17th European Carabidologists Meeting

Learning about carabid habits and habitats – a continuous process in a continuously changing environment

Book of abstracts

Edited by: L. Šerić Jelaska & S.D. Jelaska

Croatian Ecological Society
20 – 25 September 2015, Primošten, Croatia

XVIIth EUROPEAN CARABIDOLOGISTS MEETING

Learning about carabid habits and habitats – a continuous process in a continuously changing environment

BOOK OF ABSTRACTS
with Programme

Primošten, 20 – 25 September, 2015

Editors

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Drawing of *Carabus croaticus* Dejean, 1826 on front cover by Iva Čupić
Photos on back cover by Sven D. Jelaska

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Dear Carabidologists,

We are very pleased to welcome you to the 17th European Carabidologists Meeting (ECM), organised for the first time in Croatia. It is a great honour and privilege to join to 12 European countries that have already hosted these distinguished meetings.
The moto of the 17th ECM, "Learning about carabid habits and habitats – a continuous process in a continuously changing environment", aims to highlight the continuous research on carabid beetles across Europe and beyond, in various types of habitats in relation to long-term environmental changes, climate changes, land use changes, habitat degradations, as well as long term recoveries after disturbances, various anthropogenic pressures, etc… . Also, the themes about morphology, physiology, taxonomy and evolution of carabids, surveyed using state of the art methodologies, will be presented as well. Regarding the scientific programme, we believe it will be held in a spirit of scientific excellence, friendship and collaboration as was so far at previous Carabidologists Meetings.
The first ECM was organised 46 years ago, in 1969, in the Netherland. In addition to such a long tradition, I'm especially proud of 35 student presentations indicating that ECMs do not follow the downward curve, but represent the link of youth and experience. Therefore, I would like to thank to our distinguished and the most experienced colleagues Carabidologists, for being such a great mentors and teachers attracting young people to study carabid beetles, for their support to young colleagues, and to their support to 17th ECM, as well. As organizers, we provide small contribution to this by arranging workshop on scientific writing where students can prepare their manuscripts for the proceedings. Proceedings will be published in *The Bulletin of Entomological Research* published by Cambridge University Press and *Periodicum Biologorum* published by the Croatian Society for Natural Sciences. Furthermore, the best student oral and poster presentations will be awarded after scientific evaluation.

Beside scientific program, we hope you will enjoy our social events and take opportunity to see some beauty of Croatia within Conference tours and during your stay in Primošten.

The meeting has been organised by the Croatian Ecological Society, in cooperation with Association BIOM, Faculty of Science and Faculty of Agriculture at the University of Zagreb, and Krka National Park. We are so grateful to all our supporting institutions and donators.
We welcome you to Primošten and wish you all a pleasant stay in this small and picturesque town, you will be able to discover in coming days of the event. We look forward to the all outcomes of this meeting.

Thank you!

On behalf of the 17th ECM Organising Committee,
Lucija Šerić Jelaska, PhD
Chair of the organising committee

In memoriam Emmanuelle Dauffy-Richard
17.11.1974.-09.06.2014.

Dear Reader,

If you expect a long and detailed in memoriam, I have to say sorry. It was my good fortune to be linked with Emmanuelle. We worked together for a 1.5-year period, which is a short period of time for knowing someone better, but it might be enough to see the private person behind the professional colleague. She was a French carabidologist, she devoted her career for carabids exclusively. She was interested in the forest ecology of ground beetles, especially in forest management and in their specificity as biodiversity indicators. We spent a lot of time to develop species-level models for carabids, she was always open for discussion, I liked her careful attention for every single phase of the jointed work. When we met she worked on at least three projects simultaneously, but she was well-determined and highly motivated to work on these topics. All these good attitudes were interrupted by a sudden twist of life and a promising lifeline was broken. Over the scientist, she left here many questions in the eyes of a devoted husband and two sons and many friends and colleagues who miss her silent, but always determined character. I came to admire her human grandeur to an even growing degree. Her strength, her purity of will, her objectivity, all these were of a kind seldom found joined in a single individual. The greatest scientific act of her life was to improve the knowledge about forest carabids in France. The strength of her character and devotion were always alive, and will be in the memories of friends and colleagues.

Zoltan Elek

Emmanuelle receiving the award for the first sent abstract for the 16th ECM in Prague (September, 2013).

CONTENT

PROGRAMME

Sunday, 20th September

17:00 – 21:00 Registration (Hotel Zora conference centre)

Monday, 21st September

8:30 - 10:00 Registration (Hotel Zora conference centre)

10:00 - 10:30 Opening Ceremony (Kravata conference room)

10:30 - 10:35 Technical Break

10:35 - 11:20 **Invited lecture**: Achille Casale "Past, present and future knowledge of subterranean carabid beetles in the Dinaric chain"

11:20 - 11:45 Coffee break (Hotel Zora conference centre)

11:45 - 13:05 **Session 1** – Carabids and peculiar habitats – evaluation and conservation (chaired by Gabor Lövei)

11:45 – 12:05
Habitat peculiarity evaluation by means of Carabid habits
R.Pizzolotto

12:05 – 12:25
Beetles *versus* Rolling Stones: carabids on cryoperturbed fellfields
M. Gobbi, C. Compostella, D. Tampucci, M. Caccianiga

12:25 – 12:45
Urban mires as hotspots of carabid beetle diversity
Norbertas Noreika*, D. Johan Kotze

12:45 – 13:05
Differences and similarities in drivers of species richness between subterranean Carabidae and Cholevidae in the Dinarides (SE Europe)
Petra Bregović*, Maja Zagmajster

13:05 - 14:30 Lunch

14:30 – 16:10 **Session 2** –Impact of habitat disturbances on carabid assemblages (chaired by John Spence)

14:30 – 14:50
The effect of different soil treatments on the carabid fauna after topsoil removal
H.J.W. Vermeulen, R. van Klink, K. van der Laaken & A. Woldering

14:50 – 15:10
Response of ground-beetle (Carabidae) assemblages to harvest and wildfire disturbances in lodgepole pine forests of western Alberta, Canada
Vincent Del Bel Belluz*, John Spence, David Langor

15:10 – 15:30
Clear-cut harvesting and impacts of variation in habitat structure on carabid beetle (Coleoptera: Carabidae) assemblages and their post-harvest recovery
Claudio La Rocca*, John R. Spence, Fangliang He

15:30 – 15:50
Body mass distributions along successional gradients in epigeic carabid beetle fauna (Coleoptera: Carabidae)
A. Schreiner, A. Kwiatkowski, J. Szyszko, A. Schwerk

15:50 – 16:10
Relation between carabid beetle fauna (Coleoptera: Carabidae) and plant succession in a post-agricultural area
Izabela Dymitryszyn, Axel Schwerk

16:10 – 16:20 Coffee break (Hotel Zora conference centre)

16:20 – 19:00 Workshop on scientific writing (Kravata conference room)

20:30 – 22:00 Welcome cocktail (the terrace of Hotel Zora conference centre)

Tuesday, 22nd September

8:30 - 9:00 Registration (Hotel Zora conference centre)

9:00 - 9:45 **Invited lecture**: Jean-Yves Rasplus "Reconstructing the biogeographical and evolutionary history of the genus *Carabus*, from multiple genes to pangenomic markers"

9:45 – 10:10 Coffee break

10:10 – 11:50 **Session 3** - Morphology, taxonomy and evolution of carabids (chaired by Claudia Drees)

10:10 – 10:30
Introgression or low molecular differentiation? The case of *Carabus clatratus maacki*
Dietrich Mossakowski

10:30 – 10:50
Phylogeographic structure in the sister species *Calathus cinctus* and *C. melanocephalus*.
Ruiz, C.; Andújar, C.; Arribas, P.; Serrano, J.

10:50 – 11:10
Evolution of sexual shape and size dimorphism and allometry in carabid beetles: an example on *Ceroglossus* spp. using geometric morphometrics.
Hugo A. Benítez*, Avaria-Llautureo J, Jerez V, Parra L, Hernández CE

11:10 – 11:30
The hows and whys of ommatidia measurement in the compound eyes of beetles
Bartosz W. Schramm*, Agnieszka Gudowska*, Filip Kapustka, Anna Maria Labecka, Marcin Czarnoleski, Jan Kozlowski

11:30 – 11:50
Phylogeography and morphology of *Calomera littoralis* in eastern Mediterranean region
R. Jaskuła, T. Rewicz, M. Grabowski, M. Płóciennik

11:50 – 12:00
Macro photography of Carabids
Gernot Kunz

12:00 – 13:00 **Poster session**

13:00 – 14:30 Lunch

14:30 – 16:30 **Session 4** - Life history traits, diversity and distribution of carabids (chaired by Roberto Pizzoloto)

14:30 – 14:50
Forest ground beetle (Coleoptera: Carabidae) diversity and assemblage structure on boreal lake islands: an island-mainland comparison
Aaron J. Bell*, Iain D. Phillips*, Scott E. Nielsen, and John R. Spence

14:50 – 15:10
Body size and wing morphology: life history traits influence the distribution of ground beetles (Coleoptera: Carabidae) on boreal lake islands in central Canada.
Aaron J. Bell*, Iain D. Phillips*, Scott E. Nielsen, and John R. Spence

15:10 – 15:30
Pushing connectivity in landscapes: species-specific life history traits and locomotory behavior as tools to design semi-open corridors
Estève Boutaud*, Dorothea Ehlers, Thorsten Assmann

15:30 – 15:50
How many carabid species are missed during biological surveys based on pitfall trapping technique?
Knapp Michal, Knappová Jana, Jakubec Pavel, Vonička Pavel, Moravec Pavel

15:50 – 16:10
How are carabid species distributed?
Stephen Venn

16:10 – 16:30
Level of parasitisation of gregarines (Eugregarinorida, Apicomplexa) is linked to the sex of ground beetles (Coleoptera, Carabidae): a case study in Poland
Paweł Sienkiewicz, Jerzy J. Lipa, Tomasz Skalski

16:30 – 16:50
Habitat requirements of *Rhysodes sulcatus*, an endangered Natura 2000 dead wood beetle
Fran Kostanjšek, Pavel Šebek, Lukaš Čižek, Vladan Riedl, Beata Baranova

16:50 – 17:00 Information about mid-conference excursion

17:00 – 17:10 Coffee break (Hotel Zora conference centre)

17:10 – 19:10 **Workshop on scientific writing** (Kravata conference room)

Recommendations for the evening: sightseeing of Primošten town, or visit of Šibenik or Trogir towns (the info about the local buses can be asked at the hotel reception).

Wednesday, 23rd September

Conference excursion to Krka National Park: visit of Skradinski buk unique waterfalls, Monastery on Visovac Island, Burnum - the archaeological collection and museum in Puljani.

8:30 – 9:30	Travel from Primošten to Krka NP by bus
9:30 – 16:00	Krka NP tour (conference photography at Burnum)
17:00 – 19:30	Traditional Dinner in Etnoland, Pakovo selo
19:30 – 20:30	Travel from Pakovo selo to Primošten by bus

Thursday, 24th September

8:30 - 9:00	Registration (Hotel Zora conference centre)
9:00 - 9:45	**Invited lecture**: Pietro Brandmayr "Climate change and its impact on epigean and hypogean carabid beetles"
9:45 – 10:10	Coffee break
10:10 – 11:50	**Session 5** - Effects of long term changes on carabids (chaired by Axel Schwerk)

10:10 – 10:30
The importance of extreme weather events for ground-beetle communities revealed by 50 year time series from The Netherlands
R. van Klink, H.J.W. Vermeulen, F. de Bello

10:30 – 10:50
Recovery of a boreal carabid fauna ten years after variable retention harvest
John R. Spence, Jaime Pinzon, Colin Bergeron, Linhao Wu and David Langor

10:50 – 11:10
Exclusive microhabitat specialist *Carabus (variolosus) nodulosus* is declining in its global population stronghold (Slovenia): large-scale and long-term study
Al Vrezec, Andrej Kapla, Špela Ambrožič

11:10 – 11:30
Ground beetles in city forests: influence of forest age and urbanization on behaviour?
Claudia Drees & Wiebke Schuett

11:30 – 11:50
Ecosystem Memory and Lasting Effects of Fire History on Early Post-Harvest Recovery of a Boreal Ground-Beetle Community
Colin Bergeron, Jaime Pinzon, John Spence

11:50 – 12:10
Ground beetles in the Kampinos catchment area – results of 16 years of observations
Jarosław Skłodowski

12:10 – 13:00 **Poster session**

13:00 – 14:30 Lunch

14:30 – 16:10 **Session 6 -** Spatial analyses of carabids –diversity of scales and methods (chaired by Sven Jelaska)

14:30 – 14:50
Interactions between agricultural systems and landscape properties exert a strong filtering on species traits in carabid communities.
Alexia Marie, A. Vialatte, Bertrand Gauffre, M. Plantegenest

14:50 – 15:10
Influence of farming system on ground beetle communities at local and landscape scales
Maud Belhache*, El Aziz Djoudi, Stéphanie Aviron, Julien Pétillon and Manuel Plantegenest

15:10 – 15:30
Ecological knowledge and remotely-sensed landscape variables: a new approach to predict biodiversity.
Ronzani Silvia*, Spence John

15:30 – 15:50
Fine-scale tree spatial distribution and carabid beetle distribution patterns in a Canadian boreal mixwood
Linhao Wu*, Jaime Pinzon, John R. Spence, Fangliang He

15:50 – 16:10
An ordinary species in ordinary landscapes – The genetic structure of *Abax parallelepipedus* in the Biodiversity Exploratories
Tamar Marcus*, Claudia Drees, Thorsten Assmann

16:10 – 16:30 Coffee break (Hotel Zora conference centre)

16:30 – 18:30 **Workshop on scientific writing** (Kravata conference room)

20:00 – 23:00 Conference dinner (Hotel Zora Piano bar)

Friday, 25th September

9:00 - 11:00 **Session 7** –Agroecology (chaired by Manuel Plantegenest)

9:00 – 9:20
Ground beetle (Coleoptera: Carabidae) assemblages in narrow hedgerows in a Danish agricultural landscape
G. L. Lövei, T. Magura

9:20 – 9:40
Conventional and non-inversion tillage systems as a factor causing changes in ground beetles (Col. Carabidae) assemblages in rape (*Brassica napus*) fields
Agnieszka Kosewska

9:40 – 10:00
Habitat preference and demographic parameters of *Nebria brevicollis* population in agricultural habitats mosaic
Oleg Aleksandrowicz, Brygida Radawiec

10:00 – 10:20
The duration of seed burial in soil affects consumption rates by carabid beetles after exhumation.
A. Honěk, Z. Martinková, P. Saska

10:20 – 10:40
Carabid habits and ecosystem services for agricultural practices
A. Albertini*, R. Petacchi, R. Pizzolotto

10:40 – 11:00
Some seasonal features of the population structure of dominant ground beetles (Coleoptera, Carabidae) species in agrocenoses
A.V. Puchkov, T.Y. Markina

11:00 – 11:25 Coffee break

11:25 – 13:25 **Session 8** - Ecotoxicology and physiology of carabids (chaired by Pavel Saska)

11:25 – 11:45
Detection of noxious high temperatures in carabids
K. Nurme*, E. Merivee, A. Must

11:45 – 12:05
Life stage specific species sensitivity of ground beetles exposed to the insecticide: chlorpyrifos.
S. B. Dehelean, F. Bakker

12:05 – 12:25
Life traits distribution of ground beetles along heavy metal gradients in Europe
T. Skalski

12:25 – 12:45
Ambient temperature affects respiration pattern and metabolic rate in carabid beetles
Agnieszka Gudowska*, Bartosz W. Schramm*, Jan Kozłowski, Ulf Bauchinger

12:45 – 13:05
Body composition and mass-scaling of metabolic rate – the Carabidae perspective
Bartosz W. Schramm*, Agnieszka Gudowska*, Ligia Kurianska-Piatek, Anna Maria Labecka, Ulf Bauchinger, Marcin Czarnoleski, Jan Kozlowski

13:05 – 13:25
Carabids as predators of forest pest moths - molecular detection of trophic interactions via carabid gut content analyses
Lucija Šerić Jelaska, Igor Matić, Inga Marijanović

13:25 – 13:50 Closing ceremony

13:50 – 14:30 Lunch

14:30 – 16:30 **Workshop on scientific writing**

16:30 – 17:00 Award of certificates for the workshop participants and information about post-meeting excursion

Recommendations for the evening: visit of Primošten vineyards of Babić vine sorts, Šibenik or Trogir town (the info about the local buses can be asked at the hotel reception).

*student

POSTER PRESENTATIONS

(in alphabetical order of presenting author)

(1) The role of semi-natural habitats for pest control
A. Albertini*, R.Petacchi, R.Pizzolotto

(2) Intraspecific altitudinal variation in body size of several common carabid beetles
Eliška Baranovská*, Michal Knapp, Věra Zaplatílková, Pavel Saska

(3) New record of *Calosoma (Campalita) auropunctatum auropunctatum* (Herbst, 1784) in Latvia
Maksims Balalaikins, Arvīds Barševskis, Vytautas Tamutis, Uldis Valainis, Sakine Serap Avgin, Stanislaw Huruk, Kristīna Aksjuta, Daiga Zviedrāne

(4) Effects of genetically modified maize for insect resistance on the composition of the ground beetle populations
R. Bažok, C.H. Krupke, L.W. Bledsoe, D. Lemić, Z. Drmić, M. Čačija, H. Virić

(5) Taxonomic studies on *Morphocarabus* species in the Pannonian biogeographical region
Bérces, Sándor, Szél, Győző, Szabó, Péter, Fülöp Dávid

(6) Epigaeic arthropod assemblages of extensive green roofs in Edmonton Canada: composition and dynamics
Colin Bergeron, Zoe Crandall, John Spence

(7) Body Size Differences, Mean Individual Biomass (MIB) and Wing Development of Ground Beetle Communities (Coleoptera: Carabidae) along an Altitudinal Gradient on the Belasitsa Mountain, Macedonia
Aleksandra Cvetkovska-Gjorgjievska, Slavčo Hristovski, Dana Prelić, Lucija Šerić Jelaska, Valentina Slavevska-Stamenković, Milica Ristovska

(8) Group selection harvesting supports the diversity of ground-dwelling carabid and spider assemblages
Zsuzsanna Debnár, Szabolcs Mizser, Roland Horváth, András Demkó, Béla Tóthmérész, Tibor Magura

(9) Estimating carabid population size: The relationship between abundance and capture area of pitfall traps
Jared Amos, Colin Bergeron, Aaron Bell*, Vincent Del Bel Belluz*, Zoltan Domahidi, Claudio La Rocca*, Seung-Il Lee, Sonya Odsen, Jaime Pinzon, Silvia Ronzani*, Linhao Wu*, John Spence

(10) Body size distribution in ground beetles (Coleoptera: Carabidae) as a possible monitoring method of environmental impacts of transgenic maize
Davide Di Grumo*, Gabor L Lövei

(11) Trapped in urban refugia? 'Cityscape' genetics of a flightless ground beetle
Lena Grieger, Claudia Drees

(12) The impact of a rural-urban gradient and spatial distribution on predation rates on sentinel prey in a riparian forest in Hungary
Csaba Béla Eötvös*, Tibor Magura, Gábor L. Lövei

(13) Chewing insect predation on artificial caterpillars is related to activity density of ground beetles (Coleoptera: Carabidae)
M. Ferrante*, G. L. Lövei

(14) A long-term project for spatio-temporal monitoring of carabid species assemblages on Central Italian Alps
M. Gobbi, T. Boscolo, C. Maffioletti, M. Caccianiga, L. Pedrotti

(15) Are carabids and chironomids experiencing similar spatial patterns along a chronosequence of glacier retreat?
V. Lencioni, M. Caccianiga, C. Compostella, A. Franceschini, C. Maffioletti, N. Salmaso, R. Seppi, M. Gobbi

(16) Long-term successional changes of functional diversity in ground beetle communities on post-industrial areas
J. Hodecek*, T. Kuras, J. Sipos

(17) The role of various hedgerow types in shaping carabid and rove beetle assemblages (Coleoptera: Carabidae, Staphylinidae) in meadow dominated landscape
Zuzana Jahnová, Michal Knapp, Jaroslav Boháč, Marie Tulachová

(18) Morphological differences between two sister species: *Carabus (Eucarabus) parreyssi* and *Carabus (Eucarabus) catenulatus* from Dinaric karst and body size variations along altitudinal gradients
Željka Jambrošić Vladić*, Sandra Postić, Lucija Šerić Jelaska

(19) Do lowland and mountainous tiger beetles use the same phenological strategy? An example from the Mediterranean region
R. Jaskuła, K. Kwiatkowski*

(20) Females are larger but males have bigger mandibles – sexual dimorphism in Balkan tiger beetles
R. Jaskuła, K. Kwiatkowski*

(21) Spatial diversity in the genus *Carabus* in extensive cultural landscape of Goričko Nature Park (NE Slovenia)
Andrej Kapla, Al Vrezec

(22) The effect of inundation frequency on ground beetle communities in a channelized mountain stream
R. Kędzior, T. Skalski ,A. Radecki-Pawlik

(23) Life-history traits of ground beetles (Coleoptera, Carabidae) on postindustrial areas of slag deposition
R. Kędzior, T. Skalski, A. Szwalec, P. Mundała

(24) Influence of mowing measures on carabid beetle fauna (Coleoptera: Carabidae) in a post-agricultural area
M. A. Kitka*, A. Schwerk

(25) Formation of ground beetle assemblages on gyttja soils depending on the selected physicochemical factors in these soils
Agnieszka Kosewska, Mariusz Nietupski, Bożena Lemkowska

(26) An effect of different systems of plant protection on carabid beetles assemblages in pea and lupine crops.
Agnieszka Kosewska, Mariusz Nietupski, Katarzyna Nijak

(27) Impact of clear-cut harvesting on functional diversity of carabid beetles (Coleoptera: Carabidae)
Claudio La Rocca*, John R. Spence, Fangliang He

(28) Influence of forest carbon stock on carabid beetle diversity in boreal forests of west-central Alberta, Canada
Claudio La Rocca*, John R. Spence, Fangliang He

(29) Morphological variation of shape and size of the *Pterostichus melanarius* population in intensive sugar beet production
D. Lemic, H. A. Benitez, I. Petrak, Ž. Graša, H. Virić Gašparić, R. Bažok

(30) Communities of beetles (Coleoptera: Carabidae) on landfills
Jozef Macko

(31) Can successional carabid beetle assemblages be discriminated from their life-history traits? A study case from an Alpine glacier foreland
C. Maffioletti, C. Compostella, M. Caccianiga, M. Gobbi

(32) Long-term dynamics of the demographic structure and spatial distribution of local ground beetle populations in a mosaic of floodplain meadows
Trushitsina O.S., Matalin A.V., Makarov K.V.

(33) Mite infection of *Carabus violaceus* in lowland oak forest fragments
Szabolcs Mizser, Leila Nagy, Dávid D. Nagy, Béla Tóthmérész

(34) Recovery dynamics of ground-dwelling arthropods after reforestation
Dávid D. Nagy, Tibor Magura, Dávid Bogyó, Szabolcs Mizser, Béla Tóthmérész

(35) The ground beetles (Coleoptera) in the entomological collection of Andrija Hensch
Ivana Pajač Živković, Tomislav Kos, Božena Barić

(36) Diel activity of carabid beetles
P. Saska, J. Lukáš, M. Vlach

(37) Different responses of epigeic beetles to heavy metal contamination depend on functional traits at the family level
Skalski T., Kędzior R., Kolbe D., Knutelski S.

(38) Interspecific interactions structuring the species composition of carabids
Tibor Magura, Katalin Sólyom*, Béla Tóthmérész

(39) Latitudinal Variation of Body Size in Ground Beetles (Coleoptera, Carabidae): the Case of Intraspecific Study
R. Sukhodolskaya, A. Saveliev

(40) The effects of fragment size and isolation on carabid and spider assemblages in dry sandy grassland fragments
Tibor Magura, Roland Horváth, Bence Tajthi, Csaba Szinetár, János Eichardt, Viktor Ködöböcz, Béla Tóthmérész

(41) Contribution to the knowledge of *Badister* (Coleoptera: Carabidae, Licininae) species in Baltic countries
V. Tamutis, M. Balalaikins

(42) Exploring the database of pitfall sampling in the Netherlands – A fauna study.
Hans Turin

(43) Does life in caves reduce the diversity of chemicals produced by the pygidial glands of carabids?
N. Vesović*, S. Ćurčić, Lj. Vujisić, M. Nenadić, G. Krstić, V. Perić-Mataruga, S. Milosavljević, D. Antić, B. Mandić, M. Petković, I. Vučković, Đ. Marković, M. Vrbica, D. Pavlović, B. Ćurčić, S. Makarov

(44) On two new high-altitude *Omphreus* subspecies (Carabidae: Harpalinae: Omphreini) from the Dinaric Alps (western Balkan Peninsula)
Srećko Ćurčić, Riccardo Sciaky, Dragan Antić and Nikola Vesović*

(45) Seven new troglobitic species of the genus *Duvalius* Delarouzée, 1859 (Coleoptera: Carabidae: Trechinae) from Eastern and Southeastern Serbia
M. Vrbica*, S. Ćurčić, N. Vesović, D. Antić, Đ. Marković, M. Petković, B. Ćurčić and S. Makarov

(46) Influence of agricultural context on carabid community structure in winter wheat fields of Southern Banat, Serbia
Srećko B. Ćurčić, Milan Plećaš, Maja Vrbica*, Miloš Brkljačić, Srđan Ž. Stamenković

(47) Metabolic traits vs. habitat niche width in different species of carabid beetles
Tatjana Simčič, Maarten de Groot, Al Vrezec

*student

Post-meeting tours:

Saturday, 26th September

8:00 – 20:00 Plitvice lakes NP (guided tour)

Sunday, 27th September

8:00 – 21:00 Brač Island tour

INVITED LECTURES (as appeared in the Programme)

Past, present and future in the knowledge of subterranean carabid beetles in the Dinaric chain

Achile Casale

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The Dinaric Alps or Dinarides are a mountain chain that fringes the Eastern side of the Adriatic sea, from the south-eastern (Julian) Alps in the NW to the Albanides/Hellenides in the SE, extended for 645 kilometres, with their highest peak in Prokletije Mt. (2,694 m) at the border of eastern Montenegro and northern Albania. Dinarides represent the north-eastern part of the Apulian continental plate, which was separated from Africa and Europe during most of the Mesozoic, and became a part of the alpine orogenetic system by the closure of Tethyan oceanic realms and associated basins in the period from Late Jurassic to the Quaternary.
They are mostly formed by Mesozoic and Cenozoic sedimentary rocks of dolomite, limestone, sand and conglomerates. This Mesozoic chain is a peculiar area of the Balkan peninsula, characterized by the deep erosion of limestone by the water. Deep valleys, big caves, and the typical features of the "Karst" are widely represented everywhere. The Quaternary ice ages – a part some of the highest peaks of the chain – only marginally influenced Dinarides, and there is a little evidence of extensive glaciation. Conversely, some coastal massifs along the eastern Adriatic coast are now characterized by etesian, maritime-subtropical climate: Orjen represents one of the rainiest area of Europe, with average annual precipitations exceeding 5000 mm (with a record of 8.063 mm in 1938), comparable to those of tropical rain forests.
For this very reason, this area as a whole represents a very important Pleistocene refugium and a centre of speciation for many living organisms. Furthermore, it is today recognized as one of the main hotspots of subterranean biodiversity in the world. Many zoological groups are represented in subterranean environment, both invertebrates (sponges, mollusks, Arthropoda) and vertebrates (the famous olm or "human-fish" *Proteus anguinus* Laurenti, 1768, the first hypogean species officially described). Not casually it is recognized that Biospeleology, the science of subterranean life, was traditionally born with the discoveries in the Postojna caves (Adelsberger grotte, Postojnska jama) of the cholevid beetle *Leptodirus hochenwarti* Schmidt, 1832 and the carabid beetle *Anophthalmus schmidtii* Sturm, 1844.
It is well known that Caraboidea are one of the most diverse groups of Coleoptera, with more than 35,000 species described so far in the world. With Coleoptera Cholevidae, they are the group of insects more represented in both superficial and deep subterranean environment. A few only lineages of them, however, were able to colonize the hypogean habitat: in particular, the tribes Ozaenini, Crepidogastrini, Nebriini, Scaritini, Promecognathini, Trechini, Bembidiini, Psydrini, Pterostichini, Harpalini, Platynini, Sphodrini, Perigonini, Lebiini, Cyclosomini, Zuphiini.

Nebriini, Scaritini, Trechini, Bembidiini, Pterostichini and Sphodrini are widely represented in the subterranean Dinaric fauna, with both hypogeophilous and troglobiont taxa. Some lineages in particular are noticeable: Scaritini with the endemic specialized genus and species *Spelaeodytes mirabilis* L. Miller, 1863, Trechini with many endemic genera and species at different degrees of specialization to the subterranean habitat (from microphthalmous and anophthalmous to aphaenopsian level), Bembidiini with the subtribe Lovriciina recently described, Pterostichini with some species of the genus Speluncarius, Sphodrini with some Laemostenus of the subgenus Antisphodrus.
Recent molecular phylogenies showed close relationships of subterranean Dinaric Trechini lineages with eastern Alpine taxa. Furthermore, it was hypothesized that the impressive, recent increasing of discoveries of new genera and species in that area should be related to phenomena of global or local climatic changes.
These are examples of scientific questions that need future, careful investigations.

Reconstructing the biogeographical and evolutionary history of the genus *Carabus*, from multiple genes to pangenomic markers

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Despite the high number of studies that have been conducted on *Carabus*, the global evolutionary history of the genus remains poorly understood. Several studies have recently proposed new phylogenetic hypotheses for the genus. These hypotheses based on molecular markers are mostly congruent and corroborate most morphological subgroups of *Carabus*. However, current morphological and molecular data appear unable to accurately infer the deep branchings within the genus. As previously highlighted by several studies, we observe conflicts between mitochondrial and nuclear topologies that may be explained by mitochondrial introgression. Dating the *Carabus* phylogeny appears challenging and different timescales have been estimated depending on calibrations, genes and methods used. I shall discuss these hypotheses and present different biogeographical scenari for the genus, including some suggesting that the present-day distribution of *Carabus* subgroups may be explained by isolation resulting from Eurasian forest fragmentation brought on by Miocene climate changes and by mountain orogenesis. Recent studies on two *Carabus* subgenera have demonstrated that restriction-site-associated DNA sequencing (RADseq) can generate useful data for phylogenomics of these clades. This novel method may thus contribute to improve our knowledge on the evolutionary history of *Carabus* subgenera. While opening new avenues for phylogeneticists, this method could open a Pandora's box of analytical issues, especially in a group where introgressive hybridization is rampant. I shall discuss the results obtained within the subgenus *Chrysocarabus* and propose new biogeographical scenario and dating.

Climate change and its impact on epigean and hypogean carabid beetles

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The presentation summarizes about 10 years research on the impact of climate change on ground beetle assemblages in Italy and on hypogean species living in Europe. The epigean research focuses on the comparison between pit-fall year samples collected about 30 years ago in forest and grassland sites of the Southern Appennine and of the Dolomites (Eastern Alps). In the first area (Pollino National Park) the changes 1977/2004 showed a minor impact in mature beech forests but a stronger one in a mountain pasture, where the three most abundant species have been substituted by thermos-xerophilic elements, testifying for an uphill shift of 300/400 meters.
In the Dolomites the research concerns an altitudinal habitat sequence from subalpine spruce forest to alpine grassland in a low disturbance area of the southeastern Dolomitesin Italy, the Paneveggio Regional Park. We compared the ground beetle (Carabidae) populations sampled in 1980 in six stands below and above the treeline (1650–2250 m a.s.l.) with those sampled in the same sites almost 30 years later (2008/9). Quantitative data (species richness and abundance) have been compared by means of several diversity indexes and with a new index, the Index of Rank-abundance Change (IRC). Our work shows that species richness and abundance have changed after almost 30 years as a consequence of local extinctions, uphill increment of abundance and uphill shift of distribution range. The overall species number dropped from 36 to 27, while in the sites above the treeline, species richness and abundance changed more than in the forest sites. Two microtherm characteristic species of the pioneer cushion grassmats, Nebriagermari and Trechusdolomitanus, became extinct or showed strong abundance reduction. In Nardetum pastures, several hygrophilic species disappeared, and xerophilic zoophytophagous elements raised their population density. In forest ecosystems, the precipitation reduction caused deep soil texture and watering changes, driving a transformation from Sphagnum-rich (peaty) tohumus-rich soil, and as a consequence, soil invertebrate biomass strongly increased and thermophilic carabids enriched the species structure. In three decades, Carabid assemblages changed consistently with the hypothesis that climate change is one of the main factors triggering natural environment modifications. Furthermore, the level of human disturbance could enhance the sensitivity of mountain ecosystems to climate change.
Despite the impressive research effort performed on surface living animals and plants, little is known about the impact on the relict lineages of cave animals. Ground beetles show a wide variety of evolutionary pathways, from soil-surface (epigean) predatory habits to life in caves and in other subterranean (hypogean) compartments. We reconstructed an unprecedented set of species/time accumulation curves of the largest carabid genera in Europe, selected by their degree of ‘underground’ adaptation, from true epigean predators to eyeless highly specialized hypogean beetles. The data show

that in recent periods an unexpectedly large number of new cave species were found lying in well established European hotspots; the first peak of new species, especially in the most evolved underground taxa, occurred in the 1920–30s and a second burst after the 70s. Temperature data show large warming rates in both periods, suggesting that the temperature increase in the past century might have induced cave species to expand their habitats into large well-aired cavities and superficial underground compartments, where they can be easily sampled. An alternative hypothesis, based on increased sampling intensity, is less supported by available data sets.

Main references:

Pietro Brandmayr, Filippo Giorgi, Achille Casale, Giorgio Colombetta, Laura Mariotti, Augusto Vigna Taglianti, Friedrich Weber and Roberto Pizzolotto, 2013 - Hypogean carabid beetles as indicators of global warming? Environ. Res. Lett. 8 (2013) 044047, doi:10.1088/1748-9326/8/4/044047. Online at stacks.iop.org/ERL/8/044047.

Roberto Pizzolotto, Mauro Gobbi & Pietro Brandmayr, 2014 - Changes in ground beetle assemblages above and below the treeline of the Dolomites after almost 30 years (1980/2009). Ecology and Evolution, doi: 10.1002/ece3.927.

ORAL PRESENTATIONS (as appeared in the Programme)

CARABIDS AND PECULIAR HABITATS – EVALUATION AND CONSERVATION

Habitat peculiarity evaluation by means of Carabid habits

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One of the main questions about managing natural resources is which among these areas should be conserved, saved, improved (CSI-target)? A reasonable answer is: the most natural, i.e. that with the naturalness highest level, where naturalness is a characteristic linked to the CSI-target biological features, quantifiable by weighting those features to get an index of the natural value (INV) of that CSI-target. There is no evidence that Carabids can give an absolute INV appliable to all CSI-targets, because for a given area there are only some particular features representing the peculiarity of that area. The aim of this research is to evaluate the natural resources of a mountain region by first stating what kind of peculiarity we want to focus on (e.g., ecological, biogeographic, touristic), and then to get an INV tailored to the CSI-target on the basis of its peculiarity. After a 8 years research in the Paneveggio Regional Park (Dolomites, Italy), from subalpine forests to pioneer grass mats, the main relationships between Carabid assemblages and vegetation has been outlined, and Carabid assemblages have been characterized by means of the species habits (e.g. number of endemics mirrors the disposition to evolve against claciations). Data analysis focused on biogeographic peculiarity for higlighting the spotted vs. widespread faunistic importance of the region, and gave results consistent with the policies adopted by the Park administration. Reliable evaluation for conservation based on Carabids can be achieved by focusing on the peculiarities to be evaluated rather than on a generic faunistic global value.

Keywords: decision support, habitat priority status, protected areas.

Beetles *versus* Rolling Stones: carabids on cryoperturbed fellfields

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Ice-debris landforms moving or creeping due to ice deformation, such as debris-covered glaciers (DCGs) and rock glaciers (RGs), characterize the glacial and periglacial mountain environments. These climate-related landforms are poorly known even if suitable habitats for life. Goal of our research is to describe the carabid populations living on DCGs and RGs of the Italian Alps and to compare them with currently ice-free neigbouring blocky landforms. We studied 3 DCGs, and 4 RGs located from Western to Eastern Italian Alps. The considered ice-debris landforms resulted mainly colonised by cold-adapted species belonging to the genera *Nebria* and *Oreonebria*. Two out of 3 DCGs host small, but permanent, populations of *Oreonebria angusticollis* (W-Alps), and *Nebria germari* (E-Alps), due to the presence of stony debris with interstitial ice; one DCG seems to be not colonised, yet. The species collected on DCGs with tongue descending down the treeline are able to survive below their average altitudinal distribution thanks to the cold and wet microclimate conditions between the stones. All the considered RGs host permanent and quite large populations of *Oreonebria castanea* (W,C-Alps), *O. angustata* and *Nebria germari* (E-Alps) due to the precence of deep ice-core rocky debris. The local climatic condition, and the elevation of each RGs drives the presence of the species also on the ice-free neigbouring blocky landforms. Our results allow to hypothesize that in the present interglacial period DCGs and RGs could act as refugium habitats for cold-adapted carabids as a consequence of their microclimate features and thermal inertia.

Keywords: cold-adapted species, debris-covered glacier, rock glacier, scree slope.

Urban mires as hotspots of carabid beetle diversity

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Natural habitats are lost and fragmented by urbanization , resulting in isolated urban remnants , devoid of specialist species. This homogenization of the urban landscape can be redressed if urban biodiversity "hotspots"can be identified and conserved. Mires have the potential of being such refuges, since they host a number of specialist species of carabid beetles. We investigated twenty pine mires that differed in urbanization level (low, intermediate and high) in southern Finland.The main aim of this study was to determine the relative roles of regional (level of urbanization, total mire area) and local (pH of peat, vegetation cover, wood volume) variables on mire carabid beetle species and communities in an urban setting.Pitfall trapping was used to collect beetles and site-level environmental variables were measured at the trap locations. High levels of urbanization had a negative effect on mire carabid beetle diversity. However, urban mirecommunity structure was not very different from rural communities as urban mires were still inhabited by mire specialists. Furthermore, tree-covered parts of urbanized mires can serve as refuges for rare forest specialist species and *Sphagnum* mosses play an important role in supporting mire species and communities, thus *Sphagnum* growth should be promoted. Urban mires can be considered urban biodiversity hotspotsand their protection should be secured in urban development.

Keywords: boreal mires, carabid beetle communities, local and regional factors, rare specialist species, urbanization

Differences and similarities in drivers of species richness between subterranean Carabidae and Cholevidae in the Dinarides (SE Europe)

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Several studies have shown that the Dinarides are a world hotspot in subterranean biodiversity. Beetles are the first studied group of subterranean animals, with relatively well resolved taxonomy and many distribution records, organised in a georeferenced SubBioDB database. They make about half of terrestrial subterranean species richness in the region, and present a model group for investigating the subterranean biodiversity patterns. Two hotspots of species richness had been identified, that cannot be explained by sampling differences only: Trechinae (Carabidae) are richest in the NW part, while Leptodirinae (Cholevidae) in the SE part of the Dinarides. We tested three hypotheses to explain this pattern: productive energy, habitat heterogeneity and historical climate stability. We used the dataset of 388 species, 142 of Trechinae, and 246 of Leptodirinae, and mapped the data onto 20 x 20 km grid. We applied generalized linear models with and without spatial component, followed by variation partitioning. Generally, habitat heterogeneity hypothesis gained the most support, being most pronounced in Leptodirinae. In Trechinae, historical climate stability was almost equaly important, while independent effect of productive energy was low in both groups. Differences in drivers of species richness between the two groups can be interpreted related to their biological traits. Even though habitat variability is smaller in subterranean compared to surface habitats, gradient is still strong enough to explain the geographical variation in species richness better than the other two hypotheses. Knowledge on the drivers of biodiversity patterns is important also for conservation planning.

Keywords: biodiversity, conservation, habitat heterogeneity, subterrannean beetles

IMPACT OF HABITAT DISTURBANCES AND ITS IMPACT ON CARABID ASSEMBLAGES

The effect of different soil treatments on the carabid fauna after topsoil removal

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To increase the amount of heathland, in an arable field, 200 ha in size and entangled by the national park Dwingelderveld (Drenthe, the Netherlands), more than 60 cm of the top-soil was removed at the end of 2011. Here, in the beginning of 2012 only a sterile bare sandy area was left. To find the fastest way to regenerate the ecological most complete heathland communities, 4 experimental areas of about 45 by 45 meters were selected to execute different treatments and combinations of treatments. Each area was divided in 9 equal sized experimental plots in which different combinations of measures were taken. Those measures consisted of abiotic: doing nothing, adding acid, adding lime and biotic: doing nothing, adding plant material gained from a nearby heathland and adding sod cuts from a nearby heathland. To catch ground-dwelling fauna in the center of each plot a pitfall trap was placed. From the early spring in 2012 up till now the sampling took place. Results so far indicate that acidification is the worst method for regenerating heathland communities. Liming gives rise to the highest biodiversity in carabid species. Spreading out heather cuttings or even better heather sod cuts leads to the fastest way of restoring heathland communities, regarding the carabid fauna. Probably spreading out heather sod cuts, combined with liming, leads to the most desirable result as far as heathland management is concerned.

Keywords: Heathland regeneration, heathland community, topsoil removal, heathland management measures & carabid fauna

Response of ground-beetle (Carabidae) assemblages to harvest and wildfire disturbances in lodgepole pine forests of western Alberta, Canada

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Periodic forest disturbance from human activity or natural events produce a mosaic of different habitats on the landscape. Conditions in these habitats differ based on time since disturbance. This forest heterogeneity thus supports development of diverse faunal communities; promoting higher levels of biodiversity than if the forest landscape was more homogenous. In this study we compared how carabid assemblages change during forest regeneration after harvest or wildfire, with a focus on late-stage succession of forests more than 30 years in age. Assemblages in stands >40 years old show signs of convergence toward those of old-growth forests that are more than 120 years old. This convergence was noted in both stands following fire and harvest disturbances, although carabid assemblages differed in younger forests. However, we note a substantial decrease in abundance of *Carabus chamissonis*, a large bodied, old-growth specialist in the 20 years since the last comprehensive sampling of this landscape. Although harvest activity does not pose an immediate threat to most elements of carabid assemblages if done in a way that conserves habitat heterogeneity, there is a clear basis for concern about species that require stable and adequate reserves of old-growth forest.

Keywords: carabids, ecology, forestry, fire

Clear-cut harvesting and impacts of variation in habitat structure on carabid beetle (Coleoptera: Carabidae) assemblages and their post-harvest recovery

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Clear-cut harvesting is a common forestry practice, and has been a significant source of disturbance in boreal ecosystems. Its impact on biodiversity is a major conservation concern: complete removal of tree cover drastically changes habitat structure for taxa adapted to forest ecosystems. Understanding these impacts and how they influence subsequent recovery of boreal forest communities will contribute to conservation of the forest biota. Plant communities of post-harvested forests gradually recover over time, following a successional trajectory that leads to climax communities with an overall structure similar to an undisturbed forest. Time since the last harvesting event is the main proxy used to assess this recovery; however, time is not a good proxy for other taxa that follow different recovery trajectories. For example, microhabitat structure can play a fundamental role in recovery processes for carabid beetles (Coleoptera: Carabidae). These features are only marginally correlated to forest age, and may instead be strongly influenced by pre- and post-harvest conditions and by post-harvest management. In turn, they may influence the speed and level of recovery of carabid beetle assemblages. We used comparison of macro- and microhabitat conditions to identify aspects of forest structure that can be used to assess the level of post-harvest recovery in biodiversity studies and conservation planning. We show that micro habitat characteristics have a more important effect on carabid beetles assemblage recovery than tree cover and its post harvest dynamics.

Keywords: forest management, biodiversity, forestry, boreal forests, assemblages recovery

Body mass distributions along successional gradients in epigeic carabid beetle fauna (Coleoptera: Carabidae)

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The body mass distributions of carabid assemblages were studied in three research areas, which were moist and wet forest stands in the Puszcza Knyszyńska forest (northeastern Poland), post-industrial areas near the city of Bełchatów (central Poland) and beech stands in the Ruhr valley (western Germany) in order to analyse the changes in the body mass distributions within single assemblages along successional gradients. For each assemblage the mean individual biomass (MIB), standard deviation (SD) and coefficient of variation (CV) were calculated. SD and CV were plotted against age of the study sites and MIB values respectively. Analyses of Covariance (ANCOVA) were carried out with SD and CV as dependent variables and age of the study sites and MIB as covariates. Standard deviations were low at young stages of succession, but increased rapidly and plateaued at advanced stages in the beech stands but not in the wet forest stands. Accordingly the variation coefficients were low at the very young stages of succession with an rapid increase and following decrease in the beech stands, whereat in the wet stands they stayed on a constant level. The observed patterns were more pronounced when plotting against MIB values. ANCOVA revealed significant differences in SD and CV between the research areas and significant changes with age or MIB. The results of the study suggest that data on body mass distributions within single carabid assemblages might be useful in assessment and comparison of succession stages and processes between different habitat types.

Keywords: MIB, succession, forest, post-industrial area, bioindication

Relation between carabid beetle fauna (Coleoptera: Carabidae) and plant succession in a post-agricultural area

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Controlling plant succession with variable management methods seems to be important for conserving biological diversity of both plants and carabid fauna. Therefore, the relation between plant succession and carabid fauna on differently managed study sites in a post-agricultural area was studied in order to test, (1) to what degree plant species composition, composition of dominant plant species and percentage cover of plants characteristic for forests, dry and fresh meadows and ruderal areas differ due to management of the study sites, (2) if plant communities of particular research plots under different management regimes show different stages of succession, and (3) if relations between mean individual biomass (MIB) as well as functional groups of carabid beetles with plant species composition exist.In order to answer these hypotheses phytosociological surveys were carried out on selected differently treated study sites and carabid beetles were collected by using pitfall traps. Based on a comprehensive data analysis, including calculation of Jaccard and Renkonen indices, application of unconstrained and constrained ordination methods and calculation of Spearman rank correlations between selected parameters, direction and degree of impact of the management treatments on flora and carabid fauna were determined. The results of the study are assessed to be important in the context of conservation of biological diversity in manmade landscapes.

Keywords: controlled succession, agricultural landscape, biological diversity, management

MORPHOLOGY, TAXONOMY AND EVOLUTION OF CARABIDS

Introgression or low molecular differentiation? The case of *Carabus clatratus maacki*

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The *Carabus* subgenera*: Limnocarabus* and *Euleptocarabus* build without doubt a monophyletic entity. Both are represented by one species. But they differ distinctly in morphology and in the range of their distribution area. *Carabus (Limnocarabus) clatratus* is one of a few widespread species within the genus; its distribution area extends from Ireland to Japan. *Euleptocarabus porrecticollis* is restricted to the Japanese island of Honshu. The form *maacki* occurs in the northern most part of Honshu (separated from *C. porrecticollis*) and on the adjacent Asian mainland. Morawitz described *maacki* as a subspecies of *C. clatratus*. High mitochondrial differences between *clatratus* and *maacki* gave support to establish *maacki* as separate species. Kim et al. (1999) studied *Euleptocarabus porrecticollis* from all over its distribution area on Honshu using ND5 sequences as molecular marker. The authors got the surprising result that the Japanese *maacki* differ from *porrecticollis* only in the same extent as the *porrecticollis* subspecies do among themselves. They assumed "..., there may be several phylogenetic species here instead of just one species with several populations." My hypothesis is that *maacki* is a *clatratus* but suffered an introgression by *porrecticollis*. A comparison using mitochondrial (ND5) and nuclear (wingless) sequence data of *maacki* from Japan with *maacki* from Russia is presented together with data on other populations of *Carabus clatratus*. The introgression hypothesis is corroborated and, in consequence, *maacki* must retain the status of a subspecies.

Keywords: phylogeography, species or subspecies

Phylogeographic structure in the sister species *Calathus cinctus* and *C. melanocephalus.*

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Calathus cinctus and *C.. melanocephalus* are two sympatric sister species with comparable ecological preferences and life history traits but with differential flight inheritance mechanisms. Wing dimorphism in *C. cinctus* is inherited by a single-locus model with brachyptery dominant to macroptery, and in *C. melanocephalus* the expression of the long winged genotype depends on a combination of genetic and environmental factors. On these differential constrains it is hypothesised that *C. cinctus* has higher dispersal potential than its sister species *C. melanocephalus*. A molecular analysis has been carried out to analyze whether these potential differences in dispersal power have resulted in contrasted genetic structure of populations located in the western Palaearctic region. Mitochondrial data showed that both species have similar genetic structure but significantly differed in the phylogeographic structure. *C. melanocephalus* showed almost no shared haplotypes and low levels of gene flow between eastern and western Palaearctic populations. On the other hand, *C. cinctus* shared haplotypes between these regions and presented higher levels of gene flow. Our results point that the contrasted flight inheritance mechanisms of *C. cinctus* and *C. melanocephalus* have differentially constrained their population structures via a higher dispersal power of *C. cinctus* mediated by the higher proportion of long winged individuals.

Keywords: population structure, haplotypes, gene flow, dispersal power.

Evolution of sexual shape and size dimorphism and allometry in carabid beetles: an example on *Ceroglossus* spp. using geometric morphometrics.

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Insect species vary greatly in the expression of secondary sexual traits, resulting in sexual dimorphism, which has been proposed to be a consequence of differences in sexual selection. The present research is focused on the evolutionary history of sexual shape variation associated with the population sex ratio in the South American carabid genus *Ceroglossus* Solier (sister clade of the European *Carabus*), which are native of Chile and Southern Argentina. Geometric morphometric and multivariate methods (principal component analysis and regression analysis) were applied to phylogenetically independent contrasts of shape data in 8 *Ceroglossus* spp. These analyses revealed a moderate phylogenetic signal on *Ceroglossus* body shape, and a clear evolutionary allometry. This evolutionary relationship revealed a striking congruence between the sexual dimorphism and sex ratio. In our results, the proportion farthest from 1:1 was associated with more disparate body shape, even though the entire group had minimum variation in sex ratio, which is an intrinsic life history character of this group. Therefore, this study reinforces that sexual selection as a microevolutionary process at intra-specific level is also very important at inter-specific level as a macroevolutionary process in this carabid genus.

Keywords: sexual dimorphism, sex ratio; shape evolution, phylogenetic signal.

The hows and whys of ommatidia measurement in the compound eyes of beetles

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The size of ommatidia is linked to the visual capacity and organismal performance. These relationships most likely explain why it correlates with the lifestyle, body size and standard metabolic rate of the organism. Ommatidia within a single eye vary in size, and differ genetically between individuals and species. Moreover, because they develop from a defined number of cells and the sizes of different cell types are usually correlated, the size of ommatidia can be used as a proxy for the average cell size in other tissues. Different methods are available for measuring ommatidia, but none of them, allows for the rapid measurement in an inexpensive manner. In our project we have overcame those difficulties by developing a method that maximises throughput and accuracy by using a free software coupled with nail polish imprints to measure ommatidia size. We conducted the measurements of ommatidia in *Carabidae* beetles (n=570) from 19 species and both sexes, ranging from approximately 20 to 2350 mg live body mass, collected in Poland in two seasons. This allowed us to detect a positive correlation between the size of ommatidia and body mass within species. When statisticaly corrected for body mass, males possessed larger ommatidia than females in autumn, but this difference could not be detected in spring. The size of ommatidia differed significantly between taxa, and to a large extent this variation was linked to the evolutionary differences in body mass: species-specific size of ommatidia scaled positively with body mass in females ($p<0.001$) and in males ($p=0.001$).

Keywords: automatic ommatidia measurements, cell size, body size, sexual and seasonal variation

Phylogeography and morphology of *Calomera littoralis* in eastern Mediterranean region

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The beetle *Calomera littoralis* is one of the most common species among tiger beetles occurring in south-eastern Europe. The species occurs on sea beaches, salt marshes, and river and lake banks. The aim of this study was to reveal the genetic and morphological structure of *C. littoralis* in the eastern Mediterranean Region as well as in isolated population inhabiting Austria. The material was collected on over 80 sapling sites during a few expeditions in Ukraine, Moldova, Romania, Bulgaria, Albania, Macedonia FYR, Turkey, Greece, Montenegro and Austria. Beetles were caught using entomological hand net and preserved in 96% ethanol. The HCO and LCO universal primers were used to amplify part of COI gene (680 bp). As a result we obtained 142 sequences among which 74 haplotypes were defined. The phylogenetic analyses with using Maximum Likelihood and Neighbor-Joining methods resulted in dendrograms of same topology showing two well supported clades. The first clade grouped specimens collected in the Mediterranean and Black Seas regions while the second included only individuals from the Black Sea coast. The genetic distance (KP2) within clades was below 1% while among them it was 4%. The differences between clades were noted also in morphology of beetles: individuals from the Black Sea coast were significantly smaller than these occurring in the Balkans.

Keywords: Coleoptera, Cicindelinae, Balkan Peninsula

(Technical Report)
Macro photography of Carabids

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Canon provides with the MPE-65mm and/or Canon EF 100mm 2,8 L IS USM Macro in combination with the Macro Ring Lite MR-14EX II or the MT-24 EX Speedlite a professional equipment for ground beetle macro photography. Some hints concerning camera and flash adjustments so as settings are given. In addition personal experiences, advantages and disadvantages of different methods of photography in the wild e.g. without manipulation in opposition to different kinds of manipulation (refrigerator, ethyl acetate and CO2) are discussed. Stack photography as an additional option is mentioned.

LIFE HISTORY TRAITS, DIVERSITY AND DISTRIBUTION OF CARABIDS

Forest ground beetle (Coleoptera: Carabidae) diversity and assemblage structure on boreal lake islands: an island-mainland comparison

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Several hypotheses (passive sampling, habitat diversity, and equilibrium theory) are commonly offered to explain species-area relationships observed on islands; however, few studies clearly discriminate among these hypotheses. Sampling a fixed area within a single habitat type makes this distinction possible because it eliminates the effect of the passive sampling (large islands intercept larger samples) and habitat diversity (number of habitats proportional to area) hypotheses on island diversity. Thus, using fixed area sampling, the equilibrium theory hypothesis can be tested directly. We sampled carabid beetles (Coleoptera: Carabidae) on 30 forested islands and the nearest mainland of Lac la Ronge, Saskatchewan, Canada. Our aims were 1) to test the equilibrium theory by asking whether carabid beetle (Coleoptera: Carabidae) diversity increases with island area and decreases with isolation, and 2) to test whether species assemblages differed between islands and the mainland, and among islands of different sizes and isolation. Rarefied species richness significantly increased with island area, providing support for the equilibrium theory hypothesis; however, richness did not vary with isolation, suggesting that diversity is not determined by this factor. Furthermore, carabid assemblage structure did not vary with isolation and was similar between islands and mainland, except for islands smaller than one hectare. Our findings suggest that island size affects population processes and that the composition of island assemblages is influenced by species interactions, as tempered by autecological characteristics (body size, dispersal ability) of individual species.

Keywords: carabid, beetle, island biogeography, Canada, non-metric multidimensional scaling

Body size and wing morphology: life history traits influence the distribution of ground beetles (Coleoptera: Carabidae) on boreal lake islands in central Canada.

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Carabid body size and wing morphology were compared on boreal lake-islands spanning an area gradient (0.2 – 980.7 ha). Mean individual body length, proportion of winged species, and wing-morph ratios of dimorphic species were used to test: (1) whether body size decreases in response to fewer resources on small islands; (2) if greater turnover rates of large-bodied carabids influences the proportion of macropterous species on small islands; and (3) whether wing-morph ratios in dimorphic species can be used to infer population age and habitat stability on islands. We found that island area significantly influenced average body size of carabid communities and the proportion of macropterous species on the islands. Small islands showed reduced average body size and a higher proportion of winged species. Comparison of wing-morph ratios varied from predominantly brachypterous in *Calathus ingratus* Dejean and *Synuchus impunctatus* (Say) to 23.8% macroptery in *Agonum retractum* LeConte. Ratios of macroptery in *A. retractum* did not vary with island area; however, females were significantly more likely to be winged, indicating inheritance of the winged trait in *A. retractum* may be sex-linked. Our findings suggest that power of dispersal is an important factor influencing the distribution of carabids on these islands. Prevalence of small-bodied, winged species on small islands indicates that these habitats are less suitable for large bodied species. Furthermore, we advocate the use of wing-morph ratios to estimate population age on islands, but caution against such an approach if the winged trait is not of simple Mendelian-inheritance.

Keywords: autecological traits, mean individual biomass, wing dimorphism, *Agonum retractum*, macroptery

Pushing connectivity in landscapes: species-specific life history traits and locomotory behavior as tools to design semi-open corridors

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Linear elements are often thought to be suitable as corridors to improve connectivity and therefore mitigate the effects of habitat fragmentation. On the other hand, corridors can increase the fragmentation of the surrounding habitats. To overcome this problem, semi-open corridors which contain a mixture of open land and woodland vegetation to enable dispersal of both stenotopic open land and woodland species have been proposed. However, designing such corridors remains a challenge due to their rarity in most landscapes. In this study we used large grids with approximately 1400 live pitfall traps in open, wooded and semi-open habitats. We tested the measured locomotory patterns for correlation with habitat structure to understand migration in semi-open habitats. The species-specific behaviour is used together with population dynamic parameters for simulation in virtual landscapes. The simulations were conducted using software "DISPERS" to test also the impact of different corridor widths on the dispersal of stenotopic ground beetle species. In general, the species-specific probability to change between main and semi-open habitats is higher than between open and wooded habitats. Species-specific responses to habitat structure range from preferences to complete absence under some habitat structures. Wider corridors seem to support dispersal of more individuals over longer distance, but the exact dimensions of the corridors depend on the given species. The results highlight species-specific responses to corridor properties emphasizing the key role that ground beetles can play in designing novel connectivity structures in our landscapes.

Keywords: dispersal, simulation, ground beetles

How many carabid species are missed during biological surveys based on pitfall trapping technique?

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Biological surveys are aimed to provide information (as complete as possible) on assemblages inhabiting particular area. The value of investigated site for conservation purposes is determined based on species composition and species richness recorded by particular biological survey. Thus application of sampling methods which selectively collect some species whereas other are omitted hampers the objectivity of obtained conservation value results. The most commonly applied method in biological surveys of ground-dwelling arthropods is pitfall trapping. To verify possible selectivity of this method for carabid beetles, we compared species lists obtained by pitfall trapping and individual sampling during 41 real biological surveys. Individual sampling detected almost twice as many carabid species compared to pitfall trapping technique (on average 24 species were recorded by pitfall traps and 46 by individual sampling per survey). Even lower pitfall trap efficiency was revealed for red-listed species (just one fifth of species recorded by individual sampling was also recorded by pitfall traps). Some carabid genera are hardly to find out by pitfall trapping (typically these with small body size e.g., *Acupalpus*, *Bembidion*, *Microlestes*, *Stenolophus*), whereas other genera are overrepresented by pitfall trapping technique (typically these with large body size e.g., *Abax*, *Carabus*, *Pterostichus*). It is neccesary to consider these sampling biases when interpreting pitfall trap data. The best way to obtain more complete carabid assemblages is to invite friends with aspirators to a field individual sampling party.

Keywords: body size, individual collecting, recorded species richness, sampling bias

How are carabid species distributed?

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One of the fundamental questions relating to empirical ecological research and study is what determines the distribution of carabid beetles – and other organisms. In many ecological studies, we try to determine how various environmental factors affect the distribution of a set of species. However, we do not necessarily have a very clear understanding of how these organisms would be distributed in the absence of such extraneous factors. We do know that some species are abundant but the majority are scarce, and that some are stenotopic and others are eurytopic. These patterns are consistent with that derived from Preston's Log-Normal Distribution, for instance. It has also been suggested that Fisher's Log Series accurately describes the typical distributions of entomological data. A number of other models have been proposed in attempts to determine the mathematical principles behind such distributions. More recently Hubbell has attempted to base an explanation for such distributions on principles of biodiversity and biogeography, rather than simply mathematical principles, in his Unified Neutral Theory. I consider the pros and cons of some of these proposed models for the distribution of carabid species, and their potential to help us understand how carabid species are distributed.

Keywords: clumped distribution, log-normal distribution, log series, unified neutral theory.

Level of parasitisation of gregarines (Eugregarinorida, Apicomplexa) is linked to the sex of ground beetles (Coleoptera, Carabidae): a case study in Poland

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The costs of resistance to parasite infestation can be related to conditions of individuals and abilities to cope with parasite infection. Sex differences in levels of parasite infection are a common rule in a wide range of animals. Especially when one sex have higher expenditure in reproduction or sexes differ in energetic budget of the individuals. Reproductive females of ground beetles (Carabidae) differ in breeding strategy and represent many life strategies as a response to habitat variation, being therefore an ideal model to study the consequences of sex-specific adaptations to habitat. We then compared the parasite intensities in a host parasite system comprising eugregarines and the ground beetles collected in various habitats during the season. The field survey was provided in the years 2006-2007 on permanent study sites in various types of habitats (forests, meadows and crops). Over 3500 specimens of Carabids were checked for density of gregarines. The generalized linear model showed that infestation was higher in adult females than in males collected across various habitats. The mean density of gregarines increased significantly from the most disturbed arable land trough meadows, taking the highest values in the forest and this relationship was always sex dependent showing higher densities among females than males. The infestation preferences to females were life-trait dependent showing the highest values among females investing more energy into their brood (forest large zoophages, brachypterous autumn breeders). Our study showed that habitat and life trait specialization and higher costs of investment into the body favors sex-biased parasitism.

Keywords: eugregarines, ground beetles, sex, parasitism, life traits

Habitat requirements of *Rhysodes sulcatus*, an endangered Natura 2000 dead wood beetle

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The purpose of this study was to identify key habitat requirements for *Rhysodes sulcatus*, an endangered. Natura 2000 saproxylic carabid beetle. The study was carried out on 3 locations in Czech Republic and 3 locations in Slovak Republic, varying from lowland floodplain soft- and hard-wood broadleaf forest, mid elevation hill forest dominated by oak, beech and spruce, and montane beech-fir forests. Fallen logs were searched under the bark and inside the wood when possible. The inspected log parameters included diameter, length, humidity, insolation, decomposition level and rot type. Surrounding forest characteristics, such as canopy closeness, main tree species, undergrowth, the amount and quality of the dead wood were also recorded. Logistic regression was used to identify key habitat preferences, and the analysis shows that the most prominent requirement is diameter of dead wood, as *R. sulcatus* was almost exclusively found only in large, well rotten logs with diameter over 60 cm. The findings may be useful in providing guidelines for sustainable forest management that would support conservation of this beetle by leaving large fallen logs inside the forest.

Keywords: *Rhysodes sulcatus*, habitat requirements

EFFECTS OF LONG TERM CHANGES ON CARABIDS

The importance of extreme weather events for ground-beetle communities revealed by 50 year time series from The Netherlands

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Climate change predictions foresee not only an increase in mean annual temperatures worldwide, but especially also an increase in the frequency of extreme weather events. Despite the strong potential of such extreme conditions to affect ecological and biological systems, knowledge on the ecological consequences of such events remains scarce. Here, we use an extensive dataset of ground beetle trappings from the Netherlands, spanning over 50 years, to investigate whether extreme weather events (drought, heatwaves, extreme precipitation, etc.) have lasting consequences for ground beetle communities and species. We first show that, on yearly scales, aggregated weather variables (total summer precipitation, mean summer temperature, number of dry, wet , hot or frost days between March and October) have little predictive power over yearly carabid catches in terms of total abundance or species richness. Ground beetle communities do, however, respond to extreme years, showing an above average temporal change in composition following such years. On short time scales, however, ground-beetle communities respond strongly to extreme events, but recover quickly. Only man-made disturbances such as burning and top-soil removal have lasting consequences. Ongoing analyses will show the importance of density dependence, interspecific interactions and compensatory dynamics in determining the long-term dynamics of these communities.

Keywords: heathlands, long-term research, drought, precipitation

Recovery of a boreal carabid fauna ten years after variable retention harvest

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Carabid beetles are a widely employed to assess responses of biodiversity to disturbance and monitor post-disturbance recovery of the invertebrate fauna. They are a central taxon used for testing hypotheses about impacts of innovative forest harvest practices on biodiversity, as applied to four common boreal mixedwood carabid habitats during 1999 at the EMEND (Ecosystem Management Emulating Natural Disturbance) experiment in NW Alberta, Canada. At EMEND we compare impacts of several levels of retention harvest (10, 20, 50 and 75%) with the standard Canadian clear-cut (c. 2% retention) and unharvested controls. Results from the first 10 years show that cumulative activity of c. 35 carabid species, including most forest specialists, was little affected (or actually increased) immediately after harvest, but then fell as populations of most forest species decreased. Despite influx of a number of species that significantly indicate more open habitat, carabid activity remained low ten years post-harvest. Impact on composition of local assemblages was directly proportional to harvest intensity, and recovery of species composition toward that of unharvested controls varied inversely with harvest intensity. Species of late-successional spruce-dominated stands (e.g., *Calathus advena, Pterostichus brevicornis*) have not recovered toward the reference (or target condition), as defined by either pre-harvest data or 10-ha unharvested control blocks. However, populations of species significantly indicating early successional poplar-dominated stands (e.g., *Agonum retractum, Platynus decentis*) show better recovery. Carabids and other epigaeic species usefully contribute to measurement of biodiversity as a criterion for assessment of the sustainability of forest management approaches.

Keywords: biodiversity, boreal forests, sustainable forest management, retention harvest, faunal conservation

Exclusive microhabitat specialist *Carabus (variolosus) nodulosus* is declining in its global population stronghold (Slovenia): large-scale and long-term study

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The *Carabus (variolosus) nodulosus* is an endangered species of European conservation concern listed at Habitat Directive. The (sub)species range extends from Germany to the central Balkan Peninsula, and Slovenia lies in its core range of distribution and most probably presents the global population stronghold. Due to recent large-scale surveys the species is widespread in Slovenia with currently known at least 200 locations. Despite it is regarded a habitat specialist confined to marsh areas, it was found to be macrohabitat generalist. It is vertically distributed from 57 to 1250 m a.s.l. with no clear altitudinal preferences, what was shown also for other macrohabitat parametrs. It can inhabit even larger forest fragments inside urban areas. However, at microhabitat scale the species is highly confined to the immediate vicinity of waterbodies, mainly forest streams, with marked limitation of activity already at 2 meters from the waterline. This aquatic and highly humid environment is exclusive only to *C. (v.) nodulosus* and is mainly avoided by other *Carabus* species, except to a lesser extent *C. granulatus*, which can share this environment in the lowlands. Long-term population annual monitoring conducted between 2007-2015 indicated that population of C. (v.) nodulosus is in moderate decline in Slovenia (TRIM trend estimation -3.8±1,2 %; $p<0.01$). Current data show, that declining trend is much more steep within Natura 2000 sites (TRIM trend estimation -3.1±1,4 %; $p<0.05$) than outside Natura 2000 network (TRIM trend estimation -1.4±2,3 %; ns), where trend is uncertain or even stable. The discrepancy shows ineffective conservation impact of Natura 2000 network for the species, what is due to the lack of suitable conservation management and knowledge over species ecology.

Keywords: *Carabus variolosus nodulosus*, Slovenia, habitat, population trend, monitoring

Ground beetles in city forests: influence of forest age and urbanization on behaviour?

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Urbanization changes abiotic conditions, increases disturbance frequency and fragments and alters habitats. This leads to shifts in species composition as species are differently adapted to cope with urbanization. On an intraspecific level, populations from urban and rural habitats differ in certain behavioural traits, such as boldness or exploratory behaviour: individuals in urban habitat are generally expected to be more exploratory and bolder than their rural conspecifics. Similarly, within-city habitats, such as forests or city parks, differ in their degree of urbanization making also within-city differences in behavioural traits likely. Moreover, within-city forests show different histories (a forest patch existed ever since with the city growing around it: ancient city forest; or a forest patch planted within a city after the city was established: recent city forest) with the ancient city forests serving as refuge areas from which the recent forests needed to be colonized. We expect that individuals in ancient forests are less exploratory than individuals in recent city forests. We developed easy-to-use field tests to assess exploratory behaviour and boldness in ground beetles. In a field study we tested more than 2000 individuals from four forest-dwelling ground beetle species from eight differently urbanized and differently aged within-city forest patches. Results show that both, habitat history and urbanization, have an impact on behavioural traits in the studied species. We discuss potential consequences of such behavioural differences in anthropogenically changed habitats for future population dynamics.

Keywords: urbanization, forest ground beetles, exploratory behaviour, boldness, behavioural differences

Ecosystem Memory and Lasting Effects of Fire History on Early Post-Harvest Recovery of a Boreal Ground-Beetle Community

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Biological legacies left after disturbance events link pre- and post-disturbance ecosystems. The extent to which these pre-disturbance residuals shape post-disturbance community development may be thought of as 'ecosystem memory'. In this talk we address two questions: 1) How do carabid assemblages respond to 300 years of fire history in mature and old growth boreal forests?; and 2) Can ecological links between fire history and carabids persist in early post-harvest succession? We found that forest with a significant portion of trees older than 177 years support highly diverse and distinct carabid assemblages compared to the surrounding matrix of mature forest. Three carabid species were stenotopic indicators of these old growth forests. Furthermore, we detected a significant effect of fire history on carabid assemblages two, five and ten years after variable retention harvesting, but this legacy effect decreased dramatically after 5 years. Patterns of post-harvest ecosystem memory detected in carabids differed from those detected in spiders, plants, and birds. As the Anthropocene brings a combination of new disturbance types to our planetary ecosystem, understanding the long term cumulative impact of disturbances is crucial for ecosystem conservation. Historical ecosystem memory provides excellent rationale for the conservation of biological legacies by natural resources extraction companies seeking to preserve the natural thread that links pre- and post-disturbance ecosystems.

Keywords: ecological memory, old-growth, carabids

Ground beetles in the Kampinos catchment area – results of 16 years of observations

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In the years 1999-2014 ground beetles were caught in modified Barber traps in ecosystems representing four initial stages of ecosystem development in the Kampinos catchment area. These included (1) periodically flood unforested riparian meadows, (2) wet meadows covered with clusters of trees, (3) wet 30-year-old willow and birch stands and (4) 40-year-old pine stands not directly affected by the stream. During the 16 years of the study 23,450 ground beetles belonging to 132 species were caught. Both the species richness of the carabids, measured using the Chao 2 estimator, and the proportions of small zoophagous and forest species depended on habitat moisture, but not on the successional stage of the ecosystem. Ecosystem moisture content and the successional stage of development of the ecosystem influenced the percentages of large zoophages, European species, hygrophilous, mesophilous and xerophilous in the assemblages. Only the percentage of open-land species depended only on the successional development of the habitats analyzed. The groundwater level in the catchment was correlated (not very highly, but significantly) with the percentage of small zoophagous (+0.17; $p = 0.017$), xerophilous (+0.23; $p = 0.002$), large zoophagous (-0.23; $p = 0.001$), hygrophilous (-0.20; $p = 0.006$) and the Chao 2 estimator (-0.16; $p = 0.005$). PRC (Principal Response Curves) analysis revealed differences between seasonal changes in the composition and abundance of ground beetles inhabiting dry forests and wet habitats. The closer the ecosystem was to the stream, the greater were these differences. PRC analysis showed that the closer the carabid assemblage was to the stream, the stronger was the response of the beetles to beavers occupying the stream and building dams on it. The observations are in line with research drawing attention to the important role of habitat moisture, in comparison to the developmental stage of the ecosystem, in determining the abundance and species richness of ground beetles.

Keywords: ecological sucession, water table, *Carabus clatratus*

SPATIAL ANALYSES OF CARABIDS – DIVERSITY OF SCALES AND METHODS

Interactions between agricultural systems and landscape properties exert a strong filtering on species traits in carabid communities.

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The intensification of agriculture and its consequences on landscapes are considered a major cause of biodiversity decline. This loss of biodiversity may strongly affect provision of ecosystem services, as pest regulation provided by natural enemies' diversity, but the precise relationship between biodiversity of regulatory species and biocontrol efficiency remains unclear. Understanding how agriculture systems impact communities and their ecological functions is then a major concern in agroecosystem management. An approach based on species traits at the community level can highlight strategies (response traits) that allow species to settle and maintain in the environment, and in the same time, help identifying filters that favor benefic traits for biological control (effect traits). During this study, we focused on carabid beetles, which are considered as good natural enemies on several pests. The work consisted in finding links between landscape composition and traits at the community level. Beetles were trapped on 57 fields spread on 3 different regions of West of France. The simultaneous analysis of beetles traits and landscape features revealed three traits syndromes associated to landscape characteristics typical to three agricultural systems: small grains farming, intensive cattle rearing and extensive cattle rearing. For each system, particular traits syndromes suggested the adoption by carabid beetles of distinct adaptive strategies to face constraints imposed by landscape and agricultural practices (disturbance regime, landscape openness and heterogeneity). These findings imply that both farming system and landscape characteristics must be taken into account in ecological management aiming at favoring services providing species.

Keywords: landscape composition, evolutionary strategies.

Influence of farming system on ground beetle communities at local and landscape scales

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The beneficial effect of organic farming on the abundance and species richness of auxiliary communities (i.e., communities of organisms providing ecosystem services as pest regulation) in agroecosystems has been repeatedly evidenced. However few studies have intended to characterize its actual contribution in terms of natural enemies' production. In this study, we carried out an analysis of the abundance and species composition of carabid beetles communities in fields managed according to the rules of organic and conventional farming. We aimed at identifying the relative contributions of the two farming systems to the production of auxiliary ground beetles at local and landscape scale. Twenty winter wheat fields (*Triticum aestivum*) were selected in Brittany (west of France), ten managed under organic farming and ten under conventional agriculture. In each fields, pitfall traps and emergence arena were installed to sample, respectively, circulating (including both individuals having overwintered in field and individuals having immigrated from the surroundings of field) and emerging (individuals having overwintered in field) individuals in those fields. Analyses of the samples showed that the structure of carabid communities was mainly driven by the type and availability of food resources. Results suggest that organic farming rather act as a sink than as a source in spring because of its attractiveness for carabid beetles. However, the best quality of habitats provided by organic crops in spring and probably also by marginal areas associated with this system throughout the year, probably contributes to make organic farming a source at other periods of the year and at the scale of multiannual dynamics.

Keywords: organic farming, arthropod predators, biological control, natural enemies, source-sink dynamics

Ecological knowledge and remotely-sensed landscape variables: a new approach to predict biodiversity.

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We assessed the ability of a depth-to-water index and associated data about flow accumulation, as derived from high resolution (1 meter) LiDAR (Light Detection and Ranging), to describe relationships between soil moisture and the diversity and composition of carabid beetle assemblages across green tree retention gradients. Soil moisture is a crucial parameter for ground beetle assemblages due to strong effects on larvae survival. The work was conducted in the boreal forest of northwestern Alberta (Canada) at the EMEND (Ecosystem Management Emulating Natural Disturbance) site. We studied four different variable retention harvesting prescriptions (2%, 20%, 50% and 100%) in three different forest cover-types (deciduous dominated, mixedwood and conifers dominated) using pitfall traps. The results are interpreted in the context of spatial distribution of suitable microhabitats for oviposition and larval survival that in turn influence composition of carabid beetle assemblages. This is a first step to assess high resolution LiDAR as an ecological tool to predict and map patterns of biodiversity that will be useful in management of the boreal forest.

Keywords: carabid beetles diversity, soil moisture, airborne laser scanning, green tree retention, boreal forest

Fine-scale tree spatial distribution and carabid beetle distribution patterns in a Canadian boreal mixwood

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Spatial distribution of species is of great and increasing interest for understanding factors that determine and influence large-scale patterns mostly. However, small scale distribution patterns are less studied and microhabitat variation is expected to drive small species compostion such as carabid beetle. This study focuses on the relationship between local distribution of carabid beetle and tree species variability within a 1-ha (100x100 m) permanent plot of mixedwood boreal forest in central Alberta (Canada). The George Lake permanent plot was divided into 25 20x20 subplots, deciduous, conifer and tall shrub basal area and density of living stems were calculated in four circular area with increasing radius (2.5, 5, 7.5, 10 m) centered at each sub-plot. These variables were used to explain the abundance of carabid beetle species across the plot by using negative binomial model. Carabid beetle sample were collected at the center of each subplot using pitfall trap during the ice-free seasons between 2011 and 2013. A total of 27 species from 6440 carabid beetle individuals were indentified. Results shows that carabid beetle composition were sigificantly correlated with tree basal area and abundance of individual species was significantly explained by deciduous, conifer and tall shrub stem density and basal area at each of the four spatial scales. Morever, species abundance is more strongly affected by basal area than by stem density. However, specific relationships between these variables and species abundance varied widely among scales. This study reveals that microhabitat variation at a small spatial scale does have an important influence on carabid beetle distribution patterns and ignoring this may have negative impact for forest biodiversity conservation.

Keywords: tree density, basal area, negative binomial model

An ordinary species in ordinary landscapes – The genetic structure of *Abax parallelepipedus* in the Biodiversity Exploratories

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Habitat history and habitat structure and their resulting effects on genetic structure are central topics in conservation genetics. Often, however, studies have concentrated on rare species or those found in extremely fragmented landscapes, so little is known about how common species react to common landscape structures. Like in much of central Europe, the current forests in Germany are embedded in complex landscapes, and are the result of a long history of changing land uses. We sampled 143 populations of *Abax parallelepipedus*, a stenotopic and flightless forest ground beetle in the forest plots of the Biodiversity Exploratories, and sequenced a set of 14 microsatellite loci. The plots are located in three separate regions across Germany, and represent a gradient of land use types and intensities and of habitat histories. Each Exploratory contains a complex landscape structure, including towns, streets, forests, and agricultural areas. The drivers of genetic diversity were found to all be related to current day population sizes, while no effects of forest history were found. We additionally that genetic differentiation between the plots is not driven by landscape or by barriers. We conclude that *A. parallelepipedus* was able to efficiently recolonize previously cleared forest patches, and that the non-extreme fragmentation levels in our landscapes together with the large population densities have prevented the development of genetic differentiation or the loss of genetic diversity. These results are a reminder that genetic processes at historical time scales must be interpreted in the context of gene flow and population sizes.

Keywords: fragmentation, habitat continuity, genetic diversity, genetic differentiation

AGROECOLOGY

Ground beetle (Coleoptera: Carabidae) assemblages in narrow hedgerows in a Danish agricultural landscape

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The role of hedgerows in supporting ground beetles (Coleoptera: Carabidae) in a Danish agricultural landscape was examined. Nine old, well established single-row hedges were selected for the study, three each of a native species (hawthorn, Crataegus monogyna), a non-native deciduous one (rowan Sorbus intermedia), and the non-native spruce (Picea spp.). We hypothesised that hedgerows with deciduous trees harbour more diverse ground beetle assemblages than hedges composed of non-native conifer trees. We also investigated which vegetation structure characteristics might influence the ground beetle assemblages. The number of ground beetle individuals and species were significantly the highest in the hawthorn hedges and significantly decreased from the hedges with rowan toward the spruce hedges. The elevated number of ground beetle individuals and species in the hawthorn hedges were due to the forest specialist species, as the number of forest specialist ground beetle individuals and species were significantly higher in the hawthorn hedges compared to the hedges with rowan and spruce. Differences in the number of the grassland and the cropland specialist ground beetle individuals and species were not statistically significant among the hedges.

Keywords: non-cultivated patches, hawthorn, rowan, spruce, diversity, character species

Conventional and non-inversion tillage systems as a factor causing changes in ground beetles (Col. Carabidae) assemblages in rape (*Brassica napus*) fields

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Tillage system is a factor influencing the biological, chemical and physical properties of soil and indirectly the organisms connected with soil, such a carabid beetles (Col. Carabidae). Predatory ground beetles, which are natural enemies of many dangerous pests, helps to prevent gradation of plant pests in agrocenoses. The purpose of this study was to determine the species composition of ground beetles colonizing fields of rape cultivated under two different systems of soil tillage – conventional and non-inversion. Another objective was identifying the factors which might have some influence on changes in some life traits of the analyzed communities of carabid beetles. The experiment was conducted in northeastern Poland, in Tomaszkowo near Olsztyn. Six fields with rape cultivation under two different systems of soil tillage were chosen. Modified Barber traps were used to capture insects. Ground beetles were caught from April to October 2011. The traps were removed during harvest and while the soil was tilled for sowing. In total, 9,968 specimens representing 56 species of the family Carabidae were captured. The most numerous species living on studied rape fields were *Poecilus cupreus, Harpalus rufipes, Agonum dorsale* and *Pterostichus melanarius*. Significant differences in ground beetles abundance and some life traits were related to the two soil tillage systems. The NMDS analysis grouped separately ground beetles assemblages in fields under conventional and non-inversion tillage.

Keywords: carabids, tillage, rape cultivation

Habitat preference and demographic parameters of *Nebria brevicollis* population in agricultural habitats mosaic

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Nebria brevicollis was characterized as forest species, and is now described as a eurytopic species with a tendency to moisture proclivity. Habitat preference of this beetle in connection with the structure of the age and gender analysis were studied on four different habitats of neighboured areas in the agricultural landscape (a wheat crop, an old fallow, a fresh fallow, and a forest) in northern Poland. The material was collected in the three growing seasons 2007-2009 using pitfall traps. A total of 621 individuals of *N.brevicollis* were trapped. An average trappability was similar in subsequent years (0.38±0.11 individuals *per* trap *per* day) but significantly differed in particular areas, which does not fully confirm eurytopic character of this species. Males and young specimen significantly dominated in all the years and all areas. It suggests the existence of a permanent and stable population of *Nebria brevicollis* in the analysed agricultural landscape with a distinct preference for the forest and the old fallow habitats.

Keywords: *Nebria brevicollis*, habitat preference, agricultural landscape

The duration of seed burial in soil affects consumption rates by carabid beetles after exhumation.

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After shedding from the plant and before germination or entering the soil seed bank, predators represent the main cause of seed mortality. Predation of seeds liberated from the soil seed bank is, however, largely unknown. This contribution provides preliminary data on the duration of burial in the soil for 26 species of herbaceous seeds, and how it affects the consumption rates and preferences by the model species of carabid seed predator, *Pseudoophonus rufipes* (DeGeer). Batches of seeds of each species mixed with fine soil particles spent 1-8 years (8 species) or 1-6 years (18 species) buried in the soil in nylon fabric bags. We used dry stored and frozen seeds as controls. In the first experiment, we presented cohorts of seeds exhumed at particular years to *P. rufipes*, each species separately. In the second set of experiments, we presented all species of seeds from the same cohort simultaneously, using frozen control seeds and 6-yrs buried seeds. In 13 species of seeds, the consumption of buried seeds was lower compared to controls. In eight species, palatability of seeds after burial was temporarily positively affected as consumption increased in the 1st and 2nd year after burial compared to controls. In four species, burial generally increased the palatability of seeds. Only in one species, there was no difference in consumption among the time cohorts. The order of preference for seeds by *P. rufipes* did not change prominently after the six year burial. Supported by the grant 14-02773S awarded by the CSF to PS.

Keywords: seed predation; granivory; soil seed bank; Harpalini

Carabid habits and ecosystem services for agricultural practices

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The exploration of the role of carabids in agroecosystem dynamics opens promising ways of managing agriculture with a sustainable approach. We sampled 15 olive orchards from 2 Italian regions (Tuscany and Calabria) to assess the potentialities of carabids as predators of the olive fruit fly *Bactrocera oleae* (Rossi), the key pest in olive orchards. By the analysis of carabids species traits and local agricultural practices we depict the most efficient combinations for pest control to be relevant as ecosystem service in Mediterranean olive orchards. Focusing on the feeding habits, our results show that zoophagy could be exploited against pests as much as olive orchards are managed with an integrated or organic approach.

Keywords: olive orchards, olive fruit fly, pest control, sustainable agriculture

Some seasonal features of the population structure of dominant ground beetles (Coleoptera, Carabidae) species in agrocenoses

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The data on seasonal changes of activity density (*Pd*), sexual index (*Is*) and egg production of females (*F*) of the dominant carabid species in agrocenoses of Ukraine are presented. The species with a spring (*Poecilus cupreus, P. sericeus. P. crenuliger, P. puncticollis, P. punctulatus*) and summer-autumn (*Harpalus rufipes, Pterostichus melanarius, Broscus cephalotes, Calathus ambiguus*) type of reproduction were studied. The common species *P. sericeus* and *P. cupreus,* demonstrate, at the beginning of their activity (end of April) a predominance of males (*Is* =0.40-0.48). As *Pd* increased (middle-to-late May), the activity of females also increased, and *Is* changed to 0.55-0.65 (*P. sericeus*) and 0.62-0.73 (*P. cupreus*). During the lower activity period in the first half of summer, the number of females decreased more than that of males (*Is*= 0.30-0.46). When the new generation appeared (late summer), the sex ratio was close to equality (*Is*=0.48-0.52) and hardly changed during the autumn. There was significant correlation between *Pd* and *Is* for these two species over the whole season (r = +0.40-0.62, P<0.05), and even higher (r = +0.62-0.78; P<0.01) over multiple years. A similar trend (though not always significant) was observed for the other spring-breeding carabid species. This relationship indicates the existence of a connection between the periods of high values of *Pd, Is* and *F* in the spring-breeding Carabidae. Apparently, the maximum activity density corresponds to the maximum of copulating activity, and the high value of *Is* indicates when most females begin to lay eggs. Reduction of *Is* at the beginning of summer can be caused by the natural mortality of females, by the decrease of their activity after oviposition or by their migration to more favorable habitats. Similar changes of *Pd*, *Is* and *F* were observed among species of the summer-autumn group. In spring, the values of *Pd* and *Is* in *H. rufipes* was low, males dominating over females (*Is* = 0.34-0.41) and ripe eggs were not found in the ovaries. During the period of emergence of the new generation, *Pd, Is* and *F* increased. Females with mature eggs predominated (*Is* =0.62-0.65). Significant correlation between *Pd* and *Is* of *H. rufipes* are marked during the middle of summer (r = 0.78; P<0.05). In late summer and autumn *Is* did not exceed 0.42-0.48 and eggs in the ovaries were not detected. A similar pattern was observed for other species in the summer-autumn group. For *P. melanarius* we found *Is*= 0.44-0.48 (during the emergence of young adults), and – 0.52-0.60 (during the breeding season). For *B. cephalotes,* these data were *Is*= 0.48-0.50 and 0.62-0.67. Therefore changes in the activity density and sexual index in ground beetles in agrocenoses during the season may indicate the state of populations of these species.
Keywords: Coleoptera, Carabidae, structure of populations, agrocenoses.

ECOTOXICOLOGY AND PHYSIOLOGY OF CARABIDS

Detection of noxious high temperatures in carabids

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Of all the environmental conditions the temperature and humidity are the most influential factors governing habitat choice of carabids. Neurophysiological and behavioural aspects underpinning thermo- and hygroreception have been relatively little studied in arthropods, despite their importance in behavioural thermo- and hygroregulation. In this presentation the results of electrophysiological study of the thermo- and hygroreceptor neurons responses from antennal dome-shaped sensilla of the carabid beetle *Pterostichus oblongopunctatus* to noxious high temperatures (20-35ºC), were measured and analysed at different humidity conditions and analysed at both constant relative and absolute air humidity conditions, are combined with the behavioural tests where carabids locomotor activity are measured in linearly increasing temperature and constant relative humidity conditions. For the first time in arthropods we documented the ability of antennal bimodal hygroreceptor neurons to produce high temperature induced spike bursts. Burstiness of the spike trains is temperature dependent and increases with temperature increase. Threshold temperatures at which the two hygroreceptor neurons switch from regular spiking to spike bursting are lower compared to that of the thermoreceptor neuron, differ and approximately coincide with the upper limit of preferred temperatures of the species. We emphasize that, in contrast to various sensory systems studied, the hygroreceptor neurons of *P. oblongopunctatus* have stable and continuous burst trains, no temporal information is encoded in the timing of the bursts. We hypothesize that temperature dependent spike bursts produced by the antennal thermo- and hygroreceptor neurons may have importance in behavioural thermoregulation of the species.

Keywords: electrophysiology; peripheral spike bursting; dome-shaped sensilla; inner structure, behavioural thermoregulation

Life stage specific species sensitivity of ground beetles exposed to the insecticide: chlorpyrifos.

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Decline of carabid beetle populations in agricultural landscapes may be linked to usage of broad spectrum insecticides. But information on species sensitivity is rare. Therefore our aim was to derive a species sensitivity distribution (SSD) using five carabid beetle species: *Carabus auratus*, *Carabus violaceus*, *Carabus nemoralis*, *Poecilus cupreus* and *Harpalus rufipes*, with two life stages: adult and larval. We have conducted laboratory bioassays with individuals collected in natural meadows from SW France that were kept under laboratory conditions. The beetles were exposed through topical application with one µL of solution and mortality was recorded after 72 hours. The mortality data was used to calculate LC_{50} values (ng a.i./µL) which were subsequently used to derive a SSD. Results show a difference between the two life stages with larvae being more sensitive than adults. Larval and adult toxicity data could be combined in one SSD with a good fit. Species sensitivity is correlated with their weight with one exception: *P. cupreus* larvae, which were less sensitive than heavier larvae of *C. auratus* and even adults of *H. rufipes*. Our research provides a baseline for the carabid species sensitivity to chlorpyrifos and presents the first SSD for a carabid community.

Keywords: LC_{50}, SSD, topical application.

Life traits distribution of ground beetles along heavy metal gradients in Europe

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The significance of energetic budget for detoxication to life-history parameters like body size, breeding season habitat preferences or food specialization and dispersal power was tested. The studies were provided in four industrial regions, varying in pollution quality (Zink, Copper and Nickel) and intensity in Poland and Great Britain. In each region, six localities with five trap row replicates in two gradient of ecological type (meadow and forest) were chosen. The heavy metal concentration varied between sites exceeding 1000 times of standardized norms of the concentration. Over one hundred species were collected along 4 meadow and forest gradients (more than 120 sites). The diversity of forest ground beetles along pollution decreased whereas meadow gradient showed opposite pattern. Large wingless carnivore specialists with autumn breeding strategy were gradually eliminated along increasing levels of contamination. There was however increase in abundance of medium sized opportunistic carnivores and omnivores. The overall pole of species however never changed. In meadow gradient, the significant increase of herbivores and reduction of carnivores in the community was the most significant when pollution increased. Not only abundance but also number of species in meadow gradient significantly increased. The ecosystem effect of life traits replacement in stress was discussed. The proportion of opportunistic herbivores and small sized species are good indicators of heavy metal pollution.

Keywords: Carabidae, life traits, heavy metal contamination, forest meadows

Ambient temperature affects respiration pattern and metabolic rate in carabid beetles

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Temperature is an important environmental factor and especially interesting in view of the global changes. Temperature affects both, behaviour and physiology of organisms including energy metabolism. This study examines (i) how metabolic rate varies with ambient temperature, (ii) do ground beetles employ one of the three different gas exchange patterns (discontinuous = DGE, cyclic or continuous) at different temperatures. We used flow-through respirometry to measure standard metabolic rate (MR) and to determine breathing patterns for three Carabidae species*: Abax ovalis, Carabus linnei and C. coriaceus* with ten individuals each, at four different temperatures: 6°C, 11°C, 16°C and 21°C. Generally, MR was the lowest at 6°C and more than four times higher at 21°C. It was 24 times more likely for carabid beetles to engage in DGE at 6°C than at 21°C with the cyclic pattern completely absent at 6°C. Continuous pattern was 6 times less likely to occur at 6°C then at 21°C. Cyclic pattern was five times more likely to appeared at 11°C than at 21°C. Our results indicate that changes in MR (related to changes in temperature) are associated with the types of gas exchange pattern employed. The differences are likely to pose constraints in whole animal energy budget that possibly shape carabid beetles life histories along a latitudinal gradient, but also with respect to global change in ambient temperatures.

Keywords: world of change, energy expenditure, breathing patterns, ectotherms

Body composition and mass-scaling of metabolic rate – the *Carabidae* perspective

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The amount of energy directed to storage (e.g. lipids) and skeleton has important implications for survival, growth and reproduction. Assessment of how the mass of these metabolically inert body parts scale with the mass of organisms is important for understanding the origin of mass-scaling of metabolism. Therefore, we measured live body mass, fat mass, lean wet tissue mass, chitin mass and whole animal CO_2 production rate in both sexes of seven species of *Carabidae* beetles (n=258), collected in spring and autumn in southern Poland. Interspecifically, the mass of fat and exoskeleton increased with body mass allometrically (SMA scaling exponents $b_{females}$=0.87 and b_{males}=0.9 for fat, and $b_{females}$=0.83 and b_{males}=0.85 for exoskeleton). Respiration rate also scaled allometrically with live body mass and lean tissue mass (exponents for both sexes ranged from 0.80 to 0.84). At a similar body mass, the mass of exoskeleton differed between seasons ($p<0.001$), males had more fat than females in autumn ($p<0.001$) and this pattern was reversed in spring when females had more fat than males ($p<0.001$). Also, if corrected for body mass, species differed in respiration and the amount of fat and skeleton ($p<0.001$). Finally, difference in scaling exponents of respiration rate when compared against live body mass and lean tissue mass could not be detected. In conclusion, body composition, namely the proportion of metabolically inert to active parts, does not explain the origin of mass-scaling of metabolism and the underlying mechanisms are yet to be discovered.

Keywords: body composition, allometry of respiration rate, allometry of fat and chitin contents.

Carabids as predators of forest pest moths-molecular detection of trophic interactions after carabid gut content analyses

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Predatory carabid beetles are important for regulating the abundance of many pest species in arable as well as in forest ecosystems. Molecular gut content analysis (MGCA) have made further advances in identifying complex trophic interactions that were difficult to identify using traditional methods. So far, the advantages of MGCA have been used primarily to reveal pest species in arable fields, while surveys of trophic interactions between invertebrates in forest ecosystems are rather scarce. In addition, existing data about predation of well known food specialists, such as the caterpillar hunting *Calosoma* beetles, and studies about controlling moth populations have been insufficient. Previous studies in forest ecosystems showed that Lepidopteran insects represent a substantial part in carabids diet. Here we used MGCA to screen the carabid guts for the presence of defoliator, the winter moth *Operophtera brumata,* a severe pest of deciduous trees and shrubs. Of 180 individual carabids, sampled using ground pitfall traps in two forests sites and tested for winter-moth presence in their guts, 10% were positive. The surveyed forests were placed in the edge of the moth distribution, thus higher proportions of detected predations by carabids could be expected at forest sites placed in centre of the *O. brumata* distribution. These preliminary results suggest that carabids could be significant predators of this moth pest in woodland ecosystems and may potentially play an important role in controlling its populations.

Key words: Carabid beetles, caterpillars, winter moth, molecular gut content analyses, soil fauna, forests

POSTER PRESENTATIONS
(in alphabetical order of presenting author)

The role of semi-natural habitats for pest control

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Semi-natural habitats, as part of agroecosystems, have recently been surveyed in terms of ecosystem services they can provide to the cultivated land. We sampled carabid beetles from 3 olive orchards and 3 surrounding woody semi-natural habitats in Tuscany from 2014 to 2015. The aim was to test the contribution of semi-natural habitats for pest control, as mediterranean olive orchards are intensively affected by olive fruit fly *Bactrocera oleae* (Rossi) infestation. We found two main carabid communities, not dependent on management type nor pest presence: one community related to the olive orchards and one to the woods. Surprisingly, the community of the semi-natural habitats was poor in terms of species composition and abundance. We argue that this perennial crop can offer more stable resources (food, shelters and hibernating/estivating sites) in comparison to their woody surroundings. Our results suggest new principles for the conservation of insect biodiversity in cultivated areas.

Keywords: olive orchards, semi-natural habitats, olive fruit fly, ecosystem services

Intraspecific altitudinal variation in body size of several common carabid beetles

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Spatial variation in body size of animals has been investigated for over 150 years. However, studies focused on insects began to appear much more recently and data are available just for a negligible minority of species. The body size is the individual trait that frequently determines other crucial traits. Insect structural body size per se is substantially affected by ambient temperature and food quality and quantity during pre-imaginal development, which suggests that body size could vary due to changes in environmental conditions linked to altitudinal gradient. However, the size and direction of these effects could be species specific and insect body size responses to altitude could range from strongly increasing body size with altitude (Bergmann's rule) to strongly decreasing body size with altitude (Converse Bergmann's rule). The main aim of this study was to detect whether there are any general trends in body size change within altitude in carabid beetles. We also investigated the effect of sex and interaction between sex and altitude on body size of selected carabids. Beetles were collected using pitfall traps installed in two mountain ranges, the Giant Mountains and the Ore Mountains, at elevations of 400m a.s.l., 700m a.s.l. and 1000m a.s.l. At each altitude two sites were sampled (meadow and spruce forest). Carabids that were collected in sufficient number in more localities were measured (elytron length and pronotum width) and their structural body size was calculated using Principal Component Analysis scores. Preliminary results indicate that majority of investigated carabids (*Pterostichus burmeisterii*, *Carabus auronitens*, *P. melanarius, C. linnei, C. silvestris* and *P. oblongopunctatus*) follow the Converse Bergmann's rule, i.e. their structural body size decrease with increasing altitude.

Keywords: Bergmann's rule, converse Bergmann's rule, geographical variation, sexual size dimorphism

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New record of *Calosoma (Campalita) auropunctatum auropunctatum* (Herbst, 1784) in Latvia

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The genus *Calosoma* includes a quite large and diverse group of ground beetles with worldwide distribution. Only 7 species are found in Europe, while 32 species are known for the Palaearctic region. Most of them are rare and sporadically distributed and have status of protected species in many countries. The genus is represented only by two species in Latvia: *Calosoma (s.str.) inquisitor inquisitor* (Linnaeus, 1758) and *Calosoma* (*Campalita*) *auropunctatum auropunctatum* (Herbst, 1784). Both of them are considered to be very rare species in the country. Before this study, *C. a. auropunctatum* had not been reported for almost 165 years in Latvia. The species has been discovered again in Latvia in 2014 and herein we are presenting this new record. The present study was done within the framework of investigations of the prevalence of ground beetles in different types of agrocenoses. The research was carried out for ten localities in the Eastern part of Latvia comprising fields of various crops and systems of management. Ground beetles were sampled with pitfall traps during one season in 10 plots, with a total four weeks period, when traps were exhibited. On the whole, 6967 specimens of 47 ground beetles species were collected in all crops during research. The crop near the Dubna village was one of the richest in the number of collected species. In general, 22 species were recorded for this sampling plot. Three specimens of very rare *C. a. auropunctatum* was found in spring 2014 on the crop field and were captured in the same trap, located at the edge of the plot.

This research was conducted in collaboration between the Daugavpils University (Daugavpils, Latvia), Kahramanmaraş Sütçü İmam University (Kahramanmaraş, Turkey) and Jan Kochanowski University (Kielce, Poland)

Keywords: Coleoptera, Carabidae, *Calosoma auropunctatum*, fauna, Latvia

Effects of genetically modified maize for insect resistance on the composition of the ground beetle populations

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It is estimated that more than 50% of U.S. genetically modified (GM) maize expressed a *Bacillus thuringiensis* (*Bt*)-derived toxin protecting the plant against targeted insect pests. The GM maize containing pesticidal toxins expressed by *Bt* genes - may affect non-target species as well. The effect of different GM maize hybrids sown in various seed mixture rates on the composition of the ground beetles populations may be influenced by trait or by ratio of the isogenic seeds in the seed mixture. Pitfall traps (nine traps per treatment) were used to monitor populations of ground beetles (Coleoptera: Carabidae) in plots of maize grown at Throckmorton Purdue Agricultural Center in 2012. Treatments included transgenic corn expressing a *Bt* proteins Cry 3Bb1 and CRY1Ab (DeKalb DKC 62-54) and Cry34/35 and Cry1F proteins (Pioneer P0916XR) sown in 90 % and 95 % seed mixtures with isogenic lines, DeKalb DKC 62-55 and Pioneer P34R65, respectively. For the control, the isogenic lines with insecticide application grown. A total of 4963 insect specimens were collected from 54 Pitfall traps during 15 weeks. This included 3393 ground beetles representing 31 species (8-15 species per treatment). The most abundant species was *Poecilus (Poecilus) chalcites* (Say, 1823) represented with 3005 individuals (88.56 %) and followed by *Harpalus pensylvanicus* (De Geer, 1774). Results indicate that various traits *Bt* seeds sown in two ratios, 90 and 95 % mixtures with isogenic lines have similar effects on ground beetles species richness and numerousness' as isogenic lines sown alone and treated with insecticide.

Keywords: *Bacillus thuringiensis* (*Bt*)-derived toxin, seed mixtures, *Poecilus (Poecilus) chalcites, Harpalus pensylvanicus*

Taxonomic studies on *Morphocarabus* species in the Pannonian biogeographical region

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The incredible morphological diversity found in members of the Morphocarabus subgenus is a hard nut for taxonomists. The subgenus is very diverse in species, subspecies and has many morphological variations, even in a single population. The taxonomic rank of many species and subspecies is uncertain, because phylogeny based species delimitation could be problematic due to the introgression and widespread hybridization among genealogical lineages. We studied phylogenetic relationships between species and some subspecies of *Carabus zawadzkii, Carabus hampei* and *Carabus scheidleri* populations in the Pannonian biogeographical region using both morphological and mitochondrial DNA data. The relationships were analyzed using both morphological and mitochondrial DNA data (cytochrome c oxidase gene subunit I). Morphology was compared with texture based, digital morphometric analysis techniques. Based on molecular methods not all the described taxa can be identified as a monophyletic group. Our results support the species rank of *C. scheidleri*, and *hampei*, however the species rank of *C. zawadszkii*, and the subspecies rank of the many described subspecies of *C. scheidleri* are questionable. The populations of the latter species and subspecies show continuous transition between traits in many cases implying that they are members of a continuous, extreme diverse morphological group, rather then discrete subspecies. We suggest *C. zawadszkii* to be a subspecies of *C. scheidleri*, and that many other subspecies rank should be merged in a few subspecies.

Keywords: *Carabus zawadzkii, Carabus hampei, Carabus scheidleri,* morphology, mitochondrial DNA data

Epigaeic arthropod assemblages of extensive green roofs in Edmonton Canada: composition and dynamics

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Vegetated ('green') roofs are gaining popularity worldwide, both to increase building efficiency and address problems created by urbanization. They provide urban habitat for natural fauna and flora that can adapt to urban situations, reduce heat island effects and storm water run-off, improve insulation, extend roof lifespan, filter pollutants and heavy metals from air and water, and decrease stress levels of urbanites. We use ground dwelling invertebrates (e.g., carabid beetles, rove beetles, spiders and ants) to determine if green roof habitats in Edmonton, AB, Canada, sustain populations of organisms similar to those of adjacent urban green space, prairie and aspen parkland areas. A first sampling season of six extensive green roofs and four extensively managed ground sites yielded a total number of 18777 invertebrates, among which 1023 were carabids. For most taxa, more individuals were caught on ground sites than on roofs with an overall average of 947 ± 131.7 invertebrates (53 ± 14.6 carabids) per roofs and 2318 ± 431 (118 ± 25.3 carabids) per ground sites. *Agonum cupreum* , *A. placidum*, *Amara patruelis* , *Pterostichus adstrictus*, and *Harpalus laevipes* were commonly caught on green roofs. Most ground beetles from roofs had long wings indicating that frequent colonization by flight contributes to maintaining populations on green roofs. Carabids may use green roofs as itinerant patches in urban environments rather than establishing viable populations on roofs. Interestingly, several species of non-native carabids (e.g. *Pterostichus melanarius*, *Carabus nemoralis*) are almost absent from roofs but dominate the catches in adjacent ground sites.

Keywords: vegetated roofs, ground-beetles, non-native, urbanization

Body Size Differences, Mean Individual Biomass (MIB) and Wing Development of Ground Beetle Communities (Coleoptera: Carabidae) along an Altitudinal Gradient on the Belasitsa Mountain, Macedonia

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Ground-beetles were sampled at 14 localities along an altitudinal gradient, ranging from 250 to 1500 m, in the oak and beech forests on Belasitsa Mountain, South-east Macedonia. Monthly sampling of ground-beetles with pitfall trapping, during the period April-November 2010, yielded 8680 individuals representing 38 species. Different carabid species showed different trends in body size variations with increasing altitude. In the case of several species (e.g. *Carabus convexus dilatatus, Carabus montivagus, Myas chalybaeus, Calosoma inquisitor*) the body size decreased with increasing altitude while the opposite trend was evident in the case of other species (e.g. *Tapinopterus balcanicus belasicensis, Cychrus semigranosus, Trechus quadristriatus, Nebria brevicollis*). However, the parameters on the community level (MIB - mean individual biomass and average body size) showed significant decrease with increasing altitude. MIB decreased from 0.411 g to 0.051 g ($r= -0.725$; $p<0.05$) while average body size decreased from 2.25 cm to 1.05 cm ($r= -0.747$, $p<0.05$). Both parameters were associated with the vegetation type. Larger bodied individuals and higher values of MIB were recorded in the white oak and oriental hornbeam forest stands than in sessile oak forests, as well as in submontane beech forest than in montane beech stands. The majority of large-bodied brachypterous individuals inhabited the lower part of the gradient, corresponding to white oak and oriental hornbeam stands, while small sized, macropterous species predominated in a clear-cut area.

Keywords: ground-beetle community, mountain forests, body size, biomas, wing development,

Group selection harvesting supports the diversity of ground-dwelling carabid and spider assemblages

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Timber-oriented forest management alters heavily the environments threaten the survival of many native species. Recognition of the scale and effects of the forest loss has resulted in a considerable degree of interest in the reforestation. During the reforestation even-aged (modified clear-cutting, seed tree method and shelterwood harvesting) and uneven-aged regeneration methods (group selection and single tree selection) are recommended, because these silvicultural practices could be less intensive and harmful than the conventional clear-cutting method. We investigated ground-dwelling carabid and spider assemblages in windthrows (size of 0.005 ha), gaps harvested by group selection (size of 0.05 ha), clear-cuts (size of 1 ha) and natural mature oak forest stands (size of 5 ha) in the Nagyerdő Forest Reserve Area (Debrecen, Hungary). Carabids and spiders were collected by litter-sifting from spring to autumn in every fourth week in 2014. We assumed that group selection harvesting do not cause considerably changes to the environments and mimics the natural processes (windthrows), while clear-cutting alters drastically the original environmental characteristics. Therefore, we hypothesised that the species richness of forest associated carabids and spiders is the lowest in the clear-cuts, compared to the gaps harvested by group selection, the windthrows and the natural forest stands. The species richness of forest associated carabids and spiders were significantly the lowest in the clear-cuts confirming our hypothesis. Our results demonstrated that group selection harvesting supports the diversity and composition of ground-dwelling carabids and spiders, and therefore we recommend this method during forest management. The study was supported by the SROP-4.2.2.B-15/1/KONV20150001 project.

Keywords: reforestation, clear-cutting, litter-sifting, forest management, diversity

Estimating carabid population size: The relationship between abundance and capture area of pitfall traps

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Pitfall traps are commonly used to sample epigaeic invertebrates, such as carabids, staphylinids and spiders in biodiversity and ecological studies. Such data are useful in comparing the structure of ground-dwelling faunas among sites or before and after impact; however, they do not give accurate estimates of population size. Although comparative data are useful in answering ecological questions, it is of interest to understand how trap captures correlate with population size in a given area. We collected carabid beetles weekly over the frost-free season using single pitfall traps centred within circular enclosures 2.5m, 5m or 10m in radius. Each group of three replicate enclosures was associated with an unenclosed or control trap, for a total of 12 traps. The enclosures allowed us to measure both mean beetle activity in specified proximity to each trap and the time it took to 'deplete' populations within each enclosure size. Overall, we caught nearly 1400 carabids. Average catches were 3±1.9, 1.93±0.77, 0.95±0.55, and 0.73±0.42 carabids/trap/day from controls, large, medium and small enclosures, respectively. Between June 16[th] and July 16[th], number of carabids caught was positively related to enclosure size, and the highest numbers of carabids were caught in controls. Catches in small and medium enclosures fell to near zero after July 16[th] compared to July 21[th] in large enclosures and the control. This supports our hypothesis that carabid catches in pitfall traps are a function of beetle abundance and helps us to better understand how activity, as reflected by carabid catches, varies with carabid density.

Keywords: ecology, sampling methods, epigaeic, beetle activity

Body size distribution in ground beetles (Coleoptera: Carabidae) as a possible monitoring method of environmental impacts of transgenic maize

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Despite the obligatory post-market environmental monitoring of genetically modified (GM) crops in Europe, there are no available standards on methods. Our aim was to examine the suitability of using changes in carabid body size distribution as a possible monitoring method. The sampling was carried out in maize plots during the summer 2014 at Flakkebjerg (Denmark). Carabids were sampled by pitfall traps placed in 10 plots of GM and 10 plots of isogenic maize. The body size distribution was investigated by calculating various measures of size inequality: the Lorenz curve, the Gini and the more informative Lorenz asymmetry coefficients. A total of 6339 carabids belonging to 38 species were captured and indentified. The analysis detected a shift in size distribution between months but no important differences in the assemblages in Bt vs. non-Bt maize plots were found. We concluded that an increasing body size trend from spring to autumn was evident, and the use of a multilevel analysis was important to correctly interpret the body size distribution. Therefore, the proposed methods are indeed sensitive to subtle changes in the structure of the carabid assemblages, and they have the potential to be used during monitoring of the unanticipated environmental effects of GM plants.

Keywords: Lorenz asymmetry coefficient, Gini coefficient, genetically modified maize, monitoring, body length.

Trapped in urban refugia? 'Cityscape' genetics of a flightless ground beetle

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Urbanization leads to changes in abiotic conditions, increased disturbance frequency and habitat fragmentation. Populations inhabiting the remaining green patches in cities are therefore often small and, if the exchange of individuals is also affected, genetically isolated. Especially forests provide an ecosystem with a wide range of habitats for specialized species. However, there might be a difference between forests which existed ever since (with the city growing around it) (ancient forests) and such forest patches that were built in a city after the city was established (recent forests). Using ground beetles as model organisms we studied differently sized and differently-aged within-city-forest-patches in three cities in northern Germany. We analysed 330 individuals of the forest dwelling, flightless ground beetle *Abax parallelepipedus* from 15 forest patches at 13 polymorphic microsatellite loci. We compared the patterns of genetic diversity to species diversity patterns of ground beetles from the studied sites. *A. parallelepipedus* could be detected in all ancient study sites (N=13) but in only three recent forest fragments. We found a strong genetic differentiation between ancient and recent forest fragments. The overall F_{ST}-value was 0.093 indicating a reduced gene flow between the patches. Forest specialist species, many of those with low dispersal abilities, were strongly associated with fragment age: In ancient forests the percentage of forest species was significantly higher. Our data highlight the special importance of ancient forests within cities and point towards a careful conservation and urban planning for these sites.

Keywords: urbanization, species richness, allelic richness, ancient woodlands, *Abax parallelepipedus*

The impact of a rural-urban gradient and spatial distribution on predation rates on sentinel prey in a riparian forest in Hungary

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Measuring predation rates under field conditions is rife with ecological and logistical difficulties. The use of artificial sentinel prey offers a simple and cheap possibility to comparable predation activity in various habitats by various predator groups. This method can replace the classical proxy for predation, the abundance based estimate. We used dummy caterpillars made from green plasticine (SMEEDI PLUS 500 g, medium green (776608)) that were produced with a modified garlic press, and were 3.5 mm wide and 2 cm long. These artificial caterpillars were glued to pieces of litter and placed on the ground, exposing them to predators for 24h. Predator identification was possible by inspecting the different marks left by the mouthparts of attacking predators. The experiments were made in riparian forests near Szeged, southern Hungary, from May to October 2014. We aimed to find out: (1) How big is the predation pressure in this kind of habitat? (2) What are the differences in predation between rural, suburban and urban habitats? (3) What inter-prey distances are necessary for different predator groups that the dummy caterpillars would be independent? We found 17.76% overall predation rate, decreasing from rural to urban habitats (33.5%, 18.29% and 3.91%, respectively). Most of the ground level arthropod predation was related to carabids. We applied variogram analysis to acquire optimal placement distances. According to our results, in case all of the predators (except mammals), 5-10 m distances between dummy caterpillars ensure spatial independence.

Keywords: urbanisation, predation rates, artificial prey, variogram analysis

Chewing insect predation on artificial caterpillars is related to activity density of ground beetles (Coleoptera: Carabidae)

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In cultivated landscapes, predatory arthropods play an important role for pest control. Traditionally, monitoring their effect on pests was done using indirect measures (e.g. characterising predator activity by the numbers of predators caught). However, the contribution of predators to predation is complicated by interactions such as cannibalism, intra-guild predation, and competition. Directly measuring predation is preferred, although ecological and logistical constraints make it difficult. Using artificial caterpillars to quantify arthropod predation is gaining more attention, as model prey are cheap, easy to use, and are informative about predator identity. In a field experiment in Denmark, performed between May and July 2014, we tested the relationship between predation rate measured using artificial caterpillars and the activity density of large (≥15mm) ground beetles collected using pitfall traps in winter wheat (*Triticum aestivum*). Forty-six percent (n=756/1637) of the artificial sentinel prey were attacked after 24 h, mostly by chewing insects (88%, n=665/756), and 1102 carabids with a size of ≥15mm were collected. Ground beetles were also the most common predatory group, followed by spiders and rove beetles (42.3%, 23.6%, and 22.9% of the total, respectively). We found a significant positive relationship ($p<0.001$, $R^2=0.50$) between (log-transformed) activity density of these larger carabids and predation rate. Our results suggest that artificial caterpillars can be used to quantify predation rate by ground beetles, and that the method is partially informative on the relationship between predators and predation.

Keywords: sentinel prey, prey-predator relationship, ecosystem services, functional diversity

A long-term project for spatio-temporal monitoring of carabid species assemblages on Central Italian Alps

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Changes in carabid richness and species assemblages are becoming evident on the Alps, due to climate change effects and anthropogenic activities. We planned a long-term project for monitoring, by pitfall traps, carabid species assemblages distribution and species richness along 12 altitudinal transects (north and south exposed), occurring at altitudes between 770 and 2690 m asl in the Stelvio National Park (Central-Eastern Italian Alps). Each transect was sampled two years consecutively, and the surveys will be repeated every five years. Here, we present the early results obtained after the first year survey (366 analysed traps) with the purpose to provide a first contribute on the species richness found in the Park. Pitfall trapping yielded a total of 17299 individuals representing 70 species. We performed a Generalized Linear Model to test which variables (habitat type as fixed factor; altitude and aspect as covariates; transects as random factor) are able to drive the species richness pattern. Species richenss trend resulted driven by a join effect of elevation and habitat type (both $p<0.0001$), but not by aspect. Specifically, species richness reaches the highest values around 1200 m asl, then decrases. Hay meadows resulted the habitat with the highest mean species richness and variance, while the other habitats did not experience any or few significant differences from each other. The mean elevation of the sampled hay meadows is 1530±280 m asl, thus we suppose that most of the carabid biodiversity along the studied altitudinal transect is influenced by the presence of meadows within in the mosaic ecosystems.

Keywords: altitudinal transects, aspect, habitat types, hay meadows, species richness.

Are carabids and chironomids experiencing similar spatial patterns along a chronosequence of glacier retreat?

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We propose the first study of comparison between the colonisation patterns of carabids and chironomids in relation to the time since deglaciation in a glacier foreland (Vedretta d'Amola, Southern Alps, Italy; 46°13'N, 10°40'E; from 2544 to 2421 m a.s.l.). Carabids were sampled by pitfall traps (summer 2011-2012). Chironomids were collected by kick sampling (summer 2014) in sites located at the same distance from the glacier as the terrestrial ones (within 1.3 km from the snout including the Little Ice Age moraines). The environmental variables recorded were: vegetation cover, gravel percentage, organic matter, pH around the traps; water temperature, discharge, channel stability, suspended solids, conductivity, pH, chlorophyll *a* and organic matter in the stream. We analysed: (i) the effect of time since deglaciation on diversity, (ii) the presence of species turnover along the glacier foreland, (iii) the relationships between species distribution and environmental variables. Ten species of chironomids and nine of carabids were identified. Shannon carabids and chironomids diversity increased progressively with the distance from the glacier but a clear species turnover was observed only for carabids, in association with significant changes in pH, organic matter, and vegetation cover. Conversely, the rather homogeneus environmental conditions characterising the studied stream reach, hinder to trigger species turnover in chironomids. In conclusion, carabids and chironomids experienced similar diversity patterns, but different species distributional patterns in relation to the time since deglaciation.

Keywords: diversity patterns, species turnover, glacier retreating, Italian Alps.

Long-term successional changes of functional diversity in ground beetle communities on post-industrial areas

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Understanding succession is one of the main goals in ecosystem ecology, but very few studies regarding arthropods have actually examined this topic in sufficient detail. Missing are studies that examine the long-term trend of primary succession of arthropods in post-industrial habitats and also the functional consequences of primary succession on arthropods. We used carabids as a model group to investigate the process of primary succession of arthropods on spoil heaps for about 30 years of spontaneous development. We calculated indices of functional diversity, i.e. functional evenness, functional richness and functional divergence. To quantify functional diversity we used these functional traits: wing morphology, habitat preference and humidity dependence. Our results reveal that the main environmental factor determining the community structure of ground beetles is spoil heap age, which is itself correlated with forest cover. Abundances of brachypterous and forest species were positively correlated with successional age. Our results provide evidence that primary succession in post-industrial habitats differs from that in more natural habitats due to the rapid rate of successional changes and their attributes. In particular, abiotic factors are constitutive in comparison to interspecific competition during succession. We assume that constant indices of functional evenness and richness reflect rapid colonization from surrounding habitats. Functional divergence was significantly correlated with increasing proportion of forest species.

Keywords: environmental factors, functional traits, primary succession, spoil heaps

The role of various hedgerow types in shaping carabid and rove beetle assemblages (Coleoptera: Carabidae, Staphylinidae) in meadow dominated landscape

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Fragmentation plays an important role not only in natural habitats, but also shapes the communities in agricultural landscapes. Less intensively managed semi-natural habitats, e.g. hedgerows, are thought to be crucial landscape components for maintaining of biodiversity in highly disturbed intensively managed agricultural landscapes. Majority of knowledge on the role of hedgerows for ground-dwelling arthropods comes from studies performed in landscapes dominated by arable fields. In this study, we focused on effects of three hedgerow types on activity-density, species richness and species composition of carabid and rove beetles recorded by pitfall traps in Central European landscapes dominated by intensively managed meadows. Carabid activity-density was significantly higher in meadows than in hedgerows and within hedgerows their activity-density increased systematically from grassy hedgerows via shrubby hedgerows to woody hedgerows. We found out that recorded species richness of both carabid and rove beetles was not significantly affected by habitat identity (hedgerow or neighbouring meadow) and hedgerow type, but rove beetles tend to be more diverse within hedgerows. Recorded species composition of both investigated taxa was significantly affected by habitat identity and interaction between habitat identity and hedgerow type. Assemblages inhabiting various hedgerow types were more dissimilar each other than assemblages from neighbouring meadows. Hedgerows within grassland dominated landscapes maintain local diversity by hosting different species from these living in surrounding meadows and there were species typical for particular hedgerow type. Our results indicate that hedgerows play important role in maintaining biodiversity either in meadow dominated agricultural landscapes nor in these dominated by arable fields.

Keywords: corridor, grassland, linear landscape structures, habitat preferences, local diversity

Morphological differences between two sister species: *Carabus* (*Eucarabus*) *parreyssi* and *Carabus* (*Eucarabus*) *catenulatus* from Dinaric karst and *body size variations along* altitudinal gradients

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Dinaric karst is considered as one of the most biodiverse areas in Europe because of its rich geological history. The great topographic diversity of Dinaric Mountains combined with habitat diversity contributed to the origin of numerous endemic species during and after the last glacial period. In this study, high-altitude *Carabus (Eucarabus) parreyssi*, endemic to NW Balkan and Alpine-Dinaric species *Carabus (Eucarabus) catenulatus,* geographical and ecological vicariants, were included. The recent phylogenetic analysis confirmed the sister status of these two species. The aims of this study were: comparison of measured morphological traits between the species and its variations with the changing altitude at which the specimens were sampled, and identification of morphological differences between these morphologically very similar species. This study included 274 specimens of *C. catenulatus* and 256 specimens of *C. parreyssi* which were collected in the area of the Risnjak National Park, the Sjeverni Velebit National Park and the Učka Nature Park. Morphological measurements included measuring of 10 morphological features. The analysis of morphological traits and the change of altitude were conducted by appropriate statistical methods (Kruskal-Wallis analysis and Mann-Whiteny U test). The obtained results showed the decrease in body size with increasing altitude for both species. Specimens of *C. parreyssi* were generally smaller in all measured traits. This result is in concordance with the reverse Bergman's rule. Additional studies, including a greater range of distributions and altitudes could allow detection of overlap zones and the possibility of finding out the ways of speciation in this two closely related species.

Keywords: endemic species, morphological traits, altitude

Do lowland and mountainous tiger beetles use the same phenological strategy? An example from the Mediterranean region

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Adult insects have relatively short period of activity. During this time they need to find sexual partner, to mate and oviposit eggs. In case of tiger beetles the air temperature is one of the most important determinants of their phenological activity. The aim of this study was to reveal if lowland and mountain tiger beetle species occurring in the Balkans and Maghreb region use the same phenological strategy. The analyses were done on the basis of literature data (over 100 papers), several entomological collections deposited in few European museums, as well as on personal data collected in most Balkan countries, Tunisia and Morocco. The results show that most lowland tiger beetle species can be characterized by shorter activity of adults, restricted usually only to hot summer period, while in mountainous taxa imagines are active from the beginning of spring to the end of summer.

Keywords: Coleoptera, Cicindelinae, Balkan Peninsula, phenology

Females are larger but males have bigger mandibles – sexual dimorphism in Balkan tiger beetles

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Sexual dimorphism of eight Balkan tiger beetles was studied: *Calomera littoralis nemoralis*, *Calomera fischeri fischeri*, *Cephalota circumdata circumdata*, *Cephalota chiloleuca*, *Cylindera trisignata trisignata*, *C. t. hellenica*, *Cicindela sahlbergi albanica*, and *Myriochila melancholica melancholica*. Biometrical studies were conducted on at east 60 individuals of each taxon (min. 30 ind. per sex). To study the morphological differences between sexes seven body parameters were measured: total body length, elytra length, maximum elytra width, maximum pronotum width, length of head, width of head, and right mandible length. Results of the investigations clearly indicate that in all studied Balkan tiger beetle females have longer and wider bodies than males. Only in case of mandible length males are characterized by higher magnitudes. It can be explained by the role of mandibles – males use them not only to catch and cut the preys but also to grasp female during copulation.

Keywords: Coleoptera, Cicindelinae, Balkan Peninsula, sexual dimorphism

Spatial diversity in the genus *Carabus* in extensive cultural landscape of Goričko Nature Park (NE Slovenia)

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Nature Park Goričko lies in outermost NE part of Slovenia and is 462 km^2 large extensive cultural landscape area characteristic for medium-humid to semi-dry meadows and wood fragments of Beech *(Fagus sylvatica)*, Pedunculate Oak *(Quercus robur)*, Chestnut *(Castanea sativa)* and Scotch Pine *(Pinus sylvestris)*, and holding middle European type of fauna and flora. In 2006 we sampled carabids using pitfall traps at 167 points scattered systematically over the area, where 10 pitfall traps were set per point. All together 12 species of genus *Carabus* were found, what was calculated also as a saturation point for total number of expected species of this genus according to species accumulation curve. The dominant species were *Carabus glabratus* and *C. intricatus*, which are rare species in Slovenia, but here had shown equable distribution pattern, while some species has shown distinct clumping distribution pattern, i.e. *C. germari* and *C. (variolosus) nodulosus*. We analyzed habitat segregation patterns between species and used that data for spatial habitat suitability modelling. Model was later used for zonation of each species of genus *Carabus* in the Goričko Nature Park.

Keywords: *Carabus*, cultural landscape, species diversity, spatial distribution models, NE Slovenia

The effect of inundation frequency on ground beetle communities in a channelized mountain stream

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European river floodplains are among the most endangered landscapes due to human modifications to river systems. Situated in a transition zone between terrestrial and aquatic environments, exposed riverine sediments (ERS) play a key role in the functioning of riverine ecosystems. This study aimed to verify whether the bare granular substrate is the only factor responsible for sustaining the ERS ground beetle communities. The study was carried out in Porębianka, a Polish Carpathian stream flowing through both unconstrained channel sections and sections with varied channelization schemes (rapid hydraulic structures, concrete revetments or rip-rap of various age). In each of the distinguished channel types, four replicates of 10 pitfall traps were established in three rows varying in distance to the mean water level (at three different benches). Principal component analysis of environmental factors indicated two main gradients: inundation frequency and channel degradation (incision). Non-metric multidimensional scaling showed significant relation of species composition to both the PCA axes. Total biomass of ground beetles and mean individual biomass differed significantly between sites of various frequency of inundation, whereas the variation in assemblage abundance and species richness was not related to the river dynamics. Our results also demonstrated that the presence of ERS does not change the structure of ground beetle communities if the frequency of inundation of river banks is reduced. This study indicated that not only habitat parameters but also biotic interactions between competing species from a regional pool are important for the conservation of riverine communities.

Keywords: river channelization, exposed riverine sediments, Carabidae, incision, redeposition

Life-history traits of ground beetles (Coleoptera, Carabidae) on postindustrial areas of slag deposition

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Land rehabilitation of the postindustrial areas is the most important direct management practice allowing to return the given area to former state. In thermal electric power station industry, the waste deposition of slag requires large areas of sediments which should be recultivated to create functioning ecosystem. The aims of the project were to estimate the influence of re-cultivation on ground beetles life traits on postindustrial areas. Within a replicated controlled re-cultivation experiment, five localities of pitfall traps were established in re-cultivated tree zone and not re-cultivated open grasslands as well as reference sites of similar environmental demands outside the sediments. Carabid beetles were classified to four life history trait categories: body size (according to classes: small < 8mm, medium: 8-18 mm, large > 18 mm), feeding strategy (predators, herbivores), breeding type (autumn and spring breeders), wing development (brachypterous, hemipterous, macropterous). Generalized linear model showed significant decrease of large brachypterous carnivores with autumn breeding strategy abundance on post-industrial areas in relation to reference sites. The only life trait parameter which is preferred on slag deposits is the herbivore feeding strategy. Similar pattern of sensitive life trait distribution was indicated on both re-cultivated and not re-cultivated treatments. Our results showed that provided re-cultivation procedures related only to trees plantations does not guarantee the successful recreation of functioning and stable ecosystem.

Key words: slag deposition, re-cultivation, ground beetle, life traits

Influence of mowing measures on carabid beetle fauna (Coleoptera: Carabidae) in a post-agricultural area

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Carabid beetles were collected on post-agricultural fallow land in Western Poland in order to study the impact of mowing treatment. Therefore, following a BACI study design, over the period of two years (2013-2014) standard arrays of pitfall traps were installed on six study sites, of which three were treated by mowing in the second year of study. The influence of this treatment was analysed statistically with respect to individual species as well as the mean individual biomass of the carabid assemblages (MIB). Additionally, an indirect gradient analysis (CA) was carried out. A total of 1995 individuals belonging to 40 species were collected, with species numbers ranging from 11 to 21 and numbers of individuals ranging from 76 to 278 individuals in the samples. In generally, rather weak effects as result of the mowing measures were observed. However, some species reacted significantly on the mowing treatment. The results of the study are assumed to be useful in the context of planning mowing measures in order to conserve biological diversity.

Keywords: BACI, fallow land, MIB, management

Formation of ground beetle assemblages on gyttja soils depending on the selected physicochemical factors in these soils

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Gyttja soils are unusual soils occurring in Poland and in the eastern and central part of Europe. The peculiarity of these soils is an extremely high content of calcium carbonate, which is the major soil substrate and also extreme moisture conditions caused by partial or total flooding. Calcium gyttja is specific bedrock with variable characteristics. Dry gyttja is a silty clay and warm formation, while with increasing moisture it becomes clammy and pasty. Unusual nature of these soils creates different conditions for plant development and thus for the accumulation of organic matter and the presence of insects associated with the soil. Ground beetles, due to high sensitivity to changing habitat conditions are good indicator organism to tracing how the selected physicochemical factors in gyttja soils may affect the changes in the structure of their communities. The study was conducted in 4 sites with gyttja soils, located on an extensively used meadow (M1, M2), on a waste wetland (W1, W2) and in 2 control meadows (C1, C2) also located on hydrogenical soils. Field studies were conducted in two stages in order to identify soil conditions and determine the present Carabidae. As a result of the conducted study statistically significant differences in the number of caught specimens and species were observed. The NMDS analysis grouped separately ground beetles assemblages in studied meadows and in the wetland. Based on the CCA analysis, the factors which affected the most the formation of Carabidae communities among the study factors were: pH of the soil, content of $CaCO_3$ and soil volumetric moisture content.

Keywords: Carabidae, gyttja, meadows, wetlands

An effect of different systems of plant protection on carabid beetles assemblages in pea and lupine crops.

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The use of plant protection products causes a lot of controversy all the time. They affect both the plants and the environment. Although much progress is visible in the field of plant protection products, expressed, among others, in the increasing of selectivity, faster degradation, as well as the use of integrated crop protection programs, but we still need to monitor the environment, particularly in terms of beneficial entomofauna occurring there. Epigeic carabid beetles (Col. Carabidae) are potential enemies of plant pests. In this study, indirect infuence of chemical protection in integrated pea and lupine cultivates on carabids was researched. Obtained results were compared with an organic fields. The study was conducted in Winna Góra near Środa Wielkopolska in Poland from May to July during three years (2006, 2010 and 2014). Two fields every studied year in each cultivate were selected: organic and integrated. The surface of each field was 0.46 ha. Ten Barber traps were placed on each field. As a result of study statistically significant differences in the number of caught specimens were observed. Most frequently occurring species were *Harpalus rufipes* and *Poecilus cupreus*. The factors having the greatest impact on the assemblages of ground beetles was the use of insecticides and herbicides.

Keywords: ground beetles, crop protection, cultivates

Impact of clear-cut harvesting on functional diversity of carabid beetles (Coleoptera: Carabidae)

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Clear-cut harvesting changes forest habitat structure and affects the diversity of forest taxa. The magnitude of such disturbance on forest communities is commonly assessed by comparing unharvested and harvested sites using classic biodiversity indexes, such as species richness or relative abundance of species. In recent years, however, the focus of biodiversity studies on disturbed ecosystems has shifted towards the use of new diversity proxies that better account for the functional complexity of communities. Functional diversity, for example, represents a range of life-history traits, such as body size, behavior, trophic role or reproductive strategies in a community, and is directly correlated with important aspects of ecosystem regulation and function. Empirical evidence shows that high functional diversity corresponds high community resilience and resistance to disturbance. Because functional diversity is influenced by habitat structure, changes in environmental conditions can alter type and frequencies of functional traits expressed in a community. Characterizing functional diversity under various disturbance regimes can show how shifts in habitat structure related to human activities influence ecosystem function. In this study we test how changes in environmental conditions subsequent to clear-cutting impact functional diversity of carabid beetles. We test two hypotheses: (1) the main components of functional diversity (Functional Richness, Functional Evenness and Functional Divergence) change significantly for carabids after clear cut harvesting; and (2) post-harvest habitat conditions act as a filter for functional traits, altering their relative frequency and selecting for specific traits.

Keywords: forest management, functional diversity, forestry, boreal forests

Influence of forest carbon stock on carabid beetle diversity in boreal forests of west-central Alberta, Canada

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Boreal forests support biodiversity of several taxa that are affected by forest management and other resource extraction activities. Diversity of these taxa is limited by the type and amount of resources available to them. Among these, carbon stored as above ground biomass (AGB), both in living vegetation and in decaying coarse and fine wood material, is strongly associated with biodiversity. Empirical evidence suggests that increases in AGB are directly related to increase of resources and ecological niches available for primary consumers, such as grazers and saproxylic arthropods, and consequently, for higher trophic levels. Relationships between components of AGB and carabid beetle diversity is poorly understood; however, understanding this correlation is fundamental to ensure the persistence of functioning litter communities in managed boreal ecosystems. We explored relationships between forest AGB and carabid beetle, and partitioned the relative influence of the living and decaying portions of AGB in forests recovering after industrial harvest.

Keywords: AGB, biodiversity, forestry, boreal forests

Morphological variation of shape and size of the *Pterostichus melanarius* population in intensive sugar beet production

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Agricultural landscapes are increasingly being simplified and undergo frequent and intense disturbances such as harvest and the input of chemicals; these factors have been postulated as contributing to failed establishment of natural enemies and biological control programmes. The breeding of sugar beet using intensive agricultural techniques and the frequent application of pesticides has long-term negative impact on the entomofauna in the lower layer of the soil. Carabid beetles are polyphagous predators that can act as biological control agents of insect pests and weeds. The abundance of carabids in crop fields has been positively correlated with prey removal rates and with a reduction of crop damage by various agricultural pests. Agricultural practices in sugar beet production often create a polluted environment, which generates different degrees of stress in insects. Previous research suggested that degrees of phenotypic disturbances reflect the ability of an individual to overcome the effects of stress. We examined the effects of insecticide application on carabids population in the cultivation of sugar beet in different crop rotation: (i) sugar beet field; (ii) corn field (sugar beet before 2 years); (iii) wheat (sugar beet before 1 year); (iv) oilseed rape (sugar beet before 3 years). This intensive agricultural production should generate different degrees of disturbances in the insect communities, whose effects can be quantified by geometric morphometric techniques. We analysed morphological differences in males and females of *Pterostichus melanarius* (Illiger, 1798) and estimated how morphological variation and sexual dimorphism may be affected by intensive agricultural production.

Keywords: carabids, insecticides, sugar beet, geometric morphometric

Communities of beetles (Coleoptera: Carabidae) on landfills

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Landfills are currently the most common method of waste disposal. The landfill‘s chemical composition can have a negative impact on the environment and pose a risk to the ecosystem. However, for many animal species, landfills represent a rich source of food and also living space with suitable conditions for reproduction as well. The research was conducted from April to November 2014 in northern Slovakia. We followed the impact of environmental degradation on the species diversity of beetles in different types of landfills and six reference areas: landfills for inert construction waste, landfills for municipal waste, reclaimed landfills and illegal landfills. A total of 31 species of ground beetles (Coleoptera, Carabidae) were recorded in the pitfall traps. I found a greater diversity and abundance of carabid beetles in the municipal landfills than in the reference areas. However, the abundance and diversity in a landfill with construction waste were lower than the reference area. I conclude that landfills for municipal waste are attractive for beetles, apparently because of more food availabile.

Keywords: landfills, diversity, municipal waste

Can successional carabid beetle assemblages be discriminated from their life-history traits? A study case from an Alpine glacier foreland

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Retreating glaciers expose large areas of pristine ground left open for colonisation of various carabid species; in addition, debris-covered glacies (DCGs) are suitable habitats for carabids. These habitats offer unique opportunities to study the life-history traits of carabid species along a primary succession and in harsh environments.We investigated the life-history traits of the carabid assemblages living on the Vedretta d'Amola DCG (Central-eastern Italian Alps) and along its glacier foreland. We (i) hypothesized that succession is reflected by shifts in life-history traits, (ii) described the life-history traits belonging to the species living on the glacier, and (iii) tested whether functional diversity increased with the age and structural complexity of the successional stage. DCG hosts a typical walking coloniser (*Nebria germari*), and olfactory and nocturnal predator with surface running larvae (mainly observed under the stones located on the glacier). In early-successional stages, species assemblages were dominated by species well adapted to life in flooded habitats due to the presence of meltwater; these were usually winged and olfactory-tactile predator species, with surface-running larvae. In late- and mid-successional stages, all larval hunting strategies were represented, with a dominance of surface-walkers; adults were mainly wingless, and there were both visual-olfactory-tactile predators and omnivorous species. In general, functional trait types increased from early- to late-successional stages due to higher habitat complexity. Successional carabid assemblages can be discriminated based on their life-history traits and this approach offers the opportunity to increase the knowledge of the ecological features of carabid species assemblages in harsh environments.

Keywords: chronosequence, glacier foreland, primary succession, species traits.

Long-term dynamics of the demographic structure and spatial distribution of local ground beetle populations in a mosaic of floodplain meadows

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In 2006-2008, the dynamics of the demographic structure of local ground beetle populations were studied in floodplain meadows of Pra River, Ryazan Area, Russia. Beetles were trapped in nine natural habitats differing in the inundation regime which ranged from high- (three variants), via middle- (two variants), to low-level (four variants) meadows. Plastic pitfall traps of 0.5 l capacity (Ø 95 mm) with 4% formalin as a fixative were used. In each habitat, ten traps were set along a transect at 10 m intervals. During the period of observation, more than 52,712 specimens of Carabidae belonging to 142 species were collected. Among them, 49 species (35%) were residents at least for one year at least in one of the habitats; 57 species (40%) were recorded only as sporadic, while 36 species (25%) were recognized either as sporadic or migrants. Only *Poecilus versicolor* was resident in all habitats during all three years of observation. Two species, *Carabus granulatus* and *Pterostichus melanarius*, were residents in seven and six habitats, respectively, during the whole study period. The range of inter-annual variation in the number of residential habitats for individual species owing to changes in air temperature and flood stage could reach 1.5-3 times. Despite this, the ordination of communities according to the list of residents appears to be more adequate than that according to a full species list. In *P. melanarius* and *Harpalus rufipes*, inter-annual variations in life cycles from annual to facultative and then to obligate biennial were observed.

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Keywords: floodplain meadows, ground beetles, local populations, demographic structure, residents

Mite infection of *Carabus violaceus* in lowland oak forest fragments

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We investigated the mite (*Acari: Mesostigmata*) infection of *Carabus violaceus* (*Coleoptera: Carabidae*) in rural and urban habitats in and around Debrecen city, Hungary. We collected *C. violaceus* by live-capture pitfall traps and preserved them frozen. We sorted mites from the host beetle and preserved them in alcohol. We trapped altogether 199 *C. violaceus* individuals: there were 101 individuals from the rural area and 98 individuals from the urban one. Total mite sample consisted of 250 individuals representing two species (*Poecilochirus carabi* and *Macrohales glaber*). We found 224 mite individuals on *C. violaceus* in the rural habitat, and 26 mite individuals on *C. violaceus* in the urban habitat. We hypothesized that the prevalence and mean intensity of mites (*Mesostigmata*) should be higher in the rural habitat than in the urban one. The *P. carabi* and *M. glaber* (*Mesostigmata*) species feed on Diptera eggs and first stage larvae, and use the beetles for transfer. Thus, the prevalence and mean intensity of these species depend on the number of Diptera individuals rather than the viability of *C. violaceus*. Our result showed that the prevalence and mean intensity of *M. glaber* and *P. carabi* were higher in the rural habitat, than in the urban one. Our results showed that the disturbance (urbanization) decreased the number of mesostigmatic mite species in the urban forest patches. The study was supported by the SROP-4.2.2.B-15/1/KONV20150001 project.

Keywords: urbanization, prevalence, Mesostigmata, live-capture traps

Recovery dynamics of ground-dwelling arthropods after reforestation

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Recovery dynamics of three groups of ground-dwelling arthropods differing mobility and trophic level were studied after reforestation with native oak: 1) ground beetles (Coleoptera: Carabidae) that are good colonisers and generalist predators or polyphagous feeders , 2) rove beetles (Coleoptera: Staphylinidae) that are good colonisers using a variety of food resources (decaying material, pollen, fungi, algae), and 3) millipedes (Myriapoda: Diplopoda) that are poor colonisers with detritivorous or saprophagous feeding habits. We compared pitfall catches among mature (130 year-old) oak forest, areas of the following ages that had been reforested: recently established (5 year-old), young (15 year-old), and middle-aged (45 year-old). There were no significant differences in carabid species richness or number of forest associated species once canopy closure began 15 years after reforestation. In contrast, overall species richness of rove beetles had not recovered after 45 years of reforestation, although number of forest associated species did not differ significantly between mature oak forest and the 45 year-old forest. Neither overall diversity of millipedes nor number of forest associated millipede recovered to that of mature forest, in even the oldest reforestation. We suggest that recovery of ground-dwelling assemblages depends on mobility and feeding habits of the particular taxa. Carabid and rove beetles should recover quickly after forest management that does not alter the basic edaphic and environmental conditions in reforested stands or the array of microhabitats required by specialist species. Prospects for recovery of the millipede fauna remain more uncertain. The study was supported by the SROP-4.2.2.B-15/1/KONV20150001 project.

Keywords: clear-felling, ground beetles, millipedes, rove beetles, silvicultural cycle

The ground beetles (Coleoptera) in the entomological collection of Andrija Hensch

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The entomological collection of A. Hensch, a regimental physician and entomologist (1857-1930), assembled mostly in the area of the former Austro-Hungarian Monarchy, is one of the largest collections in Croatia and includes over 80,000 specimens of insects. The collection is included in the List of Important Entomological Collections of the World, but some parts of it and some of the ground beetles have not been scientifically analyzed. The Hensch Collection includes about 20,000 specimens of beetles, but the exact number of individuals and species of ground beetles has not been published. After a revision of the Hensch ground beetles collection, a list of species adjusted to the recent classification presented in the Lobl & Smetana catalogue (2003) was made. In the list are specially designated species included on the Red List of Ground Beetles of Croatia and species that are not listed for the Croatian territory in the relevant catalogue. A total of 4,122 specimens of ground beetles have been inventoried, and a detailed list of the species will be given in the paper. Results of this revision will be useful for future research into the ground beetles of the Palearctic region.

Keywords: Carabidae, Hensch Collection, inventory

Diel activity of carabid beetles

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Carabid beetles are active during various periods of the day, and their activity is species-specific. Despite the fact that carabids are a popular subject of study, their diel activity has not been studied well enough and available data are often contradicting. In this paper we studied the diel activity of ground beetles in four agricultural habitats that differed with plant density, testing the hypothesis that the structure of vegetation can modulate the circadian rhythms of arthropods. Diurnal activity was monitored using time-sorting pitfall traps, which can split the daily capture into 12 two-hour intervals. Field experiments were carried out during a total of nine periods from June to September 2014, when traps were always run for four days. The data were then processed using the methods of circular statistics. The most abundant species in this study was *Pseudoophonus rufipes*, which was significantly more active at night, but the peak hours of its activity differed according to the site (type of vegetation). We found prominent diel activity patterns in several other carabid species. The diel activity data for some of these taxa are the first available in the literature. Supported by the grant LH12210 of the Ministry of Education, Youth and Sports of the Czech Republic awarded to PS.

Keywords: diurnal rhythmicity; pitfall traps; vegetation; circular statistics

Different responses of epigeic beetles to heavy metal contamination depend on functional traits at the family level

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Beetles are the most diverse group of animals in the world, with various functions in all types of terrestrial ecosystems. The aim of the paper was to propose a simple method for evaluating the functioning of forest ecosystems on the basis of changes in life traits of beetles along a gradient of heavy metal contamination. A total of 16 families of beetles (32100 individuals) were recorded in 18 sample-sites (rows of pitfall traps), along a zinc-contamination gradient (166-3.957 mg/kg dw) in two consecutive years. NMDS ordination analysis indicated a tendency towards differentiation of beetle families between contamination levels (ANOSIM comparison). SIMPER analysis confirmed that three groups (Geotrupidae, Carabidae and Silphidae) were more abundant on reference sites, whereas weevils (Curculionidae), representing herbivores, and small-sized predators of the rove beetles (Staphylinidae) were more abundant on heavily contaminated sites. A generalized linear model showed that pollution class and season were responsible for most of the variation of their abundance. Our results indicated that beetles identified to family level are good indicators of heavy-metal concentration. They can accumulate a large amount of pollutants that reduce their survival rate and may also be good indicators of ecological processes such as impoverishment of food-web chains and reduced decomposition rates. Moreover, simple methods of sampling and taxonomic identification, as well as variation in life traits along a disturbance gradient, make it possible to obtain valuable information on the condition of forest ecosystems contaminated by heavy metals.

Keywords: beetles, ecological indicators, heavy metals, functional traits

Interspecific interactions structuring the species composition of carabids

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In carabidology, a crucial question whether the populations of various carabid species sharing the same habitat in a particular time could be regarded as an assemblage or a community. The organisms living in a community interact with one another through trophic and spatial relationships, and affecting each other's abundance, distribution, adaptation, and existence. These interspecific interactions like concurrence or competition are among the basic elementary processes that influence species abundances and the community composition and organization. Without interspecific interactions, species composition in a community is determined only by simple chance rule; therefore, whatever species combination from the species pool can be occurred (neutral model of community structure). Contrarily, in a real community in which interspecific interactions are the main forces structuring the species composition, particular species combination cannot be occurred (real or non-neutral model of community structure). Using pitfall trapped carabid data from an oak-hornbeam forest stand we compared the number and the diversity of species compositions of the real data set with those of the random resampling from the real data set. At all studied spatial scale both the number and the diversity of species combinations from the real, pitfall trapped carabid data set were considerably lower compared to those from the randomly resampled data set. Our result suggests that the studied coexisted carabid species exhibit non-random co-occurrence patterns, therefore they constitute a community.

The study was supported by the SROP-4.2.2.B-15/1/KONV20150001 project. The project has been supported by the European Union, cofinanced by the European Social Fund.

Keywords: community, co-occurrence pattern, species combinations, neutral model

Latitudinal Variation of Body Size in Ground Beetles (Coleoptera, Carabidae): the Case of Intraspecific Study

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Comparative studies show that arthropod species feature a range of relationships of body size with latitude within species. Both Bergmann size clines, showing increased body size at higher latitudes and converse Bergmann clines, showing decreased body size at higher latitudes are about equally common. We studied body size variation in six species of Carabids –*Carabus granulatus* L., 1758, *Carabus cancellatus* Ill., 1798, *Carabus hortensis* L., 1758, *Pterostichus melanarius* Ill., 1798, *Pterostichus niger* Schall., 1783, *Poecilus cupreus* L., 1758. Beetles were sampled in different parts of their areas beginning from 45° till 58° N and from 41 ° till 87 ° E. In each region beetles were sampled in different types of habitats - natural biotopes, cities, suburbs and agrilandscapes. Then morphometric analysis was reformed. All measurements were made with a Leitz RS stereoscopic dissecting microscope at a magnification of 10 diameters, using a calibrated ocular grid with a scale interval of 0.1 mm. For each of specimens six variables were measured, including: elytra length and width, pronotum length and width, head length and distance between eyes. All dimensions (in millimeters) were $\log_{10}$ transformed to ensure normality. Data sets for each species were formed and we used linear models to reveal how different environmental factors affected morphometric traits. The models like those gave the possibility to identify the influence of each factor in its range. In presented paper we discuss the contribution of latitude to the carabids different organs size variation. We found that elytra, pronotum and head in the certain species of carabids could vary in differing directions in latitude gradient. In the whole *C. granulatus* followed Bergmann's rule, *P. cupreus* – converse Bergmann's rule. In *C. cancellatus, C. hortensis and P. melanarius* the number of cases which followed direct Bergmann's clines, converse ones and non-significant shifts were equal. *P. niger* - didn't show any clines at all. Our results confirmed conclusions of researchers in body size variation in latitude gradient that studies that were too geographically broad, such as over multiple continents—or too small, such as a single city, tended to miss the real patterns behind the insect sizes. We conclude that studies of "Bergmann's Rule" should focus within species and look at widespread but contiguous populations to account for all sources of variation while minimizing error.

Keywords: morphometric variation, body size, latitude gradient, Bergmann rule, Carabidae

The effects of fragment size and isolation on carabid and spider assemblages in dry sandy grassland fragments

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Habitat fragmentation and isolation are major threats to biodiversity in natural and semi-natural habitats. Due to the increase of intensity of agricultural activities and abandonment of the traditional management practices grasslands are one of the most threatened habitat types. Rules of island biogeography suggest that the species richness increases with the size and decreases with the isolation of habitat fragments. We tested these rules on ground-dwelling arthropods in sandy grassland fragments. Ground beetles and spiders were sampled in eight differently sized and isolated dry sandy grassland fragments in the Nyírség region of the Great Hungarian Plain (Eastern Hungary). Contrary to the classical island biogeography theory, we found a significant negative relationship between the total number of ground beetle and spider species and the grassland size. However, the ratio of grassland specialist ground beetle and spider species increased with fragment size. The total number of ground beetle species increased as the isolation of fragments increased, while there was no significant relationship between the total number of spider species and the isolation of fragments. The ratio of grassland specialist spider species decreased with the increasing of isolation, while there was no statistically significant relationship between the isolation and the ratio of grassland specialist ground beetles. Based on our results, to conserve the grassland specialist arthropod species, the large and least isolated grassland fragments should be preserved and the adjacent croplands of the heavily fragmented and isolated grassland patches should be restored. The study was supported by the SROP-4.2.2.B-15/1/KONV20150001 project.

Keywords: fragmentation, island biogeography, species richness, grassland specialist

Contribution to the knowledge of *Badister* (Coleoptera: Carabidae, Licininae) species in Baltic countries

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The aim of our study was to find proper morphological characters which could be used for faithful identification of "problematic" species of the genus *Badister* and re-exam material of the genus from Baltic countries: Estonia, Latvia, Lithuania, and Kaliningrad region. We found that such species as *B. dilatatus*, *B. collaris,* and *B. peltatus* could be faithfully distinguished by structural features of male and female genitalia and by microsculpture of frons. Other sibling species, *B. bullatus* and *B. meridionalis,* could be well distinguished by microsculpure of elytra. During the study a total of 741 specimens from above mentioned countries were examined. We found that four species (*B. bullatus*, *B. unipustulatus*, *B. lacertosus* and *B. dilatatus)* are distributed in all Baltic countries. After re-examination of the material from Estonia we found that *B. meridionalis* and *B. peltatus* were erroneously identified as *B. bullatus* and *B. dilatatus* respectively. Four species - *B. peltatus*, *B. collaris*, *B. dorsiger* and *B. sodalis* - were additionally confirmed for Latvia. For Lithuania was additionally confirmed *B. meridionalis*; however distribution of this species in Estonia, Latvia and Kaliningrad Region was disproved.

Keywords: *Badister*, Baltic countries, identification, distribution.

Exploring the database of pitfall sampling in the Netherlands – A fauna study.

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During 40 years a database was built up of all carabidological sampling schemes carried out in the Netherlands since 1950. The database consists now of over 4200 year samples and 1500 short-term samples, from more than 1500 localities all over the Netherlands, covering 18 biotopes. In 65 years, in total about 3.5 millions specimens were collected from about 300 species. From many, but not all, sites we have detailed descriptions and/or photos. The data will be used for analyzing the Dutch ground beetle fauna of all 18 recognized biotopes in a standardized way with respect to species' diversity, turn-over of species and trends in fauna composition and also to habitat size, isolation and fragmentation. From species' point of view, we will do an attempt to make a better habitat classification for all species with sufficient data. From methodological point of view we hope to get a better insight in the pitfalls of pitfall sampling. Is this method useful or useless, or something in between? The result will be presented in a book and some striking issues maybe in separate papers.

Keywords: methods, pitfalls, year samples, diversity, ecology

Does life in caves reduce the diversity of chemicals produced by the pygidial glands of carabids?

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Carabids have paired pygidial glands in the abdomen that produce a great diversity of chemicals. Adults of three cave-dwelling (both troglophilous and troglobite) ground beetles from southeastern Serbia were induced to discharge secretions of the pygidial glands into vials. Extraction with dichloromethane was used in order to obtain the secretions, and the compounds were identified by gas chromatography-mass spectrometry (GC-MS). The aims of the study were to identify the chemical contents of the released compounds, to check whether the underground way of life had influenced both composition of the secretions and the number of the pygidial chemicals, and to search for possible new compounds that have not previously been reported in Carabidae. Totally, 42 compounds were identified. *Pheggomisetes ninae* contained 32, *Laemostenus* (*Pristonychus*) *punctatus* 13, while *Duvalius* (*Paraduvalius*) *milutini* had nine glandular compounds. Caproic, oleic, palmitic and stearic acids were present in the samples of all analyzed species. Heptacosene and nonacosadienes were predominant in the pygidial extract in *P. ninae*. Undecane was the major component in the secretion of *L. punctatus*. The most abundant compound in *D. milutini* secretion was palmitic acid. The adaptation to underground life did not lead to a reduction or changes of chemical defense mechanism in all analyzed Platyninae and Trechinae taxa.

Keywords: Carabidae, Platyninae, Trechinae, cave-dwelling insects, gas chromatography-mass spectrometry (GC-MS).

On two new high-altitude *Omphreus* subspecies (Carabidae: Harpalinae: Omphreini) from the Dinaric Alps (western Balkan Peninsula)

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The genus *Omphreus* Dejean, 1828 consists of three subgenera: *Omphreus* s. str., *Neomphreus* Winkler, 1933 and *Paromphreus* Ganglbauer, 1887. The genus belongs to the monotypic tribe Omphreini. All specimens of the new *Omphreus* subspecies were collected by pitfall traps. The following two new subspecies, *Omphreus* (*Omphreus*) *morio sandeli* Ćurčić & Sciaky, 2015 (from Mts. Zelengora and Maglić, eastern Bosnia and Herzegovina) and *O*. (*O*.) *morio durmitorensis* Ćurčić & Sciaky, 2015 (from Mt. Durmitor, northwestern Montenegro), are recently described and diagnosed. The male and female genitalia and other taxonomically important morphological characteristics were used for separating the taxa. The new subspecies are morphologically compared with two most related subspecies of *Omphreus* (*Omphreus*) *morio* Dejean, 1828. These are *O*. (*O*.) *morio beckianus* Ganglbauer, 1888 and *O*. (*O*.) *morio serbicus* Winkler, 1933. The new subspecies are distinctly different from the nearest relatives and represent both endemics and relicts inhabiting limited high-altitude Dinaric areas in Bosnia and Herzegovina and Montenegro (western Balkan Peninsula). Currently, the genus *Omphreus* contains 18 species and 15 subspecies inhabiting the Balkan Peninsula and Asia Minor. A detailed study of all *Omphreus* taxa is necessary in order to define their real taxonomic status (subspecies or species).

Keywords: Carabidae, Harpalinae, *Omphreus morio*, soil-dwelling fauna, ground beetles

Seven new troglobitic species of the genus *Duvalius* Delarouzée, 1859 (Coleoptera: Carabidae: Trechinae) from Eastern and Southeastern Serbia

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Seven new troglobitic trechine ground beetle species of the subgenus *Paraduvalius* Knirsch, 1924 (genus *Duvalius* Delarouzée, 1859) have been recently described from caves in Serbia. Five of them inhabit underground habitats in the eastern part of the country: *Duvalius* (*Paraduvalius*) *trifunovici* Vrbica, S. Ćurčić, Antić & B. Ćurčić, 2013, from the Mandina Pećina Cave, Kučajske Planine Mts., *D.* (*P.*) *rtanjensis* Vrbica, S. Ćurčić, Antić & B. Ćurčić, 2013, from the Golema Porica Pit, Mt. Rtanj, *D.* (*P.*) *bogovinae* S. Ćurčić, Vrbica, Antić & B. Ćurčić, 2014, from the Bogovinska Pećina Cave, Kučajske Planine Mts., *D.* (*P.*) *beljanicae* S. Ćurčić, Vrbica, Antić & B. Ćurčić, 2014, from the Velika Atula Cave, Mt. Beljanica, and *D.* (*P.*) *petrovici* S. Ćurčić, Vrbica, Antić & B. Ćurčić, 2014, from the Resavska Pećina Cave, Kučajske Planine Mts. Additional two new species live in cave habitats in southeastern Serbia: *D.* (*P.*) *milutini* S. Ćurčić, Vrbica, Antić & B. Ćurčić, 2014, from the Samar cave system, Mt. Kalafat, and *D.* (*P.*) *sotirovi* S. Ćurčić, Vrbica, Antić & B. Ćurčić, 2014, from the Ogorelička Pećina Cave, Svrljiške Planine Mts. All taxonomically important morphological characters of the habitus and the genital structures were described and compared. These are relicts and endemics of the Carpatho-Balkan mountain system and are ancient taxa.

Keywords: Trechini, *Paraduvalius*, new taxa, cave-dwelling fauna, Carpatho-Balkanides

Influence of agricultural context on carabid community structure in winter wheat fields of Southern Banat, Serbia

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A study (2008-2009) was conducted on winter wheat fields in the Southern Banat region of the Vojvodina Province, near Belgrade, Serbia, to assess the potential effect of three spatio-temporal variables on carabid diversity. We sampled two differing landscapes: large fields dominated by cereal monocultures and low proportion of natural habitats , and small fields of rotating crop polyculture and higher proportion of natural habitats . Edge effects were tested by sampling near the edge of the field (*edge_near*) and deeper within the field (*edge_far*). Temporal effects were tested by sampling in the flowering phase of wheat (*season_early*) and prior to harvest (*season_late*). A redundancy analysis ordination of 32 species from 42 samples (out of 78 species from 48 samples), coupled with a three-factor (*landscape/edge/season*) conditional-effect variance partitioning was conducted to examine the influence of the constraining factors (15.1% total variation accounted for, *pseudoF*=2.2, p=0.002). The effects of *landscape* (7.6%) and *season* (5.2%) were significant, while the effect of *edge* was not (2.3% variation, *pseudoF*=1.0, p=0.368). The partial effects of *edge_season/landscape* and *phase_landscape/edge* were significant, showing that carabids responded to landscape setting, edge reservoirs and crop phenology in a complex manner. A higher proportion of phytophagous carabids occurred in small fields, near the edge and early in the season.

Keywords: carabid diversity, landscape complexity, edge effects, phenology, trophic guilds

Metabolic traits vs. habitat niche width in different species of carabid beetles

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We used determination of electron transport system (ETS) activity and oxygen consumption for explaining and understanding the biochemical and physiological traits of carabid beetles and relate them to ecological specialization. It was shown that ETS activity and oxygen consumption differed significantly between six studied carabid species: *Carabus coriaceus, C. (variolosus) nodulosus, C. catenulatus, Pterostichius fasciatopunctatus, Abax parallelepipedus, Laemostenus schreibersii*. The lowest ETS activity was in *C. coriaceus* and the highest in *C. catenulatus, P. fasciatopunctatus* and *L. schreibersii*. Low oxygen consumption was measured in *C. coriaceus*, while other species had higher oxygen consumption. Moreover, the ratio between ETS activity (i.e. metabolic potential) and oxygen consumption (ETS/R ratio) is an important index of an organism's metabolism. As expected, ETS/R ratio differed significantly between studied species. It was low in *C. (v.) nodulosus*, but high in *C. catenulatus* and *P. fasciatopunctatus*. High ETS/R ratio means less intensive exploitation of metabolic potential for basal metabolism and activity. The ecological specialization was defined by the niche width. This was calculated by the diversity of habitat types used by the species. The lowest niche width was found in *P. fasciatopunctatus* followed by *C. (v.) nodulosus* and *L. schreibersii*. *A. parallelepipedus* was found in the highest diversity of habitat types. In general there is no clear correlation between niche width and the metabolic trait studied, but rather depends on the habitat they occur.

Keywords: metabolic activity, oxygen consumption, electron transport system activity, habitat niche, Carabidae

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