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ŠTEFANA MICHIELIJA

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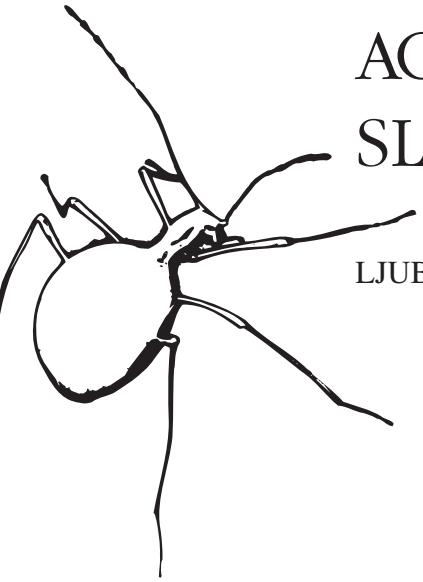

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ACTA ENTOMOLOGICA SLOVENICA

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RAZŠIRJENOST JAMSKIH HROŠČEV PODZEMLJARJEV RODU *PROSPELAEOBATES* (COLEOPTERA; LEIODIDAE; LEPTODIRINI) IN NJIHOVO ŽIVLJENJSKO OKOLJE

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Izvleček – Rod hroščev podzemljarjev *Prospelaeobates* je bil odkrit in opisan šele leta 1996, hkrati z opisom dveh vrst, *P. vrezeci* iz jame Medvedjak v Matarskem podolju (Slovenija) in *P. bognoloi* iz Petričeve jame na Cresu (Hrvaška). Leta 2003 je bila opisana še tretja vrsta, *P. brelihi* iz ledenih jam na Snežniku (Slovenija). V prispevku so podani novi podatki o razširjenosti vrst in opredeljen ter diskutiran njihov primarni habitat. Ugotovljeno je, da vrste tega rodu verjetno živijo pretežno v površinskem podzemeljskem okolju (MSS), v večje jamske prostore pa zaidejo le občasno in naključno.

KLJUČNE BESEDE: Leptodirini, *Prospelaeobates vrezeci, Prospelaeobates brelihi, Prospelaeobates bognoloi*, razširjenost, MSS, Slovenija, Hrvaška

Abstract – DISTRIBUTION OF THE SUBTERRANEAN BEETLE GENUS *PROSPELAEOBATES* SPECIES (COLEOPTERA; LEIODIDAE; LEPTODIRINI) AND THEIR HABITAT

The suberranean Leptodirini beetle genus *Prospelaeobates* was discovered and described recently in 1996 at the same time as the two new species; *P. vrezeci* from Medvedjak cave in Matarsko podolje (Slovenia) and *P. bognoloi* from Petričeva cave on Island of Cres (Croatia). In 2003, a third species *P. brelihi* from ice caves on Snežnik (Slovenia) was described. The paper presents new data on the distribution of species and identifies and discusses their primary habitat. It has been found that the species of this genus probably live predominantly in the shallow subterranean habitats (MSS) and enter large cave spaces only occasionally and randomly.

KEY WORDS: Leptodirini beetles, *Prospelaeobates vrezeci, Prospelaeobates brelihi, Prospelaeobates bognoloi*, distribution, MSS, Slovenia, Croatia

Uvod

Slovenija slovi po pestri favni jamskih hroščev in velja tudi za eno bolje pokritih dežel v smislu raziskanosti podzemeljskega živalstva. Kljub temu pa se odkrivanja novih vrst in celo novih rodov jamskih hroščev še vedno vrstijo. Svojevrstno presenečenje je bilo odkritje primerkov drobnih hroščev podzemeljarjev leta 1994 v jami Medvedjak v Matarskem podolju in podobnih primerkov hroščev istega leta v Petričevi jami na severnem delu Cresa. Leta 1996 sta italijanska entomologa Pier Mauro Giachino in Mirto Etonti zanju opredelila nov rod podzemljarjev *Prospelaeobates* in opisala novi vrsti *P. vrezeci* (dolžine telesa 1,8–2,0 mm) iz jame Medvedjak ter *P. bognoloi* (dolžine telesa 2,3–2,6 mm) iz Petričeve jame na otoku Cres. Avgusta leta 2001 smo v malem breznu oziroma ledenici blizu Mašuna v snežniškem pogorju našli primerke jamskih hroščev, ki so ustrezali opisu rodu *Prospelaeobates.* Jama še ni bila speleološko raziskana in ni bila evidentirana v katastru jam Slovenije, zato smo jo poimenovali z delovnim imenom Jama v Kovačiji po bližnjem lokalnem imenu območja. V naslednjih letih smo intenzivneje raziskovali jamske objekte po Snežniku in primerke rodu *Prospelaeobates* našli še v Lekšanovi mrzli jami na Javornikih. Avtor in Marco Bognolo sta primerke rodu *Prospelaeobates* našla še v breznu imenovanem Felajeva luknja 1 v snežniškem pogorju. Na osnovi bistvenih morfoloških razlik zbranih primerkov iz jam na Snežniku (dolžine telesa 2,4–2,7 mm), sta leta 2003 opisala novo vrsto *P. brelihi*. Vse tri vrste tega rodu veljajo za redke in zelo lokalno razširjene. Ob raziskavah jamskih hroščev v kasnejših letih smo našli več novih lokalitet tega rodu, zlasti vrste *P. brelihi*. Namen prispevka je podati trenutno poznavanje razširjenost in ekologije vseh treh znanih vrst tega rodu.

Material in metode

Osebke jamskih hroščev podzemljarjev smo iskali z neposrednim pregledovanjem sten in kamenja na dnu jamskih objektov. Ker smo za vrsto *P. brelihi* predvidevali, da živi v hladnejših jamah in jamah ledenicah s stalnim snegom in ledom, smo načrtno pregledovali take objekte. Za obisk večine jam je bila potrebna uporaba sodobne jamarske plezalne vrvne tehnike. V nekaterih jamah smo nastavili pasti, lončke z usmrajenim mesom in vodno raztopino kuhinjske soli kot konzervansom (pit-fall traps), ali pa živolovne pasti z vabo brez konzervansa. V enem primeru in sicer v Jami v Kovačiji, kasneje poimenovani Jama jugozahodno od Mašuna, smo v sodelovanju z Davidom Culverjem (Washingtonska Univerza) in Tanjo Pipan (Inštitut za raziskovanje krasa ZRC SAZU) s pomočjo avtomatskih merilcev temperature (Onset (Tidbit)^{TM} temperature data loggers, ki beležijo temperaturo vsako uro) merili temperaturo v različnih delih jame in okolice v obdobju enega leta od aprila 2008 do junija 2009. Zbrani primerki hroščev so shranjeni v Zbirki hroščev Notranjskega muzeja Postojna, del pa predan za primerjalne zbirke ostalim naravoslovnim muzejem v regiji (Zbirka Egona Pretnerja v Prirodoslovnem muzeju Slovenije; Prirodoslovni muzej v Trstu, Prirodoslovni muzej Zagreb). Za potrebe molekularnih filogenetskih raziskav, ki so v teku, je bilo manjše število primerkov shranjenih v 96% etanolu.

Ostale podatke o najdbah teh hroščev povzemamo po objavljeni dostopni literaturi. Katastrske številke (kat. št.) jamskih objektov se nanašajo na zaporedne številke jam v katastru jam Slovenije, ki ga vodita Inštitut za raziskovanje krasa ZRC SAZU in Jamarska zveza Slovenije. Raziskave jamskih hroščev so bile opravljene z dovoljenjem Agencije RS za okolje (Št. 35714-75/2002, 35701-29/2004, 3561-30/2010-7, 35601-39/2015-4).

Rezultati

Razširjenost vrste ***Prospelaeobates vrezeci*** Giachino & Etonti 1996

Vrsta je bila doslej znana le iz tipske lokalitete jame Medvedjak (kat. št. 881) in je opredeljena kot tipska vrsta za opis novega rodu (Giachino in Etonti 1996). Medvedjak se nahaja v Matarskem podolju blizu naselja Skadanščina v bližini Materije na nadmorski višini 522 metrov. To je jama s 45 metrskim vhodnim breznom, ki se nadaljuje v dober kilometer dolg jamski rov in na najnižji točki sega 129 metrov pod površje. Doslej so bili znani le primerki, zbrani v pasteh za hrošče, nastavljenimi med 7. 5. 1994 in 16. 3. 1996 ter so opredeljeni v tipski seriji osebkov za opis vrste (Giachino in Etonti 1996). Med raziskavami jamske favne slovenskega in hrvaškega dela Istre v okviru mednarodnega projekta »KUP – *Karst Underground Protection*« (Ozimec s sod. 2011, Polak s sod. 2012), se je v tri dni nastavljene živolovne pasti za proučevanje jamske favne dne 12. 8. 2012 ujel le en živ osebek te vrste (slika 1). Čeprav smo imeli pasti za hrošče z usmrajenim mesom nastavljene po celotnem profilu jame, se je primerek ujel le v past, nastavljeno v končnem delu jame pod velikim kaminom, kjer s stropa izdatno kaplja prenikla voda.

Slika 1: *Prospelaeobates vrezeci,* fotografiran 22. 10. 2010 v Jami Medvedjak pri Markovščini (Matarsko podolje).

Fig. 1: *Prospelaeobates vrezeci* photographed 22.10.2010 in Medvedjak cave near Markovščina (Matarsko podolje).

Vrsto *P. vrezeci* smo našli tudi na še eni novi lokaciji in sicer v Račiški pečini (kat. št. 942), kar je drugo znano nahajališče te vrste (Polak s sod. 2012). Račiška pečina se nahaja na nadmorski višini 600 metrov blizu naselja Račice v bližini mejnega prehoda Starod z republiko Hrvaško. Objekt je 304 metre dolga vodoravna fosilna jama, ki pa je bila že med obema svetovnima vojnama v vojaški uporabi kot skladišče goriva in je zato ostala biološko neraziskana. Račiška pečina je danes zavarovana kot paleontološko nahajališče pleistocenske favne in zaprta za nekontroliran obisk. Jamsko živalstvo te jame smo podrobneje raziskovali v letih 1995, 1996 in 1997, a vrste *P. vrezeci* v tej jami nismo potrdili, tudi z nastavljenimi pastmi z vabo ne. Ob podrobnejšem pregledu jame dne 20.10.2010, smo v pozabljenem kozarcu polnem vode našli en osebek *P. vrezeci* in sicer v končnem in edinem bolj vlažnem ter zasiganem delu jame. Najdba osamljenega primerka v edinem delu jame, kjer s stropa izdatno kaplja prenikla voda kaže, da vrsta v jami ni pogosta, oziroma da jamsko okolje Račiške pečine ni primarni habitat te vrste, pač pa vrsta verjetno živi v sistemu razpok nad jamo.

Razširjenost vrste ***Prospelaeobates bognoloi*** Giachino & Etonti 1996

Vrsta je bila opisana na osnovi primerkov, ki jih je nabral Marco Bognolo v Petričevi jami blizu naselja Beli na severnem delu hrvaškega otoka Cres v Kvarnerju. Jama je stopnjasto brezno z 12 in 30 metrskima vhodnima breznoma na nadmorski višini 300 metrov. Osebki vrste *P. bognoloi* so bili ulovljeni 21. 10. 1994, 5. 3. 1995 in 10. 3. 1996 v pasteh, postavljenih daljši čas na dnu brezen. O morebitnih novih nahajališčih vrste na otoku Cresu odtlej nimamo novejših podatkov (Jalžić, B. ustno poročanje).

Razširjenost vrste ***Prospelaeobates brelihi*** Polak & Bognolo 2003

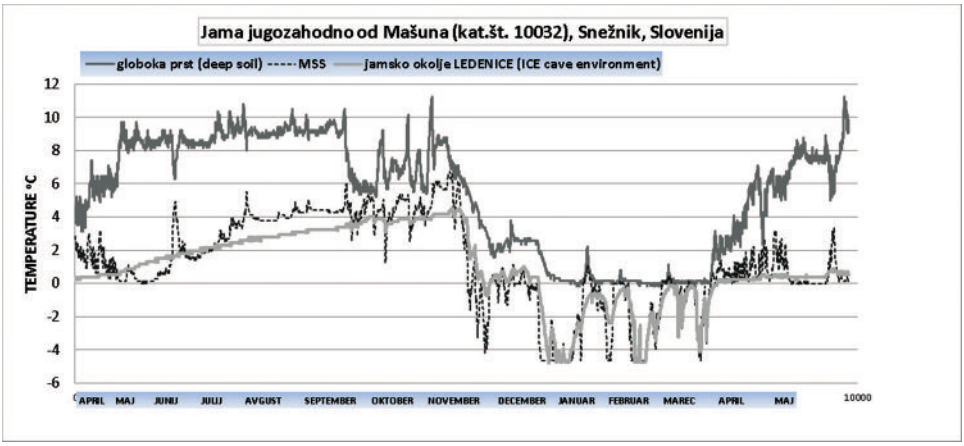
Kot tipska lokaliteta te vrste (slika 2) je bila opredeljena Felajeva luknja 1 (kat. št. 6654), saj prvo najdišče te vrste z delovnim imenom Jama v Kovačiji ob času opisa vrste ni bila speleološko registrirana in ni imela uradnega imena. Felajeva luknja 1 je 42 metrov globoko stopnjasto brezno v osrčju snežniških gozdov na nadmorski višini 990 m. Ob prvi speleološki registraciji jame leta 1986 se je v breznu nahajal led, kar je bil tudi razlog za ciljno iskanje primerkov rodu *Prospelaeobates*. V dneh 6. 7. 2002 in 2. 11. 2002 je bila med raziskovanjem jame zbrana serija v originalnem opisu opredeljenih tipskih primerkov. V času raziskav so bili v breznu le še borni ostanki ledu. Brezno je sicer občutno hladnejše od ostalih raziskanih bližnjih jam.

Tako imenovano Jamo v Kovačiji so šele 21. 6. 2009 speleološko registrirali zamejski tržaški jamarji in ji dali ime Jama jugozahodno od Mašuna (kat. št. 10032). Jama je 16 metrov globoka vrtača s strmimi brežinami in breznom, ki je zapolnjeno z gruščem ter stalnim ledom na dnu. Nahaja se na višini 1010 metrov. V malem jamskem prostoru na dnu vrtače smo primerke vrste *B. brelihi* našli pod kamenjem, pogosto tudi v bližini ledu, ob vsakem poznopomladanskem, poletnem in jesenskem obisku (16. 6. 2002, 6. 7. 2002, 15. 7. 2002, 28. 7. 2002, 12. 9. 2002, 15. 9. 2002, 29.

Slika 2: *Prospelaeobates brelihi,* fotografiran 12. 8. 2012 v Jami jugozahodno od Mašuna (Snežnik).

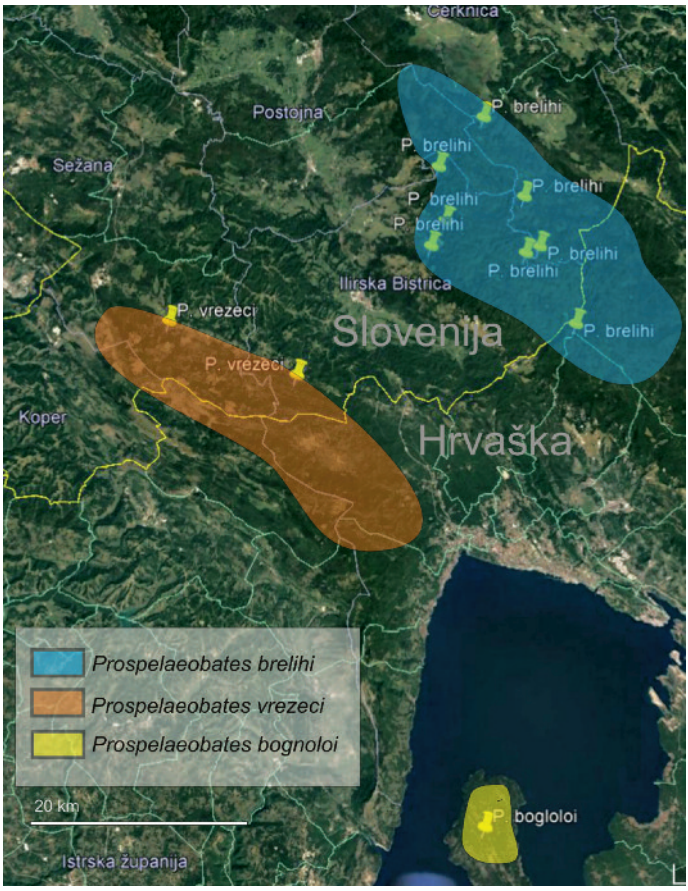
Fig. 2: *Prospelaeobates brelihi* photographed 12.8.2012 in Jama jugozahodno od Mašuna (Snežnik).

9. 2002, 23. 4. 2008, 9. 6. 2009, 12. 8. 2012, 19. 4. 2020). Ob pozno jesenskih obiskih po koncu novembra pa v jami ni bilo moč najti nobenega jamskega hrošča več. Z analizo podatkov avtomatske meritve temperature na treh mestih v različnih okoljih v profilu vrtače in jame v obdobju od 23. 4. 2008 do 9. 6. 2009, smo ugotovili izrazito temperaturno dinamiko, ki pojasni sezonske migracije jamske favne (slika 3). Temperature v jamskem okolju na dnu jame v bližini ledenega čepa so bile od marca do konca aprila le nekoliko nad ledišcem. V maju se je temperatura začela dvigati in do



Slika 3: Temperaturna nihanja v in pred ledenico Jama jugozahodno od Mašuna v obdobju od 23. 4. 2008 do 9. 6. 2009.

Fig 3: Temperature fluctuations in, and in front of the ice cave Jama jugozahodno od Mašuna in the period from 23.4.2008 to 9.6.2009.



Slika 4: Znane lokacije treh vrst podzemljarjev rodu *Prospelaeobates* v Sloveniji in na Hrvaškem ter z barvami označeni njihovi verjetni areali. Kartografska podlaga: Google Earth.

Fig. 4. Known locations of three species of the genus *Prospelaeobates* in Slovenia and Croatia and their probable distributions marked in colors. Map: Google Earth.

začetka novembra (13. 11. 2008) dosegla najvišjo izmerjeno temperaturo v jami 4,5°C. V novembru je začel v jamo vdirati hladen zrak iz okolice in temperatura je v jami nenadno (26. 11. 2008) padla pod ledišče. Glede na zimske temperaturne razmere na površini je temperatura v jami večkrat zdrsnila do -5°C. V tem zimskem obdobju se v jami ledenici kopiči led. Temperature se v jami konec marca stabilizirajo pri ledišču ter v marcu začno spet rahlo naraščati. Istočasno merjenje temperature v bližnjem okolju MSS, to je grušč in razpoke med kamni prekritimi s prstjo blizu površja (slika 5), je pokazalo podobno dinamiko, le da smo v MSS zaznali izrazitejša kratkotrajna temperaturna nihanja z nekoliko višjimi temperaturami od tistih izmerjenih v jami v obdobju od marca do novembra. Temperature izmerjene v zimskem delu leta pa so bile občasno še nižje. Nihanja temperature v okolju MSS v območju razpok med kamenjem, kjer je bilo zaznati zračne tokove, so bila neposredno povezana z nihanji temperature, merjenimi na površini pred jamo. Temperature merjene v globoki prsti na meji med prstjo in MSS okoljem so se še izraziteje odzivale na nihanje površinske temperature in so v poletnem času dosegale do 10°C. V zimski polovici leta, ko je

Slika 5: Mesto merjenja temperature in vzorčenja jamskih hroščev v MSS pred Jamo jugozahodno od Mašuna, 9. 6. 2009.

Figure 5: Site of temperature measurement and sampling of cave beetles in MSS in front of the cave Jama jugozahodno od Mašuna, 9.6.2009.

območje prekril sneg, se je nihanje temperatur v globoki prsti in MSS prekinilo in tu temperature niso več padle pod zmrzišče (Pipan s sod. 2011, Polak 2012, 2016). Vzporedno in kasnejše vzorčenje jamske favne je pokazalo, da so nekatere vrste podzemeljskih živali povsem prilagojene okolju ledenih jam z nizkimi temperaturami med 1°C in 5°C. V Jami jugozahodno od Mašuna so to vrste *Prospelaeobates brelihi*, *Parpropus sericeus* in *Bathyscimorphus (Drovenikia) serkoi*. Konec novembra, ko se temperature v jami ledenici spustijo pod zmrzišče, se jamski hrošči umaknejo bodisi globlje v podzemlje, kot to predvidevamo za vrsto *Parapropus sericeus,* bodisi se v zimski polovici leta zatečejo prek razpok plitvega podzemeljskega okolja (MSS) v globoko prst v okolici jame, kjer prezimijo (Polak 2012, 2016). Tako smo 30. 11. 2011 večje število primerkov vrste *Prospelaeobates brelihi* in *Bathyscimorphus (Dro-*

venikia) serkoi našli v pasteh, zakopanih približno 10 in 20 centimetrov globoko v MSS – grušč, prekrit s prstjo izven jame (slika 5). Z meritvami in vzorčenjem v različnih okoljih tako pojasnjujemo izrazito sezonsko migracijo jamskih hroščev kot odziv na temperaturna nihanja v okolju.

Tretje znano nahajališče vrste *P. brelihi* pred opisom vrste je bila še Lekšanova mrzla jama (kat. št. 5237). Jama je 28 metrov globoka udornica z bolj ali manj stalnim ledom na dnu. Nahaja se na severnem pobočju javorniških gozdov, že blizu Loške doline na nadmorski višini 1018 metrov. Jamo smo raziskovali trikrat in sicer 18. 8. 2001, 27. 10. 2001 ter 5. 7. 2002. Primerke vrste *P. brelihi* smo našli tako ob ledu v spodmolu na dnu jame, kot tudi pod kamni in v grušču v še osvetljenem delu podornega stožca na dnu udornice (Polak in Bognolo 2003).

Med sistematskim pregledovanjem ledenic snežniškega pogorja je bila vrsta *P. brelihi* najdena tudi v Prepadu pri Breznu pod Snežnikom (kat. št. 1001), imenovanem tudi Spodnje ali Malo Snežniško brezno. Nahaja se le nekoliko nižje od zelo znanega in 191 metrov globokega Snežniškega brezna (kat. št. 2420), imenovanega tudi Grda jama in je z njim gotovo povezana s sistemom razpok. Prepad pri Breznu pod Snežnikom je bil leta 1953 registriran kot le 10 metrov globoko široko brezno z ledenim čepom na dnu. Jamo smo prvič raziskovali 23. 8. 2001, vendar v pasti nastavljene ob robu ledeniškega čepa nismo ujeli jamskih hroščev. Šele po večkratnih poskusih in znatnem znižanju ledenega čepa, se je bilo možno dne 28. 10. 2002 spustiti po nastali približno meter široki cevi v ledeniku in prebiti do manjšega jamskega prostora na dnu. Poleg primerkov *P. brelihi* so bile tu najdene še vrste *Astagobius angustatus, Aphaobus milleri* in *Bathyscimorphus (Drovenikia) serkoi*.

Planincem in obiskovalcem Notranjskega Snežnika (1796 m) je dobro znana ledeniška, 16 metrov globoka razpoka na ovršju Snežnika, imenovana Snežnica vrh Snežnika (kat. št. 807). Ta je večinoma zapolnjena s snegom in ledom, ki zaradi višje nadmorske višine (1785 m) vztraja čez celotno leto. Večji del leta je zato objekt nedostopen, le proti koncu poletja in jeseni se led v razpoki dovolj stopi, kar omogoča, da lahko dosežemo kamninsko podlago. V pasteh za jamske hrošče, nastavljenih 24. 11. 2003 in pobranih naslednjo pomlad 26. 3. 2004 ter 26. 9. 2004, smo ujeli več primerkov vrste *P. brelihi*, *Spelaeodromus sneznikensis, Parapropus sericeus, Astagobius angustatus, Aphaobus milleri* in *Bathyscimorphus (Drovenikia) serkoi*. Snežnica vrh Snežnika je doslej edina znana jama z vrsto *P. brelihi* nad drevesno mejo.

V jami imenovani Jama Suha reber (kat. št. 6589), ki se nahaja na robu snežniške planote nad Pivško kotlino na nadmorski višini 920 metrov, smo dne 6. 6. 2004 na dnu te sicer 53 metrov globoke in 85 metrov dolge jame, našli nekaj primerkov *P. brelihi.* V nastavljene pasti, zakopane med grušč podornega stožca, pa smo v obdobju od 14. 4. do 1. 6. 2019 ponovno ulovil večjo serijo primerkov te vrste. V jami so bile ugotovljene še vrste *Astagobius angustatus, Aphaobus milleri* in *Bathyscimorphus (Drovenikia) serkoi*. Velja omeniti, da v končnem in bolj zasiganem delu jame, primerkov *P. brelihi* nismo potrdili.

Zadnje odkrito nahajališče vrste *P. brelihi* je Mrzla jama na Javornikih (kat. št. 3402), imenovana tudi Mrzla jama pod Hudičevim hribom. Nahaja se v javorniških gozdovih na nadmorski višini 960 metrov. Jama je dobro poznana, lahko dostopna in

so jo obiskali tudi entomologi. Razlog, da te vrste speleobiologi in zbiralci tu doslej niso našli, je v tem, da smo primerke *P. brelihi* dobili le v pasteh zakopanih od 14. 4. do 1. 6. 2019 v grušču in sicer v še osvetljenem delu pred jamo. V istih pasteh smo dobili še vrsti *Aphaobus milleri* in *Bathyscimorphus (Drovenikia) slavkoi*. Mrzla jama na Javornikih je 53 metrov globoka udornica s temperaturnim obratom, kar je vzrok, da v jami in pred njo sneg in led vztrajata še pozno v poletje.

Vrsta *P. brelihi* pa je bila pričakovano najdena tudi na hrvaški strani snežniškega masiva. Med sistematičnimi raziskavami jam območja Šverde, tik ob državni meji, so hrvaški jamarji s pridruženimi mednarodnimi ekipami v trinajstih letih, od leta 2005 do leta 2018, raziskali kar 156 jamskih objektov. Pridružili so se jim tudi speleobiologi in raziskovali jamsko živalstvo (Pavlek s sod. 2018). Kljub velikemu raziskovalnemu naporu so vrsto *P. brelihi* našli le v eni jami, imenovani Pupak (Pušak) svijeta (Speleološka Udruga »Estavela«, kat. broj 140) in sicer le en osebek (Ozimec 2005, Pavlek s sod. 2018). To je za sedaj tudi edino nahajališče te vrste na Hrvaškem. Majhna, le 8 metrov globoka jama z ozkim vhodom, je sicer tudi ledenica in se nahaja v območju imenovanem Šverda na nadmorski višini 1240 metrov.

Diskusija

Jamske, ali bolje rečeno podzemeljske vrste hroščev in seveda predstavnikov druge podzemeljske favne ne zasledimo izključno v jamah oziroma v podzemlju, pač pa jih najdemo tudi v gozdni stelji in gozdni prsti, torej v okolju, ki ga uvrščamo med epigeična okolja. Pravo podzemeljsko – hipogeično okolje se nahaja globlje v podzemlju, pod to površinsko plastjo. Meja med površinskimi in podzemeljskimi okolji pa v naravi ni ostra.

Pri pregledu okolij, v katerih smo doslej našli predstavnike podzemljarjev rodu *Prospelaeobates*, smo prišli do ugotovitve, da njihov osnovni življenjski prostor niso le kraške jame, pač pa tudi sistem razpok in preplet majhnih prostorov med gruščem in globoko zakopanimi kamni. Takšno okolje opredeljujemo kot plitvo oziroma površinsko podzemeljsko okolje imenovano MSS. Površinsko podzemeljsko okolje, ali s kratico MSS za »*Milieu Souterrain Superficiel*« je bilo podrobneje opredeljeno šele nedavno prav na primeru jamskih hroščev (Juberthie 1983, Giachino in Vailati 2010). MSS velja le za eno od okolij tako imenovanih plitvih podzemeljskih okolij »*Shallow subterranean habitats*«, kamor prištevamo tudi nekatera vodna okolja in epikras (Giachino in Vailati 2010, Culver in Pipan 2014). Podanih je več definicij podobnega okolja, zato je pri uporabi teh izrazov med biologi in geografi sicer nekaj nedoslednosti. Med entomologi se je najbolj uveljavilo poimenovanje kar MSS, ki izvira iz originalnega opisa (Juberthie 1983). To je sistem razpok in preplet majhnih prostorov med gruščem in skalami v globini 10 do 70 centimetrov pod debelo plastjo prsti. Tako okolje je specifično in drugačno od podzemnih jam, saj kaže močnejša sezonska, dnevna in letna temperaturna nihanja kot globoko jamsko okolje (Pipan s sod. 2011, Culver in Pipan 2014).

Vsaj za vrsti *P. brelihi* in *Bathyscimorphus (Drovenikia) serkoi,* ki živita na višjih nadmorskih višinah, smo ugotovili, da živita oziroma prezimujeta celo v globoki

gozdni prsti prav blizu površja. To dejstvo sicer ni bilo tuje našim starejšim entomologom, ki so vedeli, da se jamske krešiče rodu brezokcev *Anophthalmus,* zlasti iz skupine *»scopolii«*, najlažje najde zgodaj spomladi ob talečem snegu na dnu kraških vrtač v gozdnatem okolju. Najdbe osebkov vrst *P. vrezeci* in *P. bognoloi* v večjih jamskih prostorih so redke in sporadične. Predvidevamo, da osebke v kraške jame zanese prenikla voda, ki pronica skozi MSS in sistem razpok v pretrti kamnini kraških vrtač nad jamami. Na ta način lahko pojasnimo izključno točkovno nahajanje primerkov *P. vrezeci* v jami Medvedjak in Račiški pečini. Petričevo jamo in okoliške jame na Cresu so med obema vojnama obiskali nekateri entomologi in tam nabirali jamske hrošče (Pretner 1973), ki pa rodu *Prospelaeobates* niso našli. Šele nastavljene pasti čez zimsko obdobje, ko je v Sredozemlju padavinski maksimum, so prispevale najdbo primerkov vrste *P. bognoloi.*

Za vrsto *P. brelihi* je bilo že ob opisu ugotovljeno, da daje prednost hladnejšim jamam in celo jamam ledenicam s stalnim ledom. Z intenzivnejšimi terenskimi raziskavami smo za vrsto *P. brelihi* našli več novih lokalitet in s tem občutno povečali znan areal razširjenosti. Vse jame se nahajajo na nadmorski višini od 920 metrov do ovršja Snežnika s skoraj 1800 metri nadmorske višine. Vsem jamam s prisotnostjo vrste *P. brelihi* je skupna nižja temperatura med 1°C in 5°C in vsaj del leta v jami prisoten sneg in led. Tu velja omeniti, da smo raziskovali še številne druge jamske objekte, med njimi tudi ledenice v istem območju, pa predstavnikov rodu *Prospelaeobates* v njih nismo našli. Območje razširjenosti vrste *P. brelihi* obsega Snežniško planoto in Vzhodne Javornike. Na voljo imamo podatke (Drame 1986), da je bilo do leta 1986 v tem območju v obsegu približno 260 km^2 znanih 279 jam, kar je 1,1 jama na kvadratni kilometer. Od teh jam je bilo 42 ledenih in 46 snežnih jam, kar je tretjina vseh (Drame 1986). Ledene jame so opredeljene kot jame, kjer se sneg in led zadržujeta čez celo leto, medtem ko v snežnih jamah sneg ostaja okoli 8 mesecev v letu in se iz njega ne dela led. Podatki iz leta 1986 pa so že nekoliko zastareli, saj so jamarji medtem v tem območju evidentirali še veliko novih jamskih objektov, obenem pa je iz številnih ledenic led v zadnjih desetletjih izginil. Na osnovi naših raziskav lahko sklepamo, da vrsta *P. brelihi* ni vezana le na ledene jame in snežnice, ampak je njen osnovni habitat MSS okolje ob ledenicah in da ima vrsta tudi izrazito sezonsko vertikalno migracijo.

Vse tri doslej znane vrste rodu *Prospelaeobates* živijo alopatrično. Njihova območja razširjenosti so geografsko dobro omejena. Najdbe novih lokacij vrste *P. bognoloi* lahko pričakujemo z raziskavami habitata MSS tudi v širšem območju severnega dela Cresa, edinega dela hrvaških otokov s submediteransko klimo v tako imenovanem območju Tramontane. Južneje od tod vrste ni pričakovati, saj je klima izrazito suha in vegetacija mediteranska. Prav tako ima vrsta *P. vrezeci* gotovo večji areal. Areal vrste bi lahko, glede na geomorfologijo in sklenjenost apnenčastih plasti, segal čez celotno območje Matarskega podolja od Kozine do Rupe in mogoče še dalje na Hrvaško do Učke (slika 4). Jame v tem območju so relativno dobro biološko raziskane, zato se je potrebno za najdbe novih lokalitet te vrste posvetiti slabo poznanemu okolju MSS. Glede na število hladnih jam, snežnic in ledenic na Snežniško-Javorniški planoti je tudi areal vrste *P. brelihi* gotovo nekoliko širši od sedaj znanih lokacij. V

tem območju je biološko raziskan le skromen delež jamskih objektov. Vrsto lahko pričakujemo še v številnih novih hladnih jamah in MSS okolju od 900 metrov nadmorske višine pa vse do ovršja Snežnika in drugih gora v območju. Prav mogoče je, da sega areal vrste še nekoliko bolj proti severu Javornikov, nedvomno pa je vrsta prisotna tudi južneje, daleč v hrvaški del Snežniško - Snježniške planote, oziroma do zahodnega Gorskega kotara (slika 4).

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REISSERONIA LESARI SP. NOV., *R. GERTRUDAE* SIEDER, 1962 AND *R. TARNIERELLA* (BRUAND, 1850) IN SLOVENIA (LEPIDOPTERA: PSYCHIDAE)

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Abstract – The present study reviews the genus *Reisseronia* (Bruand, 1850) in Slovenia. Two species, *R. gertrudae* Sieder, 1962 and *R. tarnierella* (Bruand, 1850), are new to Slovenian fauna and *Reisseronia lesari* sp. nov. is described from Radensko polje in the central part of the country. The new species is parthenogenetic and is compared with several related taxa. Morphological differences are presented and shown in figures. Additional data about the habitat and biology of the discussed species are provided.

Key words: Lepidoptera, Psychidae, *Reisseronia*, new species, fauna, Slovenia.

Izvleček – *REISSERONIA LESARI* NOVA VRSTA, *R. GERTRUDAE* SIEDER, 1962 IN *R. TARNIERELLA* (BRUAND, 1850) V SLOVENIJI (LEPIDOPTERA: PSYCHIDAE)

Pričujoča študija nam daje pregled rodu *Reisseronia* (Bruand, 1850) v Sloveniji. Dve vrsti, *R. gertrudae* Sieder, 1962 in *R. tarnierella* (Bruand, 1850), sta novi za slovensko favno, *Reisseronia lesari* nova vrsta za znanost pa je opisana z Radenskega polja v osrednjem delu države. Nova vrsta je partenogenetska. Primerjamo jo z več sorodnimi vrstami in predstavljamo njihove morfološke razlike v besedi in sliki. Podajamo dodatne informacije o habitatu in biologiji obravnavanih vrst.

Ključne besede: Lepidoptera, Psychidae, *Reisseronia*, nova vrsta, favna, Slovenija.

Introduction

Members of the genus *Reisseronia* are small psychids, the wingspan of males being between 6 and 11.4 mm. The females are wingless (Arnscheid & Weidlich

2017). Larvae live a very secret life in the herbal layer and are therefore difficult to find. The genus *Reisseronia* Sieder, 1956, contains 15 species, distributed in central and south-eastern Europe and south-western Asia (Hättenschwiler 1982, 2004; Hauser 1996; Rutjan 2003; Kurz *et al*. 2006; Weidlich 2006, 2016; Malkiewicz *et al*. 2013; Larysz 2017). Some of them have been discovered in the recent decade: *R*. *satanella*, *R*. *muscaelutum* Kurz *et al*., 2006; *R*. *arnscheidi* Weidlich, 2006; *R*. *ionica* Weidlich, 2016; *R*. *imielinella* Malkiewicz *et al*., 2013 and *R*. *annae* Larysz, 2017.

In Slovenia, no species of the genus *Reisseronia* have been identified so far (Carnelutti 1992a, 1992b; Lesar & Govedič 2010; Sobczyk 2011; Arnscheid & Weidlich 2017). In 2012, the first specimen was obtained by the third author, on a dry meadow near the village of Socerb on the Karst edge. A single male was collected by net, but enough to start intensive research on this genus. A few years later, the first author found typical *Reisseronia* larval cases near the first locality and in Lokavec near Ajdovščina, on a dry extensive meadow. All these finds, after detailed morphological examination confirmed the presence of *R*. *tarnierella.* This is not a coincidence, because the familiar localities Alesso and Interneppo in northern Italy (Sieder 1972) are located not far from the state border with Slovenia.

Twelve parthenogenetic species have so far been found among the Psychidae, of which a high percentage are endemic, due to poor mobility (Malkiewicz *et al*. 2013; Arnscheid & Weidlich 2017; Larysz 2017). Among *Reisseronia*, three parthenogenetic

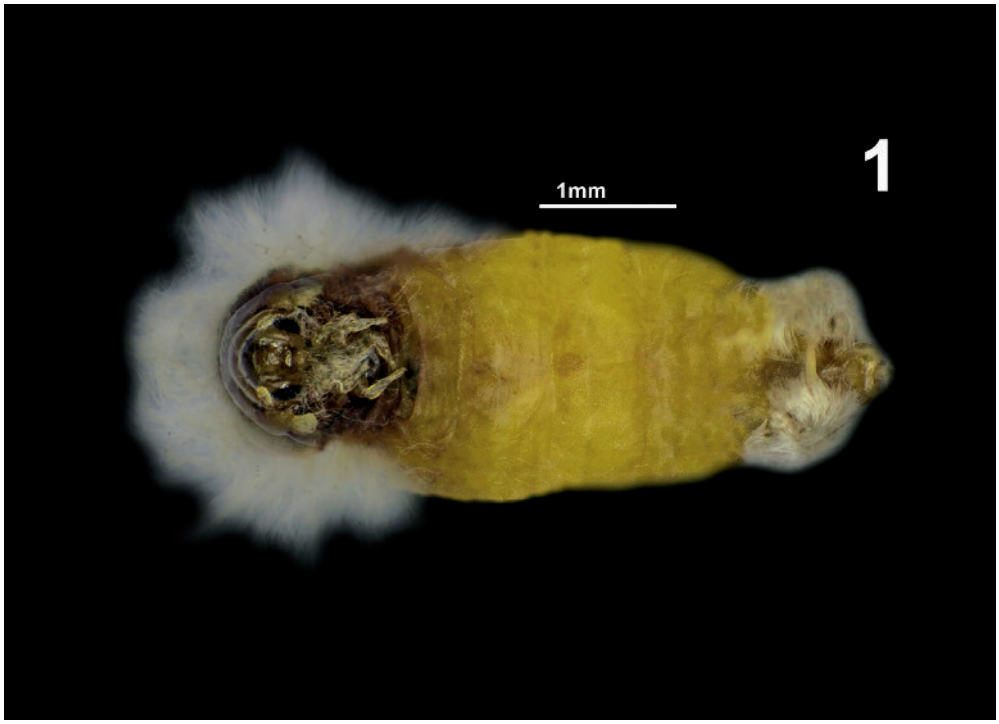


Figure 1. *Reisseronia lesari* sp. nov, female, holotype, ventral view.

species have been identified to date: *R. gertrudae* Sieder, 1962, *R. imielinella* Malkiewicz *et al*., 2013 and *R. annae* Larysz, 2017. Field research for parthenogenetic populations in Slovenia was focused at first on the northern border area, where *R. gertrudae* was expected due to the proximity of its known localities on the Austrian side. In 2015, the first author found the first *Reisseronia* population with parthenogenetic development in the vicinity of Vinica, and soon thereafter, enriched with new experience, new finds followed. In the period of 2016 to 2020, a larger number of larval cases were collected in all localities. Three populations from northern (Goričko) and south-western (Bela krajina) parts of Slovenia are clearly *R. gertrudae*: reduced legs without tarsal segments, with unpaired claws and antenna reduced to one segment. The population from moist meadows of one of the smaller flooded karst fields, Radensko polje, in the north-western part of the Dolenjska region initially showed a lot of similarity with *R. imielinella* Malkiewicz *et al*., 2013 and *R. annae* Larysz, 2017. Based on morphological differences of adults and immature stages, we describe them as a new species *Reisseronia lesari* sp. nov. Predovnik, Rekelj & Gomboc.

Materials and Methods

Collections

Specimens examined in this study were obtained by rearing adults from larvae collected in a conventional manner, with great difficulty due to the small size and unrecognizability of larval cases in the herbal layer. Collected larvae were stored in the breeding containers with some soil and herbal layer taken from the origin locality. They were kept in natural conditions, protected from direct sunlight. To avoid too high humidity, we moistened the herbal layer moderately and selectively every second or third day, occasionally only a few plants and mosses. Breeding containers were sprayed with water every morning, in sunny days also in the evening. Some adult males of *R. tarnierella* were collected on sunny days between one to three p.m., by using the method of sweeping over the vegetation with a net.

Morphology

All female specimens were conserved in an alcohol-glycerol solution (75% rectified spirit-ethanol, 15% glycerol, 10% distilled water) and stored in small plastic vials. Determination and comparative work were done using an Olympus SZ51 stereomicroscope. Preparation of genitalia and individual parts of females, such as legs or antennae, followed standard techniques according to Robinson (1976).

Macro photographs were taken with a Cannon EOS 40D digital camera, through an Olympus SZ51 stereomicroscope and Reichert microscope. Images, further details and figures were later processed with Adobe photoshop CS5 master collection software. Drawings were made by using Indian ink on transparent sheets and later converted into a digital format. All drawings and micro photographs are the work of the second author. A pinned male specimen of *R. tarnierella* was photographed with a Cannon EOS 40D digital camera with macro 100mm lens. Photographs of the type localities were taken using a Canon PowerShot G5 digital camera.

All measurements were performed through a stereomicroscope, using a measuring eyepiece micrometer with appropriate magnification. One distinctive measuring method was used in this paper, called the eye index (Dierl 1969: 168; Arnscheid & Weidlich 2017: 6–7), which is calculated by measuring the minimum distance between the eyes, and dividing this value by the maximum eye diameter. The quotient resulting from this division is then converted into an index.

For nomenclature of species we referred to papers by Sobczyk (2011) and Arnscheid & Weidlich (2017). The terminology of morphological characters for imagines follows Sauter & Hättenschwiler (1999) and for the immature stages Gepp & Trattnig (1990), Patočka & Turčani (2005).

The species examined for comparative purposes were *R. imielinella*: 3 ♀, Paratype, Poland CA75, Imielin, 24.5.2007, leg. A. Larysz; *R. annae*: 4 ♀ with larval cases, Poland CA66, Katowice-Janów, 29.5.2013, leg. A. Larysz, all in coll. USMB.

Abbreviations used in description

PMSL	Prirodoslovni muzej Slovenije
USMB	Upper Silesian Museum Bytom, Poland
ŽPSL	Željko Predovnik, Slovenia
JRSL	Jurij Rekelj, Slovenia
SGSL	Stanislav Gomboc, Slovenija
coll.	collection
e.o.	ex ovo
e.l.	ex larva
leg.	legerer in Latin (collected)
n=	number of specimens examined
A1-10	abdominal segments of female, larva and pupa
№	number

Results

Reisseronia lesari sp. nov.

Diagnosis

Fifteen species have so far been identified in the genus *Reisseronia*. A total of 12 species have a bisexual reproduction strategy (with known males) and just three species *R. gertrudae* Sieder, 1962, *R. imielinella* Malkiewicz *et al*., 2013 and *R. annae* Larysz, 2017, are parthenogenetic. Observations under controlled laboratory conditions confirmed that *R. lesari* sp. nov. also has parthenogenetic development.

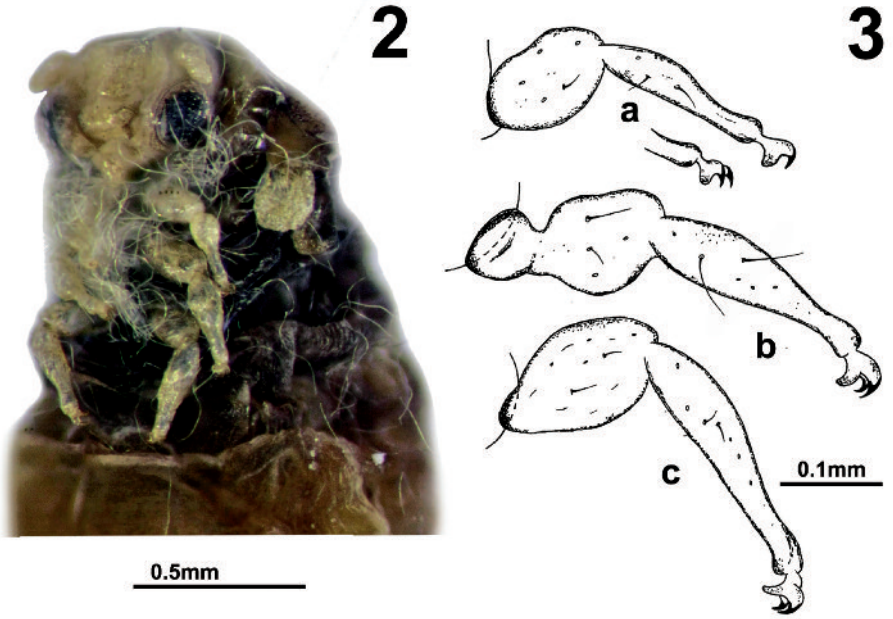
The new species can easily be distinguished from the following species: *R. tarnierella* (Bruand, 1851), *R. nigrociliella* (Rebel, 1934), *R. pusilella* (Rebel, 1940), *R.*

magna Hättenschwiler, 1982 and *R. ionica* Weidlich, 2016, by the smaller size of females and larval cases and also by the absence of tarsal segments in all legs.

Females of *R. satanella* Kurz, Kurz & Zeller-Lukashort, 2006, *R. staudingeri* (Heylaerts, 1879), and *R. arnscheidi* Wiedlich, 2006 are similar in size but *R. satanella* has six to eight fused antennal segments (*R. lesari* sp. nov. only two antennal segments) and larger larval cases (length 7.0–9.5 mm). *R. staudingeri* is distinguished by the smaller number of antennal segments (only one) and much larger larval cases (length 11.0–14.0 mm). *R. arnscheidi* differs in a higher number of antennal segments (two to three), the presence of a single tarsal segment and larger larval cases (length 8.0–10.0 mm).

The new species is distinguished from reduced females of *R. tschetverikovi* Solyanikov, 1990 and *R. muscaelutum* Kurz *et al*., 2006, by long curled hairs on the head and thorax (*R. tschetverikovi* and *R. muscaelutum* have short, erect hairs). *R. tschetverikovi* also differs in having only one antennal segment (*R. lesari* sp. nov. two antennal segments), while *R. muscaelutum* also differs in having smaller larval cases, which are six mm long (*R. lesari* sp. nov. 6.2–7.6 mm).

Females of *R. lesari* sp. nov. are most similar to the following three parthenogenetic species: *R. gertrudae*, *R. imielinella*, and *R. annae*. They can be distinguished from all three species by the presence of setae on the antennae (Fig. 4), clearly visible wings (reduced small oval lobes) (Fig. 5), and a higher number of spines (32–44) in the second row of the A5 pupal segment (*R. gertrudae* 26–33, *R. imielinella* 15 and



Figures 2-3. *Reisseronia lesari* sp. nov, female, holotype. **2.** Head and thorax, latero-ventral view. **3.** Legs of female. **a.** fore leg. **b.** middle leg. **c.** hind leg.

R. annae 20–26 spines). The new species also differs from *R. gertrudae* in having separate femur and tibia and in having paired claws (details in Table 2). The new species also differs in the colour of the hairs on the head and thorax (*R. imielinella* gray, *R. lesari* sp. nov. creamy) and the presence of spines on the vertex (Fig. 4). Females of the new species are also distinguished from *R. annae* by a smaller number of antennal segments (*R. lesari* sp. nov. two, *R. annae* three), the absence of tarsal segments and the presence of spines on the vertex. All important morphological characteristics of all four parthenogenetic species are shown in Table 1.

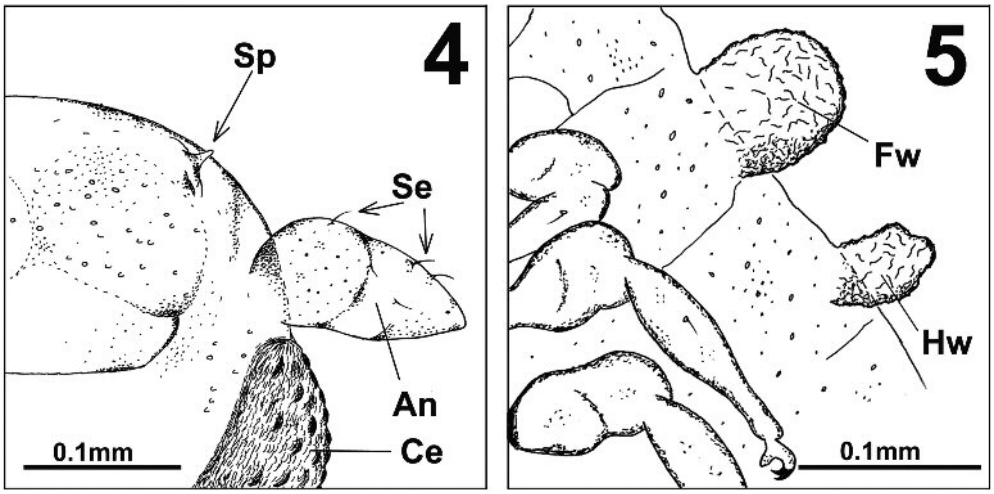
Table 1. Presentation of important distinguishing features of the imagines and immature stages of parthenogenetic species of the genus *Reisseronia* (according to Sieder 1962; Malkiewicz *et. al*. 2013; Larysz 2017; supplemented by our own investigations).

Imago - ♀	***gertrudae***	***imielinella***	***annae***	***lesari* sp.nov.**
length / width	3.0 1.0–1.5	3.3–5.2 1.0–1.8	3.0–4.2 0.9–1.3	3.4–5.1 1.0–1.9
antennal segments	1	1–2	3	2
antennal setae	absent	absent	absent	present
vertex spines	present	absent	absent	present
thorax hairs colour	creamy	gray	creamy	creamy
wings	microscop. tiny lobes	microscop. tiny lobes	not visible	strong reduced oval lobes
femur / tibia	fused	separated	separated	separated
tarsal segments	absent	variable 0–1	all legs with one	absent
leg claws	allunpaired	allpaired	allpaired	variable
Immature stages				
larval case length larval case width	6.0–7.0 2.0	5.5–7.2 1.5–2.0	6.3–8.2 1.6–2.6	6.2–7.6 2.1–2.6
pupal spines ofA5 - second row	26–33	15	20–26	32–44

Description

Adults. Parthenogenetic females with reduced wings, small length of fresh specimens 3.4 to 5.1 mm (average 4.25 mm), width 1.0 to 1.9 mm (average 1.45 mm), Fig. 1.

Head. (Fig. 4) Brown, with rippled creamy hairs. Vertex dorsal with two small excrescences, spine-like shape (these two processes have already been described in *R. gertrudae* by Sieder 1962:89), (Fig. 4). Antennae translucent, basic, reduced to only two segments, which are often fused into a whole. Segments with one to five microscopically small setae (Fig. 4). Eyes black, oval, eye index 1.9 to 2.2 (n = 10), labial and maxillary palpi absent.



Figures 4-5. *Reisseronia lesari* sp. nov. **4.** Head structures, dorsal view. **Sp.:** vertex spine; **Se:** antennal setae; **An:** antenna; **Ce:** compound eye. **5.** Thorax structures, ventral view. **Fw:** reduced forewing. **Hw:** reduced hindwing.

Thorax. Segments brown, sclerotized, with long curled creamy hairs (Fig. 1). Wings clearly visible, forewings very reduced to small oval lobes, hindwings much more reduced to tiny lobes, or barely noticeable in most specimens (Fig. 5). Legs pale brown, transparent, reduced, all with distinct separate femur and tibia, tarsal segments absent, all legs with a few microscopically tiny setae (Fig. 3). Fore leg claws paired in 30%, middle leg claws paired in 80%, hind leg claws all paired (Table 2).

Table 2. Variability of claws on legs of females from *Reisseronia lesari* sp. nov.

№	Specimen №	claws fore leg	claws middle leg	claws hind leg
1	19 387	1	1	2
2	19 388	2	2	2
3	19 389	1	2	2
4	19 390	2	2	2
5	19 392	1	2	2
6	19 397	2	2	2
7	19 403	1	2	2
8	UA 014	1	1	2
9	UA 015	1	2	2
10	UA 016	1	2	2
average		30% paired	80% paired	100% paired

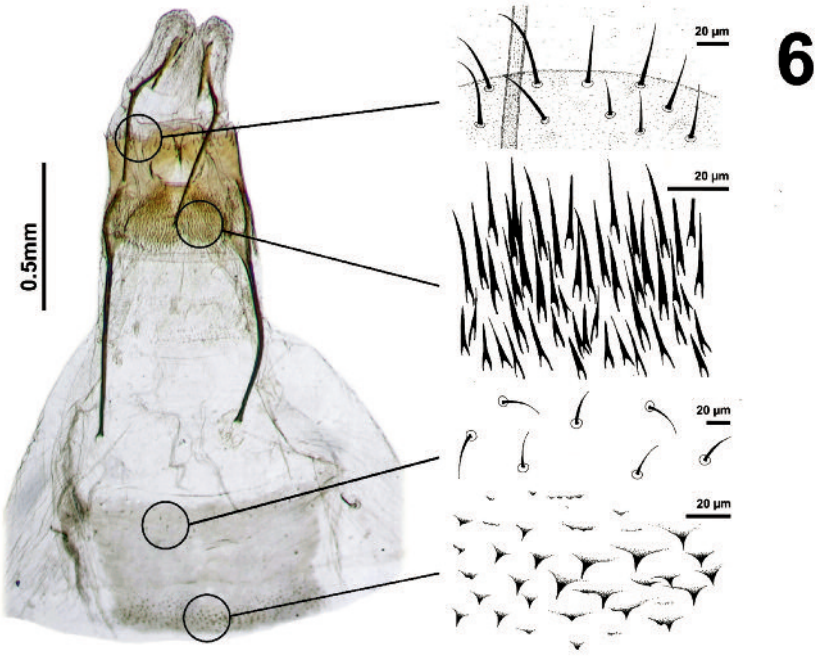


Figure 6. *Reisseronia lesari* sp. nov., female, paratype, genitalia and last abdominal segments with details, ventral view.

Abdomen. Yellowish-brown, ventrally lighter than dorsally. Sternites one to three poorly sclerotized, four to six sclerotized slightly, as a narrow strip. Seventh sternite sclerotized wider, moderately, with a narrow field of spines (Fig. 6). Segment A7 with long curled white-gray hairs prior to oviposition.

Genitalia. (Fig. 6). Ovipositor lobes rounded, membranous, slightly setose. Pseudapophyses straight, very short, less than one third the length of posterior apophyses. Posterior apophyses curved, about one third smaller than anterior apophyses. Segment A8 relatively short, cylindrical, well sclerotized in the first two thirds, with two fields of spines. Spines on postvaginal plate pointed, long and thick. Bursa copulatrix not visible.

Larva. Length of last instar larvae is between five and seven mm. The colour of abdominal segments is generally creamy to light orange, the sclerotized parts of the thoracic segments are black to dark brown, the head capsule is smooth, black and shiny (Figs. 8b, 9). The setae are translucent, long, and some are curved at the tips. Sclerotized parts of the thoracic shield are different widths, the widest part being on the prothorax and the narrowest on the metathorax. Small, sclerotized areas are also visible laterally on the mesothorax and metathorax. Dorsally on thoracic segments, a line-like, poorly sclerotized part is also visible, which is widest at the metathorax. Thoracic legs strong, moderately sclerotized, of dark brown colour, the claws long and slightly curved. Spiracles are poorly separable from the base colour of the abdo-

men, pinaculas are not visible. Crochets on abdominal prolegs are arranged in uniordinal penellipse, number of crochets 18–23 (n = 4).

Larval cases. Typical of the genus *Reisseronia*, length 6.2 to 7.6 mm (on average 6.8 mm) and width 2.1 to 2.6 mm (on average 2.3 mm), (n = 31). They are rounded in cross-section, composed of straight and narrow debris of grasses with some dark brown-black particles of soil incorporated (Figs. 8c, 9). Debris of grasses are placed longitudinally and larger pieces, typical of the genus *Reisseronia*, are almost the same length and never exceed the base of the larval case.

Pupa. (Fig. 7). Integument weakly sclerotized, pale brown. Exuvia length 4.9–5.9 mm, width 1.2–1.4 mm (n = 6). The capito-prosternal plate (Fig. 8a) is small, rounded, and mostly stays on the head of the imago. The length of antennae covers slightly exceeds the eyes. Abdominal segments with dorsal and lateral setae are a creamy white colour. Segments A4–8 dorsally with anterior bands of spines: A4 with 9–13 spines, A5 with 24–28 spines, A6–7 with 26–30 spines and A8 with 5–7 gathered spines, forming a small protuberance. Spines are small, short, triangular in shape, many times interrupted. Segment A5 has a second posterior row of 25–44 spines, which are about one-half smaller than the others and facing in the opposite direction (Fig. 7b). Cremaster reduced, simple. Details of abdominal segments A8–10 and cremaster are shown in Fig. 7c.

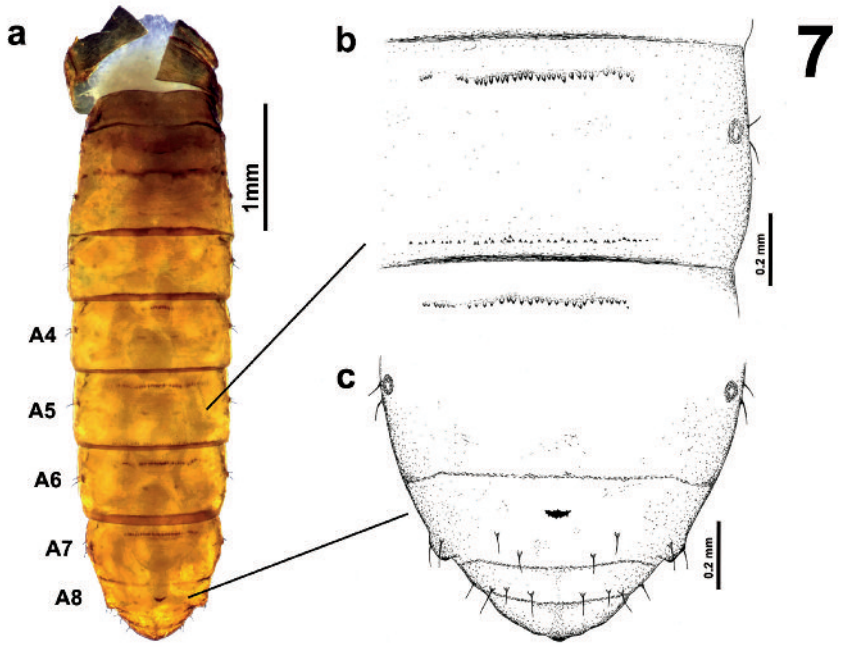


Figure 7. *Reisseronia lesari* sp. nov. **a.** exuvium, dorsal view. **b.** detail of A5 abdominal segiment with a second posterior row of spines. **c.** detail of abdominal segments A8–10 and cremaster.

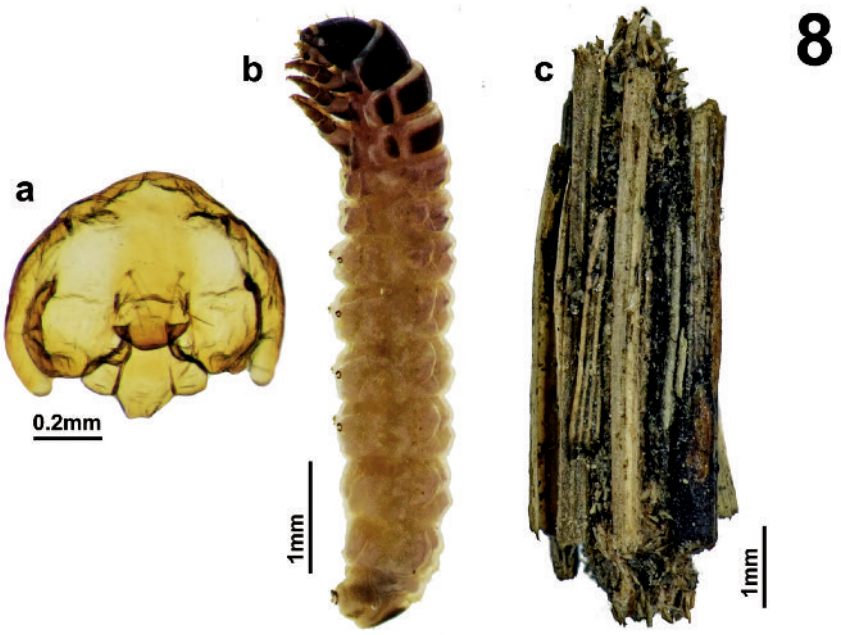


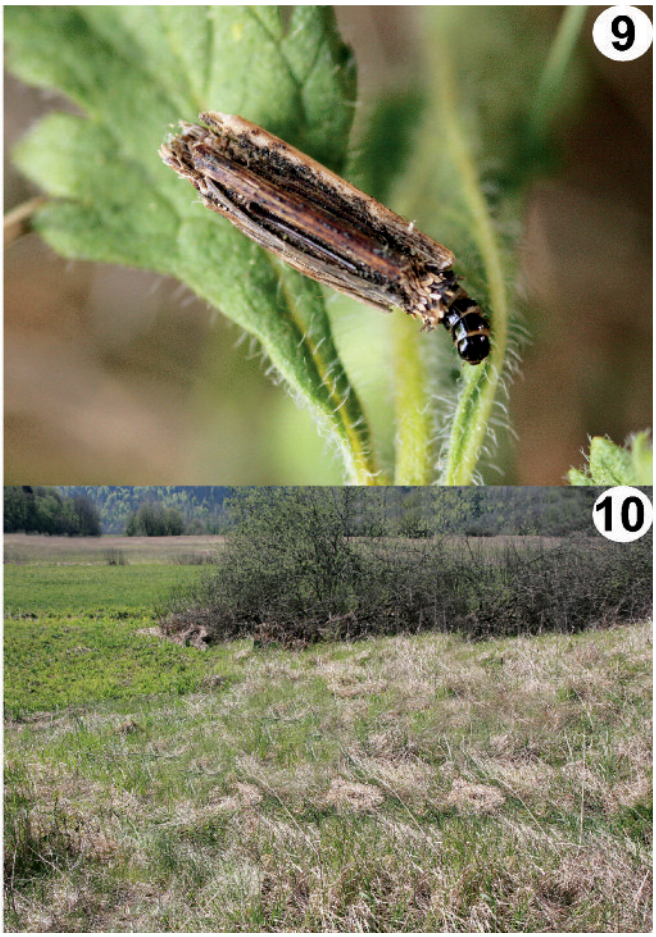
Figure 8. *Reisseronia lesari* sp. nov., female, paratype. **a.** capito-prosternal plate. **b.** mature larva, lateral view. **c.** larval case.

Type material

Holotype. ♀, stored in alcohol-glicerol solution in a small plastic vial, with larval case glued on mounting board 7x14 and pinned. Original labels: "Slovenia, Radensko polje, Mokrine, 325 m, 24.3.2019 (e.l. 27.5.2019), leg. Ž. Predovnik", "HOLOTYPE *Reisseronia lesari* Predovnik, Rekelj & Gomboc" (red label, handwriting).

Paratypes. 2♀♀, with larval cases, Slovenia, Radensko polje, Mokrine, 325, 1.4.–14.5.2017 (e.l. 26.5.2017), leg. Ž. Predovnik, coll. ŽPSL; 21♀♀, with larval cases, same locality, 24.3.–11.5. 2019 (e.l. 18.5.–16.6.2019), leg. Ž. Predovnik, coll. ŽPSL; 6♀♀, with larval cases, same locality, 3.–7.4.2019 (e.l. 25.5.–10.6.2019), leg. J. Rekelj, coll. JRSL; 5♀♀, with larval cases, same locality, 30.4.2020 (e.l. 17.5.–3.6.2020), leg. Ž. Predovnik, coll. ŽPSL; 10♀♀, with larval cases, same locality, 14.3.2020 (e.l. 16.–25.5.2020), leg. J. Rekelj, coll. JRSL; 3♀♀, with larval cases, same locality, 9.–10.6.2019 (e.l. 24.3.–11.5.2019) (1a393, 1a394, 1a396), leg. Ž. Predovnik, coll. USMB.

Paratypes of larvae. 1 larva, with larval case, 6.10.2016, leg. Ž. Predovnik, coll. ŽPSL; 2 larvae, with larval cases, 8.6.2018, leg. Ž. Predovnik, coll. ŽPSL; 4 larvae, with larval cases, 20.4.2018, leg. Ž. Predovnik, coll. ŽPSL; 1 larva, with larval cases, same locality, 1.5.2018, leg. Ž. Predovnik, coll. ŽPSL; 3 larvae, with larval cases, 20.4.2019, leg. Ž. Predovnik, coll. ŽPSL; 3 larvae, with larval cases, 11.5.2019, leg. Ž. Predovnik, coll. ŽPSL; 4 larvae, with larval cases, same locality, 3.–7.4. 2019, leg.



Figures 9-10. *Reisseronia lesari* sp. nov. **9.** Mature larva in larval case, Slovenia, Radensko polje, 2.5.2018 (photo Ž. Predovnik). **10.** Natural habitat, Slovenia, Radensko polje, Mokrine, 22.4.2019 (photo J. Rekelj).

J. Rekelj, coll. JRSL; 1 larva, with larval case, same locality, 14.3.2020, leg. J. Rekelj, coll. JRSL; 2 larvae, with larval cases, same locality, 11.5.2019 (1a360, 1a363), leg. Ž. Predovnik, coll. USMB.

Paratypes of pupae. 4 pupae, with larval cases, same locality, 20.4–13.5.2018 (e.l. 8.6.2018), leg. Ž. Predovnik, coll. ŽPSL; 7 exuviae, same locality, 3.–7.4.2019, leg. J. Rekelj, coll. JRSL; 1 pupa, with larval case, same locality, 14.3.2020, leg. J. Rekelj, coll. JRSL.

Paratypes of larval cases. 6 empty larval cases, same locality, 1.4.2017, leg. Ž. Predovnik, coll. ŽPSL; 15 empty larval cases, same locality, 6.5.2017, leg. Ž. Predovnik, coll. ŽPSL; 4 empty larval cases, same locality, 1.5.2018, leg. Ž. Predovnik, coll. ŽPSL; 38 empty larval cases, same locality, 24.3.2019, leg., J. Rekelj, coll. JRSL; 26 empty larval cases, same locality, 3.–7.4.2019, leg. J. Rekelj, coll. JRSL; 33 empty larval cases, same locality, 30.4.2020, leg. Ž. Predovnik, coll. ŽPSL; 40 empty larval cases, same locality, 12.5.2020, leg. J. Rekelj, coll. JRSL.

Deposition of types

Holotype ♀ and 2♀♀ paratypes of *R. lesari* sp. nov. are preserved in coll. PMSL, 42♀♀ paratypes are deposited in coll. ŽPSL and in coll. JRSL, 3♀♀ paratypes are deposited in coll. USMB. 2 paratypes of larvae are deposited in coll. USMB, all other paratypes of larvae, pupae, exuviae and larval cases are deposited in coll. ŽPSL and in coll. JRSL.

Etymology

The new species is named after our late entomological friend Tone Lesar who dedicated his life to researching the butterfly fauna of Slovenia, focusing on the Štajerska region.

Distribution

Only known from a small area in the central part of Radensko polje in Mokrine, south to southwest and south of the village Zagradec, at an altitude 325m (Fig. 10).

Habitat

Radensko polje Landscape Park is the smallest of the nine most distinct karst fields, but includes all karst features such as karst springs, swallets, estavelles and swallow holes and is one of the larger areas of extensive meadows in central Slovenia (Perko & Orožen Adamič 1998; Lampič & Smrekar 1998; Florjanc & Jernejc-Babič 1999). The largest part of the park is covered by Central European mesotrophic to eutrophic lowland meadows, which are mixed in wet areas with wet mesotrophic and eutrophic meadows. They are intensive to extensive and are regularly or occasionally fertilized and mown several times a year (Poboljšaj *et al*. 2000).

We found larvae of *R. lesari* sp. nov. on several locations in the central part of the park on elevated sunny edges of moist or wet oligotrophic grassland - (*Molinia caerulea*) meadows and related communities. They prefer south and southwestern positions of slide slopes, which are away from the floodplain and protected from standing moisture. Their microlocalities may occasionally be flooded during medium-high floods, for a few days in spring and autumn. However, during the occurrence of maximum flooding every few years, water levels may rise all the way to surrounding villages (almost the entire Radensko polje is under water) and can remain for several days (Meze *et al*. 1981).

Localities are often in the early stages being overgrown with *Calluna vulgaris* L. and hydrophilous ligneous species such as *Alnus glutinosa* (L.), *Frangula alnus* Mill., *Salix sp*., and also: *Cornus sanguinea* L., *Prunus spinosa* L., *Quercus robur* L. and *Rosa sp*. The most populated areas are those with dominant plant taxons: *Brachypodium rupestre* (Host) Roem. & Schult., *Carex tomentosa* L. and *Festuca rupicola* Heuff.

Biology and ecology

Larvae of *R. lesari* sp. nov. live relatively hidden lives in the lower herb layer in scattered and localized colonies. The best time to find and observe active larvae is

from mid March to late May. During this time, the larval cases are large enough to be discerned in the vegetation. They are most active on sunny days in the early afternoon but, with great patience, we also found them in October and even in mid-November, when the daily temperature was above 8 degrees celsius.

Larvae were relatively easy to rear under laboratory conditions. They prefer to feed on flowers and foliage of *Plantago lanceolata* L., *Ranunculus acris* L. and *Taraxacum officinale* Web. They generally feed on dry or semi-dry foliage rather than fresh. A small number of larval cases were always found empty, or the larvae died later during breeding, because of mildew or parasitism. However, we noticed that dry winters without snow (such as winters 2018/19 and 2019/20), and consequently less moisture on Radensko polje, noticeably reduced the mildew mortality of larvae and increased parasitism.

We could not determine where mature larvae attach their larval cases in nature, but probably hidden in the lower herbal layer. In captivity, we found them fixed on the foliage or stems of food plants, on the ground and on the edges and walls of the breeding containers. They were fixed individually or, more often, in small groups. Some were hidden in the moss so that only the top of the larval case was visible from above and, lastly, some of them simply remained unfixed at the bottom. In outdoor temperature conditions, the first mature larvae began to fix larval cases in early May, with a peak in early June. A small number of larvae remain active until the second half of June or to the middle of July, but no adults emerged from these later. The pupal stage lasts 15 to 23 days.

Only females emerged, from mid-May to late June, with a peak in early June, so generally slightly later than with *R. gertrudae*. It was difficult to predict when the females would emerge and start laying eggs, because this process remains hidden inside the larval case. However, with some detailed observation, it was possible occasionally to see the activity of females before laying eggs, which was reflected by the following: the female pulled out her head from the back of the larval case for a short time and then pulled back in again. This had already been observed in *R. gertrudae* by Sieder (1962). Females do not feed, and they have a very short life. In room conditions, they mostly became active in their larval cases around midday and in the early afternoon. When they lay their 22 to 28 fairly large yellowish eggs into pupal exuvia, they leave them and quickly die. Larvae hatch from the eggs in 17 to 20 days, mostly from the second half of June until the beginning of July, eat their eggshell and immediately start to build their own larval cases, using material from their mother's case. They feed until late fall, then hibernate during the third stage of their development. In spring, they continue feeding until they mature and pupate.

Other species of Psychidae

In a natural habitat, *R. lesari* sp. nov. cohabits with the following species of bagworms: *Psyche casta* (Pallas, 1767), *Psyche crassiorella* (Bruand, 1851), *Epichnopteryx* cf. *plumella kovacsi* Sieder, 1955, *Bijugis* sp., *Rebelia* cf. *plumella* (Ochsenheimer, 1810) and *Canephora hirsuta* (Poda, 1761).

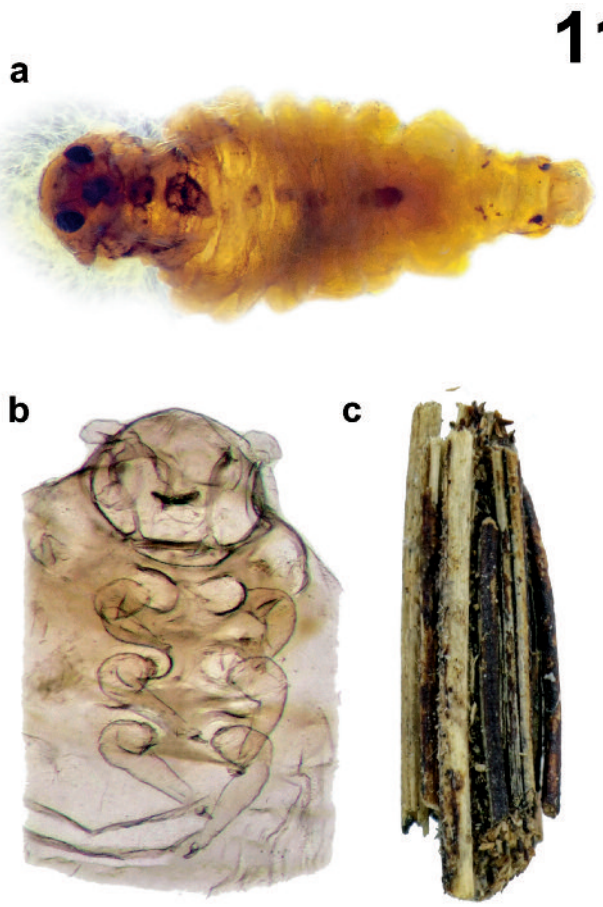


Figure 11. *Reisseronia gertrudae*, Slovenia, Vinica, Podklanec. **a.** female, ventral view. **b.** female, head and thorax details, ventral view. **c.** larval case.

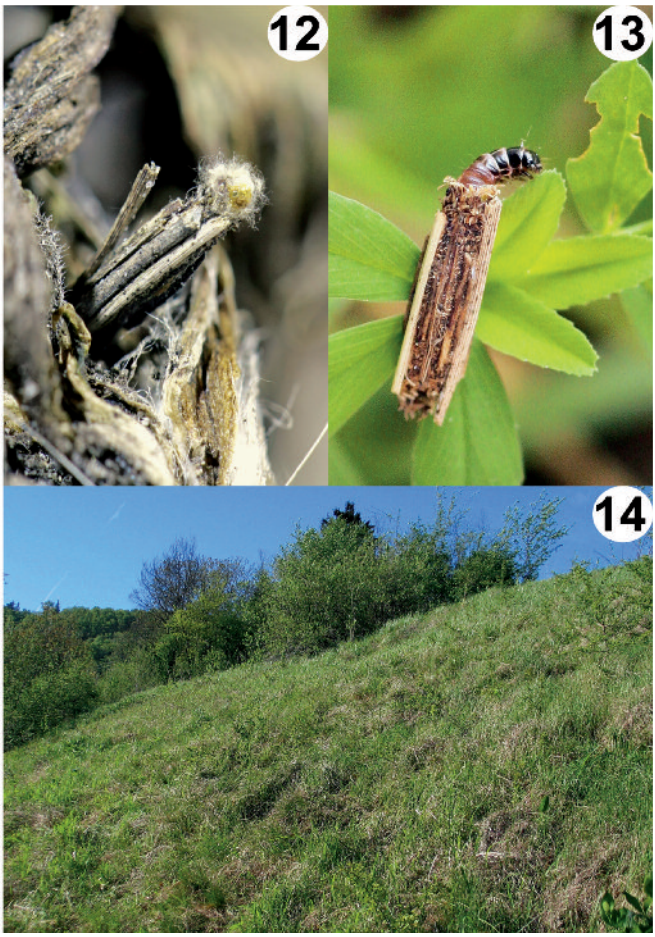
***Reisseronia gertrudae* Sieder, 1962**

Distribution

So far, the parthenogenetic species *R. gertrudae* has only been found in three localities in southern Styria in Austria. It is already extinct at the type locality and, according to recent data, is on the verge of extinction (Sieder 1962, Gepp & Tratnigg 1990; Arnscheid & Weidlich 2017). This interesting species was found for the first time in Slovenia by the first author in 2015. It has to date been confirmed in three localities: Sotinski breg near the village of Sotina in Goričko, and Vukovci and Podklanec, near Vinica in Bela krajina, close to the border with Croatia (Fig. 19).

Habitat

According to Gepp & Tratnigg (1990) in Austria *R. gertrudae* prefers xerothermal positions at an altitude of 300–670 m above sea level.



Figures 12-14. *Reisseronia gertrudae*. **12.** Female in larval case, Slovenia, Goričko, Sotina, Sotinski breg, 20.4.2020 (photo J. Rekelj). **13.** Mature larva in larval case, Slovenia, Vinica, Podklanec, 29.4. 2018 (photo Ž. Predovnik). **14.** Natural habitat, Slovenia, Vinica, Podklanec, 16.4.2017 (photo Ž. Predovnik).

In Slovenia, the habitat is semi-natural dry grasslands and scrubland facies (*Festuco-Brometalia*) on calcareous substrate. The species lives here on extensive hay meadows in old orchards (most fruit trees have already been cut down), bounded by shrub hedges and nearby forest. The most populated areas were those with an abundance of herbaceous plants such as *Thymus* sp., *Fragaria vesca* L. and mosses.

The habitat in the vicinity of Vinica in Slovenia is also semi-natural dry grasslands and scrubland facies (*Festuco-Brometalia*) on calcareous substrates, which even have a sub-Mediterranean character in some small areas (Ambrožič *et al*. 2013). Both localities are situated on south and southwest facing grassy slopes on extensively mown meadows with a xerothermal character, always above a stream or river, which gives those micro-localities slightly mesophilic microclimatic conditions.

In the village of Podklanec near Vinica, a small population lives on a dry, south-exposed slope above a small stream at an altitude of 177 m (Fig. 14). The meadow is rich in herbaceous vegetation, such as *Achillea* sp., *Euphorbia ciparissias* L., *Fragaria*

vesca L., *Plantago lanceolata* L., *Salvia pratensis* L., *Thymus* sp., and also various grasses, mosses and lichens. Abandonment of mowing and grazing already shows the early stages of overgrowing with ligneous shrubs, mainly *Prunus spinosa* L.

In the village of Vukovci near Vinica, another small population lives on an extensive hay meadow at an altitude of 229 m, not far from the river Kolpa. This meadow is partly overgrown with ligneous shrubs and bounded by vineyard and nearby forest. The composition of the herb layer is very similar to the previous one.

In Sotinski breg, Goričko, we found larvae on a south-west facing and xerothermic grassy slope with *Euphorbia cyparissias* L., *Fragaria vesca* L. *Hypericum perforatum* L, *Rumex* sp. *Salvia pratensis* L., *Thymus* sp. and with various mosses and lichens.

Biology and ecology

Similar to citations of Sieder (1962) and Gepp & Trattnig (1990) larvae of *R. gertrudae* live fairly hidden lives in the herb layer. In Slovenia, we found them very locally and in relatively small numbers. We achieved the best results for observation of active larvae in the second half of March to the end of April, during sunny weather between 14–17 h. Some active, half-grown larvae were also found on sunny days in October.

Larvae apparently feed on various plants. In the natural habitat, we observed feeding on leaves of *Fragaria vesca* L., but in captivity they quickly accepted *Taraxacum officinale* Web. (fresh flowers and leaves) and *Plantago lanceolata* L., when, despite there being fresh leaves, they fed more often on dry or semi-dry foliage. In captivity, the first larvae fixed their larval cases on April 23, continuing until early June. Only females hatched from middle May to late June, with a peak from the end of May to early June.

Many larvae were infested with an unindentified species of small parasitoid wasp (Hymenoptera). The level of parasitism was noticeably higher than with populations of *R. lesari* sp. nov. from Radensko polje.

Breeding of the F1 generation

In the first stages of their development, young larvae feed on fresh leaves of *P. lanceolata*, *T. officinale* and *Trifolium pratense* L.: later mostly on *P. lanceolata*. In the fall, breeding containers with third instar larvae were placed outside, to provide natural conditions for their hibernation. During the winter they became partially active on warmer days, but it was only the spring thawing that really reactivated their feeding. They resumed feeding from the end of March, until they completed their development and pupated in May. Completion of development (the emergence of females and the laying of eggs), was completed approximately 15 days earlier than in nature. Specimens cultivated ex. ovo were noticeably larger than in nature.

Remarks

Specimens from southern localities Podklanec and Vukovci, deviate slightly morphologically from the classical form from the north of the country. The difference is

Figures 15-17. *Reisseronia tarnierella*. **15.** Male resting on grass, Slovenia, Socerb, 5.4.2020, 12:20 pm, (photo J. Rekelj). **16.** Female in larval case transmitting pheromones, Slovenia, Socerb, 7.4.2020 (studio photo J. Rekelj). **17.** Mature larva in larval case, Slovenia, Lokavec, 5.4.2020 (photo Ž. Predovnik).

noticeable in a reduction of the legs, meaning that specimens have some legs with separated femur and tibia. This is usually only noticeable in one or two legs in a single specimen and can be seen on any leg and not necessarily in pairs. No other morphological differences were observed.

Material

Slovenia, Bela krajina, Vinica, Podklanec, 177 m, all leg. Ž. Predovnik, coll. ŽPSL: 4 larvae, with larval cases, 24.10.2015; 3 larvae, with larval cases, 2 empty larval cases, 2.4.2016; 2 larvae, with larval cases, 8 empty larval cases, 12.4.2016; 4 larvae, with larval cases, 8 empty larval cases, 16.4.2016; 7 larvae, with larval cases, 7 empty larval cases, 30.4.2016; 4 larvae, with larval cases, 2 empty larval cases, 18.5.2016; 9 ♀♀, with larval cases, 7 pupae with eggs, with larval cases, 13.6.2016 (e.o. 7.–27.5.2017); 5 larvae, with larval cases, 2 empty larval cases, 20.4.2018; 2 mature larvae, with larval cases, 1 pupa, with larval case, 22.4.2018 (e.l. 8.6.2018); 2

larvae, with larval cases, 7 empty larval cases, 2 pupae, with larval cases, 28.4.2018 (e.l. 11.6.2018); 1♀, with larval case, 16.3.2019 (e.l. 10.5.2019).

Slovenia, Bela krajina, Vinica, Vukovci, 229 m, all leg. Ž. Predovnik, coll. ŽPSL: 2 ♀♀, with larval cases, 31.3.2019 (e.l. 23.5.2019); 2 ♀♀, with larval cases, 6.4.2019 (e.l. 25.5 and 29.5.2019); 4 ♀♀, with larval cases, 20.4.2019 (e.l. 23.5–3.6.2019).

Slovenia, Goričko, Sotina, Sotinski breg, 404 m: 1 larva, with larval case, 1.2.2020, leg. Ž. Predovnik, coll. ŽPSL; 1 larva, 2 empty cases, 8.2.2020, leg. Ž. Predovnik, coll. ŽPSL; 15 larvae, 28 empty larval cases, 28.3.2020, leg. Ž. Predovnik, coll. ŽPSL; 4♀♀, with larval cases, 28.3.2020 (e.l. 20.–28.4.2020), leg. J. Rekelj, coll. JRSL; 4 larvae, with larval cases, 28.3.2020, leg. J. Rekelj, coll. JRSL; 7 larvae, 9 empty larval cases, 2.5.2020, leg. Ž. Predovnik, coll. ŽPSL; 3 larval cases with exuviae, 29 empty larval cases, 2.5.2020, leg. J. Rekelj, coll. JRSL.

Other species of Psychidae

In the Podklanec locality, *R. gertrudae* cohabits with the following species of bagworms: *Rebelia* sp., *Acanthopsyche atra* (Linnaeus, 1767) and in the Vukovci locality with: *Epichnopteryx* cf. *plumella kovacsi*, Sieder, 1955, *Bijugis bombycella* (Denis & Schiffermüller, 1775), *Rebelia* cf. *plumella* (Ochsenheimer, 1810) and *Rebelia* sp.

In locality Sotinski breg *R. gertrudae* cohabits with *Psyche casta* (Pallas, 1767), *Psyche crassiorella* (Bruand, 1851), *Bijugis bombycella* (Denis & Schiffermüller, 1775) and *Rebelia plumella* (Ochsenheimer, 1810).

***Reisseronia tarnierella* (Bruand, 1851)**

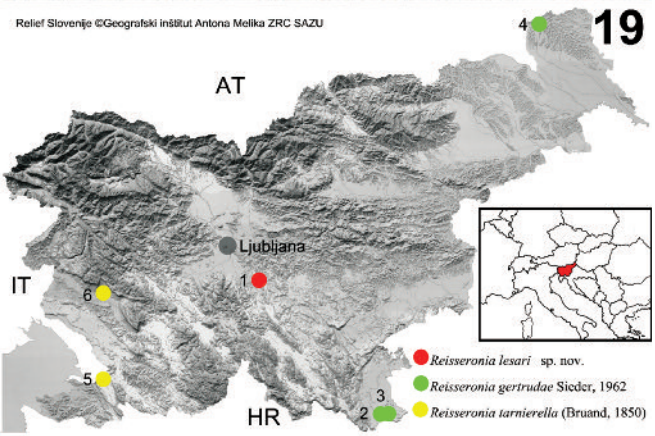
Distribution

R. tarnierella is a generally widespread species in Europe but highly local. It has been found in small, scattered colonies in central France, the Netherlands, Belgium, western Germany, Slovakia and northern Italy (Weidlich 2011; Arnscheid & Weidlich 2017). This species was found in Slovenia for the first time in a sub-Mediterranean region on the Karst edge in the vicinity of the village of Socerb and in Lokavec near Ajdovščina (Fig. 19).

Habitat

The habitat is semi-natural, eastern sub-Mediterranean (submediterranean-illyrian) dry and semi-dry grasslands: extensively used medows and pastures. The first male specimen was collected by net, during routine investigation of dry rocky karst meadow with *Euphorbia nicaeensis* All., *Euphorbia fragifera* Jan., *Eryngium amethystinum* L., *Festuca* sp., *Satureja montana* L, *Thymus* sp., etc.

After a few years, this meadow was turned into pasture on which, despite researching, no specimen at any development stage has been confirmed. This led us to find a similar, more preserved biotope in the surrounding area. The new locality shows a slightly different picture. The species lives here on a dry, southerly



Figures 18-19. Natural habitat, Slovenia, Socerb, 21.3.2020 (photo J. Rekelj). **19.** Distribution map of *Reisseronia* species in Slovenia: **1**–Radensko polje, Mokrine; **2**–Vinica, Podklanec; **3**–Vinica, Vukovci; **4**–Sotinski breg; **5**–Socerb; **6**–Lokavec.

exposed, extensively mown meadow with deeper soil. Among the plant species we found there, *Anthyllis vulneraria* L., *Dianthus sanguineus* Vis., *Helianthemum ovatum* (Viv.), *Onobrychis* sp., *Plantago holosteum* Scop., *Salvia pratensis* L., *Sanguisorba minor* Scop., *Scorzonera villosa* Scop. and various grasses dominate (Fig. 18). The habitat is limited by a typical karst hedge, composed mainly of trees and shrubs, such us *Crataegus monogyna* Jacq., *Cornus sanguinea* L., *Cotinus coggygria* Scop., *Fraxinus ornus* L., *Ligustrum vulgare* L., *Ostrya carpinifolia* Scop., *Prunus mahaleb* L. *Prunus spinosa* L. and *Quercus pubescens* Willd. In the Lokavec locality near Ajdovščina, the habitat is a dry, south-exposed slope with exstensively mown meadow with a rich herbaceous layer. The composition of the plant species is similar to that in Socerb: *Fragaria* sp., *Galium* sp., *Helianthemum ovatum* (Viv.), *Salvia pratensis* L., *Sanguisorba minor* Scop., *Thymus* sp. etc. There are also *Euphorbia cyparissias* L., *Hypericum perforatum L.* and various mosses and grasses.

Biology and ecology

R. tarnierella is one of the smallest species in the genus *Reisseronia*, with a wingspan of males between 6–7 mm (Arnscheid & Weidlich 2017). It is very difficult to observe the species in nature, not only because of the hidden life of larvae and, consequently, difficulties in finding the right habitat, but also because of the extremely short life span of specimens (Weidlich 2011). Near Gemone in Italy, adults emerge in the first half of June, and males are active between 12:30 –14:30 h (Sieder 1956, 1972).

In Slovenia, we collected larvae at the end of March and in April. In captivity, larvae accepted mainly *Taraxacum officinale* Web., as well as *Plantago lanceolata* L. and *Trifolium pratense* L. According to modest data from the field and the results of breeding, adults of *R. tarnierella* in the Socerb and Lokavec locality appear at the end of April to the begining of May. Three males were collected in Socerb with the method of sweeping over the vegetation with a net in sunny and dry weather between 13:00–14:00 h. Their flight was surprisingly fast and barely noticeable between the vegetation. Females were only observed in laboratory conditions (e.p.), and transmitted pheromones for several days up to 16:00 h.

Remarks

Larval cases in the Socerb locality were composed from closely attached fine particles of dry grass, placed longitudinally. The length of larger females was 8.0 to 9.0 mm and width 2.0 to 2.3 mm. Larval cases of males were smaller, length 6.0 to 7.0 mm and width 1.9 to 2.0 mm.

Material

Slovenia, Primorska, Socerb, 400 m: 1 ♂, 27.5.2001, leg. S. Gomboc, coll. SGSL.

Slovenia, Primorska, Socerb, 370 m: 2 empty larval cases, 10.4.2016, leg. Ž. Predovnik, coll. ŽPSL; 3 larvae, with larval cases, 7 empty larval cases, 22.4. 2016, leg. Ž. Predovnik, coll. ŽPSL; 2 ♂♂, 13.38 h and 13.46 h, 22.5.2016, leg. Ž. Predovnik, coll. ŽPSL; 1 ♀, with larval case, 20.5.2016 (e.l. 4.6.2016), leg. J. Rekelj, coll. JRSL; 4 ♂♂, 3 ♀♀, with larval cases, 1 empty larval case, 8.3.2020 (e.l. 1.–5.4.2020), leg. J. Rekelj, coll. JRSL.

Slovenia, Primorska, Lokavec near Ajdovščina, Slokarji, 301 m, all leg. Ž. Predovnik, coll. ŽPSL: 2 ♂♂, with larval cases, 21.3.2020 (e.l. 20.4. and 25.4.2020); 7 ♀♀, with larval cases, 21.3. and 23.3.2020 (e.l. 15.–27.4.2020); 20 empty larval cases, 21.3. and 23.3.2020.

Other species of Psychidae

In Socerb locality, *R. tarnierella* cohabits with the following species of bagworms: *Epichnopterix* cf., *Rebelia* sp., *Megalophanes viciella* (Denis & Schiffermüller, 1775), *Acanthopsyche zelleri* (Mann, 1855), *Pachythelia villosella* (Ochsenheimer, 1810), *Phalacropterix praecellens* (Staudinger, 1870).

In the Lokavec locality, the species cohabits with *Taleporia politella* (Ochsenheimer, 1816), *Rebelia* sp., *Acanthopsyche zelleri* (Mann, 1855), *Pachythelia villosella* (Ochsenheimer, 1810) and *Phalacropterix praecellens* (Staudinger, 1870).

Discussion

Parthenogenesis in the genus *Reisseronia* is well known, although no more detailed genetic studies have been conducted in this field to reveal details of the type of parthenogenesis and relatedness of the populations found. The evolution of parthenogenetic populations was already investigated by Soumalainen (1961). He published a morphometric study of polyploid and parthenogenetic weevil populations, whereby he assumed that the characters that he had chosen to study were little affected by environmental variability. In this first experimental demonstration he stressed that "*evolution has not come to a complete standstill in polyploid parthenogenetic populations. Polyploid parthenogenetic weevils and other similar forms still possess some mechanism which allows genotypic differentiation of populations and thus secures continued evolution*" (Soumalainen 1961:330). This study suggested that parthenogenetic populations of the genus *Reisseronia* have a common ancestor and that they are capable of evolution, despite the asexual reproduction. *R. lesari* sp. nov. is well distinguished from the other three parthenogenetic species by serial morphological features. In doing so, the primary structures (setae on the antennae and legs) suggest that this population might be (the oldest and perhaps) the origin of the parthenogenetic mode of reproduction (A. Larysz 2020, pers. comm., 25 March). The new species is also interesting because of the habitat choice, which differs slightly from classical "*Reisseronia* habitats". It inhabits floodplain areas, where water can occasionally remain for several days during major floods in spring and autumn (Meze *et al*., 1981). Further studies are needed to clarify how *R. lesari* sp. nov. manage to survive this period. Likewise, the distribution of the species is not yet definitive and is presently limited only to the type locality. In the coming years, we will be carrying out additional fauna studies in several similar habitats in central Slovenia. In the last year, we have already found another new locality with a parthenogenetic population of *Reisseronia* near the capital Ljubljana, and another on wet meadows of Prekmurje in the vicinity of Lendava. Collection of specimens and comparative studies are already in progress.

R. gertrudae is seriously endangered in Austria (Arnscheid & Weidlich 2017), so the Slovenian populations are a very important contribution to the survival of this species in general. The recently discovered locality in Sotina in northeast Slovenia is not a surprise, being actually only 8 kilometers away from a familiar locality at St. Anna am Aigen in Austria. A real surprise was the discovery of populations in the vicinity of Vinica in the far southeast of the country. This currently known, unusual pattern of distribution in Slovenia, indicates the possibility of the existence of intermediate populations and also populations on the Croatian side.

These findings lead us to the conclusion that Austrian localities belong to the northwestern areal, which is the extreme for distribution of this species.

According to the current investigation, *R. tarnierella* is very choosy about habitat and present very locally on the floristically richest dry meadows in the sub-Mediterranean part of Slovenia. The new findings are due to a good knowledge of biotopes and hard work. For example, in the vicinity of the village of Lokavec near Ajdovščina, only two of the six selected meadows gave a few results and only one gave a few more. As with the previous two parthenogenetic species, there are still plenty of suitable habitats to continue investigations, so we can expect a larger distribution in the future.

Acknowledgements

We would like to thank Adam Larysz (Poland), for the opportunity to study the comparative material of *R. imielinella* and *R. annae* under his care, and for his help with valuable information about the new species, as well as for his comments on the manuscript.

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CONFIRMED AND POTENTIAL WILD HOSTS OF THE SPOTTED WING DROSOPHILA (*DROSOPHILA SUZUKII*) IN SLOVENIA

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Abstract The spotted wing drosophila (*Drosophila suzukii* (Matsumura)) is a highly invasive species and attacking different species of berry carrying hosts. Much research has already been done on the crop hosts over the world and in Slovenia, but for wild hosts less is known. On basis of literature and fieldwork we prepared a list of potential and actual known species of wild hosts for Slovenia. In 2019, berries of different species were collected and *D. suzukii* was either reared from these berries or berries were dissected. In total we found in the literature for Europe 99 species which were used as host for *D. suzukii*. For Slovenia we found 71 potential hosts and 14 hosts which were actually infested. in Slovenia there was a broad range of potential hosts from 41 genera. The genera with the most potential hosts were *Prunus*, *Lonicera* and *Vaccinium*. Among the potential hosts were also many species which were invasive alien or alien species. The list was discussed in the context of management implications and further research on *D. suzukii* in Slovenia.

KEY WORDS: Spotted wing drosophila, *Drosophila suzukii*, berries, potential hosts, wild hosts, Slovenia, forests, pest control

Izvleček – POTENCIALNI IN POTRJENO NAPADENI DIVJI GOSTITELJI PLODOVE VINSKE MUŠICE (*DROSOPHILA SUZUKII*) V SLOVENIJI

Plodova vinska mušica (*Drosophila suzukii* (Matsumura)) je invazivna tujerodna žuželka, ki napada številne rastline s sočnimi plodovi, zlasti jagodičje. Narejenih je bilo že veliko raziskav v povezavi z gostitelji *D. suzukii*, ki so gojeni kot ekonomsko pomembne kmetijske rastline, malo pa je znanega o divje rastočih, t.j. negojenih gostiteljih te vrste. V naši raziskavi smo na podlagi pregleda literature in lastnih raziskav izdelali seznam potencialnih in znanih divjih gostiteljev plodove vinske mušice v Sloveniji. V sezoni 2019 smo nabrali plodove različnih vrst divjih gostiteljev, ki smo jih v laboratoriju analizirali na prisotnost *D. suzukii*. Literatura navaja, da je v Evropi

101 vrsta rastlin primerna kot gostiteljska za *D. suzukii*. Od teh je v Sloveniji prisotnih 72 vrst, ki spadajo v 41 rodov. *D. suzukii* je bila pri nas potrjena na 16 vrstah. Najpogostejši gostitelji plodove vinske mušice v Sloveniji so iz rodov *Prunus*, *Lonicera* in *Vaccinium*. Med potencialnimi divjimi gostitelji za *D. suzukii* v Sloveniji so tudi rastline, ki so tujerodne ali invazivne tujerodne vrste. Članek obravnava seznam divjih gostiteljev plodove vinske mušice v Sloveniji v luči iskanja novih načinov zatiranja plodove vinske mušice in daje smernice za nadaljnje raziskave na tem področju.

Ključne besede: Plodova vinska mušica, *Drosophila suzukii*, jagodičje, potencialni gostitelji, divji gostitelji, Slovenija, gozdovi, zatiranje

Introduction

The Spotted wing drosophila (SWD) (*Drosophila suzukii* (Matsumura, 1931)), originating from Asia, is highly invasive and damaging of economical crops in EU and USA (Cini *et al*., 2012; Asplen *et al*., 2015) (Figure 1). In Europe, it was first found in Spain in 2008 and rapidly spread throughout Europe (Asplen *et al.*, 2015). It was first observed in Slovenia in 2011 (Seljak, 2011). One of the reasons for its invasiveness is the fact that it has multiple generations and a large variety of host plants (Asplen *et al.*, 2015). One of the difference between European Drosophilidae fruit fly species and the SWD is that the SWD female is able to damage healthy, undamaged fruits with its serrated ovipositor, while the females of other species can only feed on rotting fruits (Sasaki in Sato, 1995).

SWD has a strong negative influence on the yield of the fruit crops. As it is highly polyphagous most of the fruit crops have problems with this species (Cini *et al.*, 2012; Asplen *et al.*, 2015). Yield losses ranging from 30-40% to 100% have been estimated, depending on the crop and the area. The costs of the SWD damage are estimated on 500 million dollars per year for only the USA (Bolda *et al.*, 2010). In Italy, the costs were estimated on 500.000 Euro in 2010 to 3 million Euro in 2011 (De Ros *et al.*, 2012). In the recent years there has been an increase of management options which increased the outcome but increased the management costs which was estimated to 1857 CHF per hectare (Mazzi *et al.*, 2017). Till now, the number of known hosts of SWD in Slovenia were 23 species, most of which are actually crop hosts (Seljak *et al.*, 2015). All berry crops in Slovenia were strongly negatively affected with in some case more than 50% of the crops (Seljak *et al.*, 2015). Due to the increasing damage caused by the SWD, new approaches and the development of new methods are needed for the control of the populations of this species to avoid large economic damages (Asplen *et al.*, 2015).

It was observed that the species has strong fluctuations over the years, where dry years have low population densities, while wet years have high densities (Seljak *et al.*, 2015). Interestingly, in the wet years also the dynamics change – the pest's flight starts earlier (Kenis *et al.*, 2016).

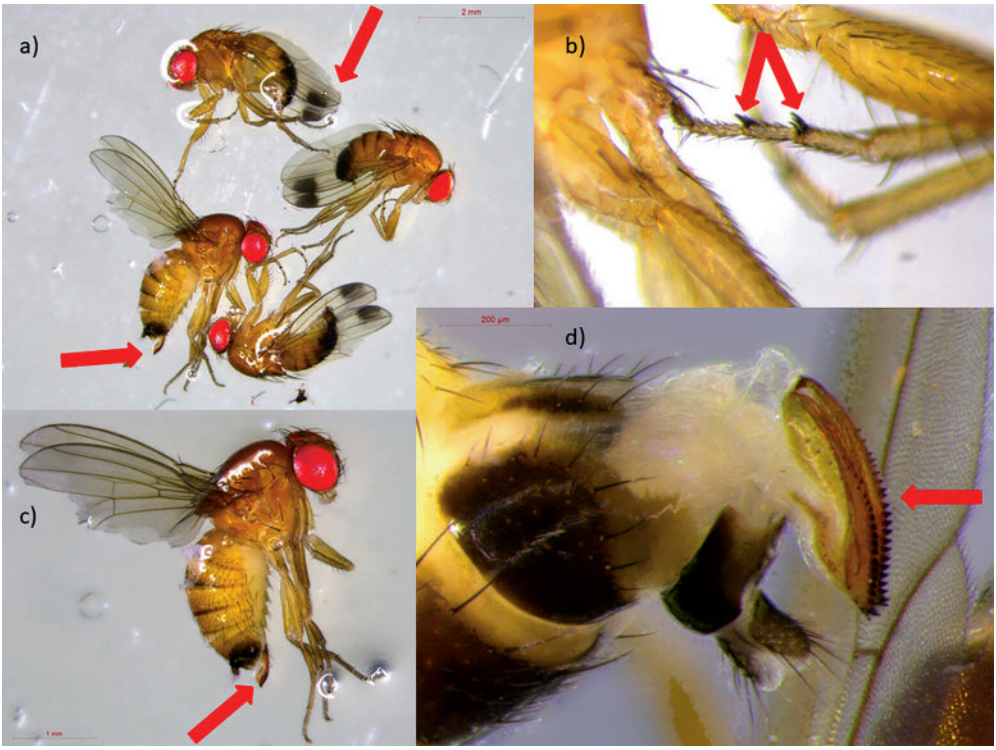

Figure 1: Recognition of the spotted wing drosophila. a) Males have a dark spot on the tip of the wings. b) Tarsomere I and II of male forelegs bear a set of spines each (sex combs). Females (c) have clear wings, and a strongly sclerotized ovipositor with black teeth (d). (photos: Jaka Razinger)

The main focus of the research on SWD management is on crops. However, many wild fruits are taxonomically related to the crop fruits and therefore it is logical to assume that many wild hosts are also infested. Two studies in Europe by Poyet *et al.* (2015) and Kenis *et al*. (2016), showed that there were respectively 33 and 84 wild hosts found. In total this comes to 88 non crop hosts of the SWD in Europe till now. The importance of the wild hosts is shown by the invasive species *Prunus serotina* which was almost 70% infested and is assumed to be a strong factor of the SWD dispersal (Poyet *et al.*, 2014). Although Seljak et al. (2015) have performed a preliminary study, in Slovenia the situation with crop/wild hosts has not yet been studied in detail.

Landscape is known to affect the population dynamics of the SWD *(*Santoiemma *et al., 2019)*. It has been shown that there is a strong spill-over effect from non-crop areas to the crops (Santoiemma *et al.*, 2018; Tonina *et al.*, 2018). Especially with the fact that SWD is a strong disperser (up to 9000 m) also forest a bit further away can have strong impacts on the SWD dynamics in crops (Tait *et al.*, 2018) It was found that forests had higher densities of SWD than meadows (Santoiemma *et al.*, 2019). Factors affecting the population densities in Europe are the forest cover (Haro-Barchin

et al., 2018) and the forest edges (Santoiemma *et al.*, 2019). Forests are an important habitat for source population, because of overwintering (many optimal microclimatic conditions) (Santoiemma *et al.*, 2018) and feeding on wild hosts which can provide breeding material during the whole flying season of SWD (Poyet *et al.*, 2015; Kenis *et al.*, 2016). The function of forests should therefore be an important focus for research on the management of SWD. Forests contain most of the wild hosts, however it was shown that there are strong regional differences in the occupancy of hosts by SWD (Kenis *et al.*, 2016).

The aim of this study was to investigate the range of wild hosts on which *Drosophila suzukii* can (potentially) reproduce in Slovenia.

Materials and methods

The preparation of the list of potential hosts of *Drosophila suzukii* in Slovenia consisted out of three steps: First a review was made of hosts used in Europe. Especially the list prepared in Kenis *et al*. (2016), Arnó *et al.* (2016) and Poyet *et al.* (2015) were used here and additional published literature which were not assessed by mentioned sources. In the second step, the flora of Slovenia (Martinčič *et al.*, 2010) was used to determine whether the host actually occurs in Slovenia. In the third step certain hosts were checked in the field whether they were colonized by SWD also in Slovenia. For this literature was checked and fruit from different (potential) host species was collected in the field. Berries were collected in 14 sites over whole of Slovenia in July 2019. The sampling sites were mainly on forest edges. The berries were put into a rearing tent in the laboratory in the Slovenian Forestry Institute, in order to let the adults of *D. suzukii* emerge. When after a week the adult did not emerge, the berries were dissected in order to see if the berries were infested with larvae.

Results

Literature survey showed that in total 101 species were found to be wild hosts of *D. suzukii* in Europe; 72 of these species occur also in Slovenia (Table 1). Of these 72 species, 14 species were found to be colonized by SWD in Slovenia. The total European species list contains 44 genera which include on average a bit more than 2 species. In Slovenia, the host plants were coming from 40 genera with on average of approximately 2 species per genus. The genera with the most host species were *Prunus*, *Lonicera* and *Vaccinium*. 14 species were found to be either used as crop but can also be found in nature.

Discussion

The results show that there are many wild hosts available which can potentially sustain SWD population dynamics in Slovenia. There were in total 71 potential wild hosts found during the literature survey which also occur in Slovenia, and from the field we detected 14 non crop species to be infested by SWD.

Table 1: Wild host species found in Europe and in Slovenia. An asterisk (*) marks species which are either native or alien and are used as crops, but can also be found in nature in Slovenia.

Plant species	Hosts in Europe	Hosts available in Slovenia	Found to be infested in Slovenia
*Actinidia chinensis**	1		
Amelanchier lamarckii	1		
Amelanchier ovalis	1	1	
Arbutus unedo	1	1	
Arum italicum	1	1	
Arum maculatum	1	1	
Atropa bella-donna	1	1	
Aucuba japonica	1		
Bryonia cretica	1		
Cornus alba	1		
Cornus kousa	1		
*Cornus mas**	1	1	
Cornus sanguinea	1	1	
Cornus sericea	1	1	
Cotoneaster franchetii	1		
Cotoneaster horizontalis	1	1	
Cotoneaster lacteus	1		
Cotoneaster rehderi	1		
Crataegus chrysocarpa	1		
Crataegus monogyna	1	1	
Daphne mezereum	1	1	
Duchesnea indica	1	1	
Eriobotrya japonica	1		
Fragaria vesca	1	1	
Frangula alnus	1	1	
Gaultheria x wisleyensis	1		
Hippophae rhamnoides	1	1	
Ligustrum lucidum	1	1	1
Ligustrum vulgare	1	1	1
Lonicera alpigena	1	1	
*Lonicera caerulea**	1	1	
Lonicera caprifolium	1	1	
Lonicera ferdinandii	1		
Lonicera nigra	1	1	
Lonicera nitida	1		
Lonicera periclymenum	1		
Lonicera xylosteum	1	1	
Mahonia aquifolium	1	1	
Malus baccata	1		
Morus alba	1	1	
Morus nigra	1	1	1
Paris quadrifolia	1	1	
Parthenocissus quinquefolia	1	1	
Photinia beauverdiana	1		
Photinia villosa	1		
Photinia prunifolia	1		

Physalis alkekengi	1	1	
Phytolacca americana	1	1	
Phytolacca esculenta	1		
Polygonatum multiflorum	1	1	
Prunus avium *	1	1	1
*Prunus cerasifera**	1	1	
Prunus cerasus *	1	1	1
*Prunus domestica**	1	1	1
Prunus laurocerasus	1	1	
Prunus lusitanica	1		
Prunus mahaleb	1	1	
Prunus padus	1	1	
Prunus serotina	1	1	
Prunus spinosa	1	1	
Pyracantha sp.	1	1	
Pyrus calleryana	1	1	
Rhamnus cathartica	1	1	
Rhamnus fallax	1	1	1
Ribes alpinum	1	1	
Ribes rubrum *	1	1	
Rosa acicularis	1		
Rosa canina *	1	1	
Rosa glauca	1	1	
Rosa pimpinellifolia	1	1	
Rosa rugosa	1		
Rubus caesius	1	1	1
Rubus fruticosus agg. *	1	1	1
Rubus idaeus *	1	1	
Rubus spp.	1	1	1
Rubus phoenicolasius *	1	1	
Rubus saxatilis	1	1	
Rubus ulmifolius	1	1	
Sambucus ebulus	1	1	
Sambucus nigra *	1	1	1
Sambucus racemosa	1	1	
Solanum chenopodioides	1		
Solanum dulcamara	1	1	
Solanum nigrum	1	1	
Sorbus aria	1	1	
Sorbus aucuparia *	1	1	
Symphoricarpos albus	1	1	
Tamus communis	1	1	
Taxus baccata	1	1	
Vaccinium myrtilloides	1		
Vaccinium myrtillus	1	1	1
Vaccinium oldhamii	1		
Vaccinium praestans	1		
Vaccinium vitis-idea	1	1	
Viburnum lantana	1	1	
Viburnum opulus	1	1	1
Viburnum rhytidophyllum	1		
Viscum album	1	1	
Vitis vinifera *	1	1	1
Total	99	71	14

We found a large number of potential host species for Slovenia over a large range of genera. This is in principle not new as it is already shown in previous studies that it is a polyphagous species (Asplen *et al.* 2015, Kenis *et al.* 2016). However, such a study was not yet done for Slovenia. The fact that there was a large number of potential hosts is probably also one of the reasons that the species could invade Slovenia so fast and can be found in large abundances throughout all of Slovenia (Seljak *et al.*, 2015).

Many of the host species listed in Table 1 are autochthonous species in Europe, but some are invasive alien species (Kenis *et al.*, 2016). It was shown that invasive alien species can be an important food source for the SWD (Kenis *et al.*, 2016). *P. serotina* was shown to have 70% of damage (Poyet *et al.*, 2014), while *Phytolacca americana* had the highest number of eggs on the fruits in a survey of 33 host species (Poyet *et al.*, 2015). With the increasing disturbance by wind and bark beetles in the forests of Slovenia (de Groot & Ogris, 2019; ZGS, 2019), many more forest gaps will develop. These gaps are suitable places for invasive alien species to grow when spread by wind or birds and support the SWD populations. On the other hand, ornamental plants which become invasive are introduced into Slovenia via the trade (De Groot *et al.*, 2017). These species, which might escape into the forests and other habitats can also become host plants for the SWD and therefore support the populations of SWD.

The European list of wild hosts mentioned in Table 1 were mainly sampled in France, Italy, Switzerland and the Netherlands (Poyet *et al.*, 2015; Kenis *et al.*, 2016). A majority of the host plant species which are found in these countries have related species in the countries of the Southern Europe. This would mean that the shown number of potential hosts can be still increased by species which are not yet surveyed. It is therefore expected that the total number of 72 wild host species for Slovenia and 101 species for Europe will still increase.

One of the advantages to be a polyphagous species is that the host species are spread in time. Kenis *et al.* (2016) and Poyet *et al.* (2015) showed already that with the combination of plant species the berries are available throughout the year. Most species are fruiting during spring and summer. The winter is a period with not so many berries available. Plant species like *Duchesnea indica*, *Prunus laurocerasus*, *Rosa canina*, *Lonicera nitida*, *Viscum album* and *Aucuba japonica* contain or can contain berries also during the winter which could sustain the population till the next year (Poyet *et al.*, 2015; Kenis *et al.*, 2016). The number of wild hosts of the SWD is expected to grow in the future. Given the trends, this could have detrimental effects on crops and economy due to the expected positive influence on the SWD population levels.

Implications for management

Slovenia is known for its large forest cover (almost 60%). Most of the forest contains host species which are presented in this study. Knowing that there is a lot of host availability in the forest, it becomes clear that the population of SWD could be sustained also from the forests. It remains therefore a question what we could do to

minimize the spillover effect from the forest to the orchards. Kenis *et al.* (2016) proposed to control the amount of wild host in the vicinity of the fruit orchards, but in light of recent research the SWD flies can migrate over long distances (Tait *et al.*, 2018); therefore this action will not have much effect. Instead, it is important to be aware, if there are many wild hosts in the vicinity of orchards and adapt management strategies accordingly. For instance, one could try to use early ripening fruit as crops, as the highest abundance of SWD is reached in the late summer (Seljak *et al.*, 2015; Tonina *et al.*, 2018). Another option is to start growing less susceptible fruit (Wang *et al.*, 2019). A third option would be that in areas with a high amount of wild hosts, monitoring would be intensified and used to time the application of insecticides on the crops to prevent damage by the SWD. A fourth option is to use appropriate nets (1 mm mesh or finer) covering entire orchards. This is mostly applicable for newly established orchards, whereas older orchards could be partially protected by the use of lateral netting (Cini *et al.*, 2012; Leach *et al.*, 2016; Weber *et al.*, 2016).

Our study shows a list of potential host species which can be or already are attacked by the SWD in Slovenian forests and other habitats of wild hosts. We show that many wild hosts are available in Slovenia for the SWD outside crop areas. However, there are concerns that invasive alien plants' abundance and distribution will increase in the coming years and therefore facilitate the population of SWD. On the other hand, climate change can increase disturbance in the forest and increase the amount of hosts in gaps like *Rubus*. Furthermore, it can also decrease the SWD development time and therefore increase the number of SWD generations. In this study the host species of SWD are pin pointed, however to understand the distribution of the host plant would give a better insight on the distribution, abundance and risk of SWD in Slovenia. Integrating wild hosts of the SWD in regard of risk maps and planning of orchards, and the use of very fine protective netting in the development of management strategies for this pest are becoming important aspects in the control of this pest in the future.

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THE BROWN LACEWING *MEGALOMUS TINEOIDES* RAMBUR, 1842 IN THE BALKAN PENINSULA (NEUROPTERA: HEMEROBIIDAE)

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Abstract - Brown lacewings are insufficiently investigated in the Balkan Peninsula. The brown lacewing *Megalomus tineoides* Rambur, 1842 is reported for the first time for Albania and North Macedonia. The male genitalia, variability of the pattern of the wing markings and natural habitats of this species are illustrated.

KEY WORDS: Neuropterida, hemerobiids, Albania, North Macedonia

Izvleček – RJAVI MREŽEKRILEC *MEGALOMUS TINEOIDES* RAMBUR, 1842 NA BALKANSKEM POLOTOKU (NEUROPTERA: HEMEROBIIDAE)

Na Balkanskem polotoku so rjavi mrežekrilci (Hemerobiidae) razmeroma slabo raziskani. Poročamo o prvih najdbah vrste *Megalomus tineoides* Rambur, 1842 za Albanijo in Severno Makedonijo. V članku so predstavljeni genitalije samca, variabilnost barvnega vzorca v krilih in naravni habitati vrste.

KLJUČNE BESEDE: Neuropterida, rjavi mrežekrilci, Albanija, Severna Makedonija

Introduction

The family Hemerobiidae, brown lacewings, with approximately 550 species, is distributed worldwide (Monserrat 1990, Oswald 1993, Aspöck et al. 2001, Tauber et

al. 2009). Adult brown lacewings are omnivorous, but a major portion of their prey consists of aphids, phylloxerids and spider mites which makes them important in the biological control of pest arthropods (New 1975, Stelzl 1991, Canard 2001, Devetak & Klokočovnik 2016).

In Europe (in the sense of Aspöck et al. 2015) there are 62 brown lacewing species listed, with 43 species in 7 genera in the Balkan Peninsula (Aspöck et al. 2001, Popov & Letardi 2010). The brown lacewing genus *Megalomus* Rambur, 1842 containing approximately 40 species is widely distributed in North and South America, Europe, northern Africa and Asia, but absent from Australia and sub-Saharan Africa (Kimmins 1935, Monserrat 1990, Oswald 1993). In the Balkan Peninsula, the genus is represented by all four European species: *Megalomus tortricoides* Rambur, 1842, *M. hirtus* (Linnaeus, 1761), *M. tineoides* Rambur, 1842 and *M. pyraloides* Rambur, 1842 (Aspöck et al. 2001, Popov & Letardi 2010).

When taking into account the morphology of the male genitalia as a criterion for identification, *Megalomus tineoides* is clearly separated from other three closely related European species (Kimmins 1935, Aspöck et al. 1980, Makarkin 1986). Knowledge of the ecology and distribution of *M. tineoides* is poor; usually only single specimens have been collected. The species is distributed in southern parts of Europe (including south of Switzerland), North Africa and western parts of Asia: Turkey, Armenia and Russian Federation (Dagestan) (Makarkin 1986, Aspöck et al. 2001, Canbulat 2007, Arı 2014). In the Balkan Peninsula *M. tineoides* has been reported in Bulgaria (Dobosz & Popov 2018), Croatia (Aspöck et al. 1980, Devetak 1992a,b), Greece (Aspöck 1962, Aspöck et al. 1980), and Serbia (Podlesnik et al. 2019).

Although the Balkan neuropterid fauna has been studied intensively in recent years (e.g. Devetak & Rausch 2016, Dobosz & Popov 2018, Devetak & Jakšić 2019) the brown lacewing fauna in the peninsula is still poorly known (see Klokočovnik et al. 2014 and Devetak & Rausch 2016 for Albania, Podlesnik et al. 2019 for Serbia). The aim of this study is to present first records of the occurrence of the brown lacewing *Megalomus tineoides* in two countries in Southern Europe and summarize new and existing data on the distribution and ecology for the species in the Balkan Peninsula.

Material and methods

Specimens were collected using portable light traps with 8 Watt actinic (368 nm) and 8 Watt black light luminescent tubes, all powered by 12 Volt batteries. Additionally, a Finnish tent trap with a 160 Watt MV bulb at the top of the pole and a 20 Watt (368 nm) black light lamp over the catching pot below were used. An additional 20 Watt (368 nm) lamp was also positioned about 70 m from the tent trap. All traps ran throughout the night.

Specimens were preserved in 70% ethanol and deposited in the first author's collection. Reliable identification of *Megalomus*-specimens is only possible by means of examination of male genitalia (Figs. 1,2). Genital preparations of voucher specimens were made by clearing the apex of the abdomen in saturated KOH solution. For identification we used the fundamental literature: Aspöck et al. (1980), Makarkin (1986).

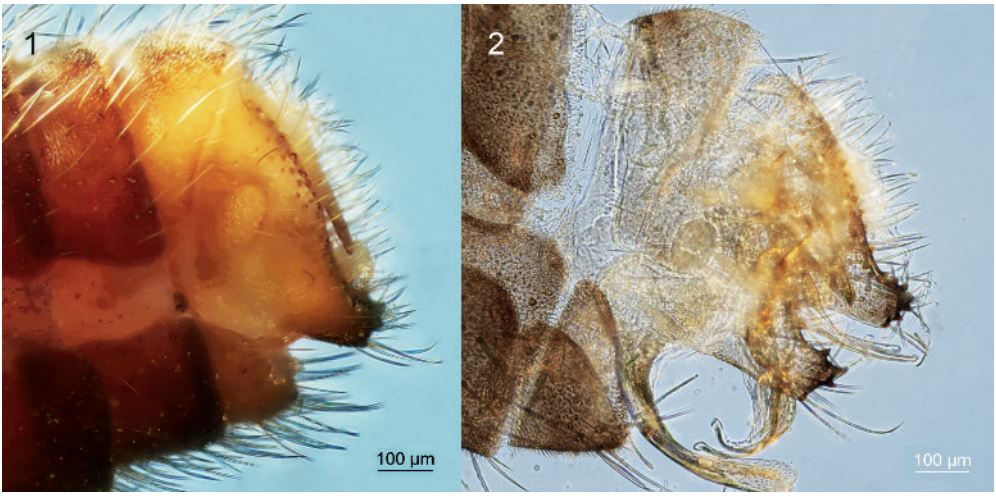

Fig. 1. Male genitalia of *Megalomus tineoides*, Demir Kapija, North Macedonia. Photo: D. Devetak.

Fig. 2. Male genitalia of *M. tineoides*, Mt. Mali me Gropë, Albania; 5-6 denticles are visible at the tip of the ectoproct. Photo: D. Devetak.

Photos of the genital preparations and the wings were taken with a stereoscopic zoom microscope Nikon SMZ 800 with a mounted digital camera Nikon DS-Fi2 and processed with NIS-Elements D 4.20 software (Nikon, 2011). The map of distribution of the species was created with RStudio (2020) using the ggplot2 (Wickham et al. 2020) and ggmap (Kahle et al. 2019) packages.

Results

Megalomus tineoides Rambur, 1842

Literature records

Aspöck (1962): Greece: Litochoro. Aspöck et al. (1980): Croatia: Split; Greece: Crete. Devetak (1992b): Croatia: Split. Dobosz & Popov (2018): Bulgaria: Struma Valley: Skakavitsa Railway Station; Sandanski; Karlanovo: NE of Melnik; Melnik; Black Sea Coast: Obzor. Podlesnik et al. (2019): Serbia: Trnava village near Preševo.

Material examined (Figs. 1-4)

In a period 2015-2019 a total of 25 males were collected in Albania, North Macedonia and Serbia.

Albania:

Dibër County; Mt. Thanës, near Bulqizë town, above Plani i Bardhë village, 767 m, 41°28'34.3"N 020°09'19.4"E, 30.IX.2018, 3 ♂, leg. A. Nahirnić & S. Beshkov.

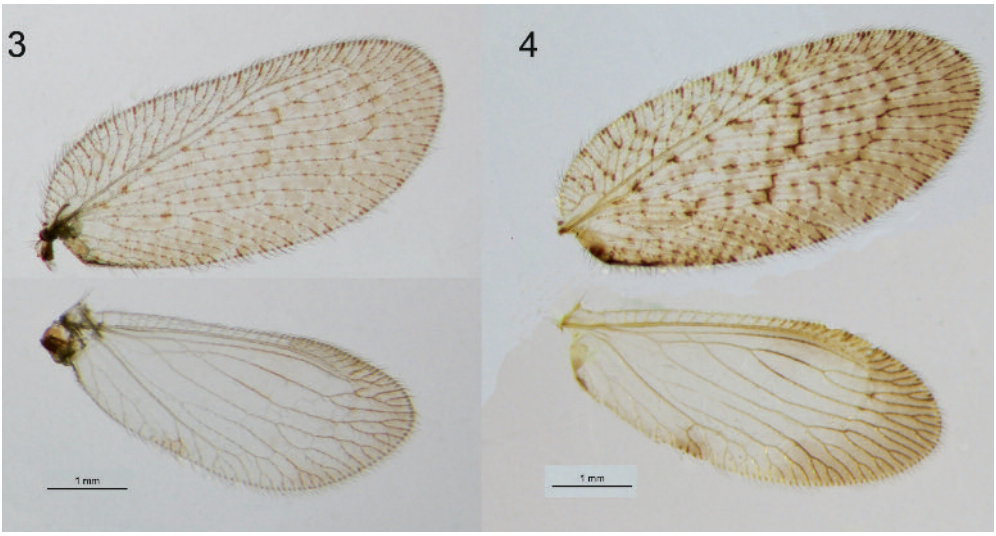

Fig. 3. Wings of *M. tineoides*, Preševo, Serbia with typical light pattern of the wings. Photo: D. Devetak.

Fig. 4. Wings of *M. tineoides*, Demir Kapija, North Macedonia with darker pattern of the wings. Photo: D. Devetak.

Fier County: near Ardenica monastery, above Kolonjë town, 127 m, 40°49'35.4"N 019°35'17.5"E, 2.XI.2018, 3 ♂, leg. A. Nahirnić & S. Beshkov.

Gjirokastër County: Përmet municipality, near Benjë-Novoselë village, 437 m, 40°14'39"N 020°25'22"E, 20.X.2017, 1 ♂, 2 ♀, leg. A. Nahirnić & S. Beshkov.

Lezhë County: Munellë Mt., above Mesul village, 1400 m, 41°56'56.8"N 020°05'33.4"E, 7.VII.2019, 1 ♂ (darker individual), leg. A. Nahirnić & S. Beshkov.

Shkodër County: Bjeshkët e Nemuna Mts. (=Prokletije Mts), Malësi e Madhe municipality, above the Cemi Selcës river valley near Gropat e Selcës village, 1236 m a.s.l., 42°32'26"N 019°41'45"E, 16.VIII.2018, 2 ♂, leg. S. Beshkov, A. Nahirnić & C. W. Plant.

Tirana County: Dajt Mt., Qafa e Mollës Pass, 675 m, 41°21'51.5"N 019°57'55.7"E, 1.XI.2018, 1 ♂, leg. A. Nahirnić & S. Beshkov; 30.IX.2019, 1 ♂, leg. A. Nahirnić & S. Beshkov.

Tirana County: Mt. Mali me Gropë (=Mt. Mali me Gropa), southern slopes, northwest from Burimas village above Shëngjergi village (Fig. 5), 1400 m a.s.l., 41°21'11.34"N 020°02'38.23"E, 13.VIII.2018, 1 ♂, leg. C.W. Plant & S. Beshkov.

Vlorë county: Ionian Sea Coast, Palasë village near Dhërmi, 274 m, 40°10'35"N 019°36'21"E, 6.VI.2016, 2 ♂, leg. A. Nahirnić & S. Beshkov.

First records in Albania.

Serbia:

Preševo town, 2 km W Trnava village, 696 m, 42°16'33"N 021°36'57"E, light trap, 18.IX.2015, 1 ♂, A. Nahirnić & S. Beshkov leg.

North Macedonia:

Vardar Region: Demir Kapija, Besvica village E, gorge of Besvički dol river, 255 m, 41°22'58"N 022°11'45"E, light traps; 05.V.2017, 1 ♂; 28.X.2018, 6 ♂; 13.VII.2019, 3 ♂; all A.Nahirnić & S.Beshkov leg. (Fig. 6).

First record in North Macedonia.

Distribution of the species in the Balkan Peninsula is shown in Fig. 7.

In Demir Kapija, North Macedonia, two dozen *Megalomus*-females and a few males of *Megalomus tortricoides* were also collected. Some of the females were typical for one of the two species, but the identity of the rest was uncertain, due to the co-occurrence of the two species.

Variability of the wing pattern

A male from the site at Preševo, Serbia has wings with light markings, typical for *M. tineoides* (Fig. 3). In contrast, a male from Mt. Mali me Gropë, Albania and most of males from North Macedonia (Fig. 4) have much darker pattern of the wings which is not a typical characteristic for this species.

Ecology

In Mt. Mali me Gropë, Albania the male was collected on the southern slopes of the mountain, characterized by dry rocky grasslands with sporadic shrubs and screes, limestone (Fig. 5). In Mt. Thanës, Albania *M. tineoides* was collected on dry rocky grasslands on serpentinites. Near Ardenica, Albania it was collected in maquis. In Mt. Munellë, Albania its habitat was mountain grasslands on limestone.

Fig. 5. Dry rocky grasslands with sporadic shrubs, Mt. Mali me Gropë, Albania. Photo: A. Nahirnić.

Fig. 6. Pseudomaquis and rocky grasslands with sporadic shrubs, vicinity of Besvica village, Demir Kapija, North Macedonia. Photo: A. Nahirnić.

Fig. 7. The present known distribution of *M. tineoides* in the Balkan Peninsula. Orig. D. Devetak.

In Demir Kapija, North Macedonia *M. tineoides* occurred in dry rocky grasslands, pseudomaquis and transition from dry rocky grasslands with sporadic shrubs to pseudomaquis, i.e. mixed sclerophyllous evergreen and deciduous shrub thickets consisting of Mediterranean and sub-Mediterranean xerophilic shrubs and small trees (in Demir Kapija: *Fraxinus ornus* L., *Juniperus excelsa* M. Bieb., *Juniperus oxycedrus* L., *Paliuris spina-christi* Mill., *Pistacia terebinthus* L., *Phillyrea latifolia* L., and *Quercus pubescens* Willd.) (Fig. 6).

Beshkov & Nahirnić (2016) described the habitat at the collecting place near Preševo, Serbia as conforming to the Serbian EUNIS habitat classification (Lakušić et al. 2005) as E1.2B2 [Serpentine Steppe on shallow, rocky soil] in a forest belt of *Quercus pubescens* Willd. and *Q. petraea* (Matt.) Liebl. and thickets as a result of degradation of that forest.

Discussion

In this paper, the occurrence of the brown lacewing *M. tineoides* in Albania and North Macedonia is confirmed for the first time. The distribution of this species in Bulgaria has been mapped very recently by Dobosz & Popov (2018).

In various parts of Europe, this species occurs on shrubs and rarely on trees, especially on oaks (*Quercus*) (Aspöck et al. 1980). In fact, *M. tineoides* is the species that does not reveal correlation with any plant specific substrate species (Monserrat & Marín 1996), it is collected mostly at light. In this paper, the habitats of the species, i.e. dry grasslands and mixed sclerophyllous evergreen and deciduous shrub thickets (pseudomaquis) in North Macedonia and serpentine steppes in Serbia are described in detail.

Acknowledgements

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ADDITIONS TO THE CRAMBIDAE (INSECTA: LEPIDOPTERA) FAUNA OF CROATIA AND BOSNIA & HERZEGOVINA

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Abstract - During recent surveys of Lepidoptera in southern Croatia and Bosnia & Herzegovina, several Crambidae species that were not previously recorded in those countries were encountered. One species, *Friedlanderia cicatricella* (Hübner, 1824), is recorded for the first time in Croatia while five are recorded for the first time in Bosnia & Herzegovina: *Euclasta splendidalis* (Herrich-Schäffer, [1848]), *Dolicharthria bruguieralis* Zeller, 1847, *Chilo phragmitella* (Hübner, [1810]), *Sclerocona acutella* (Eversman, 1842) and *Duponchelia fovealis* Zeller, 1847. All of the species were recorded is southern Dalmatia & Herzegovina, showing the importance of the area for the Crambidae fauna and the need of further faunistical surveys.

KEY WORDS: grass moth, Hutovo blato, Neretva river delta, wetlands, invasive species

Izvleček – PRISPEVKI K FAVNI DRUŽINE CRAMBIDAE (INSECTA: LEPIDOPTERA) HRVAŠKE TER BOSNE IN HERCEGOVINE

Med nedavnimi raziskavami metuljev na jugu Hrvaške ter v Bosni in Hercegovini je bilo najdenih več vrst družine Crambidae, ki v teh državah prej niso bile zabeležene. Ena vrsta, *Friedlanderia cicatricella* (Hübner, 1824), je bila prvič zabeležena na Hrvaškem, medtem ko je bilo v Bosni in Hercegovini prvič zabeleženih pet vrst: *Euclasta splendidalis* (Herrich-Schäffer, [1848]), *Dolicharthria bruguieralis* Zeller, 1847, *Chilo phragmitella* (Hübner, [1810]), *Sclerocona acutella* (Eversman, 1842) in *Duponchelia fovealis* Zeller, 1847. Vse vrste so bile zabeležene v južni Dalmaciji in Hercegovini, kar kaže na pomen območja za favno družine Crambidae in potrebo po nadaljnjih favnističnih raziskavah.

KLJUČNE BESEDE: travniške vešče, Hutovo blato, delta reke Neretve, močvirja, invazivne vrste

Introduction

The large and diverse superfamily Pyraloidea in Europe contains more than 850 species (Karsholt, & Razowski 1996). In the Balkan peninsula, no less than 569 species are known so far, of which 310 belong to Crambidae and 259 to Pyralidae families (Plant & Jakšić 2018). With recent checklists (Gumhalter 2019a, b) and species' overviews, this superfamily becomes, if not one of the best studied microlepidoptera superfamilies in the Balkan peninsula, the superfamily for which most comprehensive data is available (see Plant & Jakšić 2018). Still, most of the available data is based on literature records (Plant & Jakšić 2018; Gumhalter 2019a) while new data remain scarce. In recent years, many new Crambidae species were recorded for the fauna of Croatia (e.g. Koren 2012, 2020; Gumhalter 2019a) while the data for the Crambidae fauna of Bosnia & Herzegovina are based only on old historical records (Lelo 2004; Plant & Jakšić 2018).

Materials and methods

During recent surveys of Croatia and Bosnia & Herzegovina, Crambidae were collected along with other Lepidoptera families. Moths were surveyed using pyramidal UV light traps in Neretva river delta and Stolac (Fig. 1). Five traps were in operation for 4h after dusk at each locality. In Hutovo blato Nature park and Klek peninsula (Fig. 1) automatic heath traps with UV lights were operated during the whole night. The collected specimens were set, identified and stored in the private collection of the author (Koren, Zagreb). For identification of species, we used Slamka (2006, 2008, 2013) and Leraut (2012).

Results

For each species, the exact locality, coordinates, date and additional notes are provided.

***Friedlanderia cicatricella* (Hübner, 1824)** (Fig. 2)

Material examined: Croatia, Neretva river delta, Pižinovac village, road east of the village surrounded by reeds and maquis, 42.984711° N, 17.544549° E, 16.viii.2020, 5 ex., leg. T. Koren.

Notes: New for the fauna of Croatia. This species is present in the surrounding countries, but has never before been found in Croatia (Slamka 2008; Gumhalter 2019a, b), so the record from Croatia fills its distributional gap in the Balkans. It is a wetland species that inhabits moist meadows and floodplains around rivers and lakes (Slamka 2008). This is in accordance to the habitat in which it was recorded, edge of channels surrounded by reeds. Several males and females were observed and collected on the site, indicating a resident population in the area. This also indicates the importance of the Neretva river delta which has so far not been part of systematic Lepidoptera surveys, and only a limited number of Crambidae species have been recorded in the

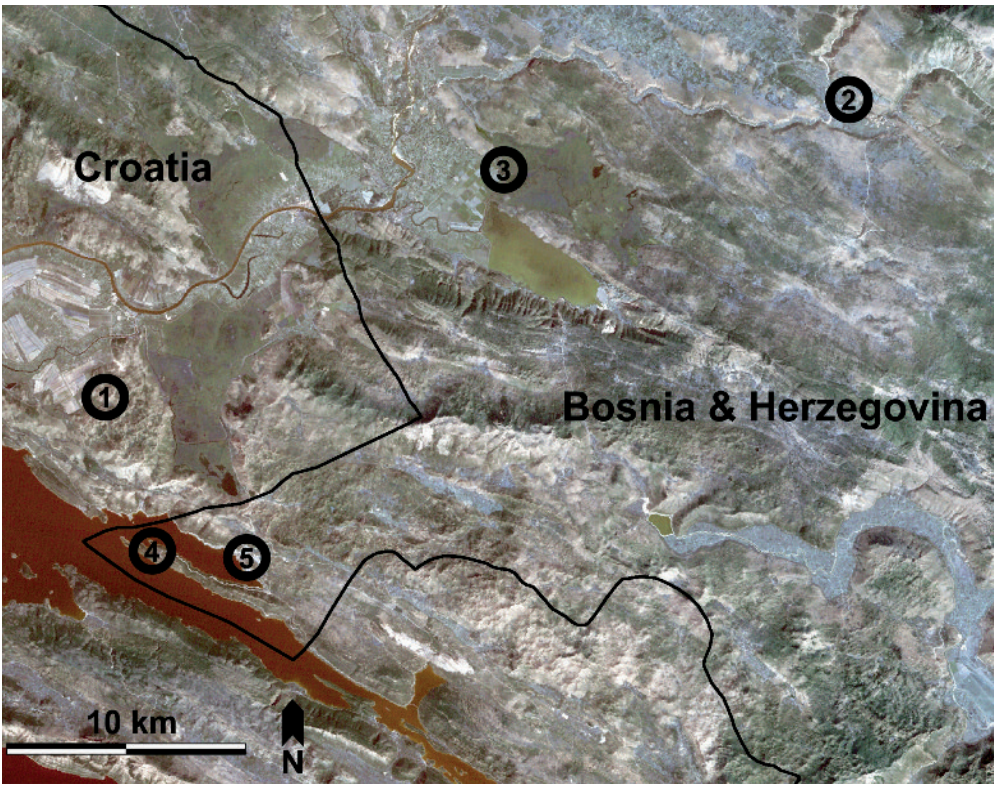

Figure 1. Map of surveyed localites.
Slika 1. Karta raziskanih lokalitet.

area (Gumhalter *et al.* 2018). Further surveys in the delta will probably reveal more localities for this wetland species.

***Chilo phragmitella* (Hübner, [1810])**

Material examined: Bosnia & Herzegovina, Stolac, forest edge NW of the settlement, 43.087647° N, 17.936115° E, 104 m a.s.l., 3.viii.2016, 2 ex., obs. T. Koren.

Notes: New for the fauna of Bosnia & Herzegovina. This is a wetland species widely distributed in Europe but missing from some Balkan countries (Slamka 2008; Plant & Jakšić 2018). It is generally common in the areas where it occurs, and is easily attracted to light traps.

***Euclasta splendidalis* (Herrich-Schäffer, [1848])**

Material examined: Bosnia & Herzegovina, Hutovo blato Nature Park, Karaotok, bank of a canal surrounded by reeds, bushes and trees, 43.065995° N, 17.754760° E, 5 m a.s.l., 05.ix.2020, 2 ex., leg. D. Kulijer.

Notes: New for the fauna of Bosnia & Herzegovina. This species has only recently been recorded in southern Croatia in the Neretva river delta, which represents the

Figure 2. *Friedlanderia cicatricella* from the Neretva river delta, close to Pižinovac village. Photo by T. Koren.

Slika 2. *Friedlanderia cicatricella* z delte reke Neretve, blizu vasice Pižinovac. Fotografiral T. Koren.

northernmost record in the Balkan peninsula (Koren 2012; Gumhalter *et al.* 2018). The record from Hutovo Blato in Bosnia & Herzegovina was expected as the area is very close to Neretva river delta and it is part of the same wetland system. Two specimens were collected by a heath moth trap in the bank of the canal surrounded by reeds, bushes and trees (Fig. 3). This is in accordance with known habitats in Croatia in the Neretva river delta.

***Dolicharthria bruguieralis* (Duponchel, 1833)**

Material examined: Bosnia & Herzegovina, Neum, Klek peninsula, edge of Opuće village, 42.927041° N, 17.571990° E, 10.ix.2020, 2 ex., leg. D. Kulijer.

Notes: New for the fauna of Bosnia & Herzegovina. This is a Mediterranean species commonly found alongside the Adriatic coast, especially in garrigue habitat. It has been recorded in most of the Balkan states (Plant & Jakšić 2018). Additional records are expected for Herzegovina area in the future.

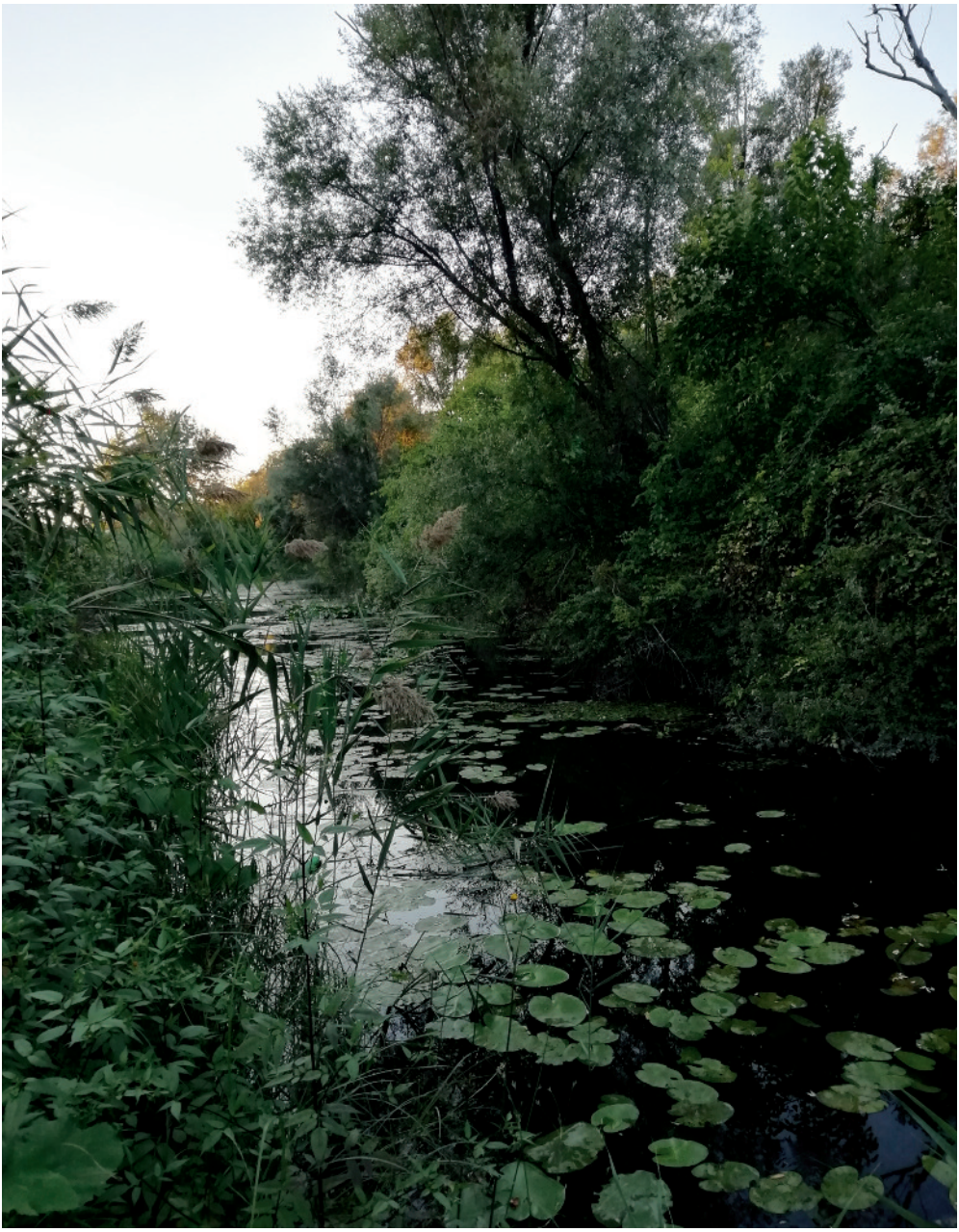

Figure 3. Habitat of *Euclasta splendidalis* in Hutovo blato Nature park. Photo by D. Kulijer.

Slika 3. Habitat vrste *Euclasta splendidalis* v Naravnem parku Hutovo blato. Fotografiral D. Kulijer.

***Duponchelia fovealis* Zeller, 1847**

Material examined: Bosnia & Herzegovina, Neum, on the wall of a store, 42.924300° N, 17.616814° E, 10.viii.2012, 2 ex., obs. T.Koren.

Notes: New for the fauna of Bosnia & Herzegovina. This is an invasive pest species attacking strawberry (*Fragaria* spp.) plants. It was firstly recorded in Europe in Italy in 1988 (Bonsignore *et al*. 2008). Afterwards it has quickly spread across most of Europe, Turkey, United States and Canada (Efil *et al*. 2014). In the Balkan peninsula it has so far been recorded in Croatia, Montenegro, Serbia, Macedonia, Albania and Greece (Plant & Jakšić 2018). Additional records are expected for Herzegovina area in the future.

***Sclerocona acutella* (Eversman, 1842)**

Material examined: L 2: Bosnia & Herzegovina, Stolac, forest edge NW of the settlement, 43.087647° N, 17.936115° E, 104 m a.s.l., 3.viii.2016, 2 ex., obs. T. Koren.

Notes: New for the fauna of Bosnia & Herzegovina. This is a rather widespread wetland species, present in most Balkan countries (Plant & Jakšić 2018). Further records are expected from other parts of Bosnia & Herzegovina as well.

Discussion

With this small, initial contribution, the number of recorded Crambidae species for Bosnia & Herzegovina rises from 152 (Plant & Jakšić 2018) to 157. This is still far from the fauna of Croatia which now contains 210 species (Plant & Jakšić 2018; Gumhalter 2019a, b; Koren, 2020). This indicates that the Crambidae moth fauna of Bosnia & Herzegovina is under-recorded in comparison with Croatia and other neighbouring countries. Four out of the six species mentioned here can be regarded as wetland specialists, indicating the importance of such habitats in both countries. Both Hutovo blato in Bosnia & Herzegovina and Neretva river delta in Croatia are parts of the same Neretva river drainage, which is one of the largest wetlands in the region. It is important to additionally protect and preserve such habitat for the long-term survival of its overall biodiversity of flora and fauna. The survey of moth fauna of the Neretva river delta commenced in 2020 (Koren, unpublished); it is highly desirable to start a similar survey in Hutovo blato in order to investigate the lepidopteran fauna to an adequate level to be able to provide advice on the protection of the area. Additional moth surveys of different parts of both countries will, without doubt, generate further new species records and expand knowledge of the distribution of other rare species.

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REDISCOVERY AND DISTRIBUTION OF THOR'S FRITILLARY *BOLORIA THORE* (HÜBNER, 1803) (LEPIDOPTERA: NYMPHALIDAE) IN SLOVENIA

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Abstract Thor's Fritillary (*Boloria thore*) has been considered extremely rare and localised at the south-eastern edge of its distribution in the Alps, especially in Slovenia. Despite surveys focused on sites with historical records (Julian Alps, Karavanke Mts.), there is almost a century long gap with no observations. Its discovery on the south-eastern slopes of Mt. Košuta (Karavanke Mts.) in 2004 was therefore unexpected, however within the known historical range of the species in the region. Since its rediscovery, the species has been observed at several new localities in the Karavanke Mts. and Julian Alps. These records are presented and habitat requirements as well as potential threats for the species are discussed.

KEY WORDS: Papilionoidea, montane species, habitat, endangerment

Izvleček PONOVNO ODKRITJE TEMNEGA TRATARJA *BOLORIA THORE* (HÜBNER, 1803) (LEPIDOPTERA: NYMPHALIDAE) IN NJEGOVA RAZŠIRJENOST V SLOVENIJI

Temni tratar (*Boloria thore*) velja na jugovzhodnem robu svoje razširjenosti v Alpah, zlasti v Sloveniji, za izredno redko in lokalno razširjeno vrsto. Kljub načrtnemu pregledu znanih zgodovinskih lokacij (Julijske Alpe, Karavanke) ga pri nas skoraj 100 let nismo našli. Njegovo ponovno odkritje na jugovzhodnih pobočjih Košute (Karavanke) leta 2004 je bilo nepričakovano, pa čeprav znotraj znanega zgodovinskega območja razširjenosti vrste v regiji. Od ponovnega odkritja je bila vrsta potrjena na več novih lokacijah v Karavankah in Julijskih Alpah. Te najdbe predstavljamo v prispevku, kjer razpravljamo še o habitatu in potencialni ogroženosti te vrste.

KLJUČNE BESEDE: Papilionoidea, montanske vrste, življenjski prostor, ogroženost

Introduction

Thor's fritillary is a boreo-alpine species distributed in the northern Palaearctic region from Japan in the east (Tuzov & Bozano 2006), throughout northern Asia to boreal northern Europe with a disjunct range in the Alps (Tolman & Lewington 2008). Here it is distributed mainly in the Central and Eastern Alps, reaching the northern Piedmont region at the south-western edge of the distribution (Mérit & Manil 2016). It is more widespread in the northern part of the Alps (e.g. Bavaria - Nunner 2013), becoming much scarcer towards south (e.g. South Tyrol – Huemer 2004, Dolomites - Bonato et al. 2014).

It is a predominantly woodland species favouring coniferous forest clearing or open coniferous or mixed woods in the montane belt in the Alps (Pro Natura 1987, Weidemann 1995). It is often found on shaded clearings, along dump forest edges, ravines and mountain streams with abundance of nectar sources (Pro Natura 1987, Tolman & Lewington 2008, Nunner 2013). Adults have a slower and more gliding flight compared to other species in the genus and are often visiting flowers, or perching on low bushes and young firs (Gorbunov & Kosterin 2007). Flight period in the Alps is from mid-June to beginning of August depending on altitude and season (Tolman & Lewington 2008). Due to large fluctuations in numbers of adults a biannual lifecycle has been anticipated (Pro Natura 1987), however not confirmed (Huemer 2004). The larvae feed on different *Viola* spp., in the Alps most commonly on *Viola biflora* L. (Pro Natura 1987). The species in general is not considered threatened in Europe (van Swaay et al. 2010), however local populations at the edge of the distribution can be affected by afforestation of clearings, intensive forest management, overgrowing of open forest areas or development of infrastructure (ski pists, etc.) (Nunner 2013).

Only three historical records were published for Thor's Fritillary in Slovenia. It was first reported by Hafner (1909) in his comprehensive overview of the fauna of the Krain region based on specimens collected by Hans Kautz in the northern Julian Alps in Pišnica Valley (18.6.1908) and at Erjavčeva hut near Vršič Pass (9.7.1908) (also mentioned in Rebel 1910). Additionally, it was reported from Mt. Baba in Karavanke Mts. (18.7.1906) (Galvagni 1910), however without precise information on the locality. It is likely, that the species was found on the southern side of the mountain (in Slovenia) as Galvagni mentions Mojstrana town as a starting point of his explorations (Galvagni 1910). There is also an additional record for Mt. Stol in the same range based on a specimen in Vienna Natural History Museum (Verovnik et al. 2005), however it is likely that the specimen was collected on the northern (Austrian) side of the mountain where the species is known to occur in nearby Bärental (Thurner 1948). Thurner (1948) also mentions the species from Quadia Alm in close proximity of the Slovenian border near Mt. Golica, and several other mountain ranges in Carinthia (Koralpe, Saualpe, Dobratsch, Carnic Alps). In Koralpe, just north of the Slovenian border near Drava River, the species was reported from both the Carinthian and Styrian part of the range (Höfner 1885, 1903, 1911, Kühnert 1966, 1978). No published

records from Friuli region could be retrieved, but species was known to occur near Fužine Lakes close to Slovenian border (Štanta Radovan, pers. observ.).

Thor's Fritillary was rediscovered in Slovenia in 2004 at Dolge Njive pastures below Mt. Košutnik in the eastern part of Karavanke Mts. (Gomboc, pers. observ.) and at several nearby sites in the subsequent years (Verovnik et al. 2012). A more detailed account of these records and additional records from western Karavanke Mts. and Julian Alps are discussed in our overview.

Methods

Focused species surveys for Thor's fritillary were based on historical records and presence of the potentially suitable habitat, mainly along streams and forest roads since the year 2000. Maps with orthophoto images, such as Geopedia (http://www.geopedia.si/) and Atlas okolja (http://gis.arso.gov.si/atlasokolja/) were also used for detection of the potential habitats. Butterflies were netted and released after examination,

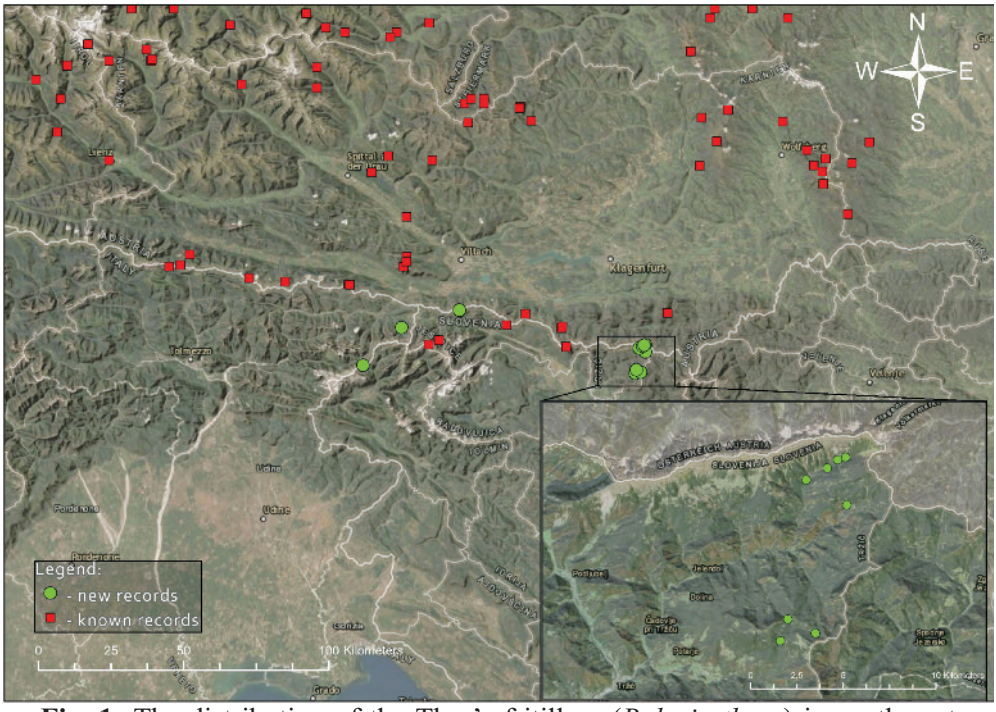

Fig. 1: The distribution of the Thor's fritillary (*Boloria thore*) in south eastern Alps. New records (green dots) are added to the known locations (red squares) based on literature data and database queries (see methods).

Sl. 1: Razširjenost temnega tratarja (*Boloria thore*) v jugovzhodnih Alpah. Novi podatki (zelene točke) so dodani k znanim lokacijam (rdeči kvadratki) iz literature in baz podatkov (glej metode).

or were observed without disturbance. Adults and habitats were documented by photographing.

Distribution map (Fig. 1) was prepared in ESRI ArcGIS Pro software, based on observation presented in this contribution, the literature data, and records from databases ZOBODAT (https://www.zobodat.at/), GBIF (https://www.gbif.org/), and Observation (https://observation.org/).

Results

Since the year 2000, which marks the large scale faunistic surveys for the butterfly atlas of Slovenia (Verovnik et a. 2012), but also earlier, the first author visited all three historical sites (Velika and Mala Pišnica Valleys, Vršič pass, Mt. Baba) with the former presence of Thor's fritillary on several occasions, however without any success. Apart from the open forest and small streams on the northern side of the Vršič pass, no potentially suitable habitat was found. The known site at nearby Lago di Fusine in Italy was also visited with a single observation in 1999 (see Table 1). In the last decade the open forests near the lake were greatly reduced and large intensive pastures have been established, so no additional observations were made.

Fig. 2: Thor's fritillary (*Boloria thore*) underside. Photographed at the quarry below Mt. Košutnik. (photo: Rudi Verovnik)

Sl. 2: Temni tratar (*Boloria thore*), spodnja stran. Fotografiran pri kamnolomu pod Košutnikom. (foto: Rudi Verovnik)

Table 1: List of localities and dates of the recent observations of Thor's fritillary (*Boloria thore*) in south-eastern Alps.

Tabela 1: Seznam lokalitet in datumov novejših najdb temnega tratarja (*Boloria thore*) v jugovzhodnih Alpah.

date	locality	Lat (WGS84)	Lon (WGS84)	Altitude (m)
31.7.2004	SI, Tržič, Mt. Košuta, upper part of the Dolge njive pastures along the dry stream in the woods	46°26′18″	14°25′10″	1465
12.7.2006	SI, Tržič, Mt. Veliki Javornik, along the road 500 m Gaberčev rovt pastures	46º 22′ 38″	14º 23′ 16″	1440
12.7.2006	SI, Tržič, Mt. Veliki Javornik, glades and pastures at the saddle N of the mountain	46º 22′ 47″	14º 24′ 17″	1470
12.7.2006, 4.7.2014, 19.6.2018, 7.7.2018	SI, Tržič, Mt. Veliki Javornik, along a small stream in the valley E of Konjščica peak	46º 23′ 04″	14º 23′ 29″	1380
6.7.2006	SI, Tržič, Mt. Košuta, clearings along the road south east of the Črna Peč peak	46º 25′ 21″	14º 25′ 12″	1210
19.6.2018	SI, Tržič, Mt. Košuta, along the stream and road in the valley N of Košutnik hut	46º 25′ 51″	14º 24′ 01″	1140
6.7.2006, 2.7.2007, 15.6.2011, 11.7.2015, 19.6.2018	SI, Tržič, Mt. Košuta, along the road near the small abandoned quarry	46º 26′ 05″	14º 24′ 38″	1290
6.7.2006	SI, Tržič, Mt. Košuta, lower part of the Dolge njive pastures and along the dry stream	46º 26′ 15″	14º 24′ 56″	1380
24.7.2018, 25.6.2019, 9.7.2020	SI, Kranjska Gora, Mt. Trupejevo Poldne, first part of the Železnica valley	46º 30′ 43″	13º 50′ 37″	1500
27.6.1999	IT, Fusine in Valromana, Lago di Fusine, small glade south-west of the upper lake	46° 28′ 29″	13° 39′ 54″	930
29.6.2019	IT, Mt. Jerebica, clearing along the track W of Jezerski pass	46° 23′ 39″	13° 32′ 45″	1610

Fig.3: Habitat of Thor's fritillary (*Boloria thore*) in the lower part of the Železnica Valley, western Karavanke Mts. (photo: Primož Glogovčan)

Sl. 3: Življenjski prostor temnega tratarja ((*Boloria thore*) v spodnjem delu doline Železnica, zahodne Karavanke. (foto: Primož Glogovčan)

The rediscovery of Thor's Fritillary in 2004 was completely coincidental, during an inventory of grasshoppers and butterflies. Only a single worn individual was observed in open spruce forest near dry stream at Dolge njive pastures. A more detailed survey of the wider region between Mt. Košuta and Mt. Storžič followed in 2006 when the species was recorded at six additional sites. Main common characteristics of the localities are the presence of open coniferous woods with open areas along roads and in most cases also small streams. Abundance of flowering plants was noted along the streams and on road verges providing the necessary nectar sources for the adults. We noticed different *Cirsium* sp., *Knautia* sp., and *Thymus* sp. as the main nectar source of the adults. The males commonly perched on small spruces or bushes 2 to 3 meters above the ground, sometimes returning to the same perch when disturbed. They were also observed patrolling along streams or roads, while females were busier visiting the flowers. Mostly, they were present in low numbers from 1 to 5 specimens per site, however in 2006 they were common near the small abandoned quarry below Mt. Košuta (Fig. 2). Closely related, montane woodland habitat specialist, Titania's fritillary (*Boloria titania* (Esper, 1793)) has been found cohabiting at most of these sites.

In 2018 the species has finally been discovered also in the western Karavanke Mts., much closer to the historical Mt. Baba locality, in Železnica Valley. The first

author visited the valley on two previous occasions, but possibly too late in the season, as only Titania's fritillary was recorded. The habitat is otherwise ideal for both fritillaries with open fir and larch woods on both slopes and glades along the stream and the narrow road meandering through the valley (Fig 3). The presence of the species was confirmed also in both consecutive years, with largest abundance of about a dozen of specimens seen in 2020.

The discovery of the species at the Mt. Jerebica (Jezerski pass) in the western Julian Alps just across the border in Italy was a bigger surprise, as the habitat there is steep grassy slope with dwarf pine and small fir trees near the ridge surrounded by otherwise dense montane forest with no stream in vicinity. Such habitat combination is widespread throughout Julian Alps in particularly on the eastern and northern edge of the range. Approximately ten adults were observed, some feeding on thistles *Adenostyles alliariae (*Gouan) A.Kern. (Fig. 4).

Discussion

Given the recent records, the Thor's fritillary is obviously not that extremely rare in south-eastern Alps as adjudging from the long gap between historical and recent

Fig.4: Thor's fritillary (*Boloria thore*) feeding on *Adenostyles alliariae* near Jezerski pass, Mt. Jerebica in western Julian Alps. (photo: Primož Glogovčan)

Sl. 4: Temni tratar ((*Boloria thore*) se hrani na *Adenostyles alliariae* v bližini Jezerskega prelaza pri Jerebici v zahodnih Julijskih Alpah. (foto: Primož Glogovčan)

observations (Verovnik et al. 2012). This could be explained by its low detectability due to short flight period, low adult abundance (possibly due to biannual life cycle (Pro Natura 1987)), and extremely localised distribution linked to availability of suitable open coniferous forest habitat. Our records span form mid-June to end of July, which is in line with observations elsewhere in the Alps (Pro Natura 1987, Tolman & Lewington 2008), however locally the adults are on the wing not more than three weeks with a peak of occurrence in Slovenia at the beginning of July.

The species is possibly more widespread in the south-eastern Alps and we expect its wider distribution in the Karavanke Mts., northern Julian Alps, and anticipate its possible occurrence also in the Pohorje Mts. further eastwards. Namely, the Thor's fritillary has been recorded from nearby Koralpe (Höfner 1885, 1903, 1911, Kühnert 1966, 1978) and both ranges share at least one boreo-alpine butterfly species *Argiades optilete* (Knoch, 1781) (Kühnert 1978, Jež 1983). Potentially suitable habitats for Thor's fritillary are present on the northern side of the Pohorje Mts. but so far no focused search has been undertaken. The geographically even closer to Koralpe are Kozjak Mts. at the border with Austria, but they are probably too low and with a predominantly southern exposition, therefore not likely to have any suitable habitat for the species.

The Thor's fritillary is listed as vulnerable in the Alpine region in the first published Red list of butterflies of Slovenia (Carnelutti 1992) with a note, that it has not been observed for a 'while'. In the Atlas of threatened butterflies of Slovenia (Čelik & Rebeušek 1996) it is considered extinct and was therefore not evaluated for the official red list of the Lepidoptera of Slovenia (Official Gazette 2004). The status of a vulnerable species has been proposed also in the Slovenian butterfly atlas (Verovnik et al. 2012) due to extreme localised distribution. Taking into consideration our recent findings we are inclined to lower its extinction risk to near threatened, as we show that the Thor's fritillary has a wider distribution in Slovenia and is predominantly distributed in areas with low human impact. Still majority of the populations are highly localised and possibly isolated, thus vulnerable to local habitat change (e.g. road construction, logging, afforestation) and over-collecting. Although climate change could also be considered a long term threat for such montane butterflies (Settele et al. 2008), a much more detailed survey and a longer time span would be required to substantiate this.

The current forest management, particularly in the Karavanke Mts., is suitable for long term maintenance of the habitat for the Thor's fritillary with large areas of open spruce woods, clearings, and fellings. Pasturing, to a smaller extent, is also important for maintenance of open habitat structures bellow the treeline, which are perquisite for flower rich areas required by the species. We hope our publication will trigger further surveys and research of this interesting species at its southern edge of the distribution in Europe.

Acknowledgment

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NEW LOCALITIES FOR RARE BUTTERFLIES *MUSCHAMPIA CRIBRELLUM* AND *MELITAEA ORNATA* (LEPIDOPTERA: HESPERIIDAE, NYMPHALIDAE) IN SERBIA

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Abstract – During project related field survey, performed from 9th to 13th of May, 2020, in southeastern Serbia, two rare butterfly species were registered at locality Izvor, at Rudina planina Mt. – *Melitaea ornata* and *Muschampia cribrellum.* New records of these species and confirmation of *M. ornata* at locality Šaprance suggest huge potential and invite further faunistic research in southeastern Serbia.

Key words: Lepidoptera, Hesperiidae, Nymphalidae, fauna, Serbia

Izvleček – NOVA NAJDIŠČA REDKIH METULJEV *MUSCHAMPIA CRIBRELLUM* IN *MELITAEA ORNATA* (LEPIDOPTERA: HESPERIIDAE, NYMPHALIDAE) V SRBIJI

Med terenskimi raziskavami povezanimi s projektom, ki so potekale od 9. do 13. maja 2020 v jugovzhodni Srbiji, smo na najdišču Izvor na Rudini planini našli dve redki vrsti metuljev – *Melitaea ornata in Muschampia cribrellum.* Nove najdbe teh vrst in potrditev vrste *M. ornata* na najdišču Šaprance kažejo na velik potencial in vabijo k nadaljnim favnističnim raziskavam v jugovzhodni Srbiji.

Ključne besede: Lepidoptera, Hesperiidae, Nymphalidae, favna, Srbija

At locality Izvor, on Rudina planina Mt. in southeastern Serbia (42.513227 N 22.519799 E, 954 m.a.s.l.), we recorded two rare butterfly species – *Melitaea ornata* Christoph, 1893 and *Muschampia cribrellum* (Eversmann, 1841).

Spinose skipper *(Muschampia cribrellum)* is a rare and local species from family Hesperiidae. Its range includes large part of Asia and only small part of Europe, and its presence was confirmed from Romania, Bulgaria, North Macedonia and Serbia. (Tolman & Lewington 2008; Dincă *et al.* 2010; Haahtela *et al.* 2011). In Bulgaria

and North Macedonia, this species was registered at several dry steppe-like localities, similar to that in Serbia (Dincă *et al.* 2010). The species was found in Serbia only recently, and thus far was recorded only from few localities in Stara Planina Mt. (Popović *et al.* 2013). New record from Izvor village at Rudina Planina Mt. is also the southernmost point of its distribution in Serbia.

Figure 1. *Melitaea ornata***,** Šaprance village: 10.05.2020. (photo: M. Djurić).

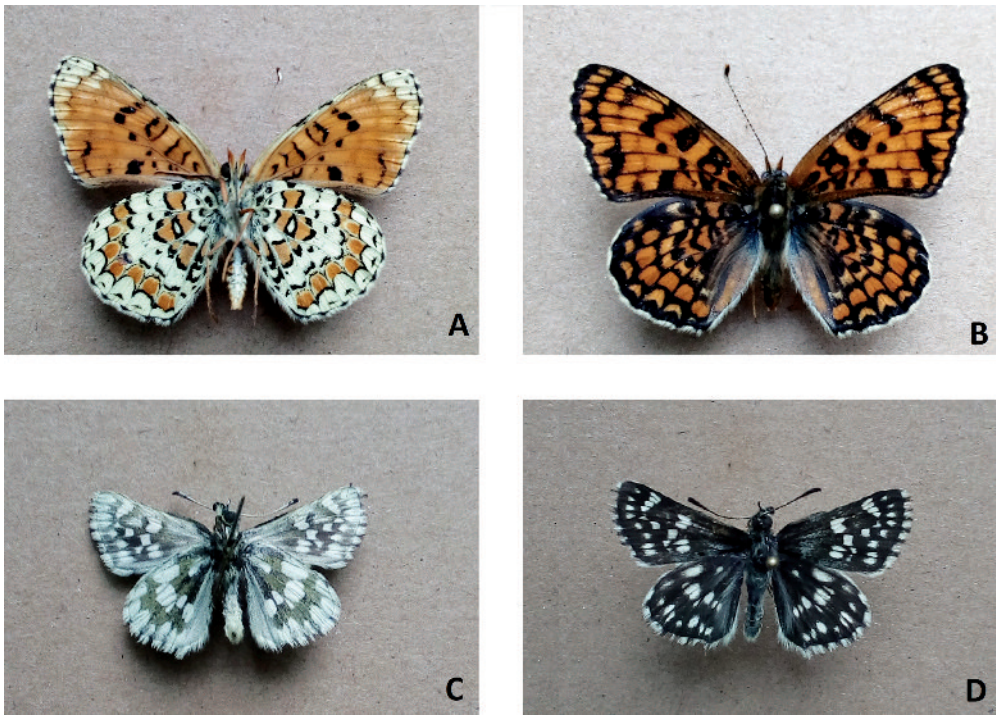

Figure 2. - *Melitaea ornata*, Izvor village, 12.5.2020. (A-B); *Muschampia cribrellum*, Izvor village, 12.5.2020. (C-D) (photos: I. Tot).

Eastern Knapweed Fritillary (*Melitaea ornata*) is a rare and local species of butterfly from family Nymphalidae whose distribution in Europe is not well understood due to confusion with similar species *Melitaea phoebe* (Denis & Schiffermüller, 1775), but also because certain authors ignore its presence in Europe (Russell & Tennent 2016). The most reliable method for identification of this species is observation of caterpillars, since they have red head, unlike congenial species *M. phoebe* whose caterpillars have black head. The other possibility is to perform DNA analysis. Russel *et al.* (2014) also described a potential hybridization of these species. Although the range of *M. ornata* isn't well known, this species is registered in many European countries, including Balkan Peninsula. This species was registered both in Bulgaria and North Macedonia, which are closest records to the localities in Serbia (Russel & Pateman 2019).

Melitaea ornata Christoph, 1893

Literature records: Stara Planina Mt. (Jakšić 2011), record very dubious (Russell & Tennent 2016); Stara Planina Mt. (Russell, pers. comm.); Trgovište, Šaprance (Popović & Verovnik 2018).

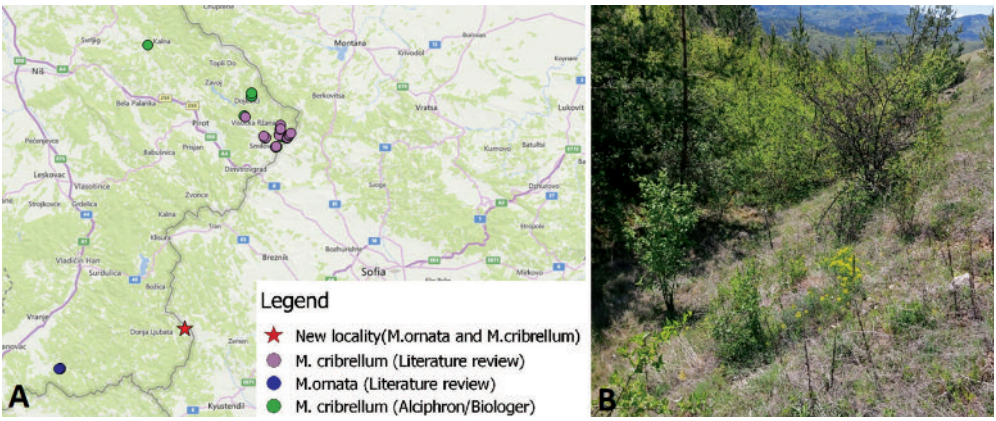

Figure 3. The distribution map of *Melitaea ornata* and *Muschampia cribrellum* in Serbia (A) and habitat of both mentioned species at Rudina Planina Mt., Izvor village (B) (photo: M. Vujić).

New records: 12.05.2020, Izvor village, leg. Tot I. & Vujić M. (Figure 2 A-B); The species has been confirmed in already known locality close to Šaprance village: 10.05.2020, leg. Djurić M. (Figure 1).

Muschampia cribrellum (Eversmann, 1841)

Literature records: Dimitrovgrad, Vidlič Mt. (Dincã *et al.* 2010) This publication includes the first record for Serbia, leg. Dodok I., 17.05.2007.; Stara Planina Mt., villages Dojkinci, Gornji Krivodol (Popović *et al.* 2013; Popović & Djurić 2014; Beshkov 2017).

Online databases: a few records on Stara Planina Mt., villages Rsovci, Dojkinci, Gornji Krivodol (Miljević & Djurić 2014–2020; Popović *et al*. 2020), Svrljiške planine (Popović *et al*. 2020)

New record: 12.05.2020, Izvor village. leg. Vujić M. (Figure 2 C-D).

Notes

New records extended the known distribution of both mentioned species. For *M. cribrellum* this is the southernmost record in Serbia that substantially extends its known distribution towards south and connects localities at Stara Planina and North Macedonia. For *M. ornata* this is the easternmost record in Serbia, although this species is probably much more widespread in Bulgaria and Serbia (Figure 3 A). In both cases for Serbia these are earliest records in the season.

Conclusion

In just a few field days spent in southeast Serbia a lot of rare butterflies and other insects were recorded. Among them special attention deserve rare and extremely

local species, such as *Melitaea ornata* and *Muschampia cribrellum*, so far known just from a few localities in the country. New records of these species and confirmation of *M. ornata* at locality Šaprance undoubtedly suggest huge potential and invite further insect research in southeast Serbia. Among visited localities special attention deserves Izvor village at Rudina Planina Mt. (Figure 3 B), due to existence of interesting habitats where many rare species were registered, inter alia *M. ornata* and *M. cribrellum*.

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NOVE NAJDBE REDKE VRSTE *PRETNERIA METKAE* BOGNOLO, 2000 (COLEOPTERA: CHOLEVIDAE: LEPTODIRINAE)

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Izvleček – Redka vrsta *Pretneria metkae* je bila na Triglavu (2863 m) najdena na 4 lokacijah: Ivačičevi jami (Kat. št.: 2399), Snežni konti pod Malim Triglavom, Kotlu pod severnim ostenjem Kredarice in na poti med Domom Planika in Triglavsko škrbino.

KLJUČNE BESEDE: Coleoptera, Cholevidae, Leptodirinae, *Pretneria*, favna, Slovenija

Abstract – NEW FINDS OF THE RARE SPECIES *PRETNERIA METKAE* BOGNOLO, 2000 (COLEOPTERA: CHOLEVIDAE: LEPTODIRINAE)

Pretneria metkae, a rare species, was found in 4 locations on the Mt. Triglav (2863m): Ivačičeva jama (Cad. No.:2399), Snežna konta under Mali Triglav, Kotel under north face of Kredarica and on the path between Dom Planika and Triglavska škrbina.

KEY WORDS: Coleoptera, Cholevidae, Leptodirinae, *Pretneria,* fauna, Slovenia

Metkina pretnerija *(Pretneria metkae)* velja za redko vrsto hrošča podzemljarja. Od najdbe prvega primerka leta 1938 je do njenega opisa leta 2000 poteklo kar 62 let. Šele Bognolo je zbral dovolj materiala za opis nove vrste. V njem (Bognolo, 2000) navaja 3 najdišča (Triglav 2200 m; Triglav, Kredarica, 2300-2500 m in Pršivec, Jama za Križem kat. št.: 642). Za prvi dve najdišči ne podaja nobenih natančnejših podatkov o njuni lokaciji. V svoji Reviziji rodu *Pretneria* (Bognolo, 2016) povzema prejšnje podatke in ne navaja novih. Tudi avtor tega prispevka v strokovni literaturi ni našel poročil o novih najdbah vrste.

Slika 1: Vhod v Ivačičevo jamo (foto Miroslava Kofler)

Biološke raziskave pod vrhom Triglava je avtor prispevka opravil v letih 2009 - 2013 in 2015 - 2018. Pri lovu je uporabil metodo talnih pasti. Vrsto je našel na štirih lokacijah:

Slika 2: Snežna konta pod Malim Triglavom (foto Miroslava Kofler)

V Ivačičevi jami (Kat. št.: 2399) (slika 1), ki se odpira v južnem ostenju Kredarice, se je večje število primerkov ulovilo v talno past, nastavljeno v zadnjem delu te ledene jame in sicer na začetku strmine, ki vodi do jamskega okna. Spremljajoča favna hroščev: *Nebria (Oreonebria) diaphana bohiniensis* Müller, 1928.

V Snežni konti pod Malim Triglavom (slika 2) so se primerki ulovili zgolj v grušču na dnu kake 4 metre globoke, skoraj navpične razpoke. Spremljajoča favna hroščev: *Nebria (Oreonebria) diaphana bohiniensis* Müller, 1928, *Nebria (Alpaeus) germari germari* Heer, 1837.

Slika 3: Kotel pod severnim ostenjem Kredarice (foto Miroslava Kofler)

V Kotlu pod severnim ostenjem Kredarice (slika 3) je avtor vrsto iskal s talnimi pastmi v številnih 4 - 10 metrov globokih breznih, pa tudi zunaj v grušču, neposredno ob zaplatah snega. Našel je nekaj primerkov v breznih, nobenega pa v pasteh izven brezen. Spremljajoča favna hroščev: *Anophthalmus nivalis nivalis* G. Müller, 1922*, Anophthalmus ravasinii alpestris* Daffner,1996, *Nebria (Alpaeus) germari germari* Heer, 1837*, Nebria (Oreonebria) diaphana bohiniensis* Müller, 1928.

Ob poti od Doma Planike proti Triglavski škrbini je avtor v manjši kotanji ujel na talno past en sam primerek. Spremljajoča favna hroščev: *Nebria (Alpaeus) germari germari* Heer, 1837.

Ulov/ preiskani material:

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Komentar:

Hrošč podzemljar metkina pretnerija poseljuje mrzle visokogorske jame, brezna in manjše prostore v razpokani kamenini, za katere so značilne nizka temperatura in visoka relativna vlaga zraka, ter dolgotrajna ali stalna prisotnost snega oziroma ledu. Med raziskavo je bilo daleč največ primerkov metkine pretnerije ulovljenih na koncu 130 m dolge in 18 m globoke Ivačičeve jame. Ostale, skromnejše najdbe izvirajo iz globokih razpok in manjših brezen. Vabe, ki so bile postavljene plitvo v tleh so bile neuspešne. Izjema je najdba enega samega primerka v pasti na dnu plitve vrtače v bližini Doma Planika.

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