The Global Insect Decline Phenomenon

Moderators and Organizers: David Wagner[2], Eliza Grames[3] and Heikki Hokkanen[1], [1]Organizer, Finland, [2]University of Connecticut, United States, [3]University of Nevada, Reno

Symposium 2: Evidence for and Causes of Declines

Daily schedules

Monday

10:30 **0123** Greeting message

10:35 **0124** Widespread loss of formerly dominant insect species and global biodiversity change. **Roel van Klink**, iDiv

10:50 **0125** Community-level change in insect abundance and biomass over 50 years in a northern forest. **Nicholas Rodenhouse**[2], Richard Holmes[1], [1]Dartmouth College, [2]Wellesley College

11:05 **0126** Winners and losers of a boreal pollinator community reflect climate and land use changes. **Susu Rytteri**[2], Anna Suuronen[1], Janne Heliölä[1], Jari Kouki[5], Juha Pöyry[1], Juho Paukkunen[3], Mikko Kuussaari[1], Nick Isaac[4], Pasi Sihvonen[3] and Petri Martikainen[5], [1]Finnish Environment Institute, [2]Finnish Environment Institute SYKE, [3]Finnish Museum of Natural History, [4]UK Centre for Ecology & Hydrology, [5]University of Eastern Finland

11:20 **0127** Precipitation Changes as Drivers of Insect Decline. **David Wagner**, University of Connecticut, United States

11:35 **0128** Human Impacts on the Polynesian Beetle Fauna: An Ongoing Apocalypse. **James Liebherr**[1], and Nick Porch[2], [1]Cornell University, [2]Deakin University

11:50 **0129** Fifty years of Lepidoptera monitoring in Great Britain: trends and drivers of change. **Richard Fox**, Butterfly Conservation, Sustainability Institute, University of Exeter, UK

12:05 **0130** Closing remarks

Available Abstracts from Symposium 2 of ”The Global Insect Decline Phenomenon” [from the ICE2022 Book of Abstracts]

Widespread loss of formerly dominant insect species and global biodiversity change

Authors: van Klink Roel, iDiv, Germany

Abstract: Widespread declines of terrestrial insect abundances are now well established. What remains unclear, however, is whether other aspects of biodiversity, such as species numbers, evenness and relative abundances, are also changing. We compiled long-term insect monitoring data to study global patterns of biodiversity change. We found that despite declines of terrestrial insect abundances, there is no average decline in species numbers, and no change in evenness. This can be explained by declines of dominant species and high rates of species replacement. In the freshwater realm, we found, apart from increases in abundance, strong increases in species numbers, and an increase in evenness. This could be explained by increases in the number of rare and intermediately common species, whereas the formerly most dominant species declined. The loss of formerly common species has probably already led to the widespread rewiring of food webs, and a change in ecosystem functioning and services, given the ecological importance of abundant species.

Community-level change in insect abundance and biomass over 50 years in a northern forest

Authors: Rodenhouse Nicholas[2] and Holmes Richard[1], [1]Dartmouth College, [2]Wellesley College, United States

Abstract: Long-term community-level study of insects is rarely embedded within an ecosystem study, but this context can provide the data needed to assess drivers of change. Monitoring and experimental study of insects and birds began in 1969 at the Hubbard Brook Experimental Forest, New Hampshire, USA, and continues. Caterpillar and flying insect abundance were monitored using visual surveys and Malaise traps, respectively, from late May to early August. Results showed that caterpillar abundance fell by half, due to the loss of outbreak peaks after the 1980s. Coleoptera captured per 24-hr declined 60%, but pulsed inputs of coarse woody debris were associated with Coleoptera increases that each lasted a decade. Trichoptera and Plecoptera showed a convex pattern of change related to minimum stream flow and stream water pH. Abundance of all flying insect taxa did not decrease, largely because Diptera showed no trend and comprised on average 61% of individuals captured. Total biomass of all taxa measured at low, mid and high elevation, 1996-2018, declined significantly but only at high elevation. We will show how these dramatic changes in the structure and dynamics of the forest insect community can be linked to climate change and forest disturbance.

Winners and losers of a boreal pollinator community reflect climate and land use changes

Authors: Rytteri Susu[1], Suuronen Anna[1], Heliölä Janne[1], Isaac Nick[3], Kouki Jari[4], Kuussaari Mikko[1], Martikainen Petri[4], Paukkunen Juho[2], Sihvonen Pasi[2] and Pöyry Juha[1], [1]Finnish Environment Institute SYKE, Finland, [2]Finnish Museum of Natural History, Finland, [3]UK Centre for Ecology & Hydrology, [4]University of Eastern Finland

Abstract: Changes in pollinator assemblages have been reported widely, raising the concern of potential reductions of pollination services. Much of the current knowledge is based on well-studied pollinator groups in temperate, agriculture-dominated regions. Thus, we largely lack the understanding of the generalisability of this knowledge to different geographic regions and taxonomic groups. Here, we present how species traits affect the occupancy trends of 28 bumblebees, 108 solitary bees, 145 hoverflies, and 19 longhorn beetles across a 1100-km latitudinal gradient across the boreal zone in Finland. Time series (1980-2019; except for wild bees 1930-2019) analysed with occupancy models consist of museum and distributional records. The occupancy of bumblebees and longhorn beetles changed more often than that of solitary bees and hoverflies. Among bumblebees, the numbers of decreasing species were higher than those of increasing species. In other taxonomic groups, the proportions of decreasing and increasing species varied more between different time periods. Southern distribution was related to increasing occupancy in all pollinator groups, while none of the northern species increased. Other traits associated with occupancy trends varied among taxonomic groups and time periods. The changes of boreal pollinator community reflect the expected outcomes of changes in climate and habitat availability.

Precipitation Changes as Drivers of Insect Decline

Authors: Wagner David, University of Connecticut, United States

Abstract: Changes in historical patterns of rain and snowfall have many consequences for the flora and fauna of terrestrial ecosystems. Insects, with their enormous surface body-to-volume ratios and dependence on spiracular ventilation, are particularly vulnerable to drying. In addition to the immediate threat of desiccation, decreases in precipitation have weighty knock-on effects for affected regions: they result in lowered surface waters, water tables, and soil-moisture levels; diminish snow cover, which can insulate in-ground faunas, and provide water over summer months via snow melt; elevate fire risks; lower hostplant fitness and affect plant defense systems; diminish nectar availability; and ultimately lead to hostplant death (and range contractions). Given that nearly one-half of all described insects are specialist herbivores, the reshaping of global plant communities, due to changed patterns of precipitation, will have enormous consequences for global food webs, that will cascade across the tree of life. The talk will anchor to data from the Southwestern USA but explore other regions where changes in rain and snowfall may be driving declines.

Human Impacts on the Polynesian Beetle Fauna: An Ongoing Apocalypse

Authors: Liebherr James[1] and Porch Nick[2], [1]Cornell University, United States, [2]Deakin University

Abstract: Polynesia is home to numerous diverse beetle lineages. We combine data from pre-colonization subfossil deposits with comprehensive field collecting of extant species to provide a deep temporal view of biodiversity loss in Polynesia. Man's earliest impacts on smaller islands resulted in mass extinctions. The Austral Islands, French Polynesia, hosted a diverse prehistoric radiation of 17 species of saproxylic Pycnomerus beetles (Zopheridae), though only four persist after human colonization. In Kauai, Hawaii, the predatory carabid beetle genus Blackburnia is represented by 34 species, 7 of which are known only from subfossils from lowland pre-Polynesian deposits. Today extant species are restricted to habitats above 800 m elevation. Finally, in Oahu, Hawaii, the Polynesian island with the longest and densest history of entomological exploration, 14 of 66 known native Carabidae have not been collected for over a Century. Loss of beetle diversity has been driven by habitat destruction associated first with agriculture, and now with urbanization, complemented by waves of invasive species. Thus forces reducing Polynesian beetle diversity are consistent with those hypothesized for other taxa across the World, though their effects are especially apparent in Polynesia due to the large numbers of endemic beetle species that have evolved on these small islands.

Fifty years of Lepidoptera monitoring in Great Britain: trends and drivers of change

Authors: Fox Richard, Butterfly Conservation, Sustainability Institute, University of Exeter, United Kingdom

Abstract: British butterflies and macro-moths are among the most comprehensively monitored insect taxa in the world, with spatially-extensive data on species distribution and population abundance dating back to the 1970s. These data, contributed mainly by citizen scientists, enable the calculation of robust long-term trends for c.450 species and provide a detailed and balanced assessment of biodiversity change. I will introduce the data sources and analysis techniques, before summarising the results of 50 years of monitoring Lepidoptera in Great Britain. The findings present a complex picture of winners and losers, challenging the contemporary narrative of insect armageddon, while remaining consistent with overall patterns of global biodiversity loss.

Much progress has been made in elucidating the drivers of change among Britain's Lepidoptera and I will review the evidence from 20 years of research, highlighting individual and synergistic effects, as well as the remaining key knowledge gaps.