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OWL-FLY *LIBELLOIDES MACARONIUS* (SCOPOLI, 1763) IN SLOVENIA
AND IN THE NORTHWESTERN PART OF CROATIA (NEUROPTERA:
ASCALAPHIDAE)

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ABSTRACT

The distribution and biology of the European ascalaphid species *Libelloides macaronius* (Scopoli) in Slovenia, Croatian Istria and Quarnero is presented. With the aim to investigate the diet of the owl-fly species, the digestive tract contents were examined. Remains of aphids, bugs, cockroaches, beetles, neuropterans and dipterans were found.

Key words: *Libelloides macaronius*, owl-flies, Neuroptera, distribution, Slovenia, Istria, Quarnero, phoresy, diet

ASCALAFI *LIBELLOIDES MACARONIUS* (SCOPOLI, 1763) IN SLOVENIA,
ISTRIA E QUARNERO (NEUROPTERA: ASCALAPHIDAE)

SINTESI

L'articolo presenta un resoconto di distribuzione e biologia dell'Ascalafide europeo *Libelloides macaronius* (Scopoli) in Slovenia, Istria e Quarnero. Gli ascalafi sono predatori polifagi che si nutrono di afidi, cimici, scarafaggi, scarabei, neurotteri e diateri. L'articolo include anche note sulla predazione di ascalafi e sulla foresi.

Parole chiave: *Libelloides macaronius*, ascalafi, Neuroptera, distribuzione, Slovenia, Istria, Quarnero, foresi, alimentazione

INTRODUCTION

Owl-flies (Ascalaphidae) are medium-sized to large neuropterans, widely distributed in tropical and subtropical regions. About 400 species in ca. 70 genera are known (Aspöck et al., 2001). In Europe, 16 species have been recorded (Aspöck et al., 2001). In the northwestern part of the Balkan Peninsula, 3 species in 2 genera occur: *Deleproctophylla australis* (Fabricius, 1787), *Libelloides lacteus* (Brullé, 1832) (syn. *Libelloides ottomanus* /Germar, 1839/) and *Libelloides macaronius* (Scopoli, 1763) (Aspöck et al., 1980, 2001; Devetak, 1992, 1995, 1996).

Libelloides macaronius was described in Scopoli's *Entomologia carniolica* in 1763 as *Papilio macaronius*. Later, the species was placed in the genus *Ascalaphus* Fabricius, 1775, and in 1972, Tjeder placed the species in the genus *Libelloides* Schäffer, 1763. *Libelloides macaronius* is polycentric Ponto-Mediterranean element known from Central, Eastern and Southern Europe and from the Palearctic region of Asia (Aspöck et al., 1980; 2001). In the Balkan countries, the species is widely distributed (Devetak, 1992).

Adult and larval morphology of *L. macaronius* was thoroughly investigated. According to the high variabil-

ity in wing-coloration patterns, a few subspecies were described but their taxonomic status is still uncertain (Aspöck et al., 1980, 2001). The larva of *L. macaronius* was described by Pieper & Willmann (1980).

Owl-flies are diurnal predators able to fly at high velocities in pursuit of small insects. They grasp their prey in flight using strong legs, and mandibles enable them to feed even on strongly sclerotised insects. From the intestinal contents one can speculate on the food supply of the animal investigated.

Since 1965 and 1967, when Gogala & Michieli (1965) and Gogala (1967) published their papers on ultraviolet sensitivity of the ascalaphid superposition eyes, a series of papers elucidating the mechanisms involved in UV vision has been published (for review see Stušek et al., 2000; Drašlar & Wolfrum, 2001; Kral, 2002). This unique sensitivity of the ascalaphid eyes is the reason why the owl-fly species *L. macaronius* has become a well-known experimental animal (Fig. 2).

In the Republic of Slovenia, *L. macaronius* is treated as endangered species. The aim of our study is to present information on the biology and distribution of the owl-fly in Slovenia and in the northwestern part of Croatia.

MATERIAL AND METHODS

Dried or in alcohol preserved adults from insect collections in the following institutions were examined: Natural History Museum of Slovenia (Ljubljana), Slovenian Academy of Science and Art (Ljubljana), Croatian Natural History Museum (Zagreb) and D. Devetak's collection (Maribor). The owl-flies were collected by the following persons: J. Ahtik (JA), J. Carnelutti (JC), A. Čehić (AČ), D. Devetak (DD), M. Devetak (MD), M. Franković (MF), V. Furlan (VF), I. Hafner (IH), M. Hafner (MH), F. Janžekovič (FJ), M. Jež (MJ), M. Kaligarič (MK), K. Kirbiš (KK), B. Kmecl (BK), V. Lesjak (VL), I. Lešnik (IL), B. Mencinger (BM), F. Perović (FP), P. Pirš (PP), J. Staudacher (JSta), J. Stussiner (JStu), A. Šentjurs (AŠ), P. Tonkli (PT) and M. Zavec (MZ).

The wings of the owl-flies from Petrinje and Pomjan were measured and analysed using descriptive statistics. The insects were collected in June and July 1996.

To investigate the digestive tract content, 25 adults from Petrinje, preserved in 70% alcohol, were dissected and the intestine was isolated. The masticated food remains suspended in alcohol were mounted on glass slides and examined microscopically. A few preparations were stained with methylene blue. The best results were obtained without staining.

In the field, activity of the owl-flies was recorded with the Sony video camera recorder CCD-TR750E. The plant communities of the meadows near Petrinje were documented; for terminology of the species see Martinčič et al. (1999).

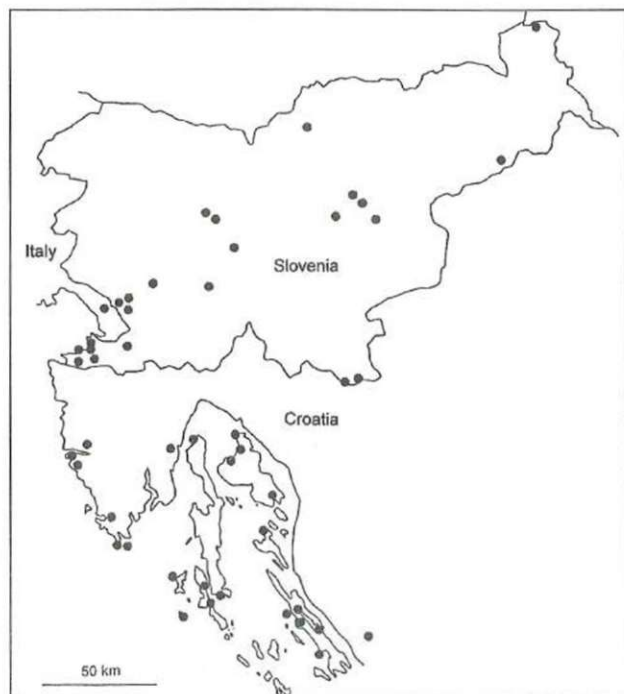


Fig. 1: Distribution of *L. macaronius* in Slovenia, Istria and Quarnero based on the owl-flies collected after 1950.

Sl. 1: Razširjenost metuljčnic *L. macaronius* v Sloveniji, Istri in v Kvarnerju glede na primerke, zbrane po letu 1950.

RESULTS

Distribution of *L. macaronius* in the northwestern part of the Balkan Peninsula

Literature records: Kačírsek (1998): the island of Krk: Baška, Jurandvor, Malinska, Njivice, Omišalj; Táborský (1936): the island of Krk; Táborský (1939): Šmarna gora.

Material examined (for the abbreviations used see Material and methods) (Fig.1):

Italy:

Trieste/Trst: Villa Opicina/Opčine, 26. VI. 1973 (PT).

Slovenia:

Ankaran, 27.-29. VII. 1982 (MZ); Bela krajina: Darnj, 4. VII. 1980 (DD); Bela krajina: Vinica, 5. VII. 1980 (DD); Cerknica, Menišija, 10. VII. 1966 (JC);



Fig. 2: Owl-fly *Libelloides macaronius* (Scopoli, 1763) in copula. (Photo: T. Makovec)

Sl. 2: Metuljčnica *Libelloides macaronius* (Scopoli, 1763) med parjenjem. (Foto: T. Makovec)

Dragonja, 17. VI. 1996 (DD, FJ, BM, PP); Goričko: Čepinci, 28. VI. 1997 (DD); Haloze: Cirkulane, 29. VI. 1997 (DD); Izola, VI. 1982 (MK); Koper, Srmin, VII. 2002 (MD); Krim, Gornji Ig, 7. VII. 1974 (PT); Kum, 2. VIII. 1918 (MH); Kurešček, Zapotok, 24. VII. 1921 (JStu); the surroundings of Laško, 30. VII. 1970 (IL); Laško, Govce, 6. VII. 1980 (IL); Laško, Šmohor, 11.-14. VII. 1990 (BK); Lisca, 10. VII. 1972 (JA); Ljubljana, along the Sava banks, 18. VI. 1932 (IH); Ludranski vrh, Najevnik (1000 m altitude), 27. VII. 1980 (MJ); Medvode, Preska, 25. VI. 1910, 1. VII. 1923, 29. VI. 1929, 22. VI. 1930 (MH); Nanos, 24. VII. 1983 (AŠ); Petrinje, nad Črnim Kalom, 12. VII. 1974 (DD), 14. VII. 1975 (DD), 16. VI. 1976 (DD), 26. VIII. 1980 (DD), 11. VII. 1982 (DD), 14.-18. VI. 1996 (DD, FJ, BM, PP), 20. VII. 1996 (AČ, KK, PP); Pod Stolom, 27. VII. 1919 (MH); Polhograjski Dolomiti: Grmada, 25. VII. 1982 (VF); Polhograjski Dolomiti: Topol, 19. VI. 1932 (JSta); Pomjan, 17. VI. 1996 (DD, FJ, BM, PP); Sežana, 22. VII. 1981 (DD); Sežana: Povir, 17. VIII. 1982 (DD); Sežana: Štorje, 22. VII. 1981 (DD); Sorško polje, Godeška Dobrava, 10. VI. 1923 (MH); Begunščica, 10. VIII. 1919 (MH).

Croatia - Istria:

Kamenjak, 12.-15. VII. 1996 (DD); Limski kanal, 16. VI. 1989 (DD); the island of Fenera, VII. 1996 (DD); Pula, 10.-15. VI. 1979, 6.-8. VII. 1983 (BK, AŠ); Rovinj, 4. VI. 1985 (DD); Rovinj, Valalta, 10. VI. 1988 (DD); Vozilići, 27. VI. 1974 (FP).

Croatia - Quarnero:

The island of Cres: Punta Križa, VI. 2002 (DD); the island of Cres, Uvala Banja, 5. VII. 1987 (MF); the island of Krk, Voz-Omišalj, 8. VI. 1938 (JSta); the island of Lošinj, VI. 1974 (VF), 7. VII. 1974 (PT); the island of Lošinj, Čunski, VII. 1974 (VF, PT), VII. 1987 (VF); the island of Lošinj: Nerezine, VI. 1999, VI. 2001, VI. 2002 (DD); the island of Pag, Caska, 23. VI. 1956, 5. VII. 1960; the island of Pag, Kolansko Blato, 11. VI. 1958; the island of Pag: Novalja, 29. VI. 1955; the island of Pag, Pag, VII. 1960, 15. VI. 1979 (VL); the island of Pag, Zaglav, VI. 1956; the island of Rab, Lopar, 21. VI. 1976 (DD); the island of Susak, 19. VI. 1962; the island of Unije, 4.-7. VII. 1964.

Length and width of the wings from Petrinje and Pomjan (Slovenia)

Means and standard deviations of length and width of the wings for both sexes and the results of F-test (ANOVA) comparisons of means between sexes are given in Table 1. Means of the males were found to be significantly smaller than in the females.

Tab. 1: Length and width of the wings of *L. macaronius* from Petrinje and Pomjan (in millimetres).**Tab. 1: Dolžina in širina kril metuljčnic *L. macaronius*, ujetih v Petrinjah in Pomjanu (v mm).**

		Petrinje		Pomjan		F-test	
		males n=53	females n=40	males n=8	females n=13	F _{1,112}	P
forewings	length	20.5 ± 0.5	23.5 ± 1.0	21.5 ± 1.0	23.0 ± 1.0	204.23	<0.0001
	width	6.5 ± 0.5	7.5 ± 0.5	7.0 ± 0.5	7.5 ± 0.5	161.88	<0.0001
hindwings	length	17.5 ± 0.5	19.5 ± 1.0	18.0 ± 1.0	19.5 ± 1.0	146.30	<0.0001
	width	6.5 ± 0.5	7.5 ± 0.5	7.0 ± 0.5	7.5 ± 0.5	159.81	<0.0001

Tab. 2: Insect fragments extracted from the digestive tract of *L. macaronius*.**Tab. 2: Delci žuželk iz prebavnega trakta metuljčnic *L. macaronius*.**

Insect order / suborder, family	structure / body part
Blattaria	Legs
Homoptera: Aphidoidea	complete aphids, legs
Hemiptera: Heteroptera	compound eyes, legs
Neuroptera: Chrysopidae	Antennae
Diptera	Legs
Coleoptera	antennae, mouthparts, chitinous plates

The digestive tract content

Well-chewed and partially digested insect fragments were found in the digestive tract (Figs. 5-9). In most cases it was impossible to determine the origin of the rest. Fragments of various body parts of different insect orders were found (Tab. 2). From two adults, fragments of plant tissues were isolated (Fig.10).

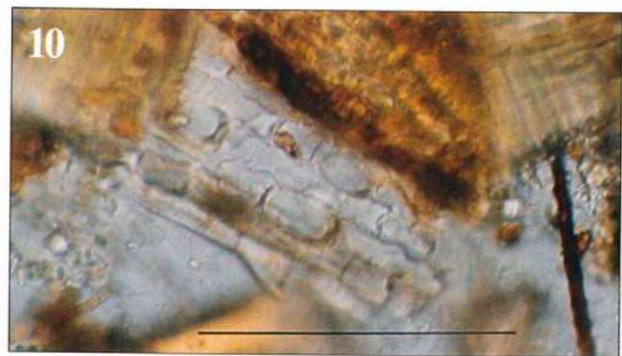
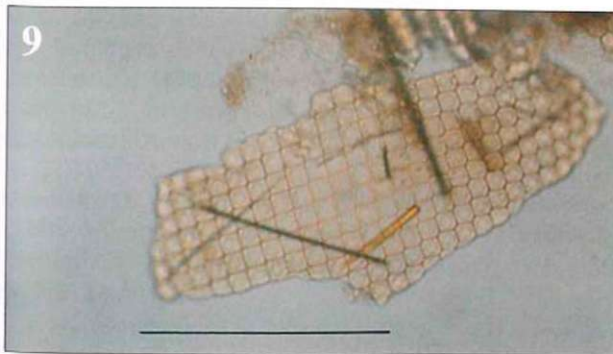
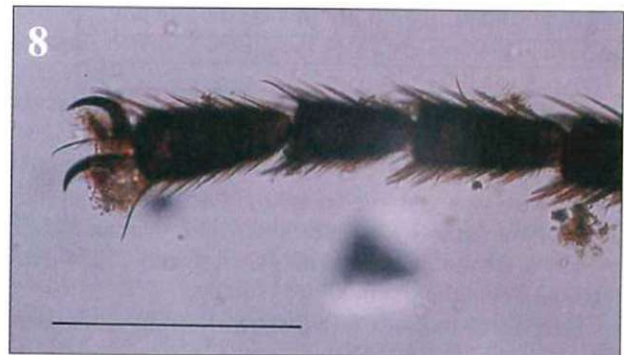
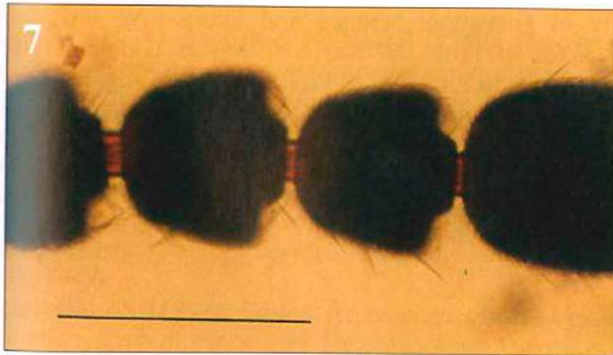
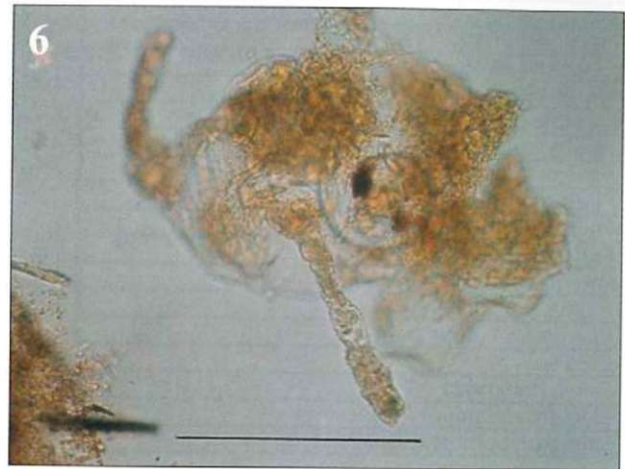
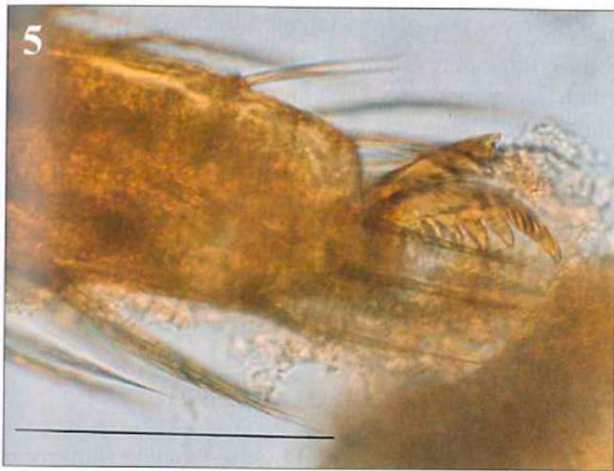
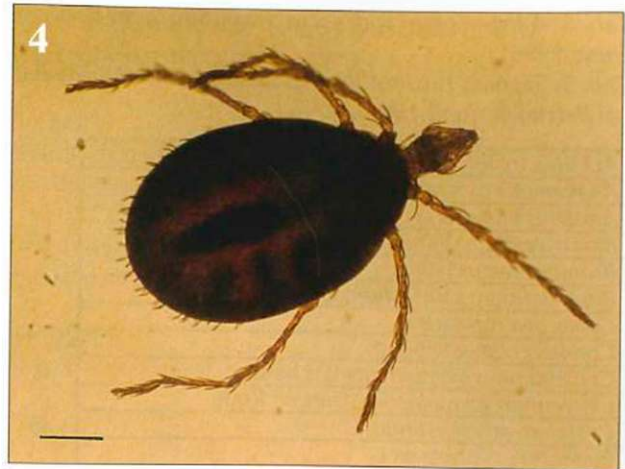
Remarks on the habitats

L. macaronius occurs in meadows, pastures and scrubs. In the Mediterranean part of Slovenia and Croatia, the owl-fly is often found in steppe with *Stipa* as a dominant grass genus.

In the surroundings of Petrinje (Karst edge/Kraški

rob), the adults were recorded in two habitats, in a scrub community and in grassland (Fig. 3). In the scrub, the dominant species were *Juniperus communis* and *Stipa pulcherrima*, and in grassland the characteristic and dominant species was *Bromus erectus*. Plant species occurring in the grassland at Petrinje in June 1996 are listed in Table 3. In the Petrinje habitats, insects of fifteen orders were recorded and most of them are a potential prey to *L. macaronius*. In The Petrinje meadows and scrubs, the following neuropteran species were also collected from low vegetation: *Semidalis aleyrodiformis* (Stephens), *Hemerobius gilvus* Stein, *H. handschini* Tjeder, *Chrysoperla lucasina* (Lacroix), *Chrysopa walkeri* McLachlan, *Ch. phyllochroma* Wesmael, *Ch. pallens* (Rambur), *Dichochrysa abdominalis* (Brauer) and *D. zelleri* (Schneider).

Fig. 3: Meadows near Petrinje, June 1996.**Sl. 3: Travniki v bližini Petrinj, junij 1996.****Fig. 4: A nymph of a mite from the family Erytraeidae. Scale bar = 200 µm.****Sl. 4: Ličinka pršice iz družine Erytraeidae. Merilo = 200 µm.****Fig. 5: A cockroach's tarsus with the pectinate claw (order Blattaria). Scale bar = 200 µm.****Sl. 5: Ščurkov tarsus z glavnikastim krempljem (red Blattaria). Merilo = 200 µm.****Fig. 6: Remainder of an aphid (order Hemiptera, Homoptera). Scale bar = 200 µm.****Sl. 6: Ostanek listne uši (red Hemiptera, Homoptera). Merilo = 200 µm.****Fig. 7: A fragment of the antenna (? order Coleoptera). Scale bar = 200 µm.****Sl. 7: Delček tipalke (? red Coleoptera). Merilo = 200 µm.****Fig. 8: Dipteran tarsal segments; the claws, empodium and pulvilli are recognized (order Diptera). Scale bar = 200 µm.****Sl. 8: Segmenti tarza dvokrilca, z dobro vidnimi kremplji, empodijem in pulvilli (red Diptera). Merilo = 200 µm.****Fig. 9: Corneal lenses of a bug's compound eye (order Heteroptera). Scale bar = 200 µm.****Sl. 9: Kornealne leče steničinega mrežastega očesa (red Heteroptera). Merilo = 200 µm.****Fig. 10: Fragments of plant tissues. Scale bar = 100 µm.****Sl. 10: Delci rastlinskih tkiv. Merilo = 100 µm.**



Tab. 3: A list of plant species in a meadow near Petrinje (June 1996).

Tab. 3: Seznam rastlinskih vrst, zabeleženih na travniku pri Petrinjah (junij 1996).

<i>Achillea millefolium</i> L.
<i>Anacamptis pyramidalis</i> (L.) L.C. Rich.
<i>Anthyllis vulneraria</i> L.
<i>Brachypodium pinnatum</i> (L.) P. Beauv.
<i>Bromus erectus</i> Huds.
<i>Buphthalmum salicifolium</i> L.
<i>Centaurea rupestris</i> L.
<i>Cotinus coggygia</i> Scop.
<i>Cynanchum vincetoxicum</i> (L.) Pers.
<i>Dorycnium germanicum</i> (Gremli) Rouy
<i>Eryngium amethystinum</i> L.
<i>Euphorbia cyparissias</i> L.
<i>Fraxinus ornus</i> L.
<i>Galium verum</i> L.
<i>Helleborus multifidus</i> Vis.
<i>Juniperus communis</i> L.
<i>Knautia illyrica</i> Beck
<i>Ligustrum vulgare</i> L.
<i>Linum tenuifolium</i> L.
<i>Melica ciliata</i> L.
<i>Pinus nigra</i> Arnold
<i>Plantago argentea</i> Chaix.
<i>Polygala nicacensis</i> Risso
<i>Potentilla tommasiniana</i> F. Schultz.
<i>Prunus mahaleb</i> L.
<i>Rhamnus saxatilis</i> Jacq.
<i>Rosa</i> sp.
<i>Salvia pratensis</i> L.
<i>Sanguisorba minor</i> Scop.
<i>Stipa pulcherrima</i> C. Koch
<i>Teucrium montanum</i> L.
<i>Teucrium chamaedrys</i> L.
<i>Thymus longicaulis</i> C. Presl.
<i>Tragopogon tommasinii</i> C.H. Schultz.
<i>Trinia glauca</i> (L.) Dum.

Notes on phoresy and spider predation

Phoresy was observed while collecting ascalaphids at Petrinje in June 1996. In one female *L. macaronius*, a nymph of a mite from the family Erytraeidae (Fig. 4) was recorded, clung to the owl-fly's hindleg.

Despite of the fact that the owl-flies are predators, they can easily become prey especially when resting on plants. In the field, they were observed while becoming a prey to birds and spiders. At Petrinje, an owl-fly male became a victim in June 1996 of an unidentified jumping spider (Salticidae).

DISCUSSION

Owl-fly *Libelloides macaronius* is widely distributed in Istria and Quarnero, and occurs also in certain warmer places in Slovenia. This ascalaphid prefers open habitats - meadows, pastures and scrub communities with low bushes. Grassland is inhabited by a number of insects from 15 orders that serve as potential prey of *L. macaronius*.

Adults are polyphagous daytime active predators, highly adapted for capturing prey in flight. Ascalaphids are able to prey upon sclerotised insects because of their strong jaws. This ability is contrary to some green lacewings (Chrysopidae), which are specialised to feed on soft-bodied insects such as aphids (Stelzl, 1991; Stelzl & Devetak, 1999), but resembles the feeding habits of adult antlions (Myrmeleontidae) (Stelzl & Gepp, 1990; Devetak, 1996, 1997). In the digestive tract of *L. macaronius*, fragments of aphids, bugs, cockroaches, beetles, green lacewings and dipterans were recorded. These findings resemble the prey-spectrum in closely related species *Libelloides coccajus* (Denis & Schiffermüller, 1763), where dipterans, coleopterans and hymenopterans are predominant prey (Stelzl, 1991). In both owl-fly species, fragments of plant tissues were also found. This plant material probably originated from the intestinal content of the herbivorous insects captured by the ascalaphids.

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METULJČNICA *LIBELLOIDES MACARONIUS* (SCOPOLI, 1763) V SLOVENIJI
IN SEVEROZAHODNEM DELU HRVAŠKE (NEUROPTERA: ASCALAPHIDAE)

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POVZETEK

Za navadno metuljčnico, *Libelloides macaronius* (Scopoli, 1763), navajamo podatke o biologiji in razširjenosti v Sloveniji in severozahodnem delu Hrvaške. Vrsta je v mediteranskem območju splošno razširjena, v celinskem delu Slovenije pa živi ponekod v toplejših travnatih in grmiščinih habitatih. Metuljčnica poseljuje travnike in grmišča; v mediteranskem območju je za travniške habitate značilna trava iz rodu *Stipa*. Na osnovi vsebine prebavila smo sklepali o prehranskem spektru vrste. V preiskanih metuljčnicah smo našli ostanke listnih uši, stenic, ščurkov, hroščev, mrežekrilcev in dvokrilcev. Zabeležili smo primer forezije, ko se je pršica iz družine *Erytraeidae* transportirala na samici. Metuljčnice so plen ptic in pajkov.

Ključne besede: *Libelloides macaronius*, metuljčnice, Neuroptera, razširjenost, Slovenija, Istra, Kvarner, forezija, prehrana

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