Plant diversity loss forces shift in ecological strategies for wild bees

Insights from historical time series at a country-wide scale

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- Introduction -

In recent decades, the intensification of agriculture and urbanization has been accompanied by an overall loss of biodiversity in the Belgian countryside [1]. Such landscape disturbances led to an overall reduction of floral resources availability at a country-wide scale.

The wild bee decline was highlighted in the 1980s in the country [2]. Because flowers are key resources for bees, the wild bee decline is likely to be caused by plant diversity loss. However, we could also observe a shift in the ecological strategy of bees to cope with plant diversity loss. Notably, we may expect an increase in generalist bee species over the course of plant diversity loss.

What are the impacts of a century of plant diversity loss on wild bee diversity and ecological strategies?

The network analysis approach, stemmed from the graph theory [3], is relevant to analyze the structural properties and dynamics of plant-pollinator interaction networks (e.g. [4]).

- Investigate species composition, their interactions and dynamics over time;
- Relate network patterns to ecological processes: species behaviour, species roles, groups of interacting species and their dynamics.

- Network analysis -

The historical database we used is one of the most comprehensive country-wide dataset [5]. It contains:

- observations of ca. 300,000 captured specimens in Belgium since 1900;
- information about the plant species visited at sampling time for almost 50,000 identified specimens.

We *a priori* split the database into three time periods [5, 6] and applied network-based approach (Figure 1) to each period in binary version.

- < 1950: before agricultural mechanization - *257 links (111 bees*123 plants)*
- 1950-1990: agricultural intensification - *1181 links (176 bees*384 plants)*
- > 1990: first environmental policy decisions - *967 links (149 bees*248 plants)*

We calculated different indices to characterize the topology of the three networks and the ecological roles of bees within these networks.

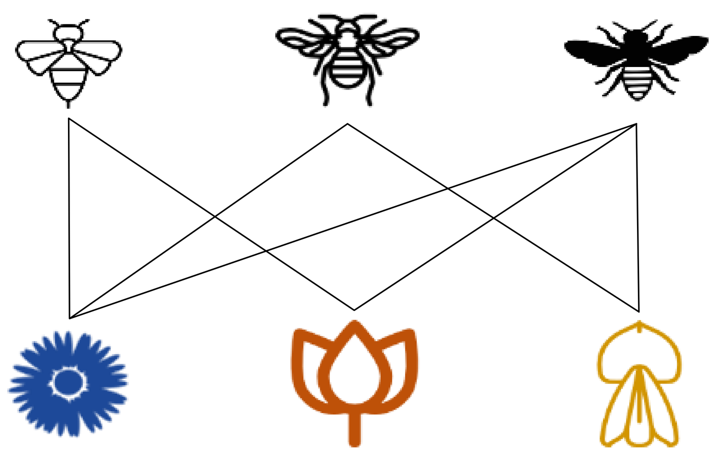


Figure 1. Schematic bipartite bee-plant interaction network.

- Results -

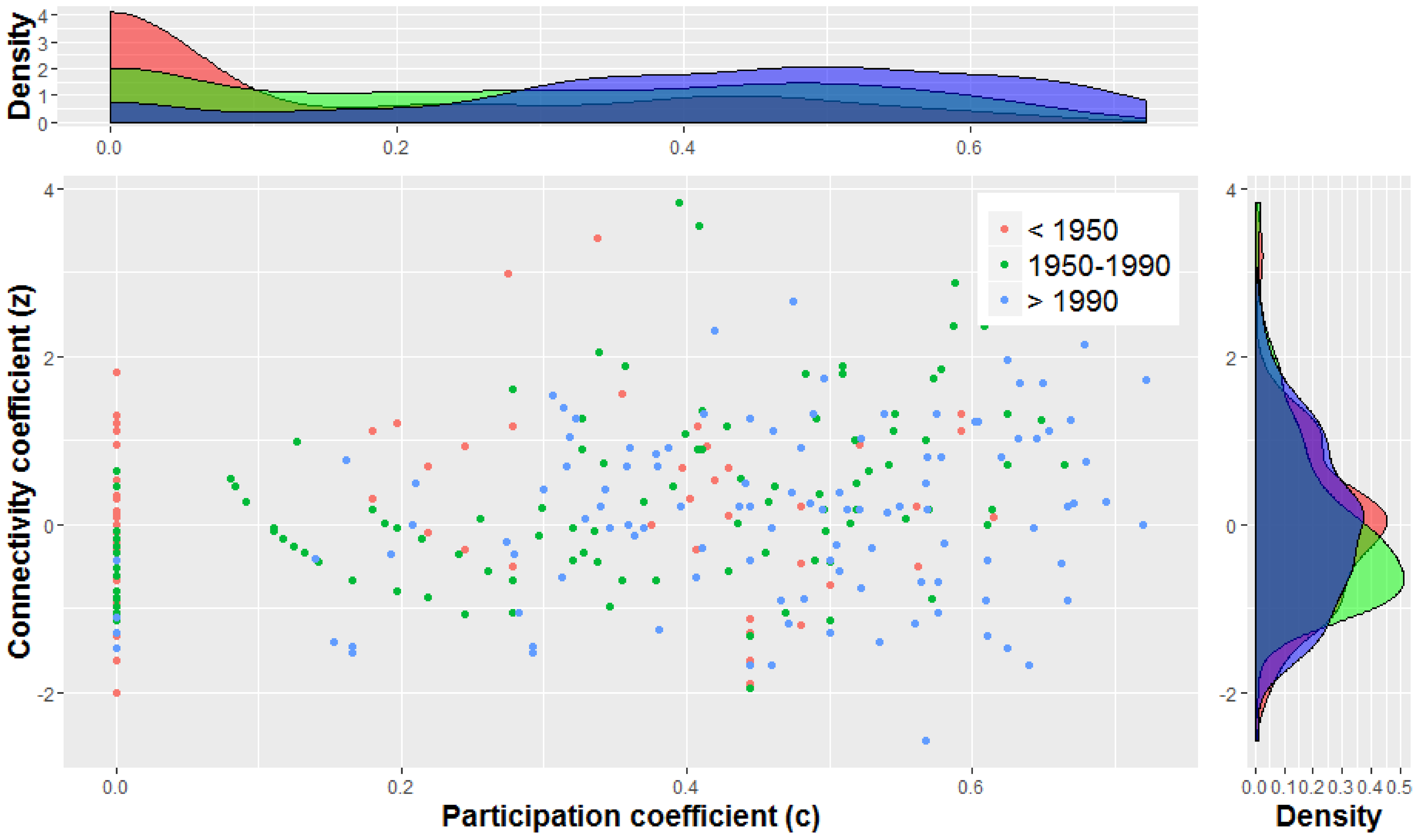


Figure 2. Change in connectivity coefficient (z) of wild bee species with their participation coefficient (c) by period. The higher the z coefficient, the more connected to other species within its module the species is; the higher the c coefficient, the more connected to species of other modules the species is. Based on [7].

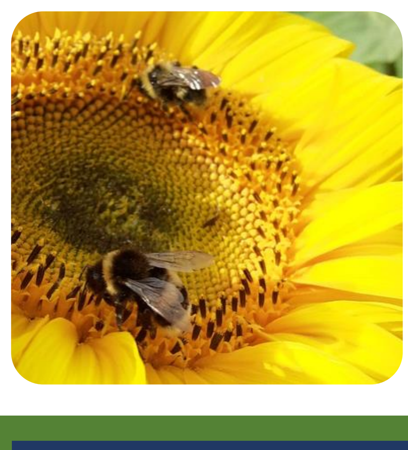
Towards a loss of bee species specialization

- Loss of very specialist bee species over time;
- Increase in the number of interactions involving the remaining species (connectance; mean bee species degree; nestedness) and decrease in network modularity;
- Greater contribution to other modules (higher *c* coefficient) (Figure 2). Bee species are less specific to their modules.

This shift towards more generalist species could have led to more stability and resilience in response to land-use intensification.

This work highlights the interest of compiling opportunistic naturalist databases to assess the impact of land-use changes on plant-bee interactions, thanks to unique historical time series, and that the naturalists systematically inform the host plants on which species are observed to better understand the changes of interaction.

It is also a step forward in the perspective of pollination service mapping and tracking of changes at a biogeographical scale.



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