The Global Insect Decline Phenomenon

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Symposium 1: Insect Diversity and Monitoring

08:00 **0109** The Global Insect Decline Phenomenon: Insect Diversity and Monitoring

08:05 **0110** Fire: death by a thousand cuts in aquatic insect community assembly of streams in western North America, concerted and confounded variables in space and time. **C. Riley Nelson[1]**, Anna L. Eichert[3], Ben W. Abbott[3], Isabella M. Errigo[3] and Paul Frandsen[2], [1]Department of Biology, Brigham Young University, [2]Department of Plant and Wildlife Sciences, Brigham Young Univ., Provo, UT, USA , [3]Department of Plant and Wildlife Sciences, Brigham Young University

08:15 **0111** Local depressions play a key role in the maintenance of ant diversity in a forested mountain landscape. **Dianne Joy Aguilon[4]**, Gábor Lorinczi[3], Gábor Módra[2], István Elek Maák[3], Orsolya Juhász[1] and Zoltán Bátori[3], [1]Department of Ecology, University of Szeged Doctoral School of Biology, University of Szeged, Hungary, [2]Department of Ecology, University of Szeged Doctoral School of Environmental Sciences, University of Szeged, Hungary, [3]Department of Ecology, University of Szeged, Hungary, [4]University of the Philippines Los Baños,Department of Forest Biological Sciencesences, University of Szeged Department of Forest Biological Sciences, College of

08:30 **0112** Drivers of insect biodiversity in urban green spaces: A review and meta-analysis. **Holly Martinson[1]**, Michael Raupp[1] and Steven Frank[2], [1]McDaniel College, United States, [1]University of Maryland College Park, United States, [2]North Carolina State University, United States

08:45 **0113** Nature conservation considering vector ecological burdens – an interdisciplinary view on cases studies from Germany. **Tarja Viviane Dworrak[1]**, Ellen Kiel[2], [1]University of Oldenburg h Group Aquatic Ecology and Nature Conservation, Germany, [2]University of Oldenburg Institute for Biology and Environmental Sciences Research Group Aquatic Ecology and Nature Conservation, Germany

09:00 **0114** 30 years of arthropod monitoring in German beech forests: outcome and outlook. **Viktor Hartung[1]**, Alexander Schneider[2], Frank Köhler, Jörg Römbke, Petra Zub[2], Steffen Pauls[2], Theo Blick and Wolfgang Dorow[2], [1]Senckenberg Gesellschaft für Naturforschung, [2]Senckenberg Research Institute and Museum Frankfurt, Germany

09:15 **0115** Towards global standards for automated insect monitoring. **Jamie Alison[1]**, Toke Hoye[1], [1]Aarhus University

09:30 **0116** Identifying and integrating diverse datasets to understand insect decline: the EntoGEM project. **Eliza Grames[2]**, Chris Elphick[1] and Graham Montgomery, [1]University of Connecticut, [2]University of Nevada, Reno

09:45 **0117** Landscape scale ecological networks as a mitigation measure against global insect declines. **James Pryke[1]**, Francois Roets[1] and Michael Samways[1], [1]Stellenbosch University, South Africa

10:00 **0118** Closing remarks

Available Abstracts from Symposium 1 of ”The Global Insect Decline Phenomenon” [from the ICE2022 Book of Abstracts]

Fire: death by a thousand cuts in aquatic insect community assembly of streams in western North America, concerted and confounded variables in space and time.

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Abstract: Megafires have burned vast stretches of wildlands in western North America in recent years during unprecedented drought. The summer of 2018 was particularly devastating in central Utah where several huge fires merged into one encompassing 610 km2 in the southern Wasatch Mountains. Within weeks remnants of an intense tropical storm dumped unseasonable amounts of rain on the fire scar in this arid watershed, triggering extensive flash flooding. These streams are tributaries of Utah Lake, the third largest freshwater lake in the contiguous western United States, whose ecology is currently a focus of renewed public scrutiny. All streams in the lake’s southern watershed were impacted to varying degrees and a sampling regime for quickly documenting changes in both abiotic (86 sites) and biotic communities (18 sites) put in place. In this report we summarize progress on measuring macroinvertebrate recovery in these streams over the past three years using species effort analyses, rapid bioassessment protocols, and community estimates using environmental DNA. Asymmetric methodologies with confounded variables for judging community decline and recovery are briefly reviewed in a context of global insect apocalypse and climate change.

Local depressions play a key role in the maintenance of ant diversity in a forested mountain landscape

Authors: Aguilon Dianne Joy[4], Lorinczi Gábor[3], Módra Gábor[2], Elek Maák István[3], Juhász Orsolya[1] and Bátori Zoltán[3], [1]Department of Ecology, University of Szeged Doctoral School of Biology, University of Szeged, Hungary, [2]Department of Ecology, University of Szeged Doctoral School of Environmental Sciences, University of Szeged, Hungary, [3]Department of Ecology, University of Szeged, Hungary, [4]University of the Philippines Los Baños, Department of Forest Biological Sciencesences, University of Szeged Department of Forest Biological Sciences, College of, Philippines

Abstract: Sinkholes (or dolines) are bowl-shaped depressions in karst surfaces. They provide a diversity of environmental factors (e.g., humidity, nutrient, soil, temperature, and water), thereby facilitating the persistence of various functional groups of species, and hence could function as local biodiversity hotspots. Here, we investigated the potential of dolines to function as safe havens by studying the distribution patterns of ants in forested and non-forested (i.e., grassland) microhabitats inside (south-facing slopes, bottoms and north-facing slopes) and outside of dolines (i.e., plateau) in the Bükk Mountains, north Hungary. We used only non-destructive sampling methods (such as baiting and hand collecting) to assess the species diversity and relative abundance of ants. We found that the fine-scale distributions of the functional groups of ants correspond to the different microhabitats and vegetation cover. The north-facing slopes and bottoms of dolines provided key habitats for ants associated with cooler and/or moister conditions (e.g., Myrmica ruginodis), while the south-facing slopes provided key habitats for ants associated with warmer and/or drier conditions (e.g., Myrmica sabuleti). The occurrence of species on the surrounding plateau indicated intermediate conditions. In addition, non-forested microhabitats had more ant species than forested ones. To our knowledge, this is the first study to illustrate that the fine-scale topography of dolines may provide microhabitats for diverse ant assemblages. We can conclude that in forested landscapes the maintenance of semi-natural grasslands may be especially important to preserve high biodiversity.

Drivers of insect biodiversity in urban green spaces: A review and meta-analysis

Authors: Frank Steven[2], Martinson Holly[1] and Raupp Michael[3], [1]McDaniel College, United States, [2]North Carolina State University, United States, [3]University of Maryland College Park, United States

Abstract: Urban forests provide critical ecosystem services by capturing carbon, mitigating pollution, reducing energy costs, improving human health, and providing habitat for wildlife. However, urbanization increases heat and pollution, fragments natural habitats, and alters the composition of the urban biota through the introduction of exotic species. Such stressors threaten the services urban forests provide and may alter the ability of these green spaces to support biodiversity. In this study, we use review and meta-analysis to synthesize the recent literature on the effects of urbanization on urban forest arthropods. We characterize published studies by spatial scale (between city, rural-urban gradient, within-city), taxonomic resolution (whole-assemblage, order, family, species), taxon, environmental variable (city size, distance to urban center, impervious surface cover, temperature, tree diversity, patch size, edge effects), and response variable (survival, fecundity, abundance, species richness, herbivory, predation, parasitism). When possible, we also quantify the magnitude of the difference in arthropod responses between high and low levels of urbanization and calculate effect sizes for meta-analysis. Through these two complementary methods, we identify key patterns of altered urban forest structure, including changes to the density, diversity, and geographic origin of trees and the ubiquity of the urban heat island effect. We tie these changes to arthropod demographic parameters, abundance, diversity, and rates of interaction. Notably, only a few taxa, including Lepidoptera and Carabidae, are well studied historically in cities, and our knowledge remains limited regarding the responses of many other groups. For the studies reporting comparable quantitative data, increasing urban pressures (such as higher impervious surface cover, lower vegetation cover, and small patch sizes) generally lead to declines in arthropod species richness, though effects on abundance are more variable and depend on the taxon and taxonomic resolution reported. Similarly, the increased proportion of exotic species in cities has led to a variety of outcomes, including reduced tree health, outbreaks of herbivores, loss of arthropod diversity, or no discernable effects. We propose that the outcome of potential novel plant-herbivore interactions, in which plants and herbivores without co-evolutionary history encounter each other, is often influenced by a combination of abiotic conditions, defense-free space, herbivore host-switching ability, and the potential for enemy escape. Our study highlights the major trends in the study of arthropod responses to urbanization, quantifies the relationships between particular urban environmental variables and arthropod responses, and points to the need for targeted future studies and the preservation of biodiversity in urban green spaces.

Nature conservation considering vector ecological burdens – an interdisciplinary view on cases studies from Germany

Authors: Dworrak Tarja Viviane[1] and Kiel Ellen[2], [1]University of Oldenburg, Germany, [2]University of Oldenburg Institute for Biology and Environmental Sciences Research Group Aquatic Ecology and Nature Conservation, Germany

Abstract: This research project focuses on one of the conflicts in wetland management. On the one hand conservation measures can benefit biodiversity. On the other hand, these measures may create stagnant water pools, which can offer suitable habitats for mosquito immatures. Mosquitoes are well known as nuisance species and carriers of infectious diseases. If nuisance mosquito species disperse numerously from wetlands to residential areas and health concerns arise, the public could then demand systematic mosquito control. Systematic mosquito control, principally control with insecticides, can affect non-target organisms and interfere with conservation goals. Knowledge about present mosquito species, their nuisance potential and the effects of wetland conservation on mosquitoes is important. However, particularly in Central Europe, this knowledge is still missing. Therefore, we studied mosquitoes before and after the implementation of conservation measures in selected wetlands in Germany from 2019 to 2021. We evaluated if and to what extent mosquito abundance, development and composition change after wetland conservation measures in wetlands along the river Danube in southern Germany and the Müritz national park in eastern Germany. In one of the four study areas at the river Danube, we noticed a marginal increase in mosquito numbers. While in other areas at the Danube and the Müritz, numbers maintained the same as before the measures. Derived from our observations, we cannot entirely exclude that conservation measures in wetlands benefit mosquitoes. Mosquito control, especially in Central Europe, usually means applying Bacillus thuringiensis var. israelensis (Bti). Bti has lethal effects on the mosquito immatures and is regarded to be the most specific agent. The impacts of Bti on non-target organisms such as chironomids and the ecosystem itself are still discussed in science. Establishing an expertise on mosquito species-specific reactions to conservation measures, can support targeted mosquito control. Additionally, the wetland type and local conditions might play an eminent role for this species-specific control and help future wetland conservation projects.

30 years of arthropod monitoring in German beech forests: outcome and outlook

Authors: Hartung Viktor[1], Schneider Alexander[2], Pauls Steffen[2], Dorow Wolfgang[2], Blick Theo, Köhler Frank, Römbke Jörg and Zub Petra[2], [1]Senckenberg Gesellschaft für Naturforschung, Germany, [2]Senckenberg Research Institute and Museum Frankfurt, Germany

Abstract: Arthropod monitoring program in Hessian forest reserves started at Senckenberg Museum in 1990 and was among the earliest initiatives of that kind in Germany. Its unique feature is concentrating not on few indicator groups, but on species-level data of many diverse taxa, i. a. Coleoptera, Aculeata, Heteroptera (ATBI-approach). 30 years of study uncovered the immense species richness in middle-European beech forest: estimated at several thousand species, 3-4 times more than the numbers accepted before. With taxa pooled and analysed together, their diversity patterns correlated i. a. with forest type, deadwood amount or forestry tradition. Diversity patterns of individual taxa mostly did not show clear environmental correlations, but high variation depending on the reserve and the group, demonstrating the analytical strength of ATBI-approach. The results of the monitoring helped to establish a list of forest affinities for taxa, enabling deeper ecological research in the future. The new monitoring concept that is being developed now will have enhanced statistical power and temporal resolution; a modular structure would make the monitoring expandable on less common forest types or habitats. It is also to integrate modern approaches such as DNA-metabarcoding with the classical morphology-based methods.

Towards global standards for automated insect monitoring

Authors: Hoye Toke[1], Alison Jamie[2], [1]Aarhus University, [2]Aarhus University, Denmark

Abstract: Advances in computer vision and deep learning provide new solutions to the challenge of understanding the potentially global insect decline. Cameras and other sensors can effectively, continuously, and non-invasively perform entomological observations throughout diurnal and seasonal cycles. The physical appearance of specimens can also be captured by automated imaging in the lab. When trained on these data, deep learning models can provide estimates of insect abundance, biomass, and diversity. Further, deep learning models can quantify variation in phenotypic traits, behaviour, and interactions. Emerging prototypes of new digital sensors hold the potential to generate automated and globally standardised insect monitoring data. However, to reach this transformative goal, international collaboration and coordination on a range of outstanding challenges is critical. Such challenges include defining minimal requirements and standards for hardware design, recording software, metadata collection, machine learning models, analyses pipelines, and the integration with existing monitoring programs. I will present examples of how these technologies are being applied to longstanding questions in insect monitoring. I will also present current steps towards global collaboration on these challenges and highlight future research avenues to facilitate the transition of these technologies from the current level of demonstration to broad scale application in global insect monitoring.

Identifying and integrating diverse datasets to understand insect decline: the EntoGEM project

Authors: Grames Eliza[3], Montgomery Graham[1], Elphick Chris[2], [1]University of California Los Angeles, [2]University of Connecticut, United States, [3]University of Nevada, Reno, United States,

Abstract: To fully understand insect population and community trends, it is necessary to identify, integrate, and synthesize datasets representing the diversity of insect taxa and their habitats globally. The literature documenting such datasets is vast and scattered across disciplines, from medical and forensic entomology, to agricultural pest management, to ecology and conservation biology, and more. The Entomological Global Evidence Map (EntoGEM) project is a systematic effort to broadly search for and catalog diverse studies with long-term data that can be used to understand changes in insect abundance and diversity. Though we have screened less than 10% of >130,000 studies that potentially contain long-term insect data, we have already identified more than 270 >10-year datasets and hundreds more shorter time series (2-9 years) documenting insect population and community trends. The datasets identified by the EntoGEM project can be used to estimate global trends more comprehensively, disentangle drivers of decline, and answer a myriad of questions about short- and long-term insect population dynamics.

Landscape scale ecological networks as a mitigation measure against global insect declines

Authors: Pryke James[1], Roets Francois[1] and Samways Michael[1], [1]Stellenbosch University, South Africa

Abstract: Mammals are globally in decline, with habitat loss a primary driver. How this activity affects functional associations of insects with large mammals, especially across transformed landscapes has received little attention. We assess how well dung beetle diversity tracks large African mammal herbivore diversity across a forestry plantation land use gradient by assessing how dung beetle richness and diversity compares to large mammal diversity and constructing a dung beetle-to-mammal interaction network. Dung beetles responded positively to an array of large mammals than to land use intensity, as they showed a strong preference for specific mammalian dung. Land use intensity categories had distinct mammal and dung beetle assemblages. Transformed areas also have conservation value, provided that there is functional connectivity between remnant vegetation within the modified landscapes. The loss of any native large mammal, especially African elephants, from transformed landscapes is likely to lead to a decline in insects. This suggests that protected areas are essential for the conservation of native insects and its interactions, while well designed and managed transformed areas have additional conservation value. African conservation managers and landowners should be encouraged to maintain a diversity of large mammals on their properties to maintain insect diversity and ultimately ecological resilience.