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Ecological Effects of Plant Invasions

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Summary

The Oxford dictionary describes the word *invasion* as "an unwelcome intrusion into another's domain". While this definition does not specifically refer to biological invasions, it is well applicable to plant and animal invasions, some of which have severely affected recipient environments. For instance, invasive species such as *Centaurea solstitialis* and *Euphorbia esula* are noxious agricultural pests in the US causing major economic losses. Others suppress native flora and fauna by competing for food or resources such as nutrients, light and space. Nowadays, there is also the concern that genetically modified organisms, in particular crops that are increasingly cultivated worldwide, can lead to invasions, either by the introgression of the transgene to wild relatives, or by the spread of crops as feral plants.

This thesis aims to increase our knowledge on ecological effects of plant invasions, particularly in relation to pollination ecology, herbivory, and native invertebrate and plant communities. Moreover, we aim to provide tools and insights that can be used for risk assessment systems, which have the purpose to reduce the risk of future invasions and their associated impact on the environment. In order to achieve these goals we used a combination of experiments and analyses of existing data.

We first investigated how the mass-flowering invasive model species *Brassica rapa* influences the insect visitation frequency to native co-flowering species (Chapter two). We observed that native species that share pollinators with the invader were affected in terms of visitation frequency, but not in seed set and seed production. This suggests that the seed set of these species is not constrained by the number of received flower visits. The flower visitation frequency of native species that did not share pollinators with the invader remained unaffected. In the same experiment we investigated the occurrence of infested seed pods of *Diplotaxis tenuifolia* growing in the presence or absence of *B. rapa*. We found that the number of infested seed pods was significantly lower for plants growing near invaders. This illustrates that native plants can also benefit from the invader's presence.

In Chapter three we describe how plant invasions can alter local invertebrate communities and how this may affect the incidence of herbivory to co-occurring natives. For this purpose we created a two-year field experiment in which we introduced two invasive model species, *Brassica napus* (oilseed rape) and *Lactuca serriola* (prickly lettuce). Invertebrate abundance and taxonomic richness within invasion plots was generally lower than in control habitat, while along the edges of invasion plots we found the opposite pattern. The incidence of herbivory for two native focal species was not affected, despite shifts in the trophic composition of invertebrates.

A meta-analysis across 56 studies showed that invaded habitat generally contains a lower arthropod abundance and taxonomic richness than uninvaded habitat (Chapter four). Moreover, we showed that woody plant invaders have a more negative effect on arthropod abundance and richness than herbaceous species. The reasons for this are unclear, but it may be related to the palatability of plant tissues to the invader.

Finally, we analysed a dataset of more than 10.000 periodically monitored vegetation plots in the Netherlands and found that on average the habitat containing one or more exotic (non-native) species is less diverse than habitat containing only native species (Chapter five). A possible explanation is that exotic species more easily invade low diversity habitat, as described by the so-called diversity-resistance hypothesis. Furthermore, we demonstrated that the rate of colonization by invaders was not correlated to the availability of bare ground, suggesting that disturbance did not facilitate colonization of exotic plants. Finally, we found that invasive exotics have a broader niche than equally common natives and that exotic plants are found in habitats that are shadier, warmer, more continental and more nutrient rich compared to native species. We conclude that these niche differences may (partly) explain the success of exotic species in the Netherlands.

This thesis provides important insights into some important direct and indirect effects that invasive species may have on native plant and animal communities. Moreover, we demonstrate how complex ecological interactions are, and that effects can vary in space and time. With this in mind, we present three tools that may be valuable for the development and improvement of risk assessment systems (Chapter six): one to predict spatial co-occurrence of invasive and native species, a second one to estimate the probability that pollination success of natives will be affected by the invader and a third to predict the sensitivity of animals to toxins produced by genetically modified plants.