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SUMMARIES!

HABITAT FRAGMENTATION AND BEETLE COMMUNITIES IN THE CITY

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Habitat fragmentation and beetle communities in the city

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Image: Basile Finand

- Habitat fragmentation is one of the major threats to biodiversity, especially in cities. It is well known that the actual configuration of the landscape has multiple consequences on current communities and populations. However, some past studies on plants suggest that the past configuration of the landscape is also important to explain current community composition due to the extinction debt.

- Studies on the impact of the configuration of the historical landscape on contemporary insect communities are lacking. This project aims to fill this gap by studying beetle communities and populations in urban forests of the Helsinki region. This region consists of many urban forests that have experienced different histories of fragmentation due to urbanization. Twenty-five forests with different historical trajectories will be sampled to evaluate the consequences of past fragmentation on current beetle communities and populations.

Habitat fragmentation and biodiversity

Habitat loss and fragmentation are considered major threats to biodiversity. Habitat fragmentation is the modification of large habitat into several smaller and isolated patches. Several processes create fragmented habitats. For instance, nature is naturally fragmented because of geological and/or climatic properties of the landscape, including the presence of mountains, lakes, or rivers. However, 75% of the terrestrial milieu is considered as severely degraded by human activities (Venter et al. 2016). Humans increase habitat loss and fragmentation via urbanization, transport infrastructure, agriculture, or deforestation.

These processes have severe effects on biodiversity at different scale: from the assembly of species (community) to individual differences in the same species (population). Habitat fragmentation reduces biodiversity from 13 to 75% depending on the habitat considered, with smaller and more isolated patches most impacted (Haddad et al. 2015). A loss of species can be observed, but also a difference in the species composition. It selects particular species characteristics (life history traits) such as, dispersal, reproductive strategies, behavior or specialization (Mahan and Yahner 1999; Kurki et al. 2000; Laurance et al. 2002) These modifications have important impacts on the functioning of ecosystems like nutrient cycling or food chain processes (Haddad et al. 2015).

The impact of habitat loss and fragmentation on biodiversity can also be between individuals of a same species. For example, several individual life history traits, including animal body size or dispersal strategy can be affected by a fragmented landscape (Cheptou et al. 2008; Warzecha et al. 2016). Dispersal capacity is a particularly important trait in the context of habitat fragmentation because it either allows individuals to move from one fragment to another and to colonize unoccupied patches or creates an obstacle to free movement across a fragmented landscape (Ronce 2007). A change in dispersal abilities has consequences like varying population size or the capacities of species to track optimal conditions (especially important in the context of climate change). Habitat fragmentation also modifies gene flow between populations (Young et al., 1996), which can result in adaptation or maladaptation, and in the longer term, speciation. Understanding how habitat fragmentation shapes communities and populations is therefore crucial in managing the biodiversity crisis. By studying habitat fragmentation in an urban context, this project aims to provide us tools for dealing with this crisis.

This project focuses on the history of fragmentation (see Fig. 1). The impact of time has been underestimated in urban studies (Ossola et al. 2021). Studies usually investigate the impact of current landscape configuration on current communities and populations (Herkert 1994; Vasconcelos et al. 2006). However, some studies suggest that the history of fragmentation, how the landscape was configured in the past, is also a key factor shaping contemporary communities (Lindborg and Eriksson 2004). One major mechanism that explains this is the extinction debt: a delayed response of populations and communities to habitat fragmentation (Kuussaari et al. 2009). Most studies that have investigated the effects of historical fragmentation on contemporary communities focused on plants, but few previous studies have looked at this effect on insects. This project aims to fill this gap.

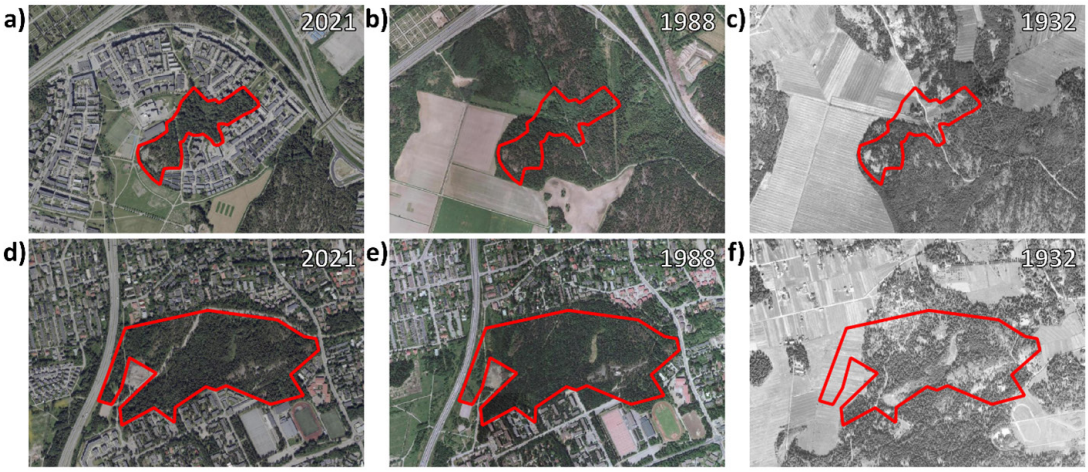

Figure 1. Examples of different fragmentation histories of urban forests in the Helsinki region. a), b), c) represent an urban forest that has experienced recent fragmentation. d), e) ,f) represent an urban forest that has experienced past, or historical, fragmentation. a) and d) are aerial photos of 2021. b) and e) are aerial photos of 1988. c) and f) are aerial photos of 1932. Red lines are the contour of the forest in 2021. The difference between the two examples is that the first forest (top panels) is not fragmented in 1988, whereas the second forest (bottom panels) is. Credits aerial photos: City of Helsinki. Scale: 1:10402

Carabid beetles in the Helsinki region

The insect group to be used in this project is carabid beetles, Coleoptera: Carabidae (Fig. 2c). It is an interesting group to study because it is species rich and species in this group occur in many different habitat types (Lövei and Sunderland 1996). We also know a lot about their characteristics (or life history traits), including different body sizes, dispersal strategies, habitat and food preferences, etc. Moreover, an impact of current habitat fragmentation has been demonstrated for this group (Niemelä, 2001). This makes these beetles a perfect tool to understand which characteristics are important in a fragmented urban environment at both the community and population levels. Indeed, preliminary work has shown intraspecific differences in body size between urban vs semi-natural environments, with smaller individuals in the city (pers. comm.). Therefore, it will be interesting to discover whether historical configurations of the landscape shape these intraspecific differences. Finally, these beetles are easy to sample using pitfall traps (Fig. 2b).

The Helsinki capital region in Finland is a perfect area to study the impact of the history of habitat fragmentation on carabid beetles. Indeed, many urban forests have clearly experienced different fragmentation histories (Fig. 1). The Helsinki capital region still has much indigenous forest left (Fig. 2a). Forests are an important habitat for these beetles, and they have been studied extensively in the past (Kotze et al. 2012).

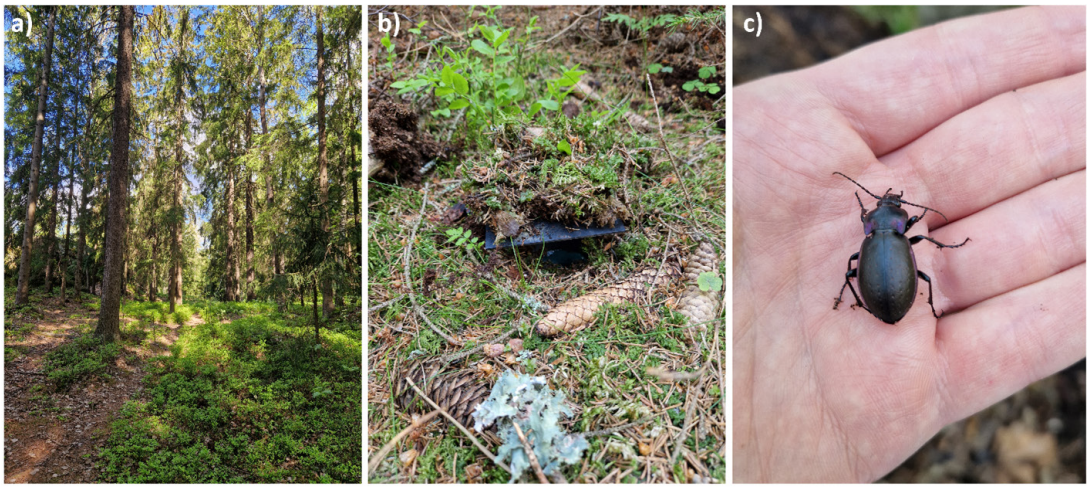

Figure 2. a) Example of an urban forest in the Helsinki region. b) Pitfall trap – a plastic cup – buried at ground level and a roof to avoid rainwater and litter from entering the trap. c) Example of one carabid beetle species (Carabus nemoralis) in a Helsinki region urban forest. Photos credit: Basile Finand

Aims and protocol

The main research questions of this project include, 1) Is the current community composition of carabid beetles a result of past fragmentation? 2) What are the effects of past fragmentation on current life history traits of species at the population and community levels (dispersal, reproduction, size, etc.)? 3) More globally, what can the current urban landscape teach us about future urban biodiversity trends? And 4) What are the implications of current urban forests management to future biodiversity?

The cities of Helsinki, Vantaa and Espoo have good open data aerial photos of the region from 1932 until the present, at least at decadal intervals. It allows for a good characterization of the history of each urban forests (Fig. 1). We selected 10 urban forests that experienced fragmentation in the past 30 years and 10 urban forests that experienced fragmentation over 30 years ago. In addition, we selected 5 control forests in and around the cities that have not experienced severe fragmentation since 1932. In each forest, we are continuously sampling carabid beetles communities using pitfall traps (Fig. 2b) and we plan on comparing communities and populations between these three groups (control forests, historically fragmented patches, contemporary fragmented forests).

To conclude, this project aims to better understand the impacts of habitat fragmentation through urbanization on biodiversity. Especially, by understanding the consequences of past city management on current biodiversity, it could help to predict what will be the impact of current management on the future of biodiversity in cities.

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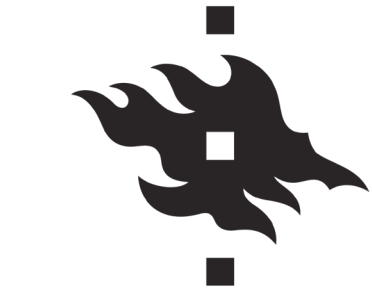

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