Short paper

Community assembly rules based on plant ecological traits in a rural landscape

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INTRODUCTION

Biological invasions pose a threat to ecological communities and global biodiversity (Lodge 1993). To prevent invasion of alien species into native communities, it is necessary to predict invasion probability before introducing alien species. The assembly rule of a native plant community based on ecological traits represents what types of plants are likely to invade the community (Koike 2001).

In this study, we determined ecological traits of native and alien plants that statistically explained the local communities in a rural landscape (from forest to herbaceous weed communities). We developed and tested statistical models to predict a community's species composition based on ecological traits of the species pool.

METHODS

This study was conducted in a 1km quadrat in Tokyo Japan (35°38'N, 139°25'E; 52–141m above sea level). Rural landscape elements (e.g. deciduous broadleaved forests, evergreen broadleaved forests, meadows at the forest edges, banks by the wayside, crop fields), residential areas, and a school were part of this area. We conducted vegetation surveys in spring, summer, autumn, winter, and early spring at 40 (41 in autumn) plots. Vegetation data was classified into community types based on species composition using TWINSPAN (Hill 1979).

We examined the flora of the study area, and 481 native and alien species were listed. 139 of these species were chosen using random numbers, because the measurement of traits is laborious. Although the aim was to measure 28 ecological traits for all 139 species, this was only possible for 50 species, due to insufficient individuals of other species. Traits measured included shade tolerance, maximum-height in the growing season, maximum height in the dormant season, proportion of dormant biomass, ratio of leaf height to total height (including reproductive organ), self-supporting stem, extension of shoots or stolons on ground surface, spread of crown, spatiality of genet, stem lignification, seed dispersal mode, how often they reproduced over a lifetime, life span, flowering/fruiting/in-leaf duration through the year and flowering/fruiting/in-leaf duration in spring/ summer/autumn/winter.

Logistic regression and decision-tree analysis (classification and regression tree: CART, Breiman *et al.* 1984) were used as statistical methods. The species was considered as the sample unit of statistical analysis; existence or absence of the species in a given community type was assumed as the dependent variable, and species traits as the independent variables. We calculated the similarity of the species composition between the actual and predicted communities using Jaccard similarity coefficient (Jaccard 1901, Kobayashi 1995, Gotelli and Ellison 2004) based on presence/absence of species determined by threshold abundance level.

RESULTS

Seven community types were obtained by TWINSPAN. These were four forest communities (evergreen broadleaved forest, abandoned coppice forest in the growing season, managed coppice forest in the growing season, and coppice forest in the dormant season), one meadow community, and two weed communities (winter-spring weed community and summer-autumn weed community). Different communities appeared at the same site in different seasons. The winter-spring weed community is often found in winter at the same site of the meadow community, and the winter-spring weed community in crop fields is replaced by the summer-autumn weed community in the next season.

Species composition was predicted through stepwise logistic regression and decision-tree analysis. In both analyses, the mean Jaccard similarity coefficient between predicted and actual communities was around 65% in most forest community types, but less than 50% in the herbaceous communities. Both logistic regression and decision tree analysis showed similar predictability.

In forest communities, strong shade tolerance

Pages 86-87. In Koike, F., Clout, M.N., Kawamichi, M., De Poorter, M. and Iwatsuki, K. (eds), *Assessment and Control of Biological Invasion Risks*. Shoukadoh Book Sellers, Kyoto, Japan and IUCN, Gland, Switzerland, 2006.

was selected by stepwise logistic regression, as the most important trait. Maximum height was also important in some cases. "Long duration of flowering" and "stems that spread on the ground" were recognised as key traits for all weed communities. In the meadow community, "stems that spread on the ground" was selected by logistic regression and "long duration of flowering" by decision-tree analysis, but predictability was low.

DISCUSSION

Our results showed that it was possible to predict species composition of the plant communities from the ecological traits to some extent. The Jaccard similarity coefficient between predicted and actual forest community was 65% and was higher than for other communities. In herbaceous communities, the predictability was considerably lower than in the forest communities. Herbaceous plants that grow in arable land rarely appear in the dark environment of the forest floor, but seedlings of forest tree species sometimes appear in herbaceous communities. The occurrence of such species in herbaceous communities might be responsible for the lower predictive ability in herbaceous communities than in forests.

Shade tolerance was the key trait for forest communities, both for woody plants and for herbaceous species. Koike (2001) showed that a strong shade tolerance was the most important trait required for woody species to exist in climax forest communities, and a large maximum height to be the next. Results of the present study were similar.

A long flowering duration was the key trait in weed communities. Mabry *et al.* (2000) found that long flowering duration was one of the key traits responsible for resistance to disturbance. Ground surface spread was also selected as a key trait. Ground surface spreading enables the survival of individuals in an environment where they are at risk of being trampled or ploughed, and it is also advantageous in terms of rapid horizontal spread.

Prediction of the meadow community was the most difficult. A typical meadow community has a stable species composition, and meadow communities at geographically distant sites have similar composition (Miyawaki 1986; Sone 1991), thus a set of key traits should exist for the community. The true key traits that predicted this community type were not clear in our study.

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