus hellenicus* Besuchet, 1955**	Pselaphinae	[27]	2
***Brachygluta* cf. xanthoptera Reichenbach, 1816**	Pselaphinae	[28]	1
Bryaxis spec.	Pselaphinae	[21]	1
***Trimium brevicorne* (Reichenbach, 1816)**	Pselaphinae	[20] [21] [27]	3
Trissemus antennatus serricornis (Schmidt-Goebel, 1838)	Pselaphinae	[25]	1
Tychobythinus spec.	Pselaphinae	[20]	1
Tychus spec.	Pselaphinae	[21]	1
***Ischnosoma longicorne* (Mäklin, 1847)**	Tachyporinae	[25]	1
***Sepedophilus marshami* (Stephens, 1832)**	Tachyporinae	[19]	1
Tachyporus nitidulus (Fabricius, 1781)	Tachyporinae	[28]	1
***Habrocerus capillaricornis* (Gravenhorst, 1806)**	Habrocerinae	[24]	1
Aloconota gregaria (Erichson, 1839)	Aleocharinae	[18] [21] [25]	3
Amarochara forticornis (Lacordaire, 1835)	Aleocharinae	[25]	2
Anaulacaspis flavomarginata Assing 2016 *	Aleocharinae	[30]	1
***Anaulacaspis laevigata* (Eppelsheim, 1883) ***	Aleocharinae	[25]	1
Anaulacaspis spec.	Aleocharinae	[30]	1
***Atheta* cf. *amplicollis* (Mulsant & Rey, 1873)**	Aleocharinae	[19]	1
***Atheta elongatula* (Gravenhorst, 1802)**	Aleocharinae	[27] [24] [25]	14
Atheta spec.	Aleocharinae	[28]	2
***Atheta triangulum* (Kraatz, 1856)**	Aleocharinae	[6] [25]	2
Cordalia obscura (Gravenhorst, 1802)	Aleocharinae	[18] [27]	3
Drusilla canaliculata (Fabricius, 1787)	Aleocharinae	[18] [25] [27] [28]	7
***Gnypeta rubrior* Tottenham, 1939**	Aleocharinae	[32/1]	1
Ischnopoda umbratica Erichson, 1837	Aleocharinae	[18] [24] [27]	5
***Meotica* cf. *filiformis* (Motschulsky, 1860)**	Aleocharinae	[12]	1
Oligota punctulata Heer, 1839	Aleocharinae	[25]	1
***Oxypoda* cf. *lurida* Wollaston, 1857**	Aleocharinae	[19]	1
Pronomaea picea Heer, 1841	Aleocharinae	[18]	1
Tachyusa coarctata Erichson, 1837	Aleocharinae	[32/1] [12] [13] [33]	7
***Tachyusa objecta* Mulsant & Rey, 1870**	Aleocharinae	[24]	1
Tetralaucopora longitarsis (Erichson, 1837)	Aleocharinae	[28] [30]	2
Tetralaucopora rubicunda (Erichson, 1837)	Aleocharinae	[18]	1
***Anotylus inustus* (Gravenhorst, 1806)**	Oxytelinae	[27]	1
Anotylus tetracarinatus (Block, 1799)	Oxytelinae	[5] [20] [24]	3
***Bledius* cf. *bosnicus* Bernhauer, 1902 ***	Oxytelinae	[11] [12] [14] [16] [20] [22] [30] [40/3] [41/1] [42/2]	62
Bledius cribricollis Heer, 1839	Oxytelinae	[13] [14] [18] [24] [25] [27] [28] [33] [35]	29

Tab. 1 continued – Fortsetzung

Species	Subfamily	Site	Speci-mens
Bledius frater Kraatz, 1857	Oxytelinae	[5] [13]	2
Bledius nanus Erichson, 1840	Oxytelinae	[9] [16] [33]	4
Bledius spec.	Oxytelinae	[3] [6] [14]	3
***Carpelimus corticinus* (Gravenhorst, 1806)**	Oxytelinae	[2] [12] [14] [24] [27]	5
Carpelimus despectus (Baudi, 1870)	Oxytelinae	[12] [14] [20]	5
***Carpelimus gracilis* (Mannerheim, 1830)**	Oxytelinae	[6] [27]	3
***Platystethus alutaceus* Thomson, 1861**	Oxytelinae	[18] [24] [25] [42/2]	18
***Platystethus capito* Heer, 1839**	Oxytelinae	[18] [24] [25] [27] [29]	24
***Platystethus cornutus* (Gravenhorst, 1802)**	Oxytelinae	[25] [27]	13
***Platystethus nitens* (C. Sahlberg, 1832)**	Oxytelinae	[18] [24] [27] [29]	14
***Thinobius* cf. *brigitteae* Schülke, 1998 ***	Oxytelinae	[6] [12]	3
Thinobius spec.	Oxytelinae	[6]	1
Euconnus intrusus (Schaum, 1844)	Scydmaeninae	[27]	3
Stenus ater Mannerheim, 1830	Steninae	[17]	1
Stenus biguttatus (Linnaeus, 1758)	Steninae	[17]	1
***Stenus* cf. *pusillus* Stephens, 1833**	Steninae	[24]	1
Stenus longipes Heer, 1839	Steninae	[12] [13] [14] [15] [18] [33] [42/2]	17
Stenus morio Gravenhorst, 1806	Steninae	[27]	1
Stenus ruralis Erichson, 1840	Steninae	[13] [14] [15]	3
Stenus spec.	Steninae	[24]	1
Achenium depressum (Gravenhorst, 1802)	Paederinae	[24]	2
***Astenus melanurus* (Küster, 1853)**	Paederinae	[2]	1
Paederidus rubrothoracicus (Goeze,1777)	Paederinae	Vjosa (no detailed information)	1
Paederus balcanicus Koch, 1938	Paederinae	[24]	1
Paederus riparius (Linnaeus, 1758)	Paederinae	[25] [28]	3
Scopaeus debilis Hochhuth, 1851	Paederinae	[27]	1
Scopaeus laevigatus (Gyllenhal, 1827)	Paederinae	[27]	1
Scopaeus pusillus Kiesenwetter, 1843	Paederinae	[29]	1
Sunius cf. *melanocephalus* (Fabricius, 1793)	Paederinae	[23]	1
***Neobisnius* cf. *lathrobioides* (Baudi, 1848)**	Staphylininae	[1]	1
Neobisnius prolixus (Erichson, 1840)	Staphylininae	[6]	1
Ocypus olens (O. Müller, 1764)	Staphylininae	[28]	1
Philonthus concinnus (Gravenhorst, 1802)	Staphylininae	[28]	1
Philonthus quisquiliarius (Gyllenhal, 1810)	Staphylininae	[27]	1
***Philonthus rubripennis* (Stephens, 1832)**	Staphylininae	[30]	1
Platydracus fulvipes (Scopoli, 1763)	Staphylininae	[28]	1
Quedius spec.	Staphylininae	[25]	2
***Stenistoderus cephalotes cephalotes* (Kraatz, 1858)**	Staphylininae	[23]	1

Fig. 2: *Stenus longipes*. A characteristical species of natural gravel banks. Photo Gernot KUNZ. – Abb. 2: *Stenus longipes*. Ein typischer Vertreter naturnaher Schotterbänke. Photo: Gernot KUNZ.

Republic, Romania, and Slovakia. 3 specimens of *Thinobius brigittae* were available; unfortunately the samples only included females. The examined specimens were compared with paratypes at the Tiroler Landesmuseum Ferdinandeum, but a male specimen would be needed for final validation. This is the first record for Albania.

Bledius cf. *bosnicus* BERNHAUER 1902 (Fig. 1).

The taxonomy of *B. bosnicus* has not yet been sufficiently clarified. According to SCHÜLKE & SMETANA (2015), *B. bosnicus* is only reported from Austria, Norway, Sweden, and Bosnia Herzegovina. SCHÜLKE (2011) confines the distribution to the area between Hungary and Greece. However, the specimens collected at Pocem floodplains fit the description given in SCHÜLKE (2011) and are identical to specimens collected from Tagliamento River, Italy (KAHLEN 2003, 2010).

Discussion

The presented material must be treated as a first superficial insight into the staphylinid fauna of the Vjosa River. Referring to other studies, the total diversity of rove beetles living in the floodplains of Vjosa could reach 400 species or more (KAHLEN 2010). Taking that into account, it is clear how little is known so far about riparian Staphylindae from the Vjosa River. The large number of new records, containing widespread as well as common species, confirms the poor knowledge-base regarding Albanian rove beetles in general. Further investigations can be considered highly promising as they might provide valuable faunistic data, potentially including hitherto unknown species.

The nature of the present material is somewhat limited due to the collection methods applied (i.e. pitfall traps, incidental hand catching). Additional selective catching methods (e.g. soil washing, flooding, sifting) would be more efficient and instrumental in obtaining samples of ecological guilds of riverine Staphylinidae, which might be underrepresented in the current material. This is particularly the case for species living close to the shoreline (*Platydomene* spp., *Thinodromus* spp., *Lesteva* spp., *Geodromicus* spp., etc.) including small and highly adapted rove beetles inhabiting the interstitial space of gravel and sand banks (*Thinobius* spp., *Hydrosmecta* spp., *Aloconota* spp.). Members of these ecological guilds are highly stenotopic, and most of them are vastly threatened by habitat loss in western industrialised countries (e.g. Kahlen et al. 1994, Kahlen 1995, Neuhäuser-Happe 1999, Bussler & Hofmann 2003). On the basis of the findings of this small-scale study, a highly diverse assemblage of shoreline species can already be assumed for the Vjosa River area.

Further targeted and intensified investigations into the Staphylinidae of the Vjosa River are recommended for several reasons. On the one hand, together with ground beetles and spiders, rove beetles represent the majority of biodiversity in exposed riverine sediments (Plachter 1986, Tockner et al. 2006, Schatz et al. 2003, Degasperi & Eckelt 2015). Furthermore, their diversity is indicative of the quality and value of a given ecosystem, which makes research into these species particularly valuable for any conservation and assessment purposes (Schatz 2007, Schatz et al. 2003, 2006, Paetzold et al. 2008). Finally, the Vjosa River area constitutes one of Europe's last braided rivers and, thus, a hotspot of diversity. A well-founded data set from this area could provide important insights into species assemblages of riverine landscapes which have already been mostly destroyed across other parts of Europe (Tockner & Stanford 2002, Tockner et al. 2008).

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First insight into the ant diversity of the Vjosa valley, Albania (Hymenoptera: Formicidae)

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Roman Borovsky & Wolfgang Paill

Thirty sites at the river Vjosa (Albania) were sampled with 150 pitfall traps in April 2017. The ant catches were determined and are presented. We identified 19 species; two of them show ripicolous tendencies. Nine species are considered to be first records for Albania; this demonstrates the poor investigation status of this territory.

Wagner H.Ch., Seifert B., Borovsky R. & Wolfgang Paill W., 2018: Erster Einblick in die Ameisendiversität des Vjosa-Tales, Albanien (Hymenoptera: Formicidae).
Dreißig Standorte am Fluss Vjosa (Albanien) wurden im April 2017 mit 150 Barberfallen beprobt. Die Ameisenfänge wurden determiniert und werden vorgestellt. Wir identifizierten 19 Arten, zwei davon zeigen ripikole Tendenzen. Neun Arten werden als Erstnachweise für Albanien betrachtet, was den schlechten Erforschungsstand dieses Landes demonstriert.

Keywords: Vjosa river, floodplain, riparian, ripicol, new records.

Introduction

The Balkans probably comprise the largest ant diversity of Europe (Borowiec & Salata 2012b, Borowiec 2014, Bračko et al. 2014, Lebas et al. 2016). Ant checklists are available for most Balkan nations (Petrov 2004, Bračko 2006, Lapeva-Gjonova et al. 2010, Borowiec & Salata 2012a, Borowiec & Salata 2012b, Kiran & Karaman 2012, Bračko et al. 2014). In contrast, the ant fauna of Albania is poorly investigated. First faunistical data were collected in the late 19th and early 20th century (Emery 1895, Maidl 1921, Finzi 1923, Finzi 1926). In "A provisional list of the Balkan ants (Hym., Formicidae)", Agosti & Collingwood (1987) mentioned 29 taxa for Albania, while Borowiec (2014) mentioned 70 species in "Catalogue of ants of Europe, the Mediterranean Basin and adjacent regions (Hymenoptera: Formicidae)". No in-depth ant study has been conducted in Albania so far. In our study, we present catches of pitfall traps of 19 species.

Materials and Methods

The ant material presented in this study was collected between 24th and 28th April 2017 using 150 pitfall traps (leg. W. Paill, J. Gunczy, T. Frank). The 30 sites near Kutë and sampling methods are described in detail in Paill et al. (2018 in this volume) and Schiemer et al. (2018 in this volume). For determination, a LEICA MZ16 A high-performance stereomicroscope with magnifications of 80–294× was used. Since no complete and reliable key for all Balkan ants is available, a number of sources had to be used for safe determination (Seifert 1988, Seifert 1992, Seifert 2003, Csősz et al. 2007, Seifert 2007, Karaman 2008, Seifert et al. 2009, Seifert & Schultz 2009, Csősz & Schulz 2010, Seifert 2016, Salata & Borowiec 2017, Seifert et al. 2017, AntWeb 2018). Material of *Tapinoma* was identified by B. Seifert based on clustering of morphometric data. The reference material included 88 samples of the three next related *Tapinoma* species and investigation of type material. Material of the *Myrmica sabuleti* complex sensu Seifert (2005) was identified by B. Seifert based on clustering of morphometric data. The reference material included 161 samples of *M. spinosior* and *M. sabuleti*. The material investigated in this study is currently stored in the collection of R. Borovsky; a few samples are in the collection of H.C. Wagner and in the Senckenberg Museum für Naturkunde Görlitz. Potential national first records were evaluated based on the list of Borowiec (2014).

Results and Discussion

The 150 pitfall traps from 30 localities provided 56 species-site combinations. In total, 19 different species could be distinguished. Of these, 18 species could be determined to species level (e.g., Fig. 1-3), however, in three cases, doubts in using the correct scientific names remain (Tab. 1). In *Myrmica hellenica* and *Camponotus vagus*, only one gyne each was collected; in all other species, workers were available. Despite the low investigation effort, nine species (= 47%) are first records for Albania: *Cardiocondyla dalmatica*, *Monomorium monomorium*, *Myrmica hellenica*, *Myrmica spinosior*, *Tapinoma* sp. BALC, *Tetramorium moravicum*, *Tetramorium* cf. *kephalosi*, *Formica clara*, and *Lasius platythorax*. Herewith, the number of ant species for Albania increases from 70 (Borowiec 2014) to 79. *Messor wasmanni* have also not been mentioned in Albanian literature; however, the name *Messor*

Tab. 1: Ant species list with information on pitfall trap locations. – Tab. 1: Liste der Ameisenarten mit Angaben zu Barberfallenstandorten.

subfamily / species	**[site]**
Myrmicinae	
Cardiocondyla dalmatica Soudek, 1925	[4], [5], [8], [15], [17], [18], [24], [30]
Crematogaster schmidti (Mayr, 1853)	[18]
Messor cf. *wasmanni* Krausse, 1911	[22]
Monomorium monomorium Bolton, 1987	[28]
Myrmica hellenica Finzi, 1926	[18]
Myrmica spinosior Santschi, 1931	[18], [19]
Pheidole pallidula (Nylander, 1849)	[10], [21], [28], [29]
Solenopsis sp.	[30]
Tetramorium moravicum Kratochvíl, 1941	[28], [29]
Tetramorium cf. *kephalosi* Salata & Borowiec, 2017	[21]
Dolichoderinae	
Tapinoma sp. BALC, according to Seifert	[6], [17], [18], [19], [28], [29], [30]
Formicinae	
Camponotus aethiops (Latreille, 1798)	[28]
Camponotus piceus (Leach, 1825)	[28]
Camponotus vagus (Scopoli, 1763)	[24]
Cataglyphis nodus (Brullé, 1832)	[9], [10], [15], [16], [22], [24]
Formica clara Forel, 1886	[4], [5], [9], [12], [13], [16], [18], [24], [28]
Lasius niger (Linnaeus, 1758)	[16]
Lasius platythorax Seifert, 1991	[24]
Plagiolepis cf. *taurica* Santschi, 1920	[4], [9], [18], [19], [20], [24], [28]

Fig. 1: Workers of *Camponotus aethiops* carrying larvae (Photo: R. Borovsky, Istria). – Abb. 1: Arbeiterinnen von *Camponotus aethiops* tragen Larven (Foto: R. Borovsky, Istrien).

barbarus var. *meridionalis* sensu Maidl (1921) and sensu Finzi (1923) putatively refers to the same species we found (cf. Borowiec 2014, cf. Bračko et al. 2014).

Two species, *Cardiocondyla dalmatica* and *Myrmica hellenica* are known to often occur in sun-exposed floodplains of rivers with sandy or gravelly soils and significant parts of bare surfaces (Seifert 2007, Seifert et al. 2009, B. Seifert in prep.). Surprisingly, common ant species with strong ripicolous tendencies like *Manica rubida* (Latreille, 1802) and members of the *Formica cinerea* group (Seifert 2002, cf. Seifert 2007, Lebas et al. 2016) have not been detected. The remaining 17 species of the presented list have a broader habitat spectrum. Most of them are known to be thermophilous (Seifert 2007, Seifert et al. 2009, Seifert 2017). Most of the ant species presented in this study are common on the Balkans, and all except *Myrmica spinosior* and *Tapinoma* sp. BALC are also known, for example, from Greece (Borowiec & Salata 2012b, Seifert 2016, Salata & Borowiec 2017).

Cardiocondyla dalmatica Soudek, 1925

The key of Seifert (2003) does not distinguish between *Cardiocondyla elegans* and *C. dalmatica*. However, a clear clustering based on morphometric data and zoogeographical arguments (unpublished data of B. Seifert) allows a separation of *C. dalmatica* as a parapatric eastern sibling species. *Cardiocondyla elegans* is known from Iberia, France, and Italy. In contrast, *C. dalmatica* occurs from Asia Minor, across the Balkans west to NW Italy and north to Hungary.

Fig. 2: Worker of *Camponotus piceus* (Photo: R. BOROVSKY, Istria). – Abb. 2: Arbeiterin von *Camponotus piceus* (Foto: R. BOROVSKY, Istrien).

Fig. 3: Workers of *Crematogaster schmidti* (Photo: R. BOROVSKY, Istria). – Abb. 3: Arbeiterinnen von *Crematogaster schmidti* (Foto: R. BOROVSKY, Istrien).

Myrmica spinosior Santschi, 1931

Based on clustering of morphometric data, material from two sites of this study clearly belongs to *Myrmica spinosior*. This species has been considered to occur (mainly) in the western Mediterranean so far (Seifert 2005, Radchenko & Elmes 2010, Borowiec 2014); however, it also occurs in Anatolia (Seifert 2005) and thus seems to be widespread in the Mediterranean. *Myrmica spinosior* is new for the Balkans!

Pheidole pallidula (Nylander, 1849)

Most Balkan *Pheidole* records were referred to *P. pallidula* for a long time (e.g., Karaman & Karaman 2006, Lapeva-Gjonova et al. 2010, Borowiec 2014, Bračko et al. 2014). Within the traditional "*Pheidole pallidula*", Seifert (2016) delimited three European species different in morphometrics of major workers. All three also occur in the southern Balkans. Morphometric investigation of our material using the discriminant D_{PBK} (Seifert 2016) revealed positive values and thus supports the affiliation to *P. pallidula*.

Tapinoma sp. BALC, according to Seifert

Tapinoma sp. BALC is an undescribed species which is very common in the southern Balkans. It is related to *T. erraticum* (Latreille, 1798) and *T. tauridis* Emery, 1925 and will be described by B. Seifert.

Tetramorium cf. *kephalosi* Salata & Borowiec, 2017

Tetramorium kephalosi is very similar to the western Mediterranean *T. semilaeve* and the most common species of the *T. semilaeve* complex on the Balkans (Salata & Borowiec 2017). Since some of the workers investigated in this study show smaller absolute and relative morphometric values than data of the smallest workers presented in the original description, doubts regarding our identification remain.

Outlook

The data shown in this study represent a first small insight into the ant fauna of the Vjosa valley. We recommend further investigations at the Vjosa river for two reasons: First, the river Vjosa is one of the last European rivers in a natural state and gives us an impression of how other European rivers might have looked hundreds of years ago (Schiemer et al. 2018 in this volume). Its riverine biotopes represent primary habitats, and further ant species specialized on such ecological conditions are likely to be detected. Second, the Albanian ant fauna, generally, is one of the least investigated of Europe. The current number of 79 species is much lower than would be expected based on the Mediterranean climate and the high species numbers of neighbouring nations (cf. Borowiec 2014). To summarize, further investigations are needed to establish meaningful ant species lists for the riverine biotopes at the river Vjosa as well as for the nation Albania.

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Amphibian and reptile fauna of the Vjosa River, Albania

Thomas Frank, Enerit Saçdanaku, Michael Duda & Ferdinand Bego

Knowledge about amphibians and reptiles of the Vjosa river is missing so far, and the present work is the first report of the herpetofauna of this part of Albania, including the types of habitats in which individual species were observed. Six amphibian and eight reptile species were found at eleven sampling sites along the Vjosa river that were surveyed during several short-term expeditions conducted from 2016 to 2017. All of these 14 species are listed in the Berne Convention on the Conservation of European Wildlife and Natural Habitats as either protected or strictly protected species. Moreover, nine species are listed in the National Red List of Flora and Fauna of Albania, and eight species are listed in Appendix IV of the European Union Habitats Directive. Thus, even this very preliminary survey of the local herpetofauna clearly shows that the area of the Vjosa river is of high conservation value for amphibians and reptiles.

Frank T., Saçdanaku E., Duda M. & Bego F., 2018: Amphibien- und Reptilienfauna der Vjosa, Albanien.
Bislang gibt es keine Literatur über die Amphibien und Reptilien an der Vjosa. Vorliegende Arbeit ist die erste über die Herpetofauna dieses Teiles Albaniens, inklusive der Beschreibung der Habitattypen, in denen die Arten nachgewiesen wurden. Sechs Amphibien- und acht Reptilienarten wurden innerhalb von einigen kurzfristigen Begehungen zwischen 2016–2017 entlang der Vjosa gefunden. Alle 14 nachgewiesenen Arten gelten nach der Berner Konvention als gefährdet oder stark gefährdet, und neun Arten sind in der Roten Liste Albaniens gelistet. Diese kurzfristigen Erstbefunde zeigen bereits, dass das Gebiet entlang der Vjosa aus der Sicht der Herpetofauna sehr schutzwürdig ist.

Keywords: Amphibia, Conservation, Reptilia, Vjosa river.

Introduction

Albania boasts a high diversity of habitats and is thus able to harbour many species. To date, 16 species of amphibians (Haxhiu 1994, Szabolcs et al. 2017) and 43 species of reptiles have been detected in Albania (Bruno 1989, Haxhiu 1998, Jablonski 2011, Mizsei et al. 2017). Mainly due to the southern location, landscape heterogeneity, and habitat-scale heterogeneity of Albania, this number of species is higher than in many other, even larger, European countries (Haxhiu 1994, 1998).

The exploration of the Albanian herpetofauna started in the early 20th century, when scientists from different countries visited Albania (e.g. Kopstein & Wettstein 1920, Bolkay 1921), but was mostly halted in the second half of the century due to the political, cultural, and scientific isolation of Albania. Recent literature provides more detailed information on the systematics, distribution, and ecology of particular species or restricted regions (e.g. Farkas & Buzás 1997, Oruçi 2010a,b, Jablonski 2011). The last major updates provide a complete annotated checklist of species and distribution maps of amphibian and reptile species in Albania (Szabolcs et al. 2017, Mizsei et al. 2017).

The decline of amphibian and reptile populations has been reported worldwide and is most often linked to habitat loss and degradation, unsustainable trade, expansion of invasive species, pollution, disease, climatic processes, and synergies between these threats (Gibbons et al. 2000, Cushman 2006, Sodhi et al. 2008, Cox & Temple 2009, Todd et. al. 2010). Globally, amphibians are considered as one of the most threatened taxonomic

Fig. 1: Sampling sites along the Vjosa River surveyed during 2016–2017: 1. Vjosa Delta; 2. Mifoli; 3. Kashishta; 4. Poçemi; 5. Kuta; 6. Ane Vjosa; 7. Tepelena; 8. Bença; 9. Lekli; 10. Lengarica; 11. Tre Urat (Permeti). – Abb. 1: Sammelpunkte entlang der Vjosa von 2016–2017: 1. Vjosa Delta; 2. Mifoli; 3. Kashishta; 4. Poçemi; 5. Kuta; 6. Ane Vjosa; 7. Tepelena; 8. Bença; 9. Lekli; 10. Lengarica; 11. Tre Urat (Permeti).

groups (Gibbons et al. 2000, Alroy 2015), with almost half of the species continuously declining (Stuart et al. 2004). As extinction risk affects 20 % of the reptile species globally (Böhm et al. 2013), knowledge of their distribution is essential for understanding biogeographic patterns and ecological processes that are fundamental to effective conservation measures (Zachos & Habel 2011).

Knowledge about amphibians and reptiles of the Vjosa River is very scarce; the only published information is that of Oruci (2010b) on amphibians of thermal waters of Benja along the Lengarica stream, a tributary of Vjosa River, with only two species recorded (*Rana balcanica* (*Pelophylax kurtmuelleri*) and *Rana graeca*).Therefore, with this study, we aim to fill gaps in our knowledge by providing the most recent records of different amphibian and reptile species along the Vjosa River including their conservation status and potential threats.

Material and Methods

Semi-aquatic and terrestrial amphibians and reptiles reported here were found in habitats that are connected with the river Vjosa and were visited during several short-term expeditions conducted from 2016 to 2017. Therefore, the species described below can only be seen as an incomplete selection of the species expected to occur alongside the Vjosa River. Nevertheless, these preliminary data already provide a good insight into the local specifics of the herpetofauna of the project area.

Data on amphibian and reptile species were primarily collected through transect campaigns at the eleven sites (Fig. 1) along the Vjosa River during 2016–2017 (March, April, June, September), not following a given sampling protocol.

The identification of the species observed was conducted based on their morphology, according to the newest field guides to the amphibians and reptiles of Europe (Arnold & Ovenden 2002, Speybroeck et al. 2016). Specimens were left in the field and neither collected nor brought to the laboratory.

Results and Discussion

Six species of amphibians and eight species of reptiles (14 species in total) were recorded (Tab. 1).

Tab. 1: Records of amphibian and reptile species present in the eleven sampling sites surveyed along the Vjosa river during 2016–2017. – Tab.1: Amphibien- und Reptiliennachweis 2016–2017 in den elf Sammelstandorten an der Vjosa.

Species	**Vjosa Delta Vjosa**	**Mifoli**	**Kashishta**	**Poçemi**	**Kuta**	**Ane Vjosa**	**Tepelena**	**Bença**	**Lekli**	**Lengarica**	**Tre Urat**
AMPHIBIANS											
1. *Bufo bufo*										+	
2. *Bufotes viridis*					+						
3. *Bombina variegata*										+	
4. *Rana graeca*					+			+		+	+
5. *Pelophylax kurtmuelleri*			+		+		+		+	+	+
6. *Pelophylax shqipericus*					+						
REPTILES											
1. *Testudo hermanni*					+	+					
2. *Emys orbicularis*	+			+	+						
3. *Mauremys rivulata*					+						
4. *Pseudopus apodus*					+						
5. *Podarcis muralis*			+								+
6. *Podarcis tauricus*		+			+	+					
7. *Natrix natrix*					+						
8. *Natrix tessellata*										+	
Total species	**1**	**1**	**2**	**1**	**10**	**2**	**1**	**1**	**1**	**5**	**3**

Amphibia

Bufo bufo (Linnaeus, 1758)

The common toad (*Bufo bufo*) is one of the most widespread species in Albania among the anuran species that can be found from coastal to mountainous areas (>2000 m a.s.l) (Haxhiu 1994). It is found in a very wide array of habitats varying from fairly dry maquis, steppes, or dunes to humid marshes, forests, or alpine meadows. It is not uncommon near human habitation, such as gardens, city parks, and ponds. Breeding occurs in an equally wide array of places, but somewhat larger, deep waters with plenty of sun are preferred, such as large ponds, lakeshores, stagnant parts of rivers, or river floodplains (Speybroeck et al. 2016). During our surveys, we observed *B. bufo* in only one site (Lengarica), which is a small river flowing into the Vjosa (Fig. 1). We observed spawning activities of the common toad along the river in March, April and June 2016 and 2017, as well as some adult individuals.

There are generally no major threats to this widespread and common species. Populations might be locally impacted through deforestation, drainage of wetlands, pollution, agricultural intensification, urbanisation, desertification, mortality on roads (migrating animals), and persecution. *B. bufo* is a protected species listed on Appendix III of the Berne Convention (1972) and in the National Red List of Flora and Fauna of Albania (2013).

Bufotes viridis (Laurenti, 1768)

Being a pioneer species, *Bufotes viridis* requires new and astatic water-bodies as spawning habitats (Heckes & Gruber 2003). Such habitats primarily occur in dynamic floodplains that periodically form temporary shallow waterbodies. Such primary waterbodies have largely disappeared from Central Europe. Thus, pioneer species usually depend on secondary habitats and are forced to adapt to substitute habitats when their original habitats have been destroyed. In a conservation programme for *B. viridis* and *B. calamita* at the Isar river in Bavaria, Pellkofer et al. (2010) listed several factors threatening toad populations. Among the most important factors were ageing of the spawning habitats leading to dense growth of vegetation, re-cultivation and abandonment of gravel pits and abandonment of extensively used ponds, frequent drying-out events at spawning habitats during summer, the increased shading of waterbodies due to the growth of bushes and trees, and introduction of predatory fish. Many of these threatening factors are characteristic of secondary habitats. However, at the highly dynamic Vjosa river we could observe *B. viridis* in its natural habitat. We found it at gravel banks, often below abundantly occurring deposits of woody debris (Fig. 3). Likewise, Schmidt & Indermaur (2014) observed *B. viridis* below wood deposits at the pristine Tagliamento river in Italy – also a natural habitat. They mention the importance of these structures for hunting and hiding, and suggest the establishment of large woody debris as a conservation measure at degraded river systems which cannot provide these important resources any longer.

Bufotes viridis is considered a strongly declining amphibian from Central, Southeastern, and Eastern Europe (Dufresnes et. al. 2011). For example, when comparing the historic with the current situation of this species in Switzerland, its populations were reported to have declined dramatically (Grossenbacher 2003). Based on its Europe-wide decline of populations, *B. viridis* is a strictly protected species listed in Appendix II of the Berne Convention (1979), and also listed in Appendix IV of the European Union Habitats Directive (1992), and in the National Red List of Flora and Fauna of Albania (2013).

Bombina variegata (Linnaeus, 1758)

The yellow-bellied toad (*B. variegata*) is a small aquatic toad with a flattened body and brightly coloured underside (typically yellow or orange with blue-grey or blackish markings), and back grey, brown, yellowish or even olive, with prominent warts, often ending with black, spiny points (Arnold & Ovenden 2002). It is a common species in Albania, often found in hilly and mountainous regions and rarely in coastal areas (Haxhiu 1994). It is a very aquatic and sociable species, i.e. many animals being found together in small areas of water. It can be found in open, often sunny, shallow, and often temporary water that may have little vegetation: small ponds, drainage ditches, pools near and around lakes, clay pits, drinking troughs, flooded tyre tracks, streams, etc. It is a lively, active toad, often seen floating with its legs spread on the surface of the water (Speybroeck et al. 2016). During our surveys it was observed in Lengarica river in June and September 2017.

At a global scale, the species appears not to be significantly threatened. Populations of this species might be locally threatened by the loss of suitable habitat due to urbanisation, road construction, industry (including oil extraction and transportation), and discharge of pollutants into wetlands. *B. variegata* is a strictly protected species listed in Appendix II of the Berne Convention (1979), and also listed in Appendices II and IV of the Habitats Directive (1992), as well as in the National Red List of Flora and Fauna of Albania (2013).

Pelophylax kurtmuelleri (Gayda, 1940)

The Balkan water frog (*P. kurtmuelleri*) belongs to the genus *Pelophylax* (water frogs), which consists of approximately 20 species that are native to the wider Eurasian continent. While water frogs are among the best-known and most characteristic amphibian species, they are notoriously difficult to distinguish. Variability within each species is considerable (Speybroeck et al. 2016). *P. kurtmuelleri* is native to Albania and Greece, but sometimes not regarded as distinct from the marsh frog (*Pelophylax ridibundus*), which is distributed all over Central and Eastern Europe including the Balkan Peninsula (Arnold & Ovenden 2002). In a recent genetic study (analysing DNA of the species), Dufresnes et al. (2017) identified three distinct *Pelophylax* species, two of which were: Balkan's frog (*P. kurtmuelleri*), native to Greece and Albania, and its sister species the Eurasian marsh frog (*P. ridibundus*), widely distributed throughout Eastern and Central Europe.

Fig. 2: An aberrant individual of *Pelophylax spp*. with partial amelanism found on Tre Urat (Permeti) (Photo: Enerit Sacdanaku). – Abb. 2: Ein unüblich gefärbtes Individuum von *Pelophylax spp*., nachgewiesen in Tre Urat (Permeti) (Foto: Enerit Sacdanaku).

Pelophylax species are highly aquatic, sun-loving frogs which can be found in a wide variety of generally well-vegetated and sunny waterbodies. The Balkan water frog can be found in swamps, ditches, marshes, and along the edges of slow-flowing rivers. It prefers water with heavily vegetated margins, reeds, and floating water weeds (Arnold & Ovenden 2002). We observed it in such habitats at six sites out of eleven (Kashishta, Tepelena, Lekli, Kuta, Lengarica, and Tre Urat), making it the most widespread species among all species observed during our survey. An interesting finding during our expedition was a strange specimen of *Pelophylax* spp. with a partial yellow coloration on the back side, observed at Tre Urat (Permeti) (40.08308333N; 20.61515E; date: 27.09.2017) in a little stream by the riverside (Fig. 2). This is a rare phenomenon occurring in some of the anuran species described as "amelanism". In the absence of melanin, xanthophores and iridophores establish the pigmentation pattern, and this usually results in a pale yellowish colour of the skin (Pabijan et al. 2004). When this is expressed uniformly throughout the body, the individuals are defined as "xantici". The phenomenon can also be present on only a few portions of skin, as in our case (Fig. 2). This is the first report of such an aberrant individual of *Pelophylax* spp. for Albania; based on the existing literature no similar case has been reported previously.

This species is threatened in its native range by drainage of wetland habitats and aquatic pollution of many waterways caused by agrochemicals and industrial (including mining) contaminants. In northern parts of its native range (e.g. Shkodra lake) it is significantly threatened by overcollection for commercial purposes. The species is additionally threatened by accidental introductions of commercially transported non-native water frogs. However, it remains abundant in many places.

It is a protected species listed on Appendix III of the Berne Convention (1979).

Pelophylax shqipericus (Hotz, Uzzell, Guenther, Tunner & Heppich, 1987)

The Albanian pool frog (*P. shqipericus*) is another water frog belonging to the genus *Pelophylax*. It is endemic to the Balkan Peninsula and native to Albania and Montenegro, where it inhabits freshwater marshes, swamps, ditches, and densely vegetated shorelines of lakes and rivers (Jablonski 2011). Recently, this species was first reported for Italy where it does not occur naturally, but unfortunately it was likely introduced through international water frog trade (Domeneghetti et al. 2013). At the Vjosa river basin we observed this frog in several bigger water bodies.

Pelophylax shqipericus is an endangered species and known populations are currently in decline. Significant threats are pollution and drainage of wetlands, and a more direct threat is the collection of the species for commercial purposes (Gratwicke et al. 2010). *Pelophylax shqipericus* is listed as an endangered species on the IUCN Red List of Threatened Species since 2004 (Uzzel & Isailovic 2009). Moreover, it is a protected species listed in Appendix III of the Berne Convention on the Conservation of European Wildlife and Natural Habitats (1979). Populations in Albania and Montenegro are diminishing due to a variety of factors. Its habitat is being fragmented by the draining of wetlands for infrastructure and farming, and the quality of its remaining habitat is declining through pollution from agricultural and industrial run-off. The northernmost part of its range is Shkodra Lake. Although Shkodra Lake is a protected site on both the Albanian and Montenegrin sides, and is recognised as an important wetland by the Ramsar Convention, there is still a significant amount of collection of amphibians that occurs at the lake for the pet trade and food industry, contributing significantly to the decline of populations.

Rana graeca (Boulenger, 1891)

The Greek stream frog (*R. graeca*) is endemic to the Balkan Peninsula (Džukić & Kalezić 2004). Its distribution ranges from Greece in the south, to parts of Bulgaria, Albania, and

Macedonia through Montenegro, Serbia, and Bosnia Herzegovina in the north (Asimakopoulos 1997). Its natural habitats are deciduous forests, temperate grasslands, perennial and intermittent rivers, springs, and pastures (Šukalo et al. 2015). We observed *R. graeca* in four (Kuta, Bença, Lengarica and Tre Urat) out of eleven sites visited (Fig. 3).

Fig. 3: *Rana graeca* (adult) observed in the area of Tre Urat, Permeti (Photo: Enerit Sacdanaku). – Abb. 3: *Rana graeca* (adult) aus der Region Tre Urat, Permeti (Foto: Enerit Sacdanaku).

Rana graeca is a protected species listed in Appendix III of the Berne Convention on the Conservation of European Wildlife and Natural Habitats (1979). In Serbia it is among the most vulnerable anurans (Vukov et al. 2015), and it is also listed in the National Red List of Flora and Fauna of Albania (2013).

Reptilia

Testudo hermanni (Gmelin, 1789)

Hermann's tortoise (*T. hermanni*) occurs throughout Southern Europe. The Western population (*T. h. hermanni*) occurs in Eastern Spain, Southern France, the Balearic islands, Corsica, Sardinia, Sicily, and South and Central Italy (Tuscany). The Eastern population (*T. h. boettgeri*) inhabits Serbia, Kosovo, Macedonia, Romania, Bulgaria, Albania, Turkey, and Greece, while *T. h. hercegovinensis* populates the coasts of Bosnia and Herzegovina, Croatia, and Montenegro. This tortoise prefers patchy landscapes equipped with shrubs, various kinds of pastures, and sparse herbaceous and grassy vegetation (Couturier et al. 2014, Popgeorgiev et al. 2014), and can frequently be encountered in areas of traditional agriculture, provided it is not too mechanised (Bertolero et al. 2011). Such conditions are fulfilled in the study region at Vjosa River where we observed this species in exactly such habitats at two sites (1. Kuta – three individuals: 40.46715 N; 19.75301667 E; 2. Ane Vjosa: one individual: 40.3886 N; 19.85813333 E) out of eleven (Fig. 4).

An investigation of *T. hermanni* in a traditionally managed rural landscape in Romania revealed its small home range combined with short-distance movements (Rozylowicz & Popescu 2013). As these tortoises have a low ability to recolonise areas

Fig. 4: *Testudo hermanni boettgeri* (adult) observed in the area of Kuta (Photo: Enerit SACDANAKU). – Abb. 4: *Testudo hermanni boettgeri* (adult) aus der Region Kuta (Foto: Enerit SACDANAKU).

Fig. 5: *Emys orbicularis* (Photo: Wolfram GRAF). – Abb. 5: *Emys orbicularis* (Foto: Wolfram GRAF).

Fig. 6: *Mauremys rivulata* (subadult) observed in the area of Kuta, Vjosa river (Photo: Enerit SACDANAKU). – Abb. 6: *Mauremys rivulata* (subadult) aus der Region Kuta an der Vjosa (Photo: Enerit SACDANAKU).

Fig. 7: *Podarcis tauricus ionicus* (adult) observed in Ane Vjosa, Vjosa river (Photo: Enerit SACDANAKU). – Abb. 7: *Podarcis tauricus ionicus* (adult) in Ane Vjosa (Photo: Enerit SACDANAKU).

which they formerly occupied (BADIANE et al. 2017), based on their restricted dispersal capability, heterogeneously structured landscapes characterised by small parcels occurring in the Vjosa study region help to sustain local populations of *T. hermanni*.

Testudo hermanni is listed in the National Red List of Flora and Fauna of Albania (2013), and is a strictly protected species listed in Appendix II of the Berne Convention on the Conservation of European Wildlife and Natural Habitats (1979).

Emys orbicularis (Linnaeus, 1758)

The European pond turtle (*E. orbicularis*) occurs in Southern and Central Europe, Western Asia, and Northern Africa. In the early post-glacial period, it had a much wider distribution, reaching as far north as southern Sweden. *Emys orbicularis* prefers to live in wetlands surrounded by a natural and wooded landscape. Specimens are also found in upland environments (FICETOLA & BERNARDI 2006). *Emys orbicularis* is usually considered semi-aquatic, as it can occasionally travel up to 4000 metres away from the nearest water resources. It is widespread in Albania, where it occurs in plains and hilly zones up to an altitude of 1000 metres. It occurs in various watery surroundings such as swamps, canals, pools, streams, water reservoirs, freshwater lakes, as well as in brackish ponds (Lezha, Shengjin) near the sea. It prefers places rich in aquatic plants (Haxhiu 1998). At the Vjosa River system the species was observed in a similar such habitat at three sites (Delta of Vjosa, Pocem and Kute) out of eleven (Fig. 5). In Poçemi it was found in a small macrophyte-rich pond at the margin of the floodplain, which would be destroyed by the planned hydropower plant at Poçemi.

This turtle has a patchy distribution in most countries even though it is widely distributed in Europe. *Emys orbicularis* is regarded as the most endangered reptile in France, and in Switzerland it was extinct at the beginning of the twentieth century and reintroduced in 2010 (Perrot 2016). Habitat loss through long-term drainage has necessitated higher mobility between ponds, leading to increased energy-expenditure and also an increased risk of road mortality (Owen-Jones et al. 2016). Additionally, Trakimas & Sidaravicius (2008) describe habitat fragmentation by traffic as a potential negative impact. Moreover, habitat pollution and the spread of invasive turtle species are further threats to the endurance of *E. orbicularis* (Krizmanić et al. 2015). None of the aforementioned threats occur in the Vjosa area, thus making this pristine ecosystem the most likely area to ensure the species' survival. This is significant, as *E. orbicularis* is listed in the National Red List of Flora and Fauna of Albania (2013). It is a strictly protected species listed in Appendix II of the Berne Convention (1979), and also listed in Appendices II and IV of the Habitats Directive (1992).

Mauremys rivulata (Valenciennes, 1833)

The Balkan terrapin (*M. rivulata*) occurs in the Southern Balkan region, Eastern Adriatic coast from South Croatia and Montenegro southwards, Albania, South Macedonia, South Bulgaria, Turkish Thrace, and Greece, including many Ionian and Aegean islands, and Crete (Speybroeck et al. 2016). It is common in Western Albania in the low and hilly regions which belong to the hilly and lowland Mediterranean climatic region. It lives in watery surroundings with or without swamps, canals, pools, or streams, as well as in brackish water (Butrinti, Shengjini) near the sea. It is abundant in the Southern zone (Saranda), but very rare in the Northern zone (Lezha, Shkodra) (Haxhiu 1998). We observed three individuals of *M. rivulata* (one subadult and two juveniles) in the area of Kuta (40.47243333 N; 19.7552 E) in small water bodies (freshwater channel but very little water remaining because of the summer droughts) covered by dense vegetation near the Vjosa River (Fig. 6). This is the first record of *M. rivulata* in this area (Kuta, Vjosa River).

Several populations of this species have experienced severe declines during the last decades due to anthropogenic pressure throughout its range. *Mauremys rivulata* has dense populations in some areas, but natural wetlands are gravely endangered in the Mediterranean area, as well as in the Middle East. Habitat loss is the main threat to survival of the species. Many aquatic habitats are either drained or canalised due to the ever-growing demand for water, especially in island habitats in the Mediterranean region (Rifai & Mantziou 2005). Fragmentation and habitat destruction is a growing threat for many aquatic animals that cannot easily move to another suitable habitat. Habitat destruction has increased in recent decades due to urban development. Habitats are often destroyed to construct roads, settlements, and hotels. The Balkan terrapin is a species which, although semi-aquatic, cannot move for very long distances in order to find a new habitat. If a small pond remains near their original habitat, turtles remain there instead of searching for a new habitat. Often, however, these remaining pools have no suitable nesting sites around them; thus, in the long term, these populations could become extirpated (Mantziou 2000, Rifai & Mantziou 2005).

M. rivulata is a strictly protected species listed in Appendix II of the Berne Convention (1979), and also listed in Appendices II and IV of the Habitats Directive (1992), as well as in the National Red List of Flora and Fauna of Albania (2013).

Pseudopus apodus (Pallas, 1775)

Pseudopos apodus has a wide distribution and populates the Balkan Peninsula and Asia Minor and Central Asia. It was formerly more widespread and its distribution also spanned Germany, as was reported from Pliocene sediments. It preferentially inhabits open dry and warm habitats, e.g. short grassland or sparsely wooded hills up to 2300 metres (Speybroeck et al. 2016). Moreover, it can be observed in cultural landscapes such as vineyards or stone walls. In Albania it occurs in fields and hilly regions from the seashore to an altitude of about 600 m (Kruje), from Hani i Hotit (north) to Konispol (south). It also enters the Central area of Albania through the valleys of the rivers and through the hilly Mediterranean zone (Haxhiu 1998).

In the study area at the Vjosa, this species was observed in an area characterised by dry grassland sparsely covered with shrubs, a habitat that would be flooded by the planned hydropower plant at Poçemi.

Pseudopos apodus is a strictly protected species listed in Appendix II of the Berne Convention (1979), in Annex IV of the European Union Habitats Directive (1992), and in the National Red List of Flora and Fauna of Albania (2013).

Podarcis muralis **(Laurenti, 1768)**

The common wall lizard (*P. muralis*) is the most common species in Albania compared to all other species of the family Lacertidae. It occurs everywhere in Albania, from the seashore up to an altitude of about 2000 metres. It occupies a wide range of sunny habitats. It can be found on rocks, stony places, walls of houses, torrents, along railways and roads, in wood and trees, in garden fences, fields etc. (Haxhiu 1998). We observed it at two sites by the river bank in Tre Urat (40.08098333 N; 20.61345 E) and Kashishta (40.59483333N; 19.53978333E). There generally appear to be no major threats to this adaptable and widespread species.

Populations are locally threatened in parts of its range, including those on islands or in mountains (for example through the development of alpine tourism in the Central Mountains of Spain). This species is listed in Appendix II of the Berne Convention (1979) and in Annex IV of the European Union Habitats Directive (1992).

Podarcis tauricus **(Pallas, 1814)**

The Balkan wall lizard (*P. tauricus*) is quite common in Albania. It prefers plains, hilly zones and valleys, and rarely occurs as high as 1000 metres. It lives in surroundings full of plants, in meadows, gardens, orchards, near woods, riversides, streams, and in sandy seashore zones (Haxhiu 1998). We observed it in such habitats by the riverside at three sites: Mifoli (40.6359N; 19.45671667E), Kuta (40.47093333N; 19.75435N), and Ane Vjosa (40.38881667N; 19.85736667E) (Fig. 7).

This species is locally threatened in parts of its range by habitat loss through agricultural intensification and pollution (largely from the use of agrochemicals), but overall it is not at significant risk. It is a strictly protected species listed in Appendix II of the Berne Convention (1992), in Annex IV of the European Union Habitats Directive (1992), and in the National Red List of Flora and Fauna of Albania (2013).

Natrix natrix (Linnaeus, 1758)

The grass snake (*N. natrix*) is common all over Albania from the seashore up to an altitude of 1700 metres (Lura Lake), probably even higher. It lives in various watery surroundings such as swamps, lakes, reservoirs, rivers, streams, pools, as well as in gardens, near houses, and in open woods. The most common subspecies in Albania is *N. n. persa* (Haxhiu 1998). We observed it in a small pool by the riverside covered by dense vegetation at one site, Kuta (40.47536667N; 19.75425E).

It is locally threatened in parts of its range by water pollution impacting prey populations (mainly amphibians), drainage of wetland habitats and general intensification of agricultural practice. It is a protected species listed in Appendix III of the Berne Convention.

Natrix tessellata (Laurenti, 1768)

The dice snake (*N. tessellata*) is distributed all over Albania, living in fresh water and sometimes also in brackish water of bays and lakes. It is more commonly found in lakes (Ohrid, Prespa, Shkodra) rather than streams or rivers (Haxhiu 1998). We observed it in Lengarica river in April and September 2017 (both adult and juveniles).

It appears not to be globally threatened. It is threatened by loss or modification of wetland habitats in parts of its range, for example through river channelisation and lakeshore development. This species is considered to be threatened in a number of Western and Central European range states. It is often killed by road traffic, particularly during the mating season. It is a strictly protected species listed in Appendix II of the Berne Convention (1979) and in Annex IV of the European Union Habitats Directive (1992).

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The European otter (*Lutra lutra*) in Vjosa River and its main tributaries

Ferdinand Bego & Etleva Hysaj

We assessed otter distribution and marking intensity along the main water course of Vjosa River and its major tributaries (Drino, Lengarica and Bença). Marking intensity was assessed in two seasons, spring and early autumn 2016 and 2017, corresponding to the highest and lowest river discharge levels, respectively. Otter signs (spraints, jellies and footprints) were searched in 16 sampling stations consisting of river stretches each 200 m long each. All surveyed sites represent permanent river courses. Vegetation coverage, hydraulic pattern and human disturbance were assessed visually for the whole length of each sampling station. Both the mean number of sprainting sites and spraints per 200m of watercourse were higher in spring (2.18 and 3.94, respectively) than in early autumn (1.37 and 1.68). In spring otter signs were recorded in all sampling stations (100 %), while in early autumn, 12 sampling stations were positive for otters (75 %). The number of sprainting sites and marking intensity was correlated to both hydraulic pattern and the vegetation coverage, while human disturbance did not significantly influenced the marking intensity of the otters. Construction of hydropower dams along the Lengarica river shows some impacts on river biota and consequently on the otter distribution pattern and foraging behavior. Therefore, it is suggested that a long-term monitoring program on the Vjosa River and its main tributaries is implemented in the coming years as a baseline to assess the conservation status and possible human impacts.

Bego F. & Hysaj E., 2018: Der europäische Fischotter (*Lutra lutra*) in der Vjosa und den wichtigen Zuflüssen.
Wir bewerteten die Fischotterverteilung und -markierung entlang des Hauptwasserlaufs der Vjosa und einigen wichtigen Zuflüssen (Drino, Lengarica und Bença). Die Markierungsintensität wurde in zwei Saisonen, Frühjahr und Frühherbst 2016 und 2017 gemessen, die dem höchsten bzw. niedrigsten Flussabfluss entsprechen. Otterzeichen (Losungen und Fußspuren) wurden in 16 Probenahmestationen gesucht, die aus jeweils 200m langen Flussabschnitten bestanden. Alle untersuchten Standorte stellen permanente Flussläufe dar. Die Vegetation, das hydraulische Muster und die menschlichen Störungen wurden visuell für die gesamte Länge jeder Probenahmestation beurteilt. Sowohl die durchschnittliche Anzahl der Losungen als auch die pro 200 m Wasserlauf waren im Frühjahr höher (2,18 bzw. 3,94) als im Frühherbst (1,37 und 1,68). Im Frühjahr wurden in allen Probenahmestellen (100 %) Otterzeichen registriert, während im Frühherbst 12 Probenahmestellen für Otter positiv waren (75 %). Die Anzahl der Losungen und die Markierungsintensität wurden sowohl mit dem Habitattypus als auch mit der Vegetationsbedeckung korreliert, während menschliche Störungen die Markierungsintensität der Otter nicht signifikant beeinflussten. Der Bau von Kraftwerken entlang des Lengarica-Flusses zeigt Auswirkungen auf Flussbiota und auf das Verteilungsmuster der Otter und ihres Nahrungssuchverhaltens. Daher wird vorgeschlagen, dass in den kommenden Jahren ein langfristiges Überwachungsprogramm für die Vjosa und ihre Hauptnebenflüsse als Grundlage für die Bewertung des Erhaltungszustands und möglicher Auswirkungen auf den Menschen durchgeführt wird.

Keywords: otter, distribution, spraints, hydraulic pattern, vegetation cover, Hydro-Powers, Vjosa river.

Introduction

The otter (*Lutra lutra* Linnaeus, 1758) is a carnivore very well adapted to aquatic life. It is always associated with rivers, streams, ponds, reservoirs, estuaries, or coastal habitats. Historically its distribution extended over Europe and Asia, but after the 1950s, the species declined substantially in Western Europe becoming absent from large areas of its former range (Mason & Macdonald 1986). Hence, in the second half of the 20th century, Eurasian otter populations decreased in most European areas, becoming rare or extinct in much of central Europe (Foster-Turley et al. 1990, Macdonald & Mason 1994). Starting from the last decade of that century, otter populations have gradually recovered in several countries (Conroy & Chanin 2001, Prigioni et al. 2007) where persistent organic pollutants (POP) have been banned or controlled by regulations (Ruiz-Olmo et al. 2000). Currently, in continental Europe the otter range consists of three disconnected portions, the largest one including most Eastern Europe (Cianfrani et al. 2011). Vegetation cover on river banks, water quality, food availability and human disturbance are the major factors determining otter distribution and behavior (Macdonald & Mason 1983, Bas et al. 1984, Delibes et al. 1991, Mason 1995, Durbin 1998, Kruuk et al. 1998). Accordingly, sprainting sites have been reported to signal the active use of food resources in both coastal (Kruuk 1992) and riparian habitats (Remonti et al. 2011), whilst cover may be not an accurate predictor of marking intensity, as a positive correlation between these two parameters has not been observed in all studied areas (Prenda & Granado-Lorencio 1996). Although many authors have discussed the reliability of marking intensity as a tool for pointing out the habitat preferences of otters since the 1980s (Kruuk et al. 1986, Kruuk & Conroy 1987, Mason & Macdonald 1987), variation in sprainting activity is believed to reflect changes in otter distribution (Chanin 2003) and the use of signs to outline patterns of habitat selection has recently been confirmed to be effective for otters (Clavero et al. 2006).

Few studies on otters in Albania have been published up to date. Prigioni et al. (1986) made a first attempt to assess the distribution of otters in the country, while, more recently, the status and distribution of the species were investigated in the valley of Drino River (Hysaj & Bego 2008, Hysaj & Bego 2010, Hysaj et al. 2013, Bego & Hysaj 2013),in the watershed of Semani River (Bego et al. 2011) and the Albanian part of Prespa lakes (Bego & Malltezi 2012). Although otters appear to be widespread throughout the country (Bego, *unpublished data*), a reduction in marking intensity suggests a possible decline in otter numbers. Distribution of the otter in Albania has been influenced by land use and human density, suggesting man-induced habitat changes since the fall of communism may have affected the quality and fragmentation of otter habitats (Balestrieri et al. 2016). River pollution, uncontrolled fishing by dynamites and poisons and river-bed excavation for the extraction of inert materials are still considered major threats to the otter, which has been included in the Red Data Book of Albanian fauna as “Vulnerable” (Misja et al. 2006, Moe 2013). In all the Mediterranean area, drought each year causes periods of low river flow in summer-early autumn. Drought generally results in most streams and small rivers becoming dry or breaking up into a series of pools embedded in dry waterbeds, while large rivers suffer marked variation in their flow (Magalhāes et al. 2002). Seasonal variation in river discharge has been reported to affect food availability for the otter (Clavero et al. 2003). The aim of this study was to provide information on otter distribution and ecology along the main water course of River Vjosa and some of its tributaries (Drino, Lengarica, Bença) prior the construction of the Hydropower dams, based on the assessment of sprainting site distribution and marking intensity. We hypothesized that, in our study area, variation in river flow and, consequently, water speed and hydraulic patterns (Hauer & Lambert 1996), was likely to affect the overall suitability of river stretches for the otter (Ruiz-Olmo & Gosálbez 1997, Prenda et al. 2001). To test for this hypothesis, ot-

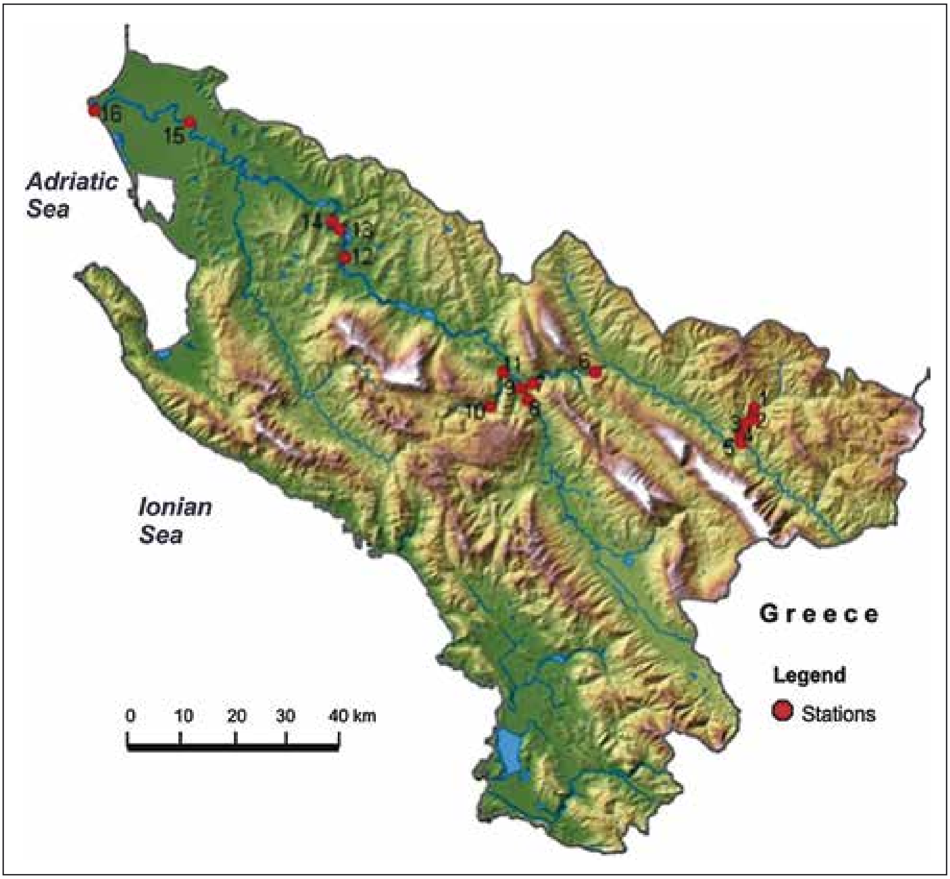

Fig. 1: Topographic map of Vjosa river basin and the location of the visited sites: 1, Lengarica-1; 2, Lengarica-2; 3, Lengarica-3; 4, Lengarica-4; 5, Petrani (Vjosa); 6, Uji Ftohte (Kelcyra); 7, Dragoti (Vjosa); 8, Lekli (Drino-1); 9, Drino-2; 10, Bença-1 (Village); 11, Bença-2 (Tepelena); 12, Kuta (Vjosa); 13, Poçemi-1; 14, Poçemi-2; 15, Mifoli (Vjosa); 16, Vjosa delta. – Abb. 1: Topografische Karte des Vjosa-Einzugsgebiets und Ort der besuchten Gebiete: 1, Lengarica-1; 2, Lengarica-2; 3, Lengarica-3; 4, Lengarica-4; 5, Petrani (Vjosa); 6, Uji Ftohte (Kelcyra); 7, Dragoti (Vjosa); 8, Lekli (Drino-1); 9, Drino-2; 10, Bença-1 (Dorf); 11, Bença-2 (Tepelena); 12, Kuta (Vjosa); 13, Poçemi-1; 14, Poçemi-2; 15, Mifoli (Vjosa); 16, Vjosa Delta.

ter distribution was assessed in two survey periods, corresponding to the lower and upper limits of the Vjosa River flow range. The obtained data would serve as baseline to measure the future cumulative impact of hydropower dams under construction or planned for construction on the otter distribution and ecology inside the Vjosa river basin.

Methods

Study area: Includes the main water course of Vjosa River from its entering from Greece to its river delta (Fig. 1). Vjosa is one of Europe's last living wild rivers. Along its entire course of over 270 kilometers it is untamed and free flowing and characterized by beau-

Tab. 1: Surveyed sites in Vjosa river basin and their geographical location in spring (S) and Early autumn (EA). – Tab. 1: Festgestellte Standorte im Vjosa-Einzugsgebiet und ihre geographische Lage im Frühjahr (S) und Frühherbst (EA).

Station no.	Name of the Sampling Station	Longitude N	Latitude E	Altitude (in m asl)	Habitat grade	Presence note	
						Spring	Early Autumn
1	Lengarica-1	40°14′ 77″	20° 26′9.27″	404	3	P	A
2	Lengarica-2	40°14′ 27.42″	20° 25′51.83″	364	2	P	A
3	Lengarica-3	40°13′ 55.38″	20° 25′23.53″	339	2	P	A
4	Lengarica-4	40°12′33.83″	20° 24′55.16″	284	2	P	P
5	Petran (Vjosë)	40°12′26.96″	20°24′55.35″	282	2	P	P
6	„Uji i Ftohtë" Këlcyrë	40°17′47.65″	20°9′43.27″	192	2	P	P
7	Ura e Dragotit	40°17′31.04″	20°4′45.01″	158	2	P	P
8	Drino-1 (Ura e Leklit)	40°15′33.47″	20°3′19.72″	153	2	P	P
9	Drino-2	40°16′38.69″	20°2′41.28″	142	2	P	P
10	Bënçë-1	40°15′49.06″	20°0′22.15″	225	2	P	P
11	Bënçë-2	40°18′20.54″	20°1′4.57″	141	2	P	P
12	Kute	40°27′31.85″	19°44′52.42″	57	2	P	P
13	Poçem-1	40°29′33.29″	19°43′33.83″	49	2	P	P
14	Poçem-2	40°30′1.50″	19°43′3.56″	43	2	P	P
15	Ura e Mifolit	40°38′3.51″	19°27′42.96″	4	2	P	P
16	Vjosa delta	40°38′44.50″	19°19′6.15″	0	1	P	A
Note: A-Otter is Absent; P- Otter is Present; Habitat grade: 1= Good; 2= Medium; 3= Poor							

tiful canyons, braided river sections, islands, oxbows and meandering stretches. In some areas the riverbed expands over more than 2 km in width. Together with its tributaries, Vjosa provides a dynamic, near-natural ecosystem. It is without par on this continent – a true, though unknown European natural heritage. On its first 80 kilometers the river flows through Greece and is named Aoos. In Albania it turns into Vjosa. The meandering lower part opens up into a valley with extensive wetlands, providing habitats for spawning fish, migratory birds and others. Finally, it drains into the sea just north of the Narta lagoon (KABO 1990). For a detailed description see SCHIEMER et al. (2018 this volume).

Surveyed sites were situated along the main water course of Vjosa River (river delta, Mifoli, Poçemi, Kuta, Kelcyra Gorge, Petrani), as well as along the main tributaries (Drino, Bença, Lengarica) (Fig. 1). Lengarica river as being under operation scheme of small scale Hydro Powers, has been more systematically investigated during the last two years (2016–2017), respectively in March, April, June and September, just to understand how the changes in the water regime is influencing the otter activity along the river. Table 1 shows the list of the surveyed sites and their geographical position and altitude. Sites were chosen to be representative of all habitat features of the Vjosa River basin (Fig. 1). Habitats were classified in three categories: 1, good; 2, medium and 3, poor. Grade 1 comprises sites with good lying-up zones in form of dense reed beds, dense thickets of willows, plane and oak, caves or rocks; grade 2 contains some scrub and reed offering limited shelter, and grade 3 has no suitable lying-up places and does not offer any shelter for otter.

Visited sites along the Vjosa River and its main tributaries (Lengarica, Drino, Bença) were selected taking into consideration the National Monitoring Program and the location of

Fig. 2: Picture 1: A new born baby otter from Bença River, October 2017 (Photo courtesy of G. Shehu, Tepelena); Pictures 2 and 3: otter spraints on stones (Bença) and debris (Kuta); 4: otter footprints (2–4, Photos © F. Bego). – Abb. 2: Bild 1: Ein neugeborener Fischotter aus dem Fluss Bença, Oktober 2017 (Foto mit freundlicher Genehmigung von G. Shehu, Tepelena); Bilder 2 und 3: Otter-Losung (Bença, Kuta); 4: Otter-Trittsiegel (2–4, Fotos © F. Bego).

the reference sites. At each site a minimum distance of 200 m was searched for otter signs, namely feces (spraints or scat) (Fig. 2), jelly excrements, footprints and other marking and feeding sings; we walked on both riversides and around small islands along the river as to investigate all shoreline areas. In most of the cases, sites were chosen for ease of access, e.g. at bridges, or where a river runs close to a road. Otter is presumed absent from a site or station when, after a search of 600 m to 1 km of river bank, no presence signs was found.

Surveys were carried out in two seasons: Spring and Autumn 2016 and 2017, respectively, corresponding to the maximum and minimum river discharge. For each site there were recorded, the number of: *i*, sprainting site, and *ii*, spraints. A sprainting site was defined as a place with spraints lying at least 1 m from other spraints (Kruuk et al. 1986). Sprainting sites were georeferenced by a GPS device and overlaid on geographical maps as to assess otter distribution in the study area. Three environmental variables of potential importance to otters were assessed visually for the whole length of each site:

1. Vegetation cover, in a 20 m large belt on both river banks (four categories: 1, 0–25 %; 2, 26–50 %; 3, 51–75 %; 4, 76–100 %).

2. Hydraulic pattern, classified according to hydro-morphologic units (PARASIEWICZ, 2007), which broadly reflect the progressive increase in water speed and surface turbulence: 0, dried riverbed; 1, stagnant (backwaters and large isolated pools caused by summer drought); 2, low (runs and pools); 3, medium (fast runs and ruffles); 4; swift (cascades, rapids and riffles).

3. Human disturbance: 0, negligible (no roads or urban areas within 1 km from the river banks); 1, low (distance between the river and a main road < 1 km); 2, moderate (presence of small villages on the riverside); 3, high (presence of towns with 10000–25000 inhabitants). The significance of seasonal variation in otter sprainting activity was tested with one-way ANOVA, using PASW Statistics 18. The correlation analyses (Spearman's test, r_s) was carried out to evaluate the strength and direction of the relationship between the habitat variables recorded and marking intensity.

Results

Most of the visited sites (12 out of 16) belong to habitat grade 2, with a medium state, contains some scrub and reed offering limited shelter, one station (Lengarica-1) to habitat grade 3 (no suitable lying-up places, not offering any shelter for otter), and one station (Vjosa delta) to habitat grade 1, with good lying-up zones in form of dense reed beds, dense thickets of willows, plane and oak, caves or rocks. Nine sites have scarce vegetation cover (0–25 %), six others have less than 50 % vegetation cover and only one site (Vjosa river delta) has a thick and dense vegetation cover (76–100 %).

In Spring season all the 16 stations were found positive for otter presence. Habitat quality, especially the combined effect of water regime and vegetation coverage seems to significantly influence otter activity during the low water flow season (late Summer/early Autumn), when both positive stations for otter presence and the sprainting activity are reduced (Tab. 1 and 2). ANOVA statistics show high significant changes in sprainting activity between Spring and Early Autumn (F=5.248, 1d.f., P=0.029 for the number of sprainting sites and F= 15.116, 1d.f., P=0.00052 for the number of spraints). It is similar with previous otter surveys conducted along Drino river (main tributary of Vjosa), where both the number of sprainting sites and spraints were the highest in spring, with the number of otter signs found being more than twice that of the late Summer/early Autumn survey (HYSAJ et al. 2013). However, in the case of Vjosa, percentage of favorable sites for otter is higher in both seasons (respectively 100 % in Spring and 75 % in early Autumn) in comparison with those observed along Drino River. It is primarily explained with permanent water flow in all 16 surveyed sites and the abundant fish along Vjosa (SHUMKA et al. 2010, SHUMKA, *unpublished data*) as the main prey for otter (HYSAJ et al. 2014).

During early autumn, with the reduction of the river flow, the otter territorial marking activity is lower almost in all sites, and in some of them it is missing, as it was confirmed in the upper part of Lengarica (sites Lengarica-1, Lengarica-2 and Lengarica-3). Construction and operation of the HPPs have reduced the water flow downstream of Lengarica River, and this might be one of the reasons why otter activity is not observed in the three upstream sites during early autumn (September). Furthermore, the number of sprainting sites and the number of spraints were higher with increased water speed and turbulence and on river banks offering vegetation cover. This correlation is stronger for number of

Tab. 2: Data on otter sprainting activity in surveyed sites along Vjosa River and its main tributaries during Spring (S) and Early Autumn (EA); HD, Human disturbance; VC, Vegetation cover. – Tab. 2: Daten über Otterlosung in den untersuchten Gebieten entlang der Vjosa und ihrer Hauptnebenflüsse während des Frühjahrs (S) und Frühherbsts (EA); HD, menschliche Störung; VC, Vegetationsdecke.

Station no.	Name of the Sampling Station	Number of Sprainting sites/200m river stretch		Number of Spraints/200m river stretch		Environmental Variables			
						Vegetation coverage	Hydraulic Pattern		Human disturbance
		Spring	Early Autumn	Spring	Early Autumn		Spring	Early Autumn	
1	Lengarica-1	0*	0	0	0	1	3	2	0–1
2	Lengarica-2	2	0	3	0	1	3	2	1–2
3	Lengarica -3	2	0	5	0	1	3	2	1
4	Lengarica-4	2	2	4	2	1	3	2	2
5	Petran (Vjosë)	3	3	7	4	2	3	2	2
6	"Uji i Ftohtë" Këlcyrë	2	1	3	1	2	2	2	2
7	Ura e Dragotit	2	1	3	1	2	2	2	2
8	Drino-1 (Ura e Leklit)	3	3	6	3	1	3	2	2
9	Drino-2	2	2	4	3	1	3	2	2
10	Bënçë-1	1	1	3	2	1	4	3	1
11	Bënçë-2	4	3	7	4	1	3	3	2
12	Kutë	3	2	5	2	2	3	2	0–1
13	Poçem-1	2	1	3	1	1	3	2	2
14	Poçem-2	2	1	2	1	2	3	2	1
15	Ura e Mifolit	3	2	5	3	2	3	2	2
16	Vjosa delta	2	0	3	0	4	2	2	0–1
Total Nb of sprainting sites and spraints		**35**	**22**	**63**	**27**				
Nb of stations		**16**	**16**	**16**	**16**				
Mean		**2.18**	**1.37**	**3.94**	**1.68**				
Mean ± SD		**2.18± 0.91**	**1.37± 1.08**	**3.94± 1.84**	**1.68± 1.40**				
One way ANOVA		**F=5.248, 1d.f., P=0.029**		**F= 15.116; 1d.f., P=0.00052**					
Spearman's test, (rs)		**0.64**		**0.72**					
P		**0.0013**		**0.00053**					
(*)-No otter spraints found but footprints and tracks observed									

spraints than number of sprainting sites (respectively, $r_s = 0.64$, $P = 0.0013$ for sprainting sites and $r_s= 0.72$, $P= 0.00053$ for spraints).

Human disturbance was negligible or low in 7 out of 16 visited sites (43.7 %), and moderate in the remaining 9 sites (56.3 %). During summer and early Autumn, human disturbance was slightly increased in some sites (Lengarica-1, Lengarica-2, Kuta and Vjosa delta) due to increased recreational activity, however, our results showed that the otter activity was not significantly influenced by low and moderate human disturbance in all surveyed stations (Tab. 2).

Discussion

Average marking intensity on the Vjosa River (sprainting sites/200 m = 1.78 and spraints/200 m = 2.8) was almost equal to the average one assessed for central and northern Albania 30 years earlier (sprainting sites/200 m = 1.7; spraints/200 m = 3.6; Prigioni et al. 1986). With respect to other Mediterranean countries, it was similar to that reported for peripheral areas of the otter range in Italy (Prigioni et al. 2006, Balestrieri et al. 2008), while it was rather lower than that found for healthy or expanding populations (Prenda & Granado-Lorencio 1996, Ruiz-Olmo & Gosálbez 1997, Prigioni et al. 2005).

Fluctuation in water availability, reducing both environmental quality and food availability, is regarded as one of the most important factors affecting the use by otters of stretches of watercourses (Prenda et al. 2001, Ruiz-Olmo et al. 2001). Rain and increasing water level have been reported to affect spraint persistence and thus otter detectability (Ruiz-Olmo & Gosálbez 1997); accordingly, Fusillo et al. (2007) suggested carrying out otter surveys in summer, when the reliability of otter standard survey methods would be the highest. Our results are consistent with those of Balestrieri et al. (2011), who reported that in Southern Italy, neither bank cover, nor water discharge affected otter detectability. In both flow regimes, marking intensity was the highest on river stretches covered by thick riparian vegetation, according to previous results reported for large Mediterranean study areas (Macdonald & Mason 1985, Delibes et al. 1991).

Vegetation cover provides shelter and suitable sites for holts, and a relationship between bank cover and the use of river stretches by otters has often been pointed out (reviewed by Mason & Macdonald, 1987). Seasonal variation in marking intensity may depend on reproductive activity, as Hysaj & Bego (2010) and Kean et al. (2011) have recently suggested. Both the large distances usually covered by otters (up to 39 km; *see* Green et al. 1984, Prigioni et al. 2006) and mean number of spraints/200 m found suggest that the otter population occurring along the Vjosa River is in good conditions, and its main tributaries, such as Drino, Bença, Lengarica, are frequently used by otters as foraging sites (Fig. 2). Several tributaries (Lengarica, Bença, Drino, Shushica and springs (Picari-Gurra, Viroi, Uji Ftohte -Tepelena, Uji Ftohte -Kelcyra, Poçemi) (Fig. 1) provide well oxygenated waters and suitable sites during the floods of the main Vjosa river (Jimėnez & Lacomba 1991, Mason 1995, Kruuk et al. 1998). Particularly, Kardhiqi and Bença streams offer a consistent flow regime and fish-farms (mostly rainbow trout), which, in their owners' opinion, suffer damage by otters during high flood periods (Hysaj et al. 2013).

The results of otter presence and sprainting activity were somehow controversy for the site no. 16 (Vjosa delta). This site in terms of habitat suitability is considered good, with slow and permanent running waters, thick vegetation coverage, and abundant fish, and therefore we may anticipate a high otter sprainting activity there; surprisingly, during Spring we noticed a moderate sprainting activity in this site (2 sprainting sites and 3 spraints), while in early Autumn no otter presence signs were observed. However, we believe that otters in the coastal areas may find other places more suitable to hide and easy find food, such as big drainage canals and ditches. It is also an opportunistic foraging behavior of otters, especially in areas where they compete for territory with other mesopredators, such as badger (*Meles meles*), jackal (*Canis aureus*) and fox (*Vulpes vulpes*), as it is confirmed by previous studies (Macdonald & Mason 1983, Mason & Macdonald 1986, Bego & Hysaj 2013).

During our early Autumn 2016 survey in the coastal area adjacent to Vjosa delta (site 16), we noticed high activity of badger, jackal and fox in the site. Our assumption is that otters, just to avoid competition with these bigger mesopredators, tend to visit other sites, such as big drainage canals and ditches of thick and dense reeds on bank sides and different preys available (fish, amphibians, water snakes, snails, crabs, etc.), as it is observed in other parts of Mediterranean basin (Jimėnez & Lacomba 1991, Prenda et al. 2001, Magalhães et al. 2002, Clavero et al.2006). Our assumption is also based on the results of a recent survey conducted in the coastal area between Semani and Vjosa rivers in the framework of wildlife survey program of the TransAdriatic Pipeline (TAP) project, implemented prior the pipeline construction. Hence, on August 12th, 2015, along the main drainage canal crossed by the 500 m wide pipeline corridor a quite high otter's territorial marking intensity was observed along a 200m long stretch of the canal: 3 sprainting sites and 17 spraints (Bego, *unpublished data*). The proximity of the drainage canal and ditches to wooded old sand dunes that are not inundated during flooding, the controlled water level in the drainage canal and ditches by the pumping stations installed close to the coast, and the abundance of food (especially fish and frogs), make the importance of this drainage network of canals and ditches to otters higher especially during dry season (late Summer-early Autumn).

The planned construction of a series of HPP dams threatens to alter the habitat structure and quality of Vjosa and its main tributaries and streams, with repercussions on otters, which need to be assessed and monitored. The first otter survey in Albania judged that the main river courses in the plains between Tirana and Vlora, i.e. the rivers Erzeni, Semani, Shkumbini and Vjosa, were unsuitable for otter, as a consequence of pollution, mainly mine drainage, and industrial activities (Prigioni et al. 1986). As more recent surveys have shown that the otter occurs, although probably in low numbers, at least in some of those watercourses; e.g. the River Semani and its main tributaries (Bego et al. 2011), Shkumbini and Erzeni rivers (Bego, *unpublished data*; Balestrieri et al. 2016), and Drino river (Hysaj et al.2013,2014); moreover, the present survey ascertained presence of otter along the main Vjosa River; it suggests that pollution control and habitat restoration can favor the population recovery of the species in Albania (Balestrieri et al. 2016). This study confirmed the importance of tributaries and smaller streams for otter during heavy rains and flood seasons (Winter/Spring, Autumn/Winter) along the main watercourse of Vjosa River, as safer sites and easier forage grounds for otters (Jimėnez & Lacomba 1991, Mason 1995, Kruuk et al. 1998, Bego & Hysaj 2013).

The otter population in Vjosa catchment should be monitored in the coming years to measure cumulative impact of the operational HPPs, and those under construction or planned, on the river biota, as well as their implications with otter's ecology and conservation along the Vjosa river and its main tributaries, such as Çarshova, Lengarica, Kardhiqi, Bença, Poçemi, and Shushica.

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The Vjosa catchment – a natural heritage

Spase Shumka, Ferdinand Bego, Sajmir Beqiraj, Anila Paparisto, Lefter Kashta, Aleko Miho, Olsi Nika, Jani Marka & Lulezim Shuka

The paper provides an overview of the existing knowledge on biodiversity of the whole Vjosa catchment. Besides major gaps in knowledge, the Vjosa catchment is one of the richest in Albania, sheltering a high diversity of habitats and species, most of them of international significance. A variety of protected areas is connected by the River Vjosa and its tributaries and serve as important ecological corridor.
Around 150 species of the already known flora and fauna species are listed in the Appendices of the Bern Convention. More than 15 priority habitat types of European interest have been identified (Habitat directive – NATURA 2000), as well as 7 habitat priority types (EUNIS, IPA) of high floristic value.
Many habitats of the Vjosa area are included in the Directive 92/42/EEC adopted in May 1992: the woody riparian vegetation along river floodplains, with the dominant species *Platanus orientalis, Populus alba, Salix* spp*., Alnus glutinosa, Fraxinus angustifolia, Quercus robur,* and *Ulmus minor*; moreover, chasmophytic vegetation is documented in the area,; coastal sandy dunes with *Ammophila arenaria* and other rare plant species; The Vjosa Delta-Narta wetland area is mentioned as the second most important site for birds in Albania, with about 80 species recorded. The area is known as the main wintering site for many water bird species including the Greater Flamingo (*Phoenicopterus roseus*) and Audouini's Gull (*Ichthyaetus audouinii*). The Dalmatian Pelican (*Pelecanus crispus*) frequently occurs in the Vjosa Delta zone. Therefore, a special attention must be paid to future hydropower development plans. Conservation actions must address threats to water quantity and quality over wide areas upstream of threatened habitats and species. Based on the presented data the floodplains of the Vjosa River from Tepelena to Mifoli are considered as a potential protected area, specifically a proposed riverscape National Park.

Shumka S., Bego F., Beqiraj S., Paparisto A., Kashta L., Miho A., Nika O., Marka J. & Shuka L., 2018: Das Vjosa-Einzugsgebiet – ein wertvolles Naturerbe.
Die Arbeit gibt einen Überblick über die Biodiversität des Vjosa-Einzugsgebiets im Lichte der Bedrohung durch die großräumig geplante Staudamm-Entwicklung. Trotz großer Wissenslücken kann festgestellt werden, dass das Vjosa-Einzugsgebiet eine der artenreichsten Regionen in Albanien ist mit einer großen Vielfalt an Lebensräumen und Arten von internationaler Bedeutung. Mehrere Schutzgebiete sind durch die Vjosa und ihre Zuflüsse als ökologische Korridore verbunden.
Viele Lebensräume stehen auf der Liste der FFH-Richtlinie der EU: z.B. die bewaldete Ufervegetation entlang der Flüsse mit den dominanten Arten *Platanus orientalis, Populus alba, Salix* spp., *Alnus glutinosa, Fraxinus angustifolia, Quercus robur*, und *Ulmus minor*; überdies wurde chasmophytische Vegetation nachgewiesen sowie küstennahe Sanddünen mit *Ammophila arenaria* und anderen seltenen Pflanzenarten; Das Vjosa Delta-Narta Feuchtgebiet wird mit etwa 80 Arten als zweitwichtigster Standort für Vögel in Albanien angeführt. Dieses Gebiet ist als Hauptüberwinterungsquartier für viele Wasservogelarten bekannt, darunter der Große Flamingo (*Phoenicopterus roseus*) und die Audouini-Möve (*Ichthyaetus audouinii*). Der Krauskopfpelikan (*Pelecanus crispus*) nutzt häufig das Vjosa-Delta.
Die hohe Schutzwürdigkeit erfordert daher besondere Aufmerksamkeit im Hinblick auf die Pläne für Wasserkraftentwicklung. Vor allem Die Überschwemmungsgebiete von Tepelena bis Mifoli gelten als potenzielle Gebiete für einen künftigen Nationalpark.

Keywords: Albanian rivers, Vjosa catchment, biodiversity data, protected areas, endangered habitats and species, HPP development.

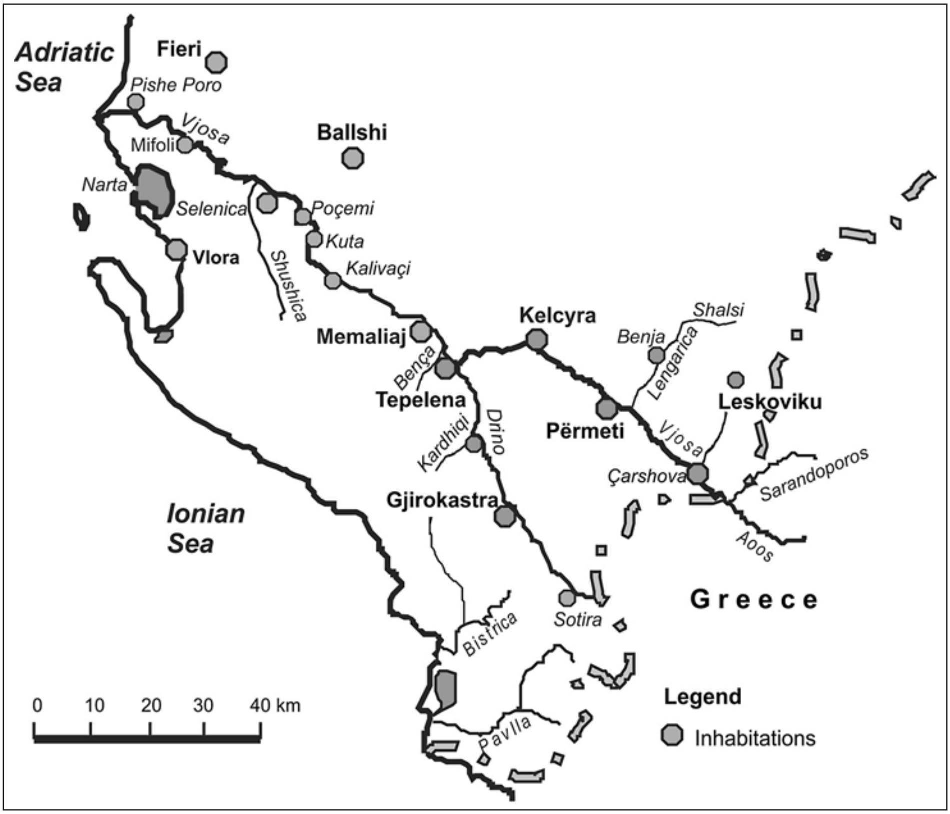

Fig. 1: Vjosa river network with the most important inhabited centers. – Abb. 1: Vjosa Flussnetz mit den wichtigsten bewohnten Zentren.

Introduction

Knowledge regarding biodiversity is very limited within the whole Vjosa catchment. However, the geographic, climatic, and landscape characteristics are quite diverse (see Durmishi et al. (2018 this volume), Schiemer et al. (2018 this volume), and Daja et al. (2018 this volume); hence, the catchment area shelters a high diversity of habitats and species from its delta in the Adriatic Sea to the uppermost mountainous parts in Albania and Greece. The Vjosa River and its tributaries are at risk of destruction by a chain of planned hydropower dams; there are about 38 small and big hydropower plants that are either already constructed, under construction or planned: e.g.in the Vjosa tributaries Langarica river (within the National Park Hotova Fir), Bença river, Kardhiqi river, Shushica river. The most severe impacts are the dams in Poçemi and Kalivaçi, in the Vjosa River itself (Fig. 1), which have already been tendered for construction by the Albanian government.

The paper provides an overview of the existing knowledge regarding biodiversity. The primary aim is to evidence the already-known natural values and to provide a critical view on large-scale Hydropower Plant (HPP) development plans, which are often closely related with habitat loss and species extinction – see discussion by Schiemer et al. (2018 this volume, introductory chapter), Miho et al. (2018), Miho et al. (2017), Diku et al. (2016), Shumka et al. (2010).

New aspects of the biodiversity of the Vjosa River are reported by various groups in this volume; based on material collected during several joint field trips between 2014 and 2018 by different working groups (Albania, Austria, Germany, etc. especially on the river floodplain system of the middle part of the Vjosa near Kut and Poçemi (Fig. 1.) For an overview of the ecological conditions and conservation, value of the Vjosa-Aoos river system see Schiemer et al. 2018 this volume).

Material and methods

Data provided here are based on the field surveys and long-term observations of the authors, monitoring data available at the University of Tirana, the Agricultural University of Tirana; additional information was collected during several joint field trips of various groups between 2014 and 2018 There is also additional information published from various sources, i.e. Buzo 2000, Misja 2006, MoE 2009, 2013, Miho et al. 2013, 2017, 2018, Miho 2018, Malo 2010, Malo & Shuka 2008a, 2008b, 2009, 2013, Shuka 2008, Shuka & Malo 2010, Shuka et al. 2011a, 2011b; Miho & Shuka 2017, Mahmutaj et al. 2014, Tan et al. 2011, Allen & Khalea 2017, Delipetrou 2011, Shumka et al. 2010, 2014, Diku et al. 2016, Amirault et al. 2016, Paparisto 2001, Shkëmbi et al. 2015, 2017, Cuvelier et al. 2018, Paspali & Bego 2008,Dhora 2002, Markova et al. 2010, Snoj et al. 2009, Korsós et al. 2008, Bego et al. 2014, Slomka et al. 2015 and 2018, Zakkak et al. 2018.

Results and discussion

The Vjosa River and its tributaries represent a highly dynamic but stable and continuous freshwater ecosystem. Based on our limited knowledge we conclude that it is one of the richest areas in the country in terms of biodiversity, which is, therefore, in need of special attention regarding future development plans. As an example of all aspects of biodiversity known to date, about 150 species living in this area belong to the Appendices of the Bern Convention (https://www.coe.int), which focus on the conservation of European wildlife and natural habitats: precisely 3 species of higher plants, 9 insects, 5 amphibians and reptiles, 107 birds and 17 mammals (Annex I).

Conservation values

Protected areas

Diverse protected areas are distributed throughout the whole catchment, most of them closely connected to watercourses and affected by HPP development plans. Albania has 799 protected areas covering about 16 % (4,600 km²) of its territory. The protected areas are proclaimed and governed following the IUCN protected area definition, management categories and governance types (http://www.akzm.gov.al).

The National Park Fir of Hotova-Dangellia near Permeti (34,361 ha; IInd IUCN category) is known for its fir forests mixed with oak and, in some parts, with Mediterranean shrubs, and sheltering rare and endangered plants and animals. **Germenji-Shelegura** (430 ha; Erseka) is an area of Habitat/Species Management (IVth category), known for its high mountains and deep valleys, wetlands, and torrents, and especially for its dense mixed forests of fir and oak, dominated by black pine; the area is also considered among the Areas of Special Conservation Interest (ASCIs) in Albania, as a NATURA 2000 site. Both areas are situated in the upper part of Vjosa catchment, and are ecologically connected with the upper part of Vjosa River, as well as with its tributaries Shalsi, Lengarica, and Çarshova, which in turn are under pressure from HPP development plans. **The Strict Nature Reserve of Kardhiqi** (1800 ha; Ist category) (Gjirokastra) is also ecologically connected with tributaries of the Kardhiqi river (Drino tributary) (Fig. 1), and is also under direct HPP pressure.

Fig. 2: Above: coastal dunes (nature monument) with European beach grass (*Ammophila arenaria*) in Poro (Narta) are ecologically connected and under direct pressure of VJosa dams. Below: Sea daffodil (*Pancratium maritimum*), an endangered species from the coastal dunes of Poro (© M. Xhulaj). – Abb. 2: Oben: Küstendünen (Naturdenkmal) mit europäischem Strandhafer (*Ammophila arenaria*) in Poro (Narta) sind ökologisch verbunden und unter direktem Druck von Vjosa Staudämmen. Unten: Narzisse (*Pancratium maritimum*), eine vom Aussterben bedrohte Art aus den Küstendünen von Poro.

More than 110 natural monuments (III[rd] category) are spread throughout the Vjosa catchment; some are close to river courses or the Vjosa Delta, and are thus under HPP pressure: i.e. Benja thermal springs and Lengarica canyon (in Lengarica river, Permeti), Çarshova canyon horizons and olistolith (Çarshova river, Permeti), Piksi canyon (in Kardhiqi river, Gjirokastra), Nivica canyon and erosive terrace of Bença (both in Bença river, Tepelena), Buronja, Kuçi (Shushica river, Vlora), Poro black pine and Poro dunes (in Vjosa delta, in Fieri and Vlora, respectively), etc. Moreover, the Fir of Sotira (1,740 ha; Gjirokastra) represents a nearly virgin forest with scientific and natural values; the Fir of Zheji (1,500 ha Gjirokastra) is known for its natural values, biodiversity, and landscape (data from http://akzm.gov.al/).

The wetland complex of the **Vjosa delta-Narta lagoon** (19,738 ha), the southern part of the Vjosa Delta (Vlora) (Fig: 1), represents a Landscape Protected Area (IV[th] category); it is also listed as an Important Bird Area (IBA) in Albania and is recently being considered among potential NATURA 2000 sites as well. **Pishe Poro** (1,500 ha), the northern part of the Vjosa Delta (Fieri), is also protected as a Habitat/Species Management Area (IV[th] category); moreover, the area between Semani river delta-Pishe Poro is a CORINE Biotope and is proposed as a Managed Nature Reserve as well. Both parts of the Vjosa Delta represent an important transitional area, with psammophytes, hygrophytes, halophytes, typical vegetation of coastal wetlands, and with Mediterranean pine forests (Miho et al. 2013). The narrow littoral belt of coastal dunes in Poro (Vlora), 5–6 m high and 20–30 m wide, is considered a Natural Monument (Fig. 2), with *Ammophila arenaria, Elymus farctus, Sporobolus pungens,* etc. Of special interest are rare species, such as *Anacamptis morio* ssp. *caucasica* and *Orchis albanica* × *O. coriophora* or the sea daffodil (*Pancratium maritimum*). Small populations of true alluvial forests with willows and white poplar still exist in some limited areas. The zone is rich in wetlands and aquatic birds (Fig. 3); it is the second most important place in Albania for waterfowl, being a very important IBA (20,000 wintering birds and over 40 species); Dalmatian Pelican (*Pelicanus crispus*) forages here, and flamingos (*Phenicopterus ruber*) are regularly encountered. Nevertheless, the whole area is directly connected to and under pressure from Vjosa dams (Poçemi and Kalivaçi) (Fig. 1).

Last but not the least, just beyond the Vjosa estuary, Karaburuni-Sazani (Vlora; 12,600 ha; II[nd] category) was declared a Marine National Park in 2010, the only one in Albania. The area from the Vjosa estuary to Sazani and Karaburuni (the entire Vlora Bay) is proposed as a Marine and Coastal Protected Area in the Strategic Plan for Marine and Coastal Protected Areas (SPMCPAs) – Plan Design & Development (2013) (Anonymous 2014); the zone is important for submerged meadows of *Posidonia oceanica* (Miho et al. 2013), with close ecological connections to the Vjosa Delta; hydropower development and damming of the Vjosa would have additional harmful effects on the ecological values and biodiversity of this sea Delta, especially in the *Posidonia* meadows.

The biodiversity of the floodplains of the Vjosa River in its middle part, from Tepelena to Mifoli (Fig. 1) is one of the most magnificent riparian ecosystems of the Balkan peninsula, standing out due to its natural hydromorphodynamic fluvial processes (Rössler et al. 2018 this volume). A broad main stream with anabranches, open gravel bars and islands and pioneer vegetation as well as bushes of willows, poplars and tamarisks give Vjosa's floodplain an extraordinary distinction. Combined with large grasslands and small-area softwood forests, they build the vegetation mosaic along the river. Results of other research

Fig. 3: Ornitofauna in Vjosa catchment: 1, Greater flamingo (*Phoenicopterus roseus*); 2, Pied Avocet (*Recurvirostra avosetta*); 3, Common Snipe (*Gallinago gallinago*); 4, Dunlin (*Calidris alpina*); 5, Egyptian Vulture (*Neophron percnopterus*); (1–4, © F. Bego; 5, © M. Topi). – Abb. 3: Ornitofauna in Vjosa Einzugsgebiet: 1, Flamingos (*Phoenicopterus roseus*); 2, Pied Avocet (*Recurvirostra avosetta*); 3, Bekassine *(Gallinago gallinago*); 4, Dunlin (*Calidris alpina*); 5, Ägyptischer Geier (*Neophron percnopterus*); (1–4, © F. Bego; 5, © M. Topi).

groups in this volume reveal additional biodiversity data underlining the conservational value of this area. This part of the Vjosa River highlights **the potential values of a protected area, of a future riverscape National Park** that would be the first protected area of this category in Albania. The Vjosa region is well known for its cultural and historic values, as well (Serjani et al. 2010).

Habitat types

Different habitat types make the Vjosa catchment an important area for conservation (MoE 2009, Mullaj et al. 2017, see also Rössler et al. (2018 this volume) and Drescher (2018 this volume). More than 15 priority habitat types of European interest have been identified (Commission European 2013), such as: *Platanus orientalis* and *Liquidambar orientalis* woods (*Platanion orientalis*) (Habitat Directive code 92C0) (Fig. 4); *Olea* and *Ceratonia* forests (9320); Constantly flowing Mediterranean rivers with *Paspalo-Agrostidion* species and hanging curtains of *Salix* and *Populus alba* (3280)*;* Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*) (91E0*); *Quercus ilex* and *Quercus rotundifolia forest*s (9340); Southern riparian galleries and thickets (*Nerio-Tamaricetea* and *Securinegion tinctoriae*) (92D0); Calcareous rocky slopes with chasmophytic vegetation (8210) (Figs. 4 and 7), four of which are priority habitat types with great conservation interest; the habitat includes thermo- and meso-Mediterranean communities (e.g.*Onosmetalia*) with *Campanula versicolor, Silene* spp., *Saxifraga* spp., *Ramonda serbica, Pinguicula hirtiflora*, etc.); Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*) (6210* important orchid sites); Shifting dunes along the shoreline with *Ammophila arenaria* (white dunes) (2120) (Fig. 2); Coastal dunes with *Juniperus* spp. (2250), habitat of community interest; Wooded dunes with *Pinus pinea* and/or *P. pinaster* (2270); Mediterranean salt meadows (*Juncetalia maritimi*) (1410); Mediterranean salt steppes (*Limonietalia*) (1510*); etc. Moreover, seven habitat priority types (European Commission, 1992), all of which are endangered and with high floristic values, are recorded in this zone.

Poorly stabilised alluvial deposits along the river courses, streams, and sediment cones of the Vjosa catchment are colonised by riparian Mediterranean vegetation (Fig. 4), largely dominated by oriental plane (*Platanus orientalis*); they can form species-rich communities with the accompanying flora, including *Populus alba, Salix alba, S. purpurea, S. amplexicaulis, S. elaeagnos, Alnus glutinosa, Fraxinus angustifolia, Quercus robur, Ulmus minor, Tamarix parviflora, Vitex agnus-castus, Rubus* spp.*, Hedera helix, Clematis vitalba, Vitis vinifera* ssp. *sylvestris,* etc. (Mullaj et al. 2017, Schiemer et al. 2018 this volume, Drescher 2018 this volume). The alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*) form arborescent galleries of tall *Salix alba*, which is an important habitat for orchid species (Fig. 8). The riparian vegetation fulfills a protective function (protecting riverbanks and streams, and strengthening soft land slopes near the watercourses), and serves, to a considerable extent, as a "water filter" for water purification, etc. These related habitat types are under continuous human pressure from gravel mining in riverbeds or from dam construction, tunneling, or flow change through HPP development. They are even affected by diseases: e.g. canker stain of plane is widespread along the Vjosa and Drino river courses; hence, the plane population has declined by more than 40 %. The oriental plane is also an IUCN red list species (Data Deficient, DD).

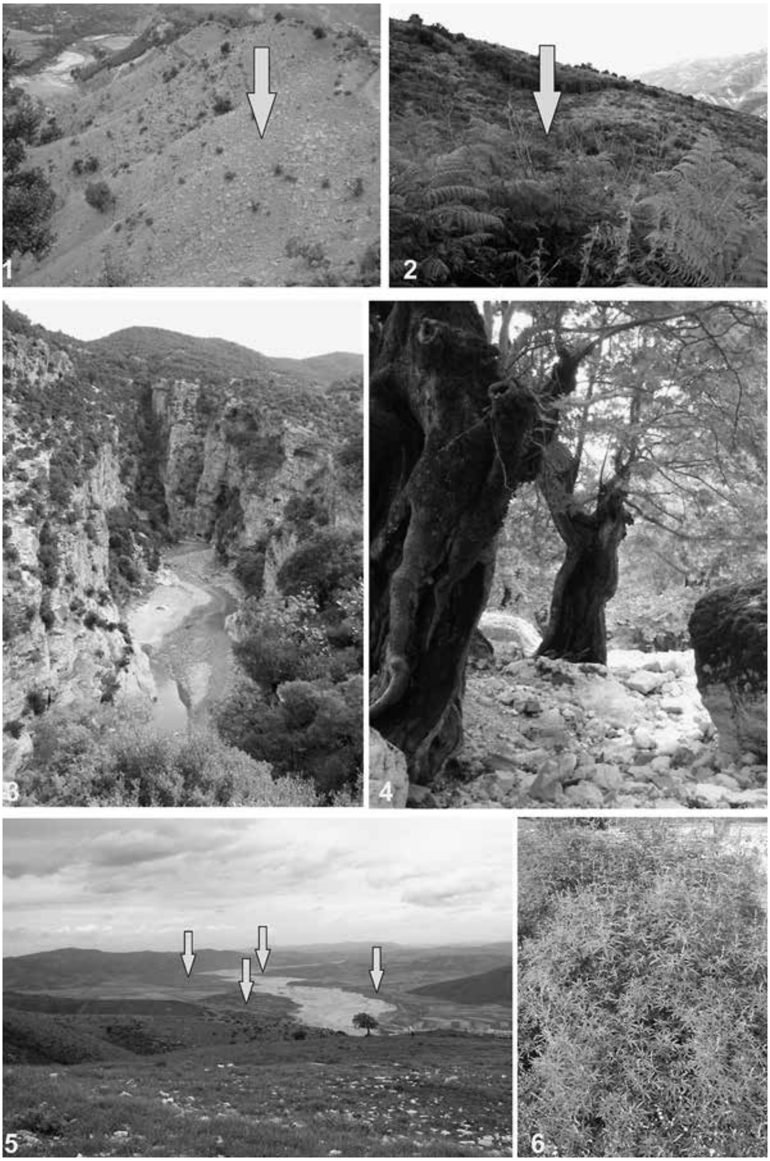

Fig. 4: Main threats facing the native Riparian Vegetation in Vjosa: 1, Clearing, logging and Erosion; 2, Burning and uncontrolled grazing. Different habitat types make Vjosa an Important Ecosystem for Biodiversity Conservation: 3, Calcareous rocky slopes with chasmophytic vegetation; 4, *Platanus orientalis* and *Liquidambar orientalis* woods; 5, Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior*; 6, Southern riparian galleries and thickets (*Nerio-Tamaricetea* and *Securinegion tinctoriae*) (© L. Shuka). – Abb. 4: Die wichtigsten Bedrohungen für die einheimische Ufervegetation in Vjosa: 1, Clearing, Holzeinschlag und Erosion; 2, Brennen und unkontrolliertes Weiden. Verschiedene Lebensräume machen Vjosa zu einem wichtigen Ökosystem für die Erhaltung der Artenvielfalt: 3, Kalkhaltige Felshänge mit chasmophytischer Vegetation; 4, *Platanus orientalis* und *Liquidambar orientalis*; 5, Auenwälder mit *Alnus glutinosa* und *Fraxinus excelsior*; 6, Südliche Ufergalerien und Dickichte (*Nerio-Tamaricetea* und *Securinegion tinctoriae*) (© L. Shuka).

Fig. 5: Greek Strawberry Tree (*Arbutus andrachne – Ericaceae*), with fruits ripen in autumn; upper part of Vjosa (from Permeti to Leskoviku) represents the only area of its natural occurrence in Albania (© L. Kashta). – Abb. 5: Griechischer Erdbeerbaum (*Arbutus andrachne – Ericaceae*), mit reifen Früchten im Herbst; Der obere Teil von Vjosa (von Permeti bis Leskoviku) stellt das einzige Gebiet seiner natürlichen Vorkommen in Albanien dar (© L. Kashta).

Moreover, chasmophytic vegetation is documented in the area (Fig. 4 and 7), consisting of plant species like *Campanula versicolor, Silene* spp., *Athamntha macedonica* ssp. *albanica* that colonises the cracks and fissures of rock faces; it is found sparsely almost everywhere along the river and its tributaries. These habitat types represent a great diversity, with many endemic and sub-endemic plant species, some of which are also indicators of habitat quality, e.g. *Hypericum haplophylloides, Cymbalaria microcalyx* ssp. *microcalyx, Alkanna corcyrensis, Lilium candidum, Silene cephallenia*. The shrub association dominated by *Arbutus andrachne* (*Andrachno-Quercetum ilicis*) (Fig. 5) from Permeti to Leskoviku is unique in Albania.

Mediterranean coniferous forest on coastal dunes on both sides of the Vjosa Delta (Pishe Poro, Fieri and Poro, Vlora), dominated by *Pinus halepensis, P. pinaster* and *P. pinea*, is partly natural and was partly planted 50–60 years ago. It plays a very important role in stabilising sand dunes and protecting arable land. Therefore, it currently represents a habitat with a priority status, included in Annex I of Directive 92/43/EEC. The dams in the Vjosa River, as well as the continuing urbanisation with tourist infrastructure, will also impact the stability of the dunes and the coastline, and the integrity of habitats and biodiversity. There are already examples of negative effects in Albania, e.g. in the Buna Delta (Velipoja reserve), in Drini of Lezha Delta (Lezha lagoons), Erzeni delta, etc. Measures to protect the coast and the related dunes are very costly!

Among the freshwater macroalgae found along the Vjosa river catchment we can mention *Chara aspera*, on retrodunal depressions close to Narta lagoon, *Chara vulgaris* var. *vulgaris* and C. *vulgaris* var. *longibracteata*, in slow-flowing waters of Drino River (Tepelena) (Fig. 6) and *Chara gymnophylla*, found in the thermal springs of Benja, Lengarica River (Kashta & Miho 2016).

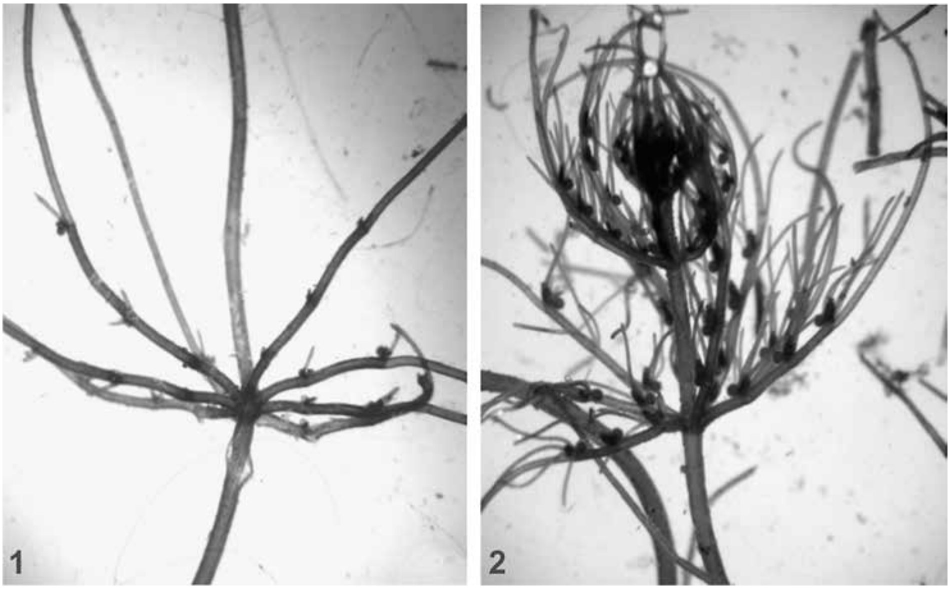

Fig. 6: Charophyta from Drino River: *Chara vulgaris* (left) and *Chara vulgaris* f. *longibracteata* with red reproductive organs (right) (© L. Kashta). – Abb. 6: Charophyta vom Fluss Drino: *Chara vulgaris* (links) und *Chara vulgaris* f. *longibracteata* mit Fortpflanzungsorganen (rechts) (© L. Kashta).

Flora and vegetation types

Flora and vegetation of the Vjosa catchment have scarcely been studied, and almost only in the last ten years. It is difficult to ascertain a total number of higher plants for the whole Vjosa catchment; however, experts confirm that it could be more than 1500 taxa (Shuka *pers. comm*.). More than 570 species of higher plants have been recorded in coastal habitats of the Vjosa delta-Narta lagoon; furthermore, some 68 higher mushrooms are recorded there as well (MoE 2009). More than 700 higher plant taxa were reported by Malo (2010) in his PhD about flora and vegetation of Gjirokastra district; about 12 taxa were new for Albania, 40 taxa were sub-endemics, and 30 taxa were rare or endangered (Malo & Shuka 2008a, 2009, 2013); *Viola acrocerauniensis* and *Stachys sericophylla* (Malo & Shuka 2008b, Shuka & Malo 2009), for example, are endemics of the region. Other endemic species have been reported recently, e.g. *Campanula longipetiolata*, *Gymnospermium maloi*, and *Hypericum haplophylloides*, recorded in the canyon of Luzati and in the subalpine grasslands of the Drino valley (Tan et al. 2011).

The river banks and rocky faces along the tributaries and the alpine limestone grasslands of the watershed are home to three other threatened species on the IUCN red list: *Aesculus hippocastanum* (Allen & Khalea 2017), *Galanthus reginae-olgae* (Davis 2011), and *Solenanthus albanicus* (Delipetrou 2011), listed as Vulnerable C2a(i), Vulnerable B2ab(iii,v), and Endangered B1ab(v)+2ab(v), respectively. Some of these places are currently under pressure from hydropower development.

Rare, or relict species are present in sandy dunes or wetlands (Fig. 8), like *Anacamptis morio* ssp. *caucasica*, *Ephedra distachya, Narcissus tazetta, Nymphaea alba, Nuphar lutea, Nymphoides peltata,* different species of the genera *Orchis, Ophrys, Limonium,* and *Scilla*;

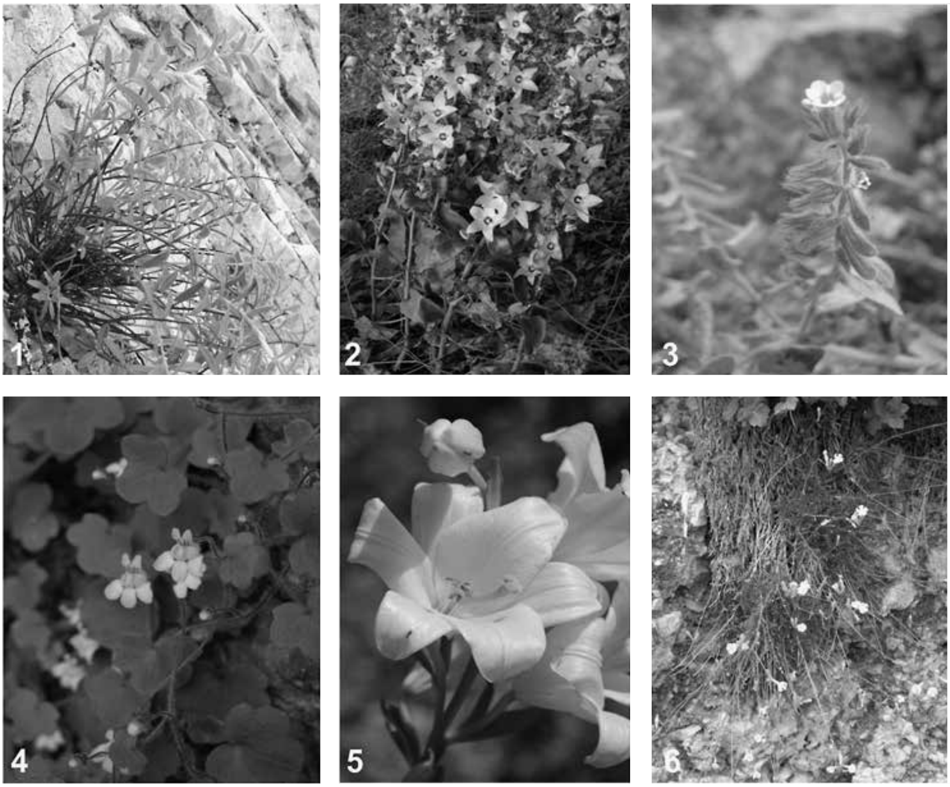

Fig. 7: Rare plants from the calcareous rocky slopes with chasmophytic vegetation: 1, *Hypericum haplophylloides*; 2, *Campanula longipetiolata*; 3, *Alkanna corcyrensis*; 4, *Cymbalaria microcalyx* subsp. *microcalyx*; 5, *Lilium candidum*; 6, *Silene cephallenia*. This habitat type occurs almost everywhere, along the river and its tributaries (© L. Shuka). – Abb. 7: Seltene Pflanzen von kalkhaltigen Felshängen mit chasmophytischer Vegetation: 1, *Hypericum haplophloides*; 2, *Campanula longipetiolata*; 3, *Alkanna corcyrensis*; 4, *Cymbalaria microcalyx* subsp. *mikrokalyx*; 5, *Lilium candidum*; 6, *Silene cephallenia*. Dieser Lebensraumtyp kommt fast überall entlang des Flusses und seiner Nebenflüsse vor (© L. Shuka).

species with rather limited distribution are also present, such as *Petrosimonia oppositifolia, Senecio vernalis, Tamarix hampeana, Peucedanum arenarium, Pholiurus panonicus*, etc. The relict aquatic fir *Marsilea quadrifolia* was verbally confirmed for the Vjosa Delta by the late botanist Kozma Buzo; however, it was not found recently during botanic field trips in the region.

The richness in plant species is important for the medicinal and aromatic plant industry. About 380 species of MAPs (Medical and Aromatic Plants) have been recorded within the watershed, 330 of which are wild species (Miho & Shuka, 2017). About 46 species are endangered, threatened, or protected to varying degrees, but are still harvested in the wild, e.g. *Salvia officinalis, Origanum vulgare, Hypericum perforatum, Orchis* spp.*, Sideritis raeseri, Laurus nobilis, Juglans regia, Juniperus* spp.*, Sambucus nigra, Tilia* spp., etc. There appears to be little correlation between the HPP development and MAP species, other than isolated flooding; however, about 70 species grow near water courses and are therefore po-

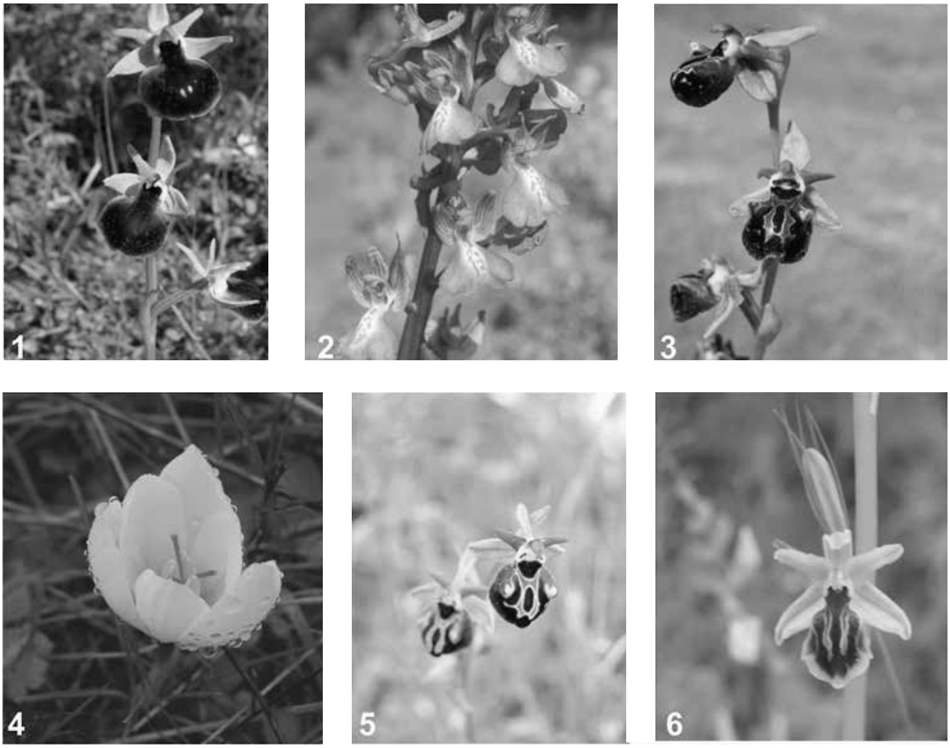

Fig. 8: Rare plants from the alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior*. They forms arborescent galleries of tall *Salix alba* and are important sites for orchid species: 1, *Ophrys helenea*; 2, *A. morio* ssp. *caucasica*; 3, *Ophrys sphegodes*; 4, *Crocus hadriaticus*; 5, *Ophrys mammosa*; 6, *Ophrys epirotica* (© L. Shuka). – Abb. 8: Seltene Pflanzen aus den Auwäldern mit *Alnus glutinosa* und *Fraxinus excelsior*. Sie bilden baumartige Galerien hoher *Salix alba* und sind wichtige Standorte für Orchideenarten: 1, *Ophrys helenea*; 2, *A. morio* ssp. *caucasica*; 3, *Ophrys sphegodes*; 4, *Crocus hadriaticus*; 5, *Ophrys mammosa*; 6, *Ophrys epirotica* (© L. Shuka).

tentially at risk from HPP activities (Miho & Shuka 2017, Amirault et al. 2016); some of them belong to the Albanian Red List of species (MoE 2013), e.g. *Adiantum capillus-veneris* (VU A1b), *Dryopteris filix-mas* (LC), *Alnus glutinosa* (Vu), *Capparis spinosa* (VU A1b), *Galanthus reginae-olgae* (CR B1), *Populus alba* (VU A2b), *Quercus robur* (VU A1b), *Salix fragilis* (VU A1b), *Sambucus nigra* (VU Alb), *Symphytum officinale* (VU A1b), *Ulmus minor* (VU A2b), *Anacamptis morio* (EN A1b), *A. pyramidalis* (EN A1b), *Colchicum autumnale* (EN A1b), etc.

Fauna

Insects: More than 150 species of winged insects (*Pterygota*) have been collected from different aquatic and terrestrial habitats in the IUCN category V (protected landscape/seascape) Vjosa-Narta zone (Paparisto 2001, Shkëmbi et al. 2015, Shkëmbi et al. 2018 this volume, Cuvelier et al. 2018) (Fig. 9). They are spread among *Lepidoptera* (63 species), *Coleoptera* (43), *Odonata* (28), *Orthoptera* (7), and others. Massive blooms, even of endangered species with polyvoltine life-cycle, such as the moths *Thaumetopoea pit-*

Fig. 9: Winged insects (*Pterygota*) from Vjosa: *Lucanus cervus* (left) and *Malcosoma neustria* (right) (© S. SHUMKA). – Abb. 9: Geflügelte Insekten (Pterygota) aus Vjosa: *Lucanus cervus* (links) und *Malcosoma neustria* (rechts) (© S. SHUMKA).

yocampa, *Hyphantria cunea*, and *Malacosoma neustria* have been reported. A total of 28 Odonata species known so far for the Vjosa catchment, all are listed in Annex II (IUCN, 2010).

Following Albanian Red Lid list (MoE 2013), important endangered species deserving mention are: the Dingy Skipper (*Erynnis tages*), the Inky Skipper (*Erynnis marloyi*), the Alexanor (*Papilio alexanor*), the African Monarch (*Danaus chrysippus*), the Dryad (*Minois dryas*), the Hermit (*Chazara briseis*), the Tree Grayling (*Hipparchia statilinus*), the Southern White Admiral (*Limenitis reducta*), the Cinnabar Moth (*Tyria jacobaeae*), etc. Aquatic invertebrates endangered on a national scale (MoE 2009) have also been recorded from marine and brackish waters of the Vjosa delta, including a large number of gastropods, bivalves and crustaceans (more than 40 species altogether). Additional information about different invertebrate groups of the Vjosa River is reported by DEGASPERI (2018 this volume), KOMNENOV (2018 this volume), BAUERNFEIND (2018 this volume), PAILL et al. (2018 this volume), GRAF et al. (2018 this volume), RABITSCH (2018 this volume), RABL & KUNZ (2018 this volume), WAGNER et al. (2018 this volume) and BEQIRAJ et al. (2018 this volume).

Molluscs: Important continental (terrestrial and freshwater) mollusc species in this area are Cochlostomatidae: *Cochlostoma tessellatum tepelenum;* Hydrobiidae: *Orientalina lbanica*, *Radomaniola albanica* (from karstic springs), *Grossuana euxina*; Ellobiidae: *Myosotella myosotis*; Argnidae: *Agardhiella truncatella*, *Albinaria senilis inconstans, Oxychilus inopinatus;* Hygromiidae: *Monacha emigrata senitshika*, *Hiltrudia kusmici, Metafruticicola occidentalis;* Helicidae: *Liburnica albanograeca;* Sphaeriidae: *Pisidium personatum* (DHORA 2002, FEHER & EROSS 2009). DUDA et al. (2018 this volume) report additional data on the terrestrial molluscs of the Poçemi floodplains.

About 60 mollusc species have been reported for the coastal habitats of the Vjosa delta to the Narta wetlands; among them are 27 gastropods (snails), 29 bivalves (mussels) and 4 cephalopods (octopus, squids and cuttlefish). Out of these, 42 species originate from marine habitats, 12 from freshwater, and 6 from terrestrial sites (BEQIRAJ 2001, 2004, BEQIRAJ et al. 2002, DHORA 2002). 32 mollusc species are listed for Narta lagoon, where gastropods are widespread: *Hydrobia acuta, Ventrosia ventrosa, Pusillina marginata, Pirenella conica, Cyclope neritea* and the bivalves *Cerastoderma glaucum* and *Scrobicularia cottardi*

Fig. 10: Fishes from Kelcyra, Vjosa: 1, *Oxynoemacheilus pindus* (VU); 2, *Misgurnus fossilis*; 3, *Anguilla anguilla*; 4, *Cobitis ohridana* (VU) (© S. Shumka). – Abb. 10: Fische aus Kelcyra, Vjosa: 1, *Oxynoemacheilus pindus* (VU); 2, *Misvurnus fossilis*; 3, *Anguilla anguilla*; 4, *Cobitis ohridana* (VU) (© S. Shumka).

(Beqiraj 2001, 2004, Beqiraj et al. 2002); *Theodoxus fluviatilis* is recorded among the endangered IUCN species.

Fishes: Shumka et al. (2018 this volume), report an annotated checklist of the fishes of the Vjosa River; at least 31 species of fish inhabit the river system (Fig. 10), 27 of which are native, including eight species endemic to the Balkan and four non-native species. The Vjosa River, its delta, and the lagoon of Narta make the wider area important for fish diversity, fishing, and aquaculture (Shumka et al. 2010, 2014, Markova et al. 2010, Snoj et al. 2009).

At the riverine mountain tributaries and river bed itself, the most widespread native species or genera recorded are *Pachichilon pictum*, *Barbus prespensis*, *Alburnus scoranza*, *Cobitis ohridana*, *Oxynoemacheilus pindus, Anguilla anguilla*, and members of the genera *Alburnoides*, *Squalius*, *Chondrostoma, Pelasgus* and *Gobio.* Presence of *Salmo faroides* has been recorded for the major part of the river and its tributaries, but at a critical level regarding population size, due to a number of primarily human impacts as overfishing, use of non friendly fishing methods, etc.

The lowland riparian flows are populated with typical migratory species, such as *Mugil cephalus, Liza ramada,* and a considerable presence of freshwater species such as *Cobitis ohridana*, *Alburnus scoranza*, *Pelasgus thesproticus*, and *Pachichilon pictum.* Following old fish records, globally endangered species of the genus *Acipenser* are also found in the Vjosa river basin. This holds also good for *Lampetra fluviatils* and *Alosa* sp.

The Vjosa River represents a biodiversity hotspot of Albania, hosting ideal aquatic habitats for various migratory fish species. These 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 high abundances of the critically endangered European eel (*Anguilla Anguilla*) highlight the importance of an undisturbed longitudinal river continuum at the Vjosa at an European scale (Jacoby & Gollock 2014).

Additionally, sub-endemic fish species like the Ohrid loach (*Cobitis ohridana*) and Pindus stone loach (*Oxynoemacheilus pindus*) occurring in the freshwater systems of Albania are present in river Vjosa. Through a considerable number of important tributaries (Voidomatis, Sarandoporo, Langarica, Drinos, Bença, Shushica, etc.), the Vjosa enables migration of anadromous and catadromous species for a large catchment area in Greece and Albania. Furthermore, the upper Vjosa valley, with its hill and mountain chains covered with shrub and forest vegetation, is also a migration corridor for large carnivores (mentioned below), not only within the Vjosa catchment, but also between the Vjosa and adjacent areas and other river catchments.

Amphibians and reptiles: The amphibians (13 out of 16 species reported from Albania) are a taxonomic group usually connected with aquatic habitats during their life-cycle, comprising both aquatic and terrestrial species (Fig. 11). Frank et al. (2018 this volume) report additional data on amphibians and reptiles of the Vjosa River, of which most are mentioned in international Red-lists.

Of the 37 reptile species reported from Albania, 32 are present in the Vjosa watershed (Fig. 7). Some of the most common reptiles are the Balkan whip snake (*Coluber gemonen-*

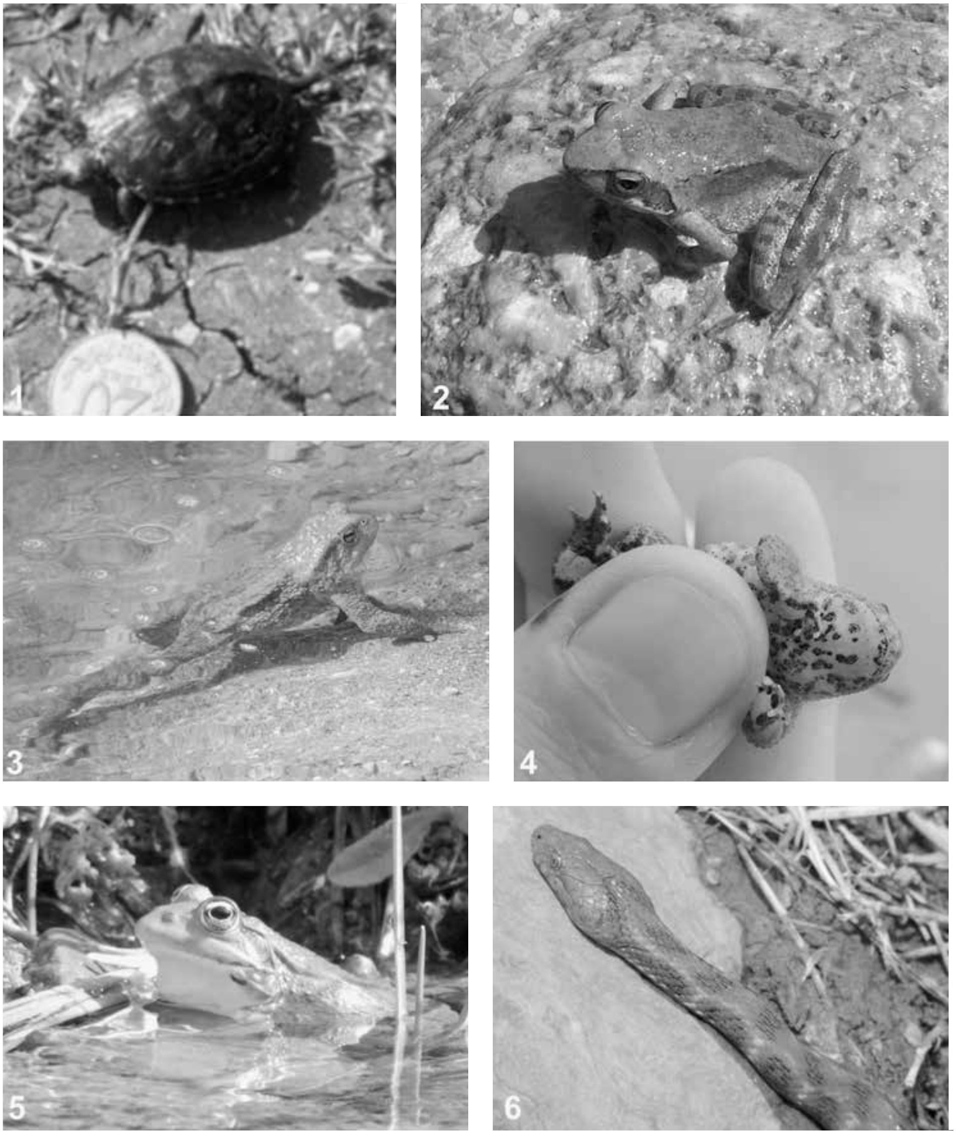

Fig. 11: Reptiles and amphibians from Vjosa: 1, *Emys orbicularis*; 2, *Rana graeca*; 3, *Bufo bufo*; 4, *Bombina variegata*; 5, *Pelophyllax ridibundus*; 6, *Natrix tessellata* (1, © S. Shumka; 2–6, © F. Bego). – Abb. 11: Reptilien und Amphibien aus Vjosa: 1, *Emys orbicularis*; 2, *Rana graeca*; 3, *Bufo bufo*; 4, *Bombina variegata*; 5, *Pelophyllax ridibundus*; 6, *Natrix tessellata* (1, © S. Shumka; 2–6, © F. Bego).

sis), Leopard snake *(Elaphe situla),* Four-lined snake *(Elaphe quatuorlineata),* Hermann's tortoise *(Testudo hermanni),* European pond turtle *(Emys orbicularis),* Erhard's wall lizard (*Podarcis erhardii*), Balkan green lizard (*Lacerta trilineata*) and the European green lizard *(Lacerta viridis).* The Vjosa catchment is also home to the meadow viper *Vipera ursinii* ssp. *graeca,* a species which was just recently found in Albania (Korsós et al. 2008).

Birds: There is a wide variety of bird species present within the Vjosa watershed, with 257 recorded species connected to the different ecosystems and habitats (MoE 2009, Bego unpub. data) (Fig. 3). Species such as the Eagle Owl (*Bubo bubo*), Long-legged Buzzard (*Buteo rufinus*), Levant Sparrowhawk (*Accipiter brevipes*), Lanner Falcon (*Falco biarmicus*), Sparrowhawk (*Accipiter nisus*), Golden Eagle (*Aquila chrysaetos*), European Honey Buzzard (*Pernis apivorus*), Goshawk (*Accipiter gentilis*), Short-toed Eagle (*Circaetus gallicus*), Egyptian Vulture (*Neophron percnopterus*), Grey-headed Woodpecker (*Picus canus*), Barn Owl (*Tyto alba*), Lesser Kestrel (*Falco naumanni*), and Common Kestrel (*Falco tinnunculus*) are present and are good indicators of the Vjosa ecosystem's condition.

Old-growth tree stands provide suitable habitats for a number of woodpeckers (*Dendrocopos syriacus, D. major, D. medius, D. minor*) and diverse passerine species, such as tits (*Parus* spp., *Aegithalos caudatus*), finches (*Fringillidae*), warblers, and European Nuthatch (*Sitta europaea*). Of the more than 70 species of waterbirds of the Vjosa watershed, its Delta, and adjacent Narta lagoon, the most characteristic are the Dalmatian Pelican (*Pelecanus crispus*), Greater Flamingo (*Phenicopterus roseus*), Pied Avocet (*Recurvirostra avosetta*), Little Egret (*Egretta garzetta*), Grey Heron (*Ardea cinerea*), cormorants, gulls, and terns.

Fig. 12: The brown bear (*Ursus arctos*) from the National Park Fir of Hotova – Dangellia (Permeti) (© PPNEA). – Abb. 12: Der Braunbär (*Ursus arctos*) von der Nationalpark-Tanne von Hotova – Dangellia (Permeti) (© PPNEA).

Mammals: The area harbours around 70 of the 86 registered terrestrial mammal species in Albania (MoE 2009, Bego unpublished data). The European otter (*Lutra lutra*) is one of the significant elements of the entire Vjosa river system (Bego et al. 2001, Bego et al. 2008, Hysaj & Bego 2008, Bego & Hysaj 2018 this volume). Large carnivores are also mentioned, such as the brown bear (*Ursus arctos*) (Fig. 12) and wolf (*Canis lupus*). Due to their mobility, the large carnivores can be found in different habitats within the valley. Large mammals in the Vjosa watershed also comprise the Chamois (*Rupicapra rupicapra balcanica*), the roe deer (*Capreolus capreolus*), and wild boar (*Sus scrofa*). The study area is rich in bats, both cave-dwelling and forest bats; 29 out of 32 bat species recorded from Albania are present within the Vjosa watershed. The most characteristic bats are *Rhinolophus euryale, R. blasii, R. hipossideros, R. ferrumequinum, Miniopterus schreibersi, Eptesicus serotinus, Myotis bechsteini,* and *M. capaccinii*). Other characteristic mammals are the red squirrel (*Sciurus vulgaris*), fat dormouse (*Glis glis*), hazel dormouse (*Muscardinus avellanarius*), beech marten (*Martes foina*), badger (*Meles meles*), red fox (*Vulpes vulpes*), and wild cat (*Felis silvestris*). The study area is the only known occurrence of the mole rat (*Spalax leucodon*) in Albania (Bego et al. 2014).

Annex I: Checklist of endangered and vulnerable species, including endangered and vulnerable migratory species living within Vjosa catchment, included in the appendices of the Bern Convention. – Anhang I: Checkliste gefährdeter und verwundbarer Arten, einschließlich gefährdeter und verwundbarer wandernder Arten, die im Vjosa-Einzugsgebiet leben und in den Anhängen des Berner Übereinkommens enthalten sind.

Scientific name	Family	Bern Convention Appendices
Plantae		
Salvinia natans	*Salviniaceae*	APPENDIX I
Typha minima	*Typhaceae*	APPENDIX I
Insecta		
Coenagrion mercuriale	*Odonata*	APPENDIX II
Leucorrhinia albifrons	*Odonata*	APPENDIX II
Lindenia tetraphylla	*Odonata*	APPENDIX II
Stylurus (= Gomphus) flavipes	*Odonata*	APPENDIX II
Lycaena dispar	*Lepidoptera*	APPENDIX II
Papilioa lexanor	*Lepidoptera*	APPENDIX II
Zerynthia polyxena	*Lepidoptera*	APPENDIX II
Lucanus cervus	*Coleoptera*	APPENDIX II
Cerambyx cerdo	*Coleoptera*	APPENDIX II
Amphibia & Reptilia		
Bufo viridis	*Bufonidae*	APPENDIX II
Emys orbicularis	*Emydidae*	APPENDIX II
Testudo hermanni	*Testudinidae*	APPENDIX II
Lacerta trilineata	*Lacertidae*	APPENDIX II
Lacerta viridis	*Lacertidae*	APPENDIX II
Fish		
Acipenser stellatus	*Acipenseridae*	APPENDIX III
Alburnoides bipunctatus	*Cyprinidae*	APPENDIX III
Chondrostoma nasus	*Cyprinidae*	APPENDIX III
Pachychilon pictum	*Cyprinidae*	APPENDIX III

Annex 1 continued – Fortsetzung

Scientific name	Family	Bern Convention Appendices
Alosa alosa	*Clupeidae*	APPENDIX III
Alosa fallox	*Clupeidae*	APPENDIX III
Aphanius fasciatus	*Cyprinodontidae*	APPENDIX III
Aphanius iberus	*Cyprinodontidae*	APPENDIX III
Lampetra fluviatilis	*Petromyzonidae*	APPENDIX III
Petromyzon marinus	*Petromyzonidae*	APPENDIX III
Misgurnus fossilis	*Cobitidae*	APPENDIX III
Salaria (Blenius) fluviatilis	*Blenniidae*	APPENDIX III
Barbus prespensis	*Cyprinidae*	Albania Endemic
Cobitis ohridana	*Cobitidae*	Albania Endemic
Oxynoemacheilus pindus	*Nemacheilidae*	Albania Endemic
Anguilla anguilla	*Anguillidae*	Endangered (CR)
Salmo faroides	*Salmonidae*	Endangered (VU)
Aves		
Ardeola ralloides	*Ardeidae*	APPENDIX II
Bubulcus ibis	*Ardeidae*	APPENDIX II
Egretta alba	*Ardeidae*	APPENDIX II
Egretta garzetta	*Ardeidae*	APPENDIX II
Ixobrychus minutus	*Ardeidae*	APPENDIX II
Pandion haliaetus	*Pandionidae*	APPENDIX II
Pernisa pivorus	*Accipitridae*	APPENDIX II
Neophron percnopterus	*Accipitridae*	APPENDIX II
Circaetus gallicus	*Accipitridae*	APPENDIX II
Accipiter gentilis arrigonii	*Accipitridae*	APPENDIX II
Accipiter nisus granti	*Accipitridae*	APPENDIX II
Aquila chrysaetos	*Accipitridae*	APPENDIX II
Falco naumanni	*Falconidae*	APPENDIX II
Falco vespertinus	*Falconidae*	APPENDIX II
Falco columbarius	*Falconidae*	APPENDIX II
Falco peregrinus	*Falconidae*	APPENDIX II
Charadrius alexandrinus	*Charadriidae*	APPENDIX II
Charadrius dubius	*Charadriidae*	APPENDIX II
Tringa hypoleucos	*Scolopacidae*	APPENDIX II
Tyto alba	*Strigiformes*	APPENDIX II
Otus scops	*Strigiformes*	APPENDIX II
Bubo bubo	*Strigiformes*	APPENDIX II
Athene noctua	*Strigiformes*	APPENDIX II
Strix aluco	*Strigiformes*	APPENDIX II
Asio otus	*Strigiformes*	APPENDIX II
Asio flammeus	*Strigiformes*	APPENDIX II
caprimulgus europaeus	*Caprimulgidae*	APPENDIX II
Apus melba	*Apodidae*	APPENDIX II
Apus pallidus	*Apodidae*	APPENDIX II
Alcedo atthis	*Alcedinidae*	APPENDIX II
Merops apiaster	*Meropidae*	APPENDIX II

Annex 1 continued – Fortsetzung

Scientific name	Family	Bern Convention Appendices
Upupa epops	*Upopidae*	APPENDIX II
Jynx torquilla	*Piciformes*	APPENDIX II
Picus viridis	*Piciformes*	APPENDIX II
Dendrocopos major	*Piciformes*	APPENDIX II
Dendrocoposs yriacus	*Piciformes*	APPENDIX II
Dendrocopos medius	*Piciformes*	APPENDIX II
Dendrocopos minor	*Piciformes*	APPENDIX II
Calandrella brachydactyla	*Alaudidae*	APPENDIX II
Riparia riparia	*Hirundinidae*	APPENDIX II
Hirundo rupestris	*Hirundinidae*	APPENDIX II
Hirundo rustica	*Hirundinidae*	APPENDIX II
Hirundo daurica	*Hirundinidae*	APPENDIX II
Delichon urbica	*Hirundinidae*	APPENDIX II
Anthus campestris	*Motacillidae*	APPENDIX II
Anthus pratensis	*Motacillidae*	APPENDIX II
Anthus spinoletta	*Motacillidae*	APPENDIX II
Motacilla flava	*Motacillidae*	APPENDIX II
Motacilla cinerea	*Motacillidae*	APPENDIX II
Motacilla alba	*Motacillidae*	APPENDIX II
Lanius collurio	*Lanidae*	APPENDIX II
Lanius minor	*Lanidae*	APPENDIX II
Lanius excubitor	*Lanidae*	APPENDIX II
Lanius senator	*Lanidae*	APPENDIX II
Cinclus cinclus	*Cinclidae*	APPENDIX II
Troglodytes troglodytes	*Troglodytidae*	APPENDIX II
Prunella modularis	*Prunellidae*	APPENDIX II
Erithacus rubecula	*Turdinae*	APPENDIX II
Luscinia megarhynchos	*Turdinae*	APPENDIX II
Monticola solitarius	*Turdinae*	APPENDIX II
Monticola saxatilis	*Turdinae*	APPENDIX II
Oenanthe hispanica	*Turdinae*	APPENDIX II
Oenanthe oenanthe	*Turdinae*	APPENDIX II
Phoenicurus ochruros	*Turdinae*	APPENDIX II
Phoenicurus phoenicurus	*Turdinae*	APPENDIX II
Saxicola rubetra	*Turdinae*	APPENDIX II
Saxicola torquata	*Turdinae*	APPENDIX II
Cettia cetti	*Sylvinae*	APPENDIX II
Cisticola juncidis	*Sylvinae*	APPENDIX II
Acrocephalus scirpaceus	*Sylvinae*	APPENDIX II
Acrocephalus arundinaceus	*Sylvinae*	APPENDIX II
Hippolais olivetorum	*Sylvinae*	APPENDIX II
Hippolais pallida	*Sylvinae*	APPENDIX II
Sylvia hortensis	*Sylvinae*	APPENDIX II
Sylvia borin	*Sylvinae*	APPENDIX II

Annex 1 continued – Fortsetzung

Scientific name	Family	Bern Convention Appendices
Sylvia atricapilla	*Sylvinae*	APPENDIX II
Sylvia communis	*Sylvinae*	APPENDIX II
Sylvia curruca	*Sylvinae*	APPENDIX II
Sylvia melanocephala	*Sylvinae*	APPENDIX II
Sylvia cantillans	*Sylvinae*	APPENDIX II
Sylvia conspicillat	*Sylvinae*	APPENDIX II
Sylvia undata	*Sylvinae*	APPENDIX II
Regulus regulus	*Regulinae*	APPENDIX II
Regulus ignicapilla	*Regulinae*	APPENDIX II
Muscicapa striata	*Muscicapinae*	APPENDIX II
Ficedula albicollis	*Muscicapinae*	APPENDIX II
Ficedula hypoleuca	*Muscicapinae*	APPENDIX II
Panurus biarmicus	*Timalinae*	APPENDIX II
Parus lugubris	*Paridae*	APPENDIX II
Parus cristatus	*Paridae*	APPENDIX II
Parus ater	*Paridae*	APPENDIX II
Parus caeruleus	*Paridae*	APPENDIX II
Parus major	*Paridae*	APPENDIX II
Remis pendulinus	*Paridae*	APPENDIX II
Sitta neumayer	*Sittidae*	APPENDIX II
Emberiza cia	*Emberizidae*	APPENDIX II
Emberiza cirlus	*Emberizidae*	APPENDIX II
Emberiza melanocephala	*Emberizidae*	APPENDIX II
Emberiza schoeniclus	*Emberizidae*	APPENDIX II
Carduelis cannabina	*Fringillidae*	APPENDIX II
Carduelis carduelis	*Fringillidae*	APPENDIX II
Carduelis chloris	*Fringillidae*	APPENDIX II
Carduelis spinus	*Fringillidae*	APPENDIX II
Coccothraustes coccothraustes	*Fringillidae*	APPENDIX II
Serinus serinus	*Fringillidae*	APPENDIX II
Oriolus oriolus	*Orolidae*	APPENDIX II
Pyrrhocorax graculus	*Corvidae*	APPENDIX II
Mammalia		
Hypsugo savii	*Vespertilionidae*	APPENDIX II
Myotis bechsteinii	*Vespertilionidae*	APPENDIX II
Pipistrellus kuhli	*Vespertilionidae*	APPENDIX II
Rhinolophus ferrumequinum	*Rhinolophidae*	APPENDIX II
Rhinolophus hipposideros	*Rhinolophidae*	APPENDIX II
Canis lupus	*Canidae*	APPENDIX II
Lutra lutra	*Mustelidae*	APPENDIX II
Ursus arctos	*Ursidae*	APPENDIX II
Felis silvestris	*Felidae*	APPENDIX II

Conclusions

Even considering the gaps in our knowledge of the area's biodiversity, the whole Vjosa catchment and the River Vjosa itself shelter a high diversity of habitats and species – one that is relatively rich compared to other similar areas in Albania. Therefore, special attention must be paid to future hydropower development plans. From its delta in the Adriatic to the uppermost mountainous part in Albania and Greece, the riverine system represents a dynamic and continuous freshwater ecosystem which is a suitable habitat for various aquatic and terrestrial species.

Around 150 species of the already known flora and fauna species are listed in the Appendices of the Bern Convention. More than 15 priority habitat types of European interest have been identified (Habitat directive – NATURA 2000), as well as 7 habitat priority types (EUNIS, IPA) of high floristic value.

Among the fish-fauna worth mentioning here are the critically endangered European eel (*Anguilla anguilla*), mullet (*Mugil cephalus*), and sub-endemic fish species such as the Ohrid loach (*Cobitis ohridana*) and Pindus stone loach (*Oxynoemacheilus pindus*); the presence of *Salmo faroides* has been recorded at a critical population size for the major part of the river and its tributaries.

A very large proportion of Albanian amphibians (13 out of 16 species reported in Albania, or more than 80 %) and reptiles (32 out of 37 species reported in Albania or more than 86 %) are present in the Vjosa watershed, either in aquatic or terrestrial habitats, and are connected to riverine habitats for at least parts of their lifecycle. A wide variety of bird species is present (257 species or approx. 80 % of the species known in Albania) and connected to the different aquatic habitats. There are more than 70 species of waterbird, mostly in the wetlands of the Vjosa Delta. The area is home to around 70 of the 83 registered mammal species in Albania (approx. 84 %), e.g. the European otter (*Lutra lutra*), a globally endangered mammal. Around 150 species of the already known flora and fauna species are listed in the Appendices of the Bern Convention. Results of other research groups in this volume reveal additional biodiversity data underlining the conservational value of this area. The floodplains of the Vjosa River in its middle part highlight **the potential values of a protected area – of a future riverscape National Park** – that would be the first protected area of this category in Albania.

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The Vjosa river system in Albania: a summary of actual challenges and agendas

Aleko MIHO, Sajmir BEQIRAJ, Wolfram GRAF & Fritz SCHIEMER

The paper provides a short summary of a volume on the natural value of the Vjosa river in Southern Albania. Despite its unique physical and biological environmental features, the riverine landscape is in danger to be critically deteriorated by a series of hydropower dams. The hazards are indicated and the expected violations of international rules and conventions are defined. We suggest a strengthening of the local scientific basis for river management in cooperation with international experts and the establishment of a platform across the science-policy interface – were science can 'speak to' policymakers, authorities and local people – with a clear participation and decision structure.

MIHO A., BEQIRAJ S., GRAF W. & SCHIEMER F., 2018: Das Vjosa Fluss System in Albanien: eine Zusammenfassung der wichtigsten Herausforderungen und Aufgaben.
Der Artikel gibt eine Zusammenfassung über den Schutzwert des Vjosa Flusses in Südalbanien. Trotz der einmaligen physikalischen und ökologischen Situation des Gebietes besteht unmittelbare Gefahr, dass die Flusslandschaft durch Staudammbauten zerstört wird. Der Artikel weist auf die verschiedenen Gefährdungen hin, sowie auf die internationalen Gesetze und Konventionen, die gegen eine Staudammerrichtung sprechen. Es wird nachdrücklich empfohlen, die lokale Fachexpertise für die Beurteilung von wasserwirtschaftlichen Maßnahmen in Kooperation mit internationalen Fachexperten zu stärken und die Wissenschaft stärker in die Entscheidungsprozesse einzubinden. Um eine dauerhafte Gesprächsbasis zwischen Wissenschaft, Politik und Vertretern der lokalen Bevölkerung zu gewährleisten sollten Flussforen mit einer klaren Teilnahme – und Entscheidungsstruktur eingerichtet werden.

Keywords: hydropower dams, natural heritage, Bern Convention, science- policy interface, international cooperation.

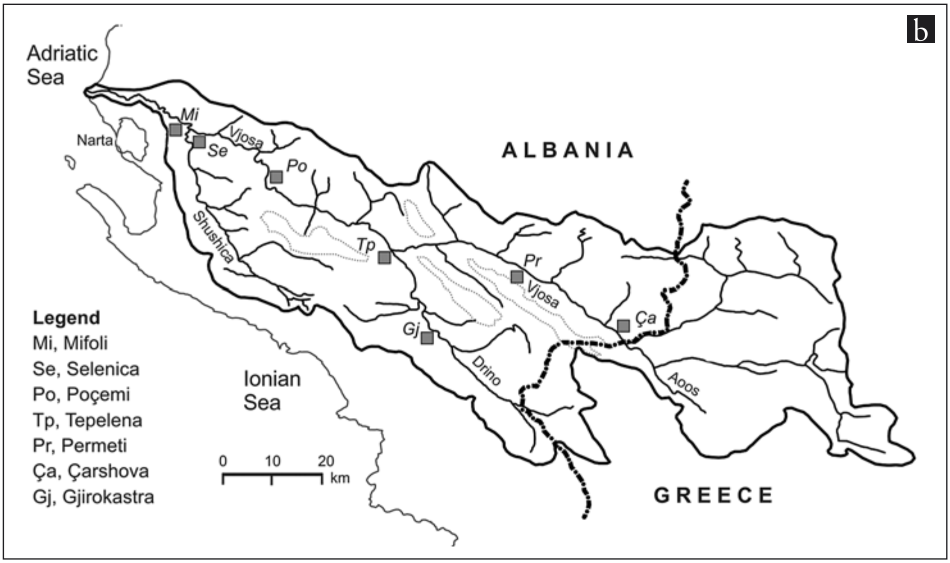
The Vjosa – a unique river – is threatened

Vjosa River is the one of the last free flowing, wild rivers in Europe (SCHIEMER et al. 2018 this volume). Together with its tributaries, the Vjosa provides a dynamic, near-natural ecosystem, comprising crystal clear streams, deep gorges, and extensive alluvial zones and floodplains (Fig. 1 u. 2). This riverine landscape is a hotspot for European biodiversity, hosting many threatened as well as endemic species. The studies summarized within this volume, represent the result of a very short research visit. They provide a first snapshot into a complex and diverse environment with high natural values, including taxa new to science and many species which were formerly abundant in Europe and are nowadays rare and endangered. The specific biodiversity is dependent on the high fluvial dynamics in the interphase of land and water. Such characteristics have, since many decades, been lost in most of the rivers in Central Europe, making the Vjosa a significant ecological refugia in Europe. About 150 species are listed in the Appendices of the Bern Convention (see SHUMKA et al. 2018 this volume). The riverine landscape is also a geological and geographic monument of international significance (DURMISHI et al. 2018 this volume).

Despite these values a large number of HPPs are planned and projected in the Vjosa and its tributaries, some of them within protected areas; The most significant risk for the river as a corridor are the planned hydropower dams in Poçemi and Kalivaçi. The construction of Kalivaçi plant started already in 2006 by an Italian company but the project came to a halt. In May 2016 the Albanian government granted a 35-year-concession to a Turkish company on the construction of Poçemi plant, which was suspended by the Administrative Court in May 2017 due to invaluable the administrative acts (https://invest-in-albania.org/administrative-court-stops-hpp-construction-vjosa-river/) (Miho 2017).

In October 2017 the Albanian government announced a continuation of the Kalivaçi project by a Turkish-Albanian consortium with the same Turkish company which had failed in the Poçemi case. The Albanian Ministry of Energy and In-

Fig. 1: a) The geographic position of Vjosa/Aoos trans-boundary river, b) Hydrographic map of Vjosa basin. – Abb. 1: a) Das Vjosa/Aoos Einzugsgebiet, b) Hydrographische Karte des Vjosa Beckens.



dustry (MEI) gave permissions to build up to 500–550 HPPs (about 18 HPPs/1000 km^2!), during yrs. 2005–2017 with the total generation capacity of about 2,200 MW. Some have been already constructed; others are under construction or planned for the near future. Over 100 HPPs are planned within the protected areas or potential protected areas as in the case of the Vjosa corridor or are already under construction like in Valbona National Park. The dams in the central part of the Vjosa valley would endanger one of the greatest Albanian natural values (Miho 2017, Diku et al. 2016, Shumka et al. 2010, Shumka et al. this volume).

Hydropower is not a green energy

Hydropower plants can have extremely destructive and, on the long run, costly effects on a catchment. The negative ecological implications are well documented (Ward & Stanford 1995, Jungwirth et al. 2006, Schmutz & Moog 2018). Serious impacts refer to the lateral, longitudinal and vertical integrity of the entire river system, leading to dramatic changes in the specific biodiversity and functional processes. Essential parameters like hydrological dynamics, sediment load, structure and distribution, nutrients, turbidity and food resources, and temperature regime as well as overall hydraulic patterns change upstream, within the impounded section and influence largely downstream reaches (e.g. summarised in Schmutz & Moog 2018).

The environmental expertise in preparing the Albanian projects so far has been very superficial, missing ecological concepts, synergic effects, biodiversity conservation, protected areas, etc. In addition there is a lack of urgently required environmental data, and a weakness of structures to control the implementation and operation of projects. (Diku et al. 2016, Miho 2017, Shumka et al. 2010, etc.).

Fig. 2: The extensive river-floodplain system upstream Kalivaçi (Photo: Subic). – Abb. 2: Die Fluss-Auen Landschaft flussauf von Kalivaçi (Foto: Subic).

In context with the planned hydropower dams in Poçemi and Kalivaçi, decision makers, investors and stakeholders should be aware of negative consequences and major environmental threats. The profound and long-term environmental consequences of dam constructions in alluvial zones have been well documented worldwide and also in Albania. Today, this historic over-regulation of rivers necessitates costly restoration measures for compensation in many industrialized countries (Naiman et al. 2002, Thorp et al. 2006, Poff et al. 2003, Schiemer 2015).

The environmental, socio-economic and legal concerns

The environmental hazards are addressed by Schiemer et al. 2018 this volume. They refer to:

- the immediate endangerment of the national heritage mentioned above by damming of the riverscape, Vjosa delta – Narta lagoon protected area especially (Miho et al. 2013, Miho 2017).
- the loss of biodiversity. The highly undisturbed river dynamics and the river-floodplain ecosystems along the Vjosa are in an excellent conservation status. All riverine habitats are listed in the Annex 1 of European Union Habitats Directive, underpinning their importance for conservation at an European scale. They harbour viable communities of species that have largely or completely disappeared from other European rivers systems. Within our study, over 100 taxa of aquatic invertebrates and nearly 400 taxa of terrestrial species were recorded. Many of them are endemic to the Balkan, a high proportion (over 40 %) has been documented for the first time for Albania. A few are described as new to science (e.g. *Isoperla vjosae*, and *Liocranoeca vjosensis*) (see Schiemer et al. 2018 this volume, Shumka et al. 2018 this volume). Much higher species numbers can be expected when long-term, detailed assessments are carried out. We can predict that the majority of this specific biodiversity will disappear in the case of the planned dam constructions due to a loss of fluvial dynamics (Schiemer 2000).
- the loss of groundwater resources in terms of quantity and quality; i.e. Poçemi springs, drinking water supply for 30,000–40,000 inhabitants, and Kafaraj springs, drinking water supply for Fieri town of about 100,000 inhabitants (Guri 2016) (see Durmishi et al. 2018 this volume).
- the deterioration of surface water quality due to eutrophication processes at high residence times can be expected to lead to toxic cyanobacterial algal blooms (see Albanian examples by Miho et al. 2014).
- production of methane and other organic compounds as a result of anaerobic processes in the flooded areas causing bed smell and harmful effects to aquatic biota including humans as water user (see Miho et al. 2009).
- coastal erosion, due to the reduction of sediment transport by the river. Guri (2016) reported that ca. 90 % of sediment load will be trapped, enhancing coastal erosion in Vjosa and Semani delta and their related protected coastal areas. Especially endangered will be the coastal dunes in both parts of Vjosa delta and the closely related Narta lagoon (see Durmishi et al. 2018 this volume).
- The increased probability of catastrophic floods because of loss of retention zones.

Besides these environmental issues, **socio-economic ambiguities require clarification**:

– a major ambiguity is the high sediment load and the stochastic seasonal flow, which will reduce the efficiency in energy use by dam filling within a period of thirty years and reduce the cost-benefit efficiency. The sediment load transported by the Vjosa at Poçemi and Kalivaçi is very high. Detailed studies are being carried out at present by C. Hauer (in prep.).

– the dams in Poçemi and Kalivaçi would flood the agricultural land, of high production quality. Albania is ranked among the countries with very little cultivated land. Therefore, care for agricultural land should be a constant challenge (Miho 2017).

– the total capacity of energy production will be 57 MW, with a production affectivity of 1 MW/70 ha (Guri 2016) which is a very low capacity in international terms.

– coastal erosion with negative effects for tourist beach infrastructures.

An array of operational and legal issues are of major concern:

The water management over the past 20 years has developed standardized operational procedures. In EU countries, for example, river management must follow the European Water Framework Directive, EU Natura 2000 Directive, EU Birds and Habitats Directive and EU Flood Risk Directive (Anonymous 2016). Regulations stipulate that projects have to be planned within a continued monitoring in the framework of a River Basin Management Plan. This requires a proper and continued scientifically based assessment both of the socio-economy of river basin development and the reactions towards human interventions.

The most important European directives providing legal guidance regarding an environmental impact assessment are:

1. EIA Directive (Directive 2011/92/EU of the European Parliament and of the Council on the assessment of the effects of certain public and private projects on the environment) requires in accordance with Annex IV to Directive 2011/92/EU, a complete assessment of sufficiently high quality. A description of the aspects of the environment factors specified in Article 3(1) likely to be significantly affected by the proposed project. These EIA have to evaluate short-, medium-, and long-term impacts on nature and affected residents of a projected hydropower plant, and must consider alternative low-impact concepts. They have to be based on detailed assessments of hydro-morphological processes, geomorphic and ecological structure and dynamics and predictions about the impacts on specific biodiversity.

2. Water Framework Directive (Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for Community action in the field of water policy)

3. Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora & Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds. Measures have to be taken to avoid, prevent, reduce and offset significant adverse effects on the environment.

4. Bern convention
   The United Nations Convention on Biological Diversity (‘the Convention’), to which the Union is party pursuant to Council Decision 93/626/EEC(9), requires assessment

of the significant adverse effects of projects on biological diversity, which is defined in Article 2 of the Convention.

5. The Eel-Directive
EC (European Commission) (2007) Council Regulation (EC) No 1100/2007 of 18 September 2007 establishing measures for the recovery of the stock of European eel. Official Journal of the European Union L248, 17–23.

General reflections

Economy vs. nature conservation – the red list of HPPs!

Based in the Regional Strategy for Sustainable Hydropower in the Western Balkans (WBEC-REG-ENE-01 2017), most of HPPs planned to build in Albania are small, only 44 can be considered important (with more than 10 MW). Among that list, about 17 projects are within protected areas (Valbona, Curraj, Shala, Qarrishta rivers), or potential protected areas (Kalivaçi & Poçemi in Vjosa). Such a list cannot be a 'green list' for the Albanian government, but a 'red or 'no-go' list; the total capacity of this 'no-go' list is about 535 MW, or about 24–25 % of the total planned generation capacity of 2200 MW, mentioned above.

The EU Reports for Albania always emphasized to save the pristine rivers from hydropower projects, especially in protected areas. In February 2017, the European Parliament explicitly criticized the Albanian government in regards to its hydropower policies, demanding a National Park for the Vjosa and a stop to HPP projects.

Therefore Albanian and international environmental experts strongly suggest – in order to conserve at least some part of the natural values – to take a balance between energy production and the preservation of important ecosystem which provide essential services. It is Albanians responsibility to conserve, maintain and restore the natural resources for future generations (Miho 2017), e.g. by establishing a Vjosa National Park.

Better knowledge (i.e. more science) is required!

The promotion of projects is haphazard and controlled by a hierarchy of stakeholder interests. We demand instead a transdisciplinary and participatory planning and decision process with clearly defined procedural steps.

Management has to be based on a well-founded understanding of the governing factors of the fluvial landscape dynamics and the ecological services of river systems and its biodiversity. This requires a truly interdisciplinary, cooperative approach (Schiemer 2015, Schiemer et al. 2018 this volume) with the goal of prognostic evaluation of the expected impact, in order to avoid undesired effects on society. Prerequisites for such an approach are well defined, science based research interdisciplinary programs combining hydrology, sediment transport processes, ecology and socio-economy. The present assessment is far from a legally binding Environmental Impact Assessment (EIA).

A platform across the science-policy interface, were science can 'speak to' policymakers, authorities and local people, requires a clear participation and decision structure. Discussions with scientists, stakeholder and persons concerned should explore scenarios for the sustainable development of the Vjosa river corridor, acknowledging the links between ecological, economic, social and cultural aspects.

Science and democracy go together (KNAW 2014). We request that Albanian politics make serious attempts to strengthen the professional knowledge and support regional capacity building. The scientific community is in debt to build up an integrated approach in regional water management.

International support and cooperation

This special volume dedicated to the Vjosa River is based on a cooperation of experts of conservation biology, hydrogeology and chemistry from various Albanian, Austrian and German institutions. Several joint field trips were organized in June, 2014, October 2016, April and May 2017, March and April 2018. Two international events were organized at the Tirana University in June 2016 (Anonymous 2016), and in September 2017. All these activities aim to provide an understanding of the natural values of Vjosa riverscape and acknowledge the links between the integrity of the Vjosa ecosystem and economic, social and cultural aspects of human well-being. As scientists from Albania, Austria and Germany, we all aim and recommend for an interdisciplinary research and attempt to structure an integrated assessment program by the Albanian and international experts which can help the decision makers in Albania to find ways for a sustainable development of the Vjosa River corridor.

At the Vjosa Science Conference in June, 2016 entitled 'The Vjosa – A unique opportunity for European River Science' scientists from Albania, Austria and Germany drafted a Memorandum about 'Research requirements for a sustainable development of the Vjosa River corridor' (Anonymous 2016), in which we strongly recommended a 3-year-moratorium on construction plans on the Vjosa and her tributaries in order to enable an integrated assessment programme. It would have also allowed exploring the possibilities for EU funding to support sustainable development in the region. The moratorium was signed by 60 scientists, participants in the Conference, and supported by more than 220 well-known scientists worldwide. We had no reaction from Albanian Government and responsible institutions in Tirana up to now.

Acknowledgments

The field trips in Vjosa region were partly supported by the Save the Blue Heart of Europe campaign and related institutions like Riverwatch and EuroNatur. The field work of the Albanian partners was carried on within the framework of the project: Assessment of biodiversity and bioquality of Vjosa riverscape and its tributaries (June 2016 – May 2017), supported by FNS, UT. EcoAlbania assisted for the logistic support provided during field survey. Gratitude to the editorial board of Acta ZooBot Austria, for publishing this special volume on Vjosa River.

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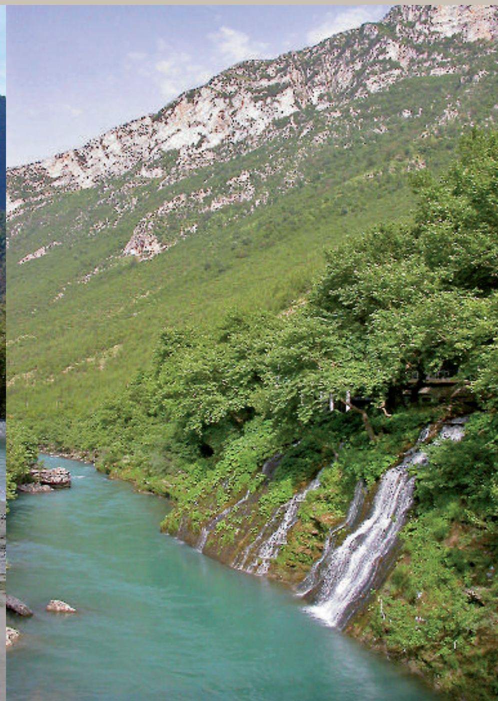


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