

Babeş-Bolyai University  
Faculty of Biology and Geology

PHD THESIS

Taxonomic and faunistic studies of the Tipulomorpha,  
Bibionomorpha and Ptychopteridae (Diptera, Insecta)  
in Southeastern Europe

Scientific supervisor:  
Prof. dr. László RÁKOSY

PhD candidate:  
Levente-Péter KOLCSÁR

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**Key words: Diptera, new species, new records, Romania, Balkans, check list, redescription**

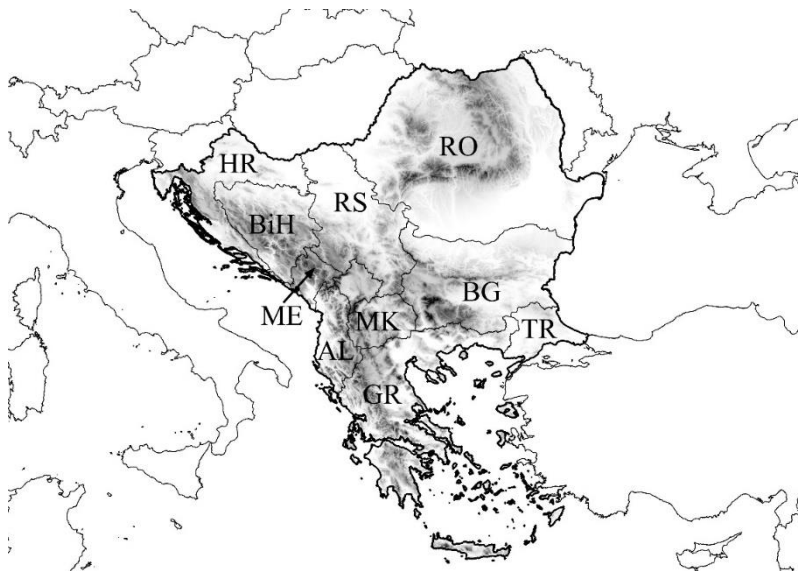
# 1. General introduction

## 1.1. Aim of thesis, studied group and area

The aim of this thesis is to present taxonomic and faunistic studies of the Tipulomorpha, Bibionomorpha and Ptychopteridae (Diptera, Insecta) groups from Southeastern Europe. These dipteran groups are traditionally called nematocerous flies and include the craneflies, St Mark's flies or March flies and gnats. Although I was primarily interested in the Tipuloidea, nonetheless I frequently collected other nematocerous flies like, fungus gnats, midges and other groups from similar habitats, all represent highly neglected groups within the geographical area investigated by me and my colleagues.

The aim of my PhD is to add additional information to the distribution, ecology and taxonomy of studied groups. In this thesis I want to demonstrate that this geographical area is particularly understudied in terms of nematoceran diptera research in comparison to the rest of Europe. Furthermore my goal is to present summarized species checklists of studied groups, from those countries from which we have enough information to do so, and more substantial new faunistic data.

Under the term of Southeastern Europe I refer to Romania (RO) and countries of the Balkan Peninsula, namely Albania (AL), Bosnia and Herzegovina (BiH), Bulgaria (BG), Croatia (HR), Greece (GR), Former Yugoslav Republic of Macedonia (MK), Montenegro (ME), Serbia (RS), and the European part of Turkey (TR) (Fig. 1). Slovenia is excluded, because it was not part of the survey area and I do not hold any specimens from this country.



**Fig. 1.** Studied area.  
Abbreviations: AL – Albania, BiH – Bosnia and Herzegovina, BG – Bulgaria, HR – Croatia, GR – Greece, MK – Macedonia, ME – Montenegro, RO – Romania, RS – Serbia, TR – Turkey (European part).

## 1.2. Taxonomy and phylogeny of studied groups

Diptera is one of the most species rich insect orders, with more than 159,000 described species worldwide (Catalogue of Life 2018, Borkent et al. 2018). Recent studies suggest that the actual number of species of extant flies is probably at least double this (Borkent et al. 2018, Brown et al. 2018). Approximately 33,000 species are known from the Palaearctic area, however new species are frequently identified, even in well-recorded areas like Europe. The biology, ecology and distribution of most species are poorly known though, despite the fact that dipterous species play an important role in natural processes, in human epidemiology and have economic importance. Dipteran species show high levels of morphological and ecological adaptations, being present in most terrestrial and freshwater habitats, and even in some marine microhabitats. Dipterous species have the most diversified feeding modes within the Insecta. Larvae can be detritivorous, fungivorous, phytophagous, predacious or even ecto- and endoparasites, and social parasites. Some adult diptera don't feed, and their mouthparts are highly reduced. Other groups have piercing and sucking mouthparts, and feed upon blood (mosquitoes, blackflies, sandflies, tsetse flies, horseflies), nectar (beeflies, hoverflies), or can be predaceous (robberflies, daggerflies) (Papp and Darvas 2000). Higher level phylogenetic studies of Diptera are still questionable, and in many cases the results of different morphological and molecular studies are contradictory (Oosterbroek and Courtney 1995, Wiegmann et al. 2011, Shin et al. 2018, Michelsen 1996, Yeates and Wiegmann 1999, Yeates et al. 2007). Most research provided the monophyly of Brachycera and the paraphyly of Nematocera, however the infraorder level phylogeny of "Nematocera" families is a problematic question (Yeates et al. 2007). Recent molecular studies confirmed the monophyly of Bibionomorpha *sensu lato* (including Sciaroidea, Bibionoidea, Anisopodoidea, and Scatopsoidea), but the position of Axymyiidae remained an open question (Ševčík et al. 2016). The monophyly of Culicomorpha and its families were recently investigated and discussed (Kutty et al. 2018). Although Ptychopteromorpha (Ptychopteridae) is a monotypic and monophyletic unit, the exact position of the family is still uncertain; some authors suggest it is a basic lineage of Diptera (Zhang et al. 2016), or sister group of Culicomorpha (Yeates et al. 2007), or Psychomorpha+Culicomorpha (Wiegmann et al. 2011, Wiegmann and Yeates 2017). The concepts of the groups Psychomorpha and Tipulamorpha is still one of the most contested questions in phylogenetic analyses (Yeates et al. 2007, Wiegmann and Yeates 2017). Currently the most widely accepted view is that the Psychomorpha include the Psychodidae, Blepharoceridae, and Tanyderidae (Wiegmann and Yeates 2017). The monophyly of Tipulamorpha were also supported and includes the Trichoceridae and Tipuloidea (Zhang et al. 2016, Kang et al. 2017). Recent studies demonstrated that Pediciidae is the sister group of the remaining Tipuloidea (Limoniidae, Cylindrotomidae and Tipulidae), and Limoniidae is a paraphyletic group (Zhang et al. 2016, Kang et al. 2017, Petersen et al. 2010, Ribeiro 2008). Nonetheless there is no new established concept for Limoniidae, so in this document I follow the traditional division of crane flies.

## 2. Material and methods

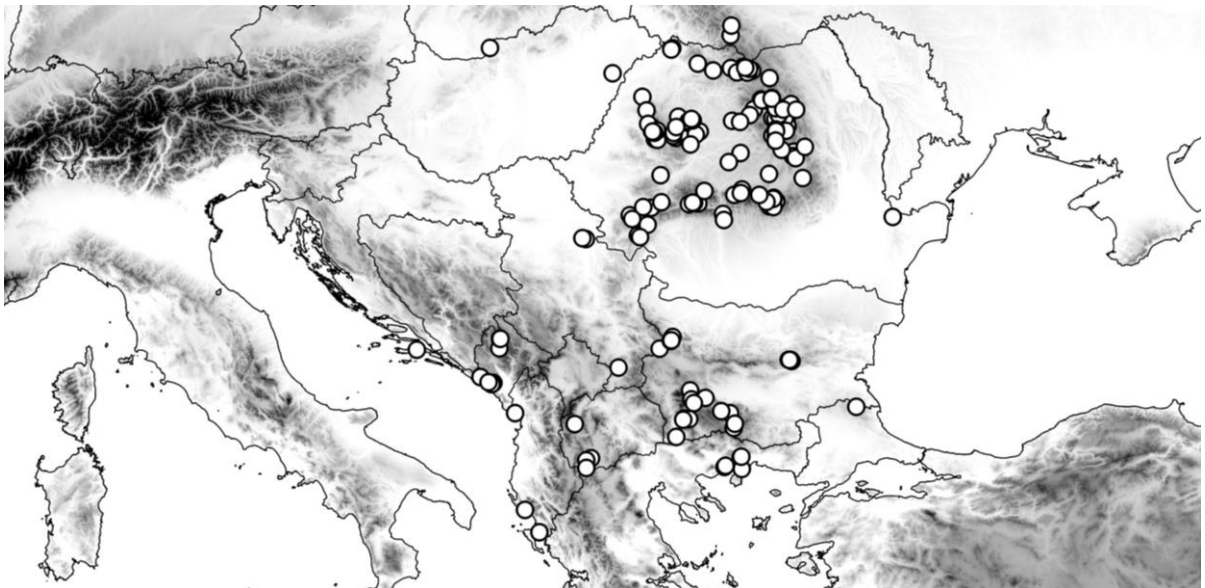
### 2.1. Material collected and examined

Specimens investigated were collected using sweep nets, Malaise-traps, beer traps, light traps, pyramid emergence traps, or collected by hand in the case of the winter active diptera species and Tipulidae larvae. The material was stored in 70-90% ethanol, or pinned and deposited in a number of different museums:

DCBBU: Diptera Collection of the Faculty of Biology and Geology, Babeş-Bolyai University, Cluj-Napoca, Romania. HNHM: Hungarian Natural History Museum, Budapest. LMM: Regional Museum of Lapland, Rovaniemi, Finland. NBC: Naturalis Biodiversity Center, Netherland.

During our workgroup field trips, approximately 10,000-11,000 diptera specimens were collected, between 2010 and 2018, from 358 collection sites in 15 different European countries. I collected diptera species from 198 collection sites (Fig. 2).

During the PhD (2014-2018) I collected or investigated 14787 specimen belong to 553 species, from which 4713 record belong to 553 species was uploaded and is available on the TransDiptera Online Database (Kolcsár et al. 2018c). From these 939 collection data are also available in Appendix table.



**Fig. 2.** My collection sites, between 2010 and 2018.

## **2.2. Equipment and programmes**

The morphological characteristics of the male and female terminalia was examined after being macerated in 10% KOH and then put on glycerol prior to morphology studies after cleaning. Specimens were examined with an Olympus SZ50 or Olympus SZ55 stereo microscope, Optika B-150 and Olympus CX23 LED microscope. Layer photos were taken using a Canon 650D or 750D camera equipped on microscope or using with a Canon 50mm objective and macro tubes. Layer photos were combined using the software Zerene Stacker or CombineZP. The drawings and figure plates were created in Adobe Photoshop CS4. Maps were created using the software QGIS (version 2.18).

## **3. Faunistic and taxonomic research of the infraorder**

### **Tipulomorpha**

The super family Tipuloidea (Cylindrotomidae, Limoniidae, Pediciidae and Tipulidae) is a relatively “well” researched group compared to the Bibionomorpha in the study area. Nonetheless the Southeastern European Tipuloidea is relative unknown if we compare to other regions of Europe.

Trichoceridae are mostly unknown from the study area, with only a small amount of data published in old papers (see chapter 3.5).

### **3.1. Tipulidae**

Tipulidae or long palped crane flies have a worldwide distribution, with nearly 4,300 described species. The family is divided to three subfamilies, from which 655 species belonging to 9 genera are reported from the Westpalaearctic region at present (Oosterbroek 2018). The family is well known in Romania. Since the last Romanian checklist (Török et al. 2013) only one additional new species has been collected from the country, which will presented in my results.

#### **3.1.1. New faunistic records of Tipulidae**

After processing more than 3,800 Tipulidae specimens from Southeastern Europe, we identified 5 species from Albania, 14 from Bulgaria, 2 from Bosnia and Herzegovina, 4 from Greece, 7 species from Montenegro, 3 from Macedonia, 2 species from Serbia and 1 species from Romania which previously were not reported from these countries. Most of collection data

will be published in the future, here only 4 species are mentioned with collection data to be published in Keresztes et al. 2018a,b. We report *Tipula (Acutipula) bosnica* Strobl, 1898 and *T. (A.) luna* Westhoff, 1879 first time from Bulgaria, *Dolichozeza (Dolichozeza) fuscipes* Bergroth, 1889 is first recorded from Albania and Montenegro and *D. (D.) nitida* Mik, 1874 from Romania.

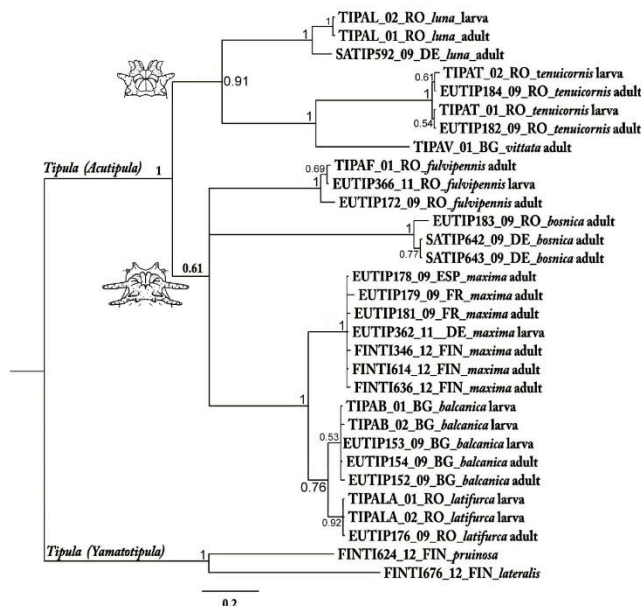
### 3.1.2. Larvae taxonomy of *Tipula (Acutipula)* (Diptera, Tipulidae)

#### Introduction

*Acutipula* Alexander, 1924 is a subgenus of *Tipula* Linnaeus, 1758 characterized mainly by adult morphological traits (Alexander 1935, Savchenko 1961). In Europe only 7 species have larger distribution. In the present study we added to knowledge of the larvae taxonomy of *Acutipula* by presenting descriptions of the hitherto unknown larvae of *T. balcanica* and *T. latifurca*.

#### Results

**Identification of the larvae:** MtCOI sequences of *T. latifurca* and *T. balcanica* are clustered together, as was also suggested by adult morphologies, and are basal for a highly supported (PP=1 and BP=98%) clade of *T. maxima* (Fig. 3).

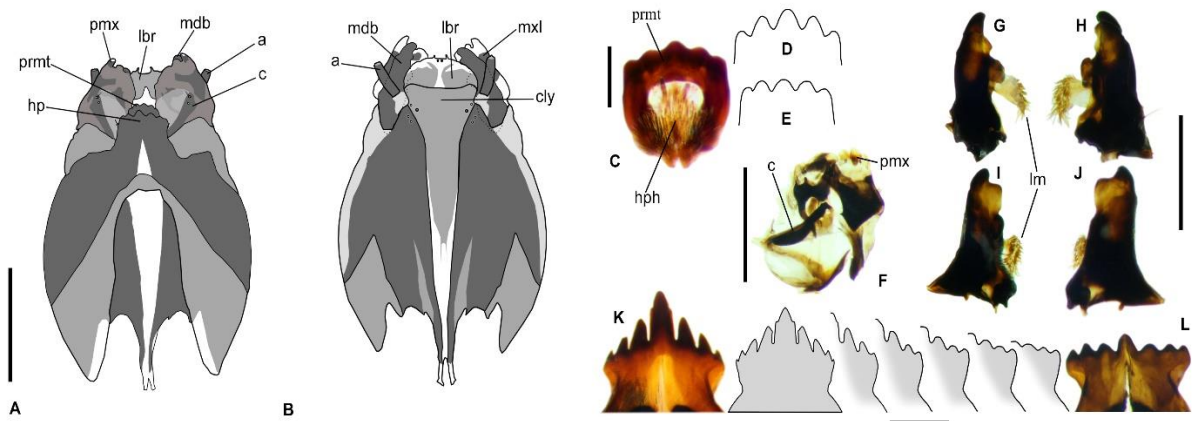


**Fig. 3.** Molecular B/MCMC and ML combined tree of *Tipula (Acutipula)* species group, with *Tipula (Yamatotipula) pruinosa* and *Tipula (Yamatotipula) lateralis* as outgroups. Posterior probabilities (PP) and bootstrap values (BP, %) for the nodes are shown under the branches.

#### Details of description of the fourth instar larva of *Tipula balcanica* Vermoolen, 1983 and *T. latifurca* Vermoolen in Keresztes et al. 2018a

General coloration is brown, length of the larva 35-62 mm (average: 47 mm). Head capsule have a length 3.4-3.5 mm and a width 1.3-1.4 mm (Fig. 4). The spiracle area of the anal segment has 6 lobes and edges with a fringe of short setae. Anal papillae surrounding the anal opening are long slender processes. There are two pairs of long lateral papillae and two pairs

of shorter processes in the middle. **Habitat and ecology:** The larvae were found in mud or in leaf litter and plant residues in water.



**Fig. 4.** Head capsule morphology of the fourth instar larvae of *Tipula (Acutipula) balcanica*. A. Head capsule in ventral view. B. Head capsule in dorsal view. Abbreviation: a - antenna, mdb - mandible, lbr - labrum, mxl - maxilla, cly - clypeus, hp - hypostomium, prmt - prementum, pmx - maxillary palp, c - cardo. Scale bar: 1 mm.

### 3.1.3. Description of a new *Tipula (Mediotipula)* (Diptera, Tipulidae) from Albania

#### Introduction

The western Palearctic *Tipula (Mediotipula)* Pierre, 1924 is a small subgenus of only 11 species of moderately-sized crane flies (Oosterbroek 2018). The majority of *Mediotipula* taxa have an isolated distribution in the western Palearctic area, showing high levels of endemism corresponding with the major biodiversity hotspots around the Mediterranean Sea while four species have a distribution area that is limited to the Iberian Peninsula (Oosterbroek 2018).

In this chapter I provide a morphological description of the new species and discuss its systematic position amongst the *Mediotipula* based upon morphological features of the male and female terminalia.

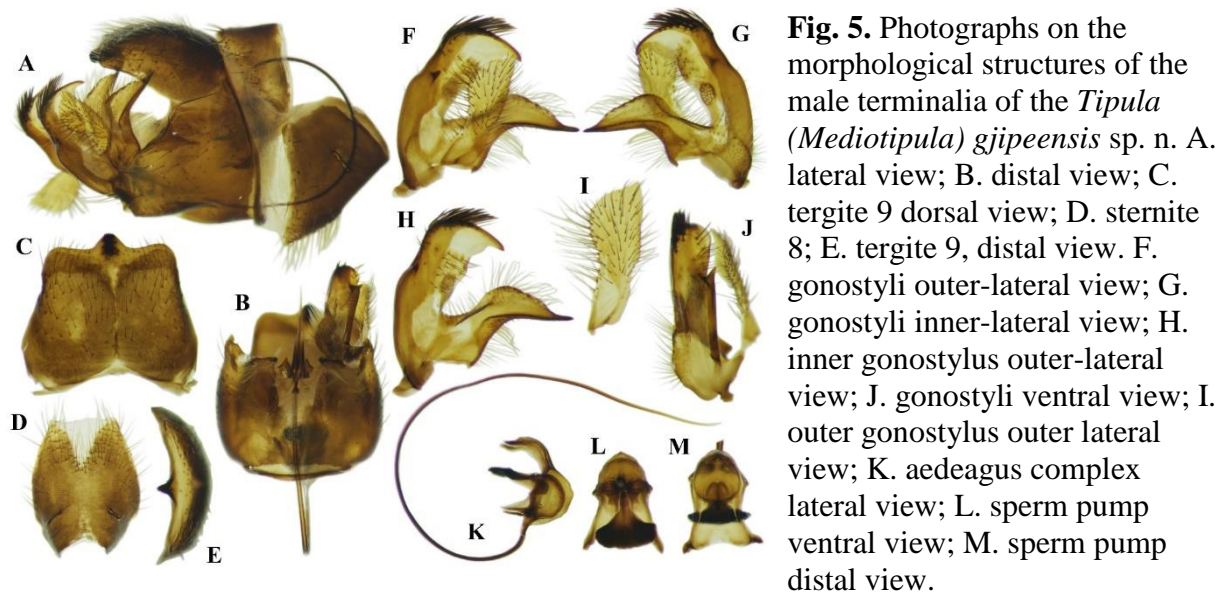
#### Results

**Details of the description of *Tipula (Mediotipula) gjipeensis* Keresztes and Kolcsár sp. n. presented in thesis and also in Keresztes et al. 2018b.**

**Diagnoses:** Males: Tergite 9-10 in males with the posterior margin having a medial spinous extension with a wide base and gradually narrowed tip. Lateral corner of the posterior margin of the tergite 9-10 is mostly rounded (Fig. 5). Outer gonostylus widened gradually to tip, ending oblique at dorsal margin. The anterior end of the anterior arm of the inner gonostylus has a long beak-like elongation. The posterior arm of the inner gonostylus has in its dorsal



margin a concentration of strong stout setae directed anteriorly, and the anterior corner ending with a thorn-like process.



**Fig. 5.** Photographs on the morphological structures of the male terminalia of the *Tipula (Mediotipula) gjipeensis* sp. n. A. lateral view; B. distal view; C. tergite 9 dorsal view; D. sternite 8; E. tergite 9, distal view. F. gonostyli outer-lateral view; G. gonostyli inner-lateral view; H. inner gonostylus outer-lateral view; J. gonostyli ventral view; I. outer gonostylus outer lateral view; K. aedeagus complex lateral view; L. sperm pump ventral view; M. sperm pump distal view.

**Ecological notes and distribution:** During our investigation in the south-western part of Albania, the new species which is described here was only detected in this highly-isolated humid habitat in the Gjipe Gorge. **Systematic position and affinities of *M. gjipeensis* Keresztes and Kolcsár sp. n.:** The new species belong to subgenus *Mediotipula*. The new species is most similar to *T. (M.) stigmatella*, having the inner gonostylus of the male terminalia about two times as high as inner gonostyli of other species of *Mediotipula*.

## 3.2. Pediciidae

Pediciidae or hairy-eyed crane flies are distributed in all biogeographic regions, with the exception of the Afrotropic and Antarctic Regions. The family comprises of 495 extant species (Oosterbroek 2018), but it is suggested that new species and faunistic novelties can be expected from even well-recorded areas such as Europe.

### 3.2.1. New faunistic records of Pediciidae

After processing more than 3,900 Pediciidae specimens from Southeastern Europe, we reported for the first time: *Dicranota (Paradicranota) minuta* Lackschewitz, 1940 species from Albania, *D. (Ludicia) lucidipennis* (Edwards, 1921) from Bosnia and Herzegovina, *D. (P.) landrocki* Czizek, 1931 and *D. (P.) mikiana* Lackschewitz, 1940 from Greece, *D. (P.) brevicornis* Bergroth, 1891 from Montenegro, *D. (P.) landrocki* Czizek, 1931, *Ula (Ula) mollissima* Haliday, 1833 from Macedonia, *D. (Dicranota) bimaculata* (Schummel, 1829), *D. (Paradicranota) pavidata* (Haliday, 1833), *Pedicia (Amalopsis) occulta* (Meigen, 1830), *Tricyphona (Tricyphona) immaculata* (Meigen, 1804) from Croatia.

### 3.2.2. Description of a new *Pentacyphona* Alexander stat. n. (Diptera, Pediciidae) from Romania

#### Introduction

Relationships within Pediciidae genera and subgenera are not investigated so far and the exact position of some subgenera is also unclear. Within the Pediciidae, an example of this problem is represented by the unclear position of *Pentacyphona* Alexander subgenus. The subgenus *Pentacyphona* Alexander belong to *Pedicia* was described based upon characters of the male antennae, wings and hypopygium (Alexander 1968).

In this study I describe a new species belonging to *Pentacyphona* collected from the Romanian Carpathians and raise *Pentacyphona* to genus rank.

#### Results

##### Genus *Pentacyphona* Alexander, 1968, stat. n.

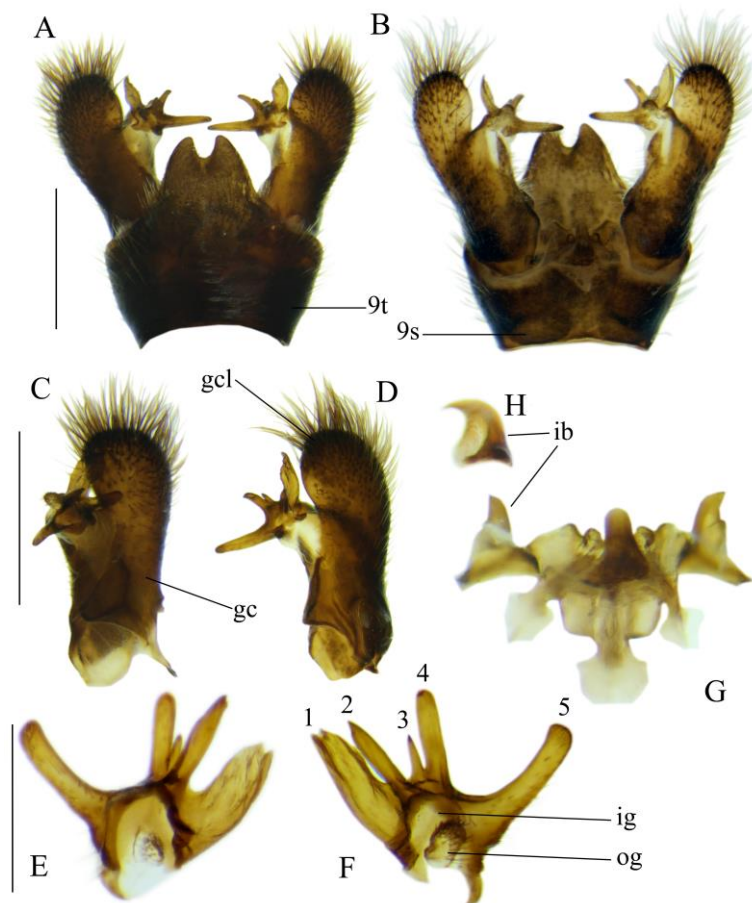
**Recognition of *Pentacyphona* Alexander, 1968:** The genus can be separated from the other genera based upon the detail of the male hypopygium: gonocoxite without interbases, inner gonostylus five lobed and outer gonostylus reduced to a globular or an oval small lobe with long hairs. The 9<sup>th</sup> tergite is well developed, with a great projection in the apical parts, sometimes with a notch on the tip. The gonostylus and 9<sup>th</sup> tergite are frequently covered in long hairs.

##### Deatails of the description of the new *Pentacyphona* sp. Kolcsár sp. n. presented in the thesis.

**Diagnosis:** The new species belongs to the genus *Pentacyphona* based on the five lobed inner gonostylus, reduced outer gonostylus to a small rounded lobe and the absence of interbases (Fig. 6). The Carpathian *Pentacyphona* sp. Kolcsár sp. n. differ from all American related species by the presence of a large apical lobe on the gonocoxite and the supernumerary spurs (2-6, generally 4) on tarsomere I.

**Distribution:** The newly discovered *Pentacyphona* species represents the first member of the genus in the Palearctic Region.

Here I raise *Pentacyphona* to genus rank, based on the male genitalia structure, which clearly differ from the type species of *Tricyphona* (*T.*) *immaculata* and to other members of European *Tricyphona*.



**Fig. 6.** Male Terminalia of *Pentacyphona* sp. Kolcsár sp. n. A. hypopygium dorsal view. B. hypopygium ventral view. C. gonocoxite and gonostylus inner lateral view. D. gonocoxite and gonostylus dorsal view. E. Gonostyli inner lateral view. F. gonostyli outer lateral view. G. aedeagus complex ventral view. H. modified interbase?.

Abbreviation: gc – gonocoxite, gcl – gonocoxal lobe, 9t – 9<sup>th</sup> tergite, 9s – 9<sup>th</sup> sternite, ig – inner gonostylus, og – outer gonostylus, ib – interbase?. Numbers refer to the lobes of inner gonostylus. Scale bars: A-D = 1 mm; E-G = 0.5 mm.

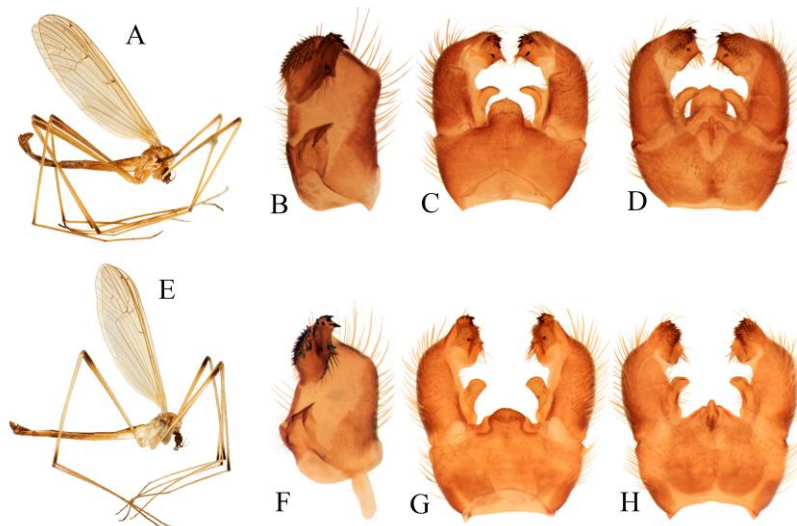
### 3.2.3. Description of three new *Pedicia* (*Crunobia*) species (Diptera, Pediciidae) from Romania

#### Introduction

*Crunobia* was established as a separate genus by Kolenati (1859) for the European widespread species *straminea* (Meigen, 1838) and later as a subgenus of *Pedicia* by Edwards (1938). A revision of the entire species group was suggested on the basis of an intensive sampling in the whole distribution area. Later, an exceptionally high molecular variability was detected within the *P. staryi* group, hence the emerging need for a comprehensive revision (Dénes et al. 2015).

#### *Pedicia* (*Crunobia*) *apusenica* Ujvárosi and Starý 2003 - redescribed

**Diagnosis:** all flagellomeres are almost uniformly colored, and there are no dark lines between antennae; the abdominal stripe starts from the second segment; the tip of the last palpus segment is darker than other segments; 9th tergite has a rounded median lobe, with a small apical emersion (Fig. 7A-D). **Distribution:** This species is known only from Western Romanian Carpathians (Apuseni Mts.).



**Fig. 7.** A-D. *Pedicia apusena* male: A. lateral habitus, B. inner lateral view of the gonocoxite, C. male hypopygium dorsal view, D. male hypopygium ventral view; E-H. *Pedicia roxolanica* male: E. lateral habitus, F. inner lateral view of the gonocoxite, G. male hypopygium dorsal view, H. male hypopygium ventral view.

***Pedicia (Crunobia) roxolanica* Kolcsár, Keresztes and Dénes, 2016**

**Diagnosis:** all flagellomeres are almost uniformly colored; the abdominal stripe starts from the first segment; the tip of last palpus segment is the same color as the other segments; 9th tergite has a rounded or rarely five angled median lobe, with a notch on the tip or rarely with a small apical emergence (Fig. 7E-H). **Distribution:** Our current knowledge suggests the species is found in the eastern parts of the Southern Carpathians (Iezer and Bugeci Mts.) and the western parts of Curvature Carpathians (Baiu Mts.).

***Pedicia (Crunobia) costobocica* Kolcsár, Keresztes and Dénes, 2016**

**Diagnosis:** the last 1–2 antennal segments are darker than others; black line between antennae; the abdominal stripe starts from the second segment; mean body size reach 13 mm; pedicel and scape darker than first flagellomere, face dark brown; 9th tergite has a rounded median lobe, usually with a notch on the tip. **Distribution:** This species known only from the Gutâi Mts. (Eastern Carpathians).

***Pedicia (Crunobia) carpianica* Kolcsár, Keresztes and Dénes, 2016**

**Diagnosis:** the last 1–2 antennal segments are darker than the others, black line between antennae; the abdominal stripe starts from the second segment; mean body size reaches 15.4 mm; pedicel and scape have the same color as the first flagellomeres; only the lump is darker than other parts of the head; 9th tergite has a rounded or five angled median lobe, usually with a notch on the tip. **Distribution and ecology:** *P. carpianica* was collected only from the southern parts of the Rodnei Mts. (Eastern Carpathians).

***Pedicia (Crunobia) staryi* Savchenko, 1978 - redescribed**

**Diagnosis:** the last 1–3 antennal segments are darker than others; black line between antennae; two brown spots on the scutum; abdominal dorsal stripe starts from first abdominal segment; 9th tergite has a rounded or five angled median lobe, sometimes with a notch on the tip. **Distribution:** This is the most widespread species of the group. It is found north to the Rodnei Mts, in the Eastern Carpathians.

### **3.3. Limoniidae**

Short-palped crane flies (Limoniidae) are the largest tipuloid family, with about 10,600 recognized species (Oosterbroek 2018). At present about 750 limonid species belonging to 63 genera are reported from the Westpalaeartic region and new species frequently described (Oosterbroek 2018). The true distribution of some species still unknown, but most of the species have a large distribution in Europe.

#### **3.3.1. New faunistic records of Limoniidae**

In the following section I present an overview of Croatia Limoniidae research. Furthermore, *Erioptera*, *Limonia* and *Molophilus* were the most abundantly collected genera, with 64% of all total specimens investigated belonging to these genera. I also present a general overview of genera in separate paragraphs, based publications Kolcsár et al. 2015a,b, 2017a,b.

#### **Croatian Limoniidae**

##### **Introduction**

The Croatian Limoniidae fauna is less studied, despite the relatively large number of publications. Oosterbroek and Simova-Tosic (2004) gave a list of Pediciidae and Limoniidae species of Croatia, based literature data.

#### **Genus *Limonia* Meigen, 1803**

##### **Introduction**

The genus *Limonia* is the type genus of the Limoniinae subfamily and contains 28 species in the West-Palaeartic area (Starý 2017, Oosterbroek 2018). Many *Limonia* species are widely distributed and can be common in various habitats. However some have a far more restricted distribution or are known only from specific countries.

#### **Genus *Erioptera* Meigen, 1803**

##### **Introduction**

The short-palped crane fly genus *Erioptera* Meigen, contains 286 species worldwide and 29 species are reliably known from the West-Palaeartic area (Oosterboek 2018). Despite the fact that they are abundant in their habitats, *Erioptera* species biology, ecology and distribution are poorly known. Here we report a number of species for the first time from various European countries and discussing their habitat preference (in the thesis).



## Genus *Molophilus* Curtis, 1833

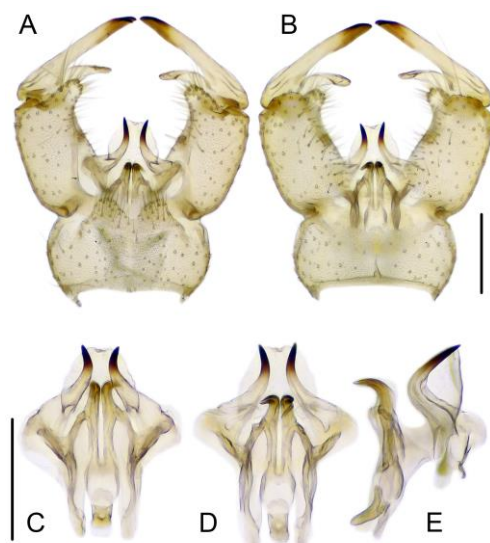
### Introduction

*Molophilus* Curtis, 1833 is the most species-rich genus in the Western-Palaeartic region, belonging to Limoniidae (Diptera). The species can be easily identified based on male robust hypopygium). At the present 98 species and subspecies are known to occur in the Western-Palaeartic region (Oosterbroek 2018, Starý 2011, Kolcsár et al. 2015b).

### Results

After processing more than 6,000 Limoniidae specimens from Southeastern Europe, we identified 1 species from Albania, 6 from Bulgaria, 3 from Bosnia and Herzegovina, 8 from Greece, 14 species from Croatia, 8 species from Montenegro, 7 from Macedonia, 6 species from Serbia and 33 species from Romania, which were previously not reported from these countries.

We reported the following species for the first time from Croatia: *Ellipteroides* (*Ellipteroides*) *lateralis* (Macquart, 1835), *Molophilus* (*M.*) *brevihamatus* Bangerter, 1947, *M. (M.) bifidus* Goetghebuer, 1920, *M. (M.) repentinus* Starý, 1971, *Ormosia* (*Oreophila*) *bergrothi* (Strobl, 1895), *Rhabdomastix* (*Rhabdomastix*) *edwardsi* Tjeder, 1967, *Rhypholophus phryganopterus* Kolenati, 1860, *Eloeophila miliaria* (Egger, 1863), *Paradelphomyia* (*Oxyrhiza*) *senilis* (Haliday, 1833), *Dicranomyia* (*D.*) *imbecilla* Lackschewitz, 1941, *D. (D.) lucida* de Meijere, 1918, *Ellipectera* *omissa* Schiner, 1863, *Lipsothrix nobilis* Loew, 1873, *Lipsothrix remota* (Walker, 1848). *Erioptera* (*E.*) *divisa* (Walker, 1848), *Erioptera* (*E.*) *lutea lutea* Meigen, 1804, *Molophilus* (*M.*) *crassipygus* de Meijere, 1918, *M. (M.) medius* de Meijere, 1918 and *Limonia phragmitidis* (Schrank, 1781) first recorded from Greece. We are reported *Erioptera* (*E.*) *flavata* (Westhoff, 1882), *Erioptera* (*E.*) *griseipennis* Meigen, 1838 for the first time from Bosnia and Herzegovina. *E. (E.) minor* de Meijere, 1920 (Fig. 8) and *M. (M.) occultus* de Meijere, 1918 new to Romanian fauna. We published the first records of *Limonia pannonica* (Kowarz, 1868) from Macedonia, *Erioptera* (*E.*) *fusculeta* Edwards, 1938 from Austria, Montenegro, and Serbia, *E. (Mesocyphona) bivittata* (Loew, 1873) from Serbia, *Molophilus* (*M.*) *cinereifrons* de Meijere, 1920 from Bulgaria and *L. splendens* Kuntze, 1920 from Serbia and Macedonia.



**Fig. 8.** *Erioptera* (*Erioptera*) *minor* de Meijere, 1920: A – male hypopygium dorsal view; B – male hypopygium ventral view; C – aedeagus complex dorsal view; D – aedeagus complex ventral view; E – aedeagus complex lateral view.

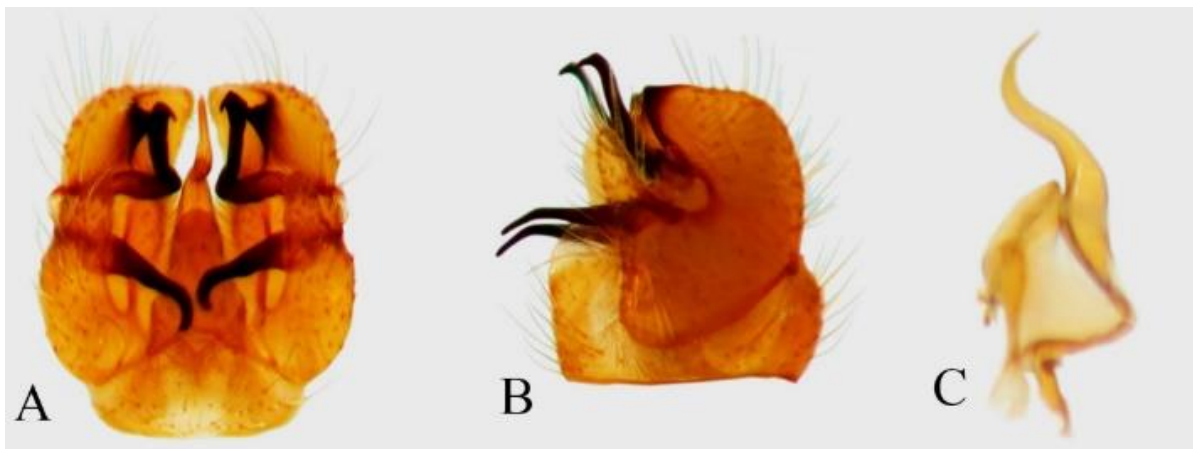
### 3.3.2. Description of a new *Molophilus* Curtis, 1833 (Diptera: Limoniidae) from Bulgaria

#### Introduction

I described a new species which is closely related to *M. serpentiger* Edwards, 1938 and *M. variispinus* Starý, 1971. Both of the two closely related species, share a unique feature within the genus *Molophilus*, the presence of an S-shaped outer gonostylus (Starý 1971a,b).

#### Results

Deatails of the description of *Molophilus (Molophilus) balcanicus* Kolcsár, 2015 presented in the thesis and Kolcsár et al. 2015b.



**Fig. 9.** *Molophilus (Molophilus) balcanicus* Kolcsár. A. male hypopygium, ventral (tergal) view B. male hypopygium, lateral view C. aedeagal complex, lateral view.

**Diagnosis:** Small species with yellowish orange general colour, body length is 4-4.5 mm and wing length 5 mm. It is very close to *Molophilus serpentiger* and *M. variispinus*. Inner gonostylus thick, narrows to end. Outer gonostylus thick S-shaped having a hook like end (Fig. 9A-C).

### 3.3.3. Description of a new *Dicranomyia* Stephens (Diptera: Limoniidae) from Bulgaria

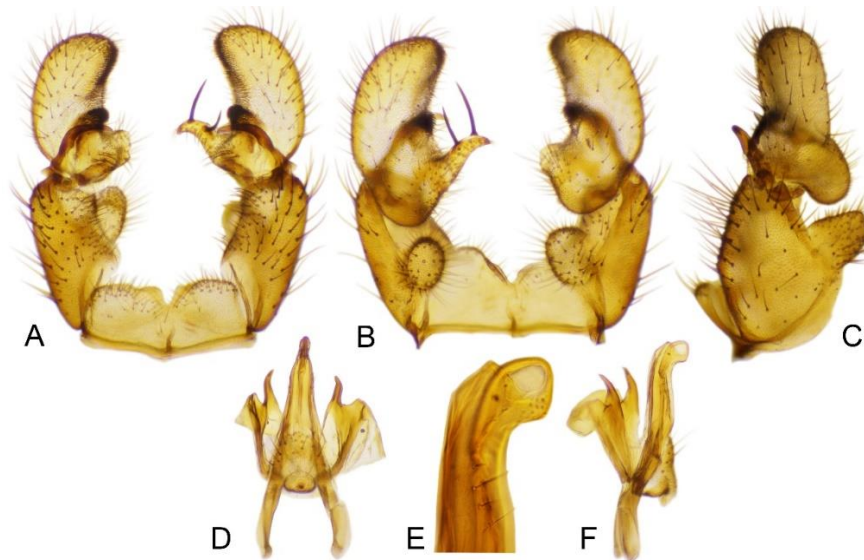
#### Introduction

*Dicranomyia* Stephens is a species rich group within short-palped crane flies (Limoniidae). *D. goritiensis* (Mik) group was mentioned by Savchenko (1984) and the conception of the group was corrected by Geiger and Starý (1994). A new species is described from Bulgaria, belongs to the *circassica* subgroup.

## Results

### Deatils of the description of the new *Dicranomyia (Dicranomyia) sp.* Kolcsár sp. n. presented in the thesis.

**Diagnosis:** A large species for *Dicranomyia*. A thumb-like lobe on dorsal face of the outer gonostylus is present, with densely covered short, black spine-like hairs (Fig. 10). The wings are decorated with large dark spots including a large, obvious one present at the apical end of the wing, which distinguishes the species from other members of *D. goritiensis* group.



**Fig. 10.** *Dicranomyia sp.* Kolcsár sp. n. A-C. hypopygium, aedeagal complex removed. A. dorsal view. B. ventral view. C. lateral view. D-F. Aedeagal complex. D. ventral view. E. lateral view. F. lateral view.

**Discussion:** The species can be distinguished from other species with that subgroup by the presence of a large spot on the tip of the wing.

## 3.4. Cylindrotomidae

Cylindrotomidae or long-bodied crane flies are a small diptera family, within Tipuloidea. To date, 70 recognized species are known worldwide, from which eight species are reported from West Palaearctic (Paramonov 2005, Oosterbroek 2018, Salmela 2013).

### 3.4.1. New faunistic records of Cylindrotomidae

During a trip in Serbia we collected seven Cylindrotomidae specimens in Kopaonik Mountains, which represent the first records of the family in Serbia. Additional records of long-bodied crane fly species are listed from Bulgaria and Romania.

#### 1. *Cylindrotoma distinctissima distinctissima* (Meigen, 1818)

Comments: We presented the first records of *Cylindrotoma distinctissima distinctissima* (Meigen, 1818) from Serbia, which represented a new family (Cylindrotomidae, Diptera) to the dipteran fauna of the country (Kolcsár et al. 2017a).



### 3.5. Trichoceridae

Trichoceridae or winter crane flies are a relatively small dipteran group. The genus *Trichocera* includes four subgenera. Among these subgenera, members of *Metatrachocera* showing the most spectacular and complex male genitalia.

#### 3.5.1. New faunistic records of Trichoceridae

Approximatively 2000 winter crane fly specimen were collected from Bulgaria, Montenegro, Romania and Serbia, between 2014 and 2018. The material only partly identified by me so far, only the 19 specimen belong to *Metatrachocera* subgenus.

##### Results

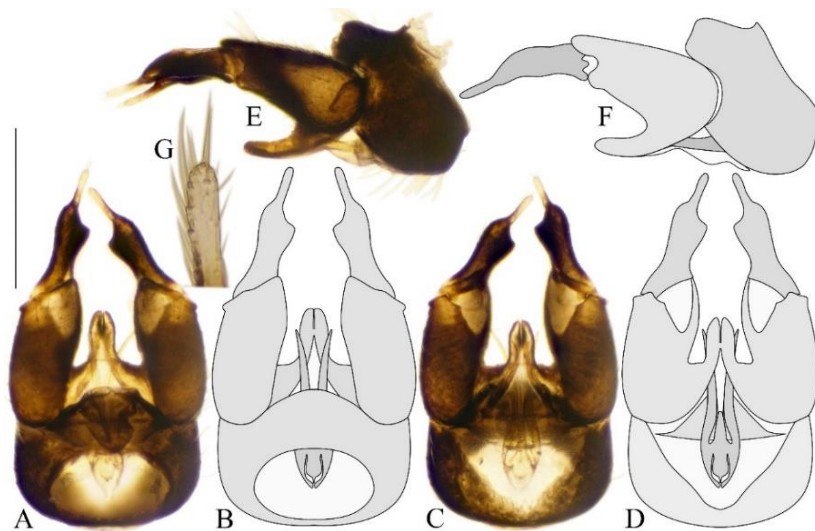
We are reported *Trichocera (Metatrachocera) forcipula* Nielsen, 1920 for the first time from Serbia and Bulgaria. *T. (M.) ticina* Starý and Podénaš, 1995 is a very rare trichocerid species. The species is reported here for the first time from Romania and Serbia, which together with *Trichocera forcipula*, represents the first records of Trichoceridae from Serbia.

#### 3.5.2. Description of a new *Trichocera (Metatrachocera) Dahl (Diptera, Trichoceridae) from Bulgaria*

**Details of the description of the *Trichocera (Metatrachocera) unica* Kolcsár, 2018 presented in the thesis and in Kolcsár et al. 2018.**

**Diagnosis:** Medium sized species, with relatively simple gonostylus, which is cylindrical in general, with a rounded projection on the interior margin in the middle, the apical end of gonostylus yellowish and finger-like. Gonocoxite cylindrical in dorsal view and the bridge distinctly fused (Fig. 11). **Distribution and ecology:** The new species is probably widely distributed in the Stara Planina Mountains and in the surrounding areas.

**Taxon discussion:** The species is unique and has a relatively simple genitalia within *Metatrachocera*, probably representing a new species group. We include the species into *Metatrachocera* based on the relatively narrow anal cell.



**Fig. 11.** *Trichocera (Metatrachocera) unica* Kolcsár, 2018 male genitalia: dorsal view A. photograph, B. schematic illustration, ventral view, C. photograph, D. schematic illustration; lateral view, E. photograph, F. schematic illustration; G. close view of apical part of gonostylus. Scale bar: 0.5 mm.

#### 4. Faunistic and taxonomic research of the infraorder Bibionomorpha

Bibionomorpha is a megadiverse group, which comprises different families, based on the concept of different authors. Bibionomorpha is a poorly known group compared with the Tipulomorpha in the study area, indeed the Bibionomorpha fauna of Southeastern Europe is barely known compared with other regions of Europe. In the following chapter I present the faunistic and taxonomic study of fungus gnats in Romania, Montenegro, and Serbia based upon the publication by Kolcsár and Salmela (2017b). Study of Sciaridae in Romania is presented based on a submitted manuscript. Faunistic study of Anisopodidae in Romania is presented based on the publication Kolcsár et al. 2016.

#### New taxonomic and faunistic records of fungus gnats (Insecta, Diptera) from Montenegro, Romania, and Serbia

##### Introduction

The first Romanian Sciaroidea records were published in the mid-19th century and after summarizing the all known literature data we suggest that a total of 270 fungus gnats species are reported from the country. The Sciaroidea of Montenegro and Serbia has been much less investigated and no national checklist has hitherto been published. We suggest that a total of 168 fungus gnats species are known from these countries, previous to this paper.

#### **4.1. Bolitophilidae**

Bolitophilidae is a small fungus gnat family. The family is mainly Holarctic in distribution (Ševčík and Papp 2004).

##### **Results**

After identification of 14 Bolitophilidae specimen from Romania and Montenegro, we identified *Bolitophila (B.) austriaca* (Mayer, 1950), *B. (B.) saundersi* (Curtis, 1836) and *B. (Cliopisa) melanoleuci* Polevoi, 1996 from Montenegro and *B. (B.) austriaca* (Mayer, 1950), *B. (B.) tenella* Winnertz, 1864 and *B. (Cliopisa) occlusa* Edwards, 1913 from Romania, which were previously not reported from these countries.

#### **4.2. Diadocidiidae**

Diadocidiidae is a small family, with only 24 recognized species in the genus *Diadocidia* Ruthe, 1831 (Bechev and Chandler 2011). Most European species are widespread, but rare collected (Rindal and Gammelmo 2007).

##### **Results**

Only a single male *Diadocidia (Diadocidia) spinosula* Tolle, was collected by my in Romania. Thus this data it is the first detailed collection data of the species from Romania.

#### **4.3. Ditomyiidae**

This is a small dipteran family, which represents a basal lineage within Sciaroidea (Ševčík et al 2016). Two species of *Ditomyia* have a Central European distribution, while the two *Symmerus* are wider spread in Europe (Mamaev and Krivosheina 1988, Gammelmo and Rindal 2006).

##### **Results**

Only 5 Ditomyiidae specimen, belong to *Ditomyia fasciata* (Meigen, 1818) and *Symmerus annulatus* (Meigen, 1830) species was collected in Romania. Both species previously reported from Romania.

#### **4.4. Keroplatidae**

The Keroplatidae is a universally distributed fungus gnat family, with nearly 1000 described species (Evenhuis 2006). At present 16 genera with more than 110 species are recognised from Europe (Chandler 2013).

##### **Results**

After identification of 21 Keroplatidae specimen we identified *Keroplatus dispar* Dufour, 1839, *K. reaumurii reaumurii* Dufour, 1839, *Macrorrhyncha rostrata* (Zetterstedt, 1851), *Monocentrotia matilei* Bechev, 1989, *Urytalpa rhapsodica* Chandler, 1995, *Macrocera*

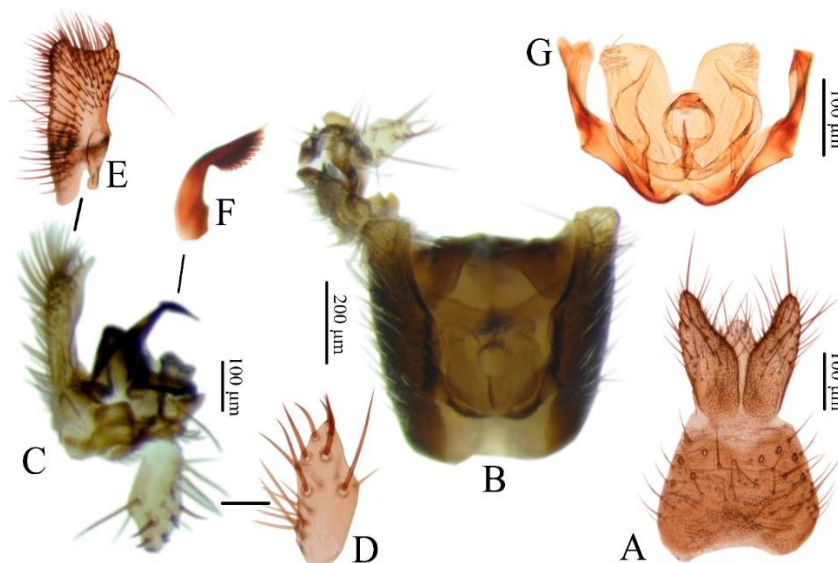
*longibrachiata* Landrock, 1917, and *M. pilosa* Landrock, 1917 species from Romania, *Cerotelion striatum* (Gmelin, 1790) from and Serbia, which were previously not reported from these countries. In addition, I collected *Cerotelion striatum* (Gmelin, 1790) in Gjipe Canyon, Albania in 27 June 2017 (unpublished data). Based Catalog of Keroplatidae of the World (Evenhuis 2006) no Keroplatidae species reported from Albania. Based on this is the first record of Keroplatidae from Albania.

#### 4.5. Mycetophilidae

This is the largest fungus gnat family, with more than 3000 described species (Bechev 2000). Approximately 1100 species are described from Europe (Jakovlev et al. 2014). Southeastern Europe is poorly known, with only the Bulgarian and Romanian fauna a little better investigated, compared to neighbouring countries. However even these species numbers are comparatively low if we compare against better investigated European countries.

#### Results

After identification of 112 Mycetophilidae specimens we identified *Mycomya* (*Mycomya*) *alpina* Matile, 1972, *M. (M.) egregia* (Dziedzicki, 1885), *M. (M.) neohyalinata* Väisänen, 1984, *Phthinia humilis* Winnertz, 1864, *Boletina joosti* Plassmann, 1987, *Coelophthinia thoracica* (Winnertz, 1864), *Docosia expectata* Laštovka and Ševčík, 2006, *Allodia* (*Allodia*) *lundstroemi* Edwards, 1921, *Anatella ciliata* Winnertz, 1864, *Synplasta gracilis* Winnertz, 1864, *Synplasta rufilatera* (Edwards, 1941), *Mycetophila deflexa* Chandler, 2001, *Mycetophila lastovkai* Caspers, 1984, *Mycetophila stylata* (Dziedzicki, 1884), *Phronia nigricornis* (Zetterstedt, 1852), and *Trichonta vulcani* (Dziedzicki, 1889) species from Romania, and *Mycomya* (*Mycomyopsis*) *trilineata* (Zetterstedt, 1838), *Coelosia fusca* Bezzi, 1892, *Docosia gilvipes* (Walker, 1856), *Exechiopsis* (*Exechiopsis*) *unguiculata* (Lundström, 1911), *Rymosia lundstroemi* Dziedzicki, 1910, *Mycetophila marginata* Winnertz, 1864, and *Phronia forcipula* Winnertz, 1864 from Montenegro, which were previously not reported from these countries. A rare species, namely *Trichonta comis* Gagné, 1981 redescribed (Fig. 12) and an identification key to European *Boletina trivittata*-group species also presented.



**Fig. 12.** *Trichonta comis* male hypopygium. A. 9th tergite and cerci, dorsal view. B. hypopygium, dorsal view. C. gonostylus, inner lateral view. D. dorsal lobe of gonostylus. E. apical half of the ventral lobe of gonostylus. F. median projection of ventral lobe of gonostylus, dorsolateral view. G. aedeagus.

## 4.6. Sciaridae

### 4.6.1. New faunistic records of Sciaridae (Insecta, Diptera) from Romania

Dark-winged fungus gnats (Sciaridae) are a large and universally distributed family, with more than 2400 described species (Carvalho Fernandes 2016). Approximately 700 species, belong to 34 genera are reported from Europe (Heller and Menzel 2009). The Romanian Sciaridae fauna is very poorly known. After summarizing the all Romanian literature data, we compiled 87 species occurring in country, previous to this study. The present chapter aims to improve the faunistic knowledge of dark-winged fungus gnats in Romania and provides an updated checklist of Sciaridae and publish the first DNA barcodes for some species.

#### Results

Here we list those species, which were previously not reported from Romania or which are otherwise important records in connection with the DNA results: *Bradysia barbarossae* Mohrig and Mamaev, 1970, *Bradysia lobata* Hondru, 1968, *Bradysia neopraecox* Rudzinski, 1996, *Bradysia nitidicollis* (Meigen, 1818), *Bradysia pectoralis* (Staeger, 1840), *Bradysia scabricornis* Tuomikoski, 1960, *Bradysia subaffinis* Mohrig and Krivosheina, 1989, *Bradysia trivittata* (Staeger, 1840), *Corynoptera flavosignata* Menzel and Heller, 2006, *Corynoptera praeforcipata* Mohrig and Mamaev, 1987, *Corynoptera tridentata* Hondru, 1968, *Cosmosciara pernicioso* (Edwards, 1922), *Cratyna (Peyerimhoffia) vagabunda* (Winnertz, 1867), *Epidapus (Epidapus) gracilis* (Walker, 1848), *Epidapus (Epidapus) microthorax* (Börner, 1903), *Leptosciarella (Leptosciarella) melanoma* (Mohrig and Menzel, 1990), *Pnyxia scabiei* (Hopkins, 1895), *Pseudolycoriella bruckii* (Winnertz, 1867), *Pseudolycoriella hispana* (Lengersdorf, 1957), *Pseudolycoriella paludum* (Frey, 1948), and *Scatopsciara (Scatopsciara) calamophila* Frey, 1948.

#### Discussion

The results suggest a potentially species-rich, but poorly researched Sciaridae fauna of Romania. Most of the recorded species proved to be common and widespread. Nevertheless, this study helped to reveal some previously unknown or undetected DNA barcodes. The barcode reference for European Sciaridae is still far from being complete. Particularly the Southern and Eastern part of Europe is still underrepresented.

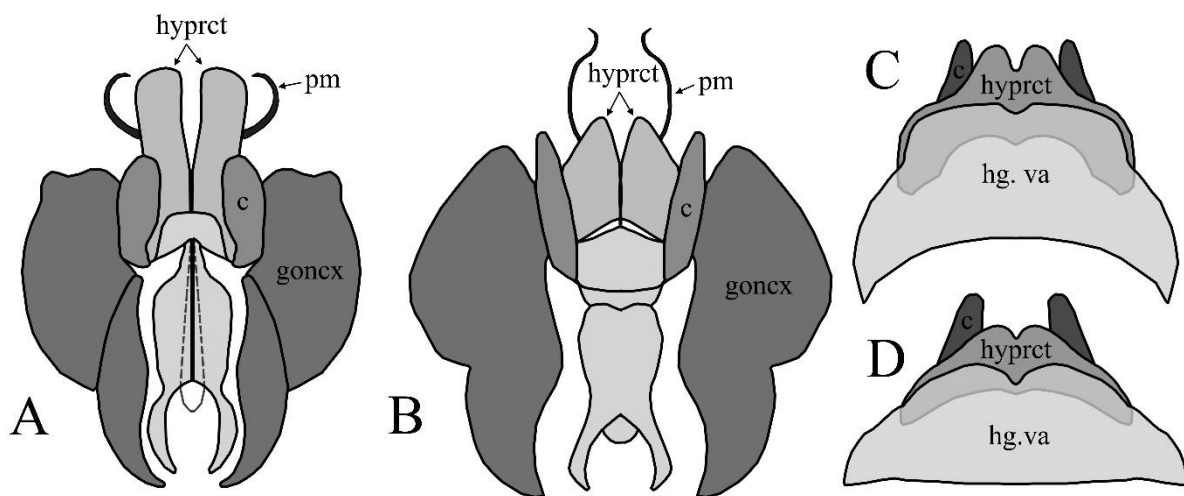
## 4.7. Anisopodidae

### 4.7.1. New faunistic records of *Sylvicola* (Diptera: Anisopodidae)

Anisopodidae is a relatively small family of Bibionomorpha *sensu lato* (Ševčík et al. 2016). The genus *Sylvicola* comprising ten species is known from Europe (de Jong et al. 2014). Distribution of the family is mostly unknown in Balkan countries.

#### Results

In total 96 male and 186 female *Sylvicola* specimens were collected that belong to three species of which *Sylvicola cinctus* and *S. fuscatus* (Fig. 13A,C) are new to the Romanian fauna. *Sylvicola cinctus* represents the first record of Anisopodidae from Albania, and it is the first reliable data of Anisopodidae from Croatia. Four species of *Sylvicola* are now known from the study area.



**Fig. 13.** *Sylvicola punctatus* (Fabricius, 1787) (A,C). *Sylvicola fuscatus* (Fabricius, 1775) (B,D). A-B. Dorsal view of the male terminalia. C-D. Ventral view of the female terminalia. Abbreviations: c=cercus, hyprct=hypoproct, hg.va=hypogynal valves, goncx=gonocoxite, pm=paramere.

## 5. Taxonomic research of the family Ptychopteridae

The phantom craneflies (Ptychopteridae) are tipuloid-like flies. Only 15 species are known from Europe and the species can be relatively easily separated based upon the wing venation and pattern, and the details of male and female genitalia. An important morphological difference was noticed between different populations of *Ptychoptera albimana* in Europe (Ujvárosi et al. 2011a), and a new species, *Ptychoptera incognita* Török, Kolcsár and Keresztes, 2015 is described using an integrative approach from Bulgaria and Romania (Török et al. 2015).

## 5.1. Description of a new *Ptychoptera* (Diptera, Ptychopteridae) from Bulgaria and Romania

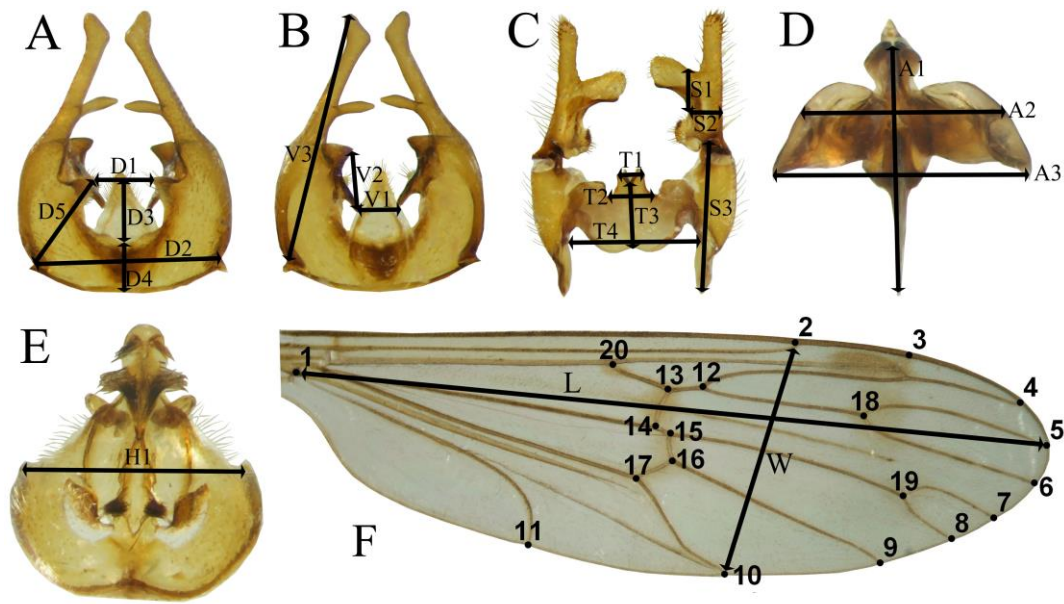
*Ptychoptera albimana* can be readily distinguished from all other members of the family by having the first metatarsomere of the hind legs white colored. *P. albimana* was considered monotypic and there were no detailed data on morphological and genetic variability of the species in its range. Quite recently an important morphological difference was noticed between different populations in Europe (Ujvárosi et al. 2011a). In the present study we analyze the morphological and genetic variability in allopatric populations of the species and test taxonomic hypotheses using an integrative approach.

**Geometric and linear morphometry:** Position of 20 landmarks at the vein intersections or terminations were designated and digitalized using TPSDig v2.16 (Fig. 14F) in cases of right wings. Linear morphometry was applied in the case of 101 male genitalia. We quantified morphological variation among surveyed populations by comparing 19 morphological features of the male genitalia.

Our morphometric data show two highly divergent morpho-groups within the widespread *P. albimana*, named below as morphotype A (the typical *albimana* generally distributed in Europe and Minor Asia) and morphotype B (the morphological divergent populations – *P. incognita* from the Carpathians and Rhodope Mountains). Specimens of *Ptychoptera incognita* had significantly longer and wider wings than specimens of *P. albimana* (Fig. 15D). The differences between the two species genitalia were based on 19 measured characters. *P. incognita* specimens had larger genitalia.

**Molecular methods and data analyses:** For genomic DNA analysis we used legs of 30 identified specimens (4 *P. contaminata* and 26 *P. albimana*), and unique accession numbers were assigned in accordance with the Barcode of Life Data System.

In the case of the ML tree, two haplotypes of *P. albimana* representing individuals from the United Kingdom and Poland were linked to sequences of the outgroup species *Bittacomorpha clavipes*. One haplotype shared by both morpho-groups form a clade with sequences of *Ptychoptera contaminata* without significant bootstrap (BP) support. A third clade was formed by sequences of both morphotypes without any further lineage differentiation (Fig. 16).



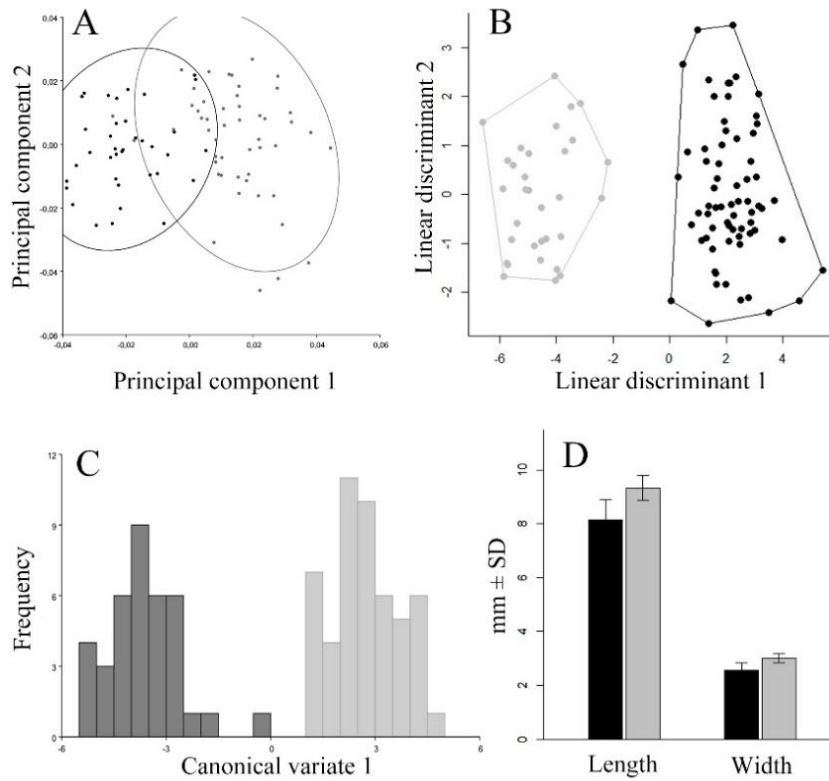
**Fig. 14.** Measured characters on parts of male genitalia (A-E). A. dorsal view of 9th tergite and surstyle, B. ventral view of 9th tergite and surstyle, C. ventral view of style and tegmen; D. ventral view of aedeagus, E. ventral view of hypandrium. F. Position of 20 landmarks and illustration of wing length (L) and width (W).

**Deatils of the description of the *Ptychoptera incognita* Török, Kolcsár and Keresztes, 2015 presented in the thesis and in Török et al. 2015**

**Diagnosis:** *Ptychoptera incognita* is similar to the sibling species *P. albimana* by coloration, shape of antenna and numbers of antennal segments, but they differ in a series of details on genitalia (in Fig. 17) and wing design (Fig. 17I,J). **Distribution:** Our data suggests that this new taxa is present in the Romanian Carpathians and Rhodope Mountains (Bulgaria).

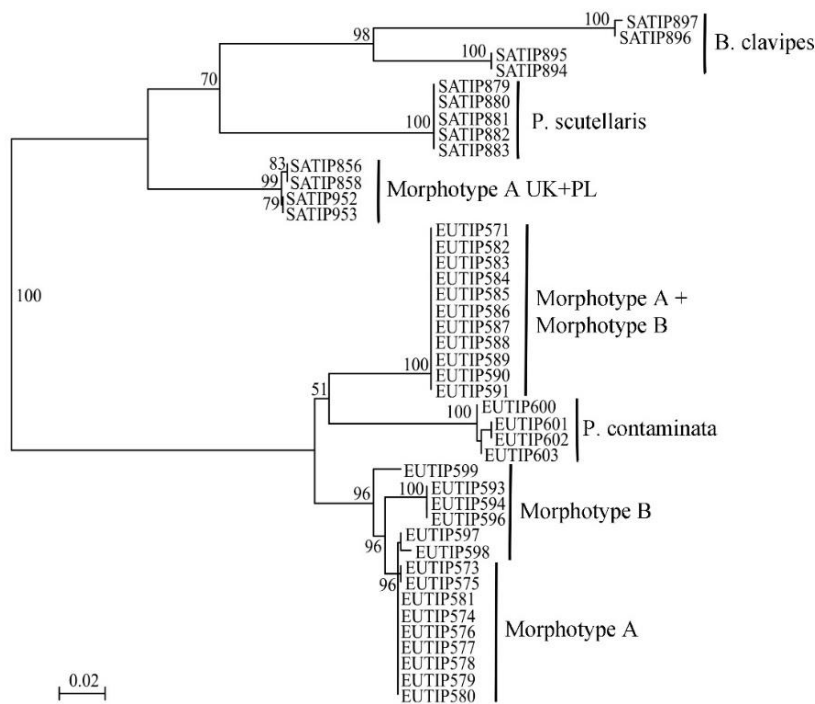
**Discussion:** The presence of two highly divergent morphological structures among *P. albimana* were statistically well supported by linear and also by geometric morphometry.



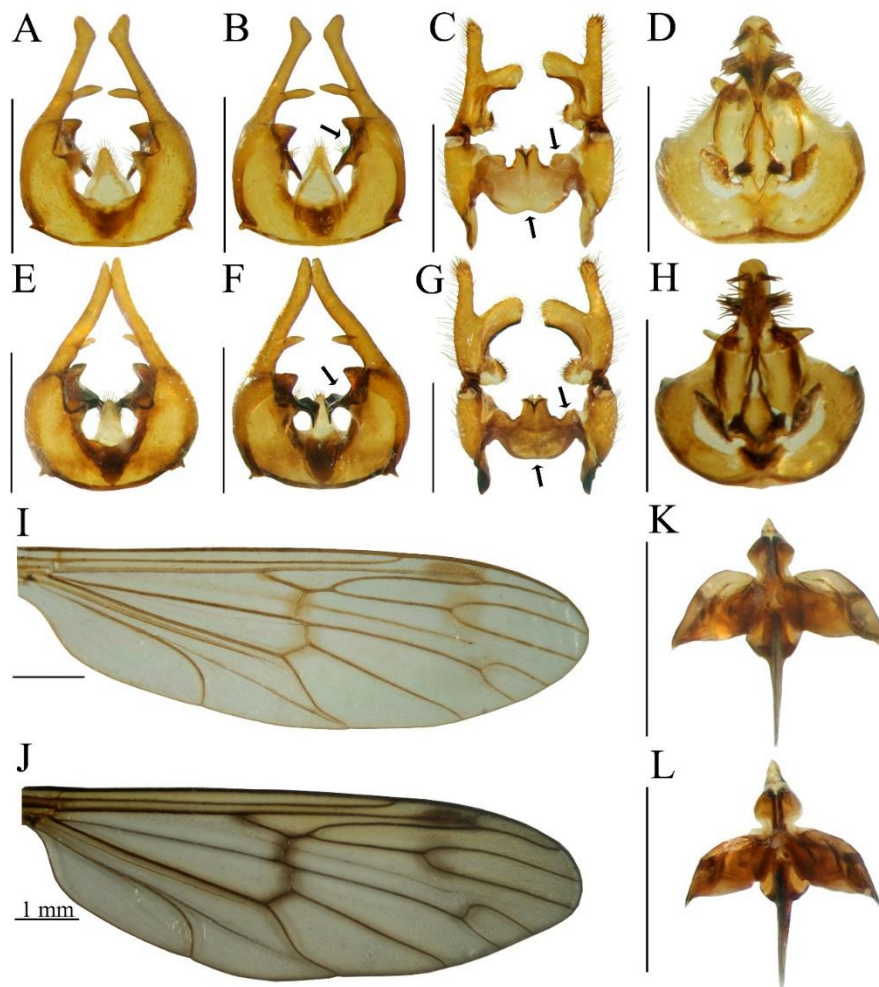


**Fig. 15.** A: Scatter plot from the Principal Component Analysis, based on position of 20 wing landmarks. Black points: morphotype A = *Ptychoptera albimana*; gray points: morphotype B = *Ptychoptera incognita*. B: D based on 19 measured character on male genitalia. Black points: morphotype A; gray points: morphotype B. C: Scatter plot from the CVA, based position of 20 wing landmarks. Dark gray column: morphotype A; light gray column: morphotype B. D: Column chart of size of wing length and width, black column:

morphotype A; gray column: morphotype B.



**Fig. 16.** Maximum Likelihood (ML) COI phylogenetic tree of *Ptychoptera albimana* (morphotype A) and *Ptychoptera incognita* (morphotype B) with *Bittacomorpha clavipes*, *Ptychoptera contaminata* and *Ptychoptera scutellaris* as outgroups.



**Fig. 17.** Parts of male genitalia and wing of *Ptychoptera albimana* (morphotype A) (A-D, K,I) and *Ptychoptera incognita* (morphotype B) (E-H, L, J). A,E. dorsal view of 9th tergite and surstyle. B,F. ventral view of 9th tergite and surstyle. C,G. ventral view of style and tegmen. D,H. ventral view of hypandrium. I, J. right wing. K,L. ventral view of aedeagus. The most distinctive characters between two species indicated with arrows.

## 6. Other faunistic records

Here is a list all other Diptera species, which were first reported by me and co-authors, but do not belong to the target groups or were collected outside of the study area of this thesis.

**Tipulidae:** We reported *Dolichopeza (Oropeza) modesta* (Savchenko, 1980), *Tipula (Pterelachisus) apicispina* Alexander, 1934, and *T. (T.) italica errans* Theowald, 1984 from Austria.

**Pediciidae:** We published the first record of *Dicranota (Paradicranota) subtilis* Loew, 1871, *Pedicia (Crunobia) pallens* Savchenko, 1978, *P. (C.) straminea* (Meigen, 1838) from Hungary and *P. (Amalopsis) fusca* Ujvárosi and Bálint, 2012 from Ukraine.

**Limoniidae:** *Erioptera (Erioptera) fusculeta* Edwards, 1938 first reported from Austria, *E. (E.) longicauda* Loew, 1871 from Hungary. *Molophilus (M.) flavus* Goetghebuer, 1920 from Andorra, *M. (M.) corniger* de Meijere, 1920 from Spain.

**Keroplatidae:** We reported *Ioneuromyia semirufa* (Meigen, 1818) from Ukraine and *Orfelia boreoalpina* Salmela, 2017 from Finland, Germany.

**Mycetophilidae:** We identified *Sciophila holopaineni* Salmela, 2017, *Sciophila curvata* Salmela, 2017, *Phronia reducta* Salmela, 2017 from Finland and Russia, *B. sasakawai* Salmela and Kolcsár, 2017 from Japan. *B. norokorpii* Salmela and Kolcsár, 2017 and *Phronia*

*sompio* Salmela, 2017 from Finland. *Phronia elegantula* Hackman, 1970 from Norway, *P. prolongata* Salmela, 2017 from Finland, Norway, Germany, Canada.

The following first reported from Romania:

**Chaoboridae:** *Chaoborus crystallinus* (De Geer, 1794), *C. flavicans* (Meigen, 1830), *C. pallidus* (Fabricius, 1794).

**Stratiomyidae:** *Allognosta vagans* (Loew, 1873).

**Rhagionidae:** *Ptiolina obscura* (Fallén, 1814).

**Pipunculidae:** *Clistoabdominalis ruralis* (Meigen, 1824), *Dorylomorpha confusa* (Verrall, 1901), *Eudorylas fuscus* (Zetterstedt, 1844), *Eudorylas subfascipes* Collin, 1956, *Eudorylas zermattensis* (Becker, 1898), *Nephrocerus flavicornis* Zetterstedt, 1844, *Pipunculus campestris* Latreille, 1805

**Tephritidae:** *Noeeta pupillata* (Fallén, 1814)

**Agromyzidae:** *Cerodontha denticornis* (Panzer, 1806), *Poemyza lateralis* (Macquart, 1835)

**Sphaeroceridae:** *Pteremis fenestralis* (Fallén, 1820)

## 7. Conclusions

Southeastern Europe remains under-examined in terms of Diptera research. None of the countries has their own Diptera checklist, and only some sporadic faunistic surveys have taken place to add information to the presumably very rich Dipteran fauna. Exceptions are those families, which have epidemiological or economical importance, however these faunistic studies are limited to a few species or groups, like mosquitoes (Culicidae), sandflies (*Phlebotomus* sp.), hoverflies (Syrphidae), and fruitflies (Tephritidae). Our results suggest that in many cases even the common and easily collectible families are reported from some of these countries; eg. Trichoceridae (first record from Serbia, Kolcsár et al. 2018a), Anisopodidae and Keroplatidae (first record from Albania, unpublished data), Chaoboridae (Romania, Soltész et al. 2016), and Dixidae (first records from Bulgaria and Macedonia, unpublished data).

The Balkan Peninsula is one of the most important Glacial refugia and one of the most species rich regions in Europe (Hewitt 2011, Previšić et al. 2014). In the case of Diptera, this is primarily true for those groups, which tolerate the Mediterranean climate, like Syrphidae, Bombyliidae, and Therevidae. In contrast most species of Tipulomorpha, Bibiomorpha and Ptychopteridae are typically associated with wet habitats, and have more diverse communities in humid and colder ecosystems, like wet mountain forests and sub-arctic habitats (Salmela et al. 2016). The *Lunatipula* subgenus (*Tipula*, Tipulidae) is an exception, this group is distributed primarily in the Mediterranean region, and has a biodiversity hotspot in this area (de Jong 1998). Some other Tipulidae groups also have a higher species number in the Mediterranean area, like *Dolicopeza*, *Tipula: Acutipula*, *Mediotipula* (de Jong 1994, 1995, Oosterbroek and Lantsov 2011). However these groups are also connected to wet habitats, and the higher species numbers are the result of the isolation of these habitats, which cause the speciation of these groups. Deep ravine valleys (like the Gjipe canyon in Albania) and cold karst springs (like Plitvice, Krčić and

Krka Springs in Croatia) are typical relict habitats in the Mediterranean area, which create cold microclimatic conditions. Thanks to that, some montane species can be found in these habitats, like *Pedicia occulta*, *Tricyphona immaculata*, *Dicranota bimaculata*, *D. mikiana* (Pediciidae), and *Molophilus repentinus* (Limoniidae).

The Balkan Peninsula Mountains, the Dinaric Alps, Balkan Mountains (Stara Planina), Pindus Mts., Macedono-Rhodope Massif and the Carpathians, all have a decisive role in the case of the groups studied. During my research I investigated only partly areas outside the Carpathians, nonetheless I found and described three new species (*Trichocera unica*, Kolcsár, 2018, *Molophilus balcanicus* Kolcsár, 2015 and *Dicranomyia* sp. Kolcsár sp. n.) from this region, with another three new species waiting for description. From the faunistic point of view, these mountains are true virgin areas, perhaps with the exceptions of the Rila, Pirin and Rodope Mts., which are relatively well-researched by Jaroslav Starý, and many new species were already described from here. Our casual collecting trips to the Balkan Peninsula revealed more than 70 species, which are new to at least one country, of which we have published 40 so far.

The Romanian Carpathians have an important role in the case of speciation of the Pediciidae. This region, with 45 species is the most species rich area in Europe. Six species, namely *Pedicia apusenica*, *P. carpiatica*, *P. costobocica*, *P. roxolanica*, *P. staryi* and the new *Pentacyphona* sp. Kolcsár sp. n. are micro-endemic species, and shown deep genetical divergence from each other and from siblings.

Summarizing our results, the studied groups are highly neglected in the Southeastern Europe, and the poorly known fauna need further surveys.

## 8. List of publications

### Main publications:

1. **Kolcsár LP**, Ivković M, Ternjej I (2015a). New records of Limoniidae and Pediciidae (Diptera) from Croatia. *ZooKeys* 5: 23-37. **IF: 0.938**
2. **Kolcsár LP**, Török E, Keresztes L (2015b). A new species and new records of *Molophilus* Curtis, 1833 (Diptera: Limoniidae) from the Western Palaearctic Region. *Biodiversity data journal* 4: e5466.
3. Török E, **Kolcsár LP**, Dénes AL, Keresztes L (2015). Morphologies tells more than molecules in the case of the European widespread *Ptychoptera albimana* (Fabricius, 1787) (Diptera, Ptychopteridae). *North-Western Journal of Zoology* 11: 304-315. **IF: 0.659**
4. Dénes AL, **Kolcsár LP**, Török E, Keresztes L (2016). Taxonomic revision of the Carpathian endemic *Pedicia* (*Crunobia*) *staryi* species-group (Diptera, Pediciidae) based on morphology and molecular data. *ZooKeys* 569: 81-104. **IF: 1.031**
5. **Kolcsár LP**, Dvořák L, Beuk PL (2016). New records of *Sylvicola* (Diptera: Anisopodidae) from Romania. *Biodiversity Data Journal* 4: e7861.
6. Soltész Z, Török E, **Kolcsár LP**, Katona P, Földvári M, Van Der Weele R, Papp L (2016). Contribution to the diptera fauna of Sălaj county (Romania). *Studia Universitatis "Vasile Goldiș", Seria Științele Vieții* 26: 169-178.

7. **Kolcsár LP**, Salmela J (2017a). New taxonomic and faunistic records of fungus gnats (Insecta, Diptera) from Montenegro, Romania, and Serbia. *Check List* 13: 533-559.
8. **Kolcsár LP**, Török E, Keresztes L (2017a). First record of *Cylindrotoma distinctissima* (Meigen, 1818) from Serbia and new data on the occurrence of Cylindrotomidae (Diptera) in Bulgaria and Romania. *Fragmenta Faunistica* 60: 107-112.
9. **Kolcsár LP**, Soos Á, Török E, Graf W, Rákosy L, Keresztes L (2017b). New faunistic records of the genus *Erioptera* Meigen (Limoniidae, Diptera, Insecta) from Europe. *Entomologica Romanica* 21: 23-44.
10. **Kolcsár LP**, Oláh T, Veres R, Török E, Keresztes L (2017c). New faunistic records of the genus *Limonia* Meigen (Limoniidae, Diptera, Insecta) from the Balkan region. *Entomologica Romanica* 21: 45-59.
11. **Kolcsár LP**, Petrašiunas A, Török E, Keresztes L (2018). A new species of *Trichocera* Meigen with further records of *Metatrachocera* Dahl from Bulgaria, Romania and Serbia (Diptera, Trichoceridae). *Turkish Journal of Zoology* 42: 172-178. **IF: 0.785**
12. Keresztes L, **Kolcsár LP**, Dénes AL, Török E (2018a). Revealing unknown larvae of the *maxima* species group of the genus *Acutipula* Alexander, 1924 (*Tipula*, Tipuloidae, Diptera) using an integrative approach. *North-Western Journal of Zoology* (in press). **IF: 0.733**
13. **Kolcsár LP**, Török E, Keresztes L (2018b). New faunistic records of Pediciidae (Diptera, Insecta) from Europe. *Entomologica Romanica*. Accepted manuscript.
14. **Kolcsár LP**, Veres R, Keresztes L (2018). *TransDiptera Online Database*. Accessed at: Accessed: <http://transdiptera.ro> doi: <https://doi.org/10.18426/obm.5sskml13ip0> Version: 23 May 2018.

#### Submitted manuscripts:

1. **Kolcsár LP** (2018b). Description of a new pattern-winged *Dicranomyia* Stephens (Diptera: Limoniidae) from Bulgaria, with an identification key to the West-Palaearctic species of *Dicranomyia goritiensis* group. *Turkish Journal of Zoology*. **IF: 0.785**
2. **Kolcsár LP**, Heller K (2018). First DNA barcodes and records of Sciaridae (Insecta, Diptera) from Romania. *Turkish Journal of Zoology*. **IF: 0.785**
3. Keresztes L, Menéndez JM, Gonzalez LM, Török E, **Kolcsár LP** (2018b). A new *Mediotipula* (Diptera, Tipulidae) crane fly from Europe, and a contribution to the Eastern Mediterranean hotspot of diversity. *Zookeys*. **IF: 1.031**

#### Other publications:

1. Dénes AL, **Kolcsár LP**, Török E, Keresztes L (2015). Phylogeography of the micro-endemic *Pedicia staryi* group (Insecta: Diptera) evidence of relict biodiversity in the Carpathians. *Biological Journal of the Linnean Society* 119: 719-731. **IF: 1.984**
2. Fenesi A, Vágási CI, Beldean M, Földesi R, **Kolcsár LP**, Shapiro JT, Török E, Kovács-Hostyánszki A (2015). *Solidago canadensis* impacts on native plant and pollinator communities in different-aged old fields. *Basic and Applied Ecology* 16: 335-346. **IF: 1.836**

3. Korneyev AV, **Kolcsár LP** (2015). First records of the trypetine mining flies (Diptera: Tephritidae: Trypetini) from Ukraine. *Ukrainska Entomofaunistyka* 6: 45-47.
4. Heiss R, Graf W, Lujza K, **Kolcsár LP**, Török E, Vogtenhuber P (2016). Beitrag zur Tipuliden-Fauna Österreichs (Diptera: Tipulidae) mit Erstnachweisen für Österreich und für einzelne Bundesländer. *Entomologica Austriaca* 23: 63-85.
5. **Kolcsár LP**, Keresztes L (2016). New records of Pediciidae (Diptera: Tipuloidea) from Hungary. *Folia Entomologica Hungarica* 77: 119-126.
6. **Kolcsár LP**, Török E (2017). New faunistic records of Pediciidae (Diptera) from Ukraine. *Ukrainska Entomofaunistyka* 8: 25-26.
7. **Kolcsár LP**, Salmela J (2017b). New faunistic records of Keroplatidae and Mycetophilidae (Diptera) from Ukraine. *Ukrainska Entomofaunistyka* 8: 27-28.
8. Salmela J, **Kolcsár LP** (2017). New and poorly known Palaearctic fungus gnats (Diptera, Sciaroidea). *Biodiversity data journal* 5: e11760.
9. **Kolcsár LP** (2018a). A new host and faunistic record of the big-headed fly *Nephrocerus flavicornis* Zetterstedt (Pipunculidae, Diptera) from Romania. *Entomologica Romanica*. Accepted paper.

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