



## Review of Antlions (Insecta: Neuroptera: Myrmeleontidae) in North Macedonia

**Dušan Devetak<sup>1,2,\*</sup>, Ana Nahirnić-Beshkova<sup>3</sup>, Predrag Jakšić<sup>4</sup>, Vesna Klokočovnik<sup>1,5</sup>, Tina Klenovšek<sup>1,6</sup>, Davide Badano<sup>7</sup> & Jan Podlesnik<sup>1,8</sup>**

<sup>1</sup>Department of Biology, Faculty of Natural Sciences and Mathematics, University of Maribor, Koroška cesta 160, 2000 Maribor, Slovenia; <sup>2</sup>E-mail: [dusan.devetak@guest.arnes.si](mailto:dusan.devetak@guest.arnes.si); <https://orcid.org/0000-0002-6854-9265>

<sup>3</sup>National Museum of Natural History, Bulgarian Academy of Sciences, 1 Tsar Osvoboditel Blvd, 1000 Sofia, Bulgaria; E-mail: [ana.diaphana@gmail.com](mailto:ana.diaphana@gmail.com); <https://orcid.org/0000-0002-7922-9910>

<sup>4</sup>Čingrišina 14/25, 11000 Beograd, Serbia; E-mail: [jaksicpredrag@gmail.com](mailto:jaksicpredrag@gmail.com); <https://orcid.org/0000-0002-2604-9449>

<sup>5</sup>E-mail: [vesna.klokočovnik@um.si](mailto:vesna.klokočovnik@um.si); <https://orcid.org/0000-0002-1526-8064>

<sup>6</sup>E-mail: [Tina.Klenovsek@um.si](mailto:Tina.Klenovsek@um.si); <https://orcid.org/0000-0003-4656-834X>

<sup>7</sup>Department of Life Sciences, University of Siena, Via A. Moro 2, 53100, Siena, Italy

E-mail: [davide.badano@unisi.it](mailto:davide.badano@unisi.it); <https://orcid.org/0000-0001-9715-3107>

<sup>8</sup>E-mail: [jan.podlesnik@um.si](mailto:jan.podlesnik@um.si); <https://orcid.org/0000-0002-3226-8605>

**Abstract:** We present the state of knowledge on the family Myrmeleontidae occurring in North Macedonia based on published records, museum specimens and new samples, and provide a comprehensive species list. North Macedonia represents only 3.9% of the area of the Balkan Peninsula but harbours 19 species belonging to 14 antlion genera, i.e., 61% of the peninsular fauna. We report collection localities, literature records and biological data for each species. Three species, *Nemoleon poecilopterus*, *Neuroleon assimilis* and *Myrmeleon inconspicuus*, are reported for the first time in North Macedonia. The genus *Nemoleon* Navás is also reported for the first time in the country.

**Key words:** myrmeleontids, checklist, distribution, new records, Balkan Peninsula

### Introduction

North Macedonia is a small, landlocked country in the south of the Balkan Peninsula, harbouring a remarkable insect biodiversity (HRISTOVSKI et al. 2015). Recently, 107 species of Neuropterida have been listed for the country (DEVETAK 2021).

The study on the antlions (Myrmeleontidae) in the present-day North Macedonia began a century ago, when the German zoologist Franz Doflein published the first faunal records in 1921. In the Doflein's famous book *Mazedonien*, which dealt with the natural history of the region, an entire chapter

was devoted to Macedonian antlions, with seven species reported for the country (DOFLEIN 1921). At that time, knowledge of both larval and adult European antlions was insufficient; thus, some of the identification attempts made by Doflein are unreliable. Two years later, the Spanish researcher Longinos Navás studying the order Neuroptera in the south of the Balkan Peninsula, recorded 5 antlion species from the area assigned to present-day North Macedonia (NAVÁS 1923). Later, the Bulgarian entomologist Ariada Dimitrova (Dimitrowa), referring mainly DOFLEIN (1921) and NAVÁS (1923), listed 19 antlions in three Balkan countries (Bulgaria, Mac-

\*Corresponding author: [dusan.devetak@guest.arnes.si](mailto:dusan.devetak@guest.arnes.si)

edonia and Greece), of which 7 species originated from the area (DIMITROVA 1924, DIMITROWA 1925). In the following four decades, no records of antlions in this area were published.

Between 1960 and 1980, Austrian and German entomologists collected intensively in the Balkan Peninsula. OHM (1965) even described a new antlion species, *Myrmeleon noacki*, based on specimens from the south of the Balkans, including paratypes originating from North Macedonia. In the monograph on the Neuropterida of Europe, ASPÖCK et al. (1980) added a couple of antlion records from the country.

Before 2015, the knowledge on lacewings, Neuroptera – especially antlions from North Macedonia – was still insufficient. Most published papers contained scattered information on the distribution of antlions (e.g., HÖLZEL 1987; for review, see HRISTOVSKI et al. 2015). The only review on antlions of three Balkan countries by KAČÍREK (2013) reported interesting new country records.

Four Slovenian Balkan neuropterological expeditions to North Macedonia (DEVETAK 2021) enabled the systematic collection of lacewings in this country. The occasional reports on the expeditions include only a few data on antlions (DEVETAK et al. 2015, 2019). A review of the insect collection at the Macedonian Museum of Natural History in Skopje (DEVETAK & ZEQRIRI 2018) reported data on the distribution of 12 myrmeleontid species.

In this article, we summarise the data on the species composition, distribution and biology of the antlion species recoded in North Macedonia.

## Materials and Methods

Adult antlions were collected with insect nets or portable light traps. Antlion larvae were excavated from their pits with a spoon. Photographs of the insects were taken using a Nikon SMZ 800 stereoscopic zoom microscope with a Nikon DS-Fi2 mounted digital camera, and processed using NIS-Elements D 4.20 software. Digital images captured at different focal planes were assembled using the Helicon Focus 4.62 Lite software. Specimens are deposited in the first author's collection. Nomenclature and taxonomy are used following OSWALD (2021) and STANGE (2004).

North Macedonia is divided into eight administrative units – statistical regions with 80 municipalities (Fig. 1). Collection sites included in the checklist are detailed in Table 1. For each species, a list of localities is given, based on collected material and literature data. The locality-codes include the two-letter abbreviations of the regions and a numerical code (Table 1).



**Fig. 1.** Map of the Statistical regions in North Macedonia (Map outline credit: MacedonianBoy, CC BY-SA 4.0, via Wikimedia Commons; modified).

## Results

### Tribe Palparini Banks, 1911

#### *Palpares libelluloides* (Linnaeus, 1764)

Jugoistočen region: JI 1 (DIMITROVA 1924, DIMITROWA 1925); JI 2; JI 3 (DEVETAK & ZEQRIRI 2018); JI 4 (DEVETAK 1996); JI 5; JI 8 (DIMITROVA 1924, DIMITROWA 1925); JI 9 (DEVETAK & ZEQRIRI 2018); JI10 (DIMITROVA 1924; JI11 (DEVETAK 1996); (DIMITROWA 1925); JI14 (DOFLEIN 1921); JI15 (DEVETAK & ZEQRIRI 2018).

Jugozapaden region: JZ 1 (DEVETAK & ZEQRIRI 2018); JZ 5 (DEVETAK et al. 2015); JZ 7 (DEVETAK & ZEQRIRI 2018).

Pelagoniski region: PE 4 (DEVETAK 1996, DEVETAK et al. 2019); PE 5 (DIMITROVA 1924); PE 7 (DEVETAK & ZEQRIRI 2018); PE 9; PE14.

Poloshki region: PO 4 (DEVETAK & ZEQRIRI 2018).

Skopski region: SK 3 (DEVETAK & ZEQRIRI 2018); SK 4 (DEVETAK & ZEQRIRI 2018); SK 6 (DEVETAK & ZEQRIRI 2018); SK 7 (DEVETAK 1996, DEVETAK & ZEQRIRI 2018); SK 9 (DEVETAK & ZEQRIRI 2018); SK11 (DEVETAK & ZEQRIRI 2018).

Vardarski region: VA 1 (DEVETAK & ZEQRIRI 2018); VA 3; VA 9 (DEVETAK 1996); VA10 (DEVETAK & ZEQRIRI 2018); VA13; VA14 (DEVETAK & ZEQRIRI 2018); VA15 (DEVETAK 1996); VA17 (DEVETAK & ZEQRIRI 2018).

**Biology:** *Palpares libelluloides* is associated with dry Mediterranean habitats, such as arid grasslands, open forests and scrublands. The larvae are ambush predators, living in the debris below bushes and low plants (ASPÖCK et al. 1980, KRIVOKHATSKY 2011, BADANO & PANTALEONI 2014).

**Table 1.** List of collecting sites in North Macedonia.

Region	Code	Collection site	Reference
<b>Istoichen region</b> [ <i>Eastern Region</i> ]			
	IS 1	Municipality of Berovo: Berovo.	DEVETAK & ZEQRIRI 2018
	IS 2	Municipality of Probishtip: Kočani town 16 km W, Buchishte village, 359 m a.s.l., 41°55'51.5"N 22°11'50.1"E, 02.VII.2016, A. Nahirnić-Beshkova & S. Beshkov leg.	this paper
<b>Jugoistoichen region</b> [= <i>Southeastern Region</i> ]			
	JI 1	Municipality of Bogdanci: Bogdanci.	DIMITROVA 1924, DIMITROWA 1925
	JI 2	Municipality of Bosilovo: Ogražden, Mt. above Shtuka and Ilovitza villages, 465 m, 41°28'43"N 22°49'32"E, 19.VI.2015, A. Nahirnić-Beshkova & S. Beshkov leg.	this paper
	JI 3	Municipality of Dojran: a: Dojran; b: Dojran [=Stari Dojran], 24.VII.1975, Students of Biology–Univ. Ljubljana leg.	a: DEVETAK 1997, DEVETAK & ZEQRIRI 2018; b: this paper
	JI 4	Municipality of Dojran: a: Gjopcheli [=»Djopčeli«]; b: Gjopcheli, 23.VII.1975, Students of Biology–Univ. Ljubljana leg.	a: DEVETAK 1996, 1997; b: this paper
	JI 5	Municipality of Dojran: Gjopcheli, between Dojransko ezero and Gjopcheli, dry grassland-bushes, 215 m a.s.l., 41°14'36.6"N 22°40'18.2"E, 21.VI.2019, Klenovšek, Klokočovnik, Podlesnik & Devetak leg.	this paper
	JI 6	Municipality of Gevgelija: Gevgelija, river Konska, 63 m, dry riverbed, 41°07'56.5"N 22°30'00.3"E, 21.VI.2019, Klenovšek, Klokočovnik, Podlesnik, Devetak leg.	this paper
	JI 7	Municipality of Gevgelija: Negorci.	DEVETAK & ZEQRIRI 2018
	JI 8	Municipality of Gevgelija: Novo Konjsko, lit. rec.: Dimitrova 1924 & Dimitrowa 1925: »Gornitschet« [=Novo Konjsko].	DIMITROVA 1924, DIMITROWA 1925
	JI 9	Municipality of Konche: Konechka planina.	DEVETAK & ZEQRIRI 2018
	JI10	Municipality of Novo Selo: Belasica Mts.	DIMITROVA 1924, DIMITROWA 1925, DEVETAK & ZEQRIRI 2018
	JI11	Municipality of Novo Selo: Novo Selo, a: Ogražden Mt.; b: Ogražden Mt., 19.VII.1983, P. Jakšić leg.	a: DEVETAK 1996; b: this paper
	JI12	Municipality of Radoviš: Kozbunar village.	DEVETAK & ZEQRIRI 2018
	JI13	Municipality of Valandovo: Bašibos.	DEVETAK & ZEQRIRI 2018
	JI14	Municipality of Valandovo: Gorna Maala, lit. rec.: Doflein 1921: »Kaluckova« [=Gorna Maala].	Doflein 1921; Devetak & Zeqiri 2018
	JI15	Municipality of Valandovo: Valandovo.	DEVETAK & ZEQRIRI 2018
<b>Jugozapaden region</b> [= <i>Southwestern Region</i> ]			
	JZ 1	Municipality of Kichevo: 10 km south of Kichevo: Belica village.	DEVETAK & ZEQRIRI 2018
	JZ 2	Municipality of Makedonski Brod: Protected Area Jasen: between Lake Kozjak and Kula, 840-900 m, 41° 49.13' N, 21° 12.99' E.	DEVETAK et al. 2015
	JZ 3	Municipality of Makedonski Brod: Protected Area Jasen: Blizansko, 483 m, 41° 45.5' N, 21° 9.7' E.	DEVETAK et al. 2015
	JZ 4	Municipality of Makedonski Brod: Protected Area Jasen: S of Lake Kozjak: Kapina, 475 m, 41°48.46'N 21°11.19'E.	DEVETAK et al. 2015

Table 1. Continuation.

Region	Code	Collection site	Reference
	JZ 5	Municipality of Makedonski Brod: Protected Area Jasen: S of Lake Kozjak: Vlaka, 472 m, 41° 40.99' N 21° 14.3' E.	DEVETAK et al. 2015
	JZ 6	Municipality of Ohrid: Galičica Mountains, near Leskoets [=Leskoec].	KAČÍREK 2013
	JZ 7	Municipality of Ohrid: Ohrid.	ASPÖCK et al. 1980, HÖLZEL 1987, DEVETAK & ZEQRIRI 2018
	JZ 8	Municipality of Ohrid: Ohrid, Plaoshnik, Sv. Jovan Kaneo, 41°06'41.0"N 20°47'20.4"E, 05.VII.2017, Devetak leg.	this paper
	JZ 9	Municipality of Struga: Jablanica Mountain, Drenok, 1106 m a.s.l.	DEVETAK & ZEQRIRI 2018
<b>Pelagoniski region</b> [=Pelagonia Region]			
	PE 1	Municipality of Bitola: Bitola – south of Bitola.	NAVÁS 1923
	PE 2	Municipality of Bitola: Pelister National Park, Hotel Molika, forest <i>Pinus peuce</i> , 1420 m, 41°02'08.5"N 21°13'34.6"E, 06.VII.2017, Klenovšek, Podlesnik, Janžekovič & Devetak leg.	this paper
	PE 3	Municipality of Bitola: Pelister National Park, near Jorgov kamen, meadow/forest with <i>Pinus peuce</i> , 1738 m, 41°01'35.6"N 21°12'44.0"E, 06.VII.2017, Klenovšek, Podlesnik, Janžekovič & Devetak leg.	this paper
	PE 4	Municipality of Bitola: Pelister National Park, village Magarevo, ca. 900 m.	DEVETAK 1996, DEVETAK et al. 2019
	PE 5	Municipality of Demir Hisar: Demir Hisar.	DIMITROVA 1924
	PE 6	Municipality of Novaci [=Novatsi]: Brod, along Crna Reka river.	NAVÁS 1923
	PE 7	Municipality of Novaci [=Novatsi]: Nidže Mt., Skočivir village.	DEVETAK & ZEQRIRI 2018
	PE 8	Municipality of Prilep: Kalen, 7 km SE from Kalen, meadow, 585 m, 41°13'03.5"N 21°41'24.1"E, 07.VII.2017, Klenovšek, Podlesnik, Janžekovič & Devetak leg.	this paper
	PE 9	Municipality of Prilep: Mariovo Mt., 10 km W from Vitolishte, meadow/sporadic trees, 640 m, 41°10'34.4"N 21°44'15.4"E, 07.VII.2017, Klenovšek, Podlesnik, Janžekovič & Devetak leg.	this paper
	PE10	Municipality of Prilep: a: Pletvar; b: a: Pletvar, ca. 1000 m, 16.VII.1980, 20.VII.1980, 20.VII.1983, 28.VII.1983 all P. Jakšić leg.	a: DEVETAK 1997, KAČÍREK 2013; b: this paper
	PE11	Municipality of Prilep: Pletvar Pass, 970 m, Babuna Mts., 41°22'12"N 21°40'11"E, light traps, 01.-03.VI.2018, 08.VII.2018, 05.VIII.2018, A. Nahirić-Beshkova & S. Beshkov leg.	this paper
	PE12	Municipality of Prilep: Pletvar Pass, 985 m, Babuna Mts., 41°22'07"N 21°39'44"E, light traps, 24.VIII.2017, A. Nahirić-Beshkova & S. Beshkov leg.	this paper
	PE13	Municipality of Prilep: Prilep.	DIMITROVA 1924, DIMITROWA 1925
	PE14	Municipality of Prilep: Prilep, Markovi Kuli, 700 m, 41°21'30.6"N 21°32'26.9"E, 08.VII.2017, Klenovšek, Podlesnik, Janžekovič & Devetak leg.	this paper
	PE15	Municipality of Prilep: Shtavica, 2 km SE, meadow, 1100-1120 m, 41°15'03.2"N 21°35'27.3"E, 07.VII.2017, Klenovšek, Podlesnik, Janžekovič & Devetak leg.	this paper

Table 1. Continuation.

Region	Code	Collection site	Reference
	PE16	Municipality of Resen: Baba Mt., above Slivnica village, 1135 m, 40°58'05"N 21°05'30"E, 07.VIII.2016, A. Nahirić-Beshkova & S. Beshkov leg.	this paper
	PE17	Municipality of Resen: Kurbinovo.	DEVETAK & ZEQRIRI 2018
	PE18	Municipality of Resen: Oteshevo-Sirhan, Prespansko Ezero, lake shore, 850 m, 40°59'18.6"N 20°55'31.9"E, 22.VI.2019, V. Klokočovnik leg.	this paper
	PE19	Municipality of Resen: Sirhan, Prespansko Ezero - lake shore, grassland / bushes, 853 m, 40°59'39.2"N 20°55'58.8"E, 22.VI.2019, Klenovšek, Klokočovnik, Podlesnik & Devetak leg.	this paper
	PE20	Municipality of Resen: Stenje, Prespansko Ezero.	KAČÍREK 2013, DEVETAK & ZEQRIRI 2018
<b>Poloshki region</b> [=Polog Region]			
	PO 1	Municipality of Mavrovo i Rostuša [=Rostusha]: Mavrovo.	DEVETAK & ZEQRIRI 2018
	PO 2	Municipality of Mavrovo i Rostuša [=Rostusha]: Lazaropole.	DEVETAK & ZEQRIRI 2018
	PO 3	Municipality of Mavrovo i Rostuša [=Rostusha]: Tresonche, river Mala reka, 1035-1050 m, 41°33'40.9"N 20°44'01.1"E, 04.VII.2017, Klenovšek, Podlesnik, Janžekovič & Devetak leg.	this paper
	PO 4	Municipality of Jegunovtse: Cerovo [=Cerovë].	DEVETAK & ZEQRIRI 2018
	PO 5	Municipality of Želino [=Zhelino]: Protected Area Jasen: Brana Kozjak /=Kozjak Dam/ - the river Treska.	DEVETAK & ZEQRIRI 2018
<b>Severoistočen region</b> [=Northeastern Region]			
	SI 1	Municipality of Rankovce: Osogovo Mts., between Zheleznica and Talashmance villages, 716 m, 42°06'00"N 22°08'07"E, 19.VI.2015, A. Nahirić-Beshkova & S. Beshkov leg.	this paper
<b>Skopski region</b> [=Skopje Region]			
	SK 1	City of Skopje, Skopje, Skopje-Centar.	DOFLEIN 1921, DEVETAK & ZEQRIRI 2018
	SK 2	Municipality of Butel (part) / Municipality of Shuto Orizari (part): Gradski park [=City Park].	DEVETAK & ZEQRIRI 2018
	SK 3	Municipality of Chucher-Sandevo: Skopska Crna Gora, Blatse.	DEVETAK & ZEQRIRI 2018
	SK 4	Municipality of Gjoče Petrov: Skopje - river Treska.	DEVETAK & ZEQRIRI 2018
	SK 5	Municipality of Karpoš: Skopje, Karpoš.	DEVETAK & ZEQRIRI 2018
	SK 6	Municipality of Karpoš: Vodno Mt.	NAVÁS 1923, DEVETAK & ZEQRIRI 2018
	SK 7	Municipality of Petrovec: a: Katlanovo; b: Katlanovo, 17.VIII.1987, P. Jakšić leg.	a: DEVETAK 1996, DEVETAK & ZEQRIRI 2018; b: this paper
	SK 8	Municipality of Petrovec: Katlanovo: Katlanovska banja [=Katlanovo Thermal Bath], 41°53'54"N 21°41'37"E, 12.VII.2011, V. Klokočovnik, F. Janžekovič & D. Devetak, leg.	this paper
	SK 9	Municipality of Petrovec: Katlanovo, Crn Vrv.	Devetak & Zeqiri 2018
	SK10	Municipality of Petrovec: Pčinja stojalište, 41°49'07.7"N 021°40'10.9"E.	DEVETAK & ZEQRIRI 2018

**Table 1.** Continuation.

Region	Code	Collection site	Reference
	SK11	Municipality of Saraj: Matka.	DEVETAK & ZEQRIRI 2018
	SK12	Municipality of Saraj: Matka, Treska: the canyon of the river Treska, 320 m, 41°57'00.0"N 21°17'59.5"E.	DEVETAK et al. 2015
	SK13	Municipality of Saraj: Protected Area Jasen: Rudine, 1050-1070 m, 41° 53.50' N, 21° 13.94' E.	DEVETAK et al. 2015
	SK14	Municipality of Saraj: Žeden Mt.	DEVETAK & ZEQRIRI 2018
	SK15	Municipality of Sopište: Patiška Reka.	DEVETAK & ZEQRIRI 2018
	SK16	Municipality of Sopište: Protected Area Jasen: Jakupica Mt.: Urnat Kamen-Goljak, 1425-1440 m, 41° 49.56' N, 21° 14.5' E.	DEVETAK et al. 2015
	SK17	Municipality of Sopište: Sopište.	DEVETAK & ZEQRIRI 2018
	SK18	Municipality of Studeničani: Jakupica Mt.	DEVETAK & ZEQRIRI 2018
<b>Vardarski region</b> [= <i>Vardar Region</i> ]			
	VA 1	Municipality of Chashka: Chashka [=Čaška].	DEVETAK & ZEQRIRI 2018
	VA 2	Municipality of Demir Kapija: Demir Kapija, 21.V.1988, P. Jakšić leg.	this paper
	VA 3	Municipality of Demir Kapija: Demir Kapija, east of Besvica village, gorge of Besvički dol river, 255 m, 41°22'58"N 22°11'45"E, 20.V.2017, 23.VI.2017, 18.VIII.2017, 13.VII.2019, A. Nahirić-Beshkova & S. Beshkov leg.	this paper
	VA 4	Municipality of Demir Kapija: Demir Kapija, river Vardar, river bank with fine sand, 97 m, 41°25'01.6"N 22°14'29.3"E, 21.VI.2019, Klenovšek, Klokočovnik, Podlesnik & Devetak leg.	this paper
	VA 5	Municipality of Gradsko: Slandol, arid grassland (pseudosteppe), 223 m, 41°36'05.7"N 21°58'07.7"E, 08.VII.2017, Klenovšek, Podlesnik, Janžekovič & Devetak leg.	this paper
	VA 6	Municipality of Gradsko: Ubogo, along Bregalnica river, 158 m, 41°38'20"N 21°56'51"E, 08.VII.2017, Klenovšek, Podlesnik, Janžekovič & Devetak leg.	this paper
	VA 7	Municipality of Gradsko: Ulanci, Gradsko, along river Vardar, 41°35'10.7"N 21°56'38.8"E, 08.VII.2017, Klenovšek, Podlesnik, Janžekovič & Devetak leg.	this paper
	VA 8	Municipality of Kavadarci: Drenovo.	OHM 1965, HÖLZEL 1987
	VA 9	Municipality of Kavadarci: Raec.	DEVETAK 1996
	VA10	Municipality of Kavadarci: Tikveshko Ezero [=Tikvesh Lake].	DEVETAK & ZEQRIRI 2018
	VA11	Municipality of Negotino: Kurija village, Negotino.	DEVETAK & ZEQRIRI 2018
	VA12	Municipality of Sveti Nikole: Sveti Nikole.	DEVETAK & ZEQRIRI 2018
	VA13	Municipality of Veles: North of Veles: Sopot, dry grassland, 217 m, 41°46'59"N 21°42'51"E, 20.VI.2019; Klenovšek, Klokočovnik, Podlesnik, Devetak leg.	this paper
	VA14	Municipality of Veles: Otovica.	DEVETAK & ZEQRIRI 2018
	VA15	Municipality of Veles: Topolka.	DEVETAK 1996
	VA16	Municipality of Veles: Topolka River Gorge, 230 m, 41°42'00"N 21°47'22"E, 02.VII.2016, A. Nahirić-Beshkova leg.	this paper
	VA17	Municipality of Veles: a: Veles; b: Veles [=former Titov Veles], 19.VII.1983, P. Jakšić leg.	a: KAČÍREK 2013, DEVETAK & ZEQRIRI 2018; b: this paper



Fig. 2. Wings of *Nemoleon poecilopterus* (Stein), female.

This species was found in North Macedonia in lowlands up to 700 m a.s.l.

**Distribution:** Southern Europe, Northwest Africa and Western Asia to Caucasus and Iran (MIRMOAYEDI et al. 2015).

#### Tribe Dendroleontini Banks, 1899

##### *Dendroleon pantherinus* (Fabricius, 1787)

Jugozapaden region: JZ 7 (DEVETAK & ZEQRIRI 2018); JZ 9 (DEVETAK & ZEQRIRI 2018).

**Biology:** *Dendroleon pantherinus* is primarily a forest-dwelling species. The larvae are found in tree holes and old trees, but also readily colonize man-made structures (ASPÖCK et al. 1980, GEPP 2010, KRIVOKHATSKY 2011, BADANO & PANTALEONI 2014). Most life history observations on this species have been made in Central Europe, although there is increasing evidence that this antlion also occurs in Mediterranean environments (RATTU et al. 2020, BADANO pers. obs.).

The collection places of *D. pantherinus* in North Macedonia are mostly in forested areas.

**Distribution:** Europe: Widely distributed in warmer parts of Europe (with the exception of the Iberian Peninsula). Asia: Turkey and Caucasus (DOBOSZ et al. 2017).

#### Tribe Nemoleontini Banks, 1911

##### *Creoleon plumbeus* (Olivier, 1811)

Jugoistočen region: JI 1 (DIMITROVA 1924, DIMITROVA 1925); JI 7 (DEVETAK & ZEQRIRI 2018); JI12 (DEVETAK & ZEQRIRI 2018).

Pelagoniski region PE 1 (NAVÁS 1923); PE 8; PE19; PE20 (DEVETAK & ZEQRIRI 2018).

Vardarski region: VA 4; VA 5; VA 7; VA 9 (DEVETAK 1996).

**Biology:** Adults of *Creoleon plumbeus* are associated with arid grasslands, open forests, and scrublands. The larvae are ambush predators living in sandy soils (ASPÖCK et al. 1980, GEPP 2010, KRIVOKHATSKY 2011).

**Distribution:** Europe: Widely distributed in southern Europe (mainly in East-Mediterranean). Asia: Middle East, Central Asia and China.

##### *Delfimeus irroratus* (Olivier, 1811)

Pelagoniski region: PE 6 (NAVÁS 1923); PE10 (KAČÍREK 2013); PE11; PE12.

**Biology:** Adults of *Delfimeus irroratus* were collected in arid rocky grassland with sporadic shrubs. The life history of this species is unknown.

**Distribution:** Europe: East-Mediterranean (Bosnia and Herzegovina, Bulgaria, Croatia, Greece, North Macedonia); Asia: Anatolia, Iraq, Israel, Syria, Lebanon, Armenia and Georgia.

##### *Nemoleon poecilopterus* (Stein, 1863) (Fig. 2)

Pelagoniski region: PE11; PE12.

**Biology:** In North Macedonia, *Nemoleon poecilopterus* is associated with arid rocky grassland with sporadic shrubs. *N. poecilopterus* is a rare and poorly known species.

**Distribution:** Europe: Bulgaria, Croatia, European Turkey, Greece, Italy, Kosovo; Asia: Cyprus (BADANO et al. 2018), Middle East, Caucasus, Turkmenistan. The present study is the first record for North Macedonia.

##### *Nedroledon anatolicus* Navás, 1914

Pelagoniski region: PE10 (KAČÍREK 2013).

**Biology:** Adults were collected from dry, for-

ested places (DOBOSZ & POPOV 2018, DVOŘÁK & GEORGIEV 2018). In North Macedonia, this species is associated with arid rocky grassland with sporadic shrubs and trees.

**Distribution:** Europe: Probably the rarest European antlion species, it is only known for a handful of records from Bulgaria, Greece, North Macedonia, and Romania; Asia: Turkey. For a review of distribution, see DOBOSZ & POPOV (2018) and DVOŘÁK & GEORGIEV (2018).

***Neuroleon tenellus* (Klug in Ehrenberg, 1834)**

Skopski region: SK10 (DEVETAK & ZEQRIRI 2018).

**Biology:** Poorly known species, occurring in arid habitats.

**Distribution:** Europe: Greece, North Macedonia; Asia: Cyprus, Middle East, Afghanistan, Azerbaijan, Kyrgyzstan, Turkmenistan, Uzbekistan; Africa: Egypt, Libya, Morocco, Sudan, and Tunisia (BADANO et al. 2018, Ábrahám & GIACOMINO 2020, OSWALD 2021).

The finding of two individuals in the collection of the Macedonian Museum of Natural History in Skopje was interesting and unexpected. So far, in Europe, the species has been known from only three collecting places, all in Greece (DEVETAK & ZEQRIRI 2018). The occurrence of this species in Spain mentioned by KIMMINS (1950) seems doubtful; the possible occurrence should be confirmed (MONSERRAT & ACEVEDO 2013).

***Neuroleon assimilis* (Navás, 1914)**

Vardarski region: VA 3. Two females were collected at light traps (18.VIII.2017) (Fig. 3).

**Biology:** Until recently, a poorly known species. In Bulgaria and Greece (Corfu), *N. assimilis* was found in scrublands, open forests, garrigues and arid grasslands with *Olea*, *Ficus* and Mediterranean vegetation (BADANO & PANTALEONI 2014, DOBOSZ & POPOV 2018). In Demir Kapija in North Macedonia, this species was found in arid rocky grasslands, pseudomaquis and transition from arid rocky grasslands to Mediterranean and sub-Mediterranean pseudomaquis consisting of small trees (e.g., *Palurus spina-christi*, *Quercus pubescens*, *Fraxinus ornus*, *Juniperus excelsa*, *J. oxycedrus*, *Pistacia terebinthus* and *Phillyrea latifolia*). The larvae of this species are ambush predators, living under rock overhangs (BADANO & PANTALEONI 2014).

**Distribution:** Europe: Bulgaria, Greece (including Crete); Asia: Turkey (Anatolia), Armenia, Syria, and Iran (LETARDI & PANTALEONI 1996, ASPÖCK et al. 2001, TRÖGER 2003, BADANO & PANTALEONI 2014, MIRMOAYEDI et al. 2015, DOBOSZ & POPOV 2018). *Neuroleon assimilis* is known from 9

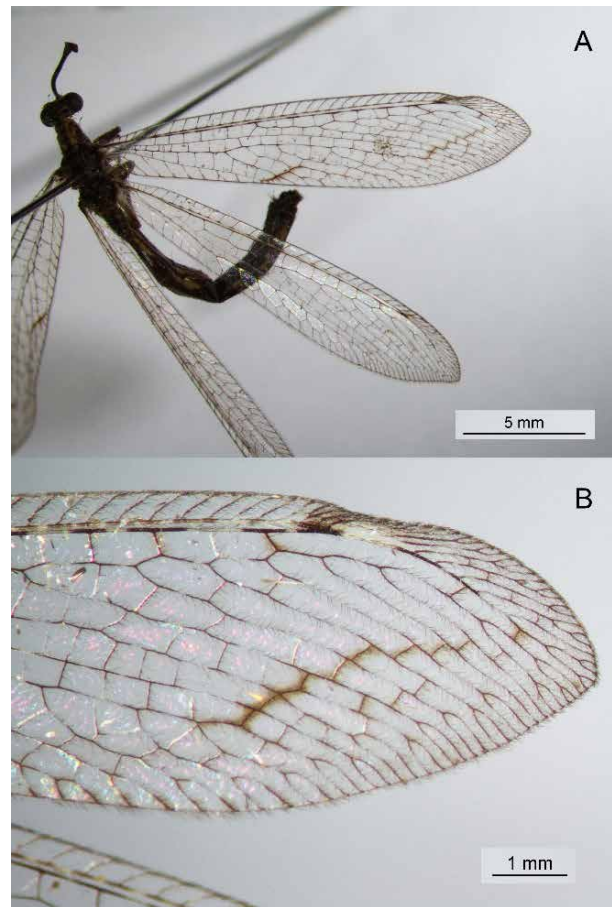


Fig. 3. *Neuroleon assimilis* (Navás): A – Pinned female; B – detail of the forewing.

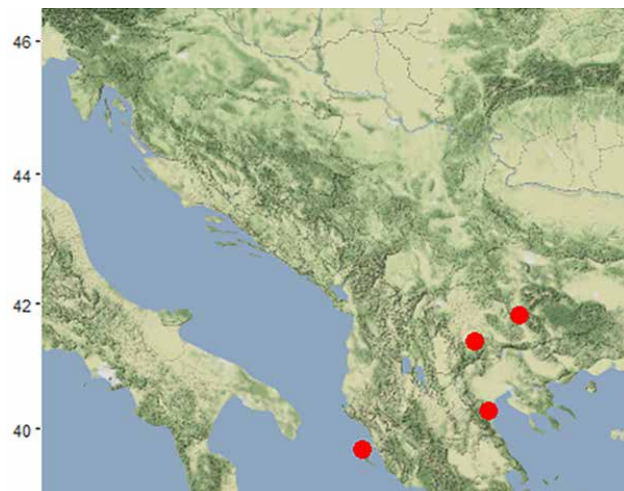


Fig. 4. Distribution of *Neuroleon assimilis* (Navás) in the Balkan Peninsula.

collecting places in Europe now (when we unite all the places on Corfu) (Fig. 4). The collecting place in North Macedonia is located on the northern border of the species range. The present study is the first record for North Macedonia.



***Neuroleon microstenus* (McLachlan, 1898)**

Jugozapaden region: JZ 7 (ASPÖCK et al. 1980).

Pelagoniski region: PE12; PE16.

Poloshki region: PO 2 (DEVETAK & ZEQRIRI 2018).

Skopski region: SK 6 (DEVETAK & ZEQRIRI 2018).

**Biology:** *Neuroleon microstenus* is associated with scrublands, open forests, garrigues, and arid grasslands. The larvae of this species are ambush predators living in rocky soils, among gravel and pebbles (DEVETAK et al. 2010, BADANO & PANTALEONI 2014).

**Distribution:** Europe: Mediterranean region, south Switzerland, Hungary, Bulgaria, Romania, Ukraine, and Russia; Asia: Turkey, Cyprus, Syria, Lebanon, Israel, Azerbaijan, Armenia and Georgia; Africa: Algeria (ASPÖCK et al. 2001, KRIVOKHATSKY 2011, DOBOSZ et al. 2017).

***Distoleon tetragrammicus* (Fabricius, 1798)**

Jugoistochen region: JI 1 (DIMITROVA 1924, DIMITROVA 1925); JI 9 (DEVETAK & ZEQRIRI 2018); JI14 (DOFLEIN 1921); JI10 (DEVETAK & ZEQRIRI 2018).

Jugozapaden region: JZ 2 (DEVETAK et al. 2015); JZ 3 (DEVETAK et al. 2015).

Pelagoniski region: PE10 (KAČÍREK 2013); PE11; PE18.

Severoistochen region: SI 1.

Skopski region: SK 1 (DEVETAK & ZEQRIRI 2018); SK 6 (NAVÁS 1923, DEVETAK & ZEQRIRI 2018); SK13 (DEVETAK et al. 2015); SK17 (DEVETAK & ZEQRIRI 2018).

Vardarski region: VA11 (DEVETAK & ZEQRIRI 2018); VA12 (DEVETAK & ZEQRIRI 2018); VA13.

**Biology:** *Distoleon tetragrammicus* is found in various habitats – scrublands, open forests, pseudo-maquis, and montane forests. The larvae are ambush predators, living in the soil or under rock overhangs or slopes (STEFFAN 1975, ASPÖCK et al. 1980, GEPP 2010, KRIVOKHATSKY 2011, BADANO & PANTALEONI 2014).

**Distribution:** Europe: Common in warmer parts of South and Central Europe, expanding north to the Baltic coast and northern France; Asia: Middle East and Caucasus; Africa: Morocco.

***Macronemurus appendiculatus* (Latreille, 1807)**

Pelagoniski region: PE 6 (NAVÁS 1923).

**Biology:** *Macronemurus appendiculatus* is a common species associated with arid grasslands. The larvae are ambush predators, digging at the base of grass tufts (ASPÖCK et al. 1980, BADANO & PANTALEONI 2014).

**Distribution:** Europe: Mediterranean region, Switzerland, Slovakia; Asia: Turkey, Israel, Lebanon; Africa: Morocco, Algeria, and Tunisia.

NAVÁS (1923) recorded *M. appendiculatus* in one collecting place in present-day North Macedonia. This species is common in the Mediterranean part of the Western Balkan but rare in other parts of the peninsula and Anatolia (ASPÖCK et al. 1980, HÖLZEL 1987, DEVETAK 1997, KRIVOKHATSKY 2011).

***Macronemurus bilineatus* Brauer, 1868**

Jugoistochen region: JI 1 (DIMITROVA 1924, DIMITROVA 1925); JI 3 (DEVETAK 1997); JI 4 (DEVETAK 1997); JI 7 (DEVETAK & ZEQRIRI 2018).

Jugozapaden region: JZ 7 (HÖLZEL 1987, DEVETAK & ZEQRIRI 2018).

Pelagoniski region: PE 1 (NAVÁS 1923); PE 6 (NAVÁS 1923); PE10 (DEVETAK 1997); PE17 (DEVETAK & ZEQRIRI 2018).

Skopski region: SK 1 (DEVETAK & ZEQRIRI 2018); SK 6 (NAVÁS 1923, DEVETAK & ZEQRIRI 2018); SK 7 (DEVETAK & ZEQRIRI 2018).

Vardarski region: VA 5; VA 8 (HÖLZEL 1987); VA13.

DOFLEIN (1921) mentioned *Macronemurus appendiculatus* for Macedonia, but from his illustration (DOFLEIN 1921, p. 475) one can conclude he figured closely related *M. bilineatus*.

**Biology:** *Macronemurus bilineatus*-adults were found in arid grasslands and low scrublands. The life history of this species is unknown.

**Distribution:** Europe: Albania, Montenegro, North Macedonia, Greece, Kosovo, Bulgaria, Hungary, Romania, European Turkey, Ukraine, Russia; Asia: Anatolia, Armenia.

***Megistopus flavicornis* (Rossi, 1790)**

Jugoistochen region: JI 1 (DIMITROVA 1924, DIMITROVA 1925).

Pelagoniski region: PE10 (KAČÍREK 2013); PE20 (KAČÍREK 2013).

Skopski region: SK 6 (DEVETAK & ZEQRIRI 2018); SK11 (DEVETAK & ZEQRIRI 2018).

Vardarski region: VA 2; VA12 (DEVETAK & ZEQRIRI 2018); VA17 (KAČÍREK 2013).

DOFLEIN (1921) listed this species for Macedonia, but the illustration on p. 479 suggests his record is questionable.

**Biology:** *Megistopus flavicornis* is found in a variety of habitats with a sandy substrate and usually with a presence of trees (STEFFAN 1975, ASPÖCK et al. 1980, GEPP 2010, KRIVOKHATSKY 2011, BADANO & PANTALEONI 2014).

**Distribution:** Europe: South Europe, Switzerland, Austria, Slovakia, Czech Republic, Hungary, Romania, Ukraine, and Russia; Asia: Middle East, Turkmenistan, and the Caucasus. Africa: Morocco.

#### Tribe Myrmecaelurini Esben-Petersen, 1918

##### *Myrmecaelurus trigrammus* (Pallas, 1771)

Istochnen region: IS 2.

Jugoistochnen region: JI 4; JI 6; JI 7 (DEVETAK & ZEQRIRI 2018); JI11; JI12 (DEVETAK & ZEQRIRI 2018).

Jugozapaden region: JZ 4 (DEVETAK et al. 2015); JZ 5 (DEVETAK et al. 2015); JZ 6 (KAČÍREK 2013).

Pelagoniski region: PE 8; PE10 (KAČÍREK 2013); PE14; PE15.

Skopski region: SK 1 (DOFLEIN 1921; DEVETAK & ZEQRIRI 2018); SK 6 (DEVETAK & ZEQRIRI 2018); SK 7 (DEVETAK & ZEQRIRI 2018; this paper).

Vardarski region: VA 4; VA13; VA14 (DEVETAK & ZEQRIRI 2018); VA16; VA17.

**Biology:** *Myrmecaelurus trigrammus* is associated with steppe-like habitats. The larvae are pit builders, digging their traps in open conditions (ASPÖCK et al. 1980, POPOV 1984, GEPP 2010, DEVETAK et al. 2013, BADANO & PANTALEONI 2014). In North Macedonia, *M. trigrammus*-adults were found in meadows and arid grasslands. The larvae constructed pits in shelters of rocks (Prilep) or in exposed microhabitats – open grasslands, meadows along rivers (Demir Kapija) or even in the dry riverbeds (river Kanska – Gevgelija).

**Distribution:** Europe: Mediterranean countries, Slovakia, Hungary, Serbia, North Macedonia, Bulgaria, Romania, Moldova, Ukraine, Russia, and Kazakhstan (European part); Asia: Middle East, Caucasus, Russia (Siberia), Kazakhstan, Kyrgyzstan, and Tajikistan.

#### Tribe Nesoleontini Markl, 1954

##### *Cueta lineosa* (Rambur, 1842)

Jugoistochnen region: JI 6.

Skopski region: SK 2 (DEVETAK & ZEQRIRI 2018); SK 6 (DEVETAK & ZEQRIRI 2018).

Vardarski region: VA13.

**Biology:** *Cueta lineosa* is associated with steppes and deserts. The larvae are pit-builders living in exposed conditions (KRIVOKHATSKY 2011, BADANO & PANTALEONI 2014). Larvae of *C. lineosa* were excavated from fine sand in the dry riverbed of the river Kanska and arid grassland along the river Vardar.

**Distribution:** Europe: Albania, Greece, Bulgaria, North Macedonia, southern Italy, Russia (Dagestan); Asia: Middle East, Caucasus, Afghani-

stan, Uzbekistan, Turkmenistan, Pakistan; Africa: Morocco, Tunisia, Egypt, Sudan, Djibouti (ASPÖCK et al. 2001, KRIVOKHATSKY 2011).

#### Tribe Myrmeleontini Latreille, 1802

##### *Myrmeleon formicarius* Linnaeus, 1767

Istochnen region: IS 1 (DEVETAK & ZEQRIRI 2018).

Jugoistochnen region: JI 3 (DEVETAK & ZEQRIRI 2018); JI13 (DEVETAK & ZEQRIRI 2018); JI15 (DEVETAK & ZEQRIRI 2018).

Jugozapaden region: JZ 2 (DEVETAK et al. 2015).

Pelagoniski region: PE 2; PE 3; PE 7 (DEVETAK & ZEQRIRI 2018); PE10 (KAČÍREK 2013).

Poloshki region: PO 1 (DEVETAK & ZEQRIRI 2018); PO 3; PO 5 (DEVETAK & ZEQRIRI 2018).

Skopski region: SK 6 (DEVETAK & ZEQRIRI 2018); SK14 (DEVETAK & ZEQRIRI 2018); SK15 (DEVETAK & ZEQRIRI 2018); SK16 (DEVETAK et al. 2015); SK18 (DEVETAK & ZEQRIRI 2018).

Vardarski region: VA17 (KAČÍREK 2013).

**Biology:** It is a widespread species in Europe. The larvae of *M. formicarius* are pit-builders often found in exposed conditions (STEFFAN 1975, ASPÖCK et al. 1980, GEPP 2010, KRIVOKHATSKY 2011, BADANO & PANTALEONI 2014). In North Macedonia, *M. formicarius* was collected at higher altitudes, from 840 to 1738 m a. s. l. Larvae built pits in light coniferous forests or grasslands.

**Distribution:** Palearctic.

##### *Myrmeleon noacki* Ohm, 1965

Pelagoniski region: PE10 (KAČÍREK 2013; this paper); PE11.

Skopski region: SK 4 (DEVETAK & ZEQRIRI 2018).

Vardarski region: VA 3; VA 8 (OHM 1965).

The original description of this species was based on the paratypes originating from North Macedonia (Vardarski region: Drenovo near Kavadarci; OHM 1965).

**Biology:** *M. noacki*-adults were collected in arid grasslands and low scrublands at altitudes 255-1000 m.

**Distribution:** Europe: Bulgaria, Greece, North Macedonia, Turkey; Asia: Anatolia.

##### *Myrmeleon inconspicuus* Rambur, 1842

Jugoistochnen region: JI 6.

Jugozapaden region: JZ 8.

Vardarski region: VA 6.

**Biology:** *Myrmeleon inconspicuus* is a widely distributed pit-building antlion in southern Europe occurring wherever a sandy substrate is present

(STEFFAN 1975, ASPÖCK et al. 1980, GEPP 2010, KRIVOKHATSKY 2011, BADANO & PANTALEONI 2014). In North Macedonia, *M. inconspicuus* was collected in dry grassland and transition of coniferous forest to grassland.

**Distribution:** Europe: Mediterranean countries, Austria, Poland, Czech Republic, Slovakia, Hungary, Serbia, North Macedonia, Bulgaria, Romania, Moldova, Ukraine, Russia, Kazakhstan (European part); Asia: Middle East, Caucasus, Kazakhstan; Africa: Morocco. The present study is the first record for North Macedonia. Despite the fact that it is a common species in warmer parts of Europe, it has been apparently overlooked in the country in the past.

### *Euroleon nostras* (Geoffroy in Fourcroy, 1785)

Skopski region: SK 8; SK12 (DEVETAK et al. 2015).

**Biology:** *Euroleon nostras* is one of the most widespread European antlions. The larvae are pit-builders and prefer sheltered places to dig their traps, easily colonizing man-made structures (STEFFAN 1975, ASPÖCK et al. 1980, GEPP 2010, KRIVOKHATSKY 2011, BADANO & PANTALEONI 2014). *Euroleon nostras*-larvae were collected in fine sand in rock overhangs in the canyon of the Treska and in abandoned stables (Katlanovo).

**Distribution:** Europe: Widespread; Asia: Anatolia and the larger Caucasus region; Africa: Morocco.

## Discussion

North Macedonia, with an area of 25,713 km<sup>2</sup>, is a relatively small country, representing only 3.9% of the area of the Balkan Peninsula. Surprisingly, of the 31 antlions species known in the Balkan Peninsula, 19 species are now listed in this small country. They represent 61% of the Balkan fauna.

In North Macedonia, no species of the tribe Acanthaclisini were found; at least, *Synclisis baetica* (Rambur) is expected in the country. Some antlions such as *Neuroleon* species, are simply overlooked because only a few specimens can be collected using the traditional collecting methods. The occurrence of *Neuroleon assimilis* and *N. tenellus* is particularly noteworthy. *Neuroleon assimilis* is a rare antlion and was only known for 8 places in Europe prior to this study (ASPÖCK et al. 1980, LETARDI & PANTALEONI 1996, TRÖGER 2003, BADANO & PANTALEONI 2014, DOBOSZ & POPOV 2018). Its collecting place in North Macedonia represents the most northwestern locality in the peninsula. Another rare antlion is *Neuroleon tenellus*; the locality in the central part of

the country is the northernmost in Europe, shifting the previously known border of its range by 600 km northwards (DEVETAK & ZEQRIRI 2018).

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