ACTA ENTOMOLOGICA SLOVENICA

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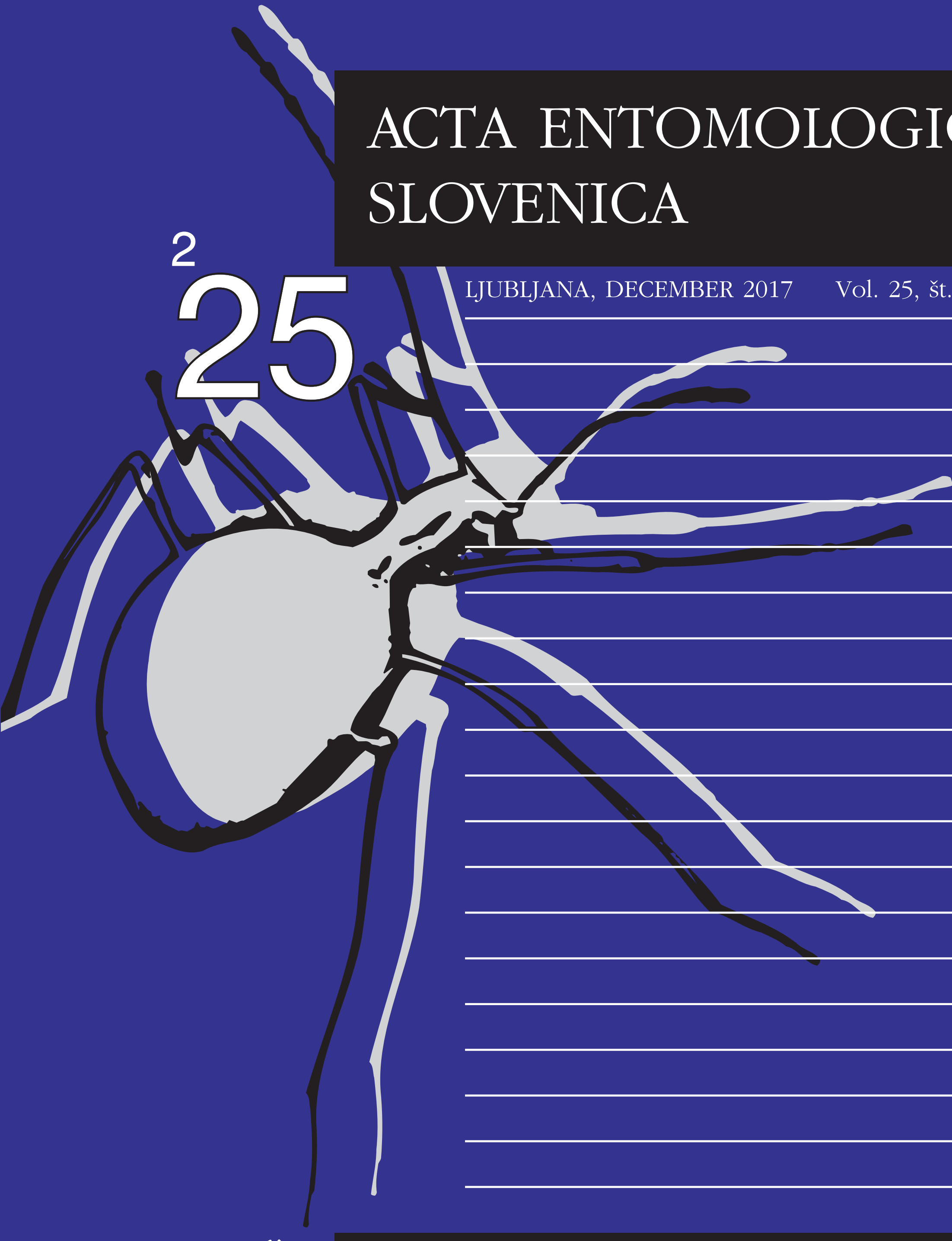
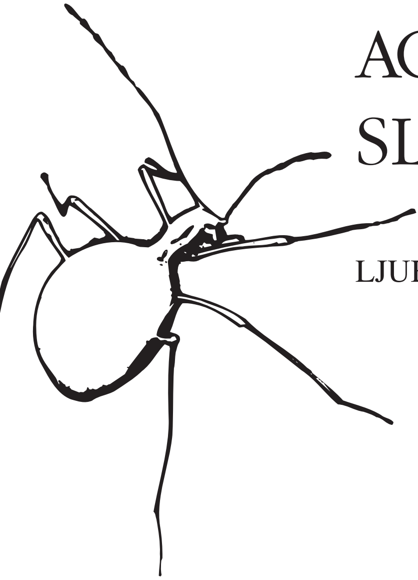
LJUBLJANA, DECEMBER 2017 Vol. 25, št./No. 2



PRIRODOSLOVNI MUZEJ SLOVENIJE
SLOVENSKO ENTOMOLOŠKO DRUŠTVO
ŠTEFANA MICHIELIJA

ISSN 1318-1998 CODEN: AESLFM



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Revija Slovenskega entomološkega društva Štefana Michielija
in Prirodoslovnega muzeja Slovenije
Izhaja dvakrat letno / Issued twice a year

ISSN 1318-1998
CODEN: AESLFM
UDC (UDK) 595.7(051)

Izdajatelja / Publishers

Slovensko entomološko društvo
Štefana Michielija
ZRC SAZU, Novi trg 5
SI-1000 Ljubljana

Prirodoslovni muzej Slovenije
Prešernova 20, p.p. 290
SI-1001 Ljubljana

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letnik/Vol. 25, št./No. 2, 2017
Tisk / Printed by: Trajanus, d.o.o., Kranj
Ljubljana, december 2017

http://www.pms-lj.si/si/o-nas/arhiv-publikacij/acta-entomologica-slovenica

Povzeto v / To be abstracted in: The Zoological Record, CAB Abstracts

Revijo dobivajo člani Slovenskega entomološkega društva Štefana Michielija
(članarina 20 EUR)
Cena posamezne številke je 8,50 EUR
Zamenjava je zaželjena / Exchanges appreciated
Publikacija je natisnjena s pomočjo Javne agencije za raziskovalno dejavnost R Slovenije.
Uredniško delo podpira Ministrstvo za kulturo R Slovenije.

Vsebina / Contents

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ACTA ENTOMOLOGICA SLOVENICA

LJUBLJANA, DECEMBER 2017 Vol. 25, št. 2: 123–140

FAVNA JAMSKIH HROŠČEV (COLEOPTERA) KRIMA (DINARIDI, OSREDNJA SLOVENIJA): ZGODOVINA RAZISKANOSTI IN FAVNISTIČNA IZOLIRANOST

Andrej Kapla, Al Vrezec

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Izvleček - Zaradi bližine Ljubljane so bile jame na Krimu, še posebej pa jama Velika Pasica (kat. št. 75), že od sredine 19. stoletja deležne raziskav jamskih hroščev, ki jih je začel Ferdinand Schmidt. Jama Velika Pasica je klasično nahajališče kar petim jamskim taksonom hroščev od skupno desetih vrst, ki poseljujejo območje Krima. Podzemlje Krimskega hribovja s Krimom in Mokrcem je, kot kaže jamska favna hroščev, dokaj izolirano glede na okoliško hribovje. Dlakavi brezokec *(Anophthalmus hirtus)* je stenendemična vrsta območja, prav tako še nadaljnja dva taksona, *Anophthalmus schmidti motschulskyi* in *Typhlotrechus bilimeki hacqueti*. V članku so predstavljene vse znane vrste jamskih hroščev, ki so bile najdene na območju Krima: *Laemostenus schreibersi, Typhlotrechus bilimeki hacqueti, Anophthalmus hirtus, Anophthalmus schmidti motschulskyi, Anophthalmus scopolii, Aphaobius milleri, Bathyscia montana, Bathysciola sylvestris, Bythoxenus subterraneus* in *Troglorhynchus anophthalmus*. Primer visoke stenendemičnosti jamske favne hroščev Krima kaže na potrebo po regionalni prioritizaciji za potrebe ohranjanja evropske in globalne biodiverzitete.

Ključne besede: Dinaridi, podzemeljska favna, Carabidae, Leiodidae, Staphylinidae, Curculionidae, kras, endemizem

Abstract – CAVE BEETLE FAUNA (COLEOPTERA) OF MT. KRIM (DINARIC ALPS, CENTRAL SLOVENIA): HISTORY OF RESEARCH AND FAUNISTIC ISOLATION

Cave beetle studies in caves of Mt. Krim, and in the cave Velika Pasica especially, were carried on since mid 19th century, starting with Ferdinand Schmidt, due to close proximity of the Ljubljana city. The cave Velika Pasica is *locus typicus* for five cave beetle taxa. Altogether ten cave beetle species are known to inhabit the area of Mt. Krim. According to cave beetle fauna, it seems that the area of Mts. Krim and Mokrec represents quite isolated subterranean environment with one endemic species *Anophthalmus hirtus* and further two endemic beetle taxa *Anophthalmus schmidti motschulskyi* and *Typhlotrechus bilimeki hacqueti*. In the paper all known cave beetle species that were found in the area of Mt. Krim are presented: *Laemostenus schreibersi, Typhlotrechus bilimeki hacqueti, Anophthalmus hirtus, Anophthalmus schmidti motschulskyi, Anophthalmus scopolii, Aphaobius milleri, Bathyscia montana, Bathysciola sylvestris, Bythoxenus subterraneus* and *Troglorhynchus anophthalmus*. High level of stenoendemism of subterranean beetle fauna of Mt. Krim calls for urgent regional prioritization for biodiversity conservation at European and global level.

KEY WORDS: Dinarids, subterranean fauna, Carabidae, Leiodidae, Staphylinidae, Curculionidae, karst, endemism

Uvod

Pestrost favne jamskih hroščev (Coleoptera) v Sloveniji je ena največjih na svetu (Culver s sod., 2006). V jamah z večjim številom prednjačita predvsem dve družini hroščev, krešiči (Carabidae) in zemljarji (Leiodidae), ostale družine, kot so kratkokrilci (Staphylinidae) in rilčkarji (Curculionidae), pa so vsaj pri nas zastopane le z manjšim številom vrst (Novak, 2005). Čeprav je ekologija jamskih hroščev slabo poznana, gre vsaj pri jamskih krešičih za dokaj dolgožive vrste, ki živijo v razmeroma majhnih populacijah (Rusdea, 1999). Pretrtost karbonatne kamnine, ki se poleg večjih jamskih prostorov in razpok, razveja še v sistem manjših razpokic in prostorčkov, daje pravzaprav jamskim hroščem nesluteno velik tridimenzionalni življenjski prostor (Giachino & Vailati 2006). Ta je precej večji kot površinski, ki ima v primerjavi s podzemljem neprimerno manjše prostorske razsežnosti. Kljub temu pa troglobionte prav ta prostor omejuje. Na spremenljive ekološke razmere zunanjega okolja so troglobionti preobčutljivi oziroma so na jamsko okolje povsem morfološko in fiziološko prilagojeni (Simčič s sod. 2005). Kjer pa ta podzemeljska okolja preseka kaka geološka prelomnica ali rečna dolina, je to za troglobionte prevelika fizična ovira, da bi jo zmogli preiti. Tako ostanejo vrste ujete na posameznih kameninskih otokih, zaradi česar je tekla speciacija ali nastajanje novih vrst na relativno majhnem, a izjemno razgibanem podzemlju Slovenije toliko hitreje kot drugod. Nič presenetljivega torej, da se je Slovenija izkazala za vročo točko Evrope glede na število podzemeljskih vrst hroščev, med katerimi so še zlasti vrstno pestri podzemeljski krešiči (Zagmajster s sod., 2008).

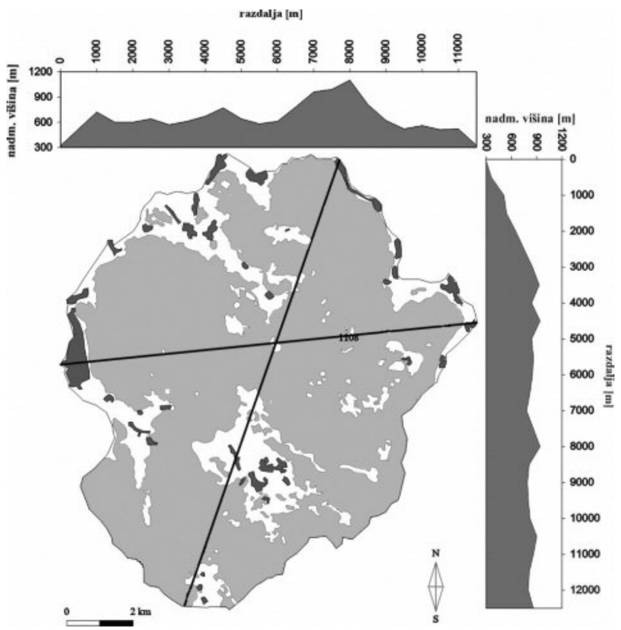
V prispevku obravnavava pestrost favne jamskih hroščev na primeru Krimskega hribovja pri Ljubljani. Ta velika gozdnata in zakrasela gora, ki se pne nad južnim robom Ljubljanskega barja, je bila zaradi bližine Ljubljane doslej deležna nekaj več biološke raziskovalne pozornosti. Podrobneje je bila na gori obdelana favna deževnikov (Lumbricidae; Hribar, 1997), ceponožnih rakov (Copepoda; Brancelj, 2002), strig (Lithobiomorpha; Kos, 1988), hroščev (Coleoptera; Furlan, 1988, Pirnat, 2001), ptic (Aves; Vrezec, 2000) in sesalcev (Mammalia; Kryštufek, 1980, 1982). Navkljub številnim krimskim jamam, so bile raziskave jamskega sveta na Krimu večinoma usmerjene v jamo Velika Pasica (ali Velika Pasjica) pri Gornjem Igu, iz katere je bilo opisano veliko novih vrst za znanost. V zadnjem času smo bili priča zlasti odkritju izjemne biotske pestrosti favne ceponožnih rakov; kar 12 vrst je bilo do danes najdenih v tej jami (Brancelj, 2002), med njimi tudi vrsta *Morariopsis dumonti*, za katero je ta jama edino do sedaj znano nahajališče (Brancelj, 2000). Da bi podrobneje raziskali ekološke značilnosti tega izjemnega jamskega okolja v Veliki Pasici že od leta 2006 potekajo intenzivne biološke in hidrografske raziskave, dostop v jamo pa je danes omejen (Brancelj in Vrezec, 2006; Wei Liu in Brancelj, 2014; Wei Liu s sod., 2014). Odkrivanja in raziskave jamskih hroščev imajo na Krimu že precej starejšo zgodovino. V prispevku podajava zgodovinski pregled raziskovanj krimske favne jamskih hroščev ter njeno pestrost.

Opis območja

Krim je del Velike notranjske planote, ki se deli na štiri skupine: Rakitniško planoto s Krimskim hribovjem (SZ), Vidovsko planoto, Bloke in Potočansko višavje (JV). Območje Krimskega hribovja, Vidovske planote in Blok predstavlja enoten karbonatni blok, sestavljen v glavnem iz mezozojskih kamenin. Krim je planotasta gora, katere višinski razpon sega od 290 m (rob Ljubljanskega barja) do 1107 m (vrh Krima), večji del planote pa se razteza na nadmorski višini med 800 in 850 m, kar je posledica učinka pliocenskega uravnavanja (slika 1). Kljub temu so se ohranili nekateri višji vrhovi. Na območju Krima je najvišji vrh Krim (1107 m), višji vrhovi so še Malinovec (1106 m), Kamenica (1050 m) in Koren (1005 m). Vrh Krima je iz jurskega apnenca in dolomita (Miler in Pavšič, 2008).

Območje Krima je del dinarskega krasa s številnimi jamami. Gotovo sta najbolj znani Velika (kat. št. 75) in Mala Pasica (kat. št. 76) pri Gornjem Igu. Na Krimu je sicer po zadnji verziji Katastra jam Slovenije iz leta 2013 poznanih 88 jam; od tega 44 brezen, 22 jam z brezni, 17 vodoravnih jam in 5 bruhalnikov oziroma ponorov, vključno s Podpeškim jezerom (kat. št. 7303). Če primerjamo enako veliko površino Krima z Ljubljanskim vrhom, je na Krimu relativno malo jam (Staut in Čekada, 2006). Vzrok temu je verjetno večja prisotnost dolomita (Miler in Pavšič, 2008).

Površinski vodotoki so z močno erozijo ustvarili tesne, globoko vrezane obrobne doline in debri, ki so ena od poglavitnih značilnosti Velike notranjske planote. Na obeh straneh Krima sta dve takšni, do 500 m globoko vrezani dolini: Iški Vintgar na vzhodni in Borovniška dolina na zahodni strani. Iški Vintgar, ki ga je izdolbla reka Iška, ločuje Krim od Mačkovca z Mokrcem (1059 m). Borovniška dolina z Borovniškim Peklom, ki jo je izdolbla reka Borovniščica, pa loči Krim od Pokojiške planote z Ljubljanskim vrhom (819 m). Na severu Krim obroblja južni rob Ljubljanskega barja, na jugu prehaja prek Rakitniške planote v Vidovsko in Bloško planoto. Na zahodu Krima je še ena dolina, ki jo je izdolbla reka Prušnica. Krimsko hribovje je malo poseljeno območje, saj spada med ene največjih sklenjenih gozdnih kompleksov v Sloveniji (Melik, 1959).



Slika 1: Obravnavano območje Krima z dvema reliefnima presekoma (sever-jug, vzhod-zahod). Svetlo sivo je označen gozd, temno sivo naselja, belo pa negozdne, večinoma travniške površine (risba: Milijan Šiško).

Povprečna letna temperatura zraka na Krimu se giblje med 8 in 10°C (Fridl s sod., 1998). Povprečno pade v letu 2000 do 3000 mm padavin. Po podatkih za Ljubljano pade največ padavin v poletnih mesecih (prek 400 mm), ko je tudi največ deževnih dni (prek 30 dni). Najmanj padavin pade pozimi (okoli 250 mm), medtem ko število deževnih oziroma snežnih dni (okoli 25 dni) pozimi sovpada z jesenjo, ko pade prek 350 mm padavin. Spomladi je število deževnih dni podobno poletnim mesecem (okoli 30 dni), vendar pade manj padavin (okoli 300 mm) (Furlan, 1988; Fridl s sod., 1998).

Na Krimu prevladujejo predvsem severne oziroma osojne ekspozicije, kar je verjetno posledica bolj strmega severnega in bolj položnega južnega pobočja. Večji del Krima pokriva gozd, povečini mešana gozdna združba dinarskega bukovega gozda z jelko (*Omphalodo-Fagetum* s. lat.). Jase oziroma negozdne čistine ne presegajo 22 %. Negozdne površine so manjše in razdrobljene, večje pa so v okolici naselij (slika 1).

Po naravnogeografski regionalizaciji Slovenije spada območje Krima v dinarski svet in sicer v območje Krimskega hribovja in Menišije (Fridl s sod., 1998) in v dinarsko fitogeografsko regijo (Martinčič in Sušnik, 1984), glede na zoogeografsko razdelitev Slovenije pa v kraško (dinarsko) regijo oziroma v kraško-predpanonsko podregijo (Mršić, 1997) oziroma alpsko-dinarsko regijo (Sket s sod., 2003).

Zgodovina raziskav jamske favne hroščev na Krimu

Raziskave jamskih hroščev so se v svetu pričele šele z letom 1832, ko je Ferdinand Schmidt opisal prvega jamskega hrošča drobnovratnika *(Leptodirus hochenwartii)* iz Postojnske jame (Polak, 2005). Schmidt je svoje pionirsko delo na področju raziskav jamskih hroščev osnoval tudi na raziskavah jamske favne Krima. Sredi 19. stoletja je namreč kot prvi entomolog obiskal jamo Veliko Pasico, iz katere je bilo po njegovi zaslugi opisanih kar pet taksonov jamskih hroščev. Leta 1853 je Jakob Sturm po Schmidtovih primerkih iz Velike Pasice opisal dva krešiča, vrsto *Anophthalmus hirtus* in podvrsto *Typhlotrechus bilimeki hacqueti*, leta 1855 je sam Schmidt opisal še kapljičarja *Aphaobius milleri* in leta 1860 krešiča podvrste *Anophthalmus schmidti motschulskyi*. V letu 1859 pa je po Schmidtovih primerkih dobila svoje mesto v svetovni znanosti še pselafida *Bythoxenus subbterraneus*, ki jo je opisal Viktor Ivanovič Motschulsky (Motschulsky 1859, Schmidt 1855 & 1860, Sturm 1853).

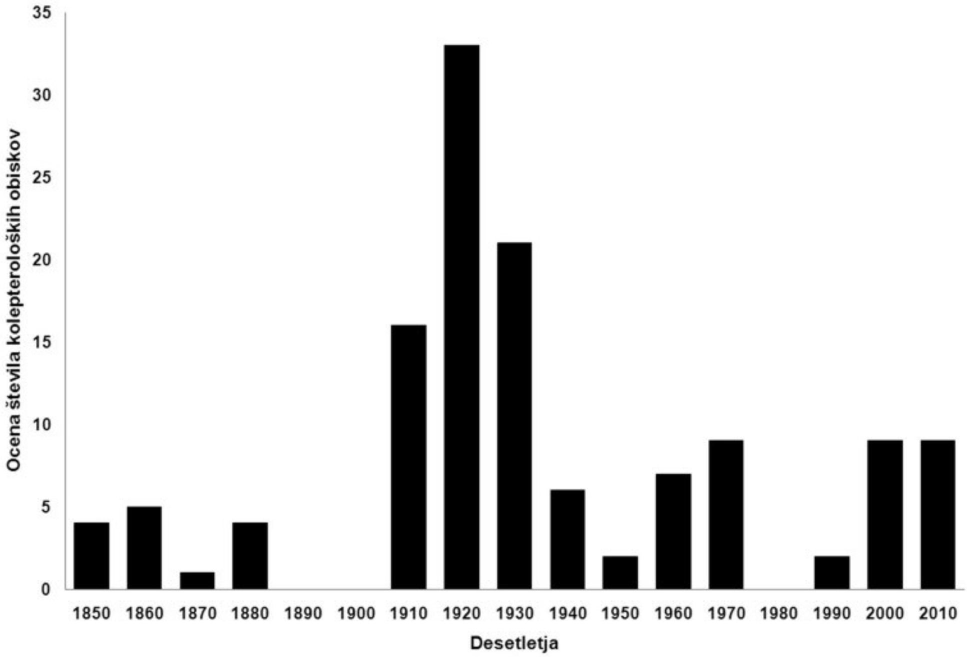
Jama Velika Pasica je ostala s stališča favne jamskih hroščev vse do danes najbolj obiskana in raziskana jama na Krimu (slika 2). Več kot polovica vseh zbranih podatkov o jamskih hroščih na Krimu je bila zbranih v Veliki Pasici (tabela 1). V manjši meri so bile koleopteroloških raziskav deležne še nekatere druge krimske jame (zapisana je navedba prvega koleopterološkega obiska): Mala Pasica (kat. št. 76; Nikolaj Hoffmann leta 1858; Hoffman 1858), Benkotova jama (kat. št. 325; Gustav Joseph leta 1871), Ledenica pri Planinci (kat. št. 77; Gustav Joseph leta 1881), Kevderc pri Planinci (kat. št. 525; Jožef Staudacher leta 1917), Golobinka pri Borovnici (kat. št. 753; Jožef Staudacher leta 1918) in Brezno v Lipovcah (kat. št. 524; Danilo Cej in Žarko Vrezec leta 1995). Najbolj intenzivne so bile raziskave v prvi polovici 20. stoletja (slika 3), ko je zlasti Veliko Pasico obiskala vrsta takrat uglednih raziskovalcev hroščev in speleobiologov, denimo Alfonz Gspan, Roman Kenk, Ljudevit Kuščer, Giuseppe Müller, Egon Pretner, Albin Seliškar in Jožef Staudacher. Kasneje so bile raziskave manj intenzivne. V pregledu krešičev (Carabidae) Krima je Irena Furlan (1988) zabeležila tri vrste jamskih krešičev, *Typhlotrechus bilimeki hacqueti, Anophthalmus hirtus* in *A. schmidti motschulskyi*. Pomemben prispevek k poznavanju krimske jamske koleopterofavne je bila tudi raziskava edafskih oziroma talnih vrst hroščev, ki je potrdila tudi prisotnost nekaterih sicer v jamah na Krimu izjemno redkih vrst; med njimi za območje novo vrsto brezokca *Anophthalmus scopolii* (Pirnat 2001).

Od 88 jam na Krimu jih je bilo s stališča favne hroščev raziskanih zgolj sedem, oziroma le 8%. Dobro raziskane, z več kot 10 zbranimi podatki, so le Velika Pasica (kat. št. 75), Kevderc pri Planinci (kat. št. 525), Ledenica pri Planinci (kat. št. 77) in Benkotova jama (kat. št. 325), ki so tudi najlažje dostopne jame. Kljub bogati zgodovini raziskav in bližini prestolnice, ostaja podzemlje Krima relativno slabo raziskano. Temu verjetno botruje dejstvo, da je večina večjih in globljih jam brezen, katerih so se raziskovalci v preteklosti izogibali, kar pa z moderno vrvno tehniko ni več ovira. Smiselno bi bilo torej zapolniti vrzeli v poznavanju podzemne entomofavne, še posebej na območju ene od zibelk speleobiologije, na Krimu. Žal pa so tako Velika Pasica kot nekatere ostale krimske jame pritegnile v preteklosti tudi pozornost različnih zbiralcev, katerih delovanje na Krimu ni dokumentirano, primerki pa so razpršeni po privatnih in javnih zooloških zbirkah po Evropi.

Tabela 1: Pregled deleža do sedaj zbranih podatkov o jamskih hroščih na Krimu po jamah (n=133 podatkov).

Kat. št.	Ime jame	Delež znanih podatkov o hroščih [%]
75	Velika Pasica	60,1
525	Kevderc pri Planinci	9,8
77	Ledenica pri Planinci	9,0
325	Benkotova jama	7,5
76	Mala Pasica	6,0
753	Golobinka pri Borovnici	5,3
	Krim - izven jame	1,5
524	Brezno v Lipovcah	0,8

Slika 2: Jama Velika Pasica (kat. št. 75) je najbolj raziskana jama s stališča favne hroščev na Krimu in predstavlja klasično nahajališče kar petim taksonom jamskih hroščev (foto: Al Vrezec).



Slika 3: Ocena intenzivnosti raziskav jamske favne hroščev oziroma koleopteroloških obiskov jam na Krimu glede na zbrane podatke o jamskih hroščih.

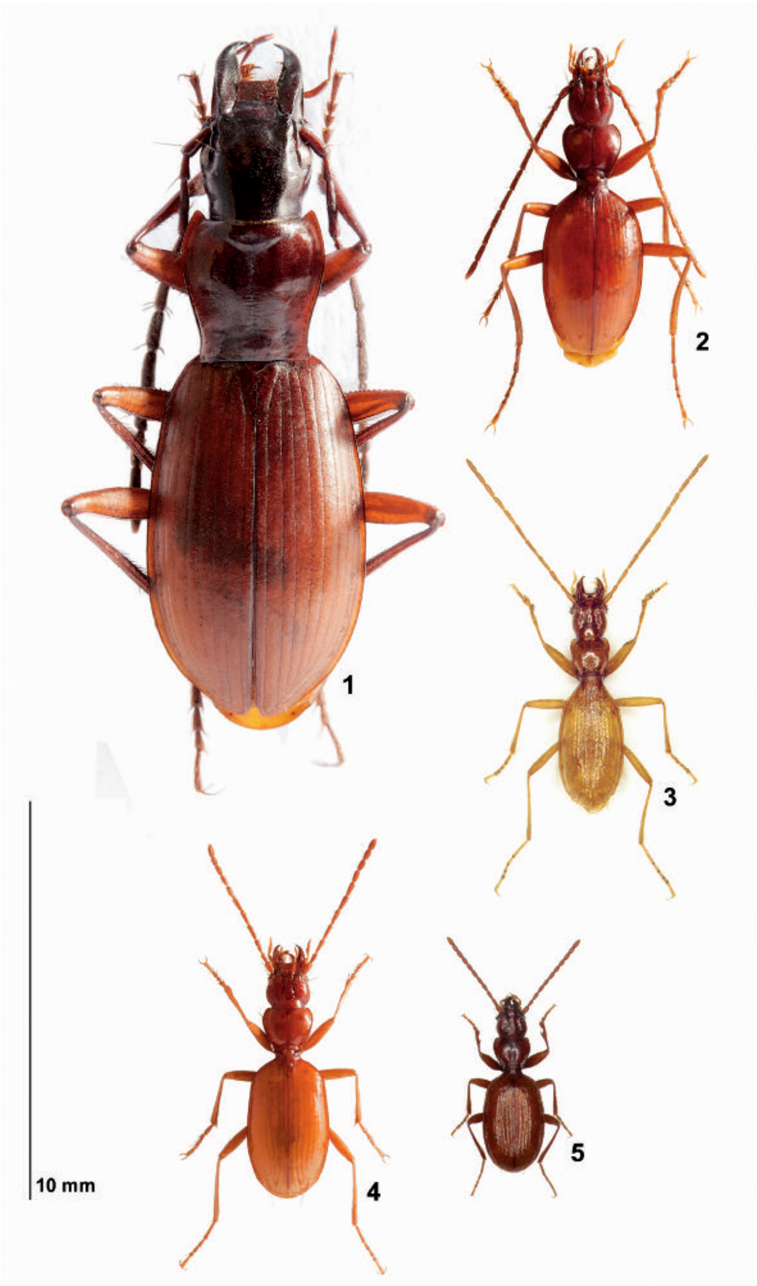
Pregled vrst jamskih hroščev Krima

Trenutno je s Krima znanih deset vrst hroščev, ki se redno pojavljajo v jamah oziroma imajo izražene troglomorfne značilnosti. V jamah na Krimu živijo vrste iz štirih družin hroščev: krešičev (Carabidae), zemljarjev (Leiodidae), kratkokrilcev (Staphylinidae) in rilčkarjev (Curculionidae). Med njimi o krešiču vrste *Lemostenus schreibersi* na Krimu poročamo prvič.

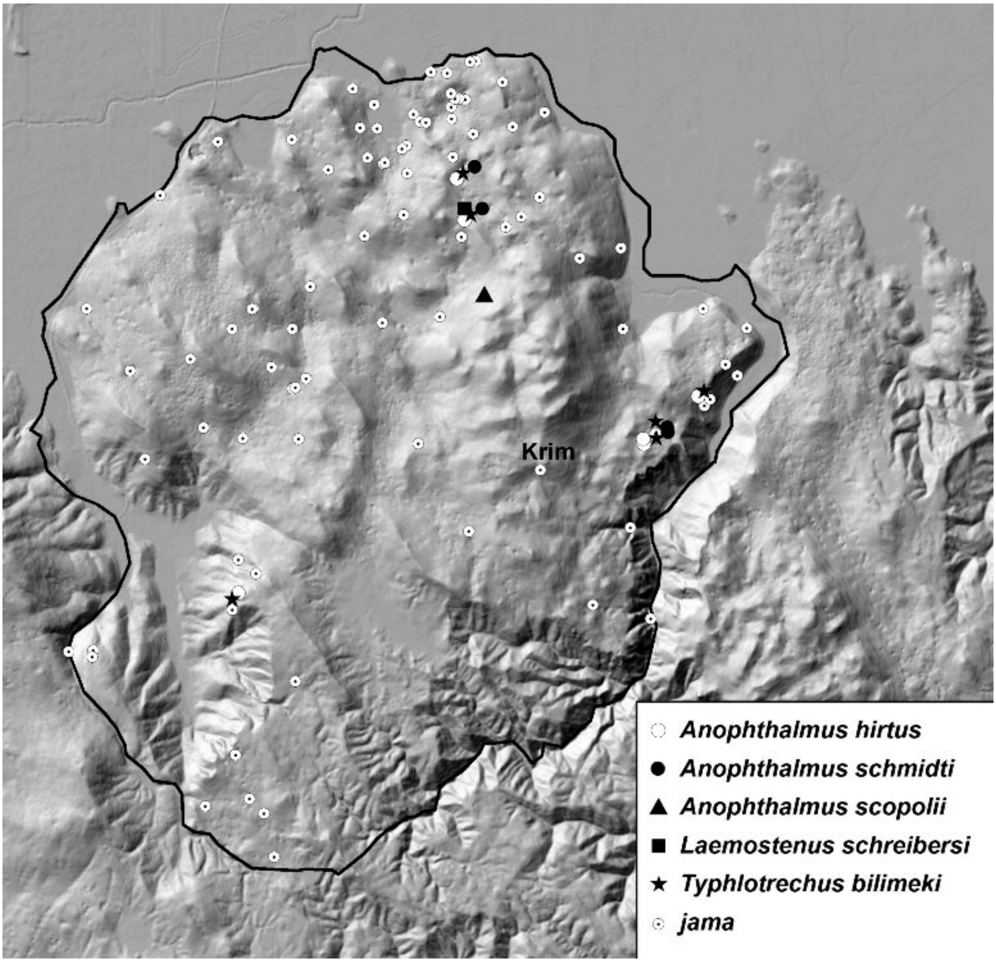
Krešiči (Carabidae)

Laemostenus schreibersi (Küster, 1846)

Krešič *Laemostenus schreibersi* je največja vrsta krešiča (slika 4), ki ga najdemo v jamah Slovenije. Opisan je bil po primerkih iz Postojnske jame (Casale, 1988). Gre za troglofilno vrsto, kar se kaže z delno pigmentiranostjo in majhnimi, ne popolno zakrnelimi očmi. Poseljuje zlasti vhodne dele jam, v primerjavi z drugimi jamskimi krešiči ga pogosto najdemo v zelo visokem številu (Vrezec in Kapla, 2010). Zlasti v organsko bogatih jamah je zelo številčen, kjer pleni druge manjše hrošče in nevretenčarje (Casale, 1988). Vrsta je tudi relativno dolgoživa, saj je bil najstarejši do sedaj znani ujeti primerek star najmanj osem let (Rusdea, 1999). Krešič *L. schreibersi* je razširjen od Hrvaške in Italije prek Slovenije do Avstrije in ni vezan samo na kras.



Slika 4: 1 – *Laemostenus schreibersi*, 2 – *Typhlotrechus bilimeki hacqueti*, 3 – dlakavi brezokec (*Anophthalmus hirtus*), 4 – *Anophthalmus schmidti motschulskyi*, 5 – Scopolijev brezokec (*Anophthalmus scopolii*) (foto: Andrej Kapla).



Slika 5: Razširjenost jamskih vrst krešičev (Carabidae) na Krimu glede na do sedaj zbrane podatke kaže na dokaj skromno entomološko raziskanost velike večine krimskih jam. Sive točke so jame brez podatkov (risba: Andrej Kapla).

Med drugim ga najdemo v zakloniščih in rudniških rovih na Pohorju ter Kozjaku. Navkljub njegovi siceršnji številčnosti in razširjenosti, pa je, kot kažejo zbrani podatki, na Krimu presenetljivo redek in maloštevilen. Po doslej zbranih podatkih smo ga na Krimu prvič našli šele leta 2001 in sicer samo v jami Kevderc pri Planinci (kat. št. 525; slika 5).

***Typhlotrechus bilimeki hacqueti* (Sturm, 1853)**

Typhlotrechus bilimeki hacqueti (slika 4) je robustna vrsta, brez oči, z debelejšim hitinskim tegumentom. Živi pod kamni in v vlažni stelji na vhodnih delih jam, kjer je več organskega materiala, proti notranjosti jam pa se njegova številčnost zmanjšuje.

Prvič je na Krimu vrsto našel Ferdinand Schmidt v jami Velika Pasica. Vrsta poseljuje Dinaride od Slovenije do Bosne (Drovenik in Peks, 1999), podvrsta *T. b. hacqueti* pa je endemit Krima in Mokreca (Jeannel, 1928). Na Krimu je to dokaj razširjena vrsta (slika 5).

***Anophthalmus hirtus* (Sturm, 1853)**

Dlakavi brezokec (*Anophthalmus hirtus*) je visoko specializirana, troglobiontska vrsta, popolnoma prilagojena na življenje v podzemlju. Ima podaljšano in sploščeno telo, dolge noge in tipalke, dolge čutilne dlake ali trihobotrije ter popolnoma zakrnele oči (slika 4). Vrsto je v jami Velika Pasica prvič našel Ferdinand Schmidt, po čigar primerkih je bil dlakavi brezokec tudi opisan. Dlakavi brezokec je endemit Krima in Mokreca, kjer je znan le iz nekaj jam (75 - Velika Pasica, 76 - Mala pasica, 77 - Ledenica pri Planinci, 325 - Benkotova jama, 353 - Brezno na Skedenici, 358 - Jama pri Riži, 525 - Kevderc pri Planinci, 753 - Golobinka pri Borovnici) (Daffner, 1996; slika 5).

***Anophthalmus schmidti motschulskyi* (Schmidt 1860)**

Tudi podvrsta Schmidtovega brezokca *Anophthalmus schmidti motschulskyi* (slika 4) je bila opisana po primerkih, ki jih je zbral Ferdinand Schmidt v Veliki Pasici. Vrsta je bila najprej najdena v Predjamskem sistemu (kat. št. 734) pri Postojni, od koder je bila leta 1844 tudi opisana kot prva vrsta rodu brezokcev (*Anophthalmus*) (Jeannel, 1928; Daffner, 1998). Schmidtov brezokec je z večimi podvrstami razširjen od Trnovskega gozda in Polhograjskih dolomitov na severu, do Učke in Gorskega kotarja na jugu (Drovenik in Peks, 1999). Na Krimu in Mokrecu živi endemična podvrsta *A. s. motschulskyi*, ki je poimenovana po ruskem entomologu Viktorju I. Motschulskyu, kateri je deloval tudi na ozemlju Slovenije (Schmidt, 1860). Do sedaj je bila ta vrsta najdena v štirih jamah na severu in vzhodu Krima (75 - Velika Pasica, 76 - Mala pasica, 77 - Ledenica pri Planinci, 525 - Kevderc pri Planinci) (slika 5).

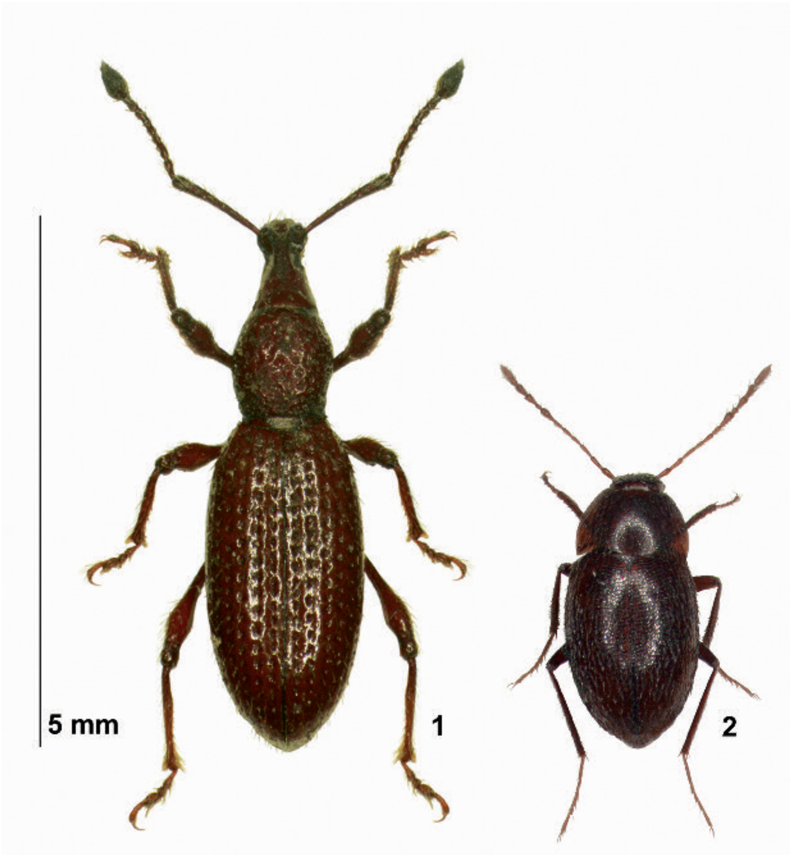
***Anophthalmus scopolii scopolii* Sturm, 1850**

Scopolijev brezokec *(Anophthalmus scopolii)* je majhna vrsta rodu brezokcev (slika 4), ki sicer ne živi v jamah, temveč pod kamni in v plitvih podzemnih prostorih. Vrsta je razširjena v severnih Dinaridih od okolice Tolmina do Gorskega kotarja (Drovenik in Peks, 1999). Med brezokci velja za primitivno vrsto, torej je zelo podoben sorodnikom, ki niso prilagojeni na življenje v podzemlju. Od njih se razlikuje le po pomanjkanju pigmenta in zakrnelih očeh. Vrsta je bila opisana z Nanosa (Jeannel, 1928). Na Krimu je Scopolijev brezokec zelo redka vrsta, ki je bila najdena le dvakrat na površini pod kamni in do sedaj nikoli v jamah (Pirnat, 2001, J. Broder, ustno; slika 5).

Zemljarji (Leiodidae)

***Aphaobius milleri* (Schmidt 1855)**

Millerjev kapljičar (*Aphaobius milleri*) (slika 6) je v Sloveniji geografsko najbolj razširjena vrsta iz tega vrstno bogatega rodu (Bognolo in Vailanti, 2010). Ostale

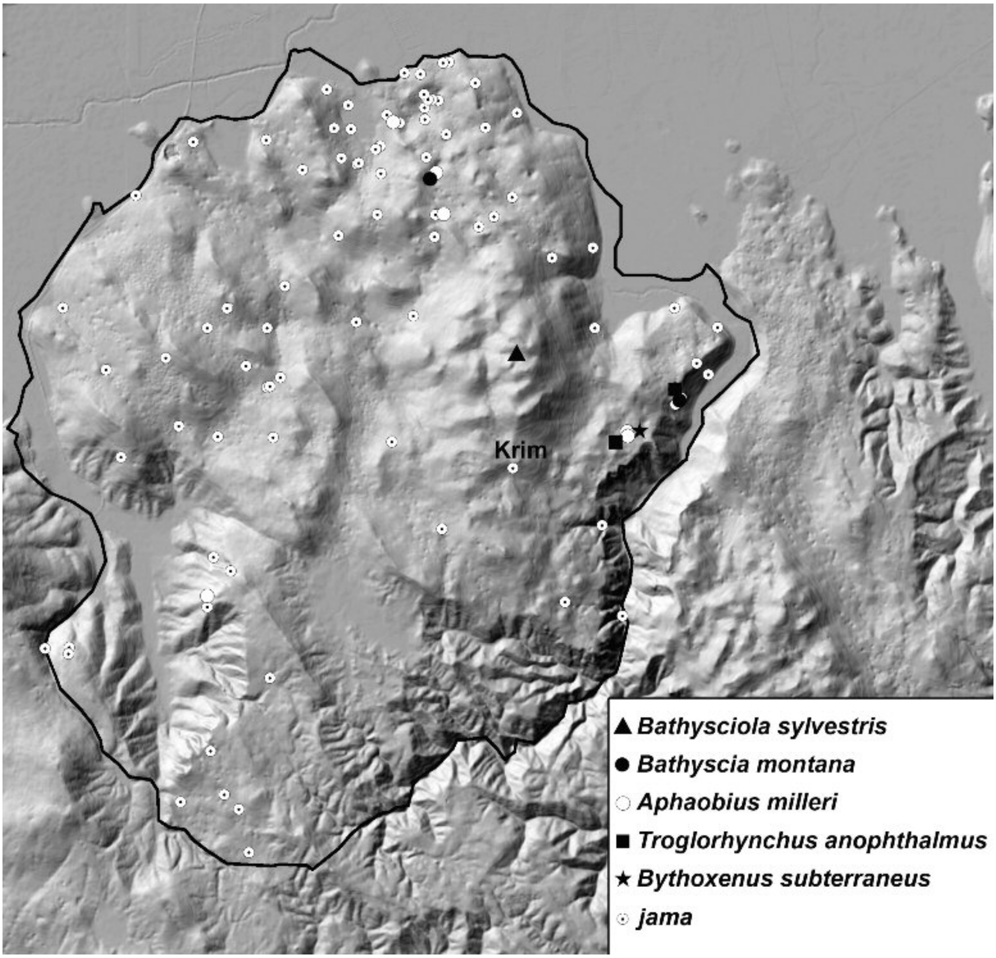


Slika 6: 1 – slepi rilčkar (*Troglorhynchus anophthalmus*), 2 – Millerjev kapljičar (*Aphaobius milleri*) (foto: Andrej Kapla).

vrste tega rodu so razširjene pretežno v alpski in predalpski regiji. Poseljuje območje zahodno od Ljubljane proti jugu do severnih predelov Hrvaške (Istra, Gorski Kotar, Žumberačka gora). Navadno ga najdemo v jamah in breznih, včasih tudi v plitvem podzemnem prostoru. Vrsto je opisal Ferdinand Schmidt leta 1855 po primerkih iz Velike Pasice (Schmidt, 1855). V jamah se lahko pojavlja v večjem številu, zlasti v bližini kakih trupel ali živalskih iztrebkov (Bognolo in Vailanti, 2010). Na Krimu gre za razširjeno in v jamah številčno vrsto (slika 7).

Bathyscia montana **Schišdte, 1848**

Bathyscia montana je zelo majhna vrsta zemljarja, ki živi v gozdni stelji in plitvem podzemnem okolju. Velika je manj kot 2 mm, slabo pigmentirana in z zakrnelimi očmi. V jamah živi pretežno na vhodnih delih, pa tudi globje, sploh po obilnejšem deževju, kamor jih spere voda (M. Bognolo, ustno). Na Krimu je bila do sedaj najdena le v dveh jamah (slika 7).



Slika 7: Razširjenost ostalih vrst jamskih hroščev na Krimu. Sive točke so jame brez podatkov (risba: Andrej Kapla).

***Bathysciola sylvestris* (Motschulsky, 1856)**

Podobna je predhodni vrsti s podobno izraženimi troglomorfnimi značilnostmi. Gre za pretežno edafsko vrsto, ki živi v gozdni stelji, vendar se pojavlja tudi na vhodnih delih jam. Na Krimu je redka, saj je bila po do sedaj zbranih podatkih najdena le enkrat in sicer jo je leta 1934 pod kamni izven jame našel Egon Pretner (slika 7).

Kratkokrilci (Staphylinidae)

***Bythoxenus subterraneus* Motschulsky, 1859**

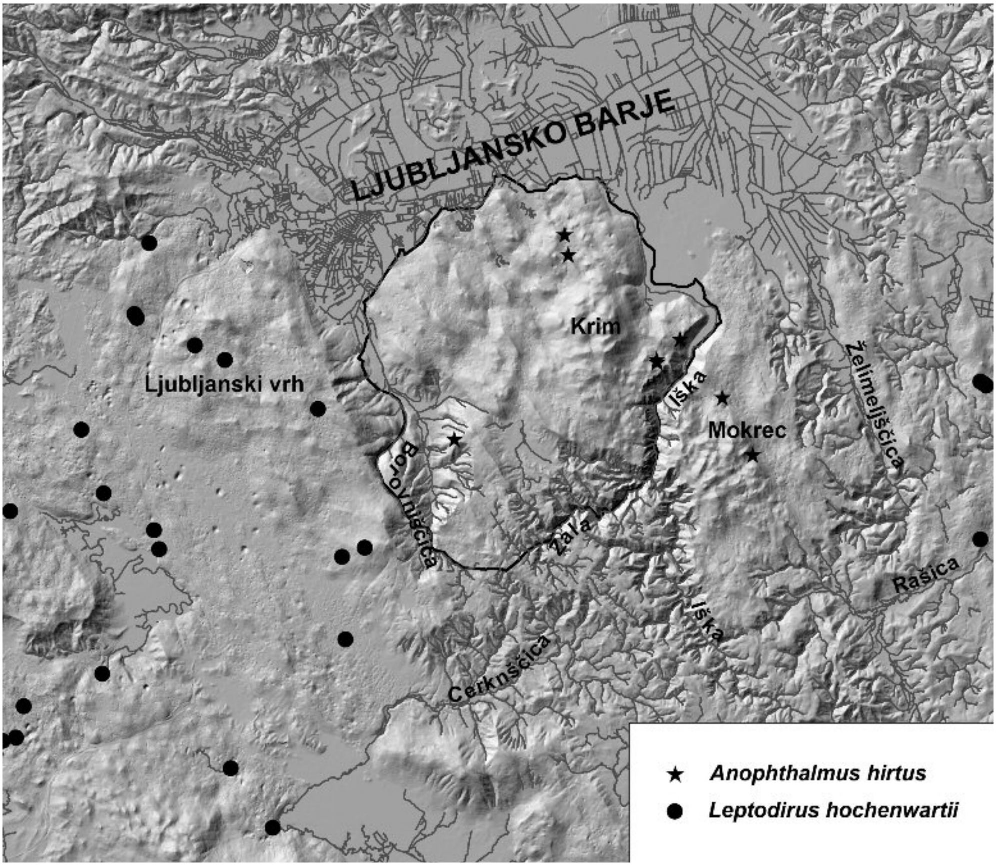
Pselafid *Bythoxenus subbterraneus* je majhna in zelo redka vrsta hrošča iz družine kratkokrilcev (Staphylinidae: Pselaphinae). Poznanih je le nekaj primerkov iz jam na

Gorenjskem in osrednje Slovenije (Broder, 1977). Njena ekologija in način življenja sta nepoznana. Vrsta je bila opisana leta 1859 po primerkih iz Velike Pasice na Krimu (Motschulsky, 1859), ki predstavlja tudi njeno edino znano lokaliteto na obravnavanem območju (slika 7).

Rilčkarji (Curculionidae)
Troglorhynchus anophthalmus **(Schmidt 1854)**
Slepi rilčkar (*Troglorhynchus anophthalmus*) ne sodi med troglobionte (slika 6), temveč je prilagojen na življenje v zemlji, kjer živi na koreninah dreves. Včasih korenine predrejo strop jame, kjer v šopih rastejo dalje in tako nudijo življenjski prostor tudi edafskim oziroma zemeljskim vrstam. Ta poseben življenjskih prostor izkorišča tudi slepi rilčkar, ki je sicer razširjen po celotnem slovenskem krasu, vendar se nikjer ne pojavlja v velikem številu (Hlaváč, 2011). Po trenutno zbranih podatkih na Krimu ni zelo razširjen (slika 7).

Izoliranost jamske favne hroščev na Krimu

Čeprav Krim geografsko sodi v enoten sklop Velike notranjske planote oziroma območja Krimskega hribovja in Menišije, ki mu poleg Krima pripadata še Mokrec in Ljubljanski vrh z Menišijo, je ta opredelitev s stališča favne jamskih hroščev manj jasna. Celotno območje Krimskega hribovja in Menišije sestavlja dolomit z vmesnimi laminami in lečami apnenca (Fridl s sod., 1998), vendar globoke rečne doline bistveno prispevajo k izolaciji podzemlja posameznih delov območja. Za oris izoliranosti krimskega podzemlja si vzemimo dve vrsti troglobiontskih hroščev, drobnovratnika *(Leptodirus hochenwartii)* in dlakavega brezokca *(Anophthalmus hirtus)*. Drobnovratnik je precej široko razširjena vrsta po severnem dinarskem krasu v Sloveniji in na Hrvaškem (Vrezec s sod., 2011). Dlakavi brezokec pa je stenendemit z zelo ozko razširjenostjo, omejeno zgolj na Krim in bližnji Mokrec (Daffner, 1996). Primerjava vzorca razširjenosti obeh vrst kaže na neko skladnost, ki se odraža v izoliranosti krimsko-mokrškega masiva od okoliških kraških masivov (slika 8). Drobnovratnika najdemo povsod v okolici Krima, na zahodni Pokojiški planoti in južneje ter vzhodno na Dolenjskem podolju. Stik med populacijama je šibek, saj je ravno tu kot kaže ločnica med dvema podvrstama, nominotipsko *L. h. hochenwartii* na zahodu in *L. h. schmidti* na vzhodu (Vrezec s sod., 2007). Obratno pa dlakavi brezokec poseljuje le vmesni del Krimskega hribovja, ki ga tvorita Krim in Mokrec, kjer drobnovratnika ni. Sosednje masive sicer poseljujejo druge dlakavemu brezokcu sorodne vrste, na primer: *Anophthalmus pubescens* na zahodu (Pokojiška planota), *A. driolii* na jugu (vznožje Blok ob Cerkniškem jezeru) in *A. kertecsi* na vzhodu (Suha krajina) (Bognolo & Etonti 1996, Daffner 1996). S stališča favne jamskih hroščev je kot kaže območje Krimskega hribovja od okolice izoliran masiv, ki ga na severu jasno omejuje Ljubljansko barje, na zahodu reka Borovniščica, na vzhodu reka Želimeljščica, na jugu pa sistem vodotokov, ki prehaja v zelo vodnato Bloško planoto s pretežno dolomitno podlago. Zanimivo pri tem je, da reka Iška z globoko vrezano dolino Iškega Vintgarja ne predstavlja večje ovire za jamske hrošče, saj sta favni Krima in Mokrca dokaj



Slika 8: Trenutno poznana razširjenost drobnovratnika *(Leptodirus hochenwartii)* in dlakavega brezokca *(Anophthalmus hirtus)* na območju Krimskega hribovja in Menišije z bližnjo okolico z označeno hidrografsko mrežo (risba: Andrej Kapla).

podobni. Poleg dlakavega brezokca namreč območji poseljujeta še dva stenendemična taksona jamskih hroščev, ki jima po trenutnih dognanjih pripisujemo status podvrst (Daffner, 1996 in 1998): *Anophthalmus schmidti motschulskyi* in *Typhlotrechus bilimeki hacqueti*.

Primer krimske jamske favne hroščev nam kaže pomen nekaterih območij v Sloveniji, ki zaradi stenendemičnih taksonov dajejo Sloveniji globalno odgovornost pri ohranjanju biodiverzitete. Trenutno so napori za ohranjanje evropske in slovenske biodiverzitete osredotočeni na ohranjanje in varstvo na evropskem nivoju izbranih varstveno pomembnih vrst, ki jih opredeljuje Habitatna Direktiva (Direktiva Sveta 92/43/EC), med katerimi je kar nekaj vrst hroščev (Vrezec s sod. 2011). Čeprav daje ta pristop dober varstveni in upravljavski okvir na evropskem nivoju, pa lahko na regionalnem ali lokalnem nivoju zgreši nekatere vrste, katerih globalno preživetje je odvisno od lokalnih upravljavskih odločitev. Prostorsko izključevanje drobnovratnika, evropske varstveno pomembne vrste, in nekaterih stenendemitov v Krimskem hribovju je le en od takih primerov. Čeprav so slovenski endemiti praviloma brez izjeme zavarovane vrste (Ur. list RS 2004), pa v praksi varstvenih ukrepov niso deležni. Poleg evropskih varstvenih prioritet, ki določajo omrežje Natura 2000, so zato nujne tudi regionalne prioritete varstva in upravljanja z območji, s katerimi bo docela mogoče ohraniti evropsko biodiverziteto (Dolman s sod. 2012), katere endemiti so seveda ključni del. Jamske stenendemične vrste imajo tako za ohranjanje slovenske biodiverzitete ključen pomen.

Zahvala

Zahvaljujemo se Slavku Polaku za prepis podatkov iz beležnic Egona Pretnerja in druge nasvete. Zahvala gre tudi Jožetu Broderju in Marcu Bognolu za koristne informacije in komentarje. Milijan Šiško je pripravil karto o reliefnih značilnostih Krima. Del podatkov smo pridobili v okviru nacionalnega monitoringa hroščev med letoma 2006 in 2009, ki ga je financiralo Ministrstvo za okolje in prostor in v okviru raziskovalnega programa št. P1-0255, ki ga financira Javna agencija za raziskovalno dejavnost Republike Slovenije. Del idej o regionalni prioritizaciji vrst za namene ohranjanja biodiverzitete pa smo pridobili v okviru projekta BID-REX (Interreg Europe PGI01505).

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Received / Prejeto: 31. 1. 2017

ACTA ENTOMOLOGICA SLOVENICA
LJUBLJANA, DECEMBER 2017 Vol. 25, št. 2: 141–158

NOVE TUJERODNE RASTLINOJEDE ŽUŽELKE V FAVNI SLOVENIJE

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Izvleček - Objavljene so najdbe petih tujerodnih rastlinojedih žuželk, ki so nove za favno Slovenije: *Prociphilus (Meliarhizophagus) fraxinifolii* (Riley 1879) [Hemiptera: Aphididae], *Cacopsylla fulguralis* (Kuwayama 1908) [Hemiptera: Psyllidae], *Epitrix hirtipennis* (Melsheimer 1847) [Coleoptera: Chrysomelidae], *Euxesta notata* (Wiedemann 1830) in *E. pechumani* Curran 1938 [Diptera: Ulidiidae]. Pri vsaki vrsti so na kratko obravnavane diagnostične značilnosti, bionomija, prehranjevalne značilnosti, razširjenost ter potencialne gospodarske in okoljske grožnje. Vse nove vrste so tudi fotografsko dokumentirane. Napravljen je ključ za določanje vrst tujerodnega rodu *Euxesta*, ki se pojavljajo v Evropi.

KLJUČNE BESEDE: tujerodne žuželke, Slovenija, razširjenost

Abstract - NEW ALIEN PHYTOPHAGOUS INSECT SPECIES TO THE FAUNA OF SLOVENIA

Five alien insects new to the fauna of Slovenia are recorded: *Prociphilus (Meliarhizophagus) fraxinifolii* (Riley 1879) [Hemiptera: Aphididae], *Cacopsylla fulguralis* (Kuwayama 1908) [Hemiptera: Psyllidae], *Epitrix hirtipennis* (Melsheimer 1847) [Coleoptera: Chrysomelidae], *Euxesta notata* (Wiedemann 1830) and *E. pechumani* Curran 1938 [Diptera: Ulidiidae]. Diagnostic characteristics, bionomics, trophic features, distribution and potential economic as well as environmental threats of each species are briefly discussed. Each species is also photographically documented. A key for the identification of the alien *Euxesta*-species occurring in Europe is provided.

KEY WORDS: alien insects, Slovenia, distribution

Uvod

Pred nedavnim je bil objavljen celovit pregled tujerodnih rastlinojedih žuželk in pršic, ki so bile ugotovljene v Sloveniji in so v večini primerov tudi že ustaljene (Seljak, 2013). Seveda je bilo odkrivanje novih tujerodnih vrst pri nas pričakovano, zlasti tistih, ki se že pojavljajo v sosednjih državah in pokrajinah. Njihovo odkrivanje pri nas je potem bolj kot ne stvar časa, klimatske in okoljske ustreznosti za njihovo naselitev in ustalitev, prisotnosti in pogostnosti prehranskih substratov (gostiteljev) ter včasih tudi strokovnih zmožnosti za njihovo prepoznavanje. Ni znano, da bi se zgodil prvinski vnos kake žuželčje vrste ali tujerodnega organizma nasploh iz tretjih držav neposredno v Slovenijo. Ti so se k nam bodisi razširili iz sosednjih držav in pokrajin ali pa smo jih z blagom nenamerno vnesli iz drugih evropskih držav. Kljub temu dejstvu je bilo v zadnjem obdobju nekaj tujerodnih vrst novih za Evropo najprej odkritih prav v Sloveniji, po tem ko so se k nam priselile iz sosednjih držav. Taki primeri so: *Euaresta aequalis* (Loew 1862) (Seljak, 2013), *Hishimonus hamatus* (Seljak, 2013) in *Aponychus corpuzae* (Seljak, 2015). Nepojasnjen ostaja le izvor listne zavrtalke *Ophiomyia kwansonis* Sasakawa 1961, ki je bila v Evropi doslej najdena le v Sloveniji in bi lahko bila vnesena neposredno, najverjetneje iz ZDA s sadikami maslenice (*Hemerocallis* spp.) (Jurc in sod., 2012). V tem prispevku je predstavljenih nadaljnjih pet tujerodnih rastlinojedih žuželk, katerih pojavljanje v Sloveniji doslej ni bilo znano ali vsaj ne objavljeno.

Material in metode dela

Večino novih tujerodnih vrst je odkril pisec tega članka sam, pogosto povsem naključno. Nekaj vrst je bilo odkritih tudi med vzorci, ki so jih v laboratorij Kmetijsko gozdarskega zavoda v Novi Gorici (KGZNG) v določitev poslale javne službe za varstvo rastlin v okviru državnega sistematičnega spremljanja tujerodne plodove vinske mušice (*Drosophila suzukii* (Matsumura, 1931). Primerki obravnavanih vrst so shranjeni v zbirki žuželk KGZNG ali v piščevi zasebni zbirki. Pri vrstah, pri katerih je za določitev potrebna mikroskopska preiskava, so bili napravljeni trajni mikroskopski preparati vloženi v "Canada balsam". Vse vrste so tudi fotografsko dokumentirane.

Ugotovitve

Prociphilus (Meliarhizophagus) fraxinifolii (Riley 1879) [Hemiptera, Sternorrhyncha: Aphididae]

Obravnavani material: Ljubljana - Šentvid (VM50), 28. 06. 2015; Nova Gorica (UL99), 10. 06. 2016, v obeh primerih na pensilvanskem jesenu (*Fraxinus pennsylvanica* Marsh.)

28. junija 2015 so v parku v Prušnikovi ulici v Šentvidu v Ljubljani pritegnili mojo pozornost močno skodrani vrhnji listi okrasnega jesena (slika 1). Vedel sem, da pri velikem jesenu (*Fraxinus excelsior* L.) takšno kodranje listov povzročata dve

vrsti listnih uši iz rodu *Prociphilus*: *P. fraxini* (Fabricius 1777) in *P. bumeliae* (Schrank 1801). Obe je mogoče zanesljivo ločiti le z mikroskopsko preiskavo prepariranih primerkov, zato sem vzel vzorec za laboratorijsko preiskavo. Ta je pokazala, da pravzaprav ne gre ne za eno in ne za drugo od prej omenjenih domorodnih vrst, pač pa za tujerodno vrsto *Prociphilus (Meliarhizophagus) fraxinifolii* (Riley 1879), ki na ozemlju Slovenije doslej še ni bila omenjena.

Uš *P. fraxinifolii* izvira iz Severne Amerike, kjer je splošno razširjena od Mehike prek ZDA do Kanade (Blackman & Eastop, 1994). V Evropi so jo najprej odkrili na Madžarskem (Remaudière & Ripka, 2003), kmalu za tem pa so o njenem pojavljanju poročali še iz Srbije, Bolgarije, Velike Britanije in Španije (Petrović-Obradović & al., 2007; Coeur D'Acier & al., 2010; Baker & Martin, 2011; Hidalgo & Durante, 2012).

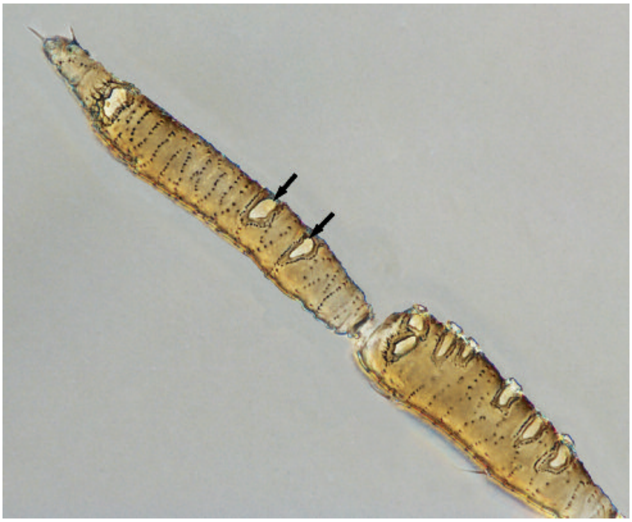
Uš *P. fraxinifolii* je enodomna (monoecična) in holociklična vrsta in živi na listih in koreninah različnih vrst ameriških jesenov, kot so: *F. americana, F. latifolia, F. nigra, F. pennsylvanica, F. quadrangulata, F. uhdei, F. velutina* (Blackman & Eastop, 1994). Nasprotno pa sta obe sorodni evropski vrsti - *P. fraxini* in *P. bumeliae* dvodomni (heterecični), pri čemer je njun glavni gostitelj veliki jesen in pomožni jelka (*Abies* spp.). Na slednjem se uši zadržujejo na koreninah (Heie, 1980).

V skodranih listih pensilvanskega jesena so bile v obeh obravnavanih primerih nekrilate in krilate uši. Krilati osebki (slika 3) so razmeroma majhni (1,4 - 2,8 mm),

Slika 1: *P. fraxinifolii* - napadeni listi pensilvanskega jesena
Fig. 1: *P. fraxinifolii* - infested leaves of *Fraxinus pennsylvanica*

Slika 2: *P. fraxinifolii* - nekrilata samica
Fig. 2: *P. fraxinifolii* - an apterous female

Slika 3: *P. fraxinifolii* - krilata samica
Fig. 3: *P. fraxinifolii* - an alate female



Slika 4: *P. fraxinifolii* - šesti člen tipalk z drugotnimi čutnimi jamicami (rhinaria - puščici)
Fig. 4: *P. fraxinifolii* - the sixth antennal segment with secondary rhinaria (arrows)

znatno manjši kot so krilati osebki obeh evropskih vrst *P. fraxini* in *P. bumeliae* (3,3-5,5 mm) (Blackman & Eastop, 1994). Dolžina telesa (brez dolžine kril) osebkov iz obravnavanih dveh vzorcev je bila med 1,8 in 2,0 mm. Osebki nekrilate oblike so nekoliko večji in so merili med 2,1 in 2,5 mm. Vse razvojne stopnje uši, zlasti ličinke in nekrilati odrasli osebki izločajo obilne voskaste nitke iz posebnih žlez (slika 2). Na hrbtu zadka so te posebno številne in tudi večje. Najbolj zanesljiv morfološki znak za ločevanje vrste *P. fraxinifolii* od obeh evropskih vrst je poleg manjše velikosti navzočnost sekundarnih čutnih jamic (rhinaria) v spodnjem delu 6. člena tipalk. Teh je od 1 do 5 in so nepravilnih oblik, medtem ko so čutne jamice na 3. členu ozke in podolgovate in potekajo prečno na os člena (Blackman & Eastop, 1994) (slika 4). Pri obeh evropskih vrstah je 6. člen tipalk brez čutnih jamic.

Do sedaj ni poročil, da bi uš *P. fraxinifolii* povzročala kakšno večjo gospodarsko škodo. Močan napad lahko nekoliko skazi videz okrasnih jesenov v urbanem okolju. Nekaj več težav bi lahko povzročala le drevesničarjem pri vzgoji sadik ameriških okrasnih jesenov, a jih je s sistemičnimi insekticidi razmeroma enostavno zatreti, le pravočasno jih je treba odkriti, še preden je škoda napravljena.

Cacopsylla fulguralis (Kuwayama 1908) [Hemiptera, Sternorrhyncha: Psyllidae] - oljčična bolšica

Obravnavani material: Nova Gorica - 100 m (UL99), 16. 4. 2015 (12 ♀♀, 13 ♂♂); Kromberk (UL99), 19. 4. 2015 (24 ♀♀, 20 ♂♂), 26. 02. 2016 (6 ♀♀, 3 ♂♂) in 10. 03. 2017 (2 ♂♂ in 2 ♀♀); vse na okrasni oljčici (*Elaeagnus x ebbingei*).

Bolšica *C. fulguralis* pripada vzhodno palearktični zoogeografski favni in je izvorno razširjena na ozemljih Kitajske, Koreje, Japonske, Tajvana, Filipinov in Ruskega Daljnega vzhoda (Ouvrard, 2015). Po letu 2000, ko je bila najprej zaznana v Franciji (Cocqempot & Germain, 2000), se je najbrž z gostiteljskimi rastlinami hitro razširila po večjem delu Evrope z nekoliko milejšo klimo. O njeni prisotnosti poročajo iz Združenega kraljestva (MALUMPHY & HALSTEAD, 2002), Nizozemske (STIGTER, 2002), Belgije (BAUGNEE, 2003), Švice (BURCKHARDT & MÜHLETHALER, 2003), Hrvaške (ŠIMALA & MASTEN, 2003), Italije (SÜSS & SAVOLDELLI, 2003) in Španije (COCQENPOT, 2008). Je oligofagna vrsta na različnih, toda ne vseh vrstah oljčic (*Elaeagnus* spp.). V Evropi se večinoma pojavlja na okrasni oljčici (*Elaeagnus* x *ebbingei*), sicer pa so njeni gostitelji še *E. commutata, E. cuprea, E. glabra, E. macrophylla, E. oldhamii* in *E. pungens* (OUVRARD, 2017).

Oljčično bolšico ni težko prepoznati po značilnem rjavem vzorcu na sprednjih krilih (slika 5), zelo dolgih tipalkah, katerih dolžina za več kot dvakrat presega širino glave ter po tem, da je vezana na rastline iz rodu *Elaeagnus* - oljčice. Odrasle bolšice se prehranjujejo na enoletnih poganjkih in listih. Samice odlagajo jajčeca posamično ali po več v skupinah na spodnjo stran mladih listov (slika 7). Ličinke in nimfe se večinoma zadržujejo v skupinah ali posamič na spodnji strani listov. Nimfe 4. in 5. razvojne stopnje se deloma preseljujejo tudi na druge dele poganjkov, zlasti v listne pazduhe. Vse razvojne stopnje ličink izločajo obilne voskaste izločke (slika 6). Poznavanje bionomije te vrste je še precej pomanjkljivo. Po nekaterih navedbah naj bi v eni rastni dobi razvila več rodov; enega do dva spomladi, na kar naj bi prešla v poletno diapavzo in nato nadaljevala razvoj jeseni (FERRE & DENIS, 2011). Na Goriškem je v letih 2015 in 2016 razvila le en spomladanski rod v aprilu in maju. Čez poletje in tudi jeseni je na gostiteljskih rastlinah nisem našel. V februarju in marcu 2017 sem najprej

Slika 5: *C. fulguralis* - imago
Fig. 5: *C. fulguralis – adult*

Slika 6: *C. fulguralis* - nimfe 5. razvojne stopnje
Fig. 6: *C. fulguralis* - 5th instar nymphs

Slika 7: *C. fulguralis* - jajčece
Fig. 7: *C. fulguralis* – egg

Slika 8 : Ličinka plenilske stenice med nimfami oljčične bolšice
Fig. 8: A predaceous bug larva among nymphs of *C. fulguralis*

v Kromberku nato pa tudi v Poreču na Hrvaškem našel različne razvojne stopnje oljčične bolšice od ličink 2. razvojne stopnje naprej do odraslih osebkov, kar kaže na to, da prezimujejo preimaginalne razvojne oblike. V letu 2016 sem na lokaliteti v Kromberku prve odrasle osebke našel že v zadnji dekadi februarja, v letu 2017 pa v začetku marca.

Nova vrsta je precej neopazna in na prostem ne povzroča opaznejših poškodb na gostiteljskih rastlinah. Najbolj so opazni obilni voskasti izločki in medena rosa, ki jo izločajo ličinke. Med naravnimi regulatorji populacije smo našli stenice iz družine Anthocoridae (slika 8)

Epitrix hirtipennis (Melsheimer 1847) [Coleoptera, Chrysomelidae: Alticinae] - tobakov bolhač

Obravnavani material: Bertoki (VL04), 29. 7. 2015; Lucija (UL94), 29. 7. 2015.

Favna bolhačev je v Sloveniji razmeroma dobro raziskana. V celovitem pregledu bolhačev slovenskega ozemlja so obravnavane tudi tri vrste iz roda *Epitrix*: *E. atropae* Foudras, 1860, *E. pubescens* (Koch, 1803) in *E. intermedia* Foudras, 1860 (Brelih & sod., 2003). Med njimi pa ni tujerodne vrste *E. hirtipennis*. Poleti 2015 sem pri terenskem zdravstvenem pregledu vrtnin v Slovenski Istri naletel na precej očitne poškodbe, značilne za bolhače, na jajčevcih (*Solanum melongena*) in v manjši meri tudi na paradižniku (*Lycopersicon esculentum*). Odvzeti vzorci bolhačev na zgoraj navedenih lokacijah so razkrili, da gre za vrsto, ki jo italijansko strokovno slovstvo že od sredine osemdesetih let prejšnjega stoletja navaja kot škodljivca razhudnikov, zlasti tobaka in jajčevca (POLLINI, 1998)

Tobakov bolhač je nearktična vrsta razširjena od Kolumbije prek Srednje Amerike, Mehike, ZDA do Kanade. Pogosta je zlasti na območjih pridelovanja tobaka in ga obravnavajo kot pomembnega škodljivca tobaka in nekaterih drugih razhudnikov. V Evropi so ga prvič opazili leta 1983 v provinci Benevento v deželi Campania v Italiji, ko je začel povzročati veliko težav pri gojenju tobaka (SANNINO & sod. 1984). Od tam se je postopno širil na sosednje dežele v Italiji in tudi zunaj nje. O njegovem pojavljanju poročajo iz Grčije (LYCOURESSIS, 1991), Turčije (DÖBERL, 1994), Makedonije (KRSTESKA & sod., 2009), Bolgarije (TRENCHEV & TOMOV, 2000), Sirije (GRUEV & DÖBERL, 2005) ter južne Rusije (ORLOVA-BIENKOWSKAYA, 2014). Povsod ga omenjajo predvsem kot resnega škodljivca na njivah s tobakom.

Tobakov bolhač je zelo majhen hrošček, ki meri v dolžino le 1,5 - 2,0 mm. Telo in pokrovke so v celoti rdečkasto rumene do rdečkasto rjave; takšne so tudi tipalke, le zadnji členi so lahko na vrhu nekoliko zatemnjeni; pokrovke so v sredini in ob osrednjem šivu pogosto temneje rdečkasto rjave (slika 10). Ovratnik je ščetinast le na robovih, sicer gol, svetleč in gosto vdrto točkast, prečna bazalna ugreznina je slabotna. Pokrovke v celoti pokrivajo zadek; na vsaki je po 11 podolžnih redi ugreznjenih točk in 12 redi svetlih štrlečih ščetin. Tobakovega bolhača prepoznamo predvsem po rdečkasto rumeni barvi vseh delov telesa, medtem ko so vse domače vrste v celoti ali vsaj deloma črno ali temno rjavo obarvane. Nekoliko so mu lahko podobni le svetlejši osebki vrste *E. atropae*, ki pa ima črno do temno rjavo vsaj glavo, ovratnik in osrednji del kril. Dodatni razlikovalni znak je oblika spermateke samic. Ta je pri vrsti *E. hirtipennis* značilne hruškaste oblike, pri vrsti *E atropae* pa je mehasta.

Ličinka je razpotegnjeno valjasta, odrasla meri 3,5 - 4,2 mm, rumenkasta do umazano bela (SANNIO & sod., 1986)

Tako v ZDA kot tudi Srednji Italiji razvije 3 rodove na leto. Prezimujejo odrasli osebki pod rastlinskimi ostanki na tleh. V aprilu začnejo dopolnilno prehranjevanje na mladih rastlinicah. Oplojene samice odlagajo posamezna jajčeca ali v manjših skupinah v tla v bližini gostiteljskih rastlin. Ličinke se prehranjujejo na drobnih koreninicah gostiteljskih rastlin, a s tem večinoma ne povzročajo opazne škode. Ličinke se po dveh levitvah prenehajo prehranjevati, se zalezejo nekoliko globlje v tla, kjer si napravijo posteljico, zaključijo tretjo razvojno stopnjo in se zabubijo. Drugi rod razvije v drugi polovici junija in v juliju ter tretjega v avgustu in septembru. Ko nastopi jesenski hlad, se odrasli osebki zavlečejo pod rastlinske ostanke na tleh, kjer prezimijo (SANNINO in sod. 1984; SANINNO in sod., 1986, POLLINI, 1998).

Nabor gostiteljskih rastlin tobakovega bolhača je razmeroma širok, a ima najraje različne gojene in divje razhudnike. Tako v Ameriki kot tudi v Evropi ga navajajo kot zelo pomembnega škodljivca tobaka, paradižnika in jajčevca, nekoliko manj krompirja, paprike in fižola. Poleg teh so med gostiteljskimi rastlinami še: pasje zelišče (*Solanum nigrum*), navadni kristavec (*Datura stramonium*), repa (*Brassica rapa*), volčje jabolko (*Physalis* spp.) in še nekatere druge (SANNINO, 1986). Poškodbe povzročajo predvsem odrasli osebki pri dopolnilnem prehranjevanju na listih, na

Slika 9: *Epitrix hirtipennis* - poškodbe na listu jajčevca
Fig. 9: *Epitrix hirtipennis* - injuries on an eggplant leaf

Slika 10: *E. hirtipennis* - imago (n.v. 1,5-2,0 mm)
Fig. 10: *E. hirtipennis* - adult (size 1.5-2.0 mm)

katerih povzročajo majhne izjedine premera 1 - 2 mm (slika 9). Škodljiv je zlasti prvi rod spomladi na sejancih in mladih rastlinah, ko je listov še razmeroma malo. V tej razvojni stopnji gojenih gostiteljskih rastlin je načrtno zatiranje pogosto nujno, zlasti pri tobaku. Pri slednjem je navadno treba preprečevati tudi poškodbe na razvitih listih prek poletja. V Sloveniji bi vrsta utegnila povzročati težave predvsem v Slovenski Istri in morda tudi na Goriškem, zlasti spomladi pri vzgoji sadik in pri mladih rastlinah paradižnika in jajčevca na vrtovih in njivah.

Euxesta notata (Wiedemann 1830) [Diptera, Ulidiidae]

Obravnavani material: Gradno (UL89), 3. 7. 2015; Miren (UL98), 31. 8. 2016; Vogrsko (VL08), 24. 6. 2015; Ljubljana - Bežigrad (VM60), 14. 8. 2015 (leg. Š. Modic); Valburga (VM51), 26. 8. 2015 (leg. J. Razinger)

in

E. pechumani Curran 1938 [Diptera, Ulidiidae]

Obravnavani material: Ljubljana - Bežigrad (VM60), 28. 5. 2015, 3. 7. 2015 in 5. 8. 2015 (leg. J. Razinger)

Rod muh *Euxesta* Loew, 1868 je povsem ameriškega porekla. Še posebno vrstno pester je ta rod v tropskih območjih Srednje in Južne Amerike. Dve vrsti tega rodu sta tudi v evropski favni, a sta bili obe že v prejšnjem stoletju zaneseni iz Severne Amerike. To sta vrsti *E. pechumani* Curran 1938 in *E. stigmatias* Loew 1873. Vrsta *E. pechumani* je bila dejansko prej najdena v Evropi kot v Ameriki, a je bila napačno določena kot *E. nitidiventris* Loew 1873 (Bezzi, 1921). Šele precej pozneje je bila ta vrsta opisana pod zdaj veljavnim imenom na podlagi vzgojenih primerkov iz New Yorka (Curran, 1938). Pozneje sta bili v palearktični regiji opisani še dve vrsti iz rodu *Euxesta*, *E. stackelbergi* Krivosheina et Krivosheina iz Turkmenistana in *E. freyi* Krivosheina et Krivosheina z Azorskih otokov (Krivosheina & Krivosheina, 1997), a se je izkazalo, da so njune razlikovalne značilnosti znotraj meja morfološke variabilnosti vrste *E. pechumani* in sta zato pozneje obe imeni poniknili na raven sinonimov te vrste (Kameneva, 2000). Ličinke te vrste živijo pod skorjo brestov (*Ulmus* spp.) (Curran, 1938). V Evropi je že splošno razširjena v številnih državah (Greve & Kameneva, 2017).

Vrsta *E. stigmatias* je bila v Evropi doslej najdena samo v Bolgariji. V Ameriki, od koder izvira, je znana pod imenom "Cornsilk fly" - muha koruznih laskov. Njene ličinke povzročajo občasno občutne poškodbe pri koruzi (Nuessly & Capinera, 2001).

V okviru sistematičnega nadzora plodove vinske mušice (*Drosophila suzukii* [Matsumura 1931]) v Sloveniji med letoma 2011 in 2016 se je na prehranske pasti sadnega ali vinskega kisa ali mešanice kisa in vina poleg plodove vinske mušice ujelo tudi veliko drugih vrst muh, med drugimi tudi vrste iz rodu *Euxesta*. Najdba vrste *E. pechumani* je bila glede na njeno razširjenost v srednji Evropi pričakovana (Greve & Kameneva, 2017). Toda vsi osebki, čeprav zelo podobni, vendarle že po barvi zadnjih členov zadka in po obliki oviskapta niso bili enaki, in očitno je postalo, da gre za neko drugo vrsto. To je potrdila tudi disekcija genitalnega segmenta samcev, ki so si sicer barvno vsaj na prvi pogled nerazločljivo podobni. Po dostopnih ključih za določanje vrst rodu *Euxesta* ter opisov posameznih vrst (Curran, 1935; Krivosheina &

Krivosheina, 1997) so raziskovani primerki povsem ustrezali le vrsti *E. notata* (Wiedemann 1830) (slika 12). Pojavljanje te vrste v Evropi je bilo prvič omenjeno šele pred kratkim v Franciji (Skuhravá & sod., 2010). Tudi na nekaterih spletnih forumih se že nekaj časa pojavljajo odlične fotografije in video posnetki te vrste iz Italije in Nemčije (Diptera.info, 2013; Wikimedia Commons, 2015), a potrditvenih objav za Evropo nisem našel. *E. notata* je v Ameriki znana pod imenom "Spotted root fly". Prehranjevala naj bi se z razpadajočimi ostanki čebule in drugih rastlinskih ostankov (Ormsby & Pottinger, 2009). V prej omenjenih spletnih forumih so kot prehranski substrati navedeni pasji in tudi človeški iztrebki.

Ker so vrste iz rodu *Euxesta* nove za favno Slovenije, dodajam poenostavljen dihotomni ključ, ki naj služi kot pomoč pri razlikovanju v Evropo zanesenih vrst. Za določitev rodu se uporabi ključ v delu Steyskal (1993).

1 Krila s štirimi temno rjavimi prečnimi progami (za zdaj potrjena samo v Bolgariji!).. *E. stigmatias*

1* Krila prozorna z dvema rjavima pegama; apikalna (trikotne oblike) in sredinska na vrhu subkostalnega polja (slika 11 in 12 - puščica) 2

2 Zadek se končuje s široko sploščeno leglico (oviscapt); ta je na prehodu v zadek razločno zažeta (slika 11 in 12). Samice 3

2* Zadek na koncu zaobljen, enobarvno črn z zelenkastim ali modrikastim kovinskim odsevom. Samci 4

3 Prehod med zadkom in leglico živo rumeno obarvan (tergiti 5 in 6 ter osnova leglice); sredinska rjava pega na krilih sega navznoter največ do druge radialne žile (R_{2+3}) (slika 12 - puščica)..*E. notata*

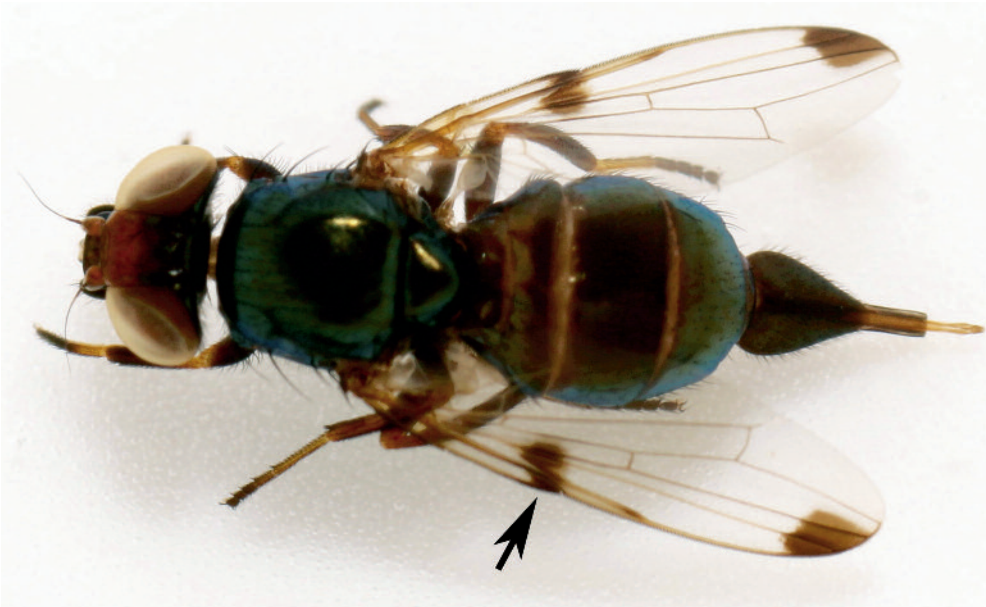
3* Zadek enobarvno črn z zelenkastim ali modrikastim kovinskim odsevom; sredinska rjava pega na krilih sega vsaj do tretje radialne žile (R_{4+5}), redkeje čez njo.. *E. pechumani*

4 Sredinska rjava pega na krilih sega navznoter največ do druge radialne žile (R2+3) (slika 12 - puščica); paritvene klešče (surstylus) na vrhu priostrene (slika 14). .... *E. notata*

4* Sredinska rjava pega na krilih sega vsaj do tretje radialne žile (R_{4+5}), redkeje celo do mediane žile (M); paritvene klešče (surstylus) na vrhu odsekano zaobljene (slika 13).. *E. pechumani*

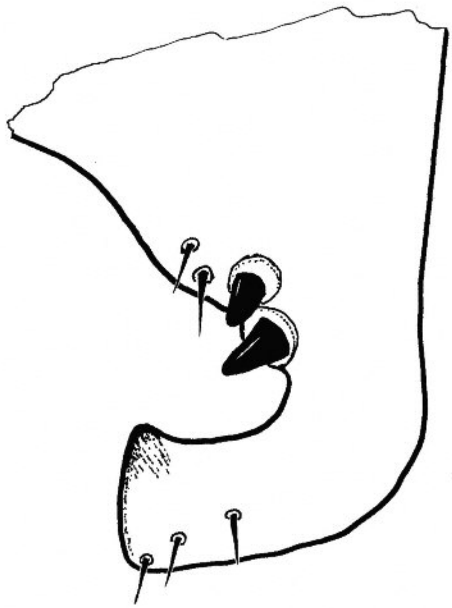
Zaključki

Za vseh pet zgoraj obravnavanih vrst velja, da je to le prva dokumentirana zabeležka njihovega pojavljanja v Sloveniji. Vse so bile najdene bolj ali manj naključno, zato je njihova stvarna razširjenost neznana in zagotovo širša kot je zabeležena v tem prikazu (slika 15). Pri večini obravnavanih vrst ni pričakovati, da bi lahko povzročale opaznejše gospodarske in okoljske težave, če jih presojamo po sedanjem poznavanju njihove bionomije in razvojne dinamike pri nas. Resnejši škodljivec bi utegnil postati le tobakov bolhač (*Epitrix hirtipennis*) pri pridelavi paradižnika in jajčevca, zlasti v zgodnji razvojni fazi in pri vzgoji sadik, ko so rastline še malo olistane.



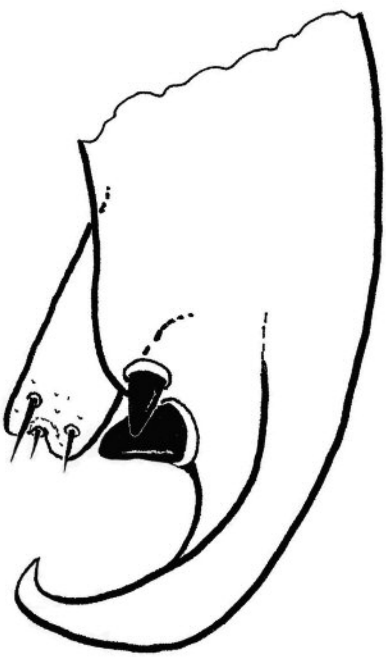
Slika 11: *E. pechumani* - samica (puščica - sredinska pega)
Fig. 11: *E. pechumani* - female (arrow - median spot)

Slika 12: *E. notata* - samica (puščica - sredinska pega)
Fig. 12: *E. notata* - female (arrow - median spot)



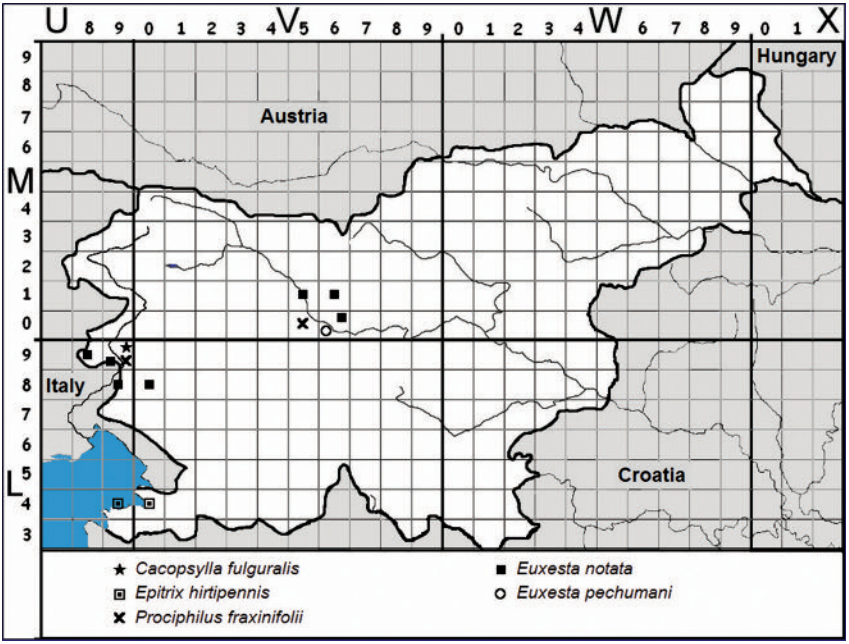
Slika 13: *E. pechumani* - samčeve paritvene klešče (surstylus) - desni krak

Fig. 13: *E. pechumani* - male's right surstylus



Slika 14: *E. notata* - samčeve paritvene klešče (surstylus) - desni krak

Fig. 14: *E. notata* - male's right surstylus



Slika 15: Dokumentirani pojavi petih novih tujerodnih vrst žuželk v Sloveniji
Fig. 15: Documented occurrences of the five new alien insects in Slovenia

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Prejeto / Received: 22. 3. 2017

ACTA ENTOMOLOGICA SLOVENICA
LJUBLJANA, DECEMBER 2017 Vol. 25, št. 2: 159–164

UNAVAILABILITY OF THE GENUS GROUP NAME *MEZAMMIRA* (HEMIPTERA: CICADIDAE)

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Abstract – The genus name *Mezammira*, attributed to Fieber 1876, was recently proposed to classify several Palaearctic cicada species by Gogala, Puissant & Trilar (2017). The availability of the genus name *Mezammira* is discussed. Following the rules of the International Code of Zoological Nomenclature, *Mezammira* cannot be used as an available name. The genus name *Oligoglena* Horváth, 1912 status revised is proposed as a substitute name. The following new combinations are recognized: *Oligoglena carayoni* (Boulard, 1982) comb.nov., *Oligoglena filoti* (Gogala & Trilar, 2017) comb.nov., *Oligoglena flaveola* (Brullé, 1833) comb.nov., *Oligoglena goumenissa* (Gogala, Drosopoulos & Trilar, 2012) comb.nov., *Oligoglena iphigenia* (Emeljanov, 1996) comb.nov., *Oligoglena parvula* (Fieber, 1876) comb.nov., *Oligoglena popovi* (Emeljanov, 1996) comb.nov., *Oligoglena sakisi* (Gogala & Trilar, 2017) comb.nov., *Oligoglena sibilatrix* (Horváth, 1901) comb.nov., *Oligoglena tibialis* (Panzer, 1798), *Oligoglena turcica* (Schedl, 2001) comb.nov.

Key words: *Mezammira*, *Cicadivetta*, *Oligoglena*, *Heptaglena*, cicadas, taxonomy, nomenclature, availability.

Izvleček – NERAZPOLOŽLJIVOST IMENA RODOVNE SKUPINE *MEZAMMIRA* (HEMIPTERA: CICADIDAE)

Rodovno ime *Mezammira*, pripisano Fiebru 1876, so Gogala, Puissant in Trilar (2017) nedavno predlagali za uvrstitev več palearktičnih vrst škržadov. Razpoložljivost rodovnega imena *Mezammira* je predmet razprave. Po pravilih Mednarodnega pravilnika zoološke nomenklature ime *Mezammira* ne more biti uporabljeno kot razpoložljivo ime. Za nadomestno ime je predlagano rodovno ime *Oligoglena* Horváth, 1912 z revidiranim statusom. Pripoznane so naslednje nove kombinacije: *Oligoglena*

carayoni (Boulard, 1982) comb.nov., *Oligoglena filoti* (Gogala & Trilar, 2017) comb.nov., *Oligoglena flaveola* (Brullé, 1833) comb.nov., *Oligoglena goumenissa* (Gogala, Drosopoulos & Trilar, 2012) comb.nov., *Oligoglena iphigenia* (Emeljanov, 1996) comb.nov., *Oligoglena parvula* (Fieber, 1876) comb.nov., *Oligoglena popovi* (Emeljanov, 1996) comb.nov., *Oligoglena sakisi* (Gogala & Trilar, 2017) comb.nov., *Oligoglena sibilatrix* (Horváth, 1901) comb.nov., *Oligoglena tibialis* (Panzer, 1798), *Oligoglena turcica* (Schedl, 2001) comb.nov.

Ključne besede: *Mezammira*, *Cicadivetta*, *Oligoglena*, *Heptaglena*, škržadi, taksonomija, nomenklatura, razpoložljivost.

Introduction

Working on the 3i World Auchenorrhyncha Database (Dmitriev, 2003 online), helped to recover several inconsistencies in the Auchenorrhyncha nomenclature (e.g. Dmitriev & Dietrich, 2006, Zahniser, McKamey & Dmitriev, 2012, Dmitriev & McKamey, 2013). Many more are still to be resolved. This paper is dedicated to the genus group name *Mezammira* which was recently used as a valid genus name for several Palaearctic species of singing cicadas.

The name *Mezammira* was first introduced by Amyot (1847: page 157) for a new species of cicada from Greece. This publication of Amyot was placed on the Official Index of Rejected and Invalid Works in Zoological Nomenclature (ICZN, 2006: Opinion 2165). Gogala, Puissant & Trilar (2017) proposed a resurrection of the genus name *Mezammira* with a new authorship attributed to Fieber (1876) and placed 11 species, including two new species, into this genus. The authors stated that Fieber (1876) was the first who used *Mezammira* Amyot as a synonym of *Cicadetta* Kolenati, 1857 and established an association of this name with *Cicadetta flaveola* (Brullé, 1833), which could be considered as a type species designation for *Mezammira*, and thus making it an available name. The authors referred to the International Code of Zoological Nomenclature (ICZN, 1999) Articles 11.6.1, which applies to a name published as a junior synonym and treated before 1961 as an available name and either adopted as the name of a taxon or treated as a senior homonym, it is made available thereby but dates from its first publication as a synonym. For the authorship of this name ICZN Article 50.7 was used: if a scientific name was first published in the synonymy of an available name and became available before 1961 through the provisions of Article 11.6, its author is the person who published it as a synonym, even if some other originator is cited, and is not the person who subsequently adopted it as a valid name.

Results

Unfortunately, *Mezammira* Fieber, 1876 cannot be adopted as neither valid nor available name for several reasons:

1). According to ICZN Article 11.6.1, to became available, the name first published as a synonym should be treated before 1961 as an available name and adopted as the name of a taxon. "Adopted as the name of a taxon" means that the name should be used as a valid name, and it should be used as valid in a work published before 1961 (see an Example to ICZN Article 11.6.1). The second option provided by ICZN Article 11.6.1 states that the name could be treated as a senior homonym before 1961. Both options are not applicable to *Mezammira* which was never used as a valid name before the paper of Gogala, Puissant & Trilar (2017), it is not also a senior homonym for another genus group name in Zoology (Nomenclator Zoologicus, 2004 online). The authors state that the name was placed in Nomenclator Zoologicus by Neave (1940), but according to ICZN Articles 11.5.2 and 23.9.6, a simple listing of the name in a nomenclator must not be taken into account in determining usage of the name.

2). According to ICZN Article 23.3, the synonymy could only be applied to taxa within one nomenclatural group, the family group, genus group or species group. This means, that a genus group name could not be treated as a synonym of a species group name. Fieber (1876) placed *Mezammira* in the list of synonyms (usages) of *Cicadetta flaveola* (Brullé, 1833) on page 121 and not in the list of synonyms of *Cicadetta,* which could be found on the page 60. This is congruent with a modern practice of placing previously used temporary names in the list of synonyms (e.g. "*Cicadetta* sp. A", listed as a synonym of a valid species). This act does not establish a synonymy in a strict ICZN (1999) sense.

3). ICZN Article 11.6 states that a name which when first published in an available work was treated as a junior synonym of a name then used as valid is not thereby made available. ICZN Article 11.6.1 provides an exception from this rule. The publication of Amyot (1847) is not an available publication, so the next available publication could potentially fix the availability of the name, if all other ICZN (1999) requirements are fulfilled. The first available paper which cites *Mezammira* is the paper by Walker (1850), and not Fieber (1876). Walker established a new species name *Cicada Mezammira*, which was proposed as valid name for *Mezammira* Amyot. *Cicada mezammira* Walker, 1850 (the initial letter of species name corrected to a lower-case according to the ICZN Article 32.5.2.5) should be considered as an available name with the availability requirements fulfilled by a reference to Amyot's publication (ICZN Article 13.1.2). The name *Cicada mezammira* Walker, 1850 was never used as a valid name by subsequent authors.

A new revised classification of the genus is proposed in accordance with ICZN Article 23.3.5: if a name in use for a taxon is found to be unavailable or invalid it must be replaced by the next oldest available name from among its synonyms. Gogala, Puissant & Trilar (2017) indicated that if *Mezammira* cannot be used as an available name, the genus name *Oligoglena* Horváth, 1912 would take precedence. They also established a new synonymy with the genus name *Cicadivetta* Boulard, 1982.

Family **Cicadidae** Latreille, 1802
Subfamily **Cicadettinae** Buckton, 1889
Tribe **Cicadettini** Buckton, 1889
***Oligoglena* Horváth, 1912 status revised**

= *Heptaglena* Horváth, 1911: 607 (type species: *Heptaglena libanotica* Horváth, 1911: 607, homonym of *Heptaglena* Schmarda, 1850: 12, type species: *Heptaglena digitata* Schmarda, 1850: 12, Rotifera)

Oligoglena Horváth, 1912: 606 replacement name for *Heptaglena* (type species *Heptaglena libanotica* Horváth, 1911: 607)

=*Cicadivetta* Boulard 1982: 50 **syn.nov.** (type species: *Tettigonia tibialis* Panzer, 1798: 5)

= *Mezammira* Gogala, Puissant & Trilar, 2017: 9 **nomen nudum**

Included species

Oligoglena carayoni (Boulard, 1982: 103) (orig. gen. *Tettigetta*) **comb.nov.**

Oligoglena filoti (Gogala & Trilar in Gogala, Puissant & Trilar, 2017: 23) (orig. gen. *Mezammira*) **comb.nov.**

Oligoglena flaveola (Brullé, 1833: 112) (orig. gen. *Tibicen*) **comb.nov.**

= *Cicada mezammira* Walker, 1850: 229 **syn.nov.**

Oligoglena goumenissa (Gogala, Drosopoulos & Trilar, 2012: 7) (orig. gen. *Cicadivetta*) **comb.nov.**

Oligoglena iphigenia (Emeljanov, 1996: 1899) (orig. gen. *Cicadetta*) **comb.nov.**

Oligoglena parvula (Fieber, 1876: 97) (orig. gen. *Cicadetta*) **comb.nov.**

Oligoglena popovi (Emeljanov, 1996: 1897) (orig. gen. *Cicadetta*) **comb.nov.**

Oligoglena sakisi (Gogala & Trilar in Gogala, Puissant & Trilar, 2017: 28) (orig. gen. *Mezammira*) **comb.nov.**

Oligoglena sibilatrix (Horváth, 1901: 483) (orig. gen. *Cicadetta*) **comb.nov.**

Oligoglena tibialis (Panzer, 1798: 5) (orig. gen. *Tettigonia*) **comb.nov.**

Oligoglena turcica (Schedl, 2001: 1287) (orig. gen. *Tettigetta*) **comb.nov.**

Conclusions

The genus group name *Mezammira*, as it was proposed by Gogala, Puissant & Trilar (2017) and used as an original genus for two new species and as a genus name in several new combinations should be treated as *nomen nudum*. It fulfils all the formal requirement for an available name, except for the provisions of ICZN Article 16.1: to be available, every new name published after 1999 must be explicitly indicated as intentionally new.

The genus group name *Mezammira* could be described as a new genus group name in the future. *Mezammira* Amyot, 1847 and *Mezammira* Gogala, Puissant &

Trilar, 2017 both are unavailable names and as such, they do not compete for priority or homonymy with any other existing or future name in zoology (ICZN Article 23.1).

Acknowledgements

I am thankful to Allen F. Sanborn (Barry University, FL, USA) for his help and contribution in the assembly of the 3i World Auchennorhyncha Database. The work was partially supported by NSF grants: DBI 14-58285 and DEB 16-39601.

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Received / Prejeto: 27. 6. 2017

ACTA ENTOMOLOGICA SLOVENICA

LJUBLJANA, DECEMBER 2017 Vol. 25, št. 2: 165–176

SYNANTHEDON THERYI LE CERF, 1916 (LEPIDOPTERA: SESIIDAE) ON THE COAST OF NORTHWESTERN ISTRIA

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Abstract – New faunistic data on the distribution of the clearwing moth species *Synanthedon theryi* Le Cerf, 1916 are given. The species was first recorded in Slovenia by M. Kastelic on 6.9.2015 in Škocjanski zatok. Between 18 June and 26 August 2017, altogether one hundred and twenty-eight males were trapped in pheromone traps at all research locations in the Slovenian coastal area. Some exuvia, larvae and cocoons were also collected. *S. theryi* is an allochthonous species and is new to the fauna of Slovenia. It has also been found on the Italian side of the border. Its discovery, distribution and biology are described.

Key words: Sesiidae, *Synanthedon theryi*, Slovenia, Istria.

Izvleček – STEKLOKRILEC *SYNANTHEDON THERYI* LE CERF, 1916 (LEPIDOPTERA: SESIIDAE) NA OBALI SEVEROZAHODNE ISTRE

Podane so nove favnistične informacije o razširjenosti steklokrilca vrste *Synanthedon theryi* Le Cerf, 1916. V Sloveniji je vrsto prvič zabeležil M. Kastelic 6. 9. 2015 v Škocjanskem zatoku. Med 18. junijem in 26. avgustom 2017 je bilo ujetih skupno sto osemindvajset samcev v feromonske pasti na skoraj vseh krajih raziskovanja na slovenskem obalnem področju. Zbranih je bilo tudi nekaj eksuvijev, ličink in kokonov. *S. theryi* je alohtona vrsta in je novost za favno Slovenije. Najdena je bila tudi na italijanski strani meje. Podan je opis njenega odkritja, razširjenost in biologija.

Ključne besede: Sesiidae, *Synanthedon theryi*, Slovenija, Istra.

Introduction

During recent research of the Sesiidae fauna of Slovenia, *S. theryi* was collected as the 18th confirmed species of the genus *Synanthedon* in this country (own data). It is not listed in the check list of Slovenian Microlepidoptera (Lesar & Govedič, 2010). It is morphologically most similar to *Synanthedon vespiformis* (Linnaeus, 1761), one of the widely distributed species in the country (author's unpubl. data). *S. theryi* have so far had a Western Mediterranean distribution, limited to stands of its host plant, various species of tamarisk (*Tamarix* spp.). Until recently, it was known from restricted areas of Algeria, Morocco, Portugal, from the Balearic Islands and from Spain (Laštůvka & Laštůvka, 2001), where it is probably widespread (Laštůvka & Laštůvka, 2014). Recent discoveries have shown its prevalence in Atlantic and Mediterranean regions of France and in Corsica (Lepinet.fr, 2016, online). In Italy, *S. theryi* was not listed by Bertaccini & Fiumi (2002). However, M. Mossenta (2016, online) found one specimen in 2015 near Palmanova in the Friuli-Venezia Giulia region (Lepiforum, 2016, online; D. Bartsch, e-mail communication), not far from the sites of the new finds mentioned in this publication. According to D. Bartsch, *S. theryi* and its host plant may have been introduced into northern Italy together with imported garden *Tamarix* plants. In the same year Miroslav Kastelic (Animalia, 2016, online) found and photographed the first known specimen of this species in the natural reserve of Škocjanski zatok in the Slovenian coastal area. Further research has shown that the species is relatively common in this part of the Adriatic coast and recent finds of the species in Muggia near Trieste confirm its presence in northern Italy. It seems that *S. theryi* had spread its area of distribution from the west to the southeast, towards the Dalmatian coast.

Abbreviations: m a.s.l: meters above sea level, pher. trap: pheromone trap, pher. old api: pheromone old apiformis, ♂: male.

Methods

Two methods of the work were used to explore the fauna in the field. One was the traditional method of searching for old exit holes, remains of cocoons, exuviae and feeding traces of larvae under the bark of the trunks and in branches of trees and bushes of *Tamarix sp.* (Tamaricaceae). The second was the method of attracting males to the most suitable synthetic pheromones, which were placed directly in the field and in pheromone traps. In addition to certain other factors, the success of directly placed pheromones strongly depends on the relevant weather conditions in the field, which were sometimes too windy during the time of the research. Special emphasis was given to working with pheromone traps as the most effective way for fauna research, which enables more comprehensive detection and research of local populations, their phenology and population dynamics. Pheromone traps were baited with pheromones originally developed for *Sesia apiformis* (Clerck, 1759), in this article under the name old apiformis and produced by Plant Research International (PRI) in Wageningen, The Netherlands. Pühringer & Ryrholm (2000) highly recommended old apiformis pheromones containing Z3,Z13-18:OH as the sole component for *S. theryi*. Each pheromone was placed singly in transparent plastic delta glue traps (RAG-Trap), which had an exchangeable bottom coated with the sticky material poliizobutilen, and in funnel plastic traps (UNI-Trap) with poison (TUS). Traps were hung at selected localities with common *Tamarix sp.* trees and bushes, sometimes on single trees, on various ruderal sites, and were fixed to tree branches at heights of 1.5 m to 3 m above the ground. One to seven traps were placed at each locality, with a distance of 2-25 meters between each. Specimens trapped in delta traps were later soaked in clean gasoline and prepared. Captured and reared specimens were identified by analysis of their external morphological characters. Representative specimens have been deposited in the private collection of the author. The nomenclature used is according to Laštůvka & Laštůvka (2001).

Biology and Phenology

There is not much reported about *S. theryi* in the literature. The host plants of oligophagous larvae are various *Tamarix* species (Tamaricaceae). According to Jogan (2001), *T. gallica* L. and *T. dalmatica* Baum. grow in the Slovenian coastal area. Larvae, often several of them together, live one year in the trunks and branches, especially in damaged places. Their presence is sometimes observable externally from traces of excrement in the bark. During its one-year development, the larva forms a short, broad and flat tunnel between the bark and the wood, where it pupates in a cocoon of saw-dust and silk beneath the bark. The flight season of adults occurs from May to

Fig. 1: Male resting on the trunk of *Tamarix* sp. Koprsko primorje, near Ankaran, 23.7.2017.

Fig. 2: Micro-habitat of the species on the beach. Muggia/Milje, San Rocco, 23.7.2017.

September (De Freina, 1997; Špatenka et al., 1999; Laštůvka et al., 2000; Laštůvka & Laštůvka, 2001, 2014; Lepinet.fr, 2016, online). According to Pühringer & Ryrholm (2000), males respond to pheromones between 11.00 to 16.00 h. Results in the Slovenian coastal area confirmed the high efficiency of the pheromone old apiformis for *S. theryi*. Males were caught in the traps between 9.45 am to 13.30 pm, on free hanging pheromones, between 11.40-12.57 h. The species was present throughout the whole research period, from 18.6. until 26.8.2017; and taking into account the first find on 6.9.2015, up to early September. Judging by the number of trapped males, the peak of activity was determined as being between late July and early August.

Results and Discussion

The investigated coastal area lies in the most northwestern part of the Istrian peninsula in the gulf of Trieste/Trst, in the northeast Adriatic Sea. The most important criterion in selecting research sites was the presence of Tamarisk (*Tamarix* spp.). The investigated area was divided into four research sites. Three of them, Koprsko primorje, Strunjan and Sečovlje saltpans, cover the Slovenian coast in its entire length. The fourth was on the Italian side of the state border, in Muggia bay. A total of twenty traps of both types baited with old api pheromone lures were

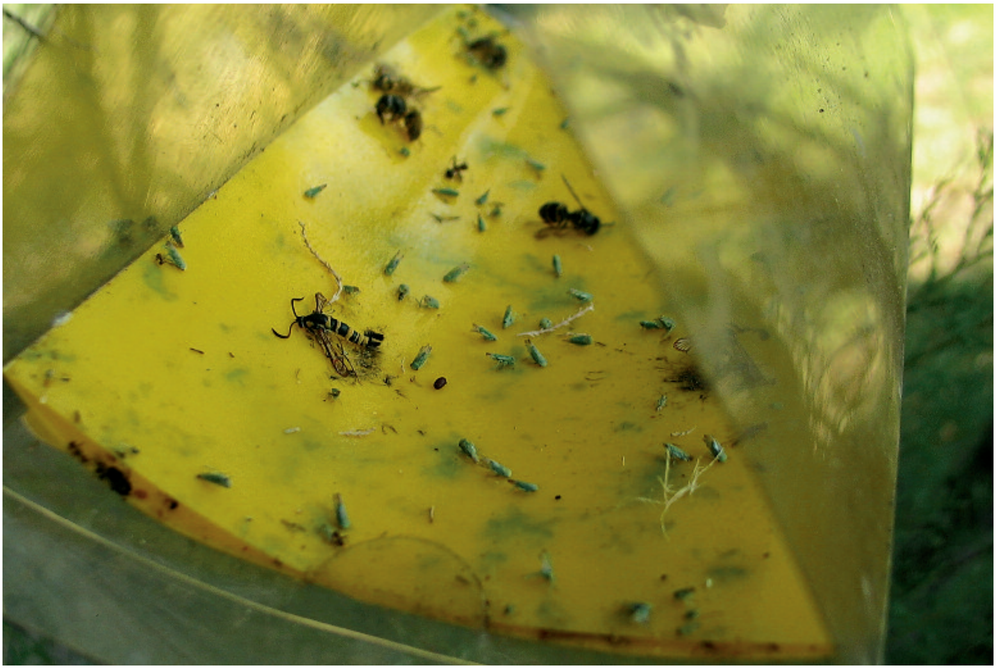

Fig. 3: Males of *S. theryi* in a delta pheromone trap RAG. Muggia/Milje, San Rocco, 23.7.2017.

Fig. 4: Micro-habitat of the species in Sečovlje saltpans, 10.8.2017.

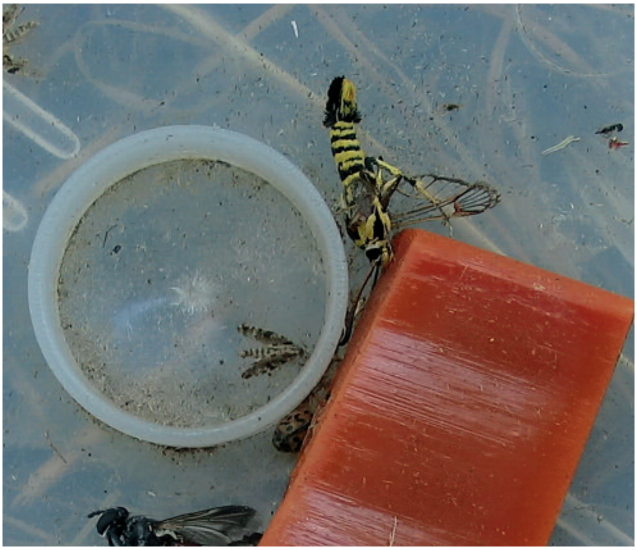

Fig. 5: Male of *S. theryi* in funnel pheromone trap UNI. Koprsko primorje, near Ankaran, 10.7.2017.

hung across the entire research area. Traps were examined differently, during the same day on examination and after one to nine days (mostly early in the afternoon), between 18.6. and 26.8.2017. Some exuviae, old cocoons and larvae were also found.

1. Koprsko primorje. The first research site was the largest and, at the same time, the most explored area in the two and a half months of research. It covered a four-kilometer wide part of the coastal flat in the hinterland of the port city of Koper, comprising the territory along the channel of the Rižana river near Ankaran over Bonifika, with the northernmost and southern edge of the natural reserve of Škocjanski zatok on the periphery of Sermin. In the periods between 18.6. and 5.8. and 15.-26.8.2017, a variable number up to a maximum of twenty traps of both types together were hung at a maximum of ten selected locations with groups or single trees of *Tamarix* spp., such as various ruderal sites along the roads, near the edges of a swamp, fields and parking lots, on construction sites and landfills. On 10.7. some of the traps were moved to the next trap locations along the coast. Trapped male specimens were recorded at seven locations, with a distance of four kilometers between the two most distant locations. In a number of cases, numerous males of the clearwing species *Bembecia ichneumoniformis* ([Denis & Schiffermüller], 1775), less of *Pyropteron chrysidiformis* (Esper, 1782), and in one case *S. vespiformis* were trapped together with males of *S. theryi* in the same pheromone traps, baited with pheromone old api. Other clearwing species that we found in the same area were *S. apiformis*, *Paranthrene tabaniformis* (Rottemburg, 1775), *Synanthedon formicaeformis* (Esper, [1783]), *S. melliniformis* (Laspeyres, 1801), *S. myopaeformis* (Borkhausen, 1789), *Bembecia pavicevici* Toševski, 1989 and *B. uroceriformis* (Treitschke, 1834).

2. Strunjan. The next research site covered the edges of Strunjan lagoon Stjuža, and saltpans in Strunjan landscape park. Five pheromone traps of both types were hung at three selected locations on the coast in the time between 10. 7. and 5.8.2017.

3. Sečovlje. This is by far the southernmost research site of *S. theryi*, separated by a distance of 31 km from the most northerly site of finds in Muggia/Milje. It covered the edge of the Sečovlje saltpans (Lera) in Sečovlje landscape park in Piran bay, not far from the border with Croatia. Seven pheromone traps of both types were hung in the time from 10.7.-5.8.2017, at two selected locations along a bike path and the marshy edges of the salt pans with groups of *Tamarix* sp.

Fig. 6: This-year's exuviae with a cocoon under the open bark of *Tamarix* sp. 20.8.2017.

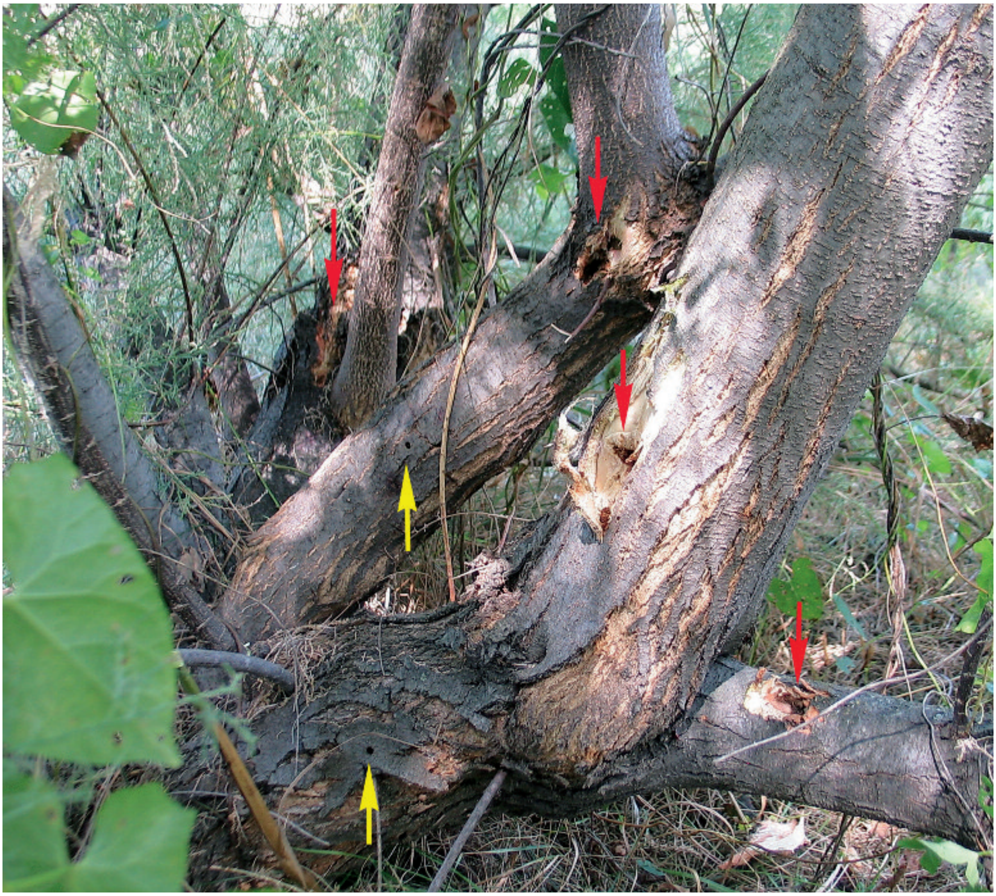

Fig. 7: Strongly attacked *Tamarix* sp. Exit holes are marked with yellow arrows, open larval chambers (with the remains of cocoons) with red arrows. Škocjanski zatok -Stanjolski zaliv, 20.8.2017.

4. Muggia/Milje, Friuli-Venezia Giulia, Italy. The last research site was situated on the Italian side of the state border, in Muggia bay, near the port city of Trieste/Trst. The town of Muggia/Milje is the most northwestern and, at the same time, the only Istrian town on the Italian side of state border. Four pheromone traps of the RAG type were hung in the time between 10.7. and 5.8.2017 at two selected locations. The first location was located directly on the beach, next to the port of San Rocco, the other next to a shopping center in the town.

Finds:

SLO: Koprsko primorje, Ankaran, along the channel of the Rižana river, near a parking place, 45°34'05.7"N 13°45'008"E, 0.8 m a.s.l., 5.-10.7., 1♂, 13.7., 13.15-

13.43 h, 1♂, 13.-15.7., 1♂, 15.7., 12.10-12.32 h, 1♂, 15.-22.7., 9♂, 23.7., 12.40-13 h, 1♂ and five old larvae traces with rests of cocoons on a site of a branch with a diameter of 60 mm, 23.-29.7., 3♂, 29.7., 7.30-14.05 h, 2♂, 29.7.-5.8., 6♂, 5.8., 8.30-12 h, 1♂, all in pher. trap UNI, pher. old api, 15.8.2017, 3♂, pher. old api, 12.48-12.57 h.

SLO: Koprsko primorje, Ankaran, along the channel of the Rižana river, near fields, 45°34'01.7"N 13°45'41.6"E, 0.2 m a.s.l., 14.5., fresh feeding trace of larvae, opened by birds; 25.6., 9.44 h, 1♂, 30.6.-5.7., 1♂, 5.-10.7., 1♂, 10.-13.7. 2017, 1♂, 15.-20.8. 2017, 1♂, all in pher. trap UNI, pher. old api.

SLO: Koprsko primorje, Ankaran, Sermin, truck stop by the river Rižana, 45°33'27.9"N 13°45'29.2"E, 0 m a.s.l, 5.-10.7.2017, 1♂, pher. trap UNI, pher. old api.

SLO: Koprsko primorje, Bertoki, Sermin, under the viaduct Bonifica, 45°33'18.9"N 13°45'17.4"E, 1.4 m a.s.l., 18.-25.6., 1♂, 30.6.-5.7., 1♂, 5.-10.7., 1♂, 10.-13. 7.2017, 1♂, all in pher. trap RAG, pher. old api.

Fig. 8: Micro-habitat of the species near Ankaran, 10.7.2017.

Fig. 9: Map of finds.

SLO: Koprsko primorje, Bertoki, Sermin, near railway station Luka Koper, 45°33’12.4”N 13°45’26.9”E, 0 m a.s.l, 5.-10.7., 2♂, 13.-15.7., 1♂, 23.-29.7., 11♂, 29.7-5.8., 13 ♂, all in trap UNI, pher. old api, 15.8.2017, 1♂, pher. old api, 11.43 h.

SLO: Koprsko primorje, Bertoki, Škocjanski zatok, northern edge of the swamp, 45°33’11.2”N 13°45’20.2”E, 0.4 m a.s.l., 18.-25.6., 1♂, 5.-10.7., 5♂, 10.-13.7., 3♂, 13.-15.7., 3♂, 15.-22.7., 3♂, 23.-29.7., 4♂, 29.7-5.8., 14 ♂, 15.8., empty cocoon under the bark, 2♂, 11-13.30 h, 15.-20.8., 5♂, 20.-26.8.2017, 4♂, all in pher. trap UNI, pher. old api.

SLO: Koprsko primorje, Koper, Škocjanski zatok - Stanjolski zaliv, southern edge of the swamp, 45°33’11.2”N 13°45’20.2”E, 2 m a.s.l., 10.-13.7., 4♂: 2♂, pher. trap UNI, pher. old api, and 2♂, pher. trap RAG, pher. old api, 13.-15.7., 1♂, pher. trap UNI , pher. old api, 15.-23.7., 2♂: 1♂, pher. trap UNI, pher. old api, and 1♂, pher. trap RAG, pher. old api, 23.-29.7., 3♂, 29.7.-5.8., 2♂, all in pher. trap UNI, pher. old api, 15.8., more old exit holes, 5 exuviae and 3 larvae, 26.8.2017, old exit hole and one exuviae, all under the bark of *Tamarix* sp.

SLO: Strunjan-Stjuža, edge of the lagoon, parking, 45°31’55.8”N 13°36’17.5”E, 1 m a.s.l., 15.-23.7. 2017, 1♂, pher. trap RAG, pher. old api.

SLO: Strunjan-Stjuža, edge of the saltpans, near road, 45°31’49.5”N 13°36’25.7”N, 23.-29.7. 2017, 1♂, pher. trap UNI, pher. old api

SLO: Sečovlje, saltpans (Lera) 45°28’48.2”N 13°37’14.1”E, 0 m a.s.l., 13.-15.7., 1♂, 15.-23.7., 1♂, 29.7.-5.8. 2017, 1♂, all in pher. trap UNI, pher. old api.

ITA: Friuli-Venezia Giulia, Muggia/Milje, San Rocco, beach near Porto, 45°36’28.5”N 13°45’24.6”E, 1.5 m a.s.l., 15.-23.7., 3♂, 23.-29.7., 1♂, 29.7.-5.8.2017, 4♂, all in pher. trap RAG, pher. old api.

Results in the field of the research show the general presence of *S. theryi* at almost any site with tamarisk and it appears to be present exclusively in places with *Tamarix* sp. Where both types of pheromone trap were set in the same location, significantly more males were caught in the UNI pheromone traps. There was a decline in the number of trapped specimens in traps from the north towards the south. Comparing the number of trapped specimens at the four locations in Koprsko primorje between 10.7. and 5.8. a total of 91 specimens were found in only four available traps, while in Strunjan only two specimens (in five traps) and in the most southern research site in Sečovlje saltpans only three specimens (in seven traps) were caught. This evidently smaller number of trapped males, despite suitable habitats with a number of host plants in Sečovlje and Strunjan, is probably related to the spread of the species towards the south-east. However, the larger number of trapped male specimens on the Slovenian coast indicates the probable frequency of *S. theryi* in unexplored areas with tamarisk, in the interior of the Primorska region, as well as in the north of the Apennine peninsula in Italy. According to Villar et al. (2012) *T. dalmatica* grows as an endemic on the Balkan peninsula and on parts of the Apennine peninsula, so it is also possibly prevalent along the Adriatic coast on the Croatian side.

Acknowledgment

I would like to thank Daniel Bartsch for his useful information about *S. theryi*, as well as Stanislav Gomboc and Tomaž Seliškar for permission to use their software for processing the faunistic data.

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Received / Prejeto: 6. 10. 2017

ACTA ENTOMOLOGICA SLOVENICA

LJUBLJANA, DECEMBER 2017 Vol. 25, št. 2: 177–190

CHEMICAL COMPOSITION, TOXICITY AND SIDE EFFECTS OF THREE ESSENTIAL OILS ON *BREVICORYNE BRASSICAE* (L.) (HEMIPTERA: APHIDIDAE) ADULTS UNDER LABORATORY CONDITIONS

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Abstract - The insecticidal effects of essential oils namely *Eucalyptus camaldulensis*, *Azadirachta indica* and *Thuja occidentalis* has been studied on *Brevicoryne brassicae* adults as fumigants by determining LC_{50} and LT_{50} values. LC_{50} value of Eucalyptus, Azadirachtin and Northern White Cedar fruit essential oils on cabbage aphid adults were 15.12, 38.79 and 56.02 ml / liter of air, respectively. The LT_{50} value of the three essential oils on cabbage aphid adults were 10.57, 11.90 and 13.86 hours, respectively. Regression analysis showed a significant relationship between log-concentrations and probit of mortality of *T. occidentalis*, *E. camaldulensis* and *A. indica* essential oils with R^2 (0.9995), (0.9779) and (0.9835), respectively. In essential oils of Eucalyptus, Azadirachtin and Northern White Cedar fruit 18, 35 and 22 components were identified by GC-MS analysis. According to the insecticidal properties of the essential oils on the cabbage aphid, the use of these oils as a safe pesticide is recommended.

Key words: Cabbage aphid, *Eucalyptus*, *Azadirachta*, *Thuja*, Insecticidal effect

Izvleček – KEMIJSKA SESTAVA, TOKSIČNOST IN STRANSKI UČINKI TREH ETERIČNIH OLJ NA ODRASLE MOKASTE KAPUSOVE UŠI (*BREVICORYNE BRASSICAE* (L.)) (HEMIPTERA: APHIDIDAE) V LABORATORIJSKIH RAZMERAH

Insekticidne učinke eteričnih olj vrst *Eucalyptus camaldulensis*, *Azadirachta indica* in *Thuja occidentalis* smo preizkušali na odraslih mokastih kapusovih ušeh (*Brevicoryne brassicae*) kot fumigante z določevanjem vrednosti LC_{50} in LT_{50}. Vrednosti LC_{50} eteričnih olj evkalipta, azadirahtina in plodov ameriškega kleka na mokastih kapusovih ušeh so bile 15,12, 38,79 in 56,02 ml / liter zraka. Vrednosti LT_{50} treh eteričnih olj na odraslih mokastih kapusovih ušeh so bile 10,57, 11,90 in 13,86 ur. Regresijska analiza je pokazala pomembno povezavo med koncentracijo eteričnih olj vrst *T. occidentalis* (0,9995), *E. camaldulensis* (0,9779) in *A. indica* (0,9835) in smrtnostjo. V eteričnih oljih evkalipta, azadirahtina in plodov ameriškega kleka smo z analizo GC-MS določili 18, 35 in 22 sestavin. Glede na insekticidne lastnosti eteričnih olj na mokaste kapusove uši priporočamo uporabo teh olj kot varnih pesticidov.

Ključne besede: mokasta kapusova uš, *Eucalyptus*, *Azadirachta*, *Thuja*, insekticidni učinek

Introduction

Cabbage aphid, *B. brassicae* is one of the most important cabbage pests in Iran especially in the central areas and many other parts of the world that causes considerable damage to the product (Khanjani, 2005; Rivnay, 2013). This aphid has a high reproductive potential and increases its population quickly; resulting in direct damage with the formation of large colonies, feeding on plant sap and causing complexity and deformity of the leaves. On the other hand, with the transfer of plant pathogenic viruses, it can lead to indirect damage (Ellis et al., 2000; Schliephake et al., 2000). Chemical control is an effective and widely used method in pest control (Pavela, 2009). These compounds have adverse effects such as environmental pollution, toxicity to non-target organisms; causing resistance in pests and leaving left overs (Ogendo et al., 2003). Development of alternative strategies for avoiding pesticides to manage phytosanitary problems is an important need mostly for agricultural activity and tendency worldwide is a growing to organic productions (Willer et al., 2010; Marques-Francovig et al., 2014). These problems prompted the researchers to look for alternative and environment-friendly control methods to control the pests (Tapondjou et al., 2005; Laznik et al., 2010; Gombač and Trdan, 2014). The good candidates for the substitution of chemical pesticides are essential oils that many studies and patents for their use have been published in recent years (Isman, 2000; Chiasson et al., 2001). Active ingredients derived from plant extracts and essential oils have fumigation effects on pests (Maciel et al., 2010). The essential oils extracted from aromatic plants, due to the intense aroma and low toxicity for mammals, lack of a significant adverse impact on the environment and acceptance among the general public, are considered very useful compounds for pest control (Isman, 2000). Currently, more than 3000 essences have been identified, of which 300 essential oils and some of their compounds have become commercially important in the pharmaceutical, agricultural, food, health and cosmetics and perfume industries (Bakkali et al., 2008).

Plant essences have repellent (Ogendo et al., 2008), insecticide (Papachristos and Stamopoulos, 2002), fungicide (Kotan et al., 2008), antibacterial (Matasyoh et al., 2007), antivirus properties (Schuhmacher et al., 2003), deter oviposition, stop development (Papachristos and Stamopoulos, 2002) and have anti-nutritional properties (García et al., 2007). There have been many studies in this area, for example, the lethal effect of plant essential oils *Artemisia indica* (Adr. Juss) against the cabbage aphid, *B. brassicae* have been studied (Pavela, 2005). In another experiment, Ebrahimi et al. (2013) showed that essential oil of azadirachtin (*Azadirachta indica* Adr. Juss.), eucalyptus (*Eucalyptus camaldulensis* Dehnh.) and laurel (*Laurus nobilis* L.) has significant lethal effect on cotton aphid; in which azadirachtin and eucalyptus had more of a lethal effect compared with laurel. Since ancient times, the natives of America have used different parts of northern white cedar such as leaves, fruit and bark of the shrub as drug and pesticides and reports of their use have been presented as books or articles during the investigation of researchers over the years (Moussa Kéïta et al., 2001).

Considering the advantages of using compounds of natural origin to control plant pests, the insecticidal effect of three essences of eucalyptus, azadirachtin and northern white cedar fruit on cabbage aphid was investigated.

Materials and methods

Extraction and analysis of essential oil

Fruits of northern white cedar *T. occidentalis* were collected from existing trees in the Entomology area of Plant Protection Department of Agriculture Faculty of Urmia University (latitude 37.53°N, 45.08°E and 1320 m above sea level) in the spring of 2014. To prepare the essential oil, fresh fruits were crushed and 100 g of it was extracted mixed with 700 ml of distilled water at a temperature of 100°C using Clevenger apparatus in 90 minutes. Obtained essences were dehydrated with Rota Evaporator-Buchi (R-3000) to a dark brown color and refrigerated in 2 ml glass containers with aluminum covers till use. Used Eucalyptus *E. camaldulensis* and Azadirachtin *A. indica* essential oils in the tests were purchased and analyzed by Barij Esans pharmaceutical company, Kashan.

Insect rearing

The cabbage aphid rearing was started with aphids collected from gardens planted with cabbage in Urmia University. It was reared on red cabbage plant, in 27 ± 2°C and 65 ± 5% RH under a 16:8 (L:D) photoperiod. Cabbage plants and colony of the aphids were maintained in a greenhouse.

Determination of the 50% Lethal Concentration (LC_{50})

Different concentrations of the essential oils were poured on filter paper in three replications based on Kéita et al. (2001) method and placed on the inside of the 305 ml glass container lids, each containing 20 adult insects with food (red cabbage leaves). Also, in order to prevent direct contact between insects and the essential oil, a net was placed between the lid and container. Container lids were tightened using special tapes (parafilm). In the tests, counting was done after 24 hours. Insects that did not show any movement when nearing the brush were considered dead. Distilled water was used in the control treatment.

Determining the 50% lethal time (LT_{50})

An experiment was designed to determine the median effective time to kill 50% of adults (LT_{50} values) at different concentration of *T. occidentalis*, *E. camaldulensis* and *A. indica* essential oils. The mortality was assessed by direct observation of the insects in 5 times including 2, 7, 12, 18 and 24 hour to obtain the desired LT_{50}. Time-mortality data for each experiment were analyzed with time as the explanatory variable to derive estimated hours for 50% adult mortality.

Data analysis

To determine the LC_{50} from six concentrations (five concentrations and control) after 24 hours of essential oil administration and control mortality correction according to Abbott (1925) formula and to determine the LT_{50}, an oil concentration at various time points (2, 7, 12, 18 and 24 hours) was used and analyzed statistically with Probit program at SPSS (V. 20) software. All tests were conducted by fumigation method. In order to draw the graph and its regression lines, we used the SigmaPlot (V. 12.3) software. The dendrogram similarity scales that are produced by the SPSS (V. 20) software range from zero (most similarity) to 25 (least similarity). The method used was ward's (Ward, 1963). Cluster validity index called Silhouette index is applied to validate the result by MATLAB Software (Rousseeuw, 1987).

Results

According to the gas chromatography (GC/MS) analysis of essential oils, it was determined that *E. camaldulensis* essential oil is composed of 18 compounds, the most important of which are 1,8-cineole (39.91%), Para-cymene (13.98%) and gamma-terpinen (12.25%) (Table 2). *A. indica* essential oil is composed of 35 compounds, the most important ones are Azadirachtin (26.55%), Palmitic acid (18.87) and Deacetylazadirachtinol (17.22%) (Table 1). *T. occidentalis* essential oil is composed of 22 compounds and their most important ones are α-thujene (47.68%) and Fenchone (15.13%) (Table 2).

Regression analysis showed a significant relationship between log-concentrations of *E. camaldulensis* and A. *indica* and *T. occidentalis* essential oils and probit of mortality with R^2 (0.9779, 0.9835 and 0.9995), respectively (Fig. 1). The results showed that the essential oils of eucalyptus, azadirachtin and northern white cedar fruit, controlled adult cabbage aphids well for 24 hours and the used concentration of these essential oils on insects in this test are very low. LC_{50} values of the essential oils were equal to 15.12, 38.79 and 56.02 ml per liter of air, respectively (Table 3). The results obtained from the bioassay test of used LC_{50} concentration of eucalyptus, azadirachtin

Table 1. Chemical composition of *A. indica* essential oil by gas chromatography (GS/MS).

No.	Compound	Retention Index	Percentage	No.	Compound	Retention Index	Percentage
1	α-Cadinol	780	3.12	19	2,3-Butanedithiol	910	0.094
2	β-Pinene	902	2.11	20	Germacrene B	680	3.63
3	Anthracene	1311	0.093	21	α-Cadinene	788	0.18
4	Ethyl butyrate	2165	0.17	22	Azadirachtin	730	26.55
5	dl-limonene	1059	0.211	23	Sabinene	842	0.147
6	Eugenol	651	10.92	24	Isobutyl stearate	764	0.209
7	Phytol	621	10.84	25	α–Terpineol	1386	0.22
8	b-Caryophyllene	1455	0.113	26	Thiophene, 2-methoxy	878	0.078
9	Palmatic acid	1978	18.87	27	Deacetylazadirachtinol	561	17.22
10	Spathulenol	1572	0.172	28	Limonene	1521	0.188
11	Verdiflorol	1991	0.162	29	Lauric acid	1186	0.302
12	1-Octadecanol	1381	0.077	30	Valencene	1772	0.170
13	Carvone	796	0.231	31	α-Methyl-1,4-benzenedimethanol	926	0.096
14	Methyl stearate	1422	0.151	32	Aristolene	1561	0.201
15	β-Germacrene	1621	0.088	33	Cadalene	1569	0.108
16	Ethyl linoleate	2108	0.105	34	Ethyl palmitate	1822	0.076
17	1,2,4-Trithiolane, 3,5-diethyl	1359	0.11	35	Other Compounds	-	2.608
18	Pentacosane	652	0.38				

and northern white cedar fruit essential oils at 3, 6, 12, 18 and 24 hours showed that eucalyptus oil at a concentration of 15.12 ml per liter of air at 10.57 hours, azadirachtin oil at a concentration of 38.79 ml per liter of air at 11.90 hours and northern white cedar fruit oil at the concentration of 56.02 ml per liter of air at 13.86 hours caused the death of 50% of adult cabbage aphids (Table 4).

Component analysis and hierarchical cluster

In order to study the likeness and relationship between essential oils (EO) composition of the previously reported samples and our studied oils, hierarchical cluster analysis (HCA) and component analysis were carried out based on similar components

Table 2. Chemical composition of *T. occidentalis* and *E. camaldulensis* essential oils by gas chromatography (GS/MS).

T. occidentalis				*E. camaldulensis*			
No.	Compound	Retention Index	Percentage	No.	Compound	Retention Index	Percentage
1	α-pinene	1004	3.14	1	α-pinene	945.35	7.45
2	4-terpineol	1548	2.03	2	α-thujene	934.88	1.3
3	α-terpinene	1149	0.30	3	Trans-Geraniol	1260.66	0.28
4	Linalool	1506	0.17	4	Valencene	1474.60	2.11
5	Camphene	1041	3.38	5	α-copaene-8-ol	1620	4.80
6	α-terpineol	1642	0.45	6	β-pinene	989.92	0.70
7	Limonene	1167	1.97	7	β-Myrcene	994.19	1.32
8	*β*-thujone	1387	8.51	8	Viridiflorol	1628.82	5.12
9	bornyl acetate	1526	2.74	9	α-Ionone	1365	0.90
10	Sabinene	1094	4.19	10	α-Terpinene	1027.68	0.25
11	*p*-cymene	1231	1.44	11	1,8-cineole	1050.83	39.91
12	Fenchone	1345	15.13	12	a-phellandrene	1015.29	1.22
13	1,8-Cineole	1450	2.06	13	terpinen-4-o1	1196.04	3.59
14	α-fenchene	1034	1.90	14	alloAromadendrene	1497.35	0.72
15	α-thujone	1373	47.68	15	α-terpineol	1207.11	2.17
16	Myrcene	1139	1.12	16	p-cymene	1039.67	13.98
17	Thymol	2110	0.27	17	γ-terpinene	1071.90	12.25
18	γ-terpinene	1210	1.11	18	Other Compounds	-	1.93
19	Borneol	1644	0.39				
20	β-pinene	1079	0.21				
21	α-terpinyl acetate	1640	1.43				
22	Terpinolene	1246	0.18				

of reported EO in the papers. Due to lack of enough similar compounds for *A. indica*, generating dendrogram was infeasible for it. The dendrogram for the HCA results using Ward´s clustering algorithm for *E. camaldulensis* is shown in Figure 2. According to the Silhouette index the best clustering for *E. camaldulensis* is five clusters (Table 5). In the đrst group (Cluster I), represented by six samples, α-pinene and terpinen-4-01 were the main components (Pappas and Sheppard-Hanger, 2000; Chalchat

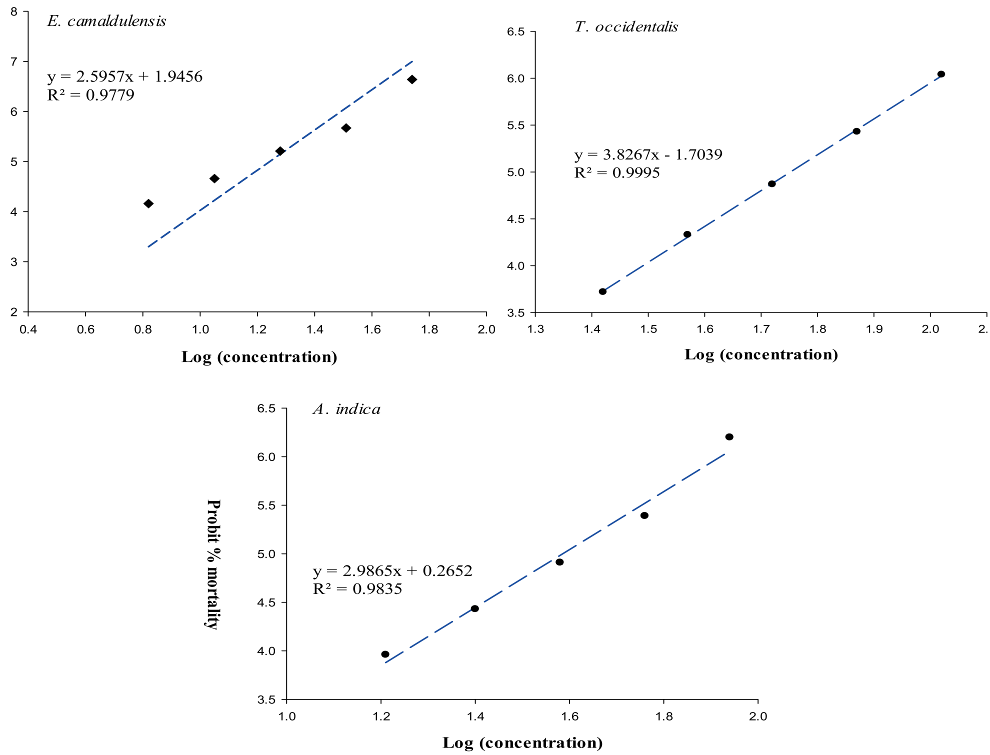

Fig 1. The relationship between log concentration of three essential oils and probit of percentage mortality after 24 hours.

et al., 2001; Verdeguer et al., 2009; Grbović et al., 2010; Khubeiz et al., 2016; Knezevic et al., 2016). Cluster II with one sample has α-pinene and *p*-Cymene as the major compounds (Cheng et al., 2009). Cluster III included two samples with high β-Pinene (Oyedeji et al., 2000; Coffi et al., 2012). Our studied EO formed an individual group from the previous reports, characterized by 1,8-cineole (Cluster IV). In Cluster V with one sample, 1,8-cineole was the main component (Faria et al., 2011).

Table 3. Estimated values of LC_{50} and LC_{95} of *E. camaldulensis*, *A. indica* and *T. occidentalis* essential oils on adult cabbage aphid after 24 hours.

LC_{95}(µL/L air)	LC_{50}(µL/L air)	χ^2(df=3)	Intercept(a)+5	Slope±SE	Total insect	Plant species
68.91 (51.88-105.24)	15.12 (12.89-17.52)	1.64	2.06	0.28±2.50	300	*E. camaldulensis*
138.97 (106.86-207.49)	38.79 (34.29-44.01)	1.24	0.28	0.34±2.97	300	*A. indica*
150.62 (122.98-203.98)	56.02 (50.88-61.94)	0.05	-1.69	0.42±3.83	300	*T. occidentalis*

Table 4. Estimated values of LT_{50} and LT_{95} of *E. camaldulensis*, *A. indica* and *T. occidentalis* essential oils on adult cabbage aphid.

LT_{95}(h)	LT_{50}(h)	χ2(df=3)	Intercept(a)	Slope±SE	Total insect	Plant species
38.16 (20.84-471.56)	10.57 (5.89-18.24)	12.41	1.98	0.30±2.95	300	*E. camaldulensis*
40.60 (31.10-57.26)	11.90 (10.49-13.53)	7.35	1.68	0.32±3.09	300	*A. indica*
47.69 (36.76-70.29)	13.86 (12.22-15.86)	4.19	1.5	0.34±3.07	300	*T. occidentalis*

Table 5. The result of average Silhouette index for *E. camaldulensis*.

Cluster	2	3	5
Index	0.7029	0.7999	0.9105

The Fig. 3 dendrogram presents the results from *T. occidentalis*. The dendrogram was divided into three groups, according to the Silhouette index (Table 6). Our study with one sample was the first cluster in the dendrogram with α-thujone as the main component (Hosseinzadeh et al., 2014). Cluster II is divided into two groups (Cluster II 1-2). Cluster II-1 included the ones with high α-thujone and β-thujone (Akkol et al., 2015; Jasuja et al., 2015); while Cluster II-2 with one sample with α-thujone and sabinene as the major constituents (Lis et al., 2016). Cluster III with one sample had α-thujone and β-thujone as the main compounds (Szołyga et al., 2014).

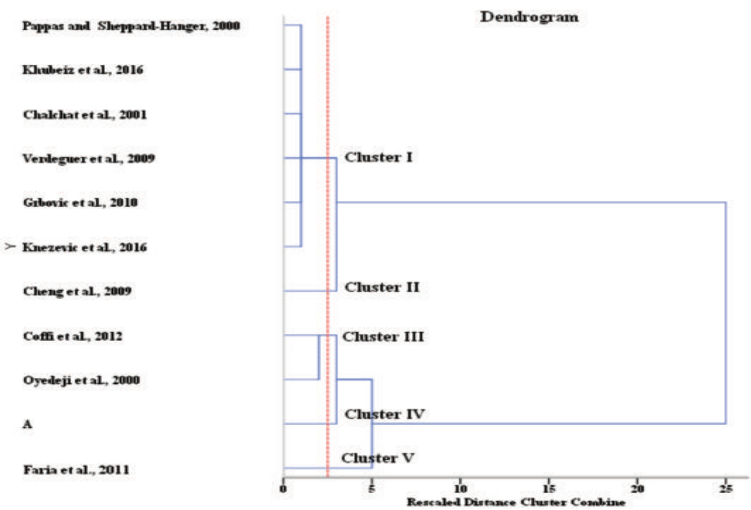

Fig 2. Dendrogram generated of cluster analysis from *E. camaldulensis* EOs based on the chemical compounds of the investigated sample (A) and those from the articles.

Table 6. The result of average Silhouette index for *T. occidentalis*.

Cluster	2	3	4
Index	0.7029	0.7999	0.9105

Discussion

Aphid control is typically done using three main categories of pesticides containing organophosphates, carbamates and pyrethroids. Long-term use of these pesticides has caused resistance in aphids and made their control difficult. Usage of essential oils to control aphids is essential due to increased reports of pest resistance to chemical pesticides and remainder of these toxins in products and environmental pollution (Sadeghi et al., 2009).

The major components of *T. occidentalis*, *E. camaldulensis* and *A. indica* essential oils in our research were the same as in previous studies and differences between this analysis and other works can be related to the time and place of the plant harvested that might influence the chemical composition of the plant essential oil (Kurose and Yatagai, 2005; Tsiri et al., 2009; Ashraf et al., 2010; Alzogaray et al., 2011; Szołyga et al., 2014).

In this study, the insecticidal properties of three essential oils of eucalyptus (*E. camaldulensis*), azadirachtin (*A. indica*) and northern white cedar fruits (*T. occidentalis*) have been studied on cabbage aphid. The results of this study show that these essential oils have a lethal effect on the tested pest and mortality rate increased with increasing concentration of oil. In recent years, extensive surveys have been carried out in order to verify the insecticidal properties of essential oils and their compounds on various pests and a number of them have had favorable effects. For example, Mareggiani et al.

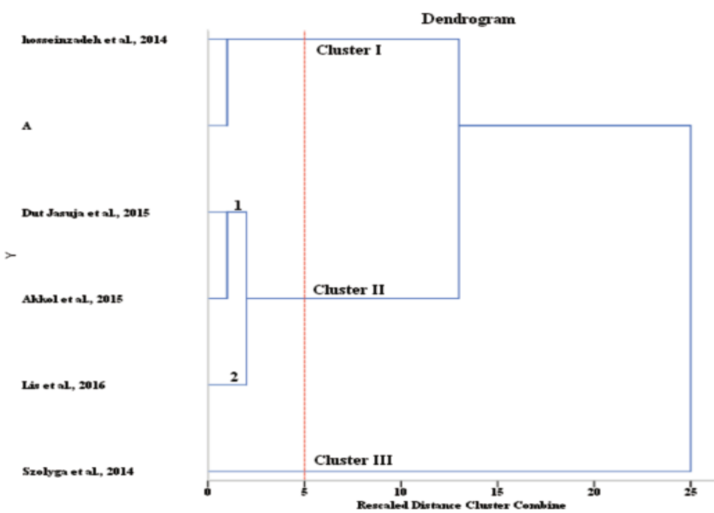

Fig. 3. Dendrogram generated of cluster analysis from *T. occidentalis* EOs based on the chemical compounds of the investigated sample (A) and those from the articles.

(2008) proved the high insecticidal activity of *Eucalyptus globules* essential oil against cotton aphid. In this regard, Ebrahimi et al. (2013) tested the plant essence of azadirachtin (*A. indica*), eucalyptus (*E. camaldulensis*) and laurel (*L. nobilis*) to control cotton aphid and concluded that azadirachtin and eucalyptus had more of a lethal effect than laurel. Also, Kraiss and Cullen (2008) studied the insecticide effect different formulations of essential oil of azadirachtin on bean aphid nymphs *Aphis glycines* Matsumura and came to the conclusion that the essence has had a high controlling effect on the pest. The findings of this study correspond with the results of the experiments done by Mareggiani et al. (2008), Ebrahimi et al. (2013) as well as Kraiss and Cullen (2008), stating that essential oils of eucalyptus and Azadirachtin show a significant lethal effect on aphids from the family Aphididae. In another experiment, controlling effect of azadirachtin and eucalyptus leaf powder on bean beetle was studied and the results showed that they have significant insecticidal and egg-killing effect (Javaid and Mpotokwane, 1997). Also Moussa Kéïta et al. (2001) proved the insecticidal effect of northern white cedar fruit essential oil with kaolin powder on the eggs and adults of bean beetle, *Callosobruchus maculatus* F. The results of these two studies are consistent with the results of this research on the toxicity of eucalyptus, azadirachtin and northern white cedar fruit on pests. In an experiment, Işık and Görür (2009) proved the effect of plant essential oils against the cabbage aphid (*B. brassicae*). Also, Pavela (2005) reported the lethal effect of *Artemisia indica* plant essential oil against the cabbage aphid (*B. brassicae*) and insecticidal activity of both laurel (*L. nobilis*) and eucalyptus (*E. camaldulensis*) essential oil on this pest (*B. brassicae*), respectively. Therefore, the obtained results by this research correspond with the findings of these researchers on insecticidal activity of essential oils such as eucalyptus on cabbage aphid. According to recent findings, various studies have been done on the insecticidal activity of essential oils on various species of aphids from the family Aphididae including the insecticidal effect of 23 plant essential oils and their main compounds against adult turnip aphid (*Lipaphis pseudobrassicae* Davis) (Sampson et al., 2005), respiratory toxicity of 12 Mediterranean species essential oils against pea aphids (*Acyrthosiphon pisum* Harris) and green peach aphid (*Myzus persicae* Sulzer) (Digilio et al., 2008), intense insecticidal activity of a number of plant essences against foxglove aphid (*Aulacorthum solani* Kalt.) (Gorski and Tomczak, 2010).

The results of this study indicate the high insecticidal activity of these essential oils on adult cabbage aphid. Therefore, a place can be reserved for these essences in pest control programs for the effective control of pests as well as reducing the use of chemical insecticides.

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Received / Prejeto: 8. 7. 2017

ACTA ENTOMOLOGICA SLOVENICA

LJUBLJANA, DECEMBER 2017 Vol. 25, št. 2: 191–198

RESPONSES OF SOMATIC TISSUES OF DEVELOPMENTAL STAGES OF VARIEGATED GRASSHOPPER, *ZONOCERUS VARIEGATUS* (L.) (ORTHOPTERA: PYRGOMORPHIDAE) TO STARVATION

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Abstract - Nymphs and adult stage of *Zonocerus variegatus* respond to environmental stress differently. The response of somatic tissues to 96 hours starvation across the post embryonic developmental stages of *Zonocerus* was investigated in this study. The organic substances (lipids, glucose and protein) concentrations were measured by standard methods before and after starvation exercise in the somatic tissues (femoral muscles, fat body and haemolymph) and the difference calculated. The adult stage experienced highest weight loss of 0.22g from the initial weight, while the 1st instar stage had the least weight loss of 0.10g from the initial weight. Glucose was the most depleted haemolymph metabolite (0.50-3.40mg/dl) and the 1st instar stage lost the least amount of metabolites. In the fat body, the highest glucose concentration was lost by the adult stage (5.70mg/dl) while the least was loss by the 1st instar stage. Lipids were the most depleted metabolite in the femoral muscles and the adult stage similarly lost the highest concentration. Comparison of means showed this pattern of metabolites loss in the three somatic tissues: glucose>lipids>protein. Despite the highest loss in concentration of metabolites, the adult stage still fared better than other stages of development during starvation because of higher stored reserves. Early instar stages of *Z. variegatus* are thus less complicated and easier to control than the tough adult stage.

Key words: somatic tissues, starvation, instar, adult stage, *Zonocerus variegatus*, metabolites

Izvleček – ODZIV TELESNIH TKIV RAZVOJNIH STOPENJ KOBILICE *ZONOCERUS VARIEGATUS* (L.) (ORTHOPTERA: PYRGOMORPHIDAE) NA STRADANJE

Ličinke in odrasla stopnja kobilice *Zonocerus variegatus* se različno odzivajo na okoljski stres. V tej raziskavi smo preučevali odziv telesnih tkiv postembrionalnih razvojnih stopenj kobilic na 96 ur stradanja. Koncentracije organskih snovi (lipidov, glukoze in proteinov) smo merili s standardnimi metodami pred in po stradanju v telesnih tkivih (stegenskih mišicah, maščobnem telesu in hemolimfi) in izračunali razliko. Odrasla stopnja je doživela največjo izgubo teže, 0,22g, od začetne teže, prva stopnja ličinke pa z 0,10g najmanjšo izgubo teže od začetne. Glukoza je bila najbolj izčrpan hemolimfni metabolit (0,50 – 3,40 mg/dl) in ličinka prve stopnje je izgubila najmanj metabolitov. V maščobnem telesu se je koncentracija glukoze najbolj zmanjšala pri odrasli stopnji (5,70 mg/dl), najmanj pa pri ličinki prve stopnje. Lipidi so bili najbolj izčrpan metabolit v stegenskih mišicah in odrasla stopnja je podobno izgubila največ koncentracije. Skupna primerjava izgube metabolitov v treh telesnih tkivih je pokazala vzorec: glukoza>lipidi>proteini. Kljub največji izgubi koncentracije metabolitov je odrasla stopnja bolje kot druge razvojne stopnje preživela stradanje zaradi več shranjenih zalog. Zgodnje razvojne stopnje *Z. variegatus* zato nadziramo lažje in z manj zapleti kot zdržljivo odraslo stopnjo.

KLJUČNE BESEDE: telesna tkiva, stradanje, razvojne stopnje, odrasla stopnja, *Zonocerus variegatus*, metaboliti

Introduction

In Nigeria, *Zonocerus variegatus* occurs in cultivated land with the nymphs and adult stage sharing same habitat which extends from rainforest zone to Guinea Savannah in the north (Youdeowei, 1974). The life cycle consists of six nymphal stages and adult stage, which is the reproductive stage. Ademolu *et al* (2013) reported that all nymphal stages together lasted for 111.1 days while female and male adults lived for 127.9 and 101.2 days respectively. Hence, the total life cycle of *Z. variegatus* was between 210.8 and 237.5 days (Ademolu *et al*., 2013).

Though living in the same habitat, the various developmental stages behave differently: 1st -3rd instars are gregarious in nature and prefer exclusively *Chromolaena odorata* while later instars and adult stage feed predominantly on *Manihot esculenta* and live dispersed (Toye, 1982). Similarly, an initial rise in the concentrations of tissue metabolites was observed during the 1st -5th nymphal stage of *Z. variegatus* which dropped at the 6th instar and rose again at the adult stage (Ademolu *et al.,* 2007).

Muse (2003) observed that starvation had significant influence on the longevity of the adult stage. Likewise, Idowu and Idowu (2001) reported that starvation reduced the volume of the repellent gland obtained from *Z. variegatus*. In *Locusta migratoria*, lipid reserves were mobilized from the fat body during starvation, resulting in increase in total haemolymph lipids and decrease in the fat body lipids (Jutsum *et al*., 1975).

Similarly, in *L. migratoria* and fruit beetles (*Paechnoda sinuata*) glycogen stores are metabolized during the initial stage of starvation and later switch to lipid and protein metabolism happens when carbohydrates are exhausted (Hill and Goldswothy, 1970; Auerswald and Gade,2000).

Starvation process reduced the colony forming unit (cfu) in the midgut, as well as the concentration of organic and inorganic substances in the haemolymph, fat body and femoral muscles of adult *Zonocerus* (Ademolu *et al*.,2011). Since the physiology of each stage of development differs, will their tissues respond differently to starvation exercise? This study attempts to examine the response of each developmental stage of *Z. variegatus* to the process of starvation.

Materials and methods

Insect samples

Newly hatched 1st instar nymphs of *Z.variegatus* were collected from a known oviposition site on the campus of Federal University of Agriculture, Abeokuta (FUNAAB), Nigeria. Being gregarious in behavior at this stage, hundreds were collected with the aid of sweep net and were transferred into wire cages (30x30x45 cm). On arrival at the insectary of Pure and Applied Zoology, FUNAAB, the insects were separated into seven cages each containing 60 individual insects and allowed to molt into its different developmental stages. The 2nd instar to the 6th instar stage individuals were maintained on leaves of *M. esculenta* (cassava) before molting into the next stage of development.

Each developmental stage was starved for 96 hours (4 days) at 2nd day after emergence following methods adopted by Ademolu *et al* (2011).

Data Collection

(a) Body weight

The body weight of the insects was taken both before and after the four days starvation experiment using sensitive digitalized weighing balance (Mettler Toledo, AE, 240).

(b) Tissue collection and preparation

Three somatic tissues (haemolymph, fat body and femoral muscles) were harvested from *Z. variegatus* before and after the 96 hours starvation period.

Haemolymph was collected following methods described by Ademolu *et al* (2011). A micro needle was inserted into the mid ventral axis of the thorax and the haemolymph coming out was collected into a calibrated syringe. The sample was centrifuged and the supernatant was kept in refrigerator for further analysis.

The peripheral fat body was carefully picked and 0.5g of it was homogenized in 5mls of distilled water and the homogenate was used for analysis.

Following the opening of the hind femora, the femoral muscles were removed by forceps into the petri dishes, dried to constant weight at 50^{o}C in an oven at 12 hours and from it, 0.5g was macerated in 0.05M KCl. The homogenate was centrifuged and supernatant obtained was kept in refrigerator until further usage.

(c) Analysis of samples

The protein, glucose and lipids of the samples were determined following the methods of Henry *et al* (1997), Baunmniger (1974) and Grant *et al* (1997) respectively.

Statistical analysis

All analyses were carried out in triplicates and the data were subjected to analysis of variance. Separation of significant means was done by Duncan Multiple Range Test.

Results

The influence of starvation on the body weight of developmental stages of *Z. variegatus* is shown in Table 1. The body weight of all developmental stages was significantly ($p<0.05$) affected by starvation. The weight loss was progressively increasing as the insect passed through the developmental stages with the adult stage having the highest weight loss.

Table 2 shows the influence of starvation on the haemolymph metabolites of developmental stages of *Z. variegatus*. There was a significant difference in the amount of glucose loss due to starvation by the different stages of development with the adult stage recording the highest glucose loss. Although no significant difference was recorded in the amount of protein and lipids loss to starvation by the developmental stages, adult stage had the highest numerical loss.

Table 1: Effects of 96 hours starvation on the body weight (g) of developmental stages of *Zonocerus variegatus* (L).

Stages of development	1st Instar	2nd Instar	3rd Instar	4th Instar	5th Instar	6th Instar	Adult
Average initial weight	0.10^{c}	0.12^{c}	0.14^{c}	0.18^{c}	0.30^{b}	0.50^{b}	0.97^{a}
Average final weight	0.09^{c}	0.11^{c}	0.12^{c}	0.16^{c}	0.25^{bc}	0.45^{b}	0.75^{a}
Average weight loss	0.01^{c}	0.01^{c}	0.02^{c}	0.02^{c}	0.05^{b}	0.05^{b}	0.22^{a}

Mean values in the same row having the same superscript are not significantly different ($p>0.05$).

Table 2: Haemolymph metabolites loss during 96 hours starvation of developmental stages of *Zonocerus variegatus* (mg/dl).

Developmental Stages	Glucose	Protein	Lipids
1st Instar	1.1[b]	0.3	1.2
2nd Instar	1.7[b]	0.2	1.4
3rd Instar	1.8[b]	0.4	1.3
4th instar	1.2[b]	0.4	1.1
5th Instar	3.4[a]	0.3	1.5
6th Instar	0.5[c]	0.4	0.7
Adult	3.2[a]	0.6	1.9

Mean values in the same column having the same superscript are not significantly different (p>0.05).

The loss of metabolites in the fat body of developmental stages of *Z.variegatus* after 96 hours starvation is shown in Table 3. There was progressive increase in the amount of metabolites loss as the insect passed through 1st instar stage to the adult stage (except lipids). The results also show that more of glucose and lipids were lost to starvation than protein.

The loss of femoral muscle metabolites due to 96 hours starvation of developmental stages of *Z.variegatus* revealed differences in the amount of metabolites lost by each stage of development (Table 4). The adult stage recorded the highest glucose and lipids loss while the earlier instars had lowest loss.

Table 3: Fat body metabolites loss during 96 hours starvation of developmental stages of *Zonocerus variegatus* (mg/dl).

Developmental Stages	Glucose	Protein	Lipids
1st Instar	0.9[c]	0.5[b]	1.5[b]
2nd Instar	1.5[c]	0.4[b]	2.3[b]
3rd Instar	1.0[c]	0.8[b]	2.5[b]
4th instar	3.2[b]	2.7[ab]	2.1[b]
5th Instar	3.5[b]	2.1[ab]	8.1[a]
6th Instar	0.2[c]	2.0[ab]	1.7[b]
Adult	5.7[a]	3.3[a]	2.1[b]

Mean values in the same column having the same superscript are not significantly different (p>0.05).

Table 4: Femoral muscles metabolites loss during 96 hours starvation of developmental stages of *Zonocerus variegatus* (mg/dl)

Developmental Stages	Glucose	Protein	Lipids
1st Instar	0.8	0.1	1.5[c]
2nd Instar	0.6	0.5	1.1[c]
3rd Instar	0.7	0.5	2.3[c]
4th instar	2.3	1.5	1.7[c]
5th Instar	0.9	2.2	1.5[c]
6th Instar	2.7	1.8	5.0[c]
Adult	3.0	2.1	7.5[a]

Mean values in the same column having the same superscript are not significantly different ($p>0.05$).

Discussion

The body weight loss of *Z. variegatus* due to 96 hours starvation increased gradually from 1st instar to the adult stage. This reflects trend of energy depletion, that is, energy depletion was more in the later instars than the early instars. The food reserves as a result of food consumption by insects increased with nymphal growth owing to increased food requirement for growth and metabolic function, thus during starvation stress, such reserves are lost or depleted in high quantity (Omkar and Jones, 2003). Also, the active nature (dispersal) of the later instars and adult stage deplete their resources more compared to the early instars that are gregarious in habit and therefore conserve or less exhaust their resources (Toye,1982). Furthermore, the difference in the way the nymphal stages and adult responded to food deprivation might be related to their water balance, because adults are more susceptible to water loss than the nymphs.

Somatic tissues of *Z. variegatus* lost significant quantity of their metabolites concentration due to starvation. Similar observation was made by Perez-Mendoza *et al.* (1999) where starvation reduced the lipids content and body weight of Lesser grain borer, *Rhyzopertha dominica.* Similarly, Auerswald and Gade, (2000) reported that in *P. sinuata,* carbohydrates were first metabolized during the initial stage of starvation, then shift to lipids and proteins happened when carbohydrates were exhausted. However, the fact that protein component of these tissues was also depleted possibly suggests that lipids and glucose metabolism were not sufficient to meet the requirement of the insect, resulting in the net reduction of protein concentration.

Comparison of means revealed that less of protein and more of glucose and lipids were lost by the somatic tissues due to starvation. This is not unexpected as carbohydrates and lipids are the predominant metabolites utilized during initial stage of starvation (Hill and Goldworthy, 1970; Hainsworth, 1981). In an experiment using *Oxya* *japonica* (Acrididae: Orthoptera), a significant decrease in the total haemolymph lipids and carbohydrates was observed when deprived of food for 96 hours (Lim and Lee, 1981). During starvation trials in two *Drosophila* species, rates of lipid and protein metabolism were similar, but carbohydrate metabolism was several fold higher (Marron *et al*., 2003).

The fat body of *Z. variegatus* experienced higher metabolites loss due to starvation than other two somatic tissues examined. This might likely be due to the higher amount of metabolites present there and thus expectedly higher loss to starvation. Ademolu *et al* (2007) observed that fat body stores more protein and lipids than the haemolymph and femoral muscles during postembryonic development of *Z. variegatus*. Similarly, the fat body was reported to have stored more glycogen, fat, protein and other substances brought into it by the haemolymph (Hannerland and Shirk, 1995)**.**

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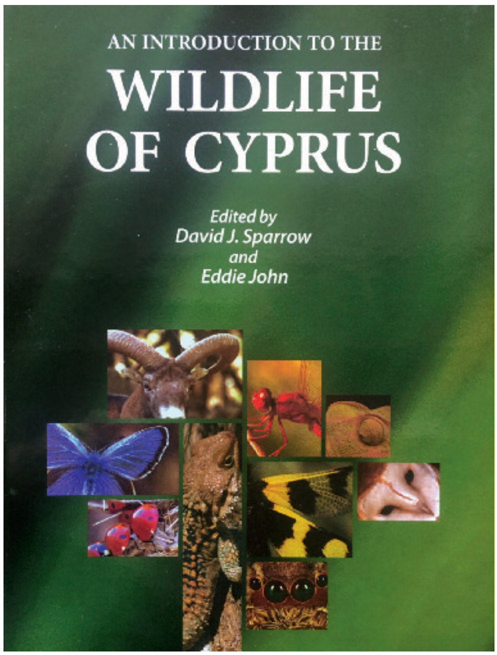
Received / Prejeto: 17. 8. 2017

ACTA ENTOMOLOGICA SLOVENICA
LJUBLJANA, DECEMBER 2017 Vol. 25, št. 2: 199–200

NOVE KNJIGE

An Introduction to the Wildlife of Cyprus,
D. J. Sparrow in E. John (ur.). 870 str., Terra Cypria, Cyprus. 2017.
ISBN 978-9963-601-45-5.



Knjiga "An Introduction to the Wildlife of Cyprus" (Uvod v živi svet Cipra) širokopotezno pristopa k prikazu živalstva na otoku Ciper. Obsežen pregled živali in nekaterih naravnih značilnosti Cipra bo pritegnil strokovno kot tudi širšo javnost. Stroki lahko knjiga služi kot pomemben osnovni dokument biotske raznolikosti otoške države, za nekatere skupine celo kot favnistični pregled, širša javnost pa si lahko ob kvalitetnem in obsežnem slikovnem materialu ter dobro napisanem besedilu ustvari splošno sliko o živalskem svetu, njegovi raznolikosti, kot tudi o posebnostih, značilnih za geografsko izolirano območje, kar od celine precej oddaljeni Ciper vsekakor je.

Knjiga je razdeljena na 4 dele, znotraj katerih se zvrsti 30 poglavij. Prispevki 44 specialistov iz 12 držav, vključno z domačimi strokovnjaki, obsegajo 870 strani. Več kot 180 fotografov je prispevalo čez 1100 fotografij in skic. Obravnave živali Cipra se knjiga loteva celovito. V prvem delu predstavi geografske, klimatske in geološke značilnosti, ki prispevajo k raznolikosti habitatov tega mediteranskega otoka. V drugem delu knjige je na kratko opredeljena klasifikacija živih bitij in biogeografski izvor živali na Cipru. V tretjem, najobsežnejšem delu, so predstavljeni nevretenčarji. Začne se s poglavjem »Uvod v nevretenčarje«, vsako naslednje poglavje pa je posvečeno svojemu razredu oz. redu nevretenčarjev. Četrti del je namenjen vretenčarjem in se prav tako začne z uvodnim poglavjem, nadaljuje pa s poglavji o ribah, dvoživkah, plazilcih, ptičih in sesalcih. Knjiga je opremljena s kratkim slovarjem ter kazalom angleških in latinskih imen živali. Predgovor sta prispevala Max Kasparek (Heidelberg) in Dr Artemis Yiordamli (Terra Cypria), spremno besedo pa urednika knjige, David J. Sparrow in Eddie John. V uvodnem delu knjige so predstavljeni avtorji prispevkov.

Poglavja o živalskih skupinah vsebujejo, ob obsežnem slikovnem materialu, informacije o njihovi biologiji, habitatu, o predstavnikih, pri nekaterih poglavjih celo določevalne ključe. Poglavja imajo precej različen obseg, v vsakem primeru pa predstavljajo vsaj dober splošen uvod v posamezno živalsko skupino. Nekateri taksoni, npr. metulji in vešče, kačji pastirji, kobilice so predstavljeni zelo temeljito, lahko tudi na več kot 100 straneh, medtem ko so druge skupine, prav tako obsežne in raznolike, npr. hrošči, obdelane na zgolj dobrih 20 straneh. To je seveda povezano s privlačnostjo in raziskanostjo posamezne skupine na Cipru, kar pa knjigi daje še dodatno vrednost, saj opozarja na živalske skupine, ki bi jim bilo v bodoče potrebno nameniti več raziskovalnega napora.

Ciper je eden večjih otokov v Sredozemskem morju, kar je organizmom omogočalo ločeno evolucijo zaradi geografske ločenosti populacij. Posledice tega so visoka stopnja endemizma ter nenavadne prilagoditve organizmov in združb. Avtorji se zelo trudijo, da bi prikazali te posebnosti otoškega življenja in poudarili pomen endemnih vrst. Takšne knjige predstavljajo pomemben dokument za zavedanje prebivalcev in obiskovalcev Cipra, kakšne naravne vrednote jih obkrožajo in kaj je v bodoče potrebno varovati in zaščititi. Za vsakega naravoslovno usmerjenega obiskovalca otoka bo ta knjiga predstavljala odličen temelj za raziskovanje narave Cipra.

Urednika v spremni besedi opozarjata, da je favna Cipra še vedno slabo raziskana. Izgleda pa, da je knjiga že v svojem nastajanju poskrbela za premike na tem področju. V poglavjih o mrežekrilcih, termitih in pajkovcih namreč že poročajo o odkrivanju za Ciper novih vrst. Pričakujem, da lahko ima tak dokument v bodoče še bolj stimulativen vpliv na nova odkritja in raziskovanje na Cipru.

Knjiga je bila izdana pri založbi Terra Cypria (včasih The Cyprus Conservation Foundation), ki je bila ustanovljena leta 1992. Ukvarjajo se s z okoljskim izobraževanjem in izdajanjem publikacij povezanih z naravovarstvom. Predstavljena knjiga je do sedaj njihova prva publikacija, ki se celostno ukvarja z biodiverziteto Cipra.

Jan Podlesnik

Vsebina / Contents