Predicting potential geographic distributions of invading species

A recent contribution to *Current Science*[1] addressed the potential geographic distribution of the sugarcane woolly aphid (*Ceratovacuna lanigera*) in India. The species, a recent invader (first recorded in 1958), has spread rapidly, creating concern regarding its geographic potential in the region. The correspondence concluded that this pest species is unlikely to spread to the southern and coastal sectors of the country, based on ecological niche models developed using two algorithms.

The approach termed ecological niche modelling (ENM) focuses on reconstructing coarse-scale (i.e. geographic-scale) ecological requirements of species in their distributions across complex landscapes. Most techniques, including those used in the study in question, relate known occurrences of species to raster GIS data layers summarizing relevant ecological dimensions to create an ENM, which is then used to identify areas on the broader landscape that fit the ecological profile of the species[2]. This approach, however, depends critically on the sampling behind the occurrence information fed into the process being unbiased with respect to environmental gradients[3] – if occurrences are sampled in a biased manner, the ENM will be similarly biased, creating a garbage-in-garbage-out situation.

Invasions by species usually begin with introductions at one or a few sites, and the species may or may not spread outward from there. As such, the ecological characteristics of invasive populations will frequently not reflect their entire ecological potential on a landscape[4–6]. Using invaded distributional information to train ENMs, therefore, runs a serious risk of underestimating ecological potential of the species[2,7], as is illustrated in Figure 1.

In the case of the sugarcane woolly aphid and the conclusion that it is unlikely to spread to coastal and southern areas, the concerns expressed above are relevant. The ENM was trained based on non-equilibrium data, as the species is still spreading within India, and current populations are restricted to the central highlands. As such, they can inform little about the ecological potential of the species in other regions, and the conclusion that it could not invade farther south is not necessarily supported. A more robust approach would be to train the ENM based on the native distributional area of the species, where it should have expanded out to the limits of its ecological potential (or until it meets geographic barriers), and then project the ENM to India[7].

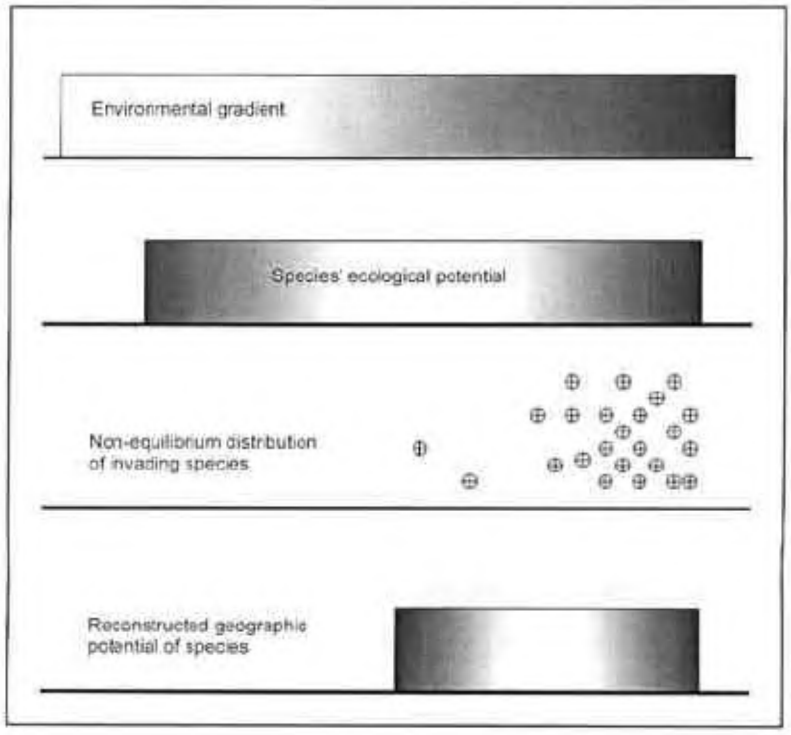

Figure 1. Diagram summarizing the dangers of using non-equilibrium occurrence data (e.g. a species invading a landscape) to train ecological niche models for predicting potential geographic distributions. Although the species in question in reality has a broad ecological potential with respect to the environmental gradient, because the invasion is still in the process of diffusing across the gradient, the species *appears* to be limited ecologically, and an incorrectly small potential geographic distribution is reconstructed.

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