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Comparisons of temporal changes in carabid communities inhabiting five different crops

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18th European Carabidologist Meeting

25-29 September 2017
Rennes - FRANCE

*Carabid contributions to
ecosystem services*

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SCIENTIFIC PROGRAM

Monday September 25th

9h00 – 11h00 **REGISTRATION**

11h00 - 11h30 **CONFERENCE OPENING**

11h30 **KEYNOTE 1.** David Renault. *Insect invasions: environmental adaptations, dispersal and spatial sorting in a carabid beetle invading subantarctic islands*

12h30 – 13h00 **SPECIAL SESSION: TRIBUTE TO PIET DEN BOER**

Rikjan Vermeulen & Hans Turin. *In Memoriam Piet den Boer: Fifty years of population dynamic research at the heathlands of the Dwingelderveld.*

13h00 – 14h30 **LUNCH**

SESSION 1: CARABIDS FACING GLOBAL CHANGES & LONG TERM PERTURBATIONS

14h30. Gabor Pozsgai & Michael Gallagher. *Climate driven size changes of ground beetles (Coleoptera: Carabidae)*

14h50. Karin Nurme *et al.* *Carabid beetle, Pterostichus oblongopunctatus, locomotor activity in changing temperature conditions*

15h10. Elena Piano *et al.* *Urbanization shifts carabid communities towards thermophilic and dispersive species*

15h30. Pierre Moret *et al.* *Monitoring the impact of global warming on high altitude carabid communities in equatorial Andes*

15h50. Roberto Pizzolotto. *Carabid long time sampling for monitoring the effects of climate change*

16h10. Presentation of posters - Session 1

16h30 – 17h00 **COFFEE BREAK**

17h00 – 17h30. Bretagne, a land of carabid beetles – Groupe d'ETude des Invertébrés Armoricaains (GRETIA)

9h00. **KEYNOTE 2.** David Bohan. *Carabid ecosystem services*

SESSION 2: REGULATION OF WEEDS AND PESTS

10h00. Stéphanie Aviron *et al.*. *Relationships between diversity of carabid communities and pest predation levels in different farming and landscape contexts in hedgerow network landscapes*

10h20. Britta Frei *et al.*. *Species-specific prey choice of carabid beetles in European cereal fields*

10h40 – 11h10 **COFFEE BREAK**

11h10. Laurence Albert *et al.*. *Opportunistic predation of Carabidae on cider-apple orchards pests in northwestern France*

11h30. Alice Charalabidis *et al.*. *Can obligatory omnivore carabids be useful for the biocontrol of weeds?*

11h50. Lucija Šerić Jelaska *et al.*. *Predation on the winter moth Operophtera brumata by carabid beetles*

12h10. Wouter Dekoninck *et al.*. *Migration patterns of some abundant carabid beetles in arable fields and their margins.*

12h30. Presentation of posters - Session 2

12h50 – 14h30 **LUNCH**

SESSION 3: LIFE HISTORY TRAITS & POPULATION DYNAMICS

14h30. Ainoa Pravia *et al.*. *Restoration trajectory of carabid assemblages and functional traits in Afforested open blanket bog*

14h50. Gaël Caro *et al.*. *Comparisons of temporal changes in carabid communities inhabiting five different crops*

15h10. Dorothea Nolte *et al.*. *Do species' traits shape carabid communities in forests?*

15h30. Eva Völler & Thorsten Assmann. *The pace of range expansion: a long-term study on the flightless ground beetle Carabus hortensis (Coleoptera: Carabidae)*

15h50. Estève Boutaud *et al.*. *Modelling ground beetle dispersal into semi-open habitats: dispersal functions and implication for conservation*

16h10. Presentation of posters - Session 3

16h30 – 17h00 **COFFEE BREAK**

17h00 – 19h00 **POSTER SESSION – PARTICIPATIVE BUFFET**

20h30 – 21h30 **FRANÇOISE BUREL'S CONFERENCE – Espace des Sciences (Rennes)**

Wednesday September 27th

9h00 – 20h00 **EXCURSION TO MONT SAINT-MICHEL'S BAY**

Thursday September 28th

9h00. **KEYNOTE 3.** Frederik Hendrickx. *Dispersal polymorphisms in carabids: ecological drivers, genomics and its consequences for community assembly.*

SESSION 4: SYSTEMATIC, TAXONOMY & EVOLUTION OF CARABIDS

10h00. Presentation of posters - Session 4 – 5 - 6

10h20. Carl Vangestel & Frederik Hendrickx. *Unravelling the genomic basis of wing polymorphism and evolutionary history of a parallel Calosoma beetle radiation at the Galápagos*

10h40 – 11h10 **COFFEE BREAK**

11h10. Katrien De Wolf & Frederik Hendrickx. *Unravelling the genomic basis of wing dimorphism in carabid beetles*

11h30. Thorsten Assmann *et al.* *Glacial refugia for carabids in Central Europe?*

11h50. José Serrano *et al.* *Barcoding and phylogeny outcomes of West Palearctic Carabidae*

12h10. Arnaud Faille. *Carabidae, a model for the study of evolution*

12h30. Thorsten Assmann *et al.* *Modern carabidology: Cybertaxonomy and cyberecology*

12h50 – 14h30 **LUNCH**

14h30. Best Posters – Prize Giving

SESSION 5: LANDSCAPE ECOLOGY OF CARABIDS

15h10. Rikjan Vermeulen *et al.* *The effect of different soil treatments for heathland regeneration on the carabid fauna after topsoil removal*

15h30. Benoît Ricci *et al.* *Spatio-temporal dynamics of weed seed eating carabid species in agricultural mosaics: variation of annual habitat quality of oil seed rape and role of grassy field margins*

15h50. Pascale Zumstein *et al.* *Are subtropical forests in China colonized by habitat-specific carabids?*

16h10. Emilie Pecheur *et al.* *Agri-environment schemes for carabids: complementary or redundant?*

16h30 – 17h00 **COFFEE BREAK**

17h00. Pietro Brandmayr *et al.* *Species traits and phylogeny of carabid communities across an environmental gradient from the nival belt of Dolomites to the salt marshes of Adriatic coast*

17h20. Colette Bertrand *et al.* *Effects of spatial and temporal heterogeneity of the crop mosaic on carabid beetles assemblages (Coleoptera: Carabidae)*

17h40. El Aziz Djoudi *et al.* *Local and landscape effects on the community structure and composition of dominant taxa of predatory arthropod (Coleoptera Carabidae) in winter wheat fields*

19h30 – 23h00 **GALA DINNER**

Friday September 29th

9h20. **KEYNOTE 4.** Johan Kotze. *Carabid beetles in urban environments: current knowledge and future prospects*

SESSION 6: COMMUNITY ASSEMBLY & INTERSPECIFIC COMPETITION

10h20. Tibor Magura & Gábor Lövei. *Environmental filtering is the main assembly rule of ground beetles in the forest and its edge but not in the adjacent grassland*

10h40 – 11h10 **COFFEE BREAK**

11h10. Béla Tóthmérész *et al.* *Recovery of ground-dwelling assemblages during reforestation with native oak*

11h30. Gloria Maria Ariza *et al.*. *Ground beetles of Dry Forest in the inter-Andean Magdalena Valley of Colombia*

11h50. Colin Bergeron *et al.* *Population dynamics of carabid and spiders from green roofs and adjacent ground sites in Edmonton, Canada.*

12h10. John Spence *et al.* *A 23-year record of colonization of a North American deciduous forest by the invasive carabid, *Pterostichus melanarius* Illiger*

12h30. Emilie Pecheur *et al.* *Conventional, simplified, organic: which crop management is more diverse in carabids?*

12h50 – 14h30 **LUNCH**

14h30. **CONFERENCE CLOSING SESSION**

SPECIAL EVENT

Tuesday, September 29th, 20h30

« Espace des Sciences »

10 Cours des Alliés, 35 000 RENNES

**Ground beetles: forest species and beneficial species.
25 years of research in the Zone Atelier Armorique
(in French)**

Françoise Burel
CNRS OSUR - Ecobio Rennes

Ground beetles are common insects in agricultural landscapes. In the Zone Atelier Armorique, on the site of Pleine Fougères, we have been studying these insects for 25 years. The network of hedges makes it possible to host forest species. For this the connectivity of the wooded network must be strong and the quality of the vegetation of the hedges isolated or bordering the green lanes bordered by two parallel hedgerows must also be sufficient. Crops, on the other hand, host many species that prefer open habitats and play an important role in pest control. The movements of these insects between the crops and the semi-natural elements of the landscape, mainly hedgerows, are constrained by the structure and dynamics of these landscapes. The abundance and richness of the carabid beetles in the crops depends on the spatial and temporal heterogeneity of the landscape and to agricultural practices. To better understand the functional role of these insects, precise studies of their diets must be developed in order to evaluate their impact on prey and to specify their place in food webs of agroecosystems.

ABSTRACTS

KEYNOTE 1

Insect invasions: environmental adaptations, dispersal and spatial sorting in a carabid beetle invading subantarctic islands

David Renault^{1, 2}

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²Institut Universitaire de France, Paris, France

ABSTRACT

The fast growing populations of aliens, their ecological niche shifts during biological invasions, and their accelerating expanding range in the introduced areas remain under deep investigation. It has been assumed that traits enhancing dispersal may be favoured in alien individuals at their expanding range edges, and the assortative mating among the dispersers could further enhance this phenomenon. Meanwhile, our current understanding of the evolutionary processes generating such phenotypic variation in dispersal ability remains incomplete. Here, we aimed at decrypting the fingerprint of dispersal evolution, and more generally phenotypic differentiation of the populations long the invasion gradient, using the well-known invasion chronosequence of a carabid insect at the French Kerguelen subantarctic islands. The flightless predatory carabid *Merizodus soledadinus* (Coleoptera: Carabidae) was uniquely introduced from the Falkland Islands 102 years ago at one site of the Kerguelen Islands. Since then, it colonized a large geographical area of the Kerguelen Islands. First, we examined if there are morphological variation along the invasion succession could be related to dispersal power? Second, physiological experiments (metabolomics) were conducted to identifying evolutionary network changes associated with differences in dispersal abilities. We mapped metabolomics data onto genome-scale metabolic networks so that we could restore the connectivity among identified metabolites. We observed that beetles sampled at the range margins were characterized by distinct physiological strategies as compared with their relatives sampled at the invasion core; large differences were observed in dispersal behavior, management of energetic budgets (starvation resistance) and metabolic signatures. Finally, survival durations to multiple environmental stressors in adult *M. soledadinus* insects collected along the invasion gradient revealed a significant correlation between residence time and stress resistance. Altogether, our data constitute a solid basis for post-introduction expansion modelling and further tests for evolutionary invasion analysis.

SPECIAL SESSION: TRIBUTE TO PIET DEN BOER

In Memoriam Piet den Boer: Fifty years of population dynamics research at the heathlands of the Dwingelderveld

Rikjan Vermeulen¹ & Hans Turin²

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² Stichting Faunistisch Onderzoek Carabidae, Renkum, the Netherlands, h.turin@hccnet.nl

ABSTRACT

Last year, in December 2016 Piet den Boer passed away. Piet den Boer was the last of the 3 famous European carabidologists, beside Carl Lindroth and Hans-Ulrich Thiele, that formed the modern carabidology. Piets most famous contribution was his theory named "Spreading of risk and stabilization of animal numbers" in 1968. Until that time, it was generally assumed that animal numbers were regulated by biotic factors, especially by population density. Since 1959 a large heathland area, close to the Biological Station of Wijster was sampled at several localities for ground beetles. In fact, this area can be considered as a large habitat island situated in surrounding agricultural land. Over the years, several ground beetle subpopulation or interaction groups appeared to fluctuate asynchronously although the total numbers caught in this area were stable. Small groups of animals could increase or decrease by simple stochastic processes rather than by regulating processes. With the island theory of MacArthur and Wilson in mind, this brought Piet to the idea that species need a certain size of habitat to persist in a long-term presence in the area, depending on radius of action and size of the species. New in this theory was that, also in mainland habitat islands, isolation and fragmentation could lead to local extinction of species. In the years after it became generally understood that areas of nature should be as large as possible or that they should be connected by dispersal corridors to prevent local and later on regional extinction of distinct species, especially where it concerns ecological specialists. The earlier view that, when a habitat has the right quality, a species will come there itself, was abandoned and nature managers started to enlarge nature reserves and build connective structures like ecoducts over habitat barriers, for instance, over highways.

KEYWORDS

Keywords: Population dynamics, Spreading of risk, dispersal, corridors, enlargement of heathlands & carabid beetles

SESSION 1: CARABIDS FACING GLOBAL CHANGES & LONG TERM PERTURBATIONS

ORAL PRESENTATIONS

Climate driven size changes of ground beetles (Coleoptera: Carabidae)

Gabor Pozsgai^{1,2} & Michael Gallagher²

¹The James Hutton Institute (Aberdeen, UK) (pozsgaig@coleoptera.hu)

²Aberdeen University (Aberdeen, UK) (michael.gallagher.11@aberdeen.ac.uk)

ABSTRACT

Climate change is influencing various aspect of insects' lives including their geographic distribution, behaviour and phenology. Changes in animals' ecology may result in a change in their physiology which has an effect their size. A decrease in insect body size as a result of climate change has been documented in numerous cases, though susceptibility of ground beetles to size changes has not been looked into yet. In order to investigate whether there is a size change in carabids, we measured several body dimensions of 2393 individuals of seven species. Specimens were collected, within the UK Environmental Change Network (ECN) framework, at two locations in Scotland from 1994 to 2012. Weather variables were obtained from the ECN database and correlation between these and beetle size variables was tested. Elytra length significantly decreased in six out of the seven species over the sampling period but the width of elytra did not show a significant change. Redundancy analysis showed a significant relationship between winter and spring temperatures and elytra length. There is little understanding of the biological mechanisms behind these processes but one of the most plausible explanations is that there may be a lower larval growth efficiency at higher temperatures. A generally shortening time window for larval development, caused by changing phenology, may also thus result in a decreased size of the adult beetles.

KEYWORDS

Climate change, UK Environmental Change Network, long-term

Carabid beetle, *Pterostichus oblongopunctatus*, locomotor activity in changing temperature conditions

Karin Nurme, Anne Must & Enno Merivee

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ABSTRACT

Many aspects of ectotherms life is affected by external temperature conditions. Therefore, thermosensation and thermoregulation are crucial for survival of ground dwelling carabid beetles. Research in sensory physiology with *Pterostichus oblongopunctatus* has shown change in the reaction of antennal thermoreceptor neurons at temperatures above the species preferred temperature. From 25 °C these neurons in dome shaped sensilla start to change from regular impulse firing to firing in bursts. We hypothesize that temperature dependent impulse bursts are involved in beetles' behavioural thermoregulation. Behavioural experiments were carried out on the arena inside the environmental test chamber in two different temperature conditions – one with linearly increasing and other with constant temperature conditions. The temperature were increased from 10 °C to 40 °C linearly during 50 min on first case and with 5 degree steps on second case with duration 50 min each step. Using automated video tracking system locomotion parameters (velocity and travelled distance) were measured. The low and high activity zones in insects' behaviour were observed, the threshold temperature where the change from one to another occurred was at 25.8 °C. This indicates that the hypotheses was correct and indeed, there is a link between spike burst of thermoreceptor neurons and the behavioural thermoregulation of the ground beetles.

KEYWORDS

Coleoptera; Carabidae; behavioural thermoregulation; locomotion parameters; peripheral spike bursting

Urbanization shifts carabid communities towards thermophilic and dispersive species

Elena Piano, Katrien De Wolf & Frederik Hendrickx

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ABSTRACT

The increasing conversion of agricultural and natural areas to human-dominated urban landscapes is predicted to lead to a major decline in biodiversity worldwide. This is mainly due to the alteration of several environmental parameters in urban environments compared to the surrounding landscape, like increased temperature and high isolation and turnover rates of natural patches. The alteration of environmental conditions in urban areas is expected to both select species with traits that make them pre-adapted to urbanization and filter out maladapted species. However, these selective processes in urban areas are still currently poorly understood. We here take advantage of a hierarchically nested sampling design to investigate the effects of urbanization on ground beetle communities in Belgium. In particular, three local-scale (200 x 200 m) urbanization levels were repeatedly sampled across three landscape-scale (3 x 3 km) urbanization levels for a total of 81 sampling sites. Our results showed that communities sampled in the most urbanized sites and landscapes displayed a distinct species composition compared to the most rural ones. We then related community means of species-specific thermal preferences and dispersal capacity (based on European distribution and wing morphology, respectively) to the urbanization gradients to test for a selective filtering of species based on their traits. We showed that urban communities were mainly composed by species preferring higher temperatures and with better dispersal capacities compared to rural communities. These shifts were caused by both a replacement of species preferring low temperatures with species tolerating high temperatures, and the loss of species with poor dispersal capacity in the most urbanized sites. Overall, our results demonstrate that urbanization exerts a strong filtering effect on species traits, like thermal niche and dispersal capacity, with a consequent change of ground beetle community composition. Given that most carabids are predators that can exert a significant top-down control on invertebrate communities, changes in their trait values may have strong repercussions on lower trophic levels, and as such impact ecosystem goods and services.

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KEYWORDS

metacommunity, urban heat island effect, habitat loss, thermal niche, dispersal capacity

Monitoring the impact of global warming on high altitude carabid communities in equatorial Andes

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ABSTRACT

Climate warming is quickly triggering changes in species distribution and community composition, specifically at high elevations. On the other hand, the effect of climate change on some mountain chains is still little known due to the limited taxonomic and species-ecology knowledge. This is the case of paramo and proglacial ecosystems of equatorial Andes. Therefore, in 2015, we have begun a project focused on carabid beetle assemblage distribution in relation to high altitude climate changes in Ecuadorian Andes. To reach this goal we are: 1. comparing surveys of the nineteenth and twentieth centuries with current observations; 2. developing standardised sampling protocols for long-term monitoring of species distribution and species activity density along several altitudinal transects and glacier forelands. In addition, in 2016, we selected three different mountains (Antisana, Pichincha and Carihuairazo), on transects ranging from 4400 to 4800 m a.s.l., where the performance of two sampling methods, pitfall traps and hand searching, has been compared. This is a focal point for calibrating sampling effort in harsh environments. The preliminary results are shading light on range shifts or contractions in response to climate change.

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KEYWORDS

Carabid communities, Climate change, Andes, Ecuador, tropical alpine biodiversity

Carabid long time sampling for monitoring the effects of climate change

Roberto Pizzolotto

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ABSTRACT

When evaluating the effects of climate change on animal species playing the role of ecological indicators, as Carabid beetles, it is important to assess whether the features of the fauna observed in a given time are consistent over long time intervals or if they show variations correlated with the trend of the yearly average temperature. It is possible to get this information by means of a permanent sampling approach (similar to the permanent square used by botanists). This type of research is gaining attention in entomological researches and could provide original data with which to evaluate the influence of climate changes on annual population density of invertebrates sensitive to temperature variation at least. After having studied the species distribution and species traits characterising an Alpic ecological landscape (Pizzolotto et al., 2014, 2016), we started a long time sampling campaign with the aim of monitoring the changes of Carabid abundance in two high altitude sites among those sampled in the past years. The first results are given about:

- environmental characteristics of the area where to set a permanent sampling site
- useful time for sampling
- data from the first samples

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KEYWORDS

Alps, Carabid beetles, climate change, ecological indicators

SESSION 1: CARABIDS FACING GLOBAL CHANGES & LONG TERM PERTURBATIONS

POSTERS

Response delay of carabid diversity to past management practices and landscape context of field margins

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LTER - « Zone Atelier Armorique », UMR 0980 BAGAP, 35042 Rennes, France

ABSTRACT

Field margins are key features of agricultural landscapes, especially in northwestern Europe where field margins planted with trees, i.e. hedgerows, are the dominant type of semi-natural habitats (Burel and Baudry, 1995). They have a wide range of purposes, including agronomical, ecological and cultural functions (Baudry et al., 2000). In particular, they support farmland biodiversity such as carabids by providing overwintering sites, food resources and shelters (Meek et al., 2002). However, little is known about the effects of management practices of field margins on biodiversity, and their historical dimension, in terms of past management practices and landscape context, is rarely considered. Here, we assessed the relative influence of current and past management practices and landscape heterogeneity (during the last five years) on the local diversity (species richness and composition) of carabid assemblages of field margins in agricultural landscapes of Brittany, France. More specifically, we tested whether there is a time lag in carabid diversity response to local management and landscape factors. We found that current carabid diversity was best explained by management practices and landscape heterogeneity measured four or five years ago. This result suggests the existence of a time lag in the response of carabid assemblages to past environmental conditions of field margins. The influence of past management practices was overall higher than the influence of past landscape heterogeneity. Carabid diversity was higher in grazed or sprayed field margins probably due to increased heterogeneity in habitat conditions. Field margins surrounded by grasslands and crops harbored carabid species associated to open habitats whilst forest carabid species dominated field margins surrounded by woodland. Landscape effect was scale-dependent and mostly detected at fine spatial scale, within 50 m around field margins. Our study highlights the importance of taking account of time to understand current patterns of carabid species. We suggest that landscape management actions and conservation strategies consider the possibility of time-lagged responses when studying biodiversity patterns in agricultural landscapes.

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KEYWORDS

time-lag, carabid assemblage, species richness, composition, landscape heterogeneity, herbicide spraying, grazing

Urban heat island and biological time-lags along a rural-urban gradient. A case study on carabid beetles in Rennes, France.

Solène Croci, A. Médrignac, X. Foissard, H. Quénoel & J. Nabucet

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ABSTRACT

Urban development, characterized by the presence of buildings and impervious surfaces, modify the local climate and in particular, enhance the urban heat island. This phenomenon raises temperatures in cities at night, which could cause discomfort and over-mortality during heat waves. However, parks and green areas appear to be colder than built-up areas (Oke 1987). This urban heat island is known to generate early growth stages of certain plants (Chmielewski and Rotzer 2001; Sparks et al. 2001; Mimet et al. 2009). Despite not numerous, some studies also tend to show an effect of the UHI on animals (e.g.: Baur and Baur 1993; Parris and Hazell 2005; Youngsteadt et al. 2017). To our knowledge, there are no studies on the effect of the UHI on carabid beetles. However, those insects have a larval development that takes place in the soil and that is sensitive to temperature (Saska and Honek, 2003). In addition, their activity seems sensitive to ground temperature (Tuf et al. 2012). In this study, we want to evaluate the role of the UHI of Rennes (Brittany, France) on the emergence and activity of carabids beetles along a gradient of urbanization. In 2013, we investigated the carabid beetles' assemblages and the evolution of the inner temperatures of 19 woodlots distributed from the town center of Rennes to its more rural surroundings. In each woodlot, the carabids' activity was estimated using 6 pitfall traps and the carabids' emergence was estimated using 3 emergence arenas of 1m² (2 pitfall traps in each). Those traps and arenas were continuously opened from May to July 2013 and insects collected every 5 days. In parallel, on the same period, we continuously recorded atmospheric (with Tinytag) and soil (with Hobo tags) temperatures in each of the 19 woodlots. First, we will study the temporal and spatial dynamic of the atmospheric and the soil temperatures along the rural-urban gradient. Then, on the basis of previous study of the UHI of Rennes (Foissard 2015), we will investigate the landscape metrics (composition and configuration) that favored this UHI. Finally, we will analyze the potential time lags of the carabid's activity and emergence along the rural-urban gradient and will estimate the role of the UHI and /or the landscape on those time lags and on the species assemblages along this rural-urban gradient.

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KEYWORDS

Carabid beetles, Urban heat island, biological time-lags, activity, emergence, rural-urban gradient.

Relative importance of sex, pre-starvation body mass and structural body size in the determination of exceptional starvation resistance of *Anchomenus dorsalis* (Coleoptera: Carabidae)

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ABSTRACT

In nature, almost all animals have to cope with periods of food shortage during their lifetimes. Starvation risks are especially high for carnivorous predatory species, which often experience long intervals between stochastic prey capturing events. A laboratory experiment using the common predatory carabid beetle *Anchomenus dorsalis* revealed an exceptional level of starvation resistance in this species: males survived up to 137 days and females up to 218 days without food at 20°C. Individual starvation resistance was strongly positively affected by pre-starvation body mass but only slightly by beetle structural body size per se. Females outperformed males even when the effect of gender was corrected for the effects of structural body size and pre-starvation body mass. The better performance of females compared to males and of beetles with higher relative pre-starvation body mass could be linked to higher fat content and lean dry mass before starvation, followed by a greater decrease in both during starvation. There was also a difference between the sexes in the extent of body mass changes both during ad libitum feeding and following starvation; the body masses of females fluctuated more compared to males. This study stresses the need to distinguish between body mass and structural body size when investigating the ecological and evolutionary consequences of body size. Investigation of the net effects of body size and sex is necessary to disentangle the causes of differences in individual performances in studies of species with significant sexual size dimorphism.

KEYWORDS

Body condition, fat content, insect, lean dry mass, longevity, sexual dimorphism, structural body size, variance partitioning

The history-based edge effect hypothesis: various responses of ground beetles in natural versus anthropogenic edges

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ABSTRACT

Worldwide fragmentation and loss of natural habitats increase the occurrence of habitat edges that are transitional zones between adjoining ecosystems or habitats. Once created, edges are distinguishable by their maintaining processes: natural vs. continued anthropogenic interventions (forestry, agriculture, urbanization). According to our history-based edge effect hypothesis, dissimilar edge histories are reflected in the diversity and assemblage composition of their inhabitants. Testing this hypothesis, we evaluated available information on ground beetles (Coleoptera: Carabidae) in forest edges. A meta-analysis based on 39 publications showed that the diversity-enhancing properties of edges significantly varied according to their history. Forest edges maintained by natural processes had significantly higher species richness than their interiors, while edges under continued anthropogenic influence did not. The filter function of edges was also essentially different, depending on their history. For forest specialist species, edges maintained by natural processes were penetrable, allowing these species to move through the edges, while edges still under anthropogenic interventions were impenetrable, preventing their between-fragment dispersal. For species inhabiting the surrounding habitats (open-habitat and generalist species), edges created by forestry activities were penetrable, and such species also invaded the forest interior. However, natural forest edges constituted a barrier and prevented the invasion of matrix species into the forest interior. Preserving and protecting all edges maintained by natural processes, and preventing anthropogenic changes to their structure, composition and characteristics are key factors to sustain biodiversity in forests. Anthropogenic edges may contribute to the loss of biodiversity; thus, the restoration of edges under continued anthropogenic intervention is an urgent task in conservation management. Promoting habitat heterogeneity, and reducing the contrast between these edges and the surrounding habitats (softening the edges) to encourage movement of forest specialist species through the edges are crucial tasks during restoration.

KEYWORDS

Dispersal, edge effect, filter function, forest edges, invasion, species richness

KEYNOTE 2

Carabid ecosystem services

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ABSTRACT

Much of the ecological carabid literature, particularly that stemming from agriculture, emphasises that carabids are highly abundance and diverse and are agents of ecological function. Since 2005, and the Millennium Ecosystem Assessment (MEA), the literature has emphasised that the ecological functions that carabids do are also ecosystem services because they are socio-economically valued by man. Aphid control, slug predation and weed seed regulation have all been recently studied and cast as ecosystem services.

In France, as part of the commitment to produce an ecosystem service monitoring and management plan as a response to the MEA, the ÉVALUATION FRANÇAISE DES ÉCOSYSTÈMES ET SERVICES ÉCOSYSTÉMIQUES (EFESE) project has mapped carabid derived weed seed regulation, across the whole of France, as a core ecosystem service of farmland. In this talk I present how this mapping work was done and how the maps might be used to preserve and improve ecosystem service supply, but more importantly the 'pitfalls' of mapping ecosystem services and fixing in two dimensions the distribution of what is a highly dynamic and context-specific ecological function.

SESSION 2: REGULATION OF WEEDS AND PESTS

ORAL PRESENTATIONS

Relationships between diversity of carabid communities and pest predation levels in different farming and landscape contexts in hedgerow network landscapes.

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ABSTRACT

Biological control of pests by their natural predators is considered as a key ecological process to reduce pesticide use in modern agricultural systems. A problematic issue in actual researches on biological control is the absence of consensus regarding the relationships between the diversity of natural predators of pests and levels of pest control. Whilst some studies have shown the importance of predator abundances or species richness (Snyder et al. 2006), others have highlighted the role of predator species identity in pest predation levels (Straub et al. 2006). Another crucial issue is to determine the environmental factors that drive the key components of predator diversity involved in pest control. Existing literature reports positive influences of low input farming practices (especially organic farming) at the field or farm scale (Bengtsson et al. 2005), and of spatial landscape heterogeneity related to the amount of semi-natural habitats (Bianchi et al. 2006). More recently, some studies have also explored the role of farming system heterogeneity at the landscape scale, but led to contradictory results (Puech et al. 2015; Diekötter et al. 2016). In the present study, we investigate the relationships between the diversity of predatory carabid beetles and pest predation levels in crops, considering different contexts in terms of field farming systems (organic vs. conventional farming) and landscape heterogeneity related to both semi-natural habitats and farming systems. We use data from a pluriannual survey of carabid beetles and predation levels of sentinel preys (aphids and weed seeds) in 20 cereal fields located in hedgerow network landscapes, in western France.

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KEYWORDS

Organic farming, landscape context, predatory carabid beetles, arthropod diversity, aphid and weed predation, hedgerows.

Species-specific prey choice of carabid beetles in European cereal fields

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ABSTRACT

Trophic interactions between species in agroecosystems provide key regulation ecosystem services and therefore also determine the dynamics, robustness and resilience of service provision. To achieve international goals of reducing application of pesticides without compromising key provisioning ecosystem services such as crop yield, recent research attaches importance to the biological control potential of carabid beetles. However, apart from feeding on pest species and weed seeds, carabids also consume non-pest prey (alternative prey) such as collembolans and earthworms, which can play a contradictory role in the efficacy of pest and weed control. Most carabids are described as generalist predators, although some species appear to be predominantly carnivorous whereas others are rather strict granivorous. The trophic plasticity in omnivorous species i.e. how they switch between prey types according to environmental conditions is poorly understood. Here, we sampled carabid beetles in cereal fields in three regions in Austria and France. Regurgitates of individuals from the three most common species, *Poecilus cupreus*, *Pterostichus melanarius*, and *Pseudoophonus rufipes*, were screened with diagnostic PCR, targeting abundant cereal pest species, weed seeds and detritivorous non-pest prey groups. The outcomes of these analyses will contribute to a better prediction of pest and weed control ecosystem services provided by these carabid species and their specific role in the functioning of agroecosystems.

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KEYWORDS

biological control, pest species, weed seed predation, alternative prey, diagnostic PCR

Opportunistic predation of Carabidae on cider-apple orchards pests in northwestern France

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ABSTRACT

Identifying trophic interactions in the field remain a challenging task, notably for species rich communities including small arthropod predators on which predation events are difficult to observe directly. Carabid communities are very abundant and diversified in European agricultural landscapes. Their large prey range, their voracity and their abundance have made them be considered one of the major groups of pest natural enemies, in many crops. However, their actual diet and its variation between species and across space and time remains poorly documented. In this study, we applied PCR diagnostic on a large sample of carabids trapped in two apple cider orchards located in Bretagne, France, from March to October to assess their predation rate on the five main cider-apple orchards pests: *Dysaphis plantaginea*, *Eriosoma lanigerum*, *Cydia pomonella*, *Anthonomus pomorum* and *Hoplocampa testudinea* along the season. A total of more than 600 individuals belonging to about 50 species were caught and analysed with species abundances varying among orchards and along the season. No predation event was detected on *H. testudinea* and only one on *A. pomorum*. Few predation events were detected on *C. pomonella*. Most predation events were detected on the two aphids, *D. plantaginea* and *E. lanigerum*, the two most frequent preys in the monitored orchards. Rates of prey detection did not significantly depend on the considered carabid species but varied in space and time in relation to prey density. Those results suggest that most carabid species are opportunistic predators preying on the most accessible and available preys. This diet adaptation to prey availability may confer carabids an important role in pest biological control.

KEYWORDS

pests, predation, regulation, orchards

Can obligatory omnivore carabids be useful for the biocontrol of weeds?

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ABSTRACT

Many thousands of carabid individuals exist in farm fields, in communities of carnivore and opportunistic (e.g. granivores) and obligate omnivore guilds. As carabids can eat a substantial amount of weed seeds they are considered as credible biocontrol agents for the regulation of weeds in arable fields. Some studies have suggested that “granivores” are more important biocontrol agents than obligate omnivorous species. Yet, in some instances, obligate omnivores are very abundant and appear to drive the predation of weeds leading some authors to question whether specialist natural enemies are better. Moreover, niche complementarity, facilitation and interference (i.e. intraguild predation), can occur in carabid communities and hinder the power of our prediction pest pest-control. Studying the foraging behaviour of obligatory and opportunistic omnivorous individuals and their sensitivity to biotic factors such as competition and predation would increase our understanding of predator interference, facilitation and niche complementarity in carabids communities and, hence, the predictability of predation. In this study we compared the foraging behaviour and weed consumption pattern of two common carabid species, one known as obligatory omnivore (*Poecilus cupreus*) and the other as a “granivore” (*Harpalus affinis*), for four species of seeds of weeds. Consumption was scored for 13h using no choice tests. The effect of biotic interactions, was also assessed by looking at the foraging behaviour of the two carabid species under 4 different experimental conditions: i) predation risk; ii-iii) intra- and interspecific competition; and, iv) control. Our results show that the consumption pattern of the two carabid species differs markedly. *P. cupreus* eat faster but express strong feeding preferences while *H. affinis* feed slowly but eat all species of seeds equally. Moreover, while the consumption pattern of *P. cupreus* remains stable between the experimental conditions, *H. affinis* change their behavior, eating more and more rapidly when faced with a risk of predation.

KEYWORDS

Carabids, intraspecific competition, interspecific competition, predation, foraging behaviour

Predation on the winter moth *Operophtera brumata* by carabid beetles

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ABSTRACT

Generalist predatory arthropods may feed with many pest species in arable and forest ecosystems. The extent to which they consume pests and alternative prey, and how availability of such prey influences biological control is not well known. This is mainly consequence of the magnitude and complexity of trophic interactions among invertebrates. In this study, we wanted to test whether consumption of forest pest winter moth *Operophtera brumata* by predatory carabid beetles correlated with moth abundance in the field. Carabid beetles were collected in two deciduous forests in the northern Croatia, in autumn 2016 and in spring 2017. In parallel, the availability of winter moth was monitored in both forests and other potential alternative prey was sampled in one forest site. Generalist predatory carabids were analysed using species-specific winter moth PCR-primers, and were positive for *O. brumata*. Current results on carabids predation in season 2016/2017 when there was an outbreak of winter moth populations in studied forests will be compared with those from previous study in 2007. We have also used PCR analyses to screen the gut of the specialist caterpillar hunter, *Calosoma inquisitor*, and those results will be compared with the data on predation of generalist's species. These preliminary results suggest that generalist predatory carabids may potentially play an important role in controlling winter moth populations.

KEY WORDS

Generalist and specialist predators, Carabid beetles, caterpillars, winter moth, molecular gut content analyses, soil fauna, forest pest

Migration patterns of some abundant carabid beetles in arable fields and their margins.

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ABSTRACT

In the framework of the European project SOLABIO (INTERREG IVA, 2009-2012), the Flemish Land Agency (VLM) launched a survey to estimate the potential added value of different types of field margins for the survival of insects which are known as natural enemies of crop pests. Such research in sustainable agriculture has stressed the importance of undisturbed field margins in intensive agro-ecosystems for the maintenance and enhancement of populations of predatory arthropods such as Carabid beetles. To study the foraging strategy of some of the most abundant carabid beetles (amongst others *Agonum dorsale*, *Pterostichus melanarius*, and *Bembidion tetracolum*) the carabid fauna in an arable field and its margins was sampled in a set-up where carabid beetles were prevented to migrate from the margins towards the arable field. For some of the species a different foraging strategy in spring was found compared to summer. Our study shows that for a variety of abundant carabid species, spatial distributions across the arable landscape and movement patterns between margin and arable field are both highly species-specific, and as such, should be adequately implemented in future management strategies

KEY WORDS

Carabidae, arable field margins, sustainable agriculture, foraging strategy

SESSION 2: REGULATION OF WEEDS AND PESTS

POSTERS

Study of the ground beetle (Coleoptera: Carabidae) community and their predation potential of *Sitona lineatus* (Coleoptera: Curculionidae) in faba bean fields and cereal-faba bean intercrops

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ABSTRACT

The protein autonomy is a major challenge of livestock farming in western France for their durability and competitiveness. Pea, lupine and faba bean are environmentally and economically sustainable alternatives to soybeans importations. However, these crops are not enough cultivated because they suffer from variable yields partly due to insufficient pest control management. Brittany and Pays de la Loire are engaged in the PROGRAILIVE program (PROduction PROtein GRAIn for LIVEstock) aiming to secure the yields of these crops and to boost their cultivation through protein legume-cereal intercropping. Beside the main benefit of such intercrops linked to atmospheric nitrogen fixation and transfer or weeds control, within plot plant diversification could lead to higher diversity and abundance of natural enemies and increased biological control. The pea leaf weevil, *Sitona lineatus* L., is one of the major pest of protein crops. Adults consume leaves and larvae feed on root nodules, hosting symbiotic bacteria fixing atmospheric nitrogen. Larval damage strongly limit ecosystem service of nitrogen transfer by the legume plant, which compensates through soil nitrogen uptake. Carabids are known to be efficient biological control agents against *S. lineatus* as they can predate several developmental stages of *S. lineatus*, and particularly eggs. Within crop diversification via intercropping could lead to a higher diversity of the carabid community and a better biological control of the different stages of *S. lineatus*, and thus reduce the impact of this pest on legume ecosystem services. In this study, we compared the composition of the carabids community in faba bean sole crops and in cereal-faba bean intercrops from April to June 2017 in several organic farms in the same pedo-climatic and landscape context. We linked these variations in time and space of carabid species to their predation potential of *S. lineatus*.

KEYWORDS

Weeds control, predation, organic

Effects of seed and carabid densities on the weed seed predation service

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ABSTRACT

Farming relies heavily on pesticides in order to maintain/increase crop production, yet, awareness of the adverse effects of pesticides on the environment and on biodiversity has triggered the search for alternative, non-chemical, pest management strategies. In arable systems, weeds remain one of the most challenging management issue. Recent research suggest that the depletion of weed seeds by naturally occurring seed consumers could impact the dynamics of problematic weeds and in temperate systems, carabid beetles are the main invertebrate consumers of weed seeds. However, predicting weed seed depletion rates in field conditions remains difficult, as carabid trophic responses are still not clearly understood. In particular, density-dependence could strongly affect the outcome of this trophic interaction and thus the potential of carabid beetles to deliver the weed seed predation service. In this study, we conducted microcosms experiments in order to assess how weed seed density and carabid density affect the weed seed consumption rate of *Poecilus cupreus* and *Harpalus affinis*. Two weed species were tested, *Taraxacum officinale* and *Viola arvensis*. The microcosms were 45 x 30 cm boxes filled with sand; three experiments were conducted, i.e. two for *P. cupreus* with the two seed, and one for *H. affinis* with *T. officinale*. In each experiment, four modalities were tested (7 replicates) that were combinations of carabid density (1 or 6 individuals) and weed density (100 or 200 seeds for *T. officinale* and 25 or 100 for *V. arvensis*). Experiments were conducted for several consecutive days and the daily number of seeds eaten was monitored. We hypothesized that (i) the predation of weed seeds is positively correlated to the density of carabid beetles and to the density of weed seeds and (ii) the per-capita carabid consumption depends on the density of carabid beetles due to interactions between individuals. Our results generally validate these hypotheses but also suggest that these relationships are strongly dependent on the strength of the trophic interaction between each pair of carabid and weed species.

KEYWORDS

Predation, Weed control, density dependence, *Poecilus cupreus*, *Harpalus affinis*.

Influence of grassland quality at local and landscape scale on carabid communities and aphid regulation in wheat fields

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ABSTRACT

As a part of the European project MULTAGRI, an experimental design was implemented to characterise the influence of grassland quality at both the local and landscape scales on natural enemy communities abundance and richness and on pest regulation services. More specifically, we addressed the following questions: (1) Does the quality of the grassland influence the richness, abundance and composition of carabid communities and the pest regulation service provided to the adjacent wheat field? (2) Do the proportion of grasslands and their quality at the landscape scale influence the richness, abundance and composition of carabid communities and the pest regulation service provided in a crop field? To address these questions, 23 wheat fields adjacent to a grassland were selected along two orthogonal gradients of age of the adjacent grassland and of proportion of grassland in a circular buffer of 2 kms diameter centred on the monitored wheat field. Age was used as a proxy for grassland quality, as it is well correlated with plant diversity. Carabid communities were monitored in the wheat fields and adjacent grasslands during spring 2013 using pitfall traps. In addition, sentinel aphid preys (*Acyrtosiphon pisum*) were exposed to assess the level of pest regulation in each monitored wheat fields. Results showed that the abundance and richness of carabid communities were significantly higher in crop fields adjacent to a permanent (old) grassland than in crop fields adjacent to a temporary (young) grassland. Analyses also revealed that the effect of grassland depended on the considered carabid species. At the landscape scale, we showed that the proportion of land covered by small grain cereal fields in the surrounding landscape negatively influenced the abundance and richness of the carabid community. Finally, we found that the pest regulation service increased with the proportion of grassland in the landscape and with the local richness of the carabid community. Altogether, these results highlight that not only the type of semi-natural elements but also their quality are important variables affecting the abundance, richness and composition of natural enemy communities and the level of pest regulation service provided in crop fields.

KEYWORDS

Grassland quality, landscape, pest control, wheat crop

Predation on the winter moth *Operophtera brumata* by carabid beetles

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ABSTRACT

Generalist predatory arthropods may feed with many pest species in arable and forest ecosystems. The extent to which they consume pests and alternative prey, and how availability of such prey influences biological control is not well known. This is mainly consequence of the magnitude and complexity of trophic interactions among invertebrates. In this study, we wanted to test whether consumption of forest pest winter moth *Operophtera brumata* by predatory carabid beetles correlated with moth abundance in the field. Carabid beetles were collected in two deciduous forests in the northern Croatia, in autumn 2016 and in spring 2017. In parallel, the availability of winter moth was monitored in both forests and other potential alternative prey was sampled in one forest site. Generalist predatory carabids were analysed using species-specific winter moth PCR-primers, and were positive for *O. brumata*. Current results on carabids predation in season 2016/2017 when there was an outbreak of winter moth populations in studied forests will be compared with those from previous study in 2007. We have also used PCR analyses to screen the gut of the specialist caterpillar hunter, *Calosoma inquisitor*, and those results will be compared with the data on predation of generalist's species. These preliminary results suggest that generalist predatory carabids may potentially play an important role in controlling winter moth populations.

KEYWORDS

Generalist and specialist predators, Carabid beetles, caterpillars, winter moth, molecular gut content analyses, soil fauna, forest pest

Intercropping winter wheat and white clover to enhance beneficial ground beetles.

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ABSTRACT

In conservation biological control, many initiatives aim at increasing interspecific plant diversity within fields or in their vicinity, in order to favor the establishment and survival of beneficial arthropods. The association of cereals and legumes is considered as a promising agroecological practice for low-input or biological agriculture because it provides ecosystem services such as weed control and N fertilization. Moreover, such an increase in field plant diversity changes the structure of the crop canopy and may therefore impact beneficial ground beetles presence and activity. This study investigates the effect of a white clover - winter wheat association on the ground beetle community in 0.72ha field experiments settled within seven organic winter wheat (*Triticum aestivum*) fields in South-East of France (Auvergne-Rhône-Alpes region). From April to June 2016 and from March to June 2017 the crop canopy characteristics at the ground level (percentage of soil cover, microclimate and luminosity) were monitored every two weeks and ground beetles were collected using 48h pitfalls traps every three weeks in 2016 and every four weeks in 2017. Potential of predation was estimated by using sentinel preys made of plasticine, which record bite attempts by ground beetles. Results from 2016 show that intercropping clover and wheat increases the proportion of covered soil by 15% in average and increase the humidity compared to sole wheat. Similarly, luminosity reaching the ground is lower in the presence of clover. We also observe that activity-density of ground beetles is positively impacted by the presence of white clover cover all over the sampling period and species richness tends to be higher in the association than in sole wheat. Predatory and polyphagous species dominate sampled ground beetle communities. Predation rate by ground dwelling chewing insects is higher in the sole wheat compared to wheat associated to clover. These results suggest that wheat-clover association might provide a more attractive habitat to beneficial ground beetles compared to sole wheat crop. However, the presence of such natural enemies might not result in higher pest control.

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KEYWORDS

Conservation Biological Control, Crop associations, Ground cover, Predation, Sentinel prey

Weeds regulation by ground beetles in Cereal/Legume Intercropping

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ABSTRACT

Biodiversity declines in agroecosystems as a result of agricultural intensification. One of the main causes of biodiversity reduction is the input use (herbicides and pesticides). Additionally, more and more organisms become resistant to these phytosanitary products. The present study is undertaken within the framework of CASDAR "APACH" (Association de Plantes en Agroécologie dans le Châtelleraudais) with the aim to evaluate the benefits of intercropping, particularly with regards to the biodiversity of auxiliaries. APACH is a multi-partner project between the CIVAM (Centre d'Initiatives pour Valoriser l'Agriculture et le Milieu rural) of the Châtelleraudais area (center of France) that includes the farmers involved in the project, and two teams of the EBI laboratory (Ecologie et Biologie des Interactions; UMR CNRS 7267, Poitiers University). Here, we tested the impact of organic cereal-legume intercropping on weed and carabid populations, and the link between them. We expect intercropping practices to favor ground beetles, which are known to regulate weed populations by predated seeds, thereby reducing weed populations. Ground beetles that were captured with pitfall traps were identified. Their diet was then characterized and classified between phytophagous, polyphagous, zoophagous and springtail specialists. Weed abundance, species richness and coverage was determined, and linked with data on carabid populations. Difference between intercropping and monoculture were evaluated. We found fewer weeds of less species with a lower coverage in intercropping than in monoculture. However, we found no difference in ground beetle population (species richness, abundance, diet) between the two modalities. We observed no link between ground beetle and weed communities. Those results show that intercropping reduces the weed development, and thus potentially reduces the competition between weeds and crops and increases crop yield. The absence of impact of intercropping on ground beetle populations might be due to our small sampling area compared to the actual range of dispersion of carabid species. Future analyses will investigate pest regulation by ground beetles by using the larva of *Callosobruchus maculatus* as model prey, within the BETSI (Biological and Ecological Traits for Soil Invertebrates) national network.

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KEYWORDS

Intercropping, ground beetles, weeds regulation, granivory

Preferences for seeds by carabid beetles

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ABSTRACT

Plant seeds constitute a significant portion in a diet in a great number of carabid beetles. The granivorous carabids, i.e. those which consume seeds, are mostly representatives of the tribes Harpalini and Zabrinini, but granivory occurs in many other tribes, including Sphodrini, Pterostichini or Trechini. Besides the trivial fact that carabids eat seeds not much is known about preferences of the majority of species. In this contribution, we refer on preferences for seeds in 35 carabid species. The preferences were established by means of a cafeteria experiment, in which each carabid species was offered with a standard range of 28 species of seeds of herbs commonly growing in agro-ecosystems, and thus forming a potential food for arable carabids. These seeds differed in taxonomic position and morphological traits, such as dimensions, shape and mass. The consumption was monitored over 5 days and seeds were replenished if more than 50 % of particular seed was removed. Using multivariate and regression methods, the most preferred seed species were identified for each species of carabids, and their breadth of preference was estimated. As expected, the species greatly varied not only in their preferences for particular species of seed, but also in their breadth of preferences, i.e. the degree of specialization. Some species accepted only a narrow range of seed species while other consumed nearly all species of seeds offered. Adult preferences match well requirements of larvae in species for which the latter is known.

Supported by the grant #17-00043S from the Czech Science Foundation to Pavel Saska

KEYWORDS

Granivory; diet; weed regulation

SESSION 3: LIFE HISTORY TRAITS & POPULATION DYNAMICS

ORAL PRESENTATIONS

Restoration Trajectory of Carabid Assemblages & Functional Traits in Afforested Open Blanket Bog

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ABSTRACT

Drainage for agriculture or afforestation is a prevalent land-use change in peatlands^{1,2}, affecting valuable ecosystem services such as biodiversity and carbon sequestration^{3,4,5}. Peatland restoration is thought to be a cost-effective conservation tool that could play a key role in preserving unique wildlife assemblages⁶ and contributing to climate change mitigation⁷. Biodiversity is intrinsically linked to the functional aspects of ecosystems, whereby species functional traits influence both ecosystem functioning and species ability to respond to environmental changes^{8,9}. This means that fluctuations in ecosystem processes could be predicted on the basis of community composition changes¹⁰. In this study, we compared a chronosequence of restoration sites to open blanket bogs (target system), and forestry plantation (initial state) at RSPB's Forsinard Flows NNR (Scotland) to examine the restoration trajectory of: 1) carabid assemblages (relative abundance of species), and 2) carabid assemblages' functional traits. Results suggest that time, or restoration "age", might not be a reliable indicator of restoration progress for invertebrates. We attributed this to rapid colonisation of fast dispersing, habitat and resource generalist carabid species. Our research also highlighted that restoration sites often displayed higher species richness and diversity, whilst blanket bog displaying more specialised and unique carabid and other arthropod assemblages.

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KEYWORDS

Peatland restoration, functional traits, open blanket bog, ecosystem services

Comparisons of temporal changes in carabid communities inhabiting five different crops

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ABSTRACT

Agricultural areas are currently expanding in the world. It resulted in the decline of biodiversity, affecting ecosystem functioning and the provision of ecosystem services associated. To decrease the pressure of agricultural activities, we should better manage the ecosystem services delivered by natural enemies, such as carabids. Carabids are usually considered as providers of ecosystem functions, such as pest regulation. The objective of this study was to investigate the effect of five different crops (Wheat, Sugar beet, Oilseed rape, Pea and Barley) under non-inversion tillage on carabid communities' dynamics during spring. We quantified three diversity indices (abundance-activity, number of species and equitability index) and used functional-trait based approach, the communities' diet profiles, as an evaluation of the ecosystem services delivered by carabid's community. The study was conducted every year from 2009 to 2012 in 5 sites located in the Seine et Marne region. The carabid communities were recorded from 67 fields cropped with: oilseed rape (9 fields), winter wheat (27 fields), sugar beet (12 fields), spring barley (11 fields) and spring pea (8 fields). Carabids were sampled using three replicate pitfall traps per field, each fulfilled with a saturated salt solution containing a small amount of strong detergent as a preservative. The carabids were sampled once time every month during four months, from March to June. 33 621 individuals have been trapped in 4 years and 11 carabid species represented each at least 2% of the total abundance-activity. In all crop, total abundance-activities significantly increased during the year as the number of species. Contrary to the indices related to taxonomic diversity, the equitability indices did not significantly change during the year in all sampled crops. Crops were characterised by significantly different composition of carabid species in April, May and June but not in March. Concerning the diet profile, the expression of phytophagous significantly increased while the expression of zoophagous significantly decreased with time, whatever the crop considered. Despite great differences between crops, ecosystem services delivered by carabid's community changed similarly during spring. According to the crop studied, agricultural practices were probably not explaining changes in carabid communities and demonstrated strong influences of resources availability. The latter seemed to be the main cause of changes in diet characteristics of carabid communities. To maximise ecosystem services related to pest regulation, it seems necessary to better understand the influences of resources used by carabid in order to control their diet expression.

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KEYWORDS

Carabids, Ecosystem services, Regulation, Diet profile, Functional traits, temporal changes

Do species' traits shape carabid communities in forests?

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ABSTRACT

Knowledge of mechanisms driving species community compositions might hold important information for biodiversity conservation. A potential correlation of functional species' traits with species occurrence probabilities can help to identify mechanisms, which drive species to extinction. Although forest coverage is increasing in Central Europe over the last two centuries, forest carabid beetles are still threatened and many species are red-listed. We used a large dataset comprised of 296 forest sites from seven regions across Central Europe containing approximately 142,000 individuals of forest ground beetle species to test whether different regions show similar species community composition and if species's traits can explain species occurrence probabilities. Community compositions were found to be similar across the given regions, as occurrence probabilities were positively correlated with each other across the given regions. A set of species' traits were identified to explain more than half of the variance in the overall occurrence probability. Geographic range size and hind wing morphology were identified as the most important drivers. Especially species holding trait characters which increase the species flexibility to adapt to diverging environmental conditions such as dimorphic hind wing morphology, the ability to hibernate both as imago and as larval instar, and to breed in two seasons showed the highest occurrence probabilities. Whereas species with small geographic range size, macropterous or brachypterous hind wing morphology, granivorous feeding behaviour, and the ability to hibernate and breed only in one stage or season showed the lowest occurrence probabilities. As the latter species are especially threatened by extinction, we suggest forest management practices related to these traits, which will provide the basis for more effective conservation strategies in Central European forest.

KEYWORDS

Central European forests, species' traits, occurrence probability

**The pace of range expansion: a long-term study on the flightless ground beetle *Carabus hortensis*
(Coleoptera: Carabidae)**

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ABSTRACT

Range shifts are predicted for numerous species due to climate change, and therefore understanding species dispersal is more crucial than ever. For some species, their low dispersal capabilities may prevent them from reaching new, suitable habitats, thus threatening their survival. This is of particular concern for those ground beetles which are flightless and depend on a specific type of habitat. However, studies on ground beetle dispersal rates are rare. We investigated the shift in distribution range of *Carabus hortensis* in northwestern Germany over a span of 18 years. We found that this species disperses on average 126 m per year with low variation between years. Although *C. hortensis* moves as much as other carabid beetles, its dispersal rate is lower than that of a *C. auronitens*, a wingless beetle of comparable size. The dispersal power of *C. hortensis* may be a limiting factor when it comes to range shifts and should be taken into account, especially for the long-term conservation under global change conditions. Conservation actions like assisted migration may be recommended for such slow dispersing species.

KEYWORDS

Ground beetle, *Carabus hortensis*, dispersal rate, range expansion

Modelling ground beetle dispersal into semi-open habitats: dispersal functions and implication for conservation

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ABSTRACT

The capacity of ground beetles species to persist in fragmented landscapes depends on sufficient movement of individuals between patches to balance local extinction. Corridors are thought to facilitate movement between disconnected habitat patches, and thus counteract the effects of habitat fragmentation. However, corridors simultaneously lead to fragmentation of other habitats. For example, a hedgerow connecting two forest patches through an open habitat forms a barrier for the open land species while serving as a corridor for forest dwellers. To overcome this challenge, semi-open habitats, which contain a mixture of open and woodland habitats, have been proposed to simultaneously enable dispersal of both stenotopic open and woodland species. In this study, we used large grids with over 1,400 live pitfall traps in open, wooded, and semi-open habitats. We constructed dispersal kernels for several brachypterous forest ground beetle species dispersing into either the matrix or into semi-open habitat. Dispersal kernels differed significantly for dispersal into the matrix and into the semi-open habitat, although the order of magnitude was species-specific. Nevertheless, our results indicate that semi-open habitats are a good strategy for connecting both open and woodland habitats simultaneously and thus contribute to prevent ground beetles species extinction.

KEYWORDS

Dispersal kernel, semi-open corridor, *Carabus*, *Abax*

SESSION 3: LIFE HISTORY TRAITS & POPULATION DYNAMICS

POSTERS

Carabids, body size and sexual size dimorphism: Inter- and intra-population clinal variation

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ABSTRACT

There has been a lot written about body size because individual body size is a remarkable trait determining many other traits of a given animal and thus influences its behaviour and physiology. In insect, variation in sexual size dimorphism is quite common pattern and could be attributed to a different selection pressure acting on particular sex at a given site. The changes in abiotic conditions and biotic interactions along geographical gradients could result in different body size clines in males and females. Interestingly, very few studies have investigated geographical clines in the most fine-scale variation in body size, i.e., variation between individuals within a given population. Therefore, in this study, we investigated between- and within-population variation in body size of several carabid species along the elevation gradients in Central European mountain ranges. We are going to explore, whether intrapopulation variation in body size differ between sexes and if the pattern is consistent across populations originating from various altitudes. Beetles were collected using pitfall traps installed in following mountain ranges: Krkonoše, Krušné hory, Jeseníky, Babiogórský national park, Bieszczady, Západní Tatry and Tichá Dolina at different altitudes from 400 to 1963 m a.s.l. Carabids that were collected in sufficient number (*Carabus linnei*, *C. auronitens*, *C. sylvestris*, *Pterostichus burmeisteri*, *P. pillosus*, *P. melanarius*) were measured (elytron length and pronotum width) and their structural body size was calculated using Principal Component Analysis scores. Preliminary results indicate that all investigated carabid species follow converse Bergmann cline. It corresponds with the life history of these species because all investigated carabid species are larger and univoltine species with relatively long preimaginal development. Sexual size dimorphism do not vary significantly along altitudinal gradient for a majority of species. Analyses of intrapopulation variation have not been done yet, but the results will be presented on the poster in September.

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KEYWORDS

Bergmann's rule, Converse Bergmann's rule, geographical variation, altitudinal gradient, Carabidae

KEYNOTE 3

Dispersal polymorphisms in carabids: ecological drivers, genomics and its consequences for community assembly.

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ABSTRACT

Carabid beetles exhibit remarkable interspecific as well as intraspecific variation in dispersal capacity, which is reflected in differences in wing size. This variation renders them ideal study organisms to investigate some central questions in ecology and evolutionary biology. Examples of these questions include: (i) What are the ecological drivers that generate variation in dispersal? (ii) What is the role of dispersal capacity in local adaptation? (iii) What is the genomic basis and architecture of profound phenotypic variation and (iv) How does a species' dispersal ability affect its vulnerability to anthropogenic change?

Based on some general principles of dispersal theory, I attempt to explain variation in dispersal capacity among carabid species, and how this can help us to understand the evolution and ubiquity of wing dimorphic species. Next, I discuss the fundamental difference between wing dimorphic and wing polymorphic species. These latter species appear to be an intriguing case of local adaptation that can evolve surprisingly fast. The fundamental difference between wing dimorphic- and wing polymorphic species is also reflected at the genomic level. A detailed genomic study on the wing polymorphic beetle *Pogonus chalceus* informs us about the genetic mechanism that can lead to fast local adaptation in dispersal capacity. Studies on the behavior of this species further show that habitat imprinting might be an important trigger in the evolution of local adaptation in highly dispersive species.

Based on data of some large scale field studies it is further shown how the vulnerability of species towards anthropogenic change depends strongly on a species dispersal' capacity, and how this information might help us to mitigate the deteriorating effects of increasing agricultural intensification and urbanization.

SESSION 4: SYSTEMATIC, TAXONOMY & EVOLUTION OF CARABIDS

ORAL PRESENTATIONS

Unravelling the genomic basis of wing dimorphism in carabid beetles

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ABSTRACT

Intra-specific dimorphisms are widespread and observed for sexual, competitive and ecological traits. The presence of discrete variants in a population is, hence, a common phenomenon. However, the molecular mechanisms how discrete morphs can be maintained in a random mating population remains poorly understood. In particular, when the dimorphism involves a complex trait whose development is polygenic, recombination is suspected to lead to intermediate phenotypes. As these intermediate morphs are surprisingly never observed, evolutionary and molecular mechanisms to prevent recombination events have probably evolved. We here investigate the molecular basis of wing dimorphism in carabid beetles. Carabid beetles show profound inter- and intra-specific variation in dispersal capacity. We sampled both flightless and flight-capable morphs, *i.e.* short-winged and long-winged, of the carabid beetle *Bembidion properans*. Via restriction site associated DNA sequencing (RAD-sequencing) we investigate the genomic region(s) associated with this variation in dispersal capacity. Furthermore, to gain insights in the possible genomic regions linked with wing-dimorphism we are building a draft reference genome of this carabid beetle. Via this combined approach, we will be able to gain insights in the molecular mechanisms that preserve discrete variants in populations.

KEYWORDS

RAD-sequencing, complex traits, population genetics, wing dimorphism

Unravelling the genomic basis of wing polymorphism and evolutionary history of a parallel *Calosoma* beetle radiation at the Galápagos

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ABSTRACT

Islands often harbour a most intriguing phenomenon as species evolve into similar phenotypic endpoints along repeated environmental gradients. At the Galápagos we study such a parallel adaptive radiation of caterpillar hunters (*Calosoma*), where representatives of this genus show wing reduction along an altitudinal gradient, thereby resulting in the repetitive occurrence of highland and lowland ecotypes on each island. It remains a contentious debate whether each island community has reached similar phenotypic endpoints either by i) true independent parallel evolution, ii) a single evolution event followed by immigration into similar habitat on different islands ('species sorting') or iii) repetitive reuse of the same adaptive alleles. The combination of chronological variation in island age and replication of environmental gradients across islands has created a unique and rare example of a speciation continuum, allowing us to study the full range of different stages in an evolutionary trajectory within a single taxon. As such, this radiation represents an unprecedented opportunity to gain insights into key mediators of species radiations in island settings. We used Restriction-Associated DNA (RAD) sequencing to associate genetic variation to flight-associated morphological metrics, allowing us to delineate a set of key genomic regions putatively underlying the observed wing polymorphism. Next, we attempted to elucidate the causal mechanisms behind this parallel radiation by contrasting genealogies of these 'speciation' regions to neutral ones. Haplotype networks of genomic regions underlying the wing polymorphism clearly pointed towards a single mutational origin, and strongly advocated that adaptive variation is repetitively reused over time, fuelling the speciation process and thereby constituting an important driver in shaping this parallel radiation.

KEYWORDS

Parallel radiation, Galápagos, *Calosoma*, wing polymorphism, genomics

Glacial refugia for carabids in Central Europe?

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ABSTRACT

Glacial refugia for carabids in Central Europe? Biogeographers and carabidologists such as Holdhaus and Lindroth postulated that the southern European peninsulas served as glacial refugia for woodland ground beetles, and that therefore highly habitat specialized species should today be found in these regions. During the interglacials and after the last glacial period the species expanded from their refugial areas northwards. This historical dynamics lead to specific, recurring patterns of genetic variability. In many species, the southern (rear or low-latitude) edge of the distribution range has higher genetic variability than the northern (leading or high-latitude) edge. For many species, plants as well as animals, including some carabids, this scenario is supported by modern phylogeography. Our findings using phylogeographic approaches (DNA sequences, climate niche modelling) show that some range-restricted ground beetles from montane elevations show strong differentiation patterns, also north of the postulated refugia in Southern Europe (so-called cryptic refugia). These geographic patterns coincide with the occurrence of endemic taxa in Central Europe, most of them described during the last decades. All datasets support a complex history of the ground beetle fauna of Central Europe during the last glacial period with a lower species turn-over than previously thought. Our results help to identify threatened lineages and have implications for the preservation of endemic biodiversity in mountains despite the ongoing changes in global climatic conditions.

KEYWORDS

Glacial period, refugia, postglacial colonisation, endemics

Barcoding and phylogeny outcomes of West Palearctic Carabidae.

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ABSTRACT

More than one thousand carabid beetles have been barcoded in our lab during the last ten years. Most of them were collected in the Mediterranean Basin. Barcode of beetles previously identified on morphological grounds showed that members of the same putative species differ in the DNA sequence of the *cox1* mitochondrial gene in varying degrees, from almost identical sequences to differences over the 3% threshold, that is often admitted as indicative of the existence of distinct species. Instances of possible cryptic taxa, usually related to geographic speciation, are commented. Phylogenetic inferences derived from the analysis of this mitochondrial marker, or after combining it with the information derived from the sequence of the nuclear *its2* gene, often lack a robust support, what shows the need of adding more informative markers to this aim. In spite of this, results in particular taxa are worth to be explored in detail as they provide the basis for testing hypotheses about their evolutionary history and species origin.

KEYWORDS

Barcoding phylogeny

Carabidae: A model for the study of Evolution

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ABSTRACT

With more than 37000 species distributed worldwide, the family Carabidae is one of the largest family of beetles. It is characterized by a huge diversity of body shapes, ecologies and life histories, and occurs in almost all terrestrial ecosystems. It is also one of the few groups which successfully colonized the subterranean realm. The origin and evolution of cave fauna has fascinated evolutionists and biologists since the discovery 250 years ago of the first troglodytic species, a blind amphibian endemic to the subterranean waters of the Dinaric karst, *Proteus anguinus* Laurenti, 1768. Organisms living underground tend to show a highly modified morphology and biology, combining loss of traits (eye degeneration, depigmentation) with enhancement of others (mechanical and chemical sensory organs and body shape modifications), often associated with changes in the life cycle and metabolism. If only a few groups of Insects have repeatedly colonised subterranean terrestrial habitats, two of them in the order Coleoptera have been really successful: Leiodidae (tribe Leptodirini) and Carabidae of the tribe Trechini. The tribe Trechini is widespread on Earth and developed multiple strategies to adapt in changing environments. Trechini ground beetles are living from the sea level (some species are intertidal elements) to the glaciers of the highest mountains. Most of the species are highly hygrophilic and had to colonize subterranean environments to survive during past warming periods: their past (fossils) and current distribution help to understand paleogeography and ancient paleoclimatic events. These peculiar histories drove the diversification of the group and led to a very high level of endemism. The species diversified underground in karstic areas of the world have independently developed similar features: they are completely blind and apterous, with a slender body form, and sometimes an extreme elongation of head, pronotum and appendages, resulting in a very characteristic appearance, the “aphaenopsian” habitus type. Subterranean species of Trechini also tend to develop K-selection strategy trends, such as the production of fewer but much larger eggs, longer life expectancy and in some cases reduction of number and length of larval instars. Because of the isolation of their populations in well-defined geological units with highly restricted gene flow, cave Carabidae isolated in karstic areas are also a unique model to study speciation and diversification processes.

KEYWORDS

Trechini, cave, speciation, adaptation, convergence, biogeography, subterranean evolution

Modern carabidology: Cybertaxonomy and cyberecology

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ABSTRACT

The development of the internet has had a strong impact on the availability of information in science. Currently, most scientific contributions are published in online journals or are at least available online, many of them freely accessible. This is also true for the field of carabidology. Despite their growing usage, digital systems have the potential to provide many additional possibilities for taxonomists and ecologists. For example, stand-alone applications (apps) for mobile phones and tablets may support taxonomic field work. Interactive identification systems can enable users to relate morpho-anatomic characters with taxon names, independent of classical dichotomous keys. High resolution photography allows scientists to accumulate virtual collections. Modern high-throughput technologies cover large parts of the genome and metabolomes. Dynamic databases can provide scientists with updated ecological information linked to other digital devices at the taxonomic level. An important approach will be the interactive bridging of taxonomic, distributional and ecological information. This poster gives an overview of the cybertaxonomic and cyberecological approaches currently in use for carabids in Europe.

KEYWORDS

Mobile phones, interactive keys, applications, taxonomy, systematics, traits

SESSION 4: SYSTEMATIC, TAXONOMY & EVOLUTION OF CARABIDS

POSTERS

DNA barcoding of Balkan tiger beetles – first results

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ABSTRACT

DNA barcoding, as a molecular identification method based on partial cytochrome c oxidase subunit 1 (COI) sequences, is well known as useful tool for species determination in many insect taxa including Adephaga beetles. In our study, we tested the effectiveness of DNA barcodes to discriminate species of most tiger beetle taxa occurring in the Balkan Peninsula, the area which - with 19 species (41% of European fauna) - is characterized by one of the most diverse region in Europe according to tiger beetle fauna (Coleoptera: Cicindelidae). In total, DNA barcodes were obtained from more than 200 specimens belonging to species collected in six countries. Morphospecies were compared to obtained MOTUs (Molecular Operational Taxonomic Units). MOTUs were delimited using five different methods: ABGD, GMYC (single- and multiple-threshold models), PTP and BINs to obtain level of cryptic diversity. Poster presents preliminary results of our work.

KEYWORDS

DNA barcoding, tiger beetles, Balkan Peninsula

Variations in shape and size of *Carabus croaticus* (Coleoptera, Carabidae) across its distribution in Dinaric mountains chain using geometric morphometry

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ABSTRACT

Carabus croaticus Dejean1826 is an endemic species of the Dinaric mountains chain. It is widespread in the northwestern Balkan where it has an inland distribution. Speciation of this species is most likely the result of events during or after the Quaternary ice ages. Geographic isolation and different ecological conditions resulted in many phenotypic variants grouped in 13 subspecies, according to literature sources. Current classifications and the status of these subspecies differ between some authors. The aims of this research are (a) to reveal morphological divergence between and within subspecies using both morphological measurements: traditional morphological measurements and geometric morphometry, and (b) to compare our results with the current classifications. To study morphological variations, we utilised landmark-based geometric morphometry (GM), as a complement to the traditional morphometric approaches in clarifying intraspecific relationships. A total of 300 specimens from Slovenia, Croatia, Bosnia and Herzegovina, Montenegro, Serbia, Kosovo and FRY of Macedonia were analysed. Seven morphological features were measured in males and females separately: head length, head width, pronotum length, pronotum width, elytra length, elytra width and total body length. Differences in measured features between different subspecies were analysed using ANOVA (Tukey HSD test). A landmark-based approach was utilised to characterise the shape variation of pronotum (10 landmarks) and head (9 landmarks), analysed within the software suite tpsDig2. MorphoJ was used to investigate the number and type of differences in pronotum shape and head shape between subspecies (Canonical Variate Analysis) and finally MANOVA was used to check differences between subspecies based on data from shapes of head and pronotum (centroid size). The results of traditional morphometry and GM are similar and do not corroborate any of the current classifications. Subspecies of *C. croaticus* differ with statistical significance ($F=3.387$, $p<0.05$) and they differ the most in the width of pronotum, the length of pronotum and the length of the head. Results of MANOVA based on centroid size for the shape of head and pronotum also show that subspecies of *C. croaticus* differ with statistical significance ($F=3.022949$, $p<0.05$). Such results point to the requirements of analysing the influence of abiotic factors on subspecies morphology as well as for molecular analysis to verify the existing subspecies and resolving classification within *C. croaticus* species.

KEYWORDS

NW Balkan, carabids, geometric morphometries, karst, molecular systematics

Is the tiger beetle *Cylindera trisignata* a one species in the Balkan Peninsula?

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ABSTRACT

Cylindera trisignata (Dejean, 1822) is a small tiger beetle distributed mainly in the Mediterranean Region. Based on morphology a few subspecies have been recognized, including two known from the Balkan Peninsula: *spp. trisignata* (Dejean, 1822) and *spp. hellenica* (Cassola, 1973). To verify taxonomic status of the Balkan population of *C. trisignata* we used a cytochrome c oxidase subunit 1 (COI) sequences for DNA analysis. In total material from four countries (Albania, Greece, Montenegro and Romania) were used, including beetles collected in locus typical for *spp. hellenica*. Subspecies were compared to obtained MOTUs (Molecular Operational Taxonomic Units). MOTUs were delimited using five different methods: ABGD, GMYC (single- and multiple-threshold models), PTP and BINs to obtain level of cryptic diversity. The preliminary results confirm that the area of the Balkan Peninsula is occupied by two different taxa, which probably should be classified as separate species.

KEYWORDS

Cryptic taxa, tiger beetles, Balkans, DNA barcoding

Rare patterns of dorsal puncture in *Pterostichus oblongopunctatus* (Coleoptera: Carabidae)

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ABSTRACT

Pterostichus oblongopunctatus is a carabid beetle species, which is common in different types of forests. With respect to this species, some unclarities exists concerning the morphological feature of punctures on the elytra. *Pterostichus oblongopunctatus* has dorsal pits in the third interval of the elytra, but concerning the puncture in other intervals the available identification keys provide with inconsistent information. During long-term studies on different study sites in Poland, I discovered rarely but regularly individuals with unusual dorsal puncture patterns, i.e. pits in the fifth and even in the seventh interval of the elytra. Since such rare patterns might be connected to special habitat characteristics and thus have potential as indicator, I tested if they are connected to specific subpopulations (interaction groups), if they are related to the sex or size of the beetles, or if they are related to specific habitat conditions. In order to do so, I counted the pits on the elytra, determined the sex, and measured the length of the right elytra of individuals of *Pterostichus oblongopunctatus* collected at numerous study sites located within the borders of Regional Directory of National Forests in Piła (Western Poland) over the period 2014-2016. Altogether, 1071 individuals of *Pterostichus oblongopunctatus* were examined. Almost 19 % of the individuals had dorsal puncture in the third interval of the elytra and about 0.7 % had dorsal puncture in the seventh interval of the elytra. In 2014 and 2015, significantly more females exhibited such unusual patterns of dorsal puncture than males. Even if not statistically significant, in 2016 also relatively more females showed such pattern. Both males and females with unusual patterns had more dorsal pits than those without. Moreover, males as well as females showed in all years a trend that individuals with unusual patterns have more pits in the third interval of the elytra. The results indicated that females are more likely to exhibit unusual patterns. Since individuals of *Pterostichus oblongopunctatus* with higher number of pits on the elytra are supposed to prevail in more wet habitats (den Boer et al. 1993), such patterns might be related to moisture conditions. The possibility of pits in the seventh interval of the elytra should be added to identification keys.

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KEYWORDS

Pterostichus oblongopunctatus, dorsal puncture, forest, succession, bioindication

Geographical variation of sexual size dimorphism in ground beetle *Pterostichus melanarius* (Coleoptera, Carabidae)

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ABSTRACT

We studied sexual size dimorphism (SSD) in ground beetle *Pterostichus melanarius* Ill. Beetles were sampled in different geographical zones of Russia, situated at different latitudes: 45° – 50° – 55° – 56° – 57° – 57° – 58° – 59°. Specimens were measured individually for six linear traits (in a whole 1382 ex. were studied). We used RMA method and then robust ones to estimate SSD direction and contribution of habitation regions into its variation. Elytra length in both sexes decreased from southern regions towards the centre of *P. melanarius* area (56°N) and then increased again, but the values of SSD in that trait were significant only at the sites on 55° and 57°. In the whole SSD was female-biased in the studied species, but regions of habitation contributed differently in traits variation and hence SSD in them. Regression coefficients (β) were positive in all studied traits showing that directions of traits variation in both sexes were similar in all studied regions. But intercepts differed, being negative or positive. SSD variation in elytra length followed Rensch's rule at the edge of area, elytra width and pronotum length – at the centre. Head length and width variation followed converse one. Our study suggests new novel investigations of the SSD variation in insects, with the lowest values in the centre of area and increased – towards the edges. The coefficients of regression were positive and varied from 0.70 to 1.21, indicating, that *Carabus granulatus* L. followed Rensch's rule only in half of studied cases and predominantly at the edge of area.

KEYWORDS

SSD, carabids, Reduced Major Axis regression, latitude – longitude variation, Rensch's rule

SESSION 5: LANDSCAPE ECOLOGY OF CARABIDS

ORAL PRESENTATIONS

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

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ABSTRACT

In the middle of the national park Dwingelderveld (the Netherlands, province of Drenthe), an area of nature consisting of at least 1700 ha of wet heathland, there was an arable enclave Noordenveld of about 200 ha in size. In 2011, the arable character of this area was wiped out by more than 60 cm of topsoil removal. This in general one of the measures to increase the areal of heathland. In the beginning of 2012 at Noordenveld only a sterile bare sandy area was left. To find the fastest way to regenerate the ecological most complete heathland communities in 4 experimental areas of about 45 by 45 meters several different treatments and combinations of treatments were executed. Two of those areas were located at wet a site and two at dry one. 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, add lime and biotic: doing nothing, adding plant material gained from a nearby heathland and adding sod cuts from a nearby heathland. In the centre of each plot 1 pitfall trap, filled with 4% formalin solution, was placed for 4 periods of 3 weeks spread over the year from early spring of 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 the combination of spreading out heather sod cuts, combined with liming, leads to the most desirable results as far as heathland management is concerned.

KEYWORDS

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

Spatio-temporal dynamics of weed seed eating carabid species in agricultural mosaics: variation of annual habitat quality of oil seed rape and role of grassy field margins

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ABSTRACT

Carabid beetles are considered as important contributors to the regulation of weeds and recent studies have shown that weed seed predation by carabids may partly substitute for herbicide use in agriculture. Enhancing this ecosystem service requires to understand the spatio-temporal distribution of these species during the cropping season. Infra-annual variation in the spatial distribution of ground beetles within agricultural mosaics is less documented but of prime importance given that agricultural landscapes are highly dynamics. Indeed, crop phenology, agricultural operations but also habitat requirements during life cycle can lead to a redistribution of individuals between crop types or between crops and semi-natural habitats. With a six months experimental monitoring, we analysed the spatio-temporal dynamics of three abundant seed-eating carabid species (*Poecilus cupreus*, *Amara similata* and *Pseudoophonus rufipes*) in oilseed rape with two types of adjacent habitat, either a cereal crop or a grassy field margin (i.e. a semi-natural habitat). We assessed the variation in time of four indicators: the activity density, the nutritional state (estimated by the measure of condition factor) in oilseed rape, the relative use of the interface with the adjacent habitat, and the proportion of carabids leaving rape fields measured with directional traps. Abundance and nutritional state of the omnivorous species *P. cupreus* decreased after harvest, a period related to a decrease of prey abundance and the end of life cycle. More interestingly, we detected a tendency of movement from oilseed rape crop to the adjacent habitat after harvest for the granivorous *A. similata*, but not as strong as expected. The presence of the grassy field margins close to the oilseed rape crop influenced the spatio-temporal dynamics of the granivorous species *P. rufipes* and *A. similata* suggesting spillover processes for these two species. Conversely, there was no effect of the presence of the grassy field margin on *P. cupreus*, which could indicate that this species can complete its lifecycle in oilseed rape crops. Monitoring four complementary indicators gave a more thorough understanding of the perception of local and adjacent habitats by ground beetles and of the potential ecological role of these habitats, a prerequisite for the identification of landscape configurations that would enhance the abundance of these natural enemies within crops in order to promote the seed predation service.

KEYWORDS

Carabidae, habitat quality, activity density, condition factor, habitat adjacency, grassy field margin, oilseed rape

Are subtropical forests in China colonized by habitat-specific carabids?

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ABSTRACT

In woodlands of the temperate and boreal climate zone of Europe, many ground beetle species occur. The diversity is high and is comparable to open habitats. In general, the dominant species are restricted to this habitat type and are not able to reproduce in open habitats. Numerous eco-physiological and behavioral facets are known which bind woodland carabids to their habitats, even in linear structures such as hedgerows and woodland strips. In other climatic regions, ground dwelling carabids which are mainly restricted to woodlands seem to be rare (e.g. in the evergreen oak maquis of the Mediterranean landscapes). The Eastern Palaearctic region also contains large tracts of woodlands. Woodlands of the boreal as well temperate zone have been studied, and seem to also exhibit a rich ground beetle fauna with clear preferences for this habitat type. The subtropics of this realm differ by dominant rainfall in summer from the Mediterranean regions of the Western Palaearctics. However, little is known about the ground-dwelling fauna of subtropical forests. In order to analyse the habitat preferences of the ground beetle species in subtropical Chinese forests, we surveyed the fauna of a national park (Gutianshan N.P., Province: Zhejiang) and of newly planted sites using pitfall traps. Expert interviews and a literature survey complemented our approach. The results of our study reveal a complex picture of the habitat preferences of ground beetle species inhabiting woodlands of the Eastern Palaearctics, which may be best understood by the historical dynamics of woodlands in the given landscapes.

KEYWORDS

south-east China, subtropical forest

Agri-environment schemes for carabids: complementary or redundant?

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ABSTRACT

In Europe, agri-environment schemes (AES) are designed to give credit to environmental issues in agricultural practices [1]. In Wallonia (Belgium), some measures are dedicated to preserve and enhance biodiversity in agroecosystems. Beyond biodiversity, AES could also be powerful tools to support some ecosystem services of interest in the crops. Carabidae, as fine ecological indicators [2] and services suppliers [3,4], were selected to explore, at a landscape scale, the redundancy or complementarity of different AES regarding biodiversity support. Data collection occurred in five categories of ecological infrastructures (EI): four types of AES (grassy strips “GS”, wildflower strips “WS”, bird-feeding margins “BFM”, species-rich meadows “SRM”) and cereal crops. Five replicates were selected for each category. Carabidae were collected with pitfall traps, placed during two weeks in May, June and July 2015. Beta-diversity index [5] was used to analyze the contribution of the different EI to carabidae diversity in an agro-landscape. The estimated overall beta diversity (β_{sor}) is 0.89. Spatial nestedness is the major contributor to betadiversity ($\beta_{sim} = 0.84$). A Non-metric Multi Dimensional Scaling plot (based on Bray-Curtis distance) was used to analyse the sites similarities based on abundance and species composition of each EI. Apart from the cereal crops and the bird-feeding margins, which are highly intertwined, SRM, WS and GS appear to show distinct groups. Finally, we applied the IndVal method [6] to characterize communities in each EI. Indicator species for each EI are highlighted in the NMDS plot. No indicator species were found for GS and a single for SRM (*Pterostichus anthracinus*). In WS, a dominant granivorous species (*Amara aulica*) and a small generalist predator (*P. vernalis*) were identified as indicator species. Cereal crops and BFC are characterized by various small carabid species and respectively two larger generalist predators (*P. melanarius* and *P. niger*) and two larger granivorous species (*Pseudophonus rufipes* and *Harpalus affinis*). The selected ecological infrastructures thus appear to act in a complementary way at the landscape scale for the preservation of carabidae. Our results also question the ability of margin AES to enhance the expect regulation services as they shelter species that may find it difficult or unnecessary to migrate into the crop field.

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KEYWORDS

Agroecosystems, agri-environment schemes, biodiversity, carabids, landscape

Species traits and phylogeny of carabid communities across an environmental gradient from the nival belt of Dolomites to the salt marshes of Adriatic coast

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ABSTRACT

About 325 year samples have collected during the years 1973-2015 along an altitude range of 2730 m and organized in bioclimate/macrohabitat or ecotope groups. The aim was to analyze the changes of species traits, biogeographic characteristics and community phylogeny of the evolutionary “pathway” of ground beetles in a temperate country landscape. The data concern 425 species and base on the count of 225,000 specimen, partly enclosing the work of other authors. The landscape units involved have ordered in the sequence: Alpine, A. prealps, Boreal conifers, Deciduous1 and 2 (beech belt and mixed forest), Med sclerophylls, upper (Gap) and lower (Lap) alluvial plain, Peat bogs (Pb), lentic inland waters (Le), riversides (Re), sand dunes (DU) and salt marshes (SM). The species n./sample decreases from lowland to the alpine nival biotopes ($r=0,72$). The percentage of endemics is steadily low in the alluvial plain and rises starting from solid bedrocks with a maximum in the nival belt (100%) and in climax habitats ($r=0,88$), but drops under 30% in the boreal conifers and in the alpine grass mats on siliceous bedrock. The maximum of phylogenetic diversity (macrotaxa) has found in Le and Re, thus in waterside habitats, as hypothesized by Erwin (1979), but both landscape units are highly diversified. Looking at the altitudinal sequence, community composition and species' traits indicate that crucial historical events (Ice ages) modified the altitude-linked continuum.

KEYWORDS

Species traits, temperate biomes, landscape ecology, ecotopes, evolutionary ecology, community phylogeny

Effects of spatial and temporal heterogeneity of the crop mosaic on carabid beetles assemblages (Coleoptera : Carabidae)

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ABSTRACT

Previous work has shown that agricultural landscapes with significant areas of semi-natural habitats are able to support higher biodiversity, which can help maintain ecosystem services. However, despite the fact that croplands occupy 40 % of the earth land surface, the habitat-matrix paradigm in landscape ecology has resulted in little consideration of cropped areas. Little is known about the effects of the composition and configuration of cultivated fields and their multi-year dynamics. In this study, we investigated the influence of spatial and multi-year temporal heterogeneity of the crop mosaic on carabid beetle assemblages of agricultural landscapes. Within the European FarmLand project (www.farmland-biodiversity.org), carabids were sampled in 40 cereal fields in western France, and their species richness, total abundance and abundance of species groups with different dispersal abilities were measured. For each sampling site, spatial heterogeneity of the surrounding landscape was characterized by the crop composition and configuration of the sampling year, while temporal heterogeneity induced by crop sequences was defined by the rate of crop rotation and the changes in crop composition over the last five years. We quantified relationships between carabid assemblages and heterogeneity metrics and tested their significance. The results show that both spatial and temporal heterogeneity have an influence on carabid beetles, affecting essentially the open ground specialists adapted to dynamic environments. Some species with high dispersal power such as *Trechus quadristriatus* were more abundant in landscapes with high spatial heterogeneity, whereas the abundance of less mobile species such as *Poecilus cupreus* was only positively influenced by temporal crop dynamics. Our results highlight the importance of taking crop mosaic heterogeneity into account in further ecological studies on biodiversity in agricultural landscapes.

KEYWORDS

Agroecology; Biodiversity; Crop mosaic; Ground beetles; Landscape heterogeneity

Local and landscape affect the community structure and composition of dominant taxa of predatory arthropod (Coleoptera Carabidae) in winter wheat fields

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ABSTRACT

It has been shown that organic farming and landscape context affect positively diversity of predators and pest control level. Generalist predators, such as carabid beetles, are abundant arthropods in agroecosystems. Despite the role of carabids may play in pest regulation, the influence of both local factors and landscape composition in shaping their assemblages remains little studied. In this study, we investigated the role of farming system and landscape characteristics and their interaction, in driving the structure and composition of carabid assemblages. Twenty pairs of organic-conventional spatially-matched fields were sampled in 2013, in western France, along a gradient of proportion of organic farming in the landscape by using pitfall traps. A total of 27767 carabids belonging to 75 species were collected. Our results show that the farming systems had a strong influence on carabids' community structure and composition. Structure of carabids was more driven by landscape variables (woodland, grassland, grass-strips and the proportion of organic farming in the landscape) and their interaction with farming system. Carabid's community composition was mostly determined by farming system and the proportion of wood around the fields. Our study underlines the importance of the local characteristics, the landscape context and their interactions in shaping assemblages of carabid beetles. And suggest the importance of complementarity local vs the landscape scale approach in the study of carabid's community in the agroecosystems.

KEYWORDS

Organic farming, conventional farming, carabids, Woodland, community structure and composition, Western France.

SESSION 5: LANDSCAPE ECOLOGY OF CARABIDS

POSTERS

Linking remote-sensing, biodiversity, connectivity and ecosystem services for ground beetles: the WOODNET project (2017-2019)

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ABSTRACT

Ground beetles are an important component of agricultural landscapes since it hosts numerous species providing ecosystem services such as pest regulation in the fields. They use differently the landscape elements through their life cycle (reproduction, wintering, feeding, dispersion, shelter areas...) according to their ecological groups (open-habitat, ubiquitous or forest species). The amount and connectivity of woody elements within landscapes (forests, hedgerows), and there internal structure seem to be key factors explaining the distribution of ground beetles in managed landscapes, especially forest specialists. Concerning the ground beetles, the European WOODNET project takes place in different agricultural landscape windows differing in the amount of woody elements, particularly in the hedgerow network, in Belgium (Waloon region) as in France (Picardy and Brittany). This project aims to integrate new remote sensing tools (i.e. LIDAR) to develop habitat suitability maps and connectivity models between woody elements for specific ground beetle species differing in their dispersion traits (*Abax parallelepipedus*, *Pterostichus madidus* and *Nebria brevicollis*). These methods will also be combined with a landscape genetic approach for two species with contrasted dispersal abilities (*P. madidus* with high dispersal abilities and *A. parallelepipedus*, with low dispersal abilities). Lastly, ecosystem services delivered by ground beetles in agro-ecosystems associated to wooded network (i.e. pest regulation) will be studied by monitoring simultaneously their population assemblages and pest population dynamics (aphids and slugs).

KEYWORDS

Ground beetles, remote-sensing, maps, rural landscapes, biodiversity, connectivity, landscape genetics, ecosystem services

Density of hedgerow networks favours ground beetles biodiversity but not their abundance

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ABSTRACT

Hedgerows are important components of rural landscape since they may mitigate loss of biodiversity caused by habitat fragmentation and land use changes, by increasing connectivity of woody habitats. Agricultural landscapes host numerous species of ground beetles providing ecosystem services such as pest regulation in the fields. The amount and connectivity of woody elements within these landscapes and their internal structure are key factors explaining the distribution of ground beetles according to their ecological groups (open-habitat, ubiquitous or forest species), especially for forest species. We studied the richness and activity-density of ground beetles in hedgerows of two contrasted agricultural landscapes (windows of 5km x 5km). The openfield landscape is characterized by a matrix of intensively cultivated croplands embedding few small forest patches and hedgerows. The bocage landscape is dominated by grasslands for cattle farming, and contains few small forest patches connected by a dense hedgerow network. We sampled 47 and 18 hedgerows in the bocage and openfield landscape windows, respectively, using pitfall traps. Hedgerows were chosen according to their physical features, localization and connection to forest fragments. The local variables were the length, the height, the width of hedgerows, and the connection or not to a forest fragment. The landscape variables were the cumulated linear of hedgerows within 500m and the percentage of forest cover within 500m. The main results of this study showed that cumulated linear of hedgerows was the most important factor explaining both richness and activity-density of ground beetles. However, species richness was decoupled from activity-density. The effect of local variables linked with hedgerow structure varied according to the ecological groups of ground beetles.

KEYWORDS

Ground beetles, hedgerow network, agricultural landscape, richness, activity-density, ecological group

Temporal variability in spatial distribution of carabid beetles in agricultural landscapes

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ABSTRACT

The aim of this study is to investigate spatial distribution of carabid beetles (Coleoptera, Carabidae) around arable field-woodland boundaries throughout the season. The field experiment was performed in the model area near Sedlčany, Czech Republic. Carabid beetles were collected using pitfall traps arranged along four transects perpendicular to arable field-woodlot boundaries. Beetles were sampled during four sampling periods: 1) early spring, 2) late spring, 3) summer and 4) late autumn. Three species groups were identified according to their habitat specialization: 1) open habitat specialists, 2) habitat generalists and 3) forest specialists; and these groups were analysed separately. Total species diversity was highest in area of ecotone between arable field and woodlot. The edge between habitats was preferred by habitat generalist species and open habitat specialist species also spilled over here. Distribution of relative species richness and relative activity density was not stable in time. Spatial distribution of forest species was relatively less variable. Open habitat species aggregated within habitat boundaries instead of field interiors in early spring, probably as a result of overwintering behaviour. Generalists were also aggregated in the edge between habitats in autumn period and during early spring occurred relatively more in the centre of woodlot than in other periods. Species composition of carabid beetles assemblages depended partly on season and also on the position on transect. There was also a significant interaction between spatial and temporal variability in species composition of carabid assemblages. Woodlot assemblages seem to be less variable in time. The results of this thesis contribute to extension of knowledge on distribution of carabid beetles in agroecosystems, where many carabids act as predators of various pests.

KEYWORDS

Coleoptera, Carabidae, species composition, habitat edge, arthropod communities, agricultural landscape, spatiotemporal variability

KEYNOTE 4

Carabid beetles in urban environments: current knowledge and future prospects

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ABSTRACT

Carabidologists do it all is a famous quote by Jari Niemelä in the preface of the 3rd International Symposium of Carabidology, held in Finland in 1995. One area in which carabidology has flourished is the field of urban ecology. This is not necessarily due to the volume of research done on carabid beetles in urban areas (ca. 140 studies since 1979 according to the Web of Science), but rather in terms of the plethora of subjects tackled in the field. I discuss three themes of considerable interest and potential progress in urban carabidology. First, urban-rural gradient studies (n = 49 studies) have dominated the field with the Globenet project being prominent in this regard. Urbanisation gradient studies have shown, generally, that forest specialist species, large-bodied species and species incapable of flight are negatively affected by urbanization. Forest specialists show nestedness, with city assemblages being subsets of rural counterparts. In terms of overall species richness, evidence is divided on whether urbanisation affects carabid beetles negatively due to the replacement of specialists with generalists or open-habitat species in the city. Additional urbanisation patterns include a higher dominance structure in cities, clear changes in assemblage structure between urban and rural environments, and a negative effect of urbanisation on predacious carabids compared to omnivores. I will discuss a new initiative from the USA, UrBioNet, which aims at evaluating the role of different urban landscape forms that drive patterns of taxonomic and functional biodiversity across taxonomic groups, which includes carabid beetles. The second theme that has attracted considerable attention recently is the role of urbanisation in accelerating phenotypic changes in wildlife. Few studies dealing with changes in carabid beetle traits in urban environments exist, but I argue that urban carabidology is ripe with opportunity to study this issue due to the morphological and ecological knowledge available on carabid beetles. Examples exist for changes/shifts in body size, dispersal capacities and thermal tolerance due to urban environmental conditions. Thirdly, I return to the quote '*carabidologists do it all*', by providing examples of various urban habitats that have been investigated over the years, including golf courses, meadows, mires, railway verges and recently green roofs. These isolated and sometimes novel environments result in a patchwork of habitat islands that is the urban fabric, providing resources to many carabid beetle species, sometimes even rare ones. Finally, I provide some information on trait-based approaches and how these can be used to improve our mechanistic understanding of carabid beetle assemblages and biotic interactions in the urban milieu.

SESSION 6: COMMUNITY ASSEMBLY & INTERSPECIFIC COMPETITION

ORAL PRESENTATIONS

Environmental filtering is the main assembly rule of ground beetles in the forest and its edge but not in the adjacent grassland

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ABSTRACT

In a fragmented landscape, transitional zones between neighbouring habitats are common, and our understanding of community organisational forces across such habitats is important. Studies on the effect of edges on invertebrate diversity showed that forest interiors can be invaded by species from the surrounding matrix, but this depends on whether the edge itself is natural or anthropogenic. Consequently, certain changes in taxonomic composition can be predicted, for example that forest specialists avoid anthropogenic edges, which curtails dispersal, having consequences for metapopulations of these forest specialists. Taxonomic composition and diversity, however, provide little information on the functioning and phylogeny of the co-existing species. Combining the evaluation of their functional and phylogenetic relationships, we aimed to assess whether ground beetle assemblages are deterministically or stochastically structured across grassland-forest gradients. Our results showed different community assembly rules on opposite sides of the natural forest edge. In the grassland, co-occurring species were functionally and phylogenetically not different from the random null model, indicating a random assembly process. Contrary to this, at the forest edge and the interior, co-occurring species showed functional and phylogenetic clustering, thus environmental filtering was the likely process structuring carabid assemblages. Community assembly in the grassland was considerably affected by asymmetrical species flows (spillover) across the natural forest edge: more forest species penetrated into the grassland than open-habitat and generalist species entered into the forest. This asymmetrical species flow underlines the importance of the filter function of natural forest edges. As unfavourable, human-induced changes to the structure, composition and characteristics of natural forest edges may alter their filter function, edges have to be specifically considered during conservation management.

KEYWORDS

asymmetrical species flow; co-existing species; functional features; phylogeny; random process; traits

Recovery of ground-dwelling assemblages during reforestation with native oak

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ABSTRACT

Recognition of the scale and effects of the primary forest loss resulted in a considerable interest in forest restoration. It is important to answer whether the diversity and composition of indigenous assemblages can recover after reforestation with native trees and to know how long is the recovery time. We studied ground beetles and millipedes from mature (130-year-old) oak forest, and recently established (5-year-old), young (15-year-old), and middle-aged (45-year-old) reforestation with native oak. We used pitfall trapping and leaf litter sifting to sample the arthropod assemblages. We found that the overall number of the ground beetle individuals and species were significantly the highest in the 5-year-old reforestation, while the overall number of millipede individuals and species were significantly the lowest in the recently established reforestation. The high number of ground beetle individuals and species in the 5-year-old reforestation were due to the colonization of good disperser open-habitat species. The number of forest-associated ground beetle individuals and species were significantly the lowest in the 5-year-old reforestation. From 15 years after the reforestation, when the canopy has been closing, there was no significant difference in the number of forest species. The number of forest-associated millipede individuals and species were significantly the lowest in the 5-year-old reforestation, and they were significantly the highest in the natural mature oak forest. The diversity and composition of ground beetles with high dispersal ability and less specific feeding habit recover after the closure of the canopy; however, millipedes with low dispersal ability and specific feeding habit do not recover. Our results suggest that soil preparation and tilling should be omitted during the reforestation and cultivation of the stands.

KEYWORDS

Carabids beetles, Clear-cutting, Millipedes, Recolonization, Reforestation

Ground beetles of dry forest in the inter-Andean Magdalena Valley of Colombia

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ABSTRACT

The dry forest biome is characterized by a marked rainy season with some months of drought. It is considered one of the most endangered forest types of the tropics, yet little is known about its faunal community. The aims of this study were to characterize the carabid beetle assemblage in Armero (Tolima) and to relate this community to key environmental variables. Sites were located in dry forests at Armero (Tolima), Colombia, and were of four habitats type: mature forest, secondary forest (30 years of recovery), pastures and natural recovery (3-7 years of recovery). Ground beetles were collected using pitfall traps; the surveys were performed each month for 12 months. Additionally, a set of environmental variables, including soil and air humidity and temperature, leaf litter depth, and canopy cover, was recorded per month at each site. In total, 15 carabid beetle morphospecies (189 individuals) were collected. The natural recovery habitat was most species rich (11 species), while the other habitat types were of similar richness (5-7 species). *Calosoma alternans* was the only species collected from all habitat types. In terms of abundance, the greatest number the individuals was caught in pastures (122 individuals) and the lowest number in mature forest (6 individuals). The most abundant species were *C. alternans* and *Tetracha affinis*. Mature forest, secondary forest and pastures possessed a unique species assemblage, while the natural recovery habitat shared species with the other habitats types. Leaf litter depth and canopy cover affected the species assemblage significantly, so too did habitat type. Seasonality did not affect the carabid beetle assemblage significantly, even though we expected moisture to structure these beetles in this dry forest biome. Our study provides valuable information on the carabid beetle community of the Dry Forest biome in Colombia, and showed that this relatively beetle-poor community is primarily structured by habitat type, and not moisture.

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KEYWORDS

Carabidae, seasonality, beetle assemblage, environmental variables

Population dynamics of carabid and spiders from green roofs and adjacent ground sites in Edmonton, Canada

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ABSTRACT

Green (vegetated) roofs are an anthropogenically engineered low-impact development increasingly perceived as functioning ecosystems. Therefore, in addition to improving building efficiency and the quality of urban life, they may also provide ecosystem services such as carbon storage and habitat for urban biodiversity. Due to their close association with soil and the vegetation layer, as well as the fact that most of their resources may be found within a relatively confined space, ground-dwelling arthropods are a taxon of choice to investigate the ecosystem function of green roofs. Despite the fact that arthropod species have been collected from green roofs all over the world, population dynamics on these urban habitat islands in relation to surrounding areas remains poorly understood. For example, it is unknown if arthropods establish viable populations on these roofs or exist only as temporary colonists. We use carabids and spiders to investigate 1) what species are found on green roofs and their natural habitat associations, 2) if any species may complete a full life cycle on green roofs, and 3) difference between roof and ground populations in terms of diversity, composition, and wing dimorphism (for carabids). We sampled adult and juvenile carabids and spiders collected by pitfall traps on six green roofs and four adjacent ground sites in Edmonton, Alberta. Species found on green roofs were often characteristic of dry habitats such as prairies, which occur naturally around Edmonton, but some specimens represented forest or hygrophilous species depending on the surrounding habitat. At least five carabid (*Agonum cupreum*, *Amara ellipsis*, *Amara cupreolata*, *Amara lunicollis*, *Pterostichus adstrictus*) and eight spider (*Pardosa distincta*, *Pardosa moesta*, *Pardosa fuscata*, *Pardosa modica*, *Xysticus ferox*, *Erigone blaesae*, *Mermessus trilobatus*, *Grammonota gentilis*) species are likely able to complete a full life cycle on green roofs, and thus, establish viable populations. There was no difference in species diversity assessed by rarefaction between roof and ground sites for either carabids or spiders, but species composition differed especially for carabids. Nearly 99% of beetles from roofs were macropterous (80% for *Pterostichus melanarius*) compared to 50% on ground sites (30 % for *P. melanarius*). At least a few carabid and spider species, mostly native to prairie habitats, establish viable populations on green roofs. These species are generally good fliers that may benefit from competitive release from more large-bodied macropterous species present on adjacent ground sites.

KEYWORDS

Urban entomology, green infrastructure, low-impact development

**A 23-year record of colonization of a North-American deciduous forest by the invasive carabid,
Pterostichus melanarius Illiger.**

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ABSTRACT

P. melanarius was introduced into North America from Europe and first detected in the City of Edmonton in 1959. Since then, this species has become one of the most abundant carabids in central Alberta. In Europe, *P. melanarius* seems to be most strongly associated with open heath and man-made habitats. In North America, this species has become established in many habitats, but especially in deciduous forests. We have followed the expansion of *P. melanarius* population from its initial discovery at George Lake, Alberta into a natural aspen forest. We used a grid of pitfall traps extending from the site of its first local discovery in 1990 in a grassy road verge to 1200 meters in a deciduous forest over four sampling periods (1991-1992; 1997; 2007-2009 and 2014) to describe the local spatial-temporal pattern of population expansion by *P. melanarius*. We found that: 1) relatively high activity-density of *P. melanarius* was restricted to the road verge in 1991-1992 but that its local distribution had expanded at least 1200 meters into the forest in 2014. By 2014, virtually no beetles were captured in the road verge but activity-density in the forest was relatively high; and 2) proportion of long-winged individuals decreased from 100% at the edge of expansion to stabilize around 40% in the forested sites, and the overall proportion of macropterous specimens decreased from 72% in 1991-1992 to 69% in 1997, 63% in 2007-2008, and 44% in 2014. The striking increase in activity-density of *P. melanarius* in forested sites preceded by a decrease in proportion of long-winged individuals supports the ideas that a dominant allele for short wings confers a local fitness advantage on short-winged individuals. To date no significant effects of this invasion on native carabid assemblages have been detected in a range of studies ... but we are still looking.

KEYWORDS

Invasive species, wing dimorphism

Conventional, simplified, organic: which crop management is more diverse in carabids?

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ABSTRACT

According to the European Biodiversity Strategy to 2020 report [1], agricultural practices have to evolve to meet ecological and sustainable criteria. Moreover, it has to fully integrate biodiversity conservation in its agenda. Among these expected changes, soil work is one of the major aim, along with the reduction of chemical inputs. This study wished to compare three different management practices of agricultural crops, using carabids as bio-indicators as they respond well to soil management [2]. Communities of carabids were compared in crops managed under: conventional practices (ploughing and chemical inputs), simplified cultivation techniques (no ploughing, with chemical inputs) and organic cropping (no soil work, no chemical inputs). Carabids were caught with pitfall traps from April to June, with traps emptied every two weeks, for a total of five catches. Multivariate analysis were performed to analyse the carabids communities. The PCoA clearly splits the carabids community from the organic fields from the two other management practices. A common pool of species is shared by all crops but the highest species diversity is found in the organic crops. Moreover, organic crops shelter 9 of the 10 rare/endangered species that were identified. Regarding some functional traits of carabids, the biggest species and most of the omnivorous or phytophagous species were found in the organic crops (Fig.1). Smaller species are found in the two other conditions, in which are also concentrated highly specialised species such as five species from the *Bembidion* genus. Following the IndVal [3] test results, three species all from *Bembidion* genus (*B. quadrimaculatum*, *B. tetracolum* and *B. femoratum*) indeed appear as indicator species of both conventional and simplified cultivation techniques conditions, while 12 indicator species are identified in organic condition. A distance-based redundancy analysis applied to the entire dataset (after log transformation) confirms the significant impact of the crops management practices (p-value = 0.02). Changing soil work practices are not enough to enhance carabids diversity in agroecosystems. Indeed, chemical inputs might be more constraining as no community differences were observed between the conventional and simplified cultivation techniques conditions. Moreover, habitat diversity and food resources appear to be key elements: organic crops show a more diverse carabids community, hosting a great part of omnivorous/phytophagous species which, probably benefit from the higher plant diversity in the crops.

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KEYWORDS

Agroecosystems, Crop management, Biodiversity, Feeding regime

SESSION 6: COMMUNITY ASSEMBLY & INTERSPECIFIC COMPETITION

POSTERS

Response of carabid specific and functional diversity to tree species mixtures

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ABSTRACT

Community assembly theory posits that, at the local scale, fine-grained habitat composition and structure drive local species assemblages through resource availability and niche opportunities. In forests, which shelter the majority of the terrestrial biodiversity, it is thus predicted that tree species richness and vertical stratification would be main drivers of animal diversity. However, this hypothesis is difficult to test in managed forests due to many confounding factors such as correlations between tree diversity and site conditions or silvicultural practices. Here, we used a tree diversity experiment to evaluate the effect of compositional and structural diversity of trees on carabid diversity. In the ORPHEE manipulative experiment, eight blocks have been established with 32 plots of 100 trees in every block, corresponding to all possible combinations of one to five tree species (*Betula pendula*, *Quercus robur*, *Q. pyrenaica*, *Q. ilex*, and *Pinus pinaster*). Tree species mixtures were established according to a substitutive design, keeping tree density and the identity of tree neighbors equal across plots. We set pitfall traps in all plots to collect carabid beetles during the summer season and evaluate the response of ground beetle species richness to the tree diversity gradient. In addition, we retrieved beetle species traits from the literature and databases in order to test the effect of forest diversity on carabid functional diversity. These results shed new lights on biodiversity - ecosystem functioning relationships, more particularly on the biological control provided by predatory carabids in mixed forests.

KEYWORDS

forest, community assembly, traits, predators, phytophagous, manipulative experiment, conservation biological control

Successional trends in the carabid beetle fauna of a young coastal dune lake in The Netherlands

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ABSTRACT

This poster presents the results of a 3-year's investigation in the carabid beetle fauna of a small coastal dune lake in the area of Berkheide (province of South Holland in The Netherlands). This lake was created in the year 2010 and was investigated in 2014, 2015 and 2016 by means of semi-permanent pitfall trapping and by hand catches. The water contains much chalk and some NaCl. Water table is very dynamic through the season, due to rain and evaporation, creating a large pendulum zone. A vegetation of *Mentha aquatica*, *Lycopus europeus*, *Samolus valerandi* and small *Juncus* species entered the area rapidly, followed by *Phragmites australis* and tall *Juncus* species. Bare sandy shores disappeared, including typical carabids like *Dyschirius* species and *Omophron limbatum*. In the 3rd year, the carabid fauna was dominated by some *Agonum* species, *Elaphrus* species and *Stenolophus mixtus*. They were accompanied by about 40 other carabid species, among them several specialists. The trends in the relative abundance of carabid species are analysed and discussed. This investigation will continue in the years to come.

KEYWORDS

Coastal dune lake succession carabids

Influence of different types of wildfire on the community structure of ground beetles (Coleoptera, Carabidae) in pine forests of the Meshchera Lowlands

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ABSTRACT

The dynamics of ground beetle communities were studied in 2011-2015 in red-stemmed feathermoss-bilberry pine forests of the Meshchersky National Park, Ryazan Area, Russia (55°08'N, 40°10'E). Pitfall trapping was conducted in three types of pine forest: unburned, after a ground fire, and after a canopy fire. The latter two forests had been burned one year prior to sampling. Plastic cups of 0.5 L capacity and 95 mm upper diameter, filled with a 4% formaldehyde solution as a fixative, were used. In each habitat, 10 traps were arranged along transects at 10 m intervals. The traps were checked every ten days. All captured beetles were dissected and six physiological states in the adults of both sexes distinguished, based on gonad condition. According to the demographic structure, the labile and stable components (Matalin, Makarov, 2011) were analyzed in each carabid community annually. During the observation period, 11,564 specimens of Carabidae belonging to 73 species were collected. Among them, only 10 species (13.7%) were residents at least for one year at least in one of the habitats, 46 species (63%) were recorded only as sporadic, while 17 species (23.3%) were recognized either as sporadic or migrants. The unburned pine forest was characterized by the lowest species diversity, because only 28 species were recorded there. Among them, four forest-associated species (*Carabus arcensis*, *Pterostichus niger*, *P. oblongopunctatus*, *Calathus micropterus*) were resident during no less than three years. In the pine forest after a ground fire, 50 species were observed, six of them being residents at least for one year: four forest-associated species (*C. arcensis*, *P. oblongopunctatus*, *C. micropterus*, *Notiophilus germinyi*), one grassland-associated species (*Calathus erratus*) and one fire-associated species (*Pterostichus quadrioveolatus*). In this habitat, *P. quadrioveolatus* was the most abundant during three years following the fire. In the pine forest after a canopy fire, 56 species were trapped, with five species recognized as residents. Surprisingly, this habitat revealed no forest-associated residents during all years of observation. Next year after the fire, only two fire-associated species (*P. quadrioveolatus*, *Sericoda quadripunctata*) were resident there, with their proportion in general abundance amounting to 89.5%. Since 2012, three grassland-associated species (*Poecilus versicolor*, *C. erratus*, *Harpalus rufipes*) were also observed as residents, but in 2015 no residents were recorded in that habitat. The community structure of unburned pine forest was more stable during five years of study, because the proportions of residents, migrants and sporadic species varied very weakly. On the contrary, in both kinds of burned forest the proportion of sporadic species during the study period increased 1.3-1.4 times.

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KEYWORDS

Wildfire, pine forest, Carabidae, labile/stable components, community structure

The community of ground beetles (Coleoptera : Carabidae) in semi-arid zone of Algeria

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ABSTRACT

Shrublands in Algeria have been marked by a rapid and severe degradation due to the action of climatic factors and anthropogenic pressure, which results in a dramatic deterioration of the various components of the ecosystem: flora, fauna and soil. Shrublands provide an important food resource, and are vital for the distribution and the structure soil and ground-dwelling arthropod communities. In the context of beetle diversity conservation, the distribution of carabid beetles in two xerophytic native shrub species (*Atriplex halimus* L. and *Artemisia herba alba* L.) was examined by pitfall trapping during four years in semi-arid zone of Algeria. A total of 51 species was found. The data show that the community composition varied between the two habitats in species richness, abundance and humidity requirements.

KEYWORDS

Carabid beetle, Shrubland, semi-arid, Assemblage, Algeria

The ground beetles (Carabidae) of the cereal field edge in north-eastern Algeria

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ABSTRACT

During four years, the ground beetles (Carabidae) of the cereal field edge were studied in north-eastern Algeria (Constantine), using pitfall traps and also collecting them from under shelters. The results showed that the cereal field edge contained a great diversity of carabid beetles. A total of 54 species was found. Adaptive parameters of species, like diet, flying ability and humidity requirement revealed that the fauna is dominated by predators, xerophilic and hydrophilic species.

KEYWORDS

Coleoptera, Carabidae, cereal field edge, north-eastern Algeria

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