



21st European Carabidologists' Meeting

3-5 June 2024, Budapest, Hungary

Book of abstracts

**Edited by
Zoltán Elek and Jana Růžičková**

University of Veterinary Medicine Budapest, 2024

Program



Day one: 3 June 2024 (Monday)

8:00 - 9:00: Registration

Registration desk will be open during the day until 15:00

9:00 - 9:15: Opening speech

Zoltán Elek and László Ózsvári (University of Veterinary Medicine)

9:15 - 10:00: Plenary talk

- **Wouter Dekoninck** et al.: The importance of natural history collections in advancing taxonomic, faunistic, conservation, evolutionary and genomic research: case studies featuring carabids from the RBINS collection

10:00 - 10:30: Coffee break

10:30 - 11:45: Morning session – Community ecology of carabids 1 (chair: ...)

- **Basile Finand** et al.: Rapid change in community composition of carabid beetles in urban remnant forests of Helsinki
- **Stephen Venn** et al.: Functional traits determine species composition under different levels of disturbance in the urban green infrastructure of Warsaw, Poland
- **Riccardo Panza*** et al.: Responses of carabids and dung beetles to the windstorm “Vaia”: susceptibility versus resilience to disturbance

11:45 - 13:00: Lunch break

13:00 - 15:05: Afternoon session – Hungry carabids in agroecosystems (chair: ...)

- **Khaldoun A. Ali** et al.: Carabids employ a comparative mechanism for guiding their seed selection decisions
- **Christian J. Willenborg** et al.: Exploring the relationship between carabid assemblage, seed predation, and vegetation structure in a remnant native prairie patch
- **Norbertas Noreika**: Pesticide-induced food and macronutrient limitation in beneficial carabid beetles in agroecosystems
- **Ambre Sacco--Martret de Preville** et al.: Contribution of non-dominant carabid species to the predation of animal prey in agroecosystems across gradients of management intensity and landscape heterogeneity
- **Pavel Saska** et al.: Field management effects on carabid beetles: a meta-analysis

15:05 - 15:30: Coffee break

15:30 - 16:45: Evening session – Phylodiversity (chair: ...)

- **Wiktorija Cechowicz*** et al.: Towards comprehensive conservation in the mega-biodiversity hotspot: establishing a DNA barcode library for epigeic Philippine tiger beetles
- **Dale Ann P. Acal*** et al.: First insight into molecular diversity of *Therates* tiger beetles (Coleoptera: Cicindelidae) in the Philippines
- **Cody Raul Cardenas*** et al.: HyRAD-X phylogeography of the Ethiopian high-plateau mountain endemic and flightless *Calosoma (Carabophanus) gestroi*

16:45 - 18:00: **Poster session** starting with the one-minute speed talks (in alphabetical order)

- **Sándor Bérces** et al.: Do carabids (Coleoptera: Carabidae) respond to nature conservation management increasing structural diversity in two Hungarian Oak forests?
- **Linda Bouguessa-Cheriak** et al.: Impact of urbanization on the diversity and abundance of the carabid population in the feeding environments of the white stork (*Ciconia ciconia* L., 1758) in the Extrem east of Algeria (Period 2000-2021)
- **Cody Raul Cardenas*** et al.: Integrative phylogenomics reveal the most comprehensive phylogeny of Carabidae through sequence curation of available Adephegan data
- **Wouter Dekoninck** et al.: Can carabids be used to evaluate the restoration of heathland and dry grassland in the northwest of Belgium?
- **Renata Kędzior** et al.: Ground beetles (Coleoptera, Carabidae) as indicators of postfire ecosystem recovery under different forest restoration techniques
- **Agnieszka Kosewska** et al.: Influence of various meadow management on the ground beetle (Coleoptera, Carabidae) assemblages
- **Tibor Magura** et al.: Increased exploratory behaviour during the breeding season in a ground beetle, *Carabus convexus*
- **Austėja Oržekauskaitė** et al.: The influence of body size on the sensitivity of ground beetles (Carabidae) and rove beetles (Staphylinidae) to pyrethroid insecticides
- **Nadia Ouchtati** et al.: Preliminary data on the carabid fauna in three different forest ecosystems of the Benisaleh reserve in Boucheougouf (Guelma, Algeria)
- **Brogan L. Pett*** et al.: Movement ecology of the Blue ground beetle (*Carabus intricatus*) assessed through radio-telemetry in an ancient temperate Atlantic rainforest fragment in the U.K.
- **Roberto Pizzolotto** et al.: Carabid Beetles in the high-altitude alpine environment of "Parco di Paneveggio" (Italy): *Nebria germari* and its trophic network
- **Gábor Pozsgai**: How does AI see carabids? The morphological accuracy of image-generating models on realistic ground beetle images
- **Yasmina Saouache** et al.: Preliminary study of ground beetles (Coleoptera: Carabidae) in a forest environment in northeastern Algeria.
- **Lucija Šerić Jelaska** et al.: Prey detected in carabids (Carabidae) in Mediterranean agriculture and their potential in biocontrol
- **Rikjan Vermeulen** et al.: Celebrating 65 years of ground beetle trapping in Drenthe (The Netherlands)
- **Jack R. Walker*** et al.: What makes an urban beetle? Carabid functional traits along an urban-rural gradient in two nearby cities

18:00 - 21:00: **Icebreaker** (Building P)

Day two: 4 June 2024 (Tuesday)

9:00 - 9:15: **Opening of the day**

9:15 - 10:00: **Plenary talk**

- **Norbertas Noreika:** Carabid beetles in ecosystem restoration

10:00 - 10:30: **Coffee break**

10:30 - 11:45: **Morning session – Community ecology of carabids 2 (chair: ...)**

- **José Serrano** et al.: Seasonal changes in carabid assemblages of Northwestern Algeria (Coleoptera, Carabidae)
- **Nawel Ganaoui*** et al.: Diversity of carabid beetles and their importance in the cork oak forests of Eastern Algeria
- **Estève Boutaud** et al.: Effect of traditional lowland heathland management methods – mowing, burning, and choppering – on ground beetles assemblages

11:45 - 13:00: **Lunch break**

13:00 - 15:05: **Afternoon session – From communities to species (chair: ...)**

- **D. Johan Kotze** et al.: Inside-out; how habitat quality within the patch and the surrounding matrix affect carabid beetle communities and populations
- **Mishkat Ullah** et al.: Exploring new frontiers: First records of ground beetles (Carabidae) from Pakistan
- **Sándor Bérces** et al.: Almost everything you want to know about *Carabus hungaricus* Fabr.
- **Virág Nyíri*** et al.: Evolutionary and conservation genomics of *Carabus hungaricus* in Central-Eastern Europe
- **Arvīds Barševskis** et al.: Fauna and biogeography of the genus *Notiophilus* Dumeril, 1806 (Coleoptera: Carabidae) in North - West Himalaya

15:05 - 15:30: **Coffee break**

15:30 - 17:10: **Evening session – Perspectives in carabidology (chair: ...)**

- **Virginia Toscano Rivalta*** et al.: Glacial and periglacial carabid beetles, spiders, and centipedes in an Alpine area deeply affected by climate warming (Breuil basin, Western Italian Alps)
- **Roberto Pizzolotto:** Carabid communities for monitoring the effects of climate change at high altitudes
- **Radomir Jaskula:** What can we learn about ecology of tiger beetles from citizen science? Preliminary results, future perspectives and gaps based on global data
- **Gábor L. Lövei** et al.: Non-lethal methods in carabidology: possibilities and challenges

17:10 - 18:15: **Poster session**

18:15 - 20:00: **Pint of Science: Non-lethal methods in carabidology (Building P)**

Warm up talks by Jana Růžicková and Gábor L. Lövei

*Student's contribution

Day three: 5 June 2024 (Wednesday)

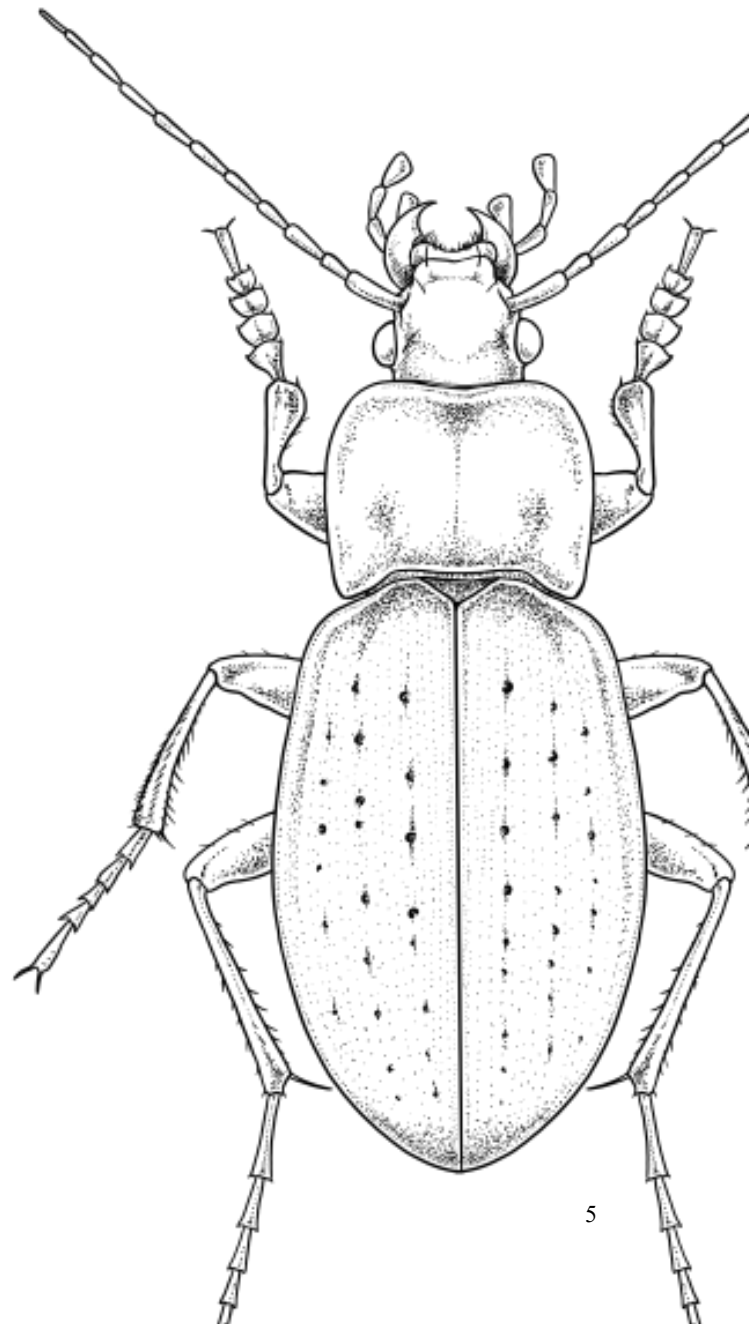
9:00 - 9:30: **Closing remarks, winners of the student competition**

9:30 - 10:00: **Coffee break**

10:00 - 16:00: **Field trip** to the Pilis Mountains near Pilisszentkereszt
Field trip guided by Zoltán Elek, Bence Kovács and Jana Růžičková

16:00 - 20:00: **Dinner in the forest**
Pilisszentkereszt, a pasture near the Som-hegy summit house

20:00 - 21:00: **Return to Budapest**



Plenary Talks



THE IMPORTANCE OF NATURAL HISTORY COLLECTIONS IN ADVANCING TAXONOMIC, FAUNISTIC, CONSERVATION, EVOLUTIONARY AND GENOMIC RESEARCH: CASE STUDIES FEATURING CARABIDS FROM THE RBINS COLLECTION

Dekoninck W., Vangestel C., Hendrickx F.

Royal Belgian Institute for Natural Sciences, Brussels, Belgium

The main objectives of the Scientific Service of Heritage, section Entomology of the Royal Belgian Institute for Natural Sciences (RBINS, Belgium) are collection management, scientific research and service. The entomological collections compile more than 20.000.000 specimens of insects and arachnomorphs and these originate from the Palaearctic (Europe: mainly Belgium and neighbouring countries); the Afrotropical region, the Oriental (mainly Southeast Asia) and the Neotropics (amongst others Galápagos islands). Some of the collections are world renown as for instance the 'de Selys Longchamps' Odonata collection (more than 700 primary types and ca. 45.000 specimens), Dr Fain's Acari collection (115.000 slides and more than 1.500 primary types) and the Staphylinidae collection of Fagel and Fauvel.

Also RBINS carabid collections have been proved indispensable for many different research pillars so far. First of all these collections were and still are repositories for taxonomic data. Each year an average of 50 new species are described from RBINS specimens. Moreover the important and voluminous historical Belgian carabid collections have been revised, digitized and databased and are up-date yearly. The oldest specimens were collected before 1950, some even already in 1820. The obtained database has been used to compile different documented red data books that contain knowledge on carabids distribution, dispersion and protection of threatened habitats/species all Belgian species.

Besides their significance in taxonomic, faunistic and conservation studies, specimens of this collection have been extensively used for evolutionary and genomic oriented research. A prime illustration of its importance in this research field lies in its unique collection of carabids of the Galápagos islands, originating from multiple expeditions of RBINS researchers to the Galápagos Archipelago during the period 1960 and 2014. This collection showed to be essential in elucidating the genomic basis underlying parallel evolution in a gradual *Calosoma* radiation across the archipelago. Another compelling example involves *Pogonus* salt-marsh beetles, where a genomic comparison of historic and recent samples allowed to track the genomic basis driving contemporary evolution in wild populations.

Besides these case studies also other examples of the use of ancient and recent voucher specimen collections in different scientific themes will be discussed.

CARABID BEETLES IN ECOSYSTEM RESTORATION

Noreika N. (1,2)

(1) *Institute of Agricultural and Environmental Sciences, Estonian University of Life Sciences, Tartu, Estonia;* (2) *Nature Research Centre, Vilnius, Lithuania*

Anthropogenic disturbances are causing degradation of ecosystems and loss of biodiversity at an unprecedented rate. Ecological restoration is one of the most efficient approaches to counteract these losses and subsequently inverse the ongoing homogenisation of biota. Carabid beetles can play a significant role in the process of ecological restoration and in the science of restoration ecology. They are found abundantly in most terrestrial ecosystems (both pristine and degraded), their species and functional diversity is notable, and they are sensitive to environmental changes. Importantly, carabid beetles contain many habitat specialist species, and these are the species we want to come back while planning and performing ecosystem restoration. However, there are many issues to consider and investigate across spatio-temporal scales for achieving success of restoration actions. Local habitat conditions, isolation, historical landscape change should be considered while prioritizing sites for restoration. As well, the target of ecological restoration should be not only increased species diversity, but also the improvement of services these species provide. Finally, in order to evaluate overall success of ecosystem restoration (at the landscape scale and/or among different taxa) I would encourage to employ integrative evaluation approaches which allow to make direct comparisons among different ecological communities. These novel approaches, as well as traditional biodiversity metrics clearly indicate that with some thought-through restoration efforts we can indeed make carabid beetles to come back to once degraded areas.

Abstracts of Talks

(in alphabetical order of presenting authors)



FIRST INSIGHT INTO MOLECULAR DIVERSITY OF *THERATES* TIGER BEETLES (COLEOPTERA: CICINDELIDAE) IN THE PHILIPPINES

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Department of Invertebrate Zoology and Hydrobiology, Faculty of Biology and Environmental Protection, University of Lodz, Lodz, Poland

DNA barcoding is a valuable tool for species identification and improves the characterization of evolutionary lineages, aiding in detecting potentially undescribed and cryptic species. Here, we have compiled the first DNA barcode reference library for molecular identification of the genus *Therates*, an understudied semi-arboreal group of tiger beetles. Over 1,000 adult beetles were collected from Mindanao and Palawan islands, with the COI gene amplified in more than 390 individuals across seven morphotaxa (4 species and 7 subspecies). The preliminary data set consisted of 335 barcode sequences. Analysis in Barcode of Life Data System (BOLD) assigned our sequences to 15 Barcode Index Numbers (BINs), of which all of them are unique to this study. Interestingly, discrepancies between morphological and molecular identification were evident, with multiple BINs observed in several taxa: *Therates fulvipennis bidentatus* (3 BINs), *T. fulvipennis everetti* (3 BINs), *T. coracinus coracinus* (5 BINs), *T. fasciatus quadrimaculatus* (4 BINs), *T. fasciatus fasciatus* (1 BIN), *T. fasciatus pseudolatreillei* (1 BIN), and *T. palawanensis* (1 BIN). The presence of multiple BINs within four morphospecies indicates significant intraspecific distance, suggesting a need for further investigation to assess potential cryptic diversity. Our initial findings revealed previously unrecognized genetic diversity within the studied taxa and highlighted the advantage of DNA barcoding in enhancing our understanding of *Therates* tiger beetle biodiversity. Additionally, establishing a DNA barcode reference library paves the way for future larval descriptions and biogeographical studies.

Student's contribution

CARABIDS EMPLOY A COMPARATIVE MECHANISM FOR GUIDING THEIR SEED SELECTION DECISIONS

Ali K.A., Willenborg C.J.

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Seed choice in carabid (ground) beetles (Coleoptera: Carabidae) is influenced by numerous ecological factors. Our previous work has shown that seed chemical traits drive seed selection decisions when seed physical traits (e.g. size and mass) are within certain limits. Beyond that, carabid-to-seed mass ratio scaling relationships will drive seed selection decisions. Thus, carabids can assess the suitability of different seed species before they identify the most suitable seed species among them, but the behavioral mechanism that underlie this assessment remain unexplored. Here, we offered seed species of different preferability to *Poecilus corvus* and *Pterostichus melanarius* in choice feeding experiments to test if these carabids would employ a fixed (Luce's Axiom; Luce,

1977) or a comparative (Dawkins' Threshold Model; Dawkins, 1969) mechanism of seed suitability assessment. Seed choice by both species was dynamic rather than fixed, as the preferable seed species changed depending on the seed options (i.e. species) offered in the experiment and the number of these options (i.e. binary or tertiary choice). Moreover, the presence of a highly preferable seed species strongly depressed the value of other seed species in three-choice experiments for both carabid species. These findings closely align with the predictions of Dawkins' Threshold Model, suggesting that carabids identify preferable seed species by comparing the suitability of different seed species available in the environment. Therefore, seed preferences by carabids are dynamic and context-dependent, and preferable seed species will differ from one location to another depending on the composition of carabid community and soil seed bank.

FAUNA AND BIOGEOGRAPHY OF THE GENUS *NOTIOPHILUS* DUMERIL, 1806 (COLEOPTERA: CARABIDAE) IN NORTH - WEST HIMALAYA

Barševskis A. (1,2), Ahmed Z. (3)

(1) *Daugavpils University, Daugavpils, Latvia*; (2) *University of Mindanao, Davao City, Philippines*; (3) *Federal Urdu University of Arts, Sciences & Technology, Karachi, Pakistan*

The genus *Notiophilus* Dumeril, 1806 (Coleoptera: Carabidae) belongs to the tribe Notiophilini of subfamily Nebriinae. In the world fauna this genus presented by 61 species and 5 subspecies, distributed in the Holarctic region. Despite the fact that the genus is generally relatively well studied, there is very little faunal material of this genus from the Himalayan region. The aim of the study is to characterize the fauna and distribution of the genus *Notiophilus* in the North-West Himalayan region (Afghanistan, India and Pakistan). By collecting literature data and materials from more than 40 world museums and private collections, eight species of this genus have been confirmed for this region: *N. dostali* Barševskis, 2011, *N. heinzi* Dostal, 1986, *N. kirschenhoferi* Dostal, 1981, *N. hiemalis* Semenov & Arnoldi, 1937, *N. nuristanensis* Barševski, 2011, *N. orientalis* Chaudoir, 1850, *N. radians radians* Andrewes, 1926, *N. sublaevis* Solsky, 1873. The distribution of all species of this genus occurring in the North-West Himalaya has been specified, supplementing it with new, unpublished finds. Six species: *N. dostali*, *N. heinzi*, *N. kirschenhoferi*, *N. nuristanensis*, *N. orientalis* and *N. radians radians* are endemic to the North-West Himalayan region. Two species: *N. hiemalis* and *N. sublaevis* are more widely distributed in Central Asia. *N. orientalis*, *N. radians radians* in the North-West Himalayan region are distributed more widely than was known until now. The species *N. dostali*, *N. heinzi*, *N. kirschenhoferi* and *N. nuristanensis* are currently known only from their type specimens.

ALMOST EVERYTHING YOU WANT TO KNOW ABOUT *CARABUS HUNGARICUS* FABR.

Bérces S. (1), Růžičková J. (2), Pokluda P.† (3), Elek Z. (4)

(1) *Duna-Ipoly National Park Directorate, Budapest, Hungary*; (2) *HUN-REN-ELTE-MTM Integrative Ecology Research Group, Eötvös Loránd University, Budapest, Hungary*; (3) *Faculty of Science, University of South Bohemia, České Budějovice, Czech Republic*; (4) *Department of Biostatistics, University of Veterinary Medicine, Budapest, Hungary*

We conducted research to contribute to evidence-based conservation policies for *Carabus hungaricus* populations. We created a comprehensive GIS database to map their distribution. A mark-release-recapture study in Pócsmegyer, Hungary revealed a population size ranging between 1317 and 2169 individuals, with adults older than a year constituting 32–42% of the population, indicating overlapping generations. Using the inverse power function, we estimated their dispersal ability. Populations in Hungary and two sites in the Czech Republic were studied, showing individuals could cover distances of up to a kilometer, but dispersal probability over 100 meters varied significantly between sites. Radio telemetry revealed that habitat type significantly influenced beetle movement, with temperature positively affecting it. We found that maintaining treeless, mosaic habitats is crucial for *C. hungaricus* persistence. Deciduous trees, shrubs, and forests act as barriers to dispersion. The research emphasizes the importance of preserving treeless habitats in a mosaic state for *C. hungaricus* conservation. Management regulations for Natura 2000 sites should consider these findings to ensure the species' long-term survival.

EFFECT OF TRADITIONAL LOWLAND HEATHLAND MANAGEMENT METHODS – MOWING, BURNING, AND CHOPPERING – ON GROUND BEETLE ASSEMBLAGES

Boutaud E. (1,2), Walmsley D. (2), Daniels J. (2), Härdtle W. (2), Temperton V. (2)

(1) *Université de Picardie Jules Verne, Laboratoire EDYSAN, France*; (2) *Institute for Ecology, Leuphana University of Lüneburg, Germany*

Lowland oceanic heathlands are among the most threatened semi-natural ecosystems in Central Europe. They are important for the protection of biodiversity because they support a distinctive and highly specialised fauna that frequently includes many threatened species. Currently, these risks are being handled with more or less intense management techniques, including burning, chopping, and mowing. However, empirical studies on the effects of such management practices on the rich invertebrate fauna of such habitats remain scarce. Our study aimed to analyse the long-term effects of heathland management measures on carabid beetles. For this, we compared carabid beetle assemblages across two gradients, from young to old successional stages and from low- to high-intensity management measures. Our results revealed that the composition of carabid beetle assemblages differed across the successional stage gradient but not across the management intensity gradient. Overall, all management measures fostered mainly heathland specialists and threatened carabid beetle species, at least in the short term. On the other hand, non-threatened heathland generalists and forest species constituted the majority of carabid beetle assemblages in the late-successional phases. In conclusion, the long-term conservation of a large extent of the specialised carabid beetle fauna of lowland heathlands depends on the permanent availability of early successional stages. Such early successional stages could be created by any of the management methods studied. An increase in the frequency at which management interventions are conducted appears necessary to ensure the permanent presence of early successional stages.

HYRAD-X PHYLOGEOGRAPHY OF THE ETHIOPIAN HIGH-PLATEAU MOUNTAIN ENDEMIC AND FLIGHTLESS *CALOSOMA (CARABOPHANUS) GESTROI*

Cardenas C.R. (1), Gauthier J. (1,2), Schmidt J. (3), Toussaint E.F.A. (1)

(1) Natural History Museum of Geneva, Geneva, Switzerland; (2) Cantonal Museum of Natural Sciences, Lausanne, Switzerland; (3) General and Systematic Zoology, University of Rostock, Rostock, Germany

Flight loss and the resulting reduction in dispersal capacity and gene flow have been suggested as major drivers of diversification. Ground beetles of the genus *Calosoma* are unique among the mostly flightless Carabinae because nearly half the species are flight capable. Most flightless *Calosoma* are found in extreme, isolated, and persistent habitats such as montane ecosystems. The genus therefore represents an ideal model system to test the impact of flight loss on diversification processes at different geographical scales. Here we focus on the flightless species *Calosoma (Carabophanus) gestroi*, found at high elevations in the southern mountains surrounding the Great Rift Valley of Ethiopia, in order to examine how flightlessness has affected its evolutionary history. Specifically, we aim to test how genetically diverse this species is and what biogeographic history has led to its current distribution. Hybridization capture from RAD-derived probes obtained from a reduced exome template and high-throughput sequencing was performed with 23 *C. gestroi* specimens. Preliminary results indicate that specimens collected from different mountains form well supported clades, yet population metrics suggest little to no population differentiation. It is expected that the localities we have sampled should be more genetically distinct than observed, particularly given that *C. gestroi* is flightless. However, the low genetic differentiation between localities may be the result of a recent colonization event in the southern plateaus in Ethiopia. Future analyses examining demographic models and a dated tree should clarify the processes driving the unexpected low genetic variation of this geographically restricted.

Student's contribution

TOWARDS COMPREHENSIVE CONSERVATION IN THE MEGA-BIODIVERSITY HOTSPOT: ESTABLISHING A DNA BARCODE LIBRARY FOR EPIGEIC PHILIPPINE TIGER BEETLES

Cechowicz W. (1), Acal D.A.P. (1), Nuñez O.M. (2), Jaskuła R. (1)

(1) Department of Invertebrate Zoology and Hydrobiology, Faculty of Biology and Environmental Protection, University of Lodz, Lodz, Poland; (2) Mindanao State University-Iligan Institute of Technology, Iligan, Philippines

Tiger beetles (Coleoptera: Cicindelidae), with nearly 3000 species, are found in almost every terrestrial ecosystem in the world except polar regions and some oceanic islands. Although this family has a wide distribution, individual species are characterized by narrow habitat specialization, making them excellent bioindicators. The Philippines, with over 180 tiger beetle taxa (with almost 85% of them being endemic), are recognized as a mega-biodiversity hotspot. Unfortunately, this diversity is threatened by increasing human pressure and ongoing climate change. Additionally, only a few Philippine Cicindelidae species have described juvenile stages, so we still know little about their comprehensive ecology and biology, and in consequence, treats. In response to these challenges, the project aims to create the first DNA barcode library for the Philippine tiger beetles. It will help to better assess the species diversity of Philippine tiger beetles (e.g., by detecting potential cryptic species) and to identify previously unknown larvae of these insects. This will lay

the groundwork for more effective species and habitat conservation efforts in the future (as DNA barcoding will also enable quick and accurate verification of taxa even by non-specialists). The first part of research material was obtained from four large Philippine islands: Mindanao, Negros, Cebu, and Bohol. Several epigeic morphospecies belonging to seven genera were selected for the analysis, whose taxonomic status was verified using markers used in the CO1 DNA barcode sequencing method. The obtained data will be deposited in the online BOLD database, which contains collections of sequences from around the world.

Student's contribution

RAPID CHANGE IN COMMUNITY COMPOSITION OF CARABID BEETLES IN URBAN REMNANT FORESTS OF HELSINKI

Finand B. (1,2), Setälä H. (1), Kotze D.J. (1)

(1) Faculty of Biological and Environmental Sciences, Ecosystems and Environment Research Programme, University of Helsinki, Lahti, Finland; (2) URBARIA, University of Helsinki, Finland

Habitat fragmentation is a major threat to biodiversity. Several studies have investigated the impact of current habitat fragmentation on contemporary carabid beetle communities. However, some studies suggest that the past configuration of the landscape can also explain contemporary communities through the extinction debt. While many of these studies have been performed on plants, few have done so for insects. Our study aims to fill this gap by studying the impact of past habitat fragmentation on contemporary carabid beetle communities and populations in remnant forests in Helsinki, Finland. We sampled ten recently fragmented urban forests (less than 35 years ago), ten historically fragmented urban forests (more than 35 years ago), and five less fragmented control forests in the summer of 2023. We compared the communities in terms of species richness, species composition and functional diversity. Moreover, we investigated changes of individual traits (size, dispersal) of the most commonly collected species at the population level. Our results showed no effect of fragmentation age on species richness and community composition. However, there is a clear difference in community composition between the fragmented and control forests. This suggests that community change is faster than expected after forest fragmentation. At the population level, no differences in size or dispersal were observed in the selected species. Our study highlights the rapid consequences of urban habitat fragmentation on biodiversity and the importance of considering time in the study of habitat fragmentation.

DIVERSITY OF CARABID BEETLES AND THEIR IMPORTANCE IN THE CORK OAK FORESTS OF EASTERN ALGERIA

Ganaoui N. (1), Ganaoui M. (2), Chakali G. (3)

(1) *Laboratory of Rural Development, Department of Ecology, University Ibn Khaldoun, Tiaret, Algeria;* (2) *Epidemiological Surveillance, Health, Production and Reproduction, Experimentation, and Cellular Therapy of Domestic and Wild Animals at the University of Chadli Bendjedid, El Tarf, Algeria;* (3) *National Higher School of Agriculture, Department of Agricultural and Forestry Zoology, El Harrach, Algiers, Algeria*

The study conducted on the biodiversity of beetles in various oak forests in northeastern Algeria identified 21 species of carabid beetles out of a total of 76 distributed among 12 genera. Most of these species are characterized by their predatory nature and their preference for humid forest habitats. Among the species recorded, some hold particular importance for protection under legislation. Species such as *Eurycarabus faminii*, *Calosoma inquisitor*, and the North African endemic species *Calathus fuscipes algericus* are examples. This group of bio-indicator insects plays a fundamental role in regulating populations of harmful insects during cyclic epidemics of oak defoliators, notably *Lymantria dispar*. Based on the data collected, the temporal abundance of species varies considerably across different oak forests surveyed, due to their structural characteristics and floristic composition. Among the visited sites, the cork oak forest stands out notably for its biological diversity, which promotes a tritrophic relationship between the forest species, its defoliator, and its predator. Among the three surveyed environments, the identified carabid species are strategically distributed according to floristic and faunistic composition.

Despite its crucial role in preserving biodiversity, the floristic and faunistic diversity, particularly the carabid fauna, remains threatened by anthropogenic effects, including periodic forest fires. The low numbers observed during our investigations indicate a significant regression of carabid beetles in these fragile environments.

Student's contribution

WHAT CAN WE LEARN ABOUT ECOLOGY OF TIGER BEETLES FROM CITIZEN SCIENCE? PRELIMINARY RESULTS, FUTURE PERSPECTIVES AND GAPS BASED ON GLOBAL DATA

Jaskuła R.

Department of Invertebrate Zoology and Hydrobiology, Faculty of Biology and Environmental Protection, University of Lodz, Lodz, Poland

The declining number of specialists in entomology on one side, and the global biodiversity crisis and insect apocalypse on the other, clearly indicate the need to use all available data in studies that can better protect species and biodiversity. Thanks to volunteers, citizen science perfectly supports such activities during the recent decades (and its role is significantly increasing), enabling the acquisition of data from large areas in short time with virtually zero research costs. It seems to be especially important in studies focused on the most diverse animal group in the world - the insects. A global analysis of selected aspects of tiger beetles (Cicindelidae) ecology was done on the basis on records collected by citizen scientists and deposited in the iNaturalist database (www.inaturalist.org). Over 219 000 records for over 700 species (ca. 25% of world Cicindelidae fauna) collected between 2008 and 2024 were taken into consideration. The following aspects of tiger beetle ecology were studied using available data: macrohabitat preferences, elevational

distribution of species, phenology of adult beetles. In addition, ecological niche modelling was done to predict future impact of climate change on Cicindelidae fauna. During the presentation preliminary results will be provided and future perspectives will be discussed clearly showing the power of citizen science in ecological studies.

INSIDE-OUT; HOW HABITAT QUALITY WITHIN THE PATCH AND THE SURROUNDING MATRIX AFFECT CARABID BEETLE COMMUNITIES AND POPULATIONS

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Urban and agricultural areas dominate the contemporary landscape, and result in insular greenspaces surrounded by matrices of various types and qualities. Additionally, these greenspaces vary in quality depending on their use, resulting in either structurally complex or simple forest floor interiors. We report on the findings of two studies that investigated the influence of various surrounding matrices (urban, agricultural, lake) and forest interior habitat quality on carabid beetle communities and populations in natural to semi-natural remnant forests in the medium-sized city of Lahti in southern Finland. We showed that the surrounding matrix type had a significant effect on carabid beetle communities within remnant forest fragments, while habitat quality within fragments had a lesser effect. Beetle communities in forest fragments in urban and lake landscapes were characterized by small species and those capable of flight. At the population level, some species were smaller in size in fragments in the urban, agricultural and/or lake landscapes compared to those collected from control forests. Forest structural complexity had varying effects on beetle size and mass, with some species displaying an increase in size and/or mass in heterogeneous forests, while others showed the opposite trend. Our findings clearly show that insular forest communities are shaped by the surrounding, highly dominant urban and agricultural landscapes, as well as by the interior quality of greenspace. This suggests that in an increasingly urban and agriculturally-intensive world, what happens in the matrix as well as within insular greenspace are likely to have significant consequences to biodiversity.

NON-LETHAL METHODS IN CARABIDOLOGY: POSSIBILITIES AND CHALLENGES

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The global biodiversity decline is of increasing scientific and public concern. Such decline arguably extends to arthropods. However, the routine toolkit used in arthropod research often causes the death of study subjects, ironically even when the research focuses on protected species. This creates a dilemma: entomologists will not be able to credibly argue for the protection of arthropods, and at the same time continue their practice as in the past. Even if the mortality caused by research is vastly smaller than other factors, this is not a "numbers game" - it is a matter of credibility in the

eyes of the public. Additionally, we realised that a much wider range of non-human animals have consciousness than previously thought. There are several recent attempts to develop a set of criteria that can be used at the planning stage, aiming to reduce needless destruction of arthropods in the name of science. This ranges from re-using museum collections, through minimising bycatch, employing automated documentation methods, using artificial intelligence, relying on observations, recording byproducts of insect activity (such as frass) to the sentinel approach focusing on the outcomes of arthropod activity. Carabidologists can use several of these methods, while others need adaptation or further development to be useful in ground beetle research. Admitting that we cannot completely abandon collecting and killing carabids, we shall review recent examples of non-lethal methods and argue that their wider use is both inevitable and necessary, both in entomology in general as well as in carabidology.

PESTICIDE-INDUCED FOOD AND MACRONUTRIENT LIMITATION IN BENEFICIAL CARABID BEETLES IN AGROECOSYSTEMS

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Pesticide usage is claimed as the main cause of insect declines. Pesticides can directly eradicate beneficial predatory beetles, but they are also exposed to indirect pesticide effects arising from reduced prey (as well as plant-based food) availability and quality in agroecosystems. The main aim of the current study was to investigate if higher food and macronutrient limitation levels in carabid beetles are related to conventional agricultural practices (especially pesticide usage). Individuals of different carabid species were collected by hand from 8 conventional and 8 organic oat fields scattered around Tartu, Estonia (three times). In the laboratory beetles were served with three semi-artificial diets: lipid-rich, protein-rich, and sugar-rich. Consumption of each diet was evaluated after 24 hours (=test1). Afterwards, beetles were fed ad libitum for a week until full satiation. Then the procedure of test1 was repeated (=test2). The differences of consumed diets among two tests showed the level of food and macronutrient limitation in carabids within assemblages. Separately, pesticide residue analyses in beetle bodies were performed. Seven different pesticides were detected in carabids from conventional fields. Several carabid species demonstrated positive body weight gain with the absence of pesticides in agroecosystems. All carabid species were food and specific macronutrient limited in the fields. Few carabid species tended to be more food as well as protein and lipid deficient with the presence of neonicotinoid insecticide. We conclude that organic farming and reduced pesticide usage would improve beneficial carabid nutrition and fitness thus leading to higher efficiency in providing biocontrol service.

EVOLUTIONARY AND CONSERVATION GENOMICS OF *CARABUS HUNGARICUS* IN CENTRAL-EASTERN EUROPE

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An emblematic carabid species of the Eurasian Steppe is *Carabus hungaricus* s.l., which is also of conservation concern on its western periphery of distribution that includes the Pannonian Basin. A good understanding of the conservation genetics of this species can significantly contribute to the long-term management of its populations. To gain insight into the genetic structure, we employed genomic approaches including de novo whole-genome sequencing and RAD-seq. Samples were collected from all regions of its occurrence in Hungary and included populations from the neighbouring countries. We successfully assembled a strong draft whole-genome of a specimen from Hungary. This was used in the RADseq work that provided insight into the phylogenetic relationship between the studied populations. All samples collected from distinct populations grouped into clades highlighting limited genetic admixture and the isolated nature of these populations. The results established a firm phylogenetic relationship between the populations uncovering the detailed phylogeography of *C. hungaricus*. The species arrived from the eastern steppes first to the Nyírség region of Hungary, then, following the course of the Tisza, this migration extended to the Deliblato Sands and then to the Danube–Tisza-Interfluve by crossing the river. Danube represented a more tough barrier: populations migrated along the Danube River, eventually crossing it only much further west in the Kisalföld region. Interestingly, Szentendre island on Danube and Mezőföld region were apparently colonised by individuals having drifted down the river. Additionally, we calculated key measures of genetic variation, which warns of low genome-wide heterozygosity urging conservation measures.

Student's contribution

RESPONSES OF CARABIDS AND DUNG BEETLES TO THE WINDSTORM "VAIA": SUSCEPTIBILITY VERSUS RESILIENCE TO DISTURBANCE

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Climate change leads to extreme events whose ecological impacts are yet to be understood. The storm "Vaia" was an extreme climatic event that – in just one day (29th of October 2018) – caused considerable large-scale damages to forests in Eastern Italian Alps. To study the short-term impact of Vaia, we focused on carabids and dung beetles of Visdende valley (the northernmost tip of the Veneto region). We placed pitfall traps in four habitats, namely a mixed forest of spruce and beech, a pasture, a spruce forest, and a former spruce forest whose crashed trees had been removed. A total 28 species of carabids and 17 species of dung beetles were collected. In both groups mean values of species-richness, abundance and Shannon diversity did not vary significantly across the four habitats. Structural and functional species composition, however, changed significantly in ground

beetles. We found that assemblages of the windthrown habitat, that lost typical forest species, were intermediate between those of the pasture and the spruce forest. In contrast, species composition did not change significantly across habitats in dung beetles. These results demonstrate that carabids are excellent indicators of extreme environmental changes and that dung beetles, responding primarily to the presence of dung, are much less reliable. However, dung beetles' resilience potentially guarantees soil fertility in all habitats. Provided the availability of dung, they may support both restoration and eventual land use change after the passage of these windstorms.

Student's contribution

CARABID COMMUNITIES FOR MONITORING THE EFFECTS OF CLIMATE CHANGE AT HIGH ALTITUDES

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A continuous sampling approach of carabid beetles gives the possibility to assess whether the characteristics of the fauna observed at a particular time remain consistent over extended periods, or if variations associated with trends in annual average temperatures were exhibited. Such research methodologies are of paramount importance in order to monitor the impacts of climate change on animal species, and offer a valuable means to assess the response of temperature-sensitive invertebrates on the basis of population density variation. The long-term sampling initiative commenced in 2013 on the Dolomites (Parco di Paneveggio, Italy) showed a clear population decrease of species strictly tied to high altitude extreme environments (*Nebria germari*, *Trechus dolomitanus*), not always paralleled by the soil temperature trend, suggesting a macro-effect, rather than micro, of climate change on soil fauna.

CONTRIBUTION OF NON-DOMINANT CARABID SPECIES TO THE PREDATION OF ANIMAL PREY IN AGROECOSYSTEMS ACROSS GRADIENTS OF MANAGEMENT INTENSITY AND LANDSCAPE HETEROGENEITY

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High species richness is generally associated with high ecosystem services provision, including biological control. However, pollination studies have shown that rare and endangered species contributed only to a limited extent to the pollination service. Similarly to pollinators' communities,

species distribution in predators' communities, like carabids, is J-shaped with a handful of species accounting for a significant proportion of the community. This study aimed to assess non-dominant species' contribution to the predation of prey of agricultural interest and if it is greater than their relative abundance suggests. The contribution to predation was calculated for 71900 sampled individuals collected in 70 fields across four European countries and three prey. The effects of species richness, species composition and abundance on carabids' predation were disentangled by using Price equations. Field management and landscape heterogeneity were tested as potential factors of variation of those components. Accumulation curves showed similar trends between relative abundance and relative contribution to predation of carabid species suggesting a low contribution of non-dominant species. Additionally, when Price equations were applied, the difference in predation between fields was explained by every component characterizing carabid communities, but mostly by the difference in the abundance of common species. Interestingly, the strength of the different components varied with the proportion of semi-natural habitat in the landscape but not with management intensity: the strength of the abundance component decreased with the increase of habitat complexity while the ones linked to species richness and composition increased.

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FIELD MANAGEMENT EFFECTS ON CARABID BEETLES: A META-ANALYSIS

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Agricultural intensification has been repeatedly reported as one of the key drivers of the ongoing decline in biodiversity. Most recent syntheses have focused on the landscape or greater scales of agricultural intensification, but it is also important to comprehensively evaluate which management practices inside the fields are the most detrimental to biodiversity, so that mitigation of these effects and provision of innovative solutions for sustainable crop production can be achieved. We address this knowledge gap by exploring the effect of the whole set of agricultural management practices on the biodiversity of arable fields. This is done with a meta-analysis of 130 published papers originating from Europe and North America to quantify the effect of management practices, using carabid beetles (Coleoptera: Carabidae) as a model group. We evaluated the associations between these practices and the crop types using multivariate techniques, to identify syndromes of agricultural production, and then tested how these suites of practices affected the catch of carabid beetles measured as activity-density and species richness. We found that practices linked with using agrochemicals and growing wide row crops were associated with a decline in carabid activity density and species richness, while the impact of the remaining practices, such as tillage, intercropping or using mulch, was weak or ambiguous. Our results suggest that measures to conserve biodiversity in arable land may not work where high levels of agrochemicals are used at the same time.

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SEASONAL CHANGES IN CARABID ASSEMBLAGES OF NORTHWESTERN ALGERIA (COLEOPTERA, CARABIDAE)

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Seasonal changes in carabid assemblages inhabiting four sites near Mostaganem (NW Algeria) were investigated from April 2019 to March 2020 by means of pitfall trapping. Sites were a citric orchard, an olive grove, one eucalyptus forest and a wetland area. Notable seasonal changes were found in all sites. The citric orchard (29 species, 747 individuals) showed a moderate species diversity (Shannon index 1.994); *Pseudoophonus rufipes* and *Licinus punctatulus* were the most abundant although spring breeders were more frequent. The olive grove (33 species, 1202 individuals) was dominated by *Orthomus abacoides* (968 individuals) what resulted in a low diversity index (Shannon 1.036). Activity-density was concentrated in spring and autumn. The lower abundance of *P. rufipes* was perhaps compensated by *Broscus politus* and *Calathus opacus*. The eucalyptus forest (22 species, 292 individuals) showed unexpected species diversity (Shannon 2.275). It seems to be a secondary habitat for large predators (*Carabus famini*, *Scarites buparius*) and is characterized by four species of *Graphipterus*, specialized ant-eaters. The wetland harbored 80 species, 4366 individuals, possibly due to the existence of an optimal trophic net. Activity-density peaked in spring but was intense in all seasons. Reproduction was higher in spring and autumn. Hygrophiles and generalist taxa were dominant during all seasons. The results indicate the ecological importance of wet areas in Algeria. Comparisons of our results with those of previous studies on cultivated, forests, and wetlands of Algeria showed differences among them mostly explained at a geographic scale rather than by ecological factors.

*Presenting author

GLACIAL AND PERIGLACIAL CARABID BEETLES, SPIDERS, AND CENTIPEDES IN AN ALPINE AREA DEEPLY AFFECTED BY CLIMATE WARMING (BREUIL BASIN, WESTERN ITALIAN ALPS)

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Glaciers are shrinking globally, while permafrost degradation is accelerating. In Europe, glaciers and rock glaciers are protected by the Habitats Directive (43/92CE), however their conservation status is unfavourable (U2), threatening the persistence of cold-adapted species. This study aims to assess carabid beetle, spider, and centipede species distribution in proglacial, periglacial, and surrounding non-glacial environments in order to test the role of an active rock glacier as warm-stage refugium for cold-adapted species. The research, conducted in the Breuil basin (Western Italian Alps), investigated a glacier front, a glacier foreland, two rock glaciers (one active, one relict), and a reference site unaffected by the Little Ice Age glaciation. The selected taxa were

sampled by pitfall traps and, for each sampling plot, soil physical (ground surface temperature-GST, texture), chemical (pH, C-N total soil content), and biological (vegetation cover) parameters were recorded. Results revealed that GST and ground cover (vegetation, rocky debris) were key factors driving species distribution. However, time since deglaciation was the most significant variable in determining the spatiotemporal species succession along the glacier chronosequence. Arthropod succession followed a "replacement model" in the first 90 years after the glacier retreat, transitioning to an "addition model" thereafter. Arthropod communities at the glacier front and recent deglaciated sites (< 50 yrs) differed from those on the active rock glacier. Some species, such as the carabid *Nebria castanea*, occurred on both landforms, but with a larger population on the active rock glacier suggesting its role as a potential warm-stage refugium for cold-adapted and cryophilous species.

Student's contribution

EXPLORING NEW FRONTIERS: FIRST RECORDS OF GROUND BEETLES (CARABIDAE) FROM PAKISTAN

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Over the course of fieldwork spanning from 2014 to 2018, comprehensive efforts were undertaken to collect specimens of Carabidae across Pakistan, resulting in the acquisition of 2050 specimens. These field collections were complemented by access to Coleoptera collections housed in prestigious repositories such as the Pakistan Museum of Natural History, Islamabad-Pakistan; the National Insect Museum at the National Agricultural Research Centre, Islamabad-Pakistan and the Natural History Museum, London-United Kingdom. This study presents a meticulously compiled checklist of ground beetles representing new records for Pakistan. The checklist comprises of 35 species distributed across 5 subfamilies, 18 tribes, 27 genera, and 18 subgenera. Detailed distributional data for each species, accompanied by images depicting dorsal habitus, are provided.

FUNCTIONAL TRAITS DETERMINE SPECIES COMPOSITION UNDER DIFFERENT LEVELS OF DISTURBANCE IN THE URBAN GREEN INFRASTRUCTURE OF WARSAW, POLAND

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We used a functional ecological approach to investigate the factors determining the structure of beetle assemblages of selected habitats within the green infrastructure of a large European city. The objective of the study was to compare the beetle assemblages of urban forests, urban parks and

botanical gardens, and find out which species traits affect the community structure. All of the study sites comprised heterogenic mosaics of woodland and open habitat. We hypothesized that there was a disturbance gradient through the sites, from low to high disturbance in forest < park < botanical garden respectively. We sampled the beetle assemblages of each site using transects of pitfall traps, set at 5m intervals and with a minimum of 50m separation among transects. All of the beetles that were caught were identified to species, or at least to genus. The total catch was 3483 individuals of 243 species, comprising 389 individuals of 58 carabid species, 331 individuals of 49 staphylinid species, 1986 individuals of 41 curculionid species, and the remaining 777 individuals of 73 species represented 33 other coleopteran taxa. In this presentation, we focus on the role of functional and morphological traits in determining the community composition in relation to level of disturbance and mainly focus on the assemblage of carabid species.

EXPLORING THE RELATIONSHIP BETWEEN CARABID ASSEMBLAGE, SEED PREDATION, AND VEGETATION STRUCTURE IN A REMNANT NATIVE PRAIRIE PATCH

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Carabid beetles contribute to biocontrol of pests and weeds in agricultural fields and as such, their conservation within a landscape is desirable. Fragmentation of the agricultural landscape can reduce populations of carabids and thus, the beneficial ecosystem services they provide. In Canada, remnant native prairie (undisturbed) patches may provide an important refuge for carabids within an otherwise unsuitable cropped landscape. Here, we characterized carabid assemblages and their relationship with seed predation and vegetation structure in a 130 ha remnant prairie patch in Saskatchewan, Canada. We sampled carabid beetles with pitfall traps and quantified seed removal of volunteer canola (*Brassica napus* L.) and kochia (*Bassia scoparia* L.) using seed cards within exclosure cages. We also explored the relationship between carabid activity-density and weed seed predation, as well as the relationship between carabid assemblages and plant vegetation. Carabid assemblages in the prairie were largely dominated by a high abundance of predatory carabids, and overall activity-density was low. Seed predation tended to peak mid-season (late-July), while carabids tended to consume more kochia (27%) than volunteer canola (19%) in the native prairie. Carabid activity density-tended to be negatively related to seed predation. Multiple carabid taxa showed associations with the vegetation structure surrounding the pitfall traps, indicating that vegetation structure seems to play an important role in driving the heterogenous distribution of carabids observed. This study suggests a positive effect of remnant native prairie patches on the diversity of carabids, especially those associated with prairie or (aspen) stands.

Abstracts of Posters

(in alphabetical order of presenting authors)



DO CARABIDS (COLEOPTERA: CARABIDAE) RESPONSE TO NATURE CONSERVATION MANAGEMENT INCREASING STRUCTURAL DIVERSITY IN TWO HUNGARIAN OAK FORESTS?

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The LIFE4OAK FORESTS project targets reversing EU oak forest biodiversity decline from human activity. Baseline studies in Hungary's Pilis and Börzsöny mountains aim to restore forest structure and species diversity. In 2019, two 80+ year-old semi-dry oak forests underwent baseline study. Each plot had a 1-hectare control and intervention area to observe responses by carabids, saproxylic beetles, mammals, and birds. Small gaps were created in 2021, and deadwood was added to enrich the environment. The ground beetle monitoring with 12 traps for 2019 and 2021 showed 842 specimens of 36 species, mostly common in native oak woodlands. *Pterostichus hungaricus* was the most abundant species (140 specimens), followed by *Carabus convexus* and *Harpalus atratus* with 107 and 73 specimens respectively. Assessing treatment impacts on ground beetle populations remains difficult at this early stage.

IMPACT OF URBANIZATION ON THE DIVERSITY AND ABUNDANCE OF THE CARABID POPULATION IN THE FEEDING ENVIRONMENTS OF THE WHITE STORK (*CICONIA CICONIA* L., 1758) IN THE EXTREM EAST OF ALGERIA (PERIOD 2000-2021)

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The white stork (*Ciconia ciconia* L., 1758) is an insectivorous bird par excellence. Its opportunism makes it possible to provide valuable information on its location, such as monitoring the dynamics of entomological populations which frequent this environment which is experiencing serious disturbances linked to urban expansion during the period 2000-2020, hence the interest of this contribution. The study is carried out in the steppe region of Tébessa in the Extrem east of Algeria and the sampling location of El Merdja is home to the main colony of White Stork (a hundred individuals), during the period 2000-2021. The methodology consists of analyzing the bird's rejection pellets by wet method, extracting the fragments of Carabidae, identifying them under a binocular magnifying glass then counting them. The results obtained showed in terms of diversity that three main subfamilies have been identified: Harpalinae, Pterostichinae and Carabinae grouping several species such as: *Poecilus vesicolor*, *Poecilus cupreus*, *Harpalus punctatostriatus*. The study of the temporal dynamics of the wading bird's food resources revealed a considerable decrease in the overall portion of carabids in its diet during the years of study, and monthly and annual fluctuations in the composition of the carabid population with the disappearance of some sensitive species such as *Licinus punctatulus* and the persistence of other species such as *Acinopus*

megacephalus. These results show that generalist insectivorous birds can be used in the field of monitoring populations in natural environments.

INTEGRATIVE PHYLOGENOMICS REVEAL THE MOST COMPREHENSIVE PHYLOGENY OF CARABIDAE THROUGH SEQUENCE CURATION OF AVAILABLE ADEPHAGAN DATA

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High-throughput sequencing of genome wide molecular data has rapidly increased the available data necessary to understand the tree of life. Recently, the beetle suborder Adephaga has been examined with diverse genomic data collection methods; namely RNAseq transcriptomics, genomes, and target sequence capture. This research addresses the extent to which all these data can be integrated. In doing so, the most comprehensive phylogeny of Carabidae using phylogenomic data is inferred. Composed of nearly 40,000 described species, it is the most diverse family of Adephaga. Even with many studies focusing on the systematics and taxonomy of Carabidae lineages, a thorough phylogeny using genome wide data is lacking. Using an integrative approach we gather available transcriptomic, genomic, ultraconserved elements, and anchored hybrid enrichment of exons for phylogenomic inferences. We refined our bioinformatic workflow by curating sequence data, using only the targeted probe region of sequence capture data and accounting for co-genic loci. This results in a 2,471 locus matrix including 79 Carabidae from 13 subfamilies for maximum likelihood and fossil-calibrated phylogenetic inference. We find good support for the placement of most accepted subfamilies within Carabidae and lineages previously recognized as separate are placed within. Lastly, the time tree suggests that Carabidae appeared during the Triassic at least 220 million years ago. While taxonomic selection is more complete, there are still numerous missing Carabidae subfamilies. However, the bioinformatic pipeline developed illustrates that integrating available data with new data can provide the denser taxonomic sampling necessary to clarify relationships within Carabidae.

Student's contribution

CAN CARABIDS BE USED TO EVALUATE THE RESTORATION OF HEATHLAND AND DRY GRASSLAND IN THE NORTHWEST OF BELGIUM?

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In the northwest of Belgium dry grasslands and heathland dominated by *Calluna vulgaris* and *Erica cinerea* (reaching its most northern distribution) disappeared more than 100 years ago due to afforestation of these open fields, lack of grazing by sheep and changing land use. Restoration of this lost vegetation was initiated since 1980 by removing of forests and in some cases removal of

the top layer of certain arable fields and clear-cuttings. The latter was particularly done in sites where recent intensive agriculture had taken place. However this type of restoration was only done very fragmentary and in some isolated cases. The presence of a seed bank of *Erica*, *Calluna* and other typical plants of dry nutrient poor grasslands and heathland resulted in the reappearance of typical heathland and dry nutrient poor grassland patches. Indeed the botanical restoration seems to be very successful and fast. But what about the insects typical for heathland and grassland that were abundant more than 100 years ago? Were they able to survive in the region and recolonise these patches? In this study we tried to evaluate the current heathland and grassland restoration management and the success of this restoration using carabids as indicator group.

To investigate carabid communities composition, pitfall traps had been installed since 2014 in more than 60 recently restored heathland and dry grassland patches and nearby forests. In two of these patches on a former maize field, carabid communities were followed for 10 years representing a succession from open sandy heathland dominated by lichens to a full grown *Erica cinerea* and *Calluna vulgaris* vegetation. The diversity and abundance of some typical heathland and grassland species changed during this period. We also found differences in carabid composition in the studied sites which differed in land use history (forests, agricultural use, etc), restoration interventions, current management and distance to other heathland and grassland patches.

GROUND BEETLES (COLEOPTERA, CARABIDAE) AS INDICATORS OF POSTFIRE ECOSYSTEM RECOVERY UNDER DIFFERENT FOREST RESTORATION TECHNIQUES

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Forest fire is an important driver of ecosystem dynamics worldwide, often disturbing soil properties and assemblages of soil and epigeic organisms. Ecosystem recovery effectiveness after fire is depend on many factors including forestation types (e.g. by different tree species) or spontaneous revegetation possibilities. In this study we analyzed the effect of afforestation by Scots pine, common birch and spontaneous revegetation as well as the soil type (loams and sands) on the diversity and life history traits of ground beetles (Coleoptera, Carabidae) as bioindicators of ecosystem recovery effectiveness in a large postfire area. The fire that occurred in this area on August 1992 was one of the largest fires in Europe after World War II. After the fire, all remaining trees were cut and postfire sites was replanted during 3 years. Non-metric multidimensional scaling (NMDS) revealed the significance differences in carabid species composition between sites afforested by Scots pine, common birch and spontaneously regenerated, on sand and loam soils. The highest abundance and diversity of carabids was observed in sites regenerated spontaneously or afforested by birch. Also in case of life traits, the tree species and type of regeneration had the strongest impact on abundance of forest predators species. We conclude that an approach based on diversity and life-history traits of Carabidae can be a useful tool indicating the direction and effectiveness of ecosystem recovery in postfire areas and can be used as a measurable criterion for assessment of regeneration activities.

INFLUENCE OF VARIOUS MEADOW MANAGEMENT ON THE GROUND BEETLE (COLEOPTERA, CARABIDAE) ASSEMBLAGES

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Meadows in river valleys are potential habitats for valuable entomofauna of ground beetles, but land-use changes and the intensification of meadow management can lead to changes in their assemblage structure. In the present study, the effect of meadow management type on species composition, abundance, richness and some life traits of ground beetles were studied. The study area consisted of agriculturally used wet meadows located in north-eastern Poland, in the valley of the Narew River. Ground beetles were caught using pitfall traps in 27 extensively and intensively (with mineral and organic fertilization) used meadows in 2017, 2018 and 2019. As a result of the study, 7013 specimens of the ground beetles belonging to 78 species were caught. The most abundant were the macropterous open area species, with a spring type of breeding and moderate to high moisture requirements, belonging to the medium and large zoophages and hemizoophages. The dominant species in the studied meadows were *Poecilus versicolor*, *Amara communis*, *Anisodactylus binotatus* and *Carabus granulatus*, but the domination structure was more even in extensively managed meadows. Our results show differences between meadow management types in species composition, abundance, and some life traits of ground beetles. In intensively managed and manure-fertilized meadows, carabid richness was the lowest in comparison to intensive with mineral fertilization and extensive meadows. Still, the highest Carabidae abundance was observed in intensively managed, mineral-fertilized meadows.

INCREASED EXPLORATORY BEHAVIOUR DURING THE BREEDING SEASON IN A GROUND BEETLE, *CARABUS CONVEXUS*

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The first level animals react to varying environmental conditions is behaviour, which may be modulated by sex, size, physiological state, condition, age, dispersal ability, and developmental stage. However, even arthropods display consistent behaviour across various situations and through time: they have personalities. However, little is known whether these personalities are inflexible or seasonally change. We investigated seven behavioural parameters of breeding and non-breeding individuals of *Carabus convexus*, a forest specialist ground beetle. Individuals behaved consistently across situations and over time, meaning they had personalities. The studied behavioural measures were divided into two groups of traits. The first can be linked to exploratory behaviour, while the other to risk-taking. Both females and males were more exploratory during than outside the reproductive period. Increased exploratory behaviour during the breeding season in males could be explained by the search for mating partners. In females, the same activity can be related to their need for high quality food required to produce eggs as well as to find microsites suitable for oviposition.

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THE INFLUENCE OF BODY SIZE ON THE SENSITIVITY OF GROUND BEETLES (CARABIDAE) AND ROVE BEETLES (STAPHYLINIDAE) TO PYRETHROID INSECTICIDES

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Insecticides effectively control the number of harmful species, but at the same time significantly disrupt the biological balance in agrocenoses and adjacent ecosystems. The material was collected in the spring-summer period of 2023 on the territory of forest ecosystems in the vicinity of Kaunas (Lithuania) using standard entomological methods. In laboratory conditions, a relationship was revealed between the body size of insects and their resistance to cypermethrin. The shorter the body length and weight of the arthropods, the higher their sensitivity to the insecticide. Small rove beetles *Aleochara lanuginosa* Grav., *Oxytelus sculptus* Grav. and ground beetles *Epaphius secalis* (Payk.) are weakly resistant to cypermethrin (LD50 mean \pm standard error $0,49 \pm 0,31$, $0,124 \pm 0,094$, $4,54 \pm 2,65$ g/ha, respectively). Median lethal dose for species with larger body sizes are significantly higher. The ground beetles *Pterostichus niger* (Schall.), *P. melanarius* (Ill.), *Pseudoophonus rufipes* (De Geer), *Nebria brevicollis* (F.), *Calathus ambiguus* (Payk.) ($58,29 \pm 9,88$, $45,78 \pm 7,33$, $41,75 \pm 7,71$, $23,20 \pm 7,49$, $20,85 \pm 5,00$ g/ha, respectively). However, exceptions have been identified. Some large species of the genus *Carabus* show high sensitivity to insecticide, inconsistent with body size (*Carabus granulatus* L. – $0,51 \pm 0,36$, *C. hortensis* L. – $0,83 \pm 0,60$ g/ha). Rove beetles are less resistant to cypermethrin. The most sensitive species of the genus *Philonthus* (*Ph. decorus* (Grav.) – $0,0029 \pm 0,0058$, *Ph. rectangulus* Sharp – $0,0035 \pm 0,0062$ g/ha). Thus, for the species studied, a wide range of variations in the values of median lethal dose of cypermethrin has been established. In most species, there is a relationship between body size and sensitivity to this insecticide.

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PRELIMINARY DATA ON THE CARABID FAUNA IN THREE DIFFERENT FOREST ECOSYSTEMS OF THE BENISALEH RESERVE IN BOUCHEGOUF (GUELMA, ALGERIA)

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This study, carried out from December 2019 to May 2020 in the forested area of the Béni Saleh nature reserve in Bouchegouf, Guelma, Algeria, was conducted within the context of biodiversity and ecology research on carabids, beetle insects that play a vital role in forest ecosystems. The carabids were captured using pitfall traps, recording a total of 10 carabid species. The dominant species encountered in the habitats are *Percus lineatus* and *Orthomus rubicundus*. Further analysis showed that the oak forest population exhibited greater diversity compared to cork oak and

eucalyptus populations. Among the species identified in the three populations, two protected species were listed according to Algerian legislation: *Eurycarabus faminii* and *Calosoma inquisitor*, recognized for their significant role in controlling forest pests.

MOVEMENT ECOLOGY OF THE BLUE GROUND BEETLE (*CARABUS INTRICATUS*) ASSESSED THROUGH RADIO-TELEMETRY IN AN ANCIENT TEMPERATE ATLANTIC RAINFOREST FRAGMENT IN THE U.K.

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Insect populations have been declining at alarming rates across Europe. Key traits that make species more vulnerable to decline and extinction include slow life histories, dispersal limitations, and habitat specialism. *Carabus intricatus* (Coleoptera: Carabidae) Linnaeus, 1761 is a threatened ancient woodland specialist in the U.K. with a highly restricted distribution. Little is known about their general ecology and nothing is known about their movement ecology despite its likely importance to conservation and management of the species. We attached radio transmitters to 35 *C. intricatus* individuals and monitored their daily and nightly movements over an eight-week period. Males and females behaved differently to one another, with males travelling further during the study period on the ground and up and down trees, whilst females spent longer in refugia sites, with different preferences for refugia substrate. Warm and humid weather considerably increased movements, and we found clear evidence for avoidance of forest edges, highlighting forest fragmentation as a barrier to dispersal in this flightless species. The sex differences observed, edge avoidance behaviour, and response to weather fluctuations have direct implications for conservation management of the species. Our results point to an uncertain future for this sensitive species; small, irregularly sized patches of forest may not be suitable for long-term persistence, and climatic shift may drastically alter movement parameters.

Student's contribution

CARABID BEETLES IN THE HIGH-ALTITUDE ALPINE ENVIRONMENT OF "PARCO DI PANEVEGGIO" (ITALY): *NEBRIA GERMARI* AND ITS TROPHIC NETWORK

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Since 2008 we have been studying the distribution of carabid beetles in the protected area of the Paneveggio - Pale di S. Martino Park in the Dolomites landscape. In particular, we have focused on a region situated between 2400m to 3000m, where soils have scarce vegetation, scarce organic matter, and are affected by long and severe winters. In this extreme environment, *Nebria germari* is the most representative species of Carabids (Pizzolotto, 2024), playing the role of model species. We have used molecular methods to investigate the food preferences of this carabid. There is no detailed information on potential preys (i.e. small invertebrates) living in this area of the Parco di Paneveggio. We first collected information from the published literature on arthropods and other

invertebrates living in other Alpine Tundra ecosystems. Based on these data, we have designed general primers to amplify Collembola, Diptera, Hemiptera, Lepidoptera, Oribatida, Aranae, Opilionidae, Anellida and Gasteropoda. We tested the primers on small invertebrates collected from Paneveggio Park, and used those pairs that gave positive and specific results on the gut content of *Nebria* samples. Although very preliminary, our data confirm the generalist feeding behaviour of *Nebria*, which eats collembola, mites, earthworms and snails, suggesting that in harsh sites, the food choice is driven mainly by the availability of the preys.

**Presenting author*

HOW DOES AI SEE CARABIDS? THE MORPHOLOGICAL ACCURACY OF IMAGE-GENERATING MODELS ON REALISTIC GROUND BEETLE IMAGES

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Computer vision and similar AI-based methods slowly precipitate into everyday ecology, especially into automated monitoring, identification or behavioural studies. Although these object detection-based methods can identify taxa even at a species level, little is known about how AI fares in the opposite process: in generating realistic images of various insects. Here, I explore the diversity and morphological accuracy of ground beetle images generated by three Generative Adversarial Network AI architectures, DALL-E, Adobe Firefly, and Playground AI. I prompted all three AIs to generate three composite images depicting ten Carabidae species and three images depicting members of the four largest subfamilies. By comparing the images, the most realistic ones at the family level were created by Adobe Firefly and the least Playground AI. The general diversity was the greatest in DALL-E but it also included images clearly not belonging to Carabidae. Although the visual resemblance was sometimes outstanding, the morphological accuracy was low and only Adobe Firefly was capable of conserving features such as antennal or tarsal structures and elytral ridges characteristic of the family. No GAN AIs fared well at the subfamily level. Indeed, all three models generated images with features characteristic of other taxa, most commonly Scarabaeidae or Lucanidae, most likely because of their high frequency among the photos found on the Internet.

PRELIMINARY STUDY OF GROUND BEETLES (COLEOPTERA: CARABIDAE) IN A FOREST ENVIRONMENT IN NORTHEASTERN ALGERIA

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Currently, biodiversity is declining rapidly due to several factors, including climate change, fires, pesticide use, and the destruction or fragmentation of natural habitats, often associated with agriculture and increasing urbanization. Arthropods play a vital role in biodiversity, and carabid beetles are particularly sensitive to environmental disturbances. To contribute to the conservation of

beetle diversity, we conducted a bioecological study of carabid fauna in a forest environment in northeastern Algeria. Sampling was conducted using 20 traps from March to June 2021. Analysis of species richness and abundance revealed differences between the two sampled stations (areas). One station is dominated by *Quercus ilex*, while the other by *Pinus halepensis*. We recorded 14 species in the first station compared to 8 species in the second. Data on species traits such as diet, dispersal ability, and habitat affinity indicate that predators, macropterous species, and hydrophilic species dominate in both habitats.

PREY DETECTED IN CARABIDS (CARABIDAE) IN MEDITERRANEAN AGRICULTURE AND THEIR POTENTIAL IN BIOCONTROL

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Carabid beetles are among the dominant predatory arthropods in agroecosystems. Therefore, they can be significant in controlling the density of prey populations, including pest species. Besides carabids, other predatory arthropods like spiders, centipedes, and harvestmen are abundant in Mediterranean agriculture. With the applications of molecular biology techniques in discovering food web interactions in the last decade, especially the development of environmental DNA techniques, in situ analyses of very complex trophic interactions among invertebrates have been intensified, contributing to the knowledge of trophic ecology. Here, we present predator-prey field interactions analyzed within the MEDITERATRI project (HRZZ UIP 05-2017-1046). We will compare carabids' potential in the biocontrol of pest species with other arthropods in the field. Sampling was done in olive groves and vineyards in Zadar County, Croatia, in 2018 and 2019. The DNA was extracted from carabid guts, and DNA fragments were amplified in Polymerase Chain Reactions (PCR) using general arthropod primers and predatory excluding primers and sequenced using Illumina High Throughput. Besides, the field diversity of potential prey sampled using entomology net, pitfall traps, yellow sticky traps, and by hand was compared with consumed prey. It belonged to various invertebrates, including pest species, among which was a newcomer, alien invasive *Laodelphax striatellus* (Auchenorrhyncha), known as a vector of some phytoplasmas whose DNA was detected in the guts of *Leistus* spp. Individuals belonging to the *Poecilus*, *Pterostichus*, and *Leistus* genera were among the dominant carabids in the field and had the broadest prey range. Overlap in consumed prey species was observed with spiders and harvestmen but was in a lower portion than overall detected prey, supporting the value of the coexistence of various predatory arthropods in the field for biocontrol of a broad range of prey. The results highlight the importance of preserving diverse predatory fauna within agroecosystems. Also, state-of-the-art techniques can help detect invasive newcomers in agricultural sites and promote pest biocontrol by natural enemies.

CELEBRATING 65 YEARS OF GROUND BEETLE TRAPPING IN DRENTHÉ (THE NETHERLANDS)

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In 1959, Piet den Boer started trapping ground beetles in the surroundings of the Biological Station Wijster (Province of Drenthé, northern Netherlands), with a strong emphasis on the heathlands of the National park Dwingelderveld. This trapping program still continues today, making it the longest running time-series of terrestrial insects in the world. Over the years, the focus of the trapping program changed. Originally, the time-series were started to study the population dynamics of ground beetles, inspired by the seminal book on animal populations by Andrewartha and Birch (1954). After it became clear in the 1970's that the trapping sites were suffering from significant environmental problems, such as habitat fragmentation and drainage, restoration plans were made. These were implemented in the 1980's, until these culmination in 'Plan Goudplevier' ('Plan Golden Plover') in 1992. Here, large areas of agricultural lands were acquired to be restored to their original heathland state, enlarging the beetle habitat, and connecting reserves. In 1998, the biological station was dissolved, but the trapping program was continued by the WBBS foundation, led by Rikjan Vermeulen. Presently, the scientific focus of these time series lies on community ecology and explaining the declines in insect numbers. Nowadays the trapping program is taking over by Roel van Klink, the third generation. The beetle populations showed equally large changes, with a decline from 1959 until the 1970's, then a rise in numbers from the 1980's until the mid-1990's, and a steady decline since then. Presently, the beetle numbers are at an all-time low, which probably reflects poor habitat quality due to atmospheric nitrogen deposition and other external influences. Our poster details the dynamic history of this time series in celebration of its 65's birthday.

**Presenting author*

WHAT MAKES AN URBAN BEETLE? CARABID FUNCTIONAL TRAITS ALONG AN URBAN-RURAL GRADIENT IN TWO NEARBY CITIES

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Species' resilience to urbanisation can be associated with their functional traits, with species possessing traits that allow them to overcome the challenges associated with urbanisation expected to exist in greater densities in urban areas. General patterns of carabid species occurrence and traits have been identified among temperate cities. However, there is a lack of replicated research drawing direct comparisons between cities that are geographically close together and could be expected to be similar in environmental conditions, and therefore trends in biodiversity and species traits. The aim of this study was to investigate how 1) species richness and abundance, 2) community assemblage, and 3) functional traits of carabids vary across an urban-rural gradient in two nearby cities – Liverpool and Manchester, UK. We also explored which site variables (abiotic and biotic) were responsible for driving patterns observed. Carabids were collected from 80 sites along an urban-rural gradient in Liverpool and Manchester using pitfall traps. We found that carabid species richness significantly declined with increasing urban intensity in both cities. We

also found that trends in abundance along the urban gradient differed between Liverpool and Manchester, but that grass height was positively associated with carabid abundance in both cities. The two cities exhibited broadly overlapping communities, but the assemblage in highly urbanised sties represented a distinct subsection of the wider carabid community. We found surprising trends in functional traits that contradict previous studies, for example, species incapable of flight were more common in urban areas in both cities.

Student's contribution

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