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Diversity of invertebrates in the Republic of Macedonia

Диверзитет на безрбетниците во Република Македонија

Slavčo Hristovski[1,2,*], Valentina Slavevska-Stamenković[1,2], Nikola Hristovski[3], Kiril Arsovski[4], Rostislav Bekchiev[5], Dragan Chobanov[6], Ivaylo Dedov[6], Dušan Devetak[7], Ivo Karaman[8], Despina Kitanova[2], Marjan Komnenov[9], Toshko Ljubomirov[6], Dime Melovski[2], Vladimir Pešić[10], Nikolay Simov[5]

[1] Institute of Biology, Faculty of Natural Sciences and Mathematics, Ss. Cyril and Methodius University, Arhimedova 5, 1000 Skopje, Macedonia
[2] Macedonian Ecological Society, Vladimir Nazor 10, 1000 Skopje, Macedonia
[3] Faculty of Biotechnology, St. Kliment Ohridski University, 7000 Bitola, Macedonia
[4] Biology Students' Research Society, Faculty of Natural Sciences and Mathematics, Ss. Cyril and Methodius University, Arhimedova 5, 1000 Skopje, Macedonia
[5] National Museum of Natural History, 1 Tsar Osvoboditel Blvd., 1000 Sofia, Bulgaria
[6] Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences, 1000 Sofia, Bulgaria
[7] Department of Biology, University of Maribor, Koroška cesta 160, 2000 Maribor, Slovenia
[8] Department of Biology and Ecology, Faculty of Sciences, Trg D. Obradovića 2, 21000 Novi Sad, Serbia
[9] Department of Molecular Biology and Genetics, Democritus University of Thrace, 68100 Alexandroupoli, Greece
[10] Department of Biology, University of Montenegro, 81000 Podgorica, Montenegro

The assessment of the diversity of invertebrates in Macedonia was based on previous assessments and analyses of new published data in the period 2003-2013 (after the first country study on biodiversity). The total number of species was estimated at almost 13400 that represents an increase of more than 3700 species. The largest number of species is in the phyllum Arthropoda (over 11800 species) i.e. the class Insecta with more than 10000 species.

In this 10-years period (2003-2013) 64 new invertebrate species have been described for science with its *locus typicus* in Macedonia or at least part of the type series originates from Macedonia.

The highest number of endemic and relict species can be found in the lakes of Ohrid and Prespa as well as the mountainous areas, especially in western Macedonia. Although less known, endogean habitats in Macedonia (including caves) hold significant diversity of species.

This paper also deals with the conservation of invertebrates. According to the national legislation there are 35 invertebrates listed as strictly protected and 513 species as protected, however the criteria for selection are vague and taxonomic status of many of these species is doubtful. This situation might be overcome by elaboration of national red list assessment. So far, only daily butterflies were subject to an attempt for assessment according to the IUCN red list criteria. Furthermore, eight Prime Butterfly Areas were designated in Macedonia on the basis of five target species.

The information on allochtonous and invasive species of invertebrates in Macedonia is very scarce. The presented list includes about 50 species.

Key words: Invertebrates, Macedonia, number of species, diversity, centres of endemism

Проценката на разновидноста на видови и подвидови безрбетници во Македонија беше направена врз база на претходните проценки и анализа на објавените податоци во периодот 2003-2013 година (по објавувањето на првата студија за биолошка разновидност). Вкупниот број видови е проценет над 13400 што претставува зголемување за над 3700 видови. Типот Arthropoda вклучува најголем дел од видовите (над 11800), поточно класата Insecta со над 10000 видови.

Во последниот 10-годишен период (2003-2013) од Македонија се опишани 64 нови видови безрбетници за науката: за поголемиот дел од нив *locus typicus* се наоѓа во Македонија, а за останатите барем дел од типската серија потекнува од Македонија.

Најголем дел од ендемичните и реликтните видови безрбетници живеат во Охридското и Преспанското Езеро, како и планинските подрачја, особено во западна Македонија. Ендогејските хабитати (вклучувајќи ги пештерите) исто така содржат значајна разновидност на видови.

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* Author for correspondence: slavco_h@pmf.ukim.mk

Во овој труд се прикажани обидите за зачувување на безрбетниците. Според националното законодавство, во Македонија се идентификувани 35 строго заштитени видови и уште 513 заштитени видови безрбетници. За жал, критериумите за селекција на видовите не се добро дефинирани, а таксономскиот статус на некои од овие видови е сомнителен. Ваквата ситуација може да се надмине само со изработка на црвена листа на загрозени видови. Единствено за дневните пеперутки е направен обид за проценка на нивниот статус според критериумите на IUCN. Дополнително, осум Значајни подрачја за пепрутки врз база на пет целни видови.

Достапната информација за алохтоните и инвазивните видови безрбетници во Македонија е многу оскудна. Засега, во листата се вклучени околу 50 видови.

Клучни зборови: Инвертебрати, Македонија, бројност на видови, диверзитет, центри на ендемизам

Introduction

In the course of preparation of the new strategy on biodiversity conservation in Macedonia we had the task to assess the diversity of invertebrates based on the assessment done within the first country study (MoEPP 2003) and the progress made in the knowledge in the last decade (2003-2013). The first assessment of the number of invertebrates (MoEPP 2003) revealed 8720 species (excluding Protozoa) for the Macedonian fauna, 618 (7.1%) of them being endemic. Later on, Petkovski (2009) updated this information and listed a total of 9706 invertebrate species with 608 endemics (6.3%).

The main goal of this study is to assess the advance in the knowledge of the diversity of invertebrates in the last 10 years, after the publication of the first Country study on biodiversity of the Republic of Macedonia (MoEPP 2003). In the cases of some less elaborated groups (e.g. Coleoptera, Diptera, Hymenoptera, Acari, Trichoptera) completely new estimation was performed.

The term endemic in the former two studies (MoEPP 2003, Petkovski 2009) was used for species that are distributed solely in Macedonia (Macedonian endemics or national endemics). This concept was inconsistently used since many of the endemics in Ohrid and Prespa lakes (distributed in Macedonia and Albania/Greece) were considered as "Macedonian endemics". On the other hand, some of the endemics (not all) distributed in mountainous border regions were not considered as "Macedonian endemics" (e.g. *Deltomerus paradoxus, Trechus thessalonicus*, etc.). Endemic species need special conservation measures no matter whether the endemic species is "Macedonian" or shared with the neighboring countries. The number of endemics among butterflies and moths was very high in MoEPP (2003) - 69 taxa and Petkovski (2009) - 62 taxa. However, the number of endemic butterflies in Macedonia is much lower if new studies on distribution of butterflies are taken into account (see references for Lepidoptera in Tab. 1). Many of the butterflies listed as endemics were recorded in other European or even Asian countries. Having in mind the complexity of the endemism in Macedonia, in this study we are not aiming at documenting and assessing the endemic species. We feel that this is one of the main lacks of the present paper since the concept of biological diversity especially cares about the diversity of species and within the species. In order to overcome the problem of inadequate knowledge on the distribution and status of the endemic taxa among invertebrates there is a need of much detailed study taking into account the exact distribution areal of species and analysis of thousands of scientific papers. Nevertheless, some of the endemic species are noted in the text regarding particular invertebrate groups.

The research on genetic diversity of invertebrates in Macedonia is negligible. Some studies that were published recently are commented in the analyses of particular invertebrate groups.

The conservation of invertebrate species in Macedonia (as in most of the world) receives much less attention compared to plants or vertebrates. Macedonia lacks official red list of threatened species. In a separate chapter, we tried to summarize the information regarding the national efforts for identification of species important for conservation.

The knowledge on allochtonous (and invasive) species in Macedonia is in its infancy. Nevertheless, some studies were published recently concerning the issue of allochtonous species. The information derived from these studies is summarized in a separate chapter, as well.

Abbreviations and explanations

MoEPP - Ministry of Environment and Physical Planning of the Republic of Macedonia

Fauna Europaea (2013) - de Jong, Y. S. D. M. (ed.) (2013) Fauna Europaea version 2.6. Web Service available online at http://www.faunaeur.org)

taxon/taxa - with this term we refer only to species and subspecies and not to supraspecific categories.

Species counts

The first estimation of the invertebrates of Macedonia of 8720 species (excluding Protozoa) was published within the Country study on biodiversity of the Republic of Macedonia (MoEPP 2003). This assessment was further amended by Petkovski (2009) by 986 species, resulting in a total of 9706 species (excluding Protozoa - 113 species). However, the sources of this amendments are not clear, although one can assume that the new literature (2003-2009) or older omitted records were taken into account. Fauna Europaea (Fauna Europaea 2013) database (de Yong ed. 2013) contains information on the presence of 10365 invertebrate species for Macedonia. These three sources of information were used as a basis for the estimation of the invertebrate species number in this study.

The Fauna Europaea (2013) database lacks information on many groups for Macedonia that is otherwise available and easy to obtain. For example the number of

Rotifera in Fauna Europaea (2013) numbers only 1 species for Macedonia, there are no species of Opiliones for Macedonia while lists of species were already published (see MoEPP 2003; Petkovski 2009).

On the other hand, the information presented in previous assessments (MoEPP 2003; Petkovski 2009) represents well the species diversity of the aquatic invertebrates, especially of the three natural lakes in Macedonia: Ohrid, Prespa and Dojran. However, some of the groups were overestimated, probably due to the misinterpretation of the published data within some of the monographic works: e.g. order Trichoptea in Petkovski (2009) counts 286 species, Fauna Europaea (2013) contains 103 species for Macedonia and the critical analysis performed within this study shows the presence of 106 species. The terrestrial invertebrates were clearly underestimated in MoEPP (2003) and consequently in Petkovski (2009) (e.g. order Hymenoptera was represented only by suborder Symphyta, without even mentioning Apocrita - the suborder containing the largest number of species).

The number of invertebrate species in Macedonia is presented in Tab. 1. At the moment, there are almost 13400 species known from Macedonia. Of course, this number is very low compared to the invertebrates that actually inhabit Macedonia, which might be exemplified with the following facts:

- a number of scientific publications published before 2000 were not reviewed or were unavailable. This is especially true for some of the large insect orders and families (e.g. Coleoptera, Diptera, former Homoptera and Hymenoptera)
- it is obvious that the intensity of research on invertebrates in Macedonia (last 100-150 years) was very low and a lot of species and higher taxa are not recorded, yet. In Croatia at the end of XIX century, 11000 beetle species (Coleoptera) of 1000 genera were already known (Durbešić 2011, p. 38) compared to 3145 species presently known in Macedonia. More than 10000 was the estimate for the Coleoptera species in Serbia, Montenegro and Kosovo (Radović et al. 1995) and ~6000 in Bulgaria (Guéorguiev et al. 1998; Hubenov, 2008a).

Analysis by systematic groups

The analysis of the progress in research within particular taxonomic groups is presented in the following text. In the case of groups with unavailable original literature data or without new records in the last decade, we relied mainly on Petkovski (2009) and Fauna Europaea (2013). The systematics follows the concept of Fauna Europaea (2013), but higher systematic taxa are sometimes grouped based on the level of knowledge and number of species (e.g. we analyze order Coleoptera by families due to the great number of species; phyllum Porifera is presented as a single group due to the low number of species; phyllum Nematoda is viewed as a single group due to the lack of knowledge).

1 Porifera

The phyllum Porifera is well elaborated by Petkovski (2009): there are 10 taxa in the three large Macedonian lakes (4 endemics for the Lake Ohrid, and one for the Prespa and Dojran lakes, each).

Special attention draw the endemic species of Porifera in the Lake Ohrid (*Ochridaspongia rotunda* Arndt, 1937, *Ochridaspongia interlithonis* Gilbert & Hadzische, 1984, *Spongilla stankovici* Arndt, 1938, *Ohridospongilla stankovici* Gilbert & Hadzische, 1984), as well as the endemic species of Prespa Lake (*Spongilla prespensis* Hadzische, 1953). The genera *Ochridaspongia* and *Ohridospongilla* are the only European representatives of the family Malawispongiidae which contains other 4 monotypic genera from the Malawi and Tanganyika lakes, the island of Sulawesi and Jordan river (Manconi & Pronzato 2007). One endemic subspecies is known from Dojran Lake: *Eunapius carteri* dojranensis Hadzisce, 1953.

2 Cnidaria

There are three species in Macedonia: two autochtonous (MoEPP 2003) and one alien species (*Craspedacusta sowerbyi* Lankaster, 1880).

3 Platyhelminthes

According to Petkovski (2009) there are 65 species of the subphyllum Turbellaria in Macedonia (Tricladida - 40, Rhabdocoela - 24, Acoela - 1), 35 of which are endemic. Few more species of Lecithoepitheliata, Macrostomida and Prolecithophora are listed in Fauna Europaea (2013) (see Tab. 1).

Sywula et al. (2003, 2006) published data on the genetics and phylogeny of some tricladid species in Lake Ohrid.

According to Petkovski (2009) the classes Trematoda and Cestoda (subphyllum Neodermata) contain 10 species each. However, the analysis of Hristovski, N. (unpublished data) revealed presence of 158 species in Macedonia.

In summary, we estimate the fauna of Platyhelminthes at 229 species (Turbellaria - 71 and Neodermata - 158).

4 Nematoda

The number of Nematoda species in previous assessments (MoEPP 2003; Petkovski 2009) was estimated at 553. Out of them, 23 are known for the Lake Ohrid, 450 are terrestrial species (mainly forest species) and 80 are parasites. Unfortunately, previous assessments do not specify the systematic affiliation of the species, nor the used literature is cited. It is obvious that the Nematoda is weakly known in Macedonia. Some new species were published by Barsi & Lamberti (2001). Andrássy (2009) reported 17 non-parasite species from the Lake Ohrid based on previous research (e.g. Schneider 1943; Gerlach and Meyl 1957). One of these species is endemic: *Punctodora ohridensis* Schneider, 1943.

The analysis of the literature published by Macedonian authors (N. Nezlobinsky, S. Stojanovski, D. Blazenkovic-Dimovska, T. Angelevski, M. Hristovski) and other authors (Stojanov, Brglez, Shinzhar) shows the presence of 82 parasitic Nematoda on animal species (Hristovski, N., unpublished data). It is possible that some of these species (but certanly not all of them) have already been included in the previous assessments (MoEPP 2003; Petkovski 2009).

Concerning parasites on plants Krnjaic (1978) published information on 29 parasitic Nematoda; Dautova & Gommers (2000) - 4 species of *Meloidogyne* on tomatoes; Grujičić (1987) and Vučkov (1987) cited species of

Pratylenchus, Paratylenchus, Ditylenchus, Helicotylenchus, Tylenchorynchus, Hoplolaimus, Tylenchus etc.

Based on the scarce literature and confusing assessments, we can estimate the number of Nematoda in Macedonia at over 600 species.

5 Rotifera

The basic information on the species of Rotifera is presented in Petkovski (2009) - 269 species. Recently, Tasevska et al. (2012) analyzed the pelagic rotifers in Ohrid, Prespa and Dojran lakes and recorded the presence of 11, 8 and 17 taxa, respectively.

6 Acanthocephala

The phyllum Acanthocephala contains 8 species (Hristovski, N., unpublished data).

7 Nemertea

Phyllum Nemertea is poorly known in Macedonia. According to Petkovski (2009) there is only one known species from Lake Ohrid: *Prostoma graecense* (Böhmig, 1892).

8 Nematomorpha

From Macedonia, only two species are known: *Gordius nonmaculatus* Heinze, 1937 (as *G. nonmaculatus balcanicus*) reported from Skopje by Čanadjija (1956) and *Gordius aquaticus* reported from Tetovska Reka (river Pena) by Kovachev et al. (1999).

9 Annelida

The fauna of Annelida of Macedonia was thoroughly studied by Jonče Šapkarev who published two monographic works on Hirudinea and Oligochaeta (Šapkarev 1970, 1978). Many other researchers in 20th century contributed to the knowledge of Annelida in Macedonia, especially in Lake Ohrid.

Petkovski (2009) cited 157 taxa of Annelida: Oligochaeta - 137 species and Hirudinea - 20 species. The number of Oligochaeta in Fauna Europaea (2013) database is 112 and additionally includes 4 more species and 1 subspecies of Branchiobdellea, as well as 30 species of Hirudinea. Recently, Szederjesi (2013) counted only 53 species of Lumbricidae. Albrecht & Wilke (2008) presented data on 24 species of Hirudinea only in Lake Ohrid (and several others undescribed). Karaman M. S. (1967, 1970), Subchev (2007, 2012) and Subchev & Gelder (2010) reported presence of 5 species of genus *Branchiobdella*.

Having in mind the published data, the fauna of Annelida in Macedonia is estimated at 175 species: Oligochaeta - 140, Hirudinea - 30 and Branchiobdellea - 5 species.

10 Mollusca

10.1 Gastropoda

The diversity of land snails was comprehensively documented in the catalogue of Stanković et al. (2006) containing information on 232 taxa (189 species and 43 subspecies). The fauna of terrestrial snails was amended by the research of Nordsieck (2009), Dedov & Neubert (2009), Dedov (2010, 2012), Dedov & Hristovski (2010), Dedov & Mitev (2011), and Dedov & Subai (2012). In the last decade 10 new taxa (species and subspecies) were described as new to science from Macedonia, one of them being a fossile species (Schnabel 2012).

The diversity of aquatic snails (107 species) was presented in Petkovski (2009). Lake Ohrid is the richest in aquatic species and holds 72 species with 56 endemics (78%).

Recently, actual and critical overview of Gastropoda was published by Bank (2011). It contains 106 aquatic and 186 terrestrial gastropods species. Other 9 terrestrial gastropods are not included in the list of Bank (Dedov 2012, Dedov & Subai 2012, Dedov, unpublished data) i.e. 301 in total.

Many molecular studies have been carried out in the last 10 years with focus on gastropods. Albrecht et al. (2012) presented the knowledge on biogeographical relationships of Great and Lesser Prespa lakes based on molecular studies of phylogenetic relationship of mollusc species. Hauswald et al. (2008) analyzed evolutionary patterns of *Valvata* (Gastropoda) species with an emphasis on Ohrid and Prespa lakes. They concluded that endemic species of *Valvata* in lake Ohrid belong to 3 distinct clades in Lake Ohrid and rejected the hypothesis on their monophyly.

10.2 Bivalvia

The most complete information on the species diversity of Bivalvia (19 species, 21 taxa) is presented by Petkovski (2009). Korniushin (2004) reported 14 species for Macedonia: Lake Ohrid - 13 species with 2 endemics, Prespa Lake - 10 with 1 endemic (see also Albrecht et al. 2012) and 7 for the other aquatic ecosystems in Macedonia.

Albrecht et al. (2007) dealt with molecular phylogeny, biogeography and systematics of *Dreissena*. Schultheiß et al. (2008) carried out a phylogenetic analysis and confirmed the sister-species relationship of the endemics *Pisidium edlaueri* Kuiper, 1960 in Lake Ohrid and *Pisidium maasseni* Kuiper, 1987 in Lake Prespa.

11 Arthropoda

11.1 Arachnida

11.1.1 Scorpiones

According to Fet (2010) there are 3 scorpion species in Macedonia. However, their correct taxonomic status in Macedonia is still unclear.

11.1.2 Pseudoscorpiones

Harvey (2007) cited 43, while Petkovski (2009) - 51 species of Pseudoscorpiones. In the last decade, 4 new species were described from Macedonia. The total number of Pseudoscorpiones in Macedonia is estimated at 54 species.

11.1.3 Solifugae

Literature data on Solifugae from Macedonia indi-

cate presence of 2 species: *Galeodes elegans* Roewer, 1934 and *G. graecus* C. L. Koch, 1842 (Drensky 1931; Roewer 1934). Additional study is needed to resolve the existing taxonomic and faunistic problems of Solifugae in Macedonia.

11.1.4 Opiliones

MoEPP (2003) estimated the fauna of Opiliones in Macedonia at 38 species or 40 taxa (the list of species was not presented) with 19 endemic species (listed). Schönhofer (2013) cited 6 species of Dyspnoi and 2 of them were newly described (Schönhofer & Martens 2009; Schönhofer et al. 2013). Also, Karaman (2008) described 1 new species from Demir Kapija. Based on the published and other data (Karaman, I. M., unpublished data) the total number of Opiliones in Macedonia is estimated at 50 species.

11.1.5 Araneae

The first checklist of spiders of Republic of Macedonia was presented by Blagoev (2002), reporting 558 species. In the period of 2002-2008, several authors added 104 new records for the Macedonian fauna: Ćurčić et al. (2004c), Deltshev (2003, 2008), Deltshev et al. (2006, 2007), Fisher & Azarkina (2005) Komnenov (2002, 2003, 2006), Komnenov & Pavićević (2008) and Stefanovska et al. (2008). Before the publication of Petkovski (2009) the checklist of spiders counted 662 species.

In the list of spiders presented in the catalogue of Petkovski (2009) an incorrect number of 702 species was given. Out of the published species (l.c.), 62 were added without having any published reference for these records in Macedonia. It is strange that all these 62 species represent local endemics for Bulgaria or Greece (some of them known only from one reference and one locality only). In addition, several publications were omitted and because of that 46 previously recorded species were not included in the catalogue.

Recently, Deltshev et al. (2013) added records of 20 species new for the Macedonian fauna. The comprehensive study of Komnenov (2013) resulted in a description of 2 new species (both local endemics from Osogovo Mt.) and records of 450 species of which 145 represent new findings for the Macedonian fauna.

After critical review of the published data and rejecting the 62 dubious species, the total number of species in Macedonian fauna is estimated at 767. Nine species are considered to be local endemics.

11.1.6 Acari

Water mites (Hydrachnidia) were reviewed by Pešić et al. (2010) on the basis of some previous studies (Pešić 2003, 2005; Smit & Pešić 2004; Pešić, V., unpublished data) and 161 species were documented for Macedonia (5 endemics). Later on, Zawal et al. (2011) recorded 13 species of Hydrachnidia including 3 new for the Macedonian fauna. Thus, the total number of Hydrachnidia is 164 species.

Concerning other groups of Acari, Kontschán (2005, 2012) recorded 12 new species for Macedonian fauna as well as one new species for science from Shar Planina (*Trachytes macedoniensis* Kontschán, 2005). Halacarid mites (Halacroidea) were reviewed by Chatterjee et al. (2010). Four halacarid mites are known from Macedonia, two of which (*Copidognathus profundus* (Viets, 1936) and *Stygohalacarus scupiensis* (Viets, 1934), the only member of the genus *Stygohalacarus*) are endemic.

The total nuber of the so far known species of Acari in Macedonia is 250.

11.2 Crustacea

Petkovski (2009) reported 475 taxa for Macedonia (456 species and additionally 18 subspecies and 1 hybrid) - at least 10 of them with unclear taxonomic status. In the last decade, 3 more species were described (two of them from Isopoda). The vast information on crustaceans from Macedonia recorded by Trajan Petkovski point out to the good level of knowledge of this group in the country (see the literature review presented in Petkovski 2009).

Having in mind the new data and the overview of Petkovski (2009) we estimated the number of Crustacea in Macedonia at 514 taxa.

The papers of Kilikowska et al. (2006, 2013) and Wysocka et al. (2008, 2013) shed light on the phylogenetic relationships in the genera *Proasellus* and *Gammarus* from Ohrid Lake, but some of the taxonomic problems still remain.

11.2.1 Branchiopoda

The class Branchiopoda is represented by 2 subclasses in Macedonia: Phyllopoda (with 2 orders: Diplostraca and Notostraca) and Sarsostraca (with 1 order: Anostraca).

11.2.1.1 Anostraca

There are 6 species of Anostraca reported for Macedonia (Petkovski 2009) and one of them (*Chirocephalus pelagonicus* Petkovski, 1986) is an endemic species known from alkaline wetlands in Pelagonija plain (Brtek & Thiéry 1995).

11.2.1.2 Notostraca

There are 2 species of Notostraca known from Macedonia, both of the family Triopsidae (Petkovski 2009): *Lepidurus apus* (Linnaeus, 1758) and *Triops cancriformis* (Bosc, 1801).

11.2.1.3 Diplostraca

Diplostraca is the most numerous order in species in Macedonia within the class Branchiopoda. In Macedonia, it is represented by 86 species and one of them (*Alona smirnovi* Petkovski & Flossner, 1972) is endemic to Lake Ohrid (Petkovski 2009).

11.2.2. Ostracoda

Recently, Lorenschat & Schwalb (2013) performed a study on the ostracods of lake Ohrid and its surroundings and recorded 47 species (40 of living specimens). This study shed light on the autecology of the ostracodan species as a preparatory phase for the

analysis of paleoenvironmental data within the Ohrid ICDP-Drilling project.

Based on the data of Petkovski (2009) and Lorenschat & Schwalb (2013) we estimated the number of the class Ostracoda in Macedonia at 172 species. They all belong to the order Podocopida. Most of the endemic ostracods are found in the genera *Candona, Paralimnocythere* and *Leptocythere,* but also in *Eucandona, Fabaeformiscandona, Typhlocypris, Cypria, Physocypria, Eucypris, Psychrodromus* and *Heterocypris* Petkovski 2009).

11.2.3 Maxillopoda

11.2.3.1 Copepoda

Based on the list presented in Petkovski (2009) and additions by Stojanovski et al. (2004) we estimated the number of Copepoda at 146 species (Calanoida - 30, Cyclopoida - 60, Harpacticoida - 54 and Poecilostomatoida - 2 species).

Order Cyclopoida contains several endemic taxa within the genera of *Eucyclops, Ochridacyclops, Cyclops, Acanthocyclops, Diacyclops, Reidcyclops* and *Microcyclops.* Endemic representatives of the order Harpacticoida can be found in the following genera: *Nitocrellopsis, Stygonitocrella, Bryocamptus, Elaphoidella, Spelaeocamptus* and *Parastenocaris* (Petkovski 2009).

We know of 12 parasitic crustaceans from subclass Copepoda (Hristovski, N., unpublished data). Stojanovski et al. (2004) found that the most common parasitic copepods of fish species in Ohrid, Prespa and Dojran lakes are: *Ergasilus sieboldi* von Nordmann 1832*, E. gibbus* von Nordmann 1832*, Lernaea cyprinacea* Linnaeus 1758 and *Lamproglena pulchella* von Nordmann 1832.

11.2.3.2 Branchiura

There are 3 species of the subclass Branchiura (order Arguloida) recorded in Macedonia (Petkovski 2009): *Argulus foliaceus* (Linnaeus, 1758), *A.* coregoni Thorell, 1864 and *A. japonicus* Thiele, 1900. Stojanovski et al. (2004) found *A. foliaceus* as a parasitoid of 3 fish species (roach, bleak and carp).

11.2.3.3 Pentastomida

Linguatula serrata Frohlich 1789 was found to be human parasitiod in Pelagonija (Hristovski, N., unpublished data). So far, it is the only Macedonian representative of the subclass Pentastomida and order Cephalobaenida.

Malacostraca

The class Malacostraca is represented by 1 subclass in Macedonia - Eumalacostraca which contains 3 superorders: Peracarida (with 2 orders: Amphipoda and Isopoda), Syncarida (with order Bathynellacea) and Eucarida (with order Decapoda).

11.2.4 Malacostraca

The class Malacostraca is represented by 1 subclass in Macedonia - Eumalacostraca which contains 3 superorders: Peracarida (with 2 orders: Amphipoda and Isopoda), Syncarida (with order Bathynellacea) and Eucarida (with order Decapoda).

11.2.4.1 Bathynellacea

According to Petkovski (2009) there are 2 species of the order Bathynellacea in Macedonia: *Bathynella natans* Vejdovsky, 1882 and *Parabathynella stygia* Chappuis, 1926. One more species is listed in Fauna Europaea (2013): *Bathynella chappuisi* Delachaux 1920.

11.2.4.2 Isopoda

The catalogue of Petkovski (2009) contains information on 16 taxa (10 species) and concerns mainly the cave isopods while the terrestrial, aquatic and myrmecophilous species were completely omitted.

Particularly interesting are the 2 species and 1 genus of isopods described in the last decade (Karaman, I. 2003; Karaman, I. & Horvatović 2008) that enrich the list of Macedonian endemics (e.g. *Macedonethes skopjensis* Buturovic, 1955*, Alpioniscus slatinensis* Buturovic, 1955*, A. vardarensis* Buturovic, 1954*, A. macedonicus* (Buturovic, 1954)*, A. karamani* Buturovic, 1955*, Vardaroniscus tetraceratus* Buturovic, 1955, etc.).

Taking into account the data from catalogues of land isopods (Karaman, M. S. 1966; Schmalfuss 2003) and some field studies (Karaman, I. M., unpublished data), the number of Isopoda in Macedonia was estimated at around 50 species, of which almost one third are endemic.

11.2.4.3 Amphipoda

The order Amphipoda counts 47 species in Macedonia with many endemic species within the genera of *Bogidiella, Gammarus, Niphargus*, *Hadzia* and *Ignolfiella* (Petkovski 2009).

11.2.4.4 Decapoda

Decapoda in Macedonia is represented by 5 species (Karaman, M. S. 1972, 1976). There are two species of **Astacidae**: *Austropotamobius torrentium* (Schrank 1803) and *Astacus astacus* (Linnaeus 1758), two species of **Potamonidae**: *Potamon fluviatile* (Herbst 1785) and *P. ibericum* (Bieberstein 1809) and one species of **Atyidae**: *Atyaephyra stankoi* (Karaman, 1972) (= *Atyaephyra desmarestii stankoi* Karaman, 1972) that is known to inhabit Dojran lake and recently received species status (Christodoulou 2012).

11.3 Myriapoda

It seems that the review of Petkovski (2009) contains most of the available data on Myriapoda in Macedonia. If newly published species and data are added (Ćurčić et al. 2002; Makarov et al. 2003; Antić et al. 2013; Nitzu et al. 2011), then the total number of Myriapoda in Macedonia counts about 100 species.

11.4 Entognatha

According to Lučić et al. (2003, 2007) the fauna of Collembola in Macedonia counts only 11 known species or only 0.6% of the European fauna (Tab. 1). Diplura and

Protura are presented by 2 and 8 species, respectively. The total number of Entognatha in Macedonia is estimated at 21 species.

11.5 Insecta

11.5.1 Zygentoma and Microcoryphia

Out of the orders Zygentoma and Microcoryphia there are 1 and 3 species known from Macedonia, respectively (Fauna Europaea 2013).

11.5.2 Ephemeroptera

Intensive research of Ephemeroptera in Macedonia was carried out by Ikonomov (1951, 1953, 1954a, 1954b, 1954c, 1958, 1959, 1960, 1961a, 1961b, 1962a, 1962b, 1962c, 1962d, 1963a, 1963b, 1964, 1970). Almost three decades later Vidinova (1998) studied the Ephemeroptera of Pena river recording 7 *Rhithrogena* species.

Bauernfeind & Soldan (2012) in the detailed overview of European Ephemeroptera have revised the published data and listed 68 species for Macedonia.

11.5.3 Odonata

Several papers were published in the last decade concerning Macedonian dragonflies (Bedjanič et al. 2008; Micevski et al. 2008; Kitanova et al. 2009; Jović 2009; Jović & Mihajlova 2009; Petkovski 2009; Zawal et al. 2010; Holuša 2012;). Critical review of the published data shows the presence of 64 Odonata species in Macedonia.

11.5.4 Plecoptera

Ikonomov (1978, 1986) and Zwick (1984) documented 95 species (10 endemics) of Plecoptera in Macedonia (Fauna Europaea 2013 contains data on 103 species). Murányi (2007) and Graf et al. (2012) described two new species for science from Macedonia. Thus, the total number of Plecoptera in Macedonia counts at least 97 species.

11.5.5. Orthoptera, Dictyoptera, Dermaptera, Embioptera

The last review of Macedonian Orthoptera listed 167 species and 2 subspecies (Chobanov & Mihajlova 2010). This paper added 9 and rejected 27 taxa from the list of 184 species published by Petkovski (2009). The list includes one newly described endemic species: *Poecilimon* (*Poecilimon*) *jablanicensis* Chobanov & Heller, 2010. Chobanov et al. (2013) suggested that one *Isophya* species found in Macedonia might probably be new to science. The list should be amended by the newly described *Troglophilus zorae* Karaman & Pavicevic 2011 (Karaman et al. 2011), *Troglophilus brevicauda* Chopard, 1934, 3 species recorded by Lemonnier-Darcemont (2010) and some species that were previously excluded. Thus, the total number of Orthoptera in Macedonia counts 175 species (and 2 subspecies). It is important to note that the fauna of Orthoptera of Pelister National Park was treated in a separate monograph (Micevski et al. 2003). Additonal faunistic data were published for Ograzhden Mt. and Mariovo Kozjak Mt. (Chobanov 2002).

The Macedonian fauna of Dictyoptera includes 12 species of cockroaches - suborder Blattodea (Fauna Europaea 2013; Bohn et al. 2013), 2 species of termites - suborder Isoptera (Karaman, Z. 1954; Murányi 2013b) and 4 Mantodea species (Chobanov & Mihajlova 2010).

Order Dermaptera counts 5 species (Murányi 2013a, 2013b).

There are no data on the order Embioptera for Macedonia. However, one species, *Haploembia solieri* (Rambur 1842), was observed in Valandovo region (Chobanov, D., unpublished data).

11.5.6 Psocoptera

The order of Psocoptera (booklice) in Macedonia counts 49 species (Petkovski 2009; Sziráki 2013; Fauna Europaea 2013)

11.5.7 Phthiraptera

Durden & Musser (1994) reported 14 species of Phthiraptera: *Enderleinellus ferrisi* (Touleshkov, 1957) as a parasite of *Spermophilus citellus* (Linnaeus 1766) and *Schizophthirus gliris* Blagoveshtchensky, 1965 (*locus typicus* in Radika gorge) as a parasite of *Glis glis* (Linnaeus 1766) as well as data on 12 wide distributed species.

11.5.8 Thysanoptera

According to Petkovski (2009) there are 42 species of Thysanoptera in Macedonia.

11.5.9 Hemiptera

11.5.9.1 Heteroptera (suborders Cimicomorpha, Dipsocoromorpha, Leptopodomorpha, Nepomorpha and Pentatomomorpha)

The data on Heteroptera for the fauna of Macedonia was summarized for the first time by Josifov (1986) revealing 698 species. Later, Protić (2001) presented new estimate of 863 species. After corrections, synonymizations and description of new species, the number of Heteroptera in Macedonia was estimated at 776 species (Aukema & Rieger 1994, 1996, 1998, 2001, 2006; Aukema et al. 2013). Fifteen endemic and six subendemic species and subspecies were recorded for the territory of the country as well as ten taxa were described as new for science from the territory of Macedonia (Josifov & Simov 2006).

Macedonia and some adjacent Balkan countries (e.g., Albania and Greece), lack taxonomic specialists on Heteroptera. Faunistic and taxonomic contributions based on materials from these countries result from the efforts of foreign specialists (Divac 1907; Daniel 1957; Göllner-Scheiding 1978, 1982; Horváth 1916, 1936; Kormilev 1936, 1938; 1939a, 1939b, 1943; Royer 1922, 1923, 1924a, 1924b; Schumacher 1918a, 1918b; Wagner 1960, 1962; Protić 1998, 2001, 2005, 2012). Thus, the Heteroptera fauna of the country remains insufficiently known (Protic 2001; Josifov & Simov 2006) and it is still difficult to conduct field research without participation of local experts. In particular, seasonal changes in the composition of the fauna are not studied well (Josifov & Simov 2006). Protic (2001) suggests that

only 62% of expected heteropteran species of Macedonia were recorded. The geographic position of the country, unique habitat diversity, comparison with well investigated true bug fauna from neighboring territories like Bulgaria (Josifov 1986) and new records made during various studies in recent five years (Simov, N., unpublished data) allows us to assume that the number of Heteroptera species in Macedonia could reach 1000.

11.5.9.2 Homoptera (suborders Cicadomorpha, Fulgoromorpha and Sternorrhyncha)

Homoptera is one of the least known orders of insects in Macedonia. Gogala et al. (2005) reported 15 cicadas of which 10 were new for the Macedonian fauna and one species - previously reported (*Tibicina steveni* (Krynicki, 1837)) was excluded.

Some Homoptera were treated in the papers of agriculturists. Atanasova (2010) recorded 33 species from 6 families (Cixiidae, Delphacidae, Dictyopharidae, Cicadidae, Membracidae and Cicadellidae) in the vineyards of the Strumica and Kavadarci regions. Further, Atanasova et al. (2013) published data on Fulgoromorpha and Cicadomorpha in Strumica region. Individual data can be found in other publications (e.g.: Evans 2007 for Aleyrodidae, Spasov 2003 for Aphidae).

11.5.10 Neuroptera, Raphidioptera, Mecoptera

The neuropterid fauna of Macedonia was investigated since the 1920s, but in the second half of 20th century and in recent years a number of papers were published (Mace 1920; Doflein 1921; Dimitrova 1924; Dimitrowa 1925; Aspöck & Aspöck 1964, 1965, 1966, 1968, 1969, 1972, 1974, 1994; Ohm 1965; Popov 1970, 1997; Gepp 1972; Holzel 1978; Aspöck, H. 1979; Aspöck, U. 1979; Aspöck et al. 1980, 1984, 1991, 2001; Devetak 1996, 1997, 1998; Saure 1989; Canard 2004; Popov 2004). Saure (1989), Devetak (1992), Aspock et al. (2001) and Popov (2004) compiled checklists from literature for Macedonia. With new records from Macedonia (Kačírek 2013; Devetak et al. in press) the number of known Neuropterida in Macedonia has increased to 68 species (Raphidioptera - 9, Neuroptera - 59). Order Mecoptera is represented by only 2 species (Devetak 1991; Willman 1977). So far, there are no data about Megaloptera species from Macedonia.

11.5.11 Trichoptera

Petkovski (2009) overestimated the Trichoptera fauna of Macedonia by listing 286 species. Fauna Europaea (2013) gives much lower number of 103 species. The research of Kumanski (1997), Kumanski & Malicky (1999), Oláh (2010) and Oláh et al. (2013a, 2013b) point to lower number of species (96). It is obvious that detailed revision of the literature data on Trichoptera for Macedonia is needed. Based on the readily available literature we estimated the number of Trichoptera in Macedonia at 106 species.

11.5.12 Lepidoptera

After the significant number of newly described species of Lepidoptera from Macedonia in XX century (Deschka & Dimić 1986; Toševski 1989; see also Daniel 1964; Thurner 1964; Klimesch 1968; Pinker 1968), only two new species were described in the first decade of XXI century: *Dichrorampha dinarica* Huemer, Zlatkov et Baixeras, 2012 and *Coleophora aleramica* Baldizzone & Stübner, 2007 (new species for science described from the Balkans or Europe, but part of the type series originated from Macedonia). Five daily and hundreds of nocturnal butterflies were recorded for the first time in Macedonia and many faunistic records for some important species were published during the last decade (Abdija et al. 2013; Beshkov 2009; Krpač & Mihajlova 1997; Fazekas 2009; Verovnik 2012; Verovnik & Micevski 2008, 2009; Huemer et al. 2011; Verovnik et al. 2010; Micevski et al. 2009a, 2009b; Krpač & Lazarevska 2008; Krpač et al. 2011a; Micevski & Micevski 2004/2005, 2005a, 2005b, 2006/2007, 2008; Melovski et al. 2003; Melovski 2004, 2010; Arsovski et al. 2010; Larsen 2010, Šumpich & Skyva 2012 etc; see also Tab. 1). Thus, the daily butterflies count 204 species and the total number of Lepidoptera in Macedonia is estimated at almost 2640 species.

11.5.13 Diptera

One of the most elaborated families in recent years is family **Syrphidae** (Krpač et al. 2006, 2009a, 2009b, 2009c; Krsteska 2008). According to Krpač et al. (2011b) the Syrphidae in Macedonia count 262 species.
Krčmar et al. (2002) reported 40 species of **Tabanidae;** Adler & Crosskey (2013) - 13 species of **Simulidae;** certain information on **Tachinidae** can be found in Hubenov (2008b); Bechev (1997) reviewed 5 families on the Balkans and concluded that **Diadocidiidae** in Macedonia is represented by 1 species, **Mycetophilidae** - 10 species, **Bolitophilidae**, **Ditomyiidae** and **Keroplatidae** are not present; Ozerov (2005) gave data on 8 species of **Sepsidae**. Evenhuis & Greathead (1999) in the global review of **Bombyllidae** included 90 species from Macedonia. Simova-Tošić et al. (2007) made complete review of **Cecidomyiidae** and established 147 species (36 first records) for Macedonia. The review of Oosterbroek & Simova-Tosic (2004) concerns Macedonian species of the families **Pediciidae** and **Limoniidae**.

Tipulidae were elaborated in the edition Fauna of Macedonia (Simova-Tošić 1977). Later on, Oosterbroek & Simova-Tosic (2004) and Oosterbroek (2009) ammended the list of Tipulidae with 4 species.
Individual records are published for some other families (Mason & Rozkosny 2003 - **Stratiomyidae**; Šifner 2008 - **Scatophagidae**; Stuke & Clements 2008 - **Conopidae**; Brake 2011 - **Carnidae**). Some of the global reviews do not include species from Macedonia (Mathis & Sueyoshi 2011 - **Dryomyzidae**; Munari & Mathis 2010 - **Canacidae**; Mathis & Munari 1996 - **Tethinidae**).

Some of the articles on Diptera concern vectors of diseases (e.g. Maroli et al. 2012 reported 2 phlebotomine species (**Psychodidae**): *Phlebotomus neglectus* Tonnoir, 1921 and *Phlebotomus perfiliewi* Parrot 1930) and some concern agrocoenoses (Ančev 1974; Krsteska et al. 2003, 2004).

The total number of Diptera in Macedonia is estimated at over 1500 species. The total number of families is 54 (125 in Europe). This is one of the insect orders that need more thorough analyses of the published data and research in the future.

11.5.14 Siphonaptera (Aphaniptera)

There are 13 species of Siphonaptera known for Macedonia (Fauna Europaea 2013). It seems that this count took into account previous publications (Christov 1964; Peus 1964; Smit & Rosický 1965; Skuratowicz et al. 1982; Brelih & Trilar 2000). So far, the best elaborated are the parasites on *Dinaromys bogdanovi* (Brelih & Trilar 2000).

11.5.15 Coleoptera

The analysis of Coleoptera is based on MoEPP (2003) and Petkovski (2009). However, for many of the families that were not treated in these two estimates or special scientific literature, we relied on the data in Fauna Europaea (2013) and the Catalogues of Palearctic Coleoptera (Löbl & Smetana 2003, 2004, 2006, 2007, 2008, 2010). At the present moment the fauna of Coleoptera in Macedonia counts over 3100 species (Tab. 1).

Carabidae. The last decade was marked by significant progress in the research of ground beetles (Hristovski et al. 2003, 2010; Hristovski 2007, 2011; Guéorguiev 2007; Mitev et al. 2010; Guéorguiev & Hristovski 2010; Giachino & Vailati 2012, etc.). These publications added more than 50 species for the Macedonian fauna (8 new for science). The total number of Carabidae in Macedonia is estimated at 573 species with additional 55 subspecies i.e. 628 taxa (Hristovski & Guéorguiev, *in litt*.).

Hydrocanthares. The number of Dytiscidae was estimated based on Löbl & Smetana (2003) and compared to Guéorguiev (1971) revealing 62 species in Macedonia. Similar analysis helped to estimate the species number of other water-diving beetles: Haliplidae - 11, Noteridae - 2 and Gyrinidae - 6 species.

Staphylinoidea. New records were published for the interesting family **Hydraenidae** and one species was described recently (Trizzino et al. 2013). The total number of species of Hydraenidae was estimated to be 42 (MoEPP 2003; Löbl & Smetana 2004; Fauna Europaea 2013). **Staphylinidae (**including Pselaphinae and Scydmaeninae) is one of the three largest families of Coleoptera in Europe. It counts 383 species in Macedonia (Löbl & Smetana 2004, Fauna Europaea 2013, Assing 2000, 2001, 2004a, 2004b, 2008, 2009a, 2009b, 2009c, 2009d, 2009e, 2010; Maus 1998; Hlaváč & Jászay 2009; Frisch 2010; Guéorguiev et al. 2010; Solodovnikov 2012; Hlavač 2013; Sabella et al 2004; Hlaváč & Stevanović 2013; Stevanović 2011). For the families **Cholevidae (Leiodidae)**, **Silphidae**, **Ptilidae, Agyrtidae** we know of 57, 14, 4 and 1 species, respectively (Löbl & Smetana 2004). The total number of species of Staphylinoidea is 516.

Hydrophiloidea. Family Hydrophilidae is represented by 33, and Histeridae by 68 species or 101 species in total (Fauna Europaea 2013; Guéorguiev 1971; Guéorguiev et al. 2010).

Lamellicornia (Scarabaeiformia), Scarabaeoidea. Rozner & Rozner (2009) recorded 99 species of Lamellicornia (10 families) whichfrom 15 species were first records for the Macedonian fauna. Data on this group can also be found in other papers (Ranius et al. 2005; Ahrens 2007; Lobo et al. 2011; Král & Hillertt 2013). In summary, Lamellicornia in Macedonia is represented by 14 families and 172 species. Nevertheless, thorough analysis of the group is needed in order to re-check all of the older monographs published in the 20th century.

Cucujoidea. The family **Coccinelidae** has 33 species (Krsteska et al. 2004; Jadwiszczak et al. 2010). Stevanović et al. (2008) in the catalogue of Balkan **Nitidulidae** reported 59 species for Macedonia (7 first records) which is twice less compared to other Balkan countries. Löbl & Smetana (2007) reported 86 species. Combined, these two sources contain information on 96 species. Thus, we accepted the estimation of Fauna Europaea (2013) which contains data on 116 species from Macedonia. It is obvious that detailed assessment is needed for this family. If representatives of other **Cucujoidea** families are included (e.g. Shockley et al. 2009 for **Endomychidae**) then the total number of species of this superfamily exceeds 200.

Chrysomeloidea (Cerambycidae, Chrysomelidae). Istvan & György (2008) recorded 156 species of **Chrysomelidae** (23 first records for the Macedonian fauna) and thus the total number of this family in Macedonia is 340 (Gruev 1998, 2003; Löbl & Smetana 2010). The family **Cerambycidae**[1] was treated only in Ćurčić et al. (2003) in the last decade (5 species and 2 subspecies recorded). According to Danilevsky (2013) the number of Cerambycidae in Macedonia is 176 species. Total number of Chrysomeloidea is 516 species.

Bostrichiformia. It is represented by the superfamily Bostrichoidea and the families **Bostrichidae**, **Dermestidae**, **Anobiidae** (incl. Ptininae) and **Nosodendridae** with 88 species in total (Fauna Europaea 2013; Löbl & Smetana 2007; Guéorguiev et al. 2010).

Cleroidea. It is represented by the families Cleridae, Dasytidae and Malachiidae in Macedonia. According to Löbl & Smetana 2007 the number of **Cleridae** species in Macedonia is 10. Liberti (2009) reported 4 species of the family **Dasytidae**, one of them being endemic for Shar Planina Mt. and combined with Löbl & Smetana (2007) the total number of Dasytidae was estimated at 17 species. The number of **Malachiidae** was estimated to be 17 species (Löbl & Smetana 2007; Mirutenko 2013). The total number of Cleroidea species is 44.

Tenebrionidae. Ulrich & Fattorini (2013) cited 35 Tenebrionidae species for Macedonia (the same figure as in Fauna Europaea 2013). Guéorguiev et al. (2010) adding new records increased the number of Tenebrionidae to 45 species. Nevertheless, this number is much lower than expected.

Elateroidea. The studies of Platia (2006, 2010), Platia & Németh (2011) and Kovács & Merkl (2013) for **Elateridae** resulted in a description of 4 new species for science and additional 4 first records for Macedonia (some of the species distributed only in Bulgaria and Greece before). The total number of Elateridae in Macedonia is estimated at 74 species. Other families of Elateroidea are: **Cantharidae** - 15, **Lampyridae** - 7 and **Lycidae** - 4 species (Löbl & Smetana 2007). The total number of Elateroidea in Macedonia is 100 species.

Curculionidae. Gültekin & Podlussany (2012) reported 2 new species records of the family Curculionidae for the Macedonian fauna. Yunakov (2005, 2006) described 2 new species for science from the genera *Amicromias* and *Brachysomus*. Marković (2013) published records for 28 species of Scolytinae from Macedo-

nia (all of these species were already published by Karaman, Z. 1971). The total number of species of Curculionidae is almost 290.

It should be stressed that many records on single species can be found in various scientific articles. However, it was impossible to include all of the scientific articles reporting isolated records on Macedonian Coleoptera (e.g. Boukal et al. 2007 for **Elmidae**; Turco & Bologna 2011 for **Meloidae,** see Tab. 1).

11.5.16 Strepsiptera

Out of the order Strepsiptera there is only one known species from Macedonia: *Hylecthrus rubi* Saunders 1850 (Fauna Europaea 2013).

11.5.17 Hymenoptera

The catalogue of Petkovski (2009) assessed the Hymenoptera in Macedonia based on the publications on Symphyta while all of the other families (Apocrita) were completely neglected.

Symphyta of Macedonia were thoroughly elaborated in the second half of XX century, and outstanding faunistic monograph was published by Čingovski (1985).

We based the assessment of Apocrita on Fauna Europaea (2013) database, few older records and recent publications. The following text focuses on the recent advances in the knowledge of Apocrita.

Kolarov (2007, 2008, 2009) reported 80 species of **Ichneumonidae** for the Macedonian fauna, three of them being endemics: *Hadrodactylus tiphae balcanicus* Seyrig, 1927, *Mesochorus venerandus* Schwenke, 1999 and *Gelis balcanicus* Horstmann, 1993 (Kolarov 2008). Kolarov & Bordera (2007) estimated the number of subfamily Cryptinae (Ichneumonidae) at 21 species in Macedonia. Based on the published records and Fauna Europaea (2013) the number of Ichneumonidae in Macedonia was estimated at 129 species.

Yefremova et al. (2010) cited 8 species for the family **Eulophidae**.

Concerning **Apidae,** Van Der Zanden (1984) reported 125 non-parasitic megachilids; Guershon & Ionescu-Hirsch (2012) - 4 *Xylocopa* species; Astafurova & Pesenko (2006) published data on *Nomiapsis*. One should note that the concept of family Apidae that we used (Fauna Europaea 2013), actually includes families Andrenidae, Apidae, Colletidae, Halictidae, Megachilidae according to (Michener 2007).

Karaman, M. G. (2009) elaborated **Formicidae** in Macedonia and listed 78 species. Later on, Bračko et al. (2013) published new estimate which includes 99 species.

Braconidae was analyzed in several papers which enabled the assessment of this family in Macedonia - over 150 species (Baylac et al. 2003; Papp 2009; Žikić et al. 2012; Stigenberg & Ronquist 2011; Simbolotti & van Achterberg 1992).

Lelej (2002) in the catalogue of Palearctic **Mutilidae** cited 21 species in Macedonia. However, with data from Fauna Europaea (2013) and other sources (see Tab. 1) the number of Mutilidae in Macedonia is estimated at 37 species.

Ćetković (2002) recorded *Vespa orientalis* (**Vespidae**) for Macedonian fauna. Based on Fauna Europaea (2013) and other data (see Tab. 1) the fauna of Vespidae in Macedonia counts about 75 species. Separate records can be found in other studies (Graham et al. 1998 - **Torymidae**; Donev 1998, 2004, 2005 - **Mymaridae**; Schmid-Egger, 2004 and Nemkov 2012 - **Crabronidae**; Rizzo & Mitroiu 2010 - **Pteromalidae**; Dollfuss 2010 and Schmid-Egger 2012 - **Sphecidae**). For the total number of species within these families see Tab. 1.

The analysis of available literature on Hymenoptera in Macedonia showed presence of almost 1100 species. This order requires more detailed analyses, especially of older literature records.

Newly described species for science from Macedonia

The following list presents the species and subspecies that were described in the last decade (since the publication of MoEPP 2003 or species that were not taken into account by Petkovski 2009). The list (most probably not complete) includes 64 taxa:

Nematoda

1. *Longidorus pius* Barsi & Lamberti, 2001

Gastropoda

2. *Tandonia sapkarevi* Stankovic, 2005
3. *Montenegrina dofleini steffeki* Eross & Szekeres, 2006
4. *Montenegrina perstriata mavrovoensis* Nordsieck, 2009
5. *Montenegrina dedovi* Nordsieck, 2009
6. *Euxinella subai Dedov & Neubert, 2009*
7. *Euxinella radikae hristovskii Dedov & Neubert, 2009*
8. *Vestia lazarovii* Dedov, 2012
9. *Euxinella alpinella Dedov, 2012*
10. *Gyralina nautilopsis Dedov & Subai, 2012*
11. *Triloba pappi Schnabel, 2012 (fossil species)*

Pseudoscorpiones

12. *Neobisium vladimirpantici* Ćurčić, 2004
13. *Neobisium tzarsamueli* Ćurčić & Dimitrijević, 2006
14. *Neobisium anaisae* Ćurčić & Lemaire, 2009
15. *Chthonius lagadini* Ćurčić & Rađa, 2011

Opiliones

16. *Cyphophthalmus markoi* Karaman, 2008
17. *Trogulus karamanorum* Schönhofer et Martens, 2009 (described from several Balkan countries, the holotype is v. Gjonovica, Bukovik).
18. *Trogulus tenuitarsus* Schönhofer Karaman et Martens, 2013

Araneae

19. *Harpactea mariae* Komnenov, 2013
20. *Typhochrestus penevi* Komnenov, 2013

Acari

21. *Trachytes macedoniensis* Kontschán, 2005

Crustacea

22. *Fabaeformiscandona svetozari* (Petkovski & Karanovic, 2004) (described as *Eucandona svetozari*)
23. *Macedonethes stankoi* Karaman, 2003
24. *Mladenoniscus belavodae* Karaman & Horva-

[1] Elaboration of Cerambycidae in Macedonia was assisted by Ljubomir Stefanov (Skopje).

tović, 2008

Myriapoda

25. Typhloiulus giganteus Curcic & Makarov, 2002
26. Brachydesmus zlatiborpetrovici Curcic & Makarov, 2002
27. Typhloglomeris varunae Makarov & al. 2003
28. Brachydesmus verrucosus Makarov & Antić, 2013

Collembola

29. Heteromurus constantinellus Ćurčić & Lučić, 2007
30. Onychiurus macedonicus Lucic, Dimitrijevic & Mihajlova, 2003
31. Onychiurus boskovae Lucic, Dimitrijevic & Mihajlova, 2003
32. Onychiurus karadzicae Lucic, Dimitrijevic & Mihajlova, 2003

Plecoptera:

33. Siphonoperla korab Graf, 2012
34. Nemoura anas Murányi, 2007 (described from Albania, Macedonia and Montenegro; holotype from Albania)

Orthoptera

35. Poecilimon jablanicensis Chobanov & Heller, 2010
36. Troglophilus zorae Karaman & Pavicevic 2011 (described from Macedonia and Albania, the holotype is from Matka)

Heteroptera

37. Adelphophylus kormilevi Protić, 2005

Trichoptera

38. Rhyacophila liutika Oláh, 2010
39. Potamophylax lemezes Oláh & Graf, 2013
40. Chaetopteroides tunik Oláh, 2013

Lepidoptera

41. Dichrorampha dinarica Huemer, Zlatkov et Baixeras, 2012 *(*described from several west-Balkan countries*)*
*42. Coleophora aleramica Baldizzone & Stübner, 2007 (*described from several European countries*)*

Coleoptera

43. Trechus galicicaensis Guéorguiev & Hristovski, 2010
44. Duvalius karaormanicus Hristovski, 2011
45. Calathus jakupicensis Guéorguiev, 2008
46. Winklerites fodori Guéorguiev, 2007
47. Winklerites blazeji Giachino et Vailati *2012*
48. Winklerites moraveci Giachino et Vailati 2012
49. Winklerites vonickai Giachino et Vailati 2012
50. Tapinopterus macedonicus S.B. Curcic, Waitzbauer, Zolda, B.P.M. Curcic & Mihajlova, 2008
51. Hydroporus macedonicus Fery & Pešić, 2006
52. Hydraena kucinici Mičetić Stanković & Jäch, 2012
53. Geostiba galicicana Assing, 2000
54. Geostiba excaecata Assing, 2001
55. Babuniella jovanhadzii Curcic & Mihajlova, 2005
- (*Petkovskiella henrikenghoffi* Curcic & Curcic, 2005, later on synonimized)
56. Athous siteki Platia, 2006
57. Athous kozufensis Platia, 2010
58. Athous jakupicicola Platia & Németh, 2011
59. Athous fodorjenoi Platia & Németh, 2011
60. Chitona macedonica Švihla, 2006
61. Chaetocnema franzi Konstantinov, Baselga, Grebennikov, Prena, Lingafelter, 2011
62. Amicromias fodori Yunakov, 2005
63. Brachysomus simplex Yunakov, 2006
64. Paramaurops vonickai Hlaváč, 2013

Centers of diversity and endemism

One of these centers that certainly deserve such a glorification is the ancient Lake Ohrid. There are many published scientific results in the 20th century on Lake Ohrid fauna which continue to this day. The last decade of the Lake Ohrid research is characterized by paeloecological and evolutionary studies that shed light on the origin of species of Lake Ohrid and their relationships with other aquatic ecosystems on the Balkans and elsewhere in the world (Albrecht et al. 2006; Kilikowska et al. 2006, 2013; Wysocka et al. 2008, 2013; Trajanovski et al. 2010). Albrecht & Wilke (2008) presented a summary of the Lake Ohrid biodiversity: Porifera - 4 species, Platyhelminthes - 75 species (~35 endemic); Rotatoria - 49, Nematoda - 24 (3 endemic), Oligochaeta - 36 taxa (17 endemic), Hirudinea - 24 (12 endemic), Acari - 43, Cladocera - 31 (1 endemic), Ostracoda - 52 (33 endemic), Copepoda - 36 (6 endemic), Decapoda - 2, Isopoda - 4 (3 endemic), Amphipoda - 10-11 (9 endemic), Insects - over 100, Gastropoda - 72 (56 endemic) and Bivalvia - 13 species (2 endemic).

Prespa Lake is another Macedonian hot-spot. It is considered as a "sister lake" to the Lake Ohrid due to its geographic proximity, common history, existing underground hydrologic connection and similar biological composition. Nevertheless, there are many differences (Albrecht et al. 2008) and recently Abrecht et al (2012) stated that the mollusk fauna of Great and Lesser Prespa lakes are "*most closely related to lakes in the western Balkans and not to nearby Lake Ohrid*". Prespa Lake has received much less attention from the biologists compared to the Lake Ohrid and complete analysis of its biodiversity is not possible at the present moment. In general, the number of species of Prespa is lower compared to Lake Ohrid. Nevertheless, Prespa Lake is one of the most important European lakes in terms of biodiversity. The total number of Mollusca of Prespa lake is 36 (Gastropoda - 27, Bivalvia - 9) (Korniushin 1998). Albrecht et al. (2012) reviewed the mollusc fauna of Prespa lake and confirmed presence of 19 native gastropods (7 of them are endemics plus 2 endemic species with no recent records: *Marstoniopsis malaprespensis* (Radoman, 1973) and *Vinodolia lacustris* (Radoman, 1973)) and 1 invasive gastropod species as well as 10 shell species (one of them is endemic - *Pisidium maassani* Kuiper, 1987). Other figures were derived from Smith et al. (2009) and some other publications (Stojanovski et al. 2004, 2006): Porifera - 3, Platyhelminthes ~ 50, Rotifera ~ 60, Annelida - 35, Crustacea ~ 90, Insecta - over 100 species. The MoEPP (2003) study presented data on 18 endemic invertebrate taxa from Lake Prespa.

Endogean fauna of Macedonia is less known (compared to most of the other Balkan countries) and according to the current knowledge it is poorer in species compared to the West-Balkan states. To be fair, we compare the Macedonian fauna to the Dinarides which are one of the richest regions with troglobionts and

stygobionts in the world (Sket et al. 2004). However, Macedonian endogean fauna has very high endemism of about 90% (Guéorguiev 1977; Sket et al. 2004; Ćurčić et al. 2004a). Macedonian stygobionts are better studied and up to now we know of 57 species. The most numerous troglobionts are found within Pseudoscorpiones - 14 species, Coleoptera - 12 and Isopoda 10. During the last decade, seven new troglobionts were described (Isopoda - 2, Pseudoscorpiones - 3 and Coleoptera - 2). The riches cave fauna is known from the cave systems in west Macedonia, particularly the caves in Radika watershed, Galichica Mt., Mokra Mt. (=Jakupica) and Poreche region.

Mountain ecosystems (beech forests, high-altitude coniferous forests and alpine pasture and rocky sites) are very rich in endemic species. This statement should be sustained by thorough analyses in the future. At present, we have data on a number of diversified genera with high percentage of endemic and relict taxa (e.g. *Molops, Tapinopterus, Zabrus, Winklerites, Dorcadion, Ottiorhynchus, Erebia,* etc.).

Refugial sites in Macedonia have been treated from their floral composition and vegetation peculiarities (Em et al. 1985). However, the presence of many endogean and other cryptic species point to the necessity to implement a faunistic research in these areas. So far, endemic species were described from such areas (mainly river gorges) within some groups (Pseudoscorpiones, Aranea, Opiliones, *Troglophilus*).

Conservation of invertebrates

Macedonia lacks official red list assessment of threatened species, including invertebrates. In order to overcome the legal problems the Ministry of Environment and Physical Planning issued a List of protected and strictly protected wild species (Official Gazette of the Republic of Macedonia, 139/2011). The list of strictly protected species (Annex I) includes 35 invertebrates: Crustacea - 31, Coleoptera (Buprestidae) - 1 and Lepidoptera (Papilionoidea) - 3 species. The list of protected species (Annex II) includes enormous number of species of invertebrates (513): Porifera - 6, Gastropoda - 125, Bivalvia - 6, Araneae - 17, Pseudoscorpiones - 30, Crustacea - 101, Myriapoda - 16 , Collembola - 1, Ephemeroptera - 6, Odonata - 1, Plecoptera - 10, Orthoptera - 13, Psocoptera - 1, Trichoptera - 5, Diptera - 8, Carabidae - 56, Cerambycidae - 3 and Lepidoptera - 59 species.

The criteria for selection of species are not elaborated. One can assume that the strictly protected species (Annex I) are the ones with international importance. The list of protected species (Annex II) includes mainly "endemic" species. The list is not consistent with latest taxonomy and contains a lot of synonyms (e.g. *Carabus intricatus macedonicus* Jureček, 1928*, Carabus violaceus skombrosensis* Eidam, 1927*, Carabus violaceus marani* Štěrba, 1945*, Cychrus attenuatus peristericus* Roubal, 1930*, Cychrus semigranosus peristericus* Roubal, 1930*, Pachycarus macedonicus* V. B. Guéorguiev & B. V. Guéorguiev, 1997*, Okuloduvalius*). On the other hand, these lists do not include some of the species with global conservation importance (e.g. *Osmoderma eremita* (s.l.)*, Lucanus cervus* (Linnaeus, 1758)*, Carabus variolosus* Fabricius, 1787*, Probaticus subrugosus* (Duftschmidt 1812), *Apatura metis* Freyer 1829*, Euphydryas aurinia* (Rottemburg 1775)*, Euphydryas* (*=Hypodryas*) *maturna* (Linnaeus 1758) *maturna, Lycaena dispar* (Haworth 1802)*, Papilio alexanor* Esper 1800, *Euplagia* (*=Callimorpha*) *quadripunctaria* (Poda 1761)*,* a number of dragonglies, etc.). It also includes species without any conservation importance (e.g. *Liposcelis macedonicus* Günther, 1980 (Psocoptera), a synonim of Holarctic species *Liposcelis decolor* Pearman, 1925). All of these lacks should be overcome by elaboration of a proper red list assessment.

Van Swaay & Warren (2003) identified 8 Prime Butterfly Areas in Macedonia (Shar Planina, Galichica, Radika gorge, Struga, Ograzhden, Kozhuf, Baba and Babuna gorge) on the basis of 5 target species: *Euphydryas aurinia* (Rottemburg 1775), *Euphydryas maturna* (Linnaeus 1758), *Lycaena ottomanus* (Lefèbvre 1830), *Phengaris* (*=Maculinea*) *arion* (Linnaeus 1758) and *Parnassius apollo* (Linnaeus 1758). Three of these areas (Galichica, Radika gorge and Baba) are alredy protected on a national level within the existing national parks of Galichica, Mavrovo and Pelister (Brajanoska et al. 2009).

Krpač & Darcemont (2012) proposed red list of daily butterflies in Macedonia. This list includes 69 species (EN - 1, VU - 15, NT - 24, the rest have no IUCN status, but are considered as important due to the restricted distribution range).

According to Savić (2007) there are six freshwater invertebrate species listed in the IUCN Red List: *Graecoanatolica macedonica* Radoman & Stanovic, 1978, *Ohridohauffenia drimica* (Radoman, 1964), *Alona smirnovi* Petkovsky & Flossner, 1972, *Astacus astacus* (Linnaeus, 1758), *Austropotamobius torrentium* (Schrank, 1803), *Chirocephalus pelagonicus* Petkovski, 1986, the first 2 species being gastropods and the last 3 - crustaceans. Albrecht et al. (2012) assessed the conservation status of the endemic mollusc species of Prespa lakes (in Macedonia, Greece and Albania) and concluded that 3 species are critically endangered: *Prespolitorea valvataeformis* (Radoman, 1973)*, Marstoniopsis malaprespensis* (Radoman, 1973) and *Vinodolia lacustris* (Radoman, 1973); 2 are vulnerable: *Bithynia prespensis* Hadžišče, 1963 and *Planorbis presbensis* (Sturany, 1894); and 5 are endangered: *Marstoniopsis macedonica* (Hadžišče, 1963)*, Pyrgohydrobia prespaensis* (Urbanski, 1939)*, Radix pinteri* Schütt, 1974*, Gyraulus stankovici* Hadžišče, 1955 and *Pisidium maasseni* Kuiper, 1987). However, many additions to the IUCN Red List of Threatened Species regarding aquatic gastropods were published in 2010 (IUCN 2013).

The IUCN Red List of Threatened Species (IUCN 2013) contains 217 taxa from Macedonia. Out of the threatened species, 2 (*Ohridohauffenia drimica* (Radoman, 1964) and *Graecoanatolica macedonica* Radoman & Stanovic, 1978) are considered to be *extinct* (EX), 14 are *critically endangered* (CR), 25 are *endangered* (EN), and 28 are *vulnerable* (VU). The rest of the species belong to the following categories: 18 are *near threatened* (NT), 19 are *data defficient* (DD) and 111 are *least concern* (LC). Most of the threatened species (57) belong to aquatic gastropods, particularly from the Ohrid and Prespa lakes and surrounding wetlands.

Allochtonous and invasive species

Very low attention and research has been dedicated to alochtonous and invasive species of invertebrates in

Macedonia. The only exceptions are the pests in agriculture and forestry (e.g. *Leptinotarsa decemlineata*). However, some projects were implemented in the last decade with an aim to enlist the allochtonous species. One of these projects (Tomov et al. 2009) recorded few allochtonous species from Macedonia: *Epitrix hirtipennis* (Melsheimer, 1847)*, Leptinotarsa decemlineata* (Say, 824)*, Pseudalacaspis pentagona* (Targioni-Tozzetti, 1886) and *Phthorimaea operculell*a (Zeller 1873).

In the following text we try to summarize the existing information on alochtnous species from Macedonia. Stoev et al. (2010) recorded one allochtonous Myriapoda: *Oxidus gracilis* (C.L. Koch, 1847). Nentwig & Kobelt (2010) recorded 8 allochtonous spiders: *Sosticus loricatus* (L.Koch 1866), *Pholcus opilionoides* (Schrank 1781), *Pholcus phalangioides* (Fuesslin 1775), *Spermophora senoculata* (Dugès 1836), *Tetragatha shoshone* (Levi 1981), *Achaearanea tepidariorum* (C.L. Koch 1841), *Steatoda grossa* (C.L. Koch 1838) and *Steatoda triangulosa* (Walckenaer 1802). Five species of mites (Acari) are known (Navajas et al. 2010): *Eriophyes pyri* (Pagenstecher, 1857), *Reckella celtis* Bagdasarian,1975, *Eotetranychus weldoni* (Ewing, 1913), *Panonychus citri* (McGregor, 1916) and *Hyalomma scupense* Delpy 1946 (the last was described from Skopje - Apanaskevich et al. 2010). Karaman, G. S. (2013a) reported 2 invasive crustaceans from the Lake Ohrid: *Orchestia cavimana* Heller, 1865 with marine origin and *Gammarus roeselii* Gervais, 1835 with origin in southeast Europe and Asia Minor. Albrecht et al. (2012) reported one invasive gastropod species (*Ferrissia wautieri* Mirolli, 1960) for Prespa lake. Rasplus & Roques 2010 considered *Ramburiella turcomana* (Fischer von Waldheim, 1846) as an allochtonous orthopteran species in Macedonia. However, this species is distributed in east Macedonia (see Chobanov & Mihajlova 2010) and should be considered as autochonous.

Coeur d'acier et al. (2010) reported 10 allochtonous Aphididae (Hemiptera): *Acyrthosiphon caraganae* Cholodkovsky, 1908, *Aphis gossypii* Glover 1877, *Aphis spiraephaga* F.P. Müller, 1961, *Brachycaudus rumexicolens* (Patch, 1917), *Chaetosiphon fragaefolii* (Cockerell, 1901), *Chromaphis juglandicola* (Kaltenbach, 1843), *Macrosiphum euphorbiae* (Thomas, 1878), *Myzus varians* Davidson, 1912, *Myzus ascalonicus* Doncaster, 1946 and *Myzus persicae* Sulzer 1776. *Stictocephala bisonia* Kopp & Yonke, 1977 is another species of Hemiptera (Mifsud et al. 2010). Lopez -Vaamonde et al. (2010) reported 11 species of allochtonous butterflies: *Hyphantria cunea* (Drury, 1773), *Phthorimaea operculella* (Zeller, 1873), *Sitotroga cerealella* (Olivier, 1789), *Parectopa robiniella* Clemens, 1863, *Phyllonorycter platani* (Staudinger, 1870), *Cadra figulilella* (Gregson, 1871), *Ephestia elutella* (Hübner, 1796), *Plodia interpunctella* (Hübner, 1813), *Antheraea yamamai* (Guérin-Méneville, 1861), *Grapholita molesta* (Busck, 1916) and *Coleophora laricella* (Hübner, 1817). There are 7 allochtonous species of Chrysomelidae, as well (Beenen & Roques 2010): *Epitrix hirtipennis* (Melsheimer, 1847), *Acanthoscelides obtectus* Say, 1831, *Acanthoscelides pallidipennis* (Motschulsky, 1874), *Bruchus pisorum* (Linnaeus, 1758), *Bruchus rufimanus* Bohemann, 1833, *Callosobruchus chinensis* (Linnaeus, 1758) and *Leptinotarsa decemlineata* (Say, 1824).

Only one allochtonous species of Diptera from Macedonia is known (Skuhravá et al. 2010): *Obolodiplosis robiniae* (Haldeman, 1847).

Other species can also be included in the list of allochtonous species, some of them well known (*Blatta orientalis* Linnaeus 1758*, Blattella germanica* (Linnaeus 1767), *Physa acuta* Draparnaud 1805*, Craspedacusta sowerbii* Lankester 1880) with low amount of data in the literature. Thus, Denux & Zagatti (2010) concluded that there is lack in knowledge concerning the allochtonous and invasive species in Macedonia.

Additions for 2014

Although the main aim of the paper was elaboration of the progress made up to 2013 it was not rational to omit all of the data published in 2014 we were aware about. Several new species for science were published recently:

Cephennium viti Stevanovic, 2014 [Stevanović, M. (2014). Study of the genus *Cephennium* Müler & Kunze, 1822 (Coleoptera, Staphylinidae, Scydmaeninae) from the Balkan Peninsula. Part II. New species of the subgenus *Cephennium* s. str. Zootaxa 3838 (3): 287–309]

Cicadetta concinna arachnocepta Gogala, Trilar et Krpač, 2014 [Gogala, M., Trilar, T., Krpač, V. (2014). New subspecies *Cicadetta concinna arachnocepta* (Hemiptera: cicadidae) from Macedonia. Acta ent. Slov. 22(2): 101-114].

Trechus nezlobinskyi Hristovski, 2014 [Hristovski, S. (2014a). *Trechus* (*Trechus*) *nezlobinskyi*, a new high-altitude ground beetle species from the Republic of Macedonia (Coleoptera: Carabidae: Trechinae). Ecologica Montenegrina 1(3): 184-188]

Winklerites macedonicus Hristovski, 2014 [Hristovski, S. (2014b). Description of *Winklerites macedonicus* n. sp. from the Republic of Macedonia (Carabidae, Trechinae, Bembidiini). Acta zoologica bulgarica 66 (3): 309-312]

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Table 1. Overview of the number of invertebrates by taxonomic groups

Taxonomic category (group)	Macedonia	Percentage of European fauna	References
1. Phylum Porifera	10	55.6	MoEPP 2003; Petkovski 2009
2. Phylum Cnidaria	3	5.6	MoEPP 2003
3. Phylum Platyhelminthes	229	7.4	Petkovski 2009
3.1. Subphylum Turbellaria	71	10.2	
3.1.1. Order Acoela	1	25	Petkovski 2009
3.1.2. Order Lecithoepitheliata	1	7.7	Fauna Europaea 2013
3.1.3. Order Macrostomida	4	7.4	Fauna Europaea 2013
3.1.4. Order Prolecithophora	1	33.3	Fauna Europaea 2013
3.1.5. Order Rhabdocoela	24	6.2	Petkovski 2009
3.1.6. Order Tricladida	40	25.3	Petkovski 2009; Stocchino et al. 2013
3.2. Subphylum Neodermata	158	6.6	
3.2.1. class Trematoda	45	3.9	Hristovski, N. (unpublished data).
3.2.2. class Cestoda	79 (38+41)	8.8	Hristovski, N. (unpublished data). This figure includes 41 species published by Nezlobinsky that have no specific geographic origin.
3.2.3. class Monogenea	34	10.4	Hristovski, N. (unpublished data).
4. Phylum Nematoda	~600	14.7	MoEPP 2003
5. Phylum Rotifera	269	20.9	Petkovski 2009
6. Phylum Acanthocephala	8	5.7	Hristovski, N. (unpublished data).
7. Phylum Nemertea	1	8.3	Petkovski 2009
8. Phylum Nematomorpha	2	2.9	Čanadjija 1956; Kovachev et al. 1999
9. Phylum Annelida	175	15.9	
9.1. Class Oligochaeta	140	14.4	Petkovski 2009, Szederjesi 2013
9.2. Class Hirudinea	30	34.5	MoEPP 2003; Albrecht & Wilke 2008;
9.3. Class Branchiobdellea	5	50	Subchev 2007, 2012; Subchev & Geld-
10. Phylum Mollusca	320	9.4	Welter-Schultes 2012
10.1. Class Gastropoda	301	9	Stankovic 2005; Erőss et al. 2006; Stankovic et al. 2006; Albrecht et al. 2008; Dedov & Neubert 2009; Nordsieck 2009; Dedov 2010, 2012; Dedov & Hristovski 2010; Bank 2011; Dedov & Mitev 2011; Welter-Schultes 2012; Dedov unpublished data
10.2. Class Bivalvia	19	34.5	Korniushin 2004; Albrecht et al. et al. 2007; Petkovski 2009
11. Phylum Arthropoda	11849	10.7	
11.1. Subphylum Chelicerata	1126	7.9	
11.1.1. Order Scorpiones	3	13	Fet 2010
11.1.2. Order Pseudoscorpiones	54	6.9	Ćurčić et al. 2004b, 2006, 2009, 2011; Harvey 2007, 2013; Petkovski 2009

Table 1. Overview of the number of invertebrates by taxonomic groups (continuation)

Taxonomic category (group)	Macedonia	Percentage of European fauna	References
11.1.3. Order Solifugae	2	11.1	Drensky 1931; Roewer 1934
11.1.4. Order Opiliones	50	15.2	MoEPP 2003; Karaman 2008; Schönhofer 2013; Schönhofer & Martens 2009; Schönhofer et al. 2013; Karaman, I., unpublished data
11.1.5. Order Araneae	767	15.6	Blagoev 2002; Komnenov 2002, 2003, 2006, 2013; Deltshev 2003, 2008; Lazarov 2004; Ćurčić et al. 2004c; Fisher & Azarkina 2005; Deltshev et al. 2006, 2007, 2013; Komnenov & Pavićević 2008; Stefanovska et al. 2008; Petkovski 2009; van Helsdingen 2013
11.1.6. Infraclass Acari	250	3	
11.1.6.1. Order Astigmata	1	0.2	Fauna Europaea 2013
11.1.6.2. Order Ixodida	13	16.9	Fauna Europaea 2013
11.1.6.3. Order Mesostigmata	14	0.9	Kontschán 2005, 2012
11.1.6.4. Order Oribatida	1	0.04	Fauna Europaea 2013
11.1.6.5. Order Prostigmata	221	5.8	Pešić 2003, 2005; Pešić et al. 2010; Smit & Pešić 2004; Chatterjee et al. 2010; Zawal et al. 2011; Heitlinger 2012; Fauna Europaea 2013
11.2. Subphylum Crustacea	521	14.9	
11.2.1. Class Branchiopoda	94	37.8	
11.2.1.1. Order Anostraca	6	12.5	Petkovski 2009
11.2.1.2. Order Notostraca	2	40	Petkovski 2009
11.2.1.3. Order Diplostraca	86	43.9	Petkovski 2009
11.2.2. Class Ostracoda	172	46	Petkovski & Karanović, 2004; Petkovski 2009; Lorenschat & Schwalb 2013
11.2.3. Class Maxillopoda	150	18.4	Petkovski 2009, Hristovski, N., unpublished data
11.2.3.1. Subclass Copepoda	146	18	Stojanovski et al. 2004; Petkovski 2009, Hristovski, N., unpublished data
11.2.3.2. Subclass Branchiura	3	100	Stojanovski et al. 2004; Petkovski 2009
11.2.3.3. Subclass Pentastomida	1	33.3	Hristovski, N., unpublished data
11.2.4. Class Malacostraca	105	5.1	
11.2.4.1. Order Bathynellacea	3	4.5	Petkovski 2009; Fauna Europaea 2013
11.2.4.2. Order Isopoda	50	3.4	Karaman, M. S. 1966; Karaman, I. 2003; Schmalfuss 2003; Karaman, I. & Horvatović 2008; Petkovski 2009
11.2.4.3. Order Amphipoda	47	10	Petkovski 2009; Karaman, G. S. 2013b
11.2.4.4. Order Decapoda	5	19.2	Karaman, M. S. 1972, 1976; Petkovski 2009; Christodolous 2012

Table 1. Overview of the number of invertebrates by taxonomic groups (continuation)

Taxonomic category (group)	Macedonia	Percentage of European fauna	References
11.3. Subphylum Myriapoda	100	4.6	Makarov 2001; Ćurčić et al. 2002; Makarov et al. 2003; Petkovski 2009; Nitzu et al. 2011; Antić et al. 2013; Kiçaj & Qirjo 2013; Simaiakis & Edgecombe 2013
11.4. Subphylum Entognatha	21	0.9	
11.4.1. Order Protura	8	4.5	Fauna Europaea 2013
11.4.2. Order Diplura	2	0.7	Fauna Europaea 2013
11.4.3. Order Collembola	11	0.6	Lučić et al. 2003, 2007
11.5. Subphylum Insecta	10081	11.4	
11.5.1. Order Zygentoma	1	1.7	Fauna Europaea 2013
11.5.2. Order Microcoryphia	3	1.4	Fauna Europaea 2013
11.5.3. Order Ephemeroptera	68	20.1	Ikonomov 1951, 1953, 1954a, 1954b, 1954c, 1958, 1959, 1960, 1961a, 1961b, 1962a, 1962b, 1962c, 1962d, 1963a, 1963b, 1964, 1970; Vidinova, 1998; Bauernfeind & Soldan 2012.
11.5.4. Order Odonata	64	48.9	Bedjanič et al. 2008; Micevski et al. 2008; Jović 2009; Jović & Mihajlova 2009; Kitanova et al. 2009; Petkovski 2009; Zawal et al. 2010; Holuša 2012
11.5.5. Order Plecoptera	97	22.8	Ikonomov 1978, 1986; Zwick, 1984; Murányi 2007; Graf et al. 2012; Fauna Europaea 2013
11.5.6. Order Dictyoptera	18	8.8	
11.5.6.1. Suborder Isoptera	2	16.7	Karaman, Z. 1954; Murányi 2013b
11.5.6.2. Suborder Mantodea	4	11.1	Chobanov & Mihajlova 2010
11.5.6.3. Suborder Blattodea	12	7.7	Bohn et al. 2013; Klaus-Gerhard 2013
11.5.7. Order Orthoptera	175	16.6	Chobanov 2002, 2010; Micevski et al. 2003; Petkovski 2009; Chobanov & Heller 2010; Chobanov & Mihajlova 2010; Lemonnier-Darcemont 2010; Karaman et al. 2011; Chobanov et al. 2013;
11.5.8. Order Embioptera	1	7.7	Chobanov, D., unpublished data
11.5.9. Order Dermaptera	5	6	Murányi 2013a, 2013b
11.5.10. Order Psocoptera	49	23	Petkovski 2009; Sziráki, 2013; Fauna Europaea 2013
11.5.11. Order Phthiraptera	14	1.9	Durden & Musser, 1994
11.5.12. Order Thysanoptera	42	7.4	Petkovski 2009
11.5.13. Order Hemiptera	938	12.6	
11.5.13.1. Suborder Heteroptera	776	28.6	Divac 1907; Horvath 1916, 1936; Schumacher 1918a, 1918b; Royer 1922, 1923, 1924a, 1924b; Kormilev 1936, 1938; 1939a, 1939b, 1943; Daniel 1957; Wagner 1960, 1962; Göllner-Scheiding 1978, 1982; Josifov 1986; Aukema & Rieger 1994, 1996, 1998, 2001, 2006; Protić 1998, 2001, 2005, 2012; Josifov & Simov 2006; Aukema et al. 2013;

Table 1. Overview of the number of invertebrates by taxonomic groups (continuation)

Taxonomic category (group)	Macedonia	Percentage of European fauna	References
11.5.13.2. Suborder Cicadomorpha	15	1.1	Gogala et al. 2005; Atanasova et al. 2013
11.5.13.3. Suborder Fulgoromorpha	13	1.8	Atanasova et al. 2013; Fauna Europaea 2013
11.5.13.4. Suborder Sternorrhyncha	134	5	Spasov 2003; Evans 2007; Atanasova 2010
11.5.14. Order Neuroptera	59	19.3	Mace 1920; Doflein 1921; Dimitrova 1924; Dimitrowa 1925; Aspock & Aspock 1964, 1965, 1966, 1968, 1969, 1972, 1974, 1994; Ohm 1965; Popov 1970, 1997, 2004; Gepp 1972; Holzel 1978; Aspock, H. 1979; Aspock, U. 1979; Aspock et al. 1980, 1984, 1991, 2001; Saure 1989; Devetak 1992, 1996, 1997, 1998; Canard 2004; Popov 2004; Kačírek 2013
11.5.15. Order Raphidioptera	9	11.1	Devetak 1992; Devetak et al. *in press.*
11.5.16. Order Mecoptera	2	8.7	Devetak 1991; Willman 1977
11.5.17. Order Trichoptera	106	10.1	Kumanski 1997; Kumanski & Malicky 1999; Petkovski 2009; Oláh 2010; Oláh et al. 2013a, 2013b; Fauna Europaea 2013
11.5.18. Order Lepidoptera	2638	26.7	Daniel 1964; Thurner 1964; Klimesch 1968; Pinker 1968, Huemer et al. 2011; Fauna Europaea 2013
11.5.18.1. Familia Endromidae	1	50	Fauna Europaea 2013
11.5.18.2. Familia Adelidae	17	34	Fauna Europaea 2013
11.5.18.3. Familia Alucitidae	8	34.8	Fauna Europaea 2013
11.5.18.4. Familia Argyresthiidae	6	13	Fauna Europaea 2013
11.5.18.5. Familia Autostichidae	12	9.2	Fauna Europaea 2013
11.5.18.6. Familia Bedelliidae	1	33.3	Fauna Europaea 2013
11.5.18.7. Familia Blastobasidae	2	3.9	Fauna Europaea 2013
11.5.18.8. Familia Brachodidae	3	20	Fauna Europaea 2013
11.5.18.9. Familia Brahmaeidae	3	50	Fauna Europaea 2013
11.5.18.10. Familia Bucculatricidae	16	29.1	Fauna Europaea 2013
11.5.18.11. Familia Carposinidae	2	28.6	Fauna Europaea 2013
11.5.18.12. Familia Chimabachidae	1	33.3	Fauna Europaea 2013
11.5.18.13. Familia Choreutidae	5	29.4	Fauna Europaea 2013
11.5.18.14. Familia Coleophoridae	84	14.8	Stübner 2007
11.5.18.15. Familia Cosmopterigidae	17	20.5	Fauna Europaea 2013
11.5.18.16. Familia Cossidae	6	18.8	Yakovlev 2005
11.5.18.17. Familia Crambidae	164	33.6	Muus & Wullaert 2008; Fazekas 2009; Šumpich & Skyva 2012
11.5.18.18. Familia Douglasiidae	4	30.8	Fauna Europaea 2013
11.5.18.19. Familia Drepanidae	13	61.9	Fauna Europaea 2013

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Taxonomic category (group)	Macedonia	Percentage of European fauna	References
11.5.18.20. Familia Elachistidae	79	16.8	Fauna Europaea 2013
11.5.18.21. Familia Epermeniidae	6	25	Fauna Europaea 2013
11.5.18.22. Familia Erebidae	144	40.8	Fauna Europaea 2013
11.5.18.23. Familia Eriocraniidae	1	11.1	Fauna Europaea 2013
11.5.18.24. Familia Euteliidae	2	100	Fauna Europaea 2013
11.5.18.25. Familia Gelechiidae	148	19.2	Bidzilya & Li 2011; Šumpich & Skyva 2012
11.5.18.26. Familia Geometridae	360	34.3	Sammut et al. 2008
11.5.18.27. Familia Glyphipterigidae	6	14	Fauna Europaea 2013
11.5.18.28. Familia Gracillariidae	41	16.3	Fauna Europaea 2013
11.5.18.29. Familia Heliozelidae	1	10	Fauna Europaea 2013
11.5.18.30. Familia Hepialidae	6	37.5	Fauna Europaea 2013
11.5.18.31. Familia Hesperiidae	26	54.3	Melovski 2003, 2004, 2010; Micevski & Micevski 2004/2005, 2005a, 2005b, 2006/2007, 2008; Krpač & Lazarevska 2008; Verovnik & Micevski 2008, 2009; Fazekas 2009; Micevski et al. 2009a, 2009b; Verovnik et al. 2010; Verovnik 2012; Arsovski et al. 2010; Krpač et al. 2011a; Abdija et al. 2013
11.5.18.32. Familia Heterogynidae	1	14.3	Fauna Europaea 2013
11.5.18.33. Familia Incurvariidae	2	14.3	Fauna Europaea 2013
11.5.18.34. Familia Lasiocampidae	20	44.4	Fauna Europaea 2013
11.5.18.35. Familia Lecithoceridae	1	10	Fauna Europaea 2013
11.5.18.36. Familia Limacodidae	2	40	Fauna Europaea 2013
11.5.18.37. Familia Lycaenidae	56	42.7	Melovski 2003, 2004, 2010; Micevski & Micevski 2004/2005, 2005a, 2005b, 2006/2007, 2008; Krpač & Lazarevska 2008; Verovnik & Micevski 2008, 2009; Beshkov 2009; Fazekas 2009; Micevski et al. 2009a, 2009b; Arsovski et al. 2010; Verovnik et al. 2010; Krpač et al. 2011a; Verovnik 2012; Abdija et al. 2013
11.5.18.38. Familia Lyonetiidae	6	20	Fauna Europaea 2013
11.5.18.39. Familia Lypusidae	1	4.8	Fauna Europaea 2013
11.5.18.40. Familia Micropterigidae	6	12.8	Zeller et al. 2007
11.5.18.41. Familia Millieridae	1	100	Fauna Europaea 2013
11.5.18.42. Familia Momphidae	3	15.8	Fauna Europaea 2013
11.5.18.43. Familia Nepticulidae	35	13.2	Fauna Europaea 2013
11.5.18.44. Familia Noctuidae	528	41.3	Stojanović & Glavendekić 2005; Pekarsky 2012; Fauna Europaea 2013
11.5.18.45. Familia Nolidae	14	34.1	Fauna Europaea 2013
11.5.18.46. Familia Notodontidae	27	49.1	Fauna Europaea 2013; Groenen 2010

Table 1. Overview of the number of invertebrates by taxonomic groups (continuation)

Taxonomic category (group)	Macedonia	Percentage of European fauna	References
11.5.18.47. Familia Nymphalidae	90	37.2	Melovski 2003, 2004, 2010; Micevski & Micevski 2004/2005, 2005a, 2005b, 2006/2007, 2008; Micevski et al. 2009a, 2009b; Krpač & Lazarevska 2008; Verovnik & Micevski 2008, 2009; Beshkov 2009; Fazekas 2009; Arsovski et al. 2010; Verovnik et al. 2010; Krpač et al. 2011a; Verovnik 2012; Abdija et al. 2013
11.5.18.48. Familia Oecophoridae	24	19.5	Fauna Europaea 2013
11.5.18.49. Familia Opostegidae	3	50	Fauna Europaea 2013
11.5.18.50. Familia Papilionidae	7	53.8	Melovski 2003, 2004, 2010; Micevski & Micevski 2004/2005, 2005a, 2005b, 2006/2007, 2008; Krpač & Lazarevska 2008; Verovnik & Micevski 2008, 2009; Beshkov 2009; Fazekas 2009; Micevski et al. 2009a, 2009b; Arsovski et al. 2010; Verovnik et al. 2010; Krpač et al. 2011a; Verovnik 2012; Abdija et al. 2013
11.5.18.51. Familia Peleopodidae	1	100	Fauna Europaea 2013
11.5.18.52. Familia Pieridae	24	44.6	Melovski 2003, 2004, 2010; Micevski & Micevski 2004/2005, 2005a, 2005b, 2006/2007, 2008; Krpač & Lazarevska 2008; Verovnik & Micevski 2008, 2009; Fazekas 2009; Micevski et al. 2009a, 2009b; Arsovski et al. 2010; Verovnik et al. 2010; Krpač et al. 2011a; Verovnik 2012; Abdija et al. 2013
11.5.18.53. Familia Plutellidae	5	21.7	Fauna Europaea 2013
11.5.18.54. Familia Praydidae	2	25	Fauna Europaea 2013
11.5.18.55. Familia Psychidae	20	8.4	Fauna Europaea 2013
11.5.18.56. Familia Pterophoridae	51	30.4	Fauna Europaea 2013
11.5.18.57. Familia Pyralidae	127	27	Fauna Europaea 2013
11.5.18.58. Familia Riodinidae	1	100	Fauna Europaea 2013
11.5.18.59. Familia Saturniidae	6	60	Fauna Europaea 2013
11.5.18.60. Familia Scythrididae	23	11.4	Fauna Europaea 2013
11.5.18.61. Familia Sesiidae	49	42.2	Bąkowski 2009
11.5.18.62. Familia Sphingidae	20	50	Kitching & Zahiri 2007
11.5.18.63. Familia Tineidae	40	14.3	Fauna Europaea 2013
11.5.18.64. Familia Tischeriidae	4	33.3	Fauna Europaea 2013
11.5.18.65. Familia Tortricidae	206	20.7	Huemer et al. 2012
11.5.18.66. Familia Yponomeutidae	11	17.5	Fauna Europaea 2013
11.5.18.67. Familia Ypsolophidae	8	18.2	Fauna Europaea 2013
11.5.18.68. Familia Zygaenidae	28	41.8	Nahirnić et al. 2012
11.5.19. Order Diptera	1556	8.1	

Table 1. Overview of the number of invertebrates by taxonomic groups (continuation)

Taxonomic category (group)	Macedonia	Percentage of European fauna	References
11.5.19.1. Familia Acroceridae	1	2.9	Fauna Europaea 2013
11.5.19.2. Familia Agromyzidae	4	0.4	Ančev 1974
11.5.19.3. Familia Anthomyiidae	1	0.2	Fauna Europaea 2013
11.5.19.4. Familia Asilidae	4	0.8	Fauna Europaea 2013
11.5.19.5. Familia Blephariceridae	8	21.6	Fauna Europaea 2013; Kovachev et al. 1999
11.5.19.6. Familia Bombyliidae	90	26.9	Evenhuis & Greathead 1999
11.5.19.7. Familia Calliphoridae	10	8.8	Fauna Europaea 2013
11.5.19.8. Familia Campichoetidae	1	14.3	Fauna Europaea 2013
11.5.19.9. Familia Carnidae	2	5.1	Brake 2011
11.5.19.10. Familia Cecidomyiidae	147	9	Krsteska et al. 2004; Simova-Tošić et al. 2007
11.5.19.11. Familia Ceratopogonidae	28	4.9	Borken & Bisset 1990; Fauna Europaea 2013
11.5.19.12. Familia Chamaemyiidae	12	11.2	Fauna Europaea 2013
11.5.19.13. Familia Chaoboridae	1	11.1	Šapkarev 1968; Slavevska-Stamenković et al. 2009, 2012
11.5.19.14. Familia Chironomidae	128	10.1	Fauna Europaea 2013
11.5.19.15. Familia Chloropidae	50	12.7	Fauna Europaea 2013
11.5.19.16. Familia Conopidae	1	1.2	Stuke & Clements 2008
11.5.19.17. Familia Culicidae	52	50	Fauna Europaea 2013
11.5.19.18. Familia Diadocidiidae	1	14.3	Bechev 2007
11.5.19.19. Familia Diastatidae	1	11.1	Fauna Europaea 2013
11.5.19.20. Familia Dolichopodidae	44	5.7	Fauna Europaea 2013
11.5.19.21. Familia Drosophilidae	17	14	Fauna Europaea 2013
11.5.19.22. Familia Empididae	25	3.1	Fauna Europaea 2013
11.5.19.23. Familia Ephydridae	19	5.6	Fauna Europaea 2013
11.5.19.24. Familia Fanniidae	2	2.4	Fauna Europaea 2013
11.5.19.25. Familia Hippoboscidae	3	10	Fauna Europaea 2013
11.5.19.26. Familia Hybotidae	15	3.4	Fauna Europaea 2013
11.5.19.27. Familia Lauxaniidae	3	1.9	Fauna Europaea 2013
11.5.19.28. Familia Limoniidae	80	14.7	Oosterbroek & Simova-Tosic 2004
11.5.19.29. Familia Microphoridae	2	11.8	Fauna Europaea 2013
11.5.19.30. Familia Muscidae	36	6.3	Fauna Europaea 2013
11.5.19.31. Familia Mycetophilidae	10	1.1	Bechev 2007
11.5.19.32. Familia Nycteribiidae	7	46.7	Fauna Europaea 2013
11.5.19.33. Familia Opomyzidae	4	12.1	Fauna Europaea 2013
11.5.19.34. Familia Pediciidae	5	7.9	Oosterbroek & Simova-Tosic 2004
11.5.19.35. Familia Phoridae	42	6.4	Langourov 1998; Fauna Europaea 2013
11.5.19.36. Familia Pipunculidae	1	0.5	Fauna Europaea 2013
11.5.19.37. Familia Platystomatidae	1	4.8	Fauna Europaea 2013
11.5.19.38. Familia Psychodidae	3	0.6	Maroli et al. 2012; Fauna Europaea 2013

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11.5.19.39. Familia Rhagionidae	2	2.4	Fauna Europaea 2013
11.5.19.40. Familia Sarcophagidae	13	4.2	Fauna Europaea 2013
11.5.19.41. Familia Scathophagidae	1	0.6	Šifner 2008
11.5.19.42. Familia Sciomyzidae	31	22.8	Fauna Europaea 2013
11.5.19.43. Familia Sepsidae	8	16.7	Ozerov 2005
11.5.19.44. Familia Simuliidae	49	21.2	Adler & Crosskey 2013; Fauna Europaea 2013
11.5.19.45. Familia Sphaeroceridae	19	7.4	Fauna Europaea 2013
11.5.19.46. Familia Stratiomyidae	37	26.2	Mason & Rozkosny 2003; Fauna Europaea 2013
11.5.19.47. Familia Syrphidae	262	31.6	Krpač et al. 2006, 2009a, 2009b, 2009c, 2011b; Krsteska 2008
11.5.19.48. Familia Tabanidae	40	18.8	Krčmar et al. 2002
11.5.19.49. Familia Tachinidae	89	10.1	Hubenov 2008b; Fauna Europaea 2013
11.5.19.50. Familia Tephritidae	12	4.5	Fauna Europaea 2013
11.5.19.51. Familia Thaumaleidae	8	10.5	Fauna Europaea 2013
11.5.19.52. Familia Tipulidae	117	25.7	Simova-Tošić 1977; Oosterbroek & Simova-Tosic 2004; Oosterbroek 2009
11.5.19.53. Familia Trixoscelididae	6	23.1	Fauna Europaea 2013
11.5.19.54. Familia Ulidiidae	1	0.9	Fauna Europaea 2013
11.5.20. Order Siphonaptera	13	4.9	Christov 1964; Peus 1964; Smit & Rosický 1965; Skuratowicz et al. 1982; Brelih & Trilar 2000; Fauna Europaea 2013
11.5.21. Order Coleoptera	3145	11.3	
11.5.21.1. Familia Agyrtidae	1	16.7	Guéorguiev et al. 2010
11.5.21.2. Familia Alexiidae	2	6.3	Löbl & Smetana 2007
11.5.21.3. Familia Anobiidae	43	10.3	Löbl & Smetana 2007; Guéorguiev et al. 2010; Fauna Europaea 2013
11.5.21.4. Familia Anthicidae	26	8.3	Fauna Europaea 2013
11.5.21.5. Familia Antrhibidae	6	9.5	Fauna Europaea 2013
11.5.21.6. Familia Aphodiidae	46	17.1	Rozner & Rozner 2009; Fauna Europaea 2013
11.5.21.7. Familia Apionidae	50	16.2	Fauna Europaea 2013
11.5.21.8. Familia Attelabidae	3	50	Fauna Europaea 2013
11.5.21.9. Familia Biphyllidae	1	20	Löbl & Smetana 2007
11.5.21.10. Familia Bostrichidae	10	23.8	Löbl & Smetana 2007; Fauna Europaea 2013
11.5.21.11. Familia Bothrideridae	1	0.9	Gueroguiev et al 2010
11.5.21.12. Familia Brachyceridae	2	10.5	Fauna Europaea 2013
11.5.21.13. Familia Brentidae	1	50	Fauna Europaea 2013
11.5.21.14. Familia Buprestidae	134	30.7	Sakalian 2000/2001; Löbl & Smetana 2006; Fauna Europaea 2013
11.5.21.15. Familia Byrrhidae	7	6.1	Fauna Europaea 2013

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11.5.21.16. Familia Cantharidae	15	3	Löbl & Smetana 2007
11.5.21.17. Familia Carabidae	573	15.3	Hristovski et al. 2003, 2010; Hristovski 2007, 2011; Guéorguiev 2007; Guéorguiev & Hristovski 2010; Mitev et al. 2010; Giachino & Vailati 2012; Hristovski & Guéorguiev, in litt.
11.5.21.18. Familia Cerambycidae	176	26	Ćurčić et al. 2003; Danilevsky 2013; Löbl & Smetana 2007
11.5.21.19. Familia Cerylonidae	3	21.4	Fauna Europaea 2013
11.5.21.20. Familia Cetoniidae	16	32.7	Fauna Europaea 2013; Löbl & Smetana 2006
11.5.21.21. Familia Chrysomelidae	340	19.3	Gruev 1998, 2003; Istvan & György 2008; Löbl & Smetana 2010; Konstantinov et al. 2011
11.5.21.22. Familia Ciidae	2	2.6	Fauna Europaea 2013
11.5.21.23. Familia Cleridae	10	14.7	Löbl & Smetana 2007
11.5.21.24. Familia Coccinellidae	33	15.3	Krsteska et al. 2004; Löbl & Smetana 2007; Jadwiszczak et al. 2010
11.5.21.25. Familia Cryptophagidae	15	5.8	Löbl & Smetana 2007
11.5.21.26. Familia Cucujidae	1	16.7	Löbl & Smetana 2007
11.5.21.27. Familia Curculionidae	288	6.6	Karaman, Z. 1971; Yunakov 2005, 2006; Petkovski 2009; Gültekin & Podlussany 2012, Marković 2013
11.5.21.28. Familia Cybocephalidae	2	7.7	Gueroguiev et al 2010
11.5.21.29. Familia Dasytidae	17	4.5	Löbl & Smetana 2007; Liberti 2009
11.5.21.30. Familia Dermestidae	34	17.3	Löbl & Smetana 2007; Fauna Europaea 2013
11.5.21.31. Familia Dryophthoridae	2	16.7	Fauna Europaea 2013
11.5.21.32. Familia Dryopidae	1	4.8	Kovács & Merkl 2013
11.5.21.33. Familia Dynastidae	4	30.8	Fauna Europaea 2013; Löbl & Smetana 2006
11.5.21.34. Familia Dytiscidae	62	16.5	Guéorguiev, 1971; Löbl & Smetana 2003
11.5.21.35. Familia Elateridae	74	11	Platia 2006, 2010; Löbl & Smetana 2007; Platia & Németh 2011; Kovács & Merkl 2013
11.5.21.36. Familia Elmidae	9	20.9	Boukal et al. 2007; Fauna Europaea 2013
11.5.21.37. Familia Endomychidae	4	5.1	Shockley et al. 2009; Fauna Europaea 2013
11.5.21.38. Familia Erirhinidae	3	6.3	Fauna Europaea 2013
11.5.21.39. Familia Euchiridae	1	50	Fauna Europaea 2013; Löbl & Smetana 2006
11.5.21.40. Familia Geotrupidae	14	23.7	Rozner & Rozner 2009; Fauna Europaea 2013
11.5.21.41. Familia Glaphyridae	8	34.8	Fauna Europaea 2013; Löbl & Smetana 2006
11.5.21.42. Familia Gyrinidae	6	35.3	Guéorguiev, 1971; Löbl & Smetana 2003

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11.5.21.43. Familia Haliplidae	11	32.4	Guéorguiev, 1971; Löbl & Smetana 2003
11.5.21.44. Familia Histeridae	68	24.6	Fauna Europaea 2013; Guéorguiev et al. 2010
11.5.21.45. Familia Hybosoridae	1	100	Fauna Europaea 2013; Löbl & Smetana 2006
11.5.21.46. Familia Hydraenidae	42	10.6	MoEPP 2003; Löbl & Smetana 2004; Mičetić Stanković & Jäch 2012; Fauna Europaea 2013; Trizzino et al. 2013
11.5.21.47. Familia Hydrophilidae	33	12.5	Guéorguiev 1971; Fauna Europaea 2013;
11.5.21.48. Familia Kateretidae	12	41.4	Fauna Europaea 2013
11.5.21.49. Familia Lampyridae	7	14.3	Löbl & Smetana 2007
11.5.21.50. Familia Languriidae	1	7.1	Fauna Europaea 2013
11.5.21.51. Familia Latridiidae	11	5.7	Fauna Europaea 2013
11.5.21.52. Familia Leiodidae	57	4.9	Löbl & Smetana 2004; Ćurčić et al. 2005
11.5.21.53. Familia Lucanidae	6	42.9	Kovács & Merkl 2013; Hristovski, S., unpublished data
11.5.21.54. Familia Lycidae	4	33.3	Löbl & Smetana 2007
11.5.21.55. Familia Malachiidae	17	5.2	Löbl & Smetana 2007; Mirutenko 2013
11.5.21.56. Familia Melandryidae	8	15.1	Fauna Europaea 2013
11.5.21.57. Familia Meloidae	45	24.9	Fauna Europaea 2013; Löbl & Smetana 2006; Turco & Bologna 2011
11.5.21.58. Familia Melolonthidae	19	6.3	Ahrens 2007; Rozner & Rozner 2009; Fauna Europaea 2013
11.5.21.59. Familia Monotomidae	3	8.8	Fauna Europaea 2013
11.5.21.60. Familia Mordellidae	45	17.6	Fauna Europaea 2013
11.5.21.61. Familia Mycetophagidae	6	19.4	Fauna Europaea 2013
11.5.21.62. Familia Nanophyidae	2	6.1	Fauna Europaea 2013
11.5.21.63. Familia Nitidulidae	116	46.8	Löbl & Smetana 2007; Stevanović et al. 2008; Fauna Europaea 2013
11.5.21.64. Familia Nosodendridae	1	100	Löbl & Smetana 2007; Fauna Europaea 2013
11.5.21.65. Familia Noteridae	2	50	Guéorguiev, 1971; Löbl & Smetana 2003
11.5.21.66. Familia Ochodaeidae	1	9.1	Rozner & Rozner 2009
11.5.21.67. Familia Oedemeridae	25	26.9	Švihla 2006; Fauna Europaea 2013
11.5.21.68. Familia Orphnidae	2	22.2	Fauna Europaea 2013
11.5.21.69. Familia Phalacridae	2	3.6	Löbl & Smetana 2007
11.5.21.70. Familia Ptiliidae	4	3.1	Löbl & Smetana 2004
11.5.21.71. Familia Pyrochroidae	1	12.5	Personal data
11.5.21.72. Familia Rhynchitidae	12	23.1	Fauna Europaea 2013
11.5.21.73. Familia Ripiphoridae	1	5.9	Fauna Europaea 2013
11.5.21.74. Familia Rutelidae	19	18.6	Fauna Europaea 2013

Table 1. Overview of the number of invertebrates by taxonomic groups (continuation)

Taxonomic category (group)	Macedonia	Percentage of European fauna	References
11.5.21.75. Familia Scarabaeidae	41	44.1	Ranius et al. 2005; Ahrens 2007; Rozner & Rozner 2009; Ziani 2009; Lobo et al. 2011; Král & Hillertt 2013
11.5.21.76. Familia Scirtidae	2	2.1	Fauna Europaea 2013; Löbl & Smetana 2006
11.5.21.77. Familia Scraptiidae	11	10.8	Fauna Europaea 2013
11.5.21.78. Familia Silphidae	14	32.6	Löbl & Smetana 2004
11.5.21.79. Familia Silvanidae	2	5	Löbl & Smetana 2007; Gueroguiev et al 2010
11.5.21.80. Familia Staphylinidae (incl. Scydmaeninae, Pselaphinae)	383	7.3	Maus 1998; Assing 2000, 2001, 2004a, 2004b, 2008, 2009a, 2009b, 2009c, 2009d, 2009e, 2010; Löbl & Smetana 2004; Sabella et al, 2004; Hlaváč & Jászay 2009; Frisch 2010; Guéorguiev et al. 2010; Stevanović, 2011; Solodovnikov 2012; Hlavač 2013; Hlaváč & Stevanović, 2013; Fauna Europaea 2013
11.5.21.81. Familia Tenebrionidae	45	3.2	Löbl & Smetana 2008; Guéorguiev et al. 2010; Ulrich & Fattorini 2013; Fauna Europaea 2013
11.5.21.82. Familia Tetratomidae	2	20	Fauna Europaea 2013
11.5.21.83. Familia Trogidae	4	17.4	Fauna Europaea 2013
11.5.21.84. Familia Zopheridae	11	8.6	Löbl & Smetana 2008; Guéorguiev et al. 2011; Fauna Europaea 2013
11.5.22. Order Strepsiptera	1	3.3	Fauna Europaea 2013
11.5.23. Order Hymenoptera	1077	6	
11.5.23.1. Suborder Symphyta	178	13.2	Čingovski 1985; Petkovski 2009; Fauna Europaea 2013
11.5.23.2. Familia Aphelinidae	4	2.1	Fauna Europaea 2013
11.5.23.3. Familia Apidae	113	5.5	Van Der Zanden 1984; Astafurova & Pesenko 2006; Guershon & Ionescu-Hirsch 2012
11.5.23.4. Familia Braconidae	156	4.5	Simbolotti & van Achterberg 1992; Baylac et al. 2003; Papp 2009; Žikić et al. 2010, 2012; Stigenberg & Ronquist 2011
11.5.23.5. Familia Chalcididae	11	11.8	Fauna Europaea 2013
11.5.23.6. Familia Crabronidae	31	4.7	Handlirsch 1889; Leclercq 1949; Atanassov 1955; de Beaumont 1961, 1967; Pulawski 1984, 2007; Dollfuss 1995, 2004; Gaybuo et al. 2003; Schmidt 2000; Schmid-Egger, 2004; Bouček 2001; Nemkov 2012;
11.5.23.7. Familia Encyrtidae	12	1.6	Fauna Europaea 2013
11.5.23.8. Familia Eucharitidae	3	20	Fauna Europaea 2013
11.5.23.9. Familia Eulophidae	40	3.4	Yefremova et al. 2010; Fauna Europaea 2013
11.5.23.10. Familia Eupelmidae	5	4.8	Fauna Europaea 2013

Table 1. Overview of the number of invertebrates by taxonomic groups (continuation)

Taxonomic category (group)	Macedonia	Percentage of European fauna	References
11.5.23.11. Familia Eurytomidae	7	2	Fauna Europaea 2013
11.5.23.12. Familia Ichneumonidae	129	2.2	Kolarov 2007, 2008, 2009; Kolarov & Bordera 2007; Fauna Europaea 2013
11.5.23.13. Familia Leucospidae	2	25	Fauna Europaea 2013
11.5.23.14. Familia Mymaridae	10	2.2	Donev 1998, 2004, 2005; Fauna Europaea 2013
11.5.23.15. Familia Ormyridae	5	20	Fauna Europaea 2013
11.5.23.16. Familia Perilampidae	2	3	Fauna Europaea 2013
11.5.23.17. Familia Vespidae	75	27.9	Atanassov 1942; Cumming 1989; Yildirim & Kojima 1999; Ćetković 2002; Fauna Europaea 2013; Arsovski, unpublished data
11.5.23.18. Familia Formicidae	99	15.5	Karaman, M. G. 2009; Bračko et al. 2013
11.5.23.19. Familia Mutillidae	37	24	Vogrin 1955; Nonveiller 1979; Petersen 1988; Nonveiller et al. 1998; Lelej 2002; Lelej et al. 2003, 2009; Muskovits & György 2011
11.5.23.20. Familia Bradynobaenidae	1	20	Invrea 1957; Nonveiller 1979
11.5.23.21. Familia Pompilidae	17	5.6	Strand 1919; Atanassov 1951; Vogrin 1955; Wahis 1970; Wahis & Schmid-Egger 2002;
11.5.23.22. Familia Scoliidae	7	31.8	Atanassov 1951; Vogrin 1955; Fauna Europaea 2013
11.5.23.23. Familia Tiphiidae	3	37	Vogrin 1955
11.5.23.24. Familia Pteromalidae	27	1.9	Rizzo & Mitroiu 2010; Fauna Europaea 2013
11.5.23.25. Familia Sphecidae	11	19	Berland 1926; Vogrin 1955; Hensen 1988; Dollfuss 2008, 2010; Schmid-Egger 2012; Arsovski, K., pers. comm.
11.5.23.26. Familia Tetracampidae	3	27.3	Fauna Europaea 2013
11.5.23.27. Familia Torymidae	17	5.2	Graham et al. 1998; Fauna Europaea 2013
11.5.23.28. Familia Trichogrammatidae	1	0.7	Fauna Europaea 2013
11.5.23.29. Superfamilia Chrysidoidea	37	3.4	Atanassov 1940; Vogrin 1955; Nagy 1976; Móczár, 2001 Rosa 2005; de Oliveira et al. 2010; Fauna Europaea 2013
11.5.23.30. Superfamilia Trigonaloidea	1	100	Wall 1994
11.5.23.31. Superfamilia Cynipoidea	13	1.7	Fauna Europaea 2013
11.5.23.32. Superfamilia Evanioidea	1	2.2	Oehlke 1983; Fauna Europaea 2013
11.5.23.33. Superfamilia Stephanoidea	1	50	Fauna Europaea 2013
TOTAL	**13447**	11.1	