J. Aquat. Plant Manage. 48: 130-133

Impact of Invasive Alligatorweed on Species Diversity and Composition of Native Insect in Wetland Vegetation: A Field Study

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INTRODUCTION

Biological invasions affect biodiversity worldwide at various scales (Mack et al. 2000). Recently, much attention has been paid to negative effects of alien species on resident communities and functioning of invaded ecosystems (Hejda et al. 2009). Studying the community level impacts in the field by comparing invaded and uninvaded plots can identify potential effects of an invading alien species and provide valuable information for landscape management and nature conservation (Zuefle et al. 2008).

The massive invasion of alligatorweed (*Alternanthera philoxeroides* [Mart.] Griseb) is considered a conservation problem in riparian habitats (Pan et al. 2007). The domi-

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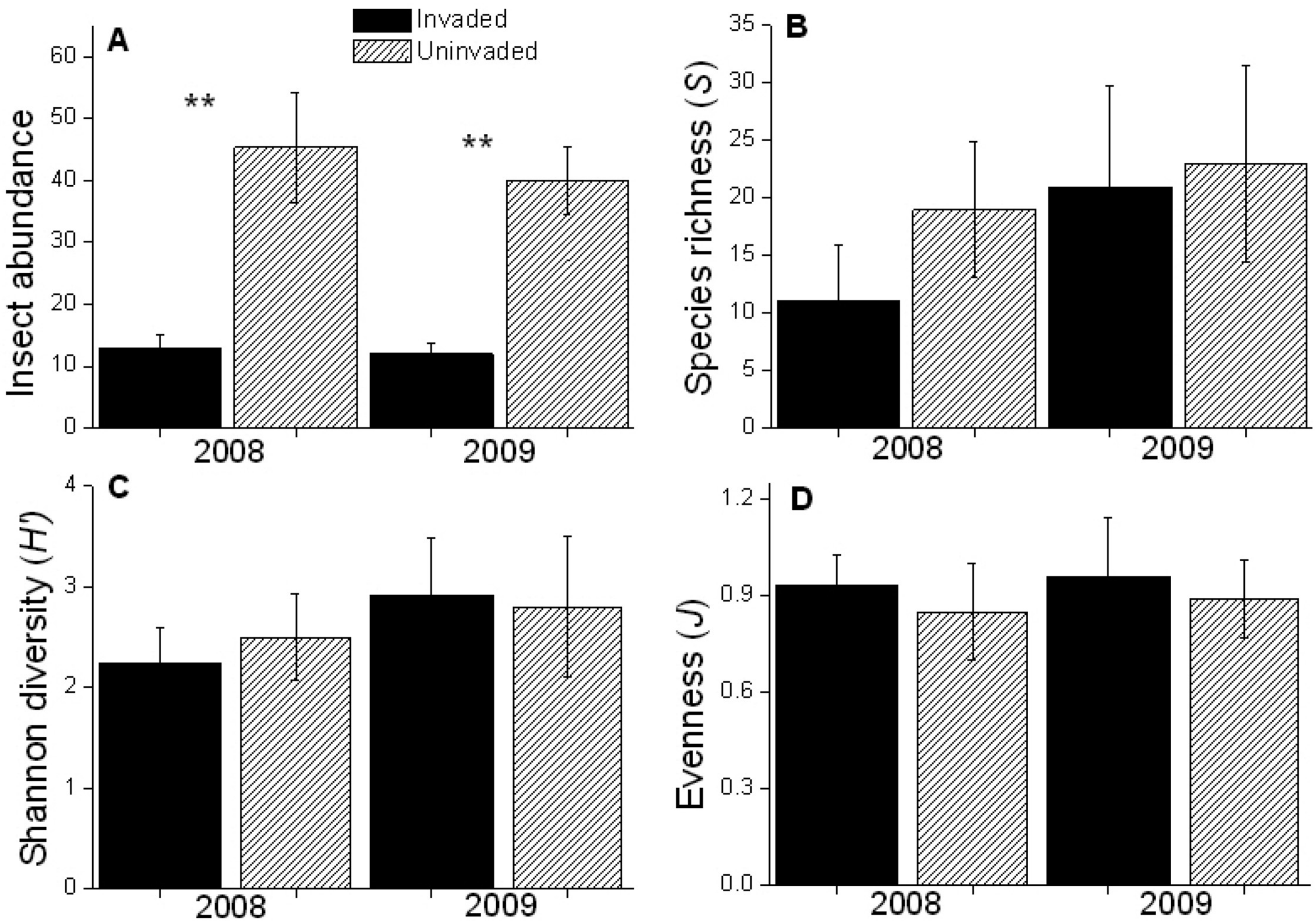

Figure 1. Average (± SE) canopy insect abundance (A), species richness (B), evenness (C), and diversity (D) sampled in uninvaded and invaded plots in 2008 and 2009. ** $P < 0.01$

nance of alligatorweed along riverbanks has been repeatedly reported to cause problems in stream management (Pan et al. 2007). Alligatorweed in south China is subjected to occasional eradication efforts, but the long term effects of these rather unsystematic schemes are very limited because the populations usually re-invade within few years (Jia et al. 2009). The aim of this study was to determine the effect of alligatorweed invasion on characteristics of invaded riparian communities and to determine whether the invasion alters insect species diversity and composition existing in the resident communities prior to the invasion.

MATERIALS AND METHODS

We conducted this study during summer (Jul) 2008 and 2009 in the valleys of the Tianmu Mountain National Nature Reserve (30°18'-30°25'N, 119°24'-119°28'E) in Lin'an County of Zhejiang Province. The climate is humid subtropical (mean annual temperature 14 C, mean annual precipitation 1200 mm), with a long growing season (approximately 220 days) and bimodal distribution of precipitation (Jun and Aug). The natural vegetation of the study sites is primarily wetland herbage (Pan et al. 2006). Alligatorweed is believed to have been accidentally introduced with vehicles in the 1990s.

To examine the effects of alligatorweed invasions on community structure of native insects in the wetlands, four pairs of adjacent 4 × 4 m vegetation plots were sampled. The plots were chosen to cover a range of site conditions and vegetation types in which alligatorweed achieves dominance in the invaded communities (Pan et al. 2006). In each vegetation type, one plot of the pair was placed in heavily invaded vegetation ("invaded plots") where the invader was dominant and had a high cover, and the second plot was placed in neighboring vegetation where alligatorweed had no cover ("uninvaded plots"). The uninvaded plot was chosen to have as similar site conditions (<10 m) as possible to the invaded plot.

All plots were sampled at approximately 24 h intervals at noon for three consecutive days. For each sample, five sweeps were taken over the vegetation canopy while walking across the middle of the 3 × 3 m subplot. The contents from the three sweeps at each site were pooled into one sample. The same person sampled all sampling plots to avoid the dif-

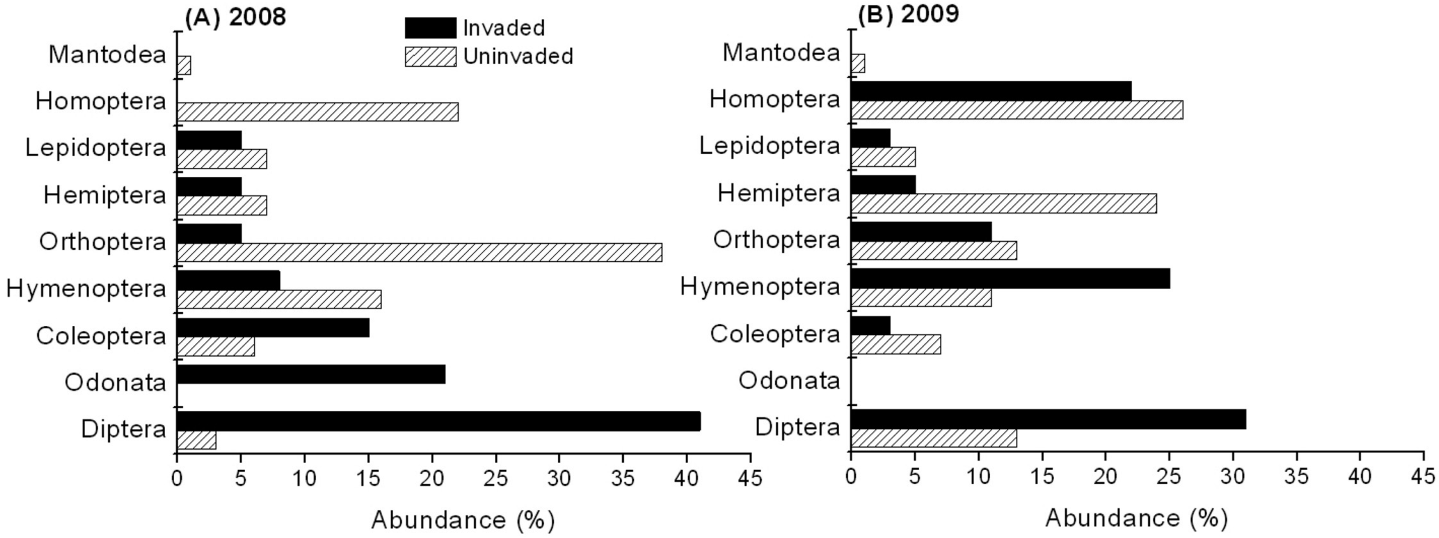

Figure 2. Relative abundance of canopy insect groups sampled in uninvaded and invaded plots in 2008 and 2009.

ferences in sampling effort caused by different persons. Insects from each sample were placed in a plastic bag and poisoned. All insects were identified to family and morphospecies, and their numbers were counted. The classification of insects followed Zheng and Gui (1999).

In each plot, the number of each morphospecies was used for calculating the Shannon diversity index H' and evenness J. Evenness was calculated as $H'/\ln S$, where S is the species richness expressed as the number of species. Differences in species richness S, Shannon index H', and evenness J between invaded and uninvaded plots were used to measure the effect of invasion on these community characteristics. Differences in diversity index of insect communities were tested by paired t-tests of invaded and uninvaded plots on square rooted data.

RESULTS AND DISCUSSION

We collected 441 individual insects comprising 37 native insect species belonging to 33 insect families and nine insect orders for 2008 and 2009 combined. Diversity indices including insect species richness S, Shannon diversity H', and evenness J were not different significantly between invaded and uninvaded plots ($P > 0.05$; Figure 1B-D). In contrast, insect number in invaded plots was significantly reduced (-70%) compared to uninvaded plots both in 2008 ($t = 9.75$, $P < 0.01$) and 2009 ($t = 8.04$, $P < 0.01$) (Figure 1A). This finding that alien plant species maintained lower abundance of native insects relative to native seems to support Ehrlich and Raven's claim (1965) that most insect herbivores require an evolutionary history with a particular plant lineage to exploit it as a host. Other studies also demonstrate that insect biomass or density was greater on native than alien plants (Gao et al. 2006, Wu et al. 2009).

Insect composition in invaded plots seemed different from that in uninvaded plots (Figure 2). Diptera (including Syrphinae, Muscidae, Ephydridae, Bombyliidae, Sarcophagidae, and Culicidae) was the most abundant taxa in invaded plots (31 to 41%) and was greater than that in uninvaded plots (3 to13%) both in 2008 ($t = 7.38$, $P < 0.01$); and 2009($t = 5.11$, $P < 0.05$). In contrast, Orthoptera and Homoptera were the dominant groups in uninvaded plots (Figure 2). This result is consistent with previous studies on invasive *Spartina alterniflora* in China. For example, Gao's study (2006) shows that Diptera was the dominated taxa in *Spartina* stands. Wu's (2009) result of a stable isotope analysis shows that *Spartina* was the main food source for Diptera insects in *Spartina* monoculture.

Considering the degree to which invasive, non-native plants are replacing native vegetation in natural areas throughout south China (Ding et al. 2008), these results may have important implications for conservation biology. Insect herbivores are the primary means by which energy captured by plants is passed to higher trophic levels in most terrestrial ecosystems (Wilson 1987). If non-native species dominate natural wetlands, the resulting reduction of insect abundance and changing of the community structure are predicted to degrade ecosystem diversity, productivity, and function.

Although this study provides new knowledge on the effects of alien invasive plants on native insect communities, the results reported here should be discussed with caution. First, observational studies comparing invaded and uninvaded habitats may be biased by factors other than the invasion. Second, arthropod communities were investigated only in a growing season (Jun and Aug), which prevents us from obtaining a general picture of the effects of alligatorweed invasions on arthropod communities, although it is probably valid only for the comparative purpose. Third, we sampled insects only by using net sweeping methods. A further investigation with different sample methods (e.g., Wu et al. 2009) is needed to confirm the effect of *A. philoxeroides* invasion on native insect community in south China.

ACKNOWLEDGMENTS

Financial support was provided by National Basic Research Program (grant No. 2009CB119201), the Public R & D Program for Environment (grant No. 200709017), and the National Natural Science Foundation of China (30400052).

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