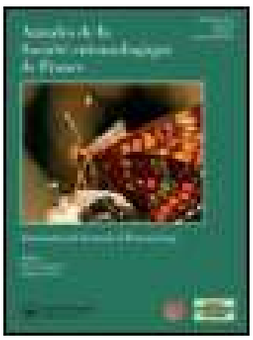

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Ovčar–Kablar Gorge (SW Serbia) – a new hotspot of Orthoptera diversity

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Summary. We present a list of Orthoptera from the Ovčar–Kablar Gorge, situated in western Serbia. During 2015 and 2016 we collected 86 Orthoptera species (50 Ensifera, 36 Caelifera). The majority of the species were registered for the first time for the locality and the presence of *Pachytrachis frater* (Tettigoniidae) in Serbia is confirmed. This study is intended to provide data for future conservation planning, to expand knowledge about rare species and to point to the high natural value of the Gorge.

Résumé. La gorge d'Ovčar–Kablar (sud-ouest de la Serbie) – un nouveau point chaud de diversité des Orthoptères. Une liste des Orthoptères de la gorge d'Ovčar–Kablar, située dans l'ouest de la Serbie, est présentée. En 2015 et 2016, 86 espèces d'Orthoptera (50 Ensifera, 36 Caelifera) ont été collectées. La majorité des espèces sont signalées pour la première fois de cette localité et la présence de *Pachytrachis frater* (Tettigoniidae) en Serbie est confirmée. Cette étude vise à fournir des données pour la future planification de la conservation de cette zone, à élargir les connaissances sur les espèces rares et à indiquer la haute valeur du patrimoine naturel de cette gorge.

Keywords: Balkan Peninsula; endemism; *Pachytrachis frater*; *Poecilimon fussii*; Tetrigidae

With almost 28,000 described species (Cigliano et al. 2018), Orthoptera are one of the largest and most diverse groups of insects. They are of significant importance in the food chain for many insectivorous animals, e.g. spiders, reptiles and birds (Belovsky & Slade 1995). Also, they are recognized as indicators of changes in land ecosystems (Báldi & Kisbenedek 1997). The orthopterous fauna in Serbia is relatively well studied, with the first data from 1861 (Brunner von Wattenwyl 1861), but in the last five years studies have been developed to improve knowledge of the Serbian fauna (e.g. Pavićević et al. 2014; Skejo & Stanković 2014; Skejo & Ivković 2015). Orthoptera diversity has been studied in different types of habitats with special attention to mountain fauna (Grebenščikov 1950; Stevanović 1953; Čejchan 1961; Adamović 1970a), while data for other habitats are scarce. Gorges are among the most uninvestigated habitats, but with promising species richness and endemic taxa, which is one of the reasons why we started this research.

Ovčar–Kablar Gorge has a large habitat diversity within a small area: a forest complex of beech, elm, hornbeam, linden and oak on Ovčar and Kablar, rocky ground and cliffs on Kablar and meadows and pastures on mountain slopes.

In 2010, biologists from several universities and non-governmental organizations started to study different organisms in the area of the Ovčar–Kablar Gorge. The most significant result of this investigations was the discovery of a new plant species, *Edraianthus canescens* Lakušić et al., 2013 (Campanulaceae). The species is only known from the type locality and it is listed as Critically Endangered (Lakušić et al. 2013).

Some data on the Orthoptera from Ovčar–Kablar Gorge were given by Pavićević and Karaman (2001), Karaman et al. (2011) and Pavićević et al. (2014), but the rich orthopterous fauna in this gorge was discovered in August 2015 by Skejo and Pantović. Therefore, an additional survey was performed by Ivković in early summer 2016 to sample early species.

On the basis of the published data and material collected by the authors, in this paper we present the current knowledge on Orthoptera of the Ovčar–Kablar Gorge, which is intended to provide data for future conservation planning and to point out the high natural value of the gorge.

Material and methods

Data collection

This research was based on literature data (Karaman et al. 2011; Pavićević et al. 2014) and material that was collected on two occasions – first 4–7.VII.2015 by J. Skejo and U.

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Pantović at 22 localities and second at 25–27.VI.2016 at 18 localities by S. Ivković. Specimens were collected using different methods. The most common method was collecting by hand, as most species were easy to observe on the bushes. Beside this, material was collected with an entomological net and following the sound. The material is preserved in 96% ethanol and is deposited in the collections of the authors.

Studied area

Ovčar–Kablar Gorge is situated in western Serbia, between Čačak and Požega. The altitudinal span is from 200 to 985 m. The gorge is settled between the mountains Ovčar and Kablar surrounding a valley, where Zapadna Morava River is flowing. Its course was managed and two artificial lakes were created – Ovčar Lake and Međuvršje Lake (Puzović et al. 2009). They are surrounded by hygrophilous vegetation of alder, poplar and birch trees and of aquatic plants rushes and reeds (Stevanović & Stevanović 1995; Đorđević et al. 1998; Puzović et al. 2009). In the gorge climatic affinities are semiarid and moderately continental, but in the majority of localities a Mediterranean climate is present.

During the surveys 30 localities were visited (Figure 1 and Table 1).

Identification, taxonomy and nomenclature

The specimens were determined in accordance to widely accepted morphological or bioacoustic diagnostic characters presented in Harz (1969, 1975), Heller (1988), Iş and Iorgu (2008), Willemse et al. (2009), Chobanov et al. (2014) and Devriese (1996). In nomenclature and taxonomic order we follow the Orthoptera Species File (Cigliano et al. 2018).

Song recording and terminology

Male specimens collected for calling song recordings were kept in net cages. Recordings were made during the day (about room temperature 24–30°C) with Roland R 05 recorder placed about 15 cm from each recorded specimen. Song analyses were conducted in Cool Edit Pro 2.1 and Adobe Audition software. The terms used to describe bioacoustics are as follows:

Calling song – the song produced by an isolated male aiming to call a female; syllable – the sound produced by opening–closing stridulatory apparatus movement cycle; syllable period – the time elapsed from the end of one syllable to the beginning of the next one; impulse – an undivided transient train of sound waves produced by stridulatory tooth striking the plectrum (the anal edge of the opposite tegmen); after-click – an isolated, distinct pulse.

Results

Here we present the Orthoptera fauna of Ovčar–Kablar Gorge, an annotated taxonomic list of species with accompanying localities for each. Numbers of localities correspond to those described in Studied area under Material and methods.

Suborder ENSIFERA

Family TETTIGONIIDAE Krauss, 1902

Subfamily PHANEROPTERINAE Burmeister, 1838

Genus *Phaneroptera* Serville, 1831

***P. falcata* (Poda, 1761)**: 4, 10, 15, 16, 17, 18, 21.

***P. nana* Fieber, 1853**: 2, 6, 10, 18, 21, 23.

Genus *Isophya* Brunner von Wattenwyl, 1978

***I. speciosa* (Frivaldszky, 1868)**: 11, 19, 23.

***I. modestior* Brunner von Wattenwyl, 1882**: 11, 24, 29.

***I. clara* Ingrisch & Pavićević, 2010**: 5, 6, 24; Literature data: Pavićević et al. (2014); Ivković (2017).

Genus *Barbitistes* Charpentier, 1825

***B. serricauda* (Fabricius, 1794)**: 23, 29.

***B. yersini* Brunner von Wattenwyl, 1978**: 10, 28, 29, 30; Literature data: Pavićević et al. (2014).

Genus *Leptophyes* Fieber, 1853

***L. albovittata* (Kollar, 1833)**: 6, 7, 8, 11, 19, 21.

***L. discoidalis* (Frivaldszky, 1868)**: 2, 10, 11, 24, 25, 26; Literature data: Pavićević et al. (2014) (Figure 2(a)).

***L. laticauda* (Frivaldszky, 1868)**: 3, 8, 13, 14, 16, 29; Literature data: Pavićević et al. (2014).

Genus *Poecilimon* Fischer, 1853

***P.* cf. *affinis* (Frivaldszky, 1868)**: 23, 28, 29, 30.

***P. schmidtii* (Fieber, 1853)**: 9.

***P. gracilis* (Fieber, 1853)**: 9, 21, 25; Literature data: Pavićević et al. (2014).

***P. thoracicus* (Fieber, 1853)**: 2, 3, 4, 6, 8, 9, 10, 11, 13, 19, 21, 22, 23, 24, 25.

***P. fussii* Fieber, 1878**: 2, 6, 9, 11, 23.

Genus *Polysarcus* Fieber, 1853

***P. denticauda* (Charpentier, 1825)**: 11.

Subfamily MECONEMATINAE Burmeister, 1838

Genus *Meconema* Serville, 1831

***M. thalassinum* (De Geer, 1773)**: 5, 9, 14.

***M. meridionale* Costa, 1860**: 9, 20 (Figure 2(d)).

Subfamily CONOCEPHALINAE Burmeister, 1838

Genus *Conocephalus* Thunberg, 1815

***C. fuscus* (Fabricius, 1793)**: 26, 27.

Genus *Ruspolia* Schulthess, 1898

***R. nitidula* (Scopoli, 1786)**: 15, 16, 17, 18, 24.

Subfamily TETTIGONIINAE Krauss, 1902

Genus *Tettigonia* Linnaeus, 1758

***T. viridissima* (Linnaeus, 1758)**: 2, 4, 5, 8, 9, 10, 11, 14, 21, 28.

***T. balcanica* Chobanov & Lemonnier-Darcemont, 2014**: 14, 27 (Figure 2(f)).

***T. caudata* (Charpentier, 1842)**: 11.

Genus *Decticus* Serville, 1831

***D. verrucivorus* (Linnaeus, 1758)**: 5, 19, 25.

Genus *Platycleis* Fieber, 1853

***P. intermedia* (Serville, 1838)**: 22.

Table 1. Surveyed localities. Numbers correspond to those on the map (Figure 1). Presented are toponyms, simple habitat descriptions, altitude in meters above the sea level, coordinates and the date(s) Orthoptera were studied for each locality.

	Locality	Description of habitat	Altitude (m)	Coordinates	Date(s)
1	Vrnčani	Dry habitat with low vegetation and bushes, on magmatic rocks	440	N 43°55′15.54″ E 20°08′11.41″	6.VIII.2015
2	Donji Karanci	Wetland with low hygrophilous vegetation	515–540	N 43°55′45.23″ E 20°08′54.88″	6.VIII.2015
3	Rošci – Carina	Wetlands surrounded by *Rubus* bushes	680	N 43°55′48.70″ E 20°09′53.80″	5.VIII.2015
4	Rošci	Wetland with various bushes	650	N 43°55′30.88″ E 20°10′19.84″	4.VIII.2015
5	Rade Mitrović‘s house	Dry pastures and meadows surrounded by beech forest	805	N 43°54′56.59″ E 20°10′50.52″	4.VIII.2015
6	Čvrkići 1	Habitat with dry and moist areas	615–640	N 43°55′23.53″ E 20°11′27.61″	4.VIII.2015 25.VI.2016
7	Čvrkići – forest	Forest clearing with sparse vegetation	640	N 43°55′20.86″ E 20°11′30.50″	4.VIII.2015 25.VI.2016
8	Čvrkići – Stari Cer 1	Pasture with grazed grass	610	N 43°55′20.76″ E 20°11′42.34″	4.VIII.2015 25.VI.2016
9	Čvrkići – Stari Cer 2	Small meadows on forest clearings	640	N 43°55′18.85″ E 20°11′51.54″	4.VIII.2015 25.VI.2016
10	Čvrkići – Stari Cer 3	Dry and wet meadows with different types of trees and bushes, rich with microhabitats	565–610	N 43°55′21.77″ E 20°11′51.78″	5.VIII.2015 25.VI.2016
11	Ljubičići	Wetland with high vegetation	560	N 43°55′29.08″ E 20°11′56.26″	25.VI.2016
12	Čvrkići 2	Dry pasture with grazed grass	520	N 43°55′12.24″ E 20°11′58.39″	25.VI.2016
13	Kablar	Forest clearing	440	N 43°54′57.45″ E 20°12′11.35″	25.VI.2016
14	Mountain lodge Kablar – Čačak	Wet forest clearing with *Rubus* bushes	300	N 43°54′43.87″ E 20°12′26.39″	4.VIII.2015
15	Zapadna Morava coast	Wetland with tall hygrophilous vegetation	280	N 43°54′55.03″ E 20°12′36.03″	4.VIII.2015
16	Zagrađe peninsula	Wetlands near the river, with rich hygrophilous vegetation and small dry parts	280	N 43°54′50.35″ E 20°12′56.16″	4.VIII.2015
17	Caganje	Wetland with low vegetation	280	N 43°56′13.09″ E 20°13′17.83″	4.VIII.2015
18	Kamenica – Vidova	Anthropogenic coast with rocks and sand	290	N 43°55′48.21″ E 20°13′58.86″	5.VIII.2015

(*continued*)

Table 1. (*Continued*).

	Locality	Description of habitat	Altitude (m)	Coordinates	Date(s)
19	Vidova 1	Habitats with dry and wet areas	320–350	N 43°55′08.73″ E 20°13′52.83″	26.VI.2016
20	Vidova 2	Dry meadows surrounded by oak forest and *Rubus* and *Sambucus* bushes	275–310	N 43°55′01.04″ E 20°13′50.64″	5.VIII.2015 26.VI.2016
21	Vevedenje monastery	Meadows with tall vegetation surrounded by forest	410–450	N 43°54′14.80″ E 20°13′58.86″	7.VIII.2015
22	Koronjski do	Dry meadow with low vegetation	815	N 43°53′31.80″ E 20°12′41.25″	7.VIII.2015 27.VI.2016
23	Dučalovići – graveyard	Habitat near the graveyard with hygrophilous vegetation	540	N 43°52′44.43″ E 20°12′36.86″	7.VIII.2015 27.VI.2016
24	Banjski potok – Dučalovići	Hygrophilous habitat, rich with nettles, surrounded by maple trees and *Rubus* bushes	365	N 43°53′02.96″ E 20°11′40.70″	6.VIII.2015 27.VI.2016
25	Dučalovići – Planinci	Mixed habitat with dry and moist areas, low and tall vegetation	585	N 43°53′05.04″ E 20°11′02.52″	6.VIII.2015 27.VI.2016
26	Ovčar Banja	River bank with high vegetation	280	N 43°53′47.63″ E 20°11′09.35″	27.VI.2016
27	Asanovački potok	Wetlands with arid areas near the hill, surrounded by forest	310–325	N 43°54′04.18″ E 20°10′16.09″	6.VIII.2015
28	Train station	Small clearings with bushes along the road	290	N 43°54′11.81″ E 20°11′32.75″	25.VI.2016 26.VI.2016 27.VI.2016
29	Restaurant “Dom”	Bushes around the restaurant	300	N 43°54′18.11″ E 20°11′38.51″	25.VI.2016 26.VI.2016 27.VI.2016
30	Old road to Ovčar Banja	Bushes along the road	300	N 43°54′19.59″ E 20°11′43.95″	25.VI.2016 26.VI.2016 27.VI.2016

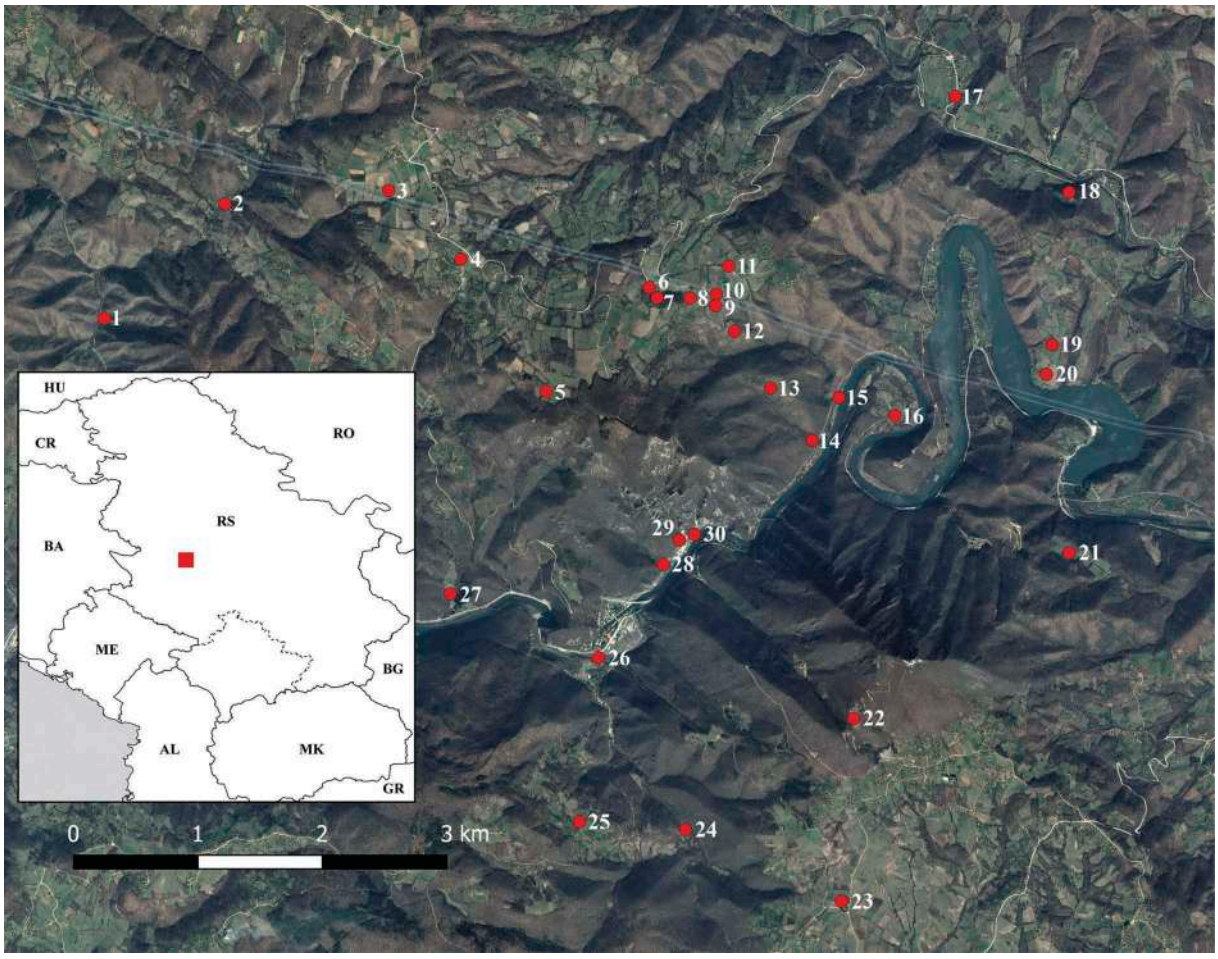

Figure 1. Map of the investigated area. Rectangle shows the Ovčar–Kablar Gorge position in Serbia. Circles with numbers represent localities listed in Material and methods section; RS – Serbia, CR – Croatia, BA – Bosnia and Herzegovina, ME – Montenegro, AL – Albania, MK – FYR Macedonia, RO – Romania, HU – Hungaria, GR – Greece, BG – Bulgaria.

***P.* (*albopunctata*) *grisea* (Fabricius, 1781)**: 5, 6, 7, 8, 10, 19, 22.

Genus *Modestana* Beier, 1955

***M. ebneri* (Ramme, 1926)**: 1, 4.

Genus *Bicolorana* Zeuner, 1941

***B. bicolor* (Philippi, 1830)**: 2, 3, 4, 5, 6, 8, 10, 11, 23, 27.

Genus *Broughtonia* Harz, 1969

***B. domogledi* (Brunner von Wattenwyl, 1882)**: 2, 4, 21, 22, 23, 24, 25 (Figure 2(b)).

Genus *Roeseliana* Zeuner, 1941

***R. roeselii* (Hagenbach, 1822)**: 2, 3, 4, 5, 6, 11, 15, 16, 18, 19, 21, 22, 24, 26, 27.

Genus *Pholidoptera* Wesmaël, 1838

***P. aptera karnyi* Ebner, 1908**: 4, 5.

***P. littoralis similis* (Brunner von Wattenwyl, 1861)**: 2, 3, 5, 6, 8, 9, 10, 11, 18, 20, 21, 24 (Figure 2(c)).

***P. transsylvanica* (Fischer, 1853)**: 2, 10.

***P. frivaldszkyi* (Herman, 1871)**: 24, 25.

***P. fallax* (Fischer, 1853)**: 2, 5, 8, 9, 10, 11, 12, 18, 21, 23, 27.

***P. griseoaptera* (De Geer, 1773)**: 2, 4, 5, 6, 9, 14, 16, 22, 23, 24, 25, 27, 28.

Genus *Eupholidoptera* Mařan, 1953

***E.* (*chabrieri*) *schmidti* (Fieber, 1861)**: 2, 4, 6, 14, 19, 21, 22, 24, 27, 28, 30.

Genus *Pachytrachis* Uvarov, 1940

***P. gracilis* (Brunner von Wattenwyl, 1861)**: 2, 4, 5, 6, 7, 8, 9, 10, 14, 15, 16, 17, 18, 20, 21, 22, 23, 24, 27.

***P. frater* (Brunner von Wattenwyl, 1882)**: 6, 10, 22.

Genus *Rhacocleis* Fieber, 1853

***R. germanica* (Herrich-Schäffer, 1840)**: 1, 16, 20, 22.

Subfamily BRADYPORINAE Burmeister, 1838

Genus *Ephippiger* Berthold, 1827

***E. ephippiger* (Fiebig, 1784)**: 3, 11, 12, 28, 30.

Family RHAPHIDOPHORIDAE Walker, 1869

Subfamily TROGLOPHILINAE Krauss, 1879

Genus *Troglophilus* Krauss, 1879

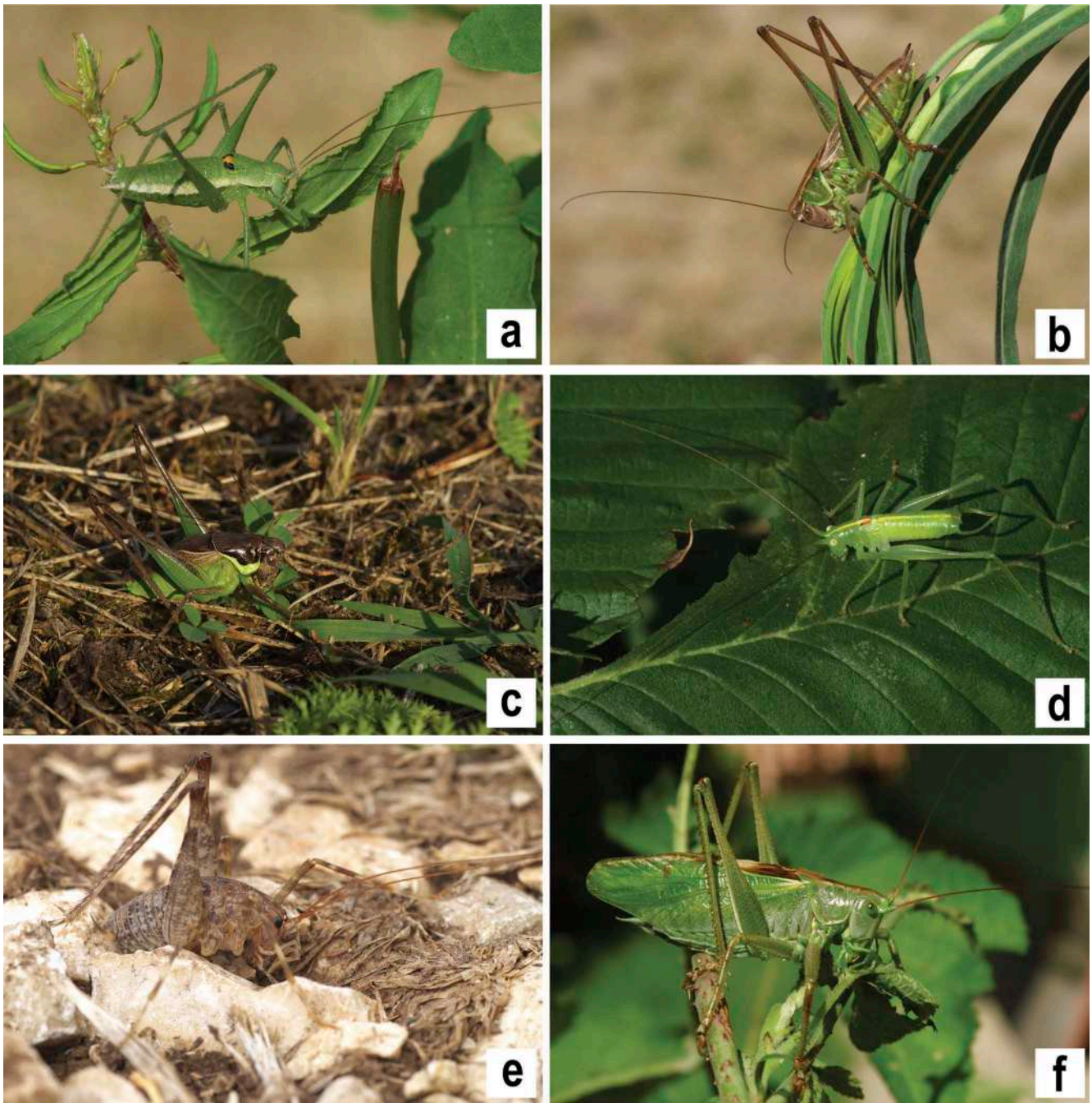

Figure 2. Some of the representatives of Ensifera collected in Ovčar–Kablar Gorge. **a**, *Leptophyes discoidalis* (Frivaldszky, 1868); **b**, *Broughtonia domogledi* (Brunner von Wattenwyl, 1882); **c**, *Pholidoptera littoralis similis* (Brunner von Wattenwyl, 1861); **d**, *Meconema meridionale* Costa, 1860; **e**, *Troglophilus cavicola* (Kollar, 1833); **f**, *Tettigonia balcanica* Chobanov & Lemonnier-Darcemont, 2014.

***T. cavicola* (Kollar, 1833)**: 14; Literature data: Karaman et al. (2011) (Figure 2(e)).

***T. brevicauda* Chopard, 1934**: 14; Literature data: Karaman et al. (2011).

Family GRYLLIDAE Laicharting, 1781

Subfamily GRYLLINAE Laicharting, 1781

Genus *Gryllus* Linnaeus, 1758

***G. campestris* Linnaeus, 1758**: 10, 11, 15, 17.

Genus *Melanogryllus* Chopard, 1961

***M. desertus* (Pallas, 1771)**: 15.

Genus *Modicogryllus* Chopard, 1961

***M. truncatus* (Tarbinsky, 1940)**: 28.

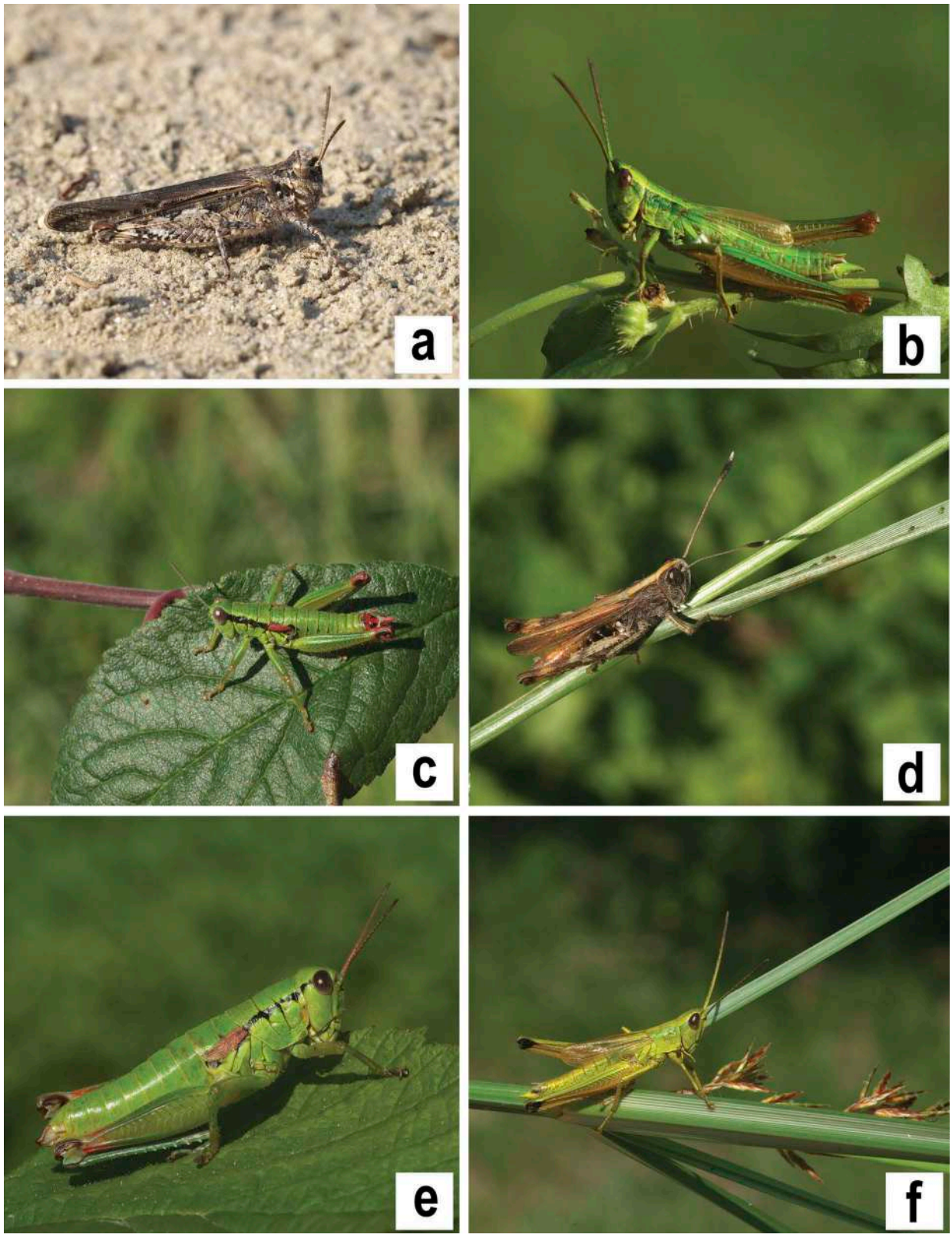

Figure 3. Some of the representatives of Caelifera collected in Ovčar–Kablar Gorge. **a**, *Acrotylus insubricus* (Scopoli, 1786); **b**, *Euthystira brachyptera* (Ocskay, 1826); **c**, *Odontopodisma albanica* Ramme, 1951; **d**, *Gomphocerippus rufus* (Linnaeus, 1758); **e**, *Pseudopodisma fieberi* (Scudder, 1897); **f**, *Chrysochraon dispar* (Germar, 1834).

Subfamily NEMOBIINAE Saussure, 1877
Genus *Pteronemobius* Jacobson, 1904
***P. heydenii* (Fischer, 1853)**: 15, 16, 26.

Subfamily OECANTHINAE Blanchard, 1845
Genus *Oecanthus* Serville, 1831
***O. pellucens* (Scopoli, 1763)**: 3, 6, 10, 14, 15, 16, 21, 28.

Suborder CAELIFERA
Family TRIDACTYLIDAE Brullé, 1835
Subfamily TRIDACTYLINAE Brullé, 1835
Genus *Xya* Latreille, 1809
***X. pfaendleri* Harz, 1970**: 26.

Family TETRIGIDAE Rambur, 1838
Subfamily TETRIGINAE Rambur, 1838
Genus *Tetrix* Latreille, 1802
***T. subulata* (Linnaeus, 1758)**: 15, 16, 24.
***T. bolivari* Saulcy, 1901**: 16.
***T. ceperoi* (Bolívar, 1887)**: 15.
***T. bipunctata* (Linnaeus, 1758)**: 15.
***T. tenuicornis* (Sahlberg, 1891)**: 18.

Family ACRIDIDAE MacLeay, 1821
Subfamily MELANOPLINAE Scudder, 1897
Genus *Pseudopodisma* Mishchenko, 1947
***P. fieberi* (Scudder, 1897)**: 2, 3, 4, 6, 9, 11, 24 (Figure 3(e)).
Genus *Odontopodisma* Dovnar-Zapolskij, 1932
***O. decipiens* Ramme, 1951**: 7, 10, 11, 12, 22, 24, 25, 27, 28, 29, 30.
***O. albanica* Ramme, 1951**: 2, 7, 10 (Figure 3(c)).

Subfamily CATANTOPINAE Brunner von Wattenwyl, 1893
Genus *Pezotettix* Burmeister, 1840
***P. giornae* (Rossi, 1794)**: 2, 4, 5, 6, 8, 10, 11, 14, 15, 16, 17, 18, 20, 21, 22, 25, 27.

Subfamily CALLIPTAMINAE Tinkham, 1940
Genus *Calliptamus* Serville, 1831
***C. italicus* (Linnaeus, 1758)**: 1, 7, 8, 9, 10, 16, 18, 20, 22.
Genus *Paracaloptenus* Bolívar, 1878
***P. caloptenoides* (Brunner von Wattenwyl, 1861)**: 6, 7, 12.

Subfamily OEDIPODINAE Walker, 1871
Genus *Oedipoda* Latreille, 1829
***O. caerulescens* (Linnaeus, 1758)**: 17, 22, 12.
Genus *Acrotylus* Fieber, 1853
***A. insubricus* (Scopoli, 1786)**: 18 (Figure 3(a)).
Genus *Aiolopus* Fieber, 1853
***A. strepens* (Latreille, 1804)**: 6, 21.

Subfamily GOMPHOCERINAE Fieber, 1853
Genus *Chrysochraon* Fischer, 1853
***C. dispar* (Germar, 1834)**: 21, 24 (Figure 3(f)).
Genus *Euthystira* Fieber, 1852
***E. brachyptera* (Ocskay, 1826)**: 2, 3, 4, 5, 6, 8, 10, 11, 15, 16, 19, 21, 22, 23, 24, 25 (Figure 3(b)).
Genus *Omocestus* Bolívar, 1878
***O. haemorrhoidalis* (Charpentier, 1825)**: 1.
***O. petraeus* (Brisout de Barneville, 1856)**: 20, 22.
***O. rufipes* (Zetterstedt, 1821)**: 4, 11, 18, 19, 20, 22, 25.
Genus *Stenobothrus* Fischer, 1853
***S. lineatus* (Panzer, 1796)**: 5, 11, 16, 20, 22, 25, 27.
***S. rubicundulus* Kruseman & Jeekel, 1967**: 1.
Genus *Gomphocerippus* Roberts, 1941
***G. rufus* (Linnaeus, 1758)**: 2, 21 (Figure 3(d)).
Genus *Stauroderus* Bolívar, 1897
***S. scalaris* (Fischer von Waldheim, 1846)**: 25.
Genus *Chorthippus* Fieber, 1852
***C.* (*vagans*) *vagans vagans* (Eversmann, 1848)**: 2, 7.
***C.* (*mollis*) *mollis mollis* (Charpentier, 1825)**: 1, 6, 8, 20.
***C.* (*brunneus*) *brunneus* (Thunberg, 1815)**: 2, 3, 4, 8, 9, 10, 16, 17, 18, 20, 22, 24, 25, 27.
***C.* (*brunneus*) *bornhalmi* Harz, 1971**: 7, 8, 10, 16, 22.
***C.* (*biguttulus*) *biguttulus biguttulus* (Linnaeus, 1758)**: 5, 10.
***C.* (*albomarginatus*) *oschei pusztaensis* Vedenina & Helversen, 2009**: 25.
***C.* (*dorsatus*) *dorsatus* (Zetterstedt, 1821)**: 1, 3, 4, 5, 6, 10, 15, 16, 17, 20, 22, 23, 25.
***C.* (*dorsatus*) *dichrous* (Eversmann, 1859)**: 20.
C.* (*dorsatus*) *dichrous* x *dorsatus: 18.
Genus *Pseudochorthippus* Defaut, 2012
***P. parallelus* (Zetterstedt, 1821)**: 2, 3, 4, 5, 6, 8, 9, 10, 11, 16, 17, 21, 22, 23, 24, 26, 27.
Genus *Euchorthippus* Tarbinsky, 1926
***E. pulvinatus* (Fischer von Waldheim, 1846)**: 10.
***E. declivus* (Brisout de Barneville, 1848)**: 2, 4, 5, 6, 8, 10, 15, 16, 18, 20, 21, 22, 23, 24.

Discussion

The results of our study expand the knowledge of Orthoptera fauna of Serbia and Europe. The 86 species (50 Ensifera, 36 Caelifera) recorded in Ovčar–Kablar show the heterogeneity of the area. The number represents 47% of the Serbian Orthoptera species. Despite the large number of species recorded, we expect that future studies will discover additional species we have overlooked. Cricket and grasshopper assemblages of the Ovčar–Kablar Gorge represent the central Balkan fauna and can be compared with the mountain fauna SE and SW to the Gorge – Radočelo Mt. (55 km SSE), Goč Mt. (65 km SSE), Studena Mt. (60 km SE), Čemerno Mt. (40 km SSE), Stolovi Mts. (50 km ESE) (Adamović

1970a, 1975; Pavićević 2016) and Jadovnik Mt. (75 km WSW) (Ivković 2017) (Table 2). Stolovi, Goč, and Studena Mts. were studied more systematically in the past (Adamović 1970a, 1975; Pavićević 2016) than Čemerno and Radočelo Mts., thus data for Čemerno and Radočelo Mts. are given in our comparison to point to lack of research in these mountains, while systematic data from Goč Mt., Jadovnik Mt., Stolovi Mts. and Studena Mt. are discussed. Orthoptera assemblages inhabiting Ovčar–Kablar are more similar to those found in the mountains that were systematically surveyed (Jadovnik, Stolovi, Goč, Studena) than to those reported from Radočelo Mt. and Čemerno Mt. Lack of systematic research on these two close mountains (10 km each from other) is obvious from a very small number of shared species (only 7) (Pavićević 2016).

Ovčar–Kablar Gorge has many more species than any of the mentioned areas, being the richest area of Orthoptera diversity in Serbia hitherto found. Rich fauna of grasshoppers and crickets is a result of microhabitat conservation and stability during geological history. Namely, diversity of habitats is a consequence of gorge formation and mountain uplifting around the Zapadna Morava River, that is from the other point of view, the river flowing between the mountains. These mountains (Ovčar and Kablar) preserved various old microhabitats (dry and wet) that were present in the central Balkans around old Zapadna Morava flow and valley. Ancient fauna that lived around the flow of the river remained untouched by upcoming biotic and abiotic factors, guarded by Ovčar and Kablar peaks. Between the mountains, numerous primordial localities survived, keeping their primordial flora and fauna, testifying on old plants and animals assemblages that were probably in the past widespread in the Balkans – today being refugia of relict biota.

Central and South European, Eurosiberian and Palearctic species represent dominant chorotype in Ovčar–Kablar and all the areas we compared the gorge with. Lineages of many of those species living in the Balkans are older than their northern relatives, because after the glacial ages, the north was populated by southern lineages (Hewitt 1996). More than 10% of all of the taxa found in the gorge belong to endemic Balkan species (some endemic to north and central Balkans, some to western Balkans). Jadovnik Mt. and Stolovi Mts. have a similar percentage of Balkan-endemic species, while Goč Mt. and Studena Mt. lack most of the endemic species, implying that their fauna is of later origin than that of Ovčar–Kablar, Jadovnik and Stolovi. In comparison with the gorge, Goč and Studena lack eastern and Carpathian elements (see Table 3). One more peculiarity of the gorge is the presence of species preferring marshy habitat, living around Zapadna Morava. Since the other mountains compared lack such large water bodies, they also lack this segment of the fauna.

In comparison with other regions of the north Balkan (e.g. Pančić 1883; Ramme 1951; Sombke & Schlegel 2007; Chobanov 2011) the fauna of Ovčar–Kablar Gorge is extremely rich in microhabitats and diverse, thus we regard it one of the micro-refugia for Orthoptera fauna on the Balkans – lifeblood of diversity, the point from where a lot of the species migrated northern and inhabited Europe and the Palearctic. The Orthoptera fauna of the investigated area is an interesting mix of continental, Dinaric, Mediterranean and Carpathian elements. This interesting combination of faunistical elements shows the necessity to continue faunistical and taxonomic investigation of this area. Since the central Balkan Peninsula was not influenced significantly by glacial ages, the fauna inhabiting this area is estimated to be older than the fauna of northern areas, which were inhabited after the glacial age by certain lineages from the southern peninsulas (Hewitt 1996). More comprehensive studies are needed in this area situated at the border of Dinaric and Rhodopian biogeographical zones.

One species, *Myrmecophilus acervorum* (Panzer, 1799), was recorded in Ovčar Banja (Pavićević & Karaman 2001), but during our research we did not find it, thus we did not list it in our species list. The majority of the species were recorded for the first time for Ovčar–Kablar Gorge and this part of Serbia, which is due to the lack of systematic research in this area in the past. The most frequent and abundant species present on more that 50% of localities and with more than 30 specimens recorded per locality were *Pachytrachis gracilis, Pezottetix giornae* and *Pseudochorthippus parallelus*. Among the observed species, several require additional attention and we discuss them in the following paragraphs.

Barbitistes serricauda and *B. yersini*

These two species were found during our research but are rare in Serbia. The former is recorded in only five localities so far, mostly in the northern part (Graber 1870; Čejchan 1961; Adamović 1975; Pavićević et al. 2014; Ivković & Horvat, Forthcoming), while the latter has been recorded in western Serbia in a few localities above 500 m only (Pavićević & Karaman 2001; Pavićević et al. 2014). Both species are morphologically similar, differing in pronotum and cerci morphology of males and coloration of inner margin of the tegmina in females (Harz 1969). We observed specimens of both species occurring together on the very same bushes. The best way for identification in the field was listening to

Table 2. Faunistic and biogeographic comparison of the composition of species recorded in OK – Ovčar–Kablar Gorge (Karaman et al., 2011; Pavićević et al., 2014; this study), J – Jadovnik Mt., (Ivković, 2017), S – Stolovi Mts. (Adamović, 1970a, 1975; Pavićević, 2016), Č – Čemerno Mt. (Brunner von Wattenwyl, 1861, 1878; Pančić, 1883; Pavićević, 2016), R – Radočelo Mt. (Iorgu & Iorgu, 2008; Pavićević, 2016), G – Goč (Adamović, 1970a) and ST – Studena Mt. (Adamović, 1970a). Species chorotypes are presented after Popov (2007), Iorgu (2008), and Ingrisch & Pavićević (2012).

Species	Chorotype	OK	J	S	Č	R	G	ST
Phaneroptera falcata	Eurosiberian	+	+					
P. nana	Holomediterranean	+	+	+			+	+
Tylopsis lilifolia	Holomediterranean			+				
Isophya speciosa	Eastern Mediterranean	+	+	+		+	+	+
I. modestior	Central and South European	+	+	+		+		
I. clara	Western Balkan	+	+	+				
Barbitistes serricauda	Central and South European	+	+					
B. yersini	Adriatic	+	+	+				
Leptophyes albovittata	European	+	+	+	+			
L. discoidalis	Central and South European	+	+	+				
L. laticauda	Adriatic	+						
Poecilimon affinis	Central and South European	+		+	+			
P. affinis dinaricus	Westen Balkan		+					
P. pseudoornatus	Central and western Balkan		+		+	+		
P. schmidtii	Central and South European	+				+	+	
P. gracilis	Southeastern European	+	+					
P. thoracicus	Northern and central Balkan	+	+	+	+	+	+	+
P. fussii	Central and South European	+	+					
P. brunneri	Northern and central Balkan			+	+			
Polysarcus denticauda	Central and South European	+	+		+			
Meconema thalassinum	European	+	+	+				
M. meridionale	Central and South European	+						
Conocephalus fuscus	Palearctic	+	+					
Ruspolia nitidula	Afrotropical–Palearctic	+	+					
Tettigonia viridissima	Palearctic	+	+	+			+	
T. balcanica	Central and south Balkan	+		+				
T. caudata	European–West Asian	+						
Decticus verrucivorus	Palearctic	+	+	+			+	+
Platycleis intermedia	Holomediterranean	+						
P. affinis	Turanian–Mediterranean		+					
P. (*albopunctata*) *grisea*	Central and South European	+	+	+			+	+
Modestana ebneri	Northwestern Balkan	+						
Metrioptera brachyptera	Eurosiberian		+	+	+			
Bicolorana bicolor	Eurosiberian	+	+	+				
Broughtonia domogledi	Northern and central Balkan	+		+				
Roeseliana roeselii	Eurosiberian	+	+	+	+		+	
Pholidoptera aptera karnyi	Northern and central Balkan	+	+	+	+	+	+	+
P. littoralis similis	Carpathian	+		+				
P. transsylvanica	Carpathian	+			+			
P. frivaldszkyi	Southeastern European	+	+	+	+		+	+
P. fallax	Central and South European	+	+	+	+		+	+
P. griseoaptera	European	+	+	+	+	+	+	+
Eupholidoptera schmidti	Adriatic	+	+	+			+	+
Psorodonotus fieberi	Northern and central Balkan			+				
P. macedonicus	Central and western Balkan		+					
Pachytrachis gracilis	Central and South European	+	+	+	+	+	+	+
P. frater	Central and western Balkan	+						
Anterastes serbicus	Balkan–Anatolian				+			
Rhacocleis germanica	Central and South European	+	+	+			+	+
Saga campbelli	Eastern Balkan			+				
Ephippiger ephippiger	Central and South European	+	+	+				
Troglophilus cavicola	Central and South European	+	+					
T. brevicauda	Central and south Balkan	+						
Gryllus campestris	Western Palearctic	+	+		+			
Melanogryllus desertus	Western Palearctic	+	+	+		+		+

(*continued*)

Table 2. (*Continued*).

Species	Chorotype	OK	J	S	Č	R	G	ST
Modicogryllus truncatus	Balkan–Anatolian	+						
Pteronemobius heydenii	Central and South European	+	+					
Oecanthus pellucens	Western Palearctic	+	+	+				+
Myrmecophilus acervorum	Central and South European	+						
Xya pfaendleri	Paleotropical–Palearctic	+						
Tetrix subulata	Holoarctic	+	+	+			+	+
T. bolivari	Turanian–Mediterranean	+						
T. ceperoi	Western Palearctic	+						
T. bipunctata	Palearctic	+	+	+			+	
T. tenuicornis	Palearctic	+	+					
Podisma pedestris	Eurosiberian		+	+			+	+
Galvagniella albanica	Western Balkan		+	+	+			
Pseudopodisma fieberi	Southeastern European	+	+	+	+	+		+
Odontopodisma decipiens	Southeastern European	+	+	+		+	+	+
O. albanica	Western Balkan	+						
Pezotettix giornae	Holomediterranean	+	+	+			+	+
Calliptamus italicus	Turanian–Mediterranean	+	+	+			+	+
Paracaloptenus caloptenoides	Central and South European	+	+	+	+		+	+
Psophus stridulus	Eurosiberian		+	+	+		+	+
Acrida ungarica	Central and South European							+
Locusta migratoria	Paleotropical–Palearctic		+					
Oedaleus decorus	Afrotropical–Palearctic			+			+	+
Oedipoda caerulescens	Palearctic	+	+	+			+	+
O. germanica	Central and South European			+			+	+
Acrotylus insubricus	Afrotropical–Palearctic	+	+	+			+	+
Aiolopus thalassinus	Cosmopolitan		+	+				
A. strepens	Afrotropical–Palearctic	+		+			+	+
Arcyptera fusca	Eurosiberian		+	+			+	+
Chrysochraon dispar	Eurosiberian	+						
Euthystira brachyptera	Eurosiberian	+	+	+	+		+	+
Omocestus haemorrhoidalis	Eurosiberian	+		+			+	+
O. petraeus	Eurosiberian	+		+			+	+
O. rufipes	Palearctic	+	+	+	+	+	+	+
Stenobothrus crassipes	Southeastern European			+			+	
S. lineatus	Eurosiberian	+	+	+			+	+
S, nigromaculatus	Eurosiberian		+	+	+		+	+
S. stigmaticus faberi	Central and South European			+	+		+	+
S. rubicundulus	Central and South European	+	+	+	+			
Gomphocerippus rufus	Eurosiberian	+	+	+		+	+	+
Myrmeleotettix maculatus	Eurosiberian		+	+				
Stauroderus scalaris	Eurosiberian	+	+	+		+		+
Chorthippus vagans	Central and South European	+						
C. mollis	Eurosiberian	+	+	+		+	+	+
C. brunneus	Eurosiberian	+	+	+	+		+	+
C. bornhalmi	Eastern Mediterranean	+		+	+			
C. biguttulus	Palearctic	+	+	+		+	+	+
C. oschei pusztaensis	Central and South European	+						
C. dorsatus	Eurosiberian	+	+	+		+	+	+
C. dichrous	Eurosiberian	+						
Pseudochorthippus parallelus	Palearctic	+	+	+	+	+	+	+
Euchorthippus pulvinatus	Turanian–Mediterranean	+						
E. declivus	Central and South European	+	+	+		+	+	+

the male calling song. The song differences are described well in Stumpner and Meyer (2001) and Stumpner et al. (2015). During the day, we found mostly only *B. yersini* resting on leaves, but during the night it was much easier to find both species (*B. yersini* and *B. serricauda*). During the night specimens were located by

Table 3. Comparison of the biogeographical elements in OK (Ovčar–Kablar), J (Jadovnik), S (Stolovi), Č (Čemerno), R (Radočelo), G (Goč) and ST (Studena). First column represents chorotype, while other columns represent percentage of species per each chorotype for each mountain.

	Mountains						
Chorotype	OK	J	S	Č	R	G	ST
Central and South European	24	20	19	21	21	18	18
Eurosiberian	17	23	24	21	21	29	29
Palearctic	11	13	10	7	16	16	11
Southeastern Europe	6	7	7	11	10	9	9
Western Palearctic	5	4	3	4	5		4
Holomediterranean	4	3	4			4	4
European	4	4	4	7	5	2	2
Adriatic	4	3	3			2	2
North and central Balkan	4	3	7	11	10	4	4
Afrotropical–Palearctic	4	3	4			7	7
Turano–Mediterranean	4	3	1			2	2
Western Balkan	2	4	3	4			
East Mediterranean	2	1	3	4	5	2	2
Carpathian	2		1	4			
Central and southern Balkan	2		1				
Balkan–Anatolian	1			4			
Paleotropical–Palearctic	1	1					
Holoarctic	1	1	1			2	2
Central and western Balkan	1	3		4	5		
Europe and West Asia	1						
North and western Balkans	1						
Eastern Balkan			1				
Cosmopolitan		1	1				

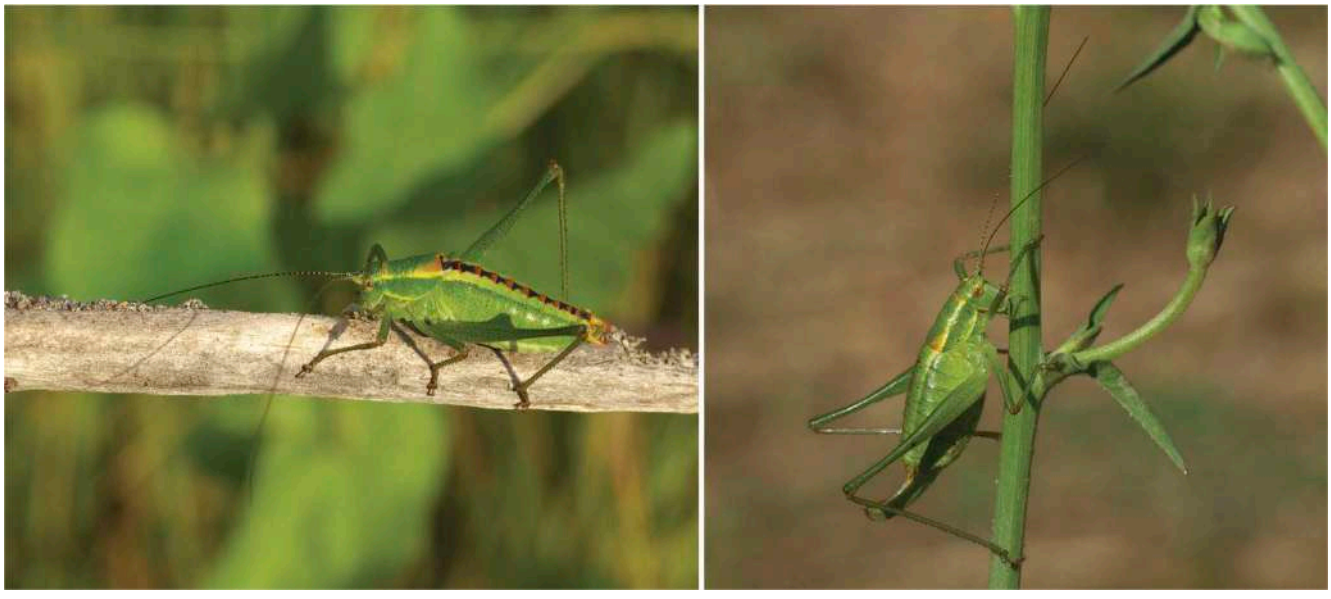

Figure 4. *Poecilimon fussii* Fieber, 1878, male and female habitus.

listening to their calling song, which can be heard from 10 m distance. The specimens were abundant on bushes by the road.

P. fussii

The calling song (Figure 4) was described by Orci (2002) for specimens from Romania and Hungary.

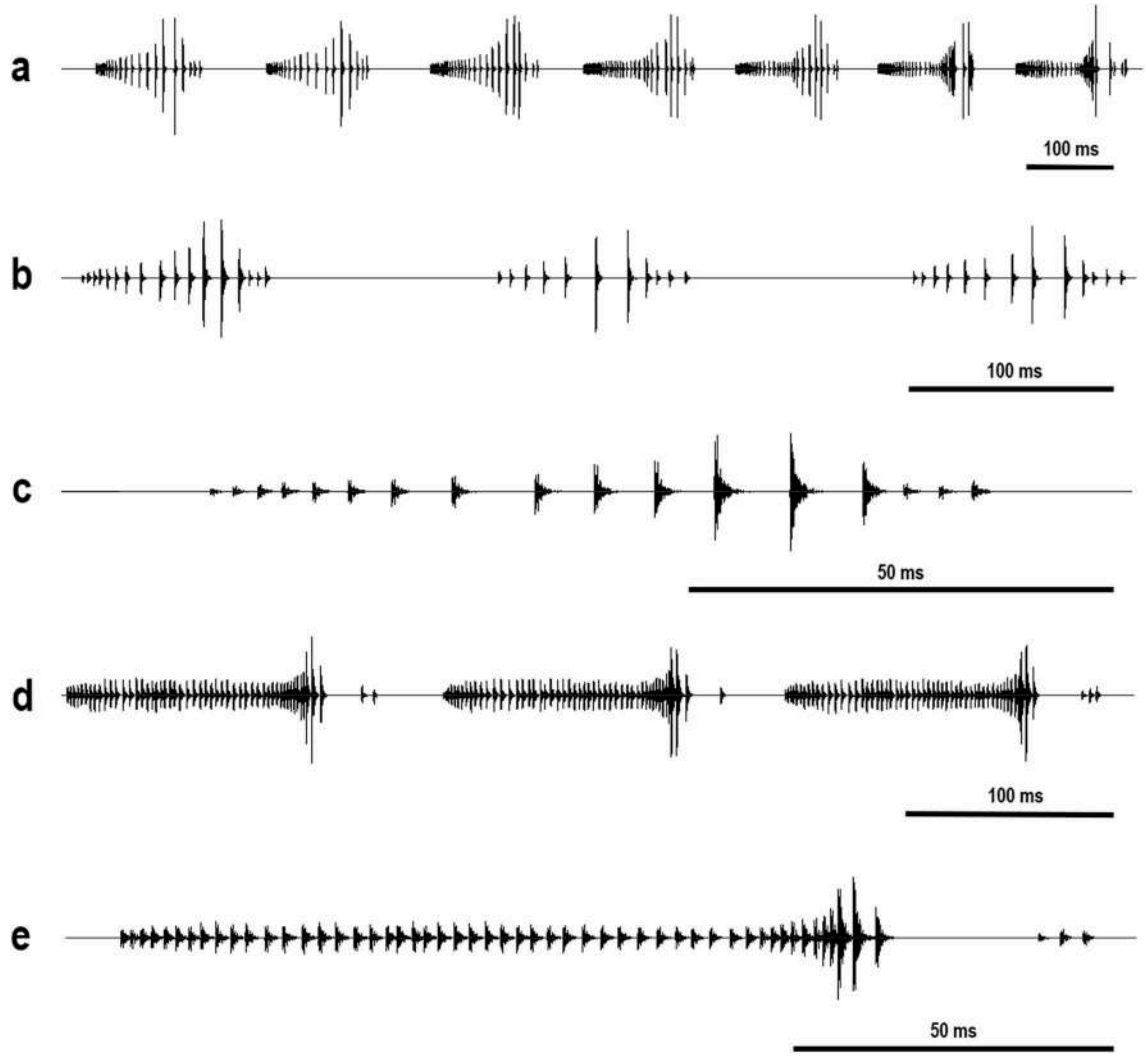

Figure 5. Oscillogram of male calling song of *Poecilimon fussii* Fieber, 1878. **a**, both types of syllables; **b, c**, first type of syllable at different velocities; **d, e**, second type of syllable at different velocities.

The song of a specimen from Ovčar–Kablar Gorge at 28°C is similar to that description – it consists of two types of syllables (Figure 5(a)). The first type (Figure 5(b), 5(c)) consists of single syllables lasting 71–135 ms and composed of 9–36 impulses with pauses of 47–346 ms between the syllables. Pauses are shorter at the transition from the first to the second type. The second type (Figure 5(d), 5(e)), which lasts 103–155 ms, consists of a main part of dense impulses and an additional part with 1–4 after-clicks. The pause between the main part, consisting of 39–54 impulses, and the additional part is 11–25 ms, while the intervals between two syllables of the second type last 29–44 ms.

Meconema meridionale

has been recently discovered in Serbia (Pavićević & Ivković 2015). Ovčar–Kablar Gorge represents a second locality of the species in Serbia. The finding suggests that *M. meridionale* could be present in the whole western part of Serbia. Further research will provide evidence on this speculation.

Tettigonia balcanica

This study represents the fourth record of this recently discovered species in Serbia.

Platycleis intermedia

The intermediate grey bush cricket has been mostly recorded in eastern and southern Serbia in the past (Pančić 1883; Us 1938; Grebenščikov 1949; Adamović 1975). Our records represent the westernmost locality of the species in the country.

Modestana ebneri

This species has been previously reported from southwestern Serbia only (Pavićević et al. 2014). Our records represent the northernmost localities in the species' distribution.

Pholidoptera transsylvanica

Endemic to the Carpathian basin (Krištín et al. 2013), *P. transsylvanica* is a species of European importance (Annex II, IV). Records in Ovčar–Kablar Gorge are rather peculiar. This represents the fifth record of the species in Serbia and the southernmost known locality of the species' distribution.

Pachytrachis frater

There is only one historical record in Serbia (Redtenbacher 1900), but it is not clear if this record referred to Serbia or Montenegro. Thus, this represents maybe the most important finding of our research, as it confirms the presence of the species in Serbia and extends the known distribution of the species. Further research should focus on finding the species in other mountainous parts of western Serbia for better knowledge of its distribution.

Tetrix ceperoi

The sand groundhopper is a widespread species in South and Central Europe, inhabiting open moist habitat, usually with a sandy substrate (Hochkirch et al. 2016a). The species is more common in the western part of its distribution than in the eastern. In the eastern part of the species' distribution, there were a lot of questionable taxonomic acts, as for example the description of *T. ceperoi balcanica* from Croatia and Macedonia (Karaman 1960). This new locality in the species distribution represents an isolated locality in central Serbia, the closest populations being those in Kosovo, FYR Macedonia, and Montenegro. Besides Kosovo and border with Romania (Kladovo) (Karaman 1965; Adamović 1970b), there are no records of the species from Serbia. The species is easily misidentified for *Paratettix meridionalis* Rambur, 1938. A practical set of identification characters to separate the species from *P. meridionalis* are: (1) short antennae – median segments about 2.5–3× longer than wide; (2) in dorsal view vertex in line with the compound eyes or insignificantly projected (about 1.1–1.2× wider than an eye); (3) median carina of the pronotum continuous; (4) dorsum of the pronotum granulose, shoulders robust, flat, median carina elevated as blade, shoulders rounded; (5) dorsal margin of the mid femora straight, slightly undulated, while ventral margin undulated; and (6) hind femora finely tuberculated, slender, about 3× long as wide. The species is probably more common in Serbia but was overlooked in the past. Diagnostic differences that could have specific or subspecific value to separate Balkan populations of *T. ceperoi* from the rest of the Europe were not found.

Xya pfaendleri

This species was recently recorded for the first time in Serbia, from Danube shores in northern Serbia and Pčinja River in southern Serbia (Pavićević et al. 2014). The population was found in typical *Xya* sp. habitat – sand pits in which they live digging burrows.

Odontopodisma albanica

This short-winged grasshopper was reported from southwestern parts of Serbia, near the border with Montenegro recently reported by Pavićević et al. (2014). This represents the northernmost locality of its distribution.

Chorthippus bornhalmi

The Balkan field grasshopper is a common species in the Balkans (Hochkirch et al. 2016b) but was regarded to be a rare Mediterranean species in the past (e.g. Massa et al. 2012). The species was described in 1971 from Dubrovnik, Croatia (Harz 1971). Later it became evident that the species is not restricted to the Adriatic coast of Croatia, but is widespread in Croatia, Montenegro, Albania, Greece, etc. (Skejo & Ivković 2015). The species was recorded in five localities in Ovčar–Kablar Gorge and the observed song seems to be intermediate between *C. brunneus* and typical Adriatic and Dinaric *C. bornhalmi*, which could imply hybridization between those species in Serbia as well. Recent research shows that the specific epitheton '*bornhalmi*' could be synonymous with '*maritimus*' (Cigliano et al. 2018).

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