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Predicting novel trophic interactions in a non-native world

Researchers at Cornell University (United States) and Eawag (Switzerland) discovered a general and flexible method to understand how insects may use non-native plants in their diet. The method could accurately predict the use of >400 non-native plants as larval hostplants by 900 different herbivorous butterfly and moth species native to Europe. The results may make the forecasting of novel herbivore communities feasible in order to better understand the fate and impact of introduced plants.

Introduced plants are now a ubiquitous component of the world's ecosystems. A major consequence of the reshuffling of the planet's flora is that novel trophic interactions will form between plants and herbivores with previously non-overlapping ranges and no recent history of interaction. The specificity and incidence of these interactions are important because native insects can limit the success of invasive plants, cause economic damage to introduced crops, and determine the fate of native herbivore communities. However, most of novel plant-insect interactions have been studied in post-hoc comparisons, even though it would be of high ecological and economic relevance to have an a priori understanding of the formation of novel trophic interactions.

A recent article by Pearse and Altermatt in *Ecology Letters* closed this major gap. The two scientists developed a novel predictive method to forecast herbivore interactions with non-native plants, prior to the plant's arrival and successfully tested it on a very extensive dataset. They extrapolated host-use from a native plant-herbivore food web and predicted the use of 459 non-native plants in Europe by 900 herbivorous butterfly and moth species. The predictions were then validated on naturally realized new interactions that have been observed over the last century. Importantly, the study was able to accurately predict the colonization and use of many economically valuable plants and potential invasive plants by native herbivores. The authors found that the patterns that govern novel interactions (such as phylogenetic constraint of herbivore host breadth) are equally applicable to non-native interactions. The results are based on biological first principles and will be directly useful in screening potential invasive plants, forecasting pest management strategies, and assessing the risk that introduced plants pose to native food webs.

The scientists were able to predict specific diet extensions of potential European pest insects to plants of forestry or agricultural interest introduced from North America, as well as the diet extension of European insects onto non-native plants that are of invasive concern. For example, they accurately predicted that the tussock moth colonizes red oak, which is a common introduced tree throughout Europe. The tussock moth is an herbivorous insect of forestry concerns, having mass-outbreaks, and it is thus critical to understand its diet extension to novel host plants. Similarly, they accurately predicted that the currant clearwing moth colonizes cultivated gooseberries introduced from North America. The currant clearwing moth is known to cause damage in agricultural gooseberry plantations, and an accurate prediction of host switch to introduced agricultural gooseberries is thus economically important. As a final example, they accurately predicted that some pug moths that are naturally feeding on various native mugworts and ragworts extended their diet onto invasive goldenrods. The study could not yet draw conclusions on temporal dynamics, and it is up to now unclear what the effects of such diet switches are for the non-native plant. However, the diet switch to a non-native plant is the first and probably most important step to use that plant more extensively. It is basically putting “the foot in the door”, which then may open up the possibility for ecological and evolutionary processes to use that novel plant more extensively. The novel aspect of the study is, that many of the actually observed switches to novel host plants could have been forecasted before the plants have been introduced. As such, the study offers a method that can be also applied for future plant introductions, and may make a valuable tool for authority and customs decisions.

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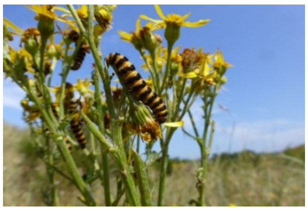

May larvae of the cinnabar moth (*Tyria jacobaeae*) feeding on native ragworts (*Senecio* sp.) also switch their diet to non-native plant species?

Larvae of the Tussock moth (*Calliteara pudibunda*) extended their diet onto the non-native red oak (*Quercus rubra*).

Larvae of the Small Emperor Moth (*Saturnia pavonia)* are relatively polyphageous, and can also include non-native plants such as *Cotoneaster dammeri* into their diet.

A female of the Small Tortoiseshell (*Aglais urticae*) is ovipositing on the native larval host plant (common nettle). May the butterfly also switch to use non-native plants?