Available online at www.sciencedirect.com
ScienceDirect
Agriculture, Ecosystems and Environment 124 (2008) 173–178
Agriculture Ecosystems & Environment
www.elsevier.com/locate/agee

Effects of Crofton weed *Ageratina adenophora* on assemblages of Carabidae (Coleoptera) in the Yunnan Province, South China

Weibin Gu [a,c], Weiguo Sang [a,*], Hongbin Liang [b], Jan C. Axmacher [d]

[a] State Key Laboratory of Vegetation and Environmental Change, Institute of Botany, The Chinese Academy of Sciences, Beijing 100093, China
[b] Institute of Zoology, The Chinese Academy of Sciences, Beijing 100043, China
[c] Graduate University of the Chinese Academy of Sciences, Beijing 100049, China
[d] Department of Geography, University College London, London WC1E 6BT, UK

Received 6 March 2007; received in revised form 3 September 2007; accepted 7 September 2007
Available online 23 October 2007

Abstract

Crofton weed (*Ageratina adenophora*) is a highly invasive weed that has spread into several provinces of southern China. This study compares carabid assemblages originating from native pastures with assemblages in Crofton weed dominated communities in the Lancang County, Yunnan Province, to assess how the invasion of this neophyte impacts the community structure of ground-dwelling arthropods.

Over a period of 16 months, a total of 1574 carabid beetles representing 28 species were collected at two types of pasture, and 679 carabid beetles representing 34 species at stands of Crofton weed. The most common carabid species, *Tetragonoderus arcuatus* and *Harpalus indicus*, were mostly found in the pastures, while four of the five rarest species were present exclusively under Crofton weed.

Alpha-diversity and evenness of carabid assemblages were greater under Crofton weed. Three distinct groups of carabid species were separated according to indicator values and a characterization of habitats: habitat generalists, Crofton weed specialists and native pasture specialists. The distribution of carabid species was related to environmental parameters such as depth of litter layer, total phosphorus, height of vegetation, amount of fresh biomass and pH of the soil. According to this study, the invasion of Crofton weed will alter the structure of carabid communities, but will not necessarily reduce the alpha-diversity of carabid assemblages.

Keywords: Biodiversity; Carabidae; *Ageratina adenophora*; Plant invasion; Pasture

1. Introduction

Biotic invasions are regarded as an important cause of biodiversity losses (Drake et al., 1989; Williamson, 1996; Shigesada and Kawasaki, 1997). They potentially modify ecosystem structure and functioning, thus creating cascading effects for resident biota by altering system-level flows, physical resources, or the availability and quality of nutrients and food (Mack et al., 2000; Crooks, 2002). Plant invasions often greatly diminish the abundance of native plant species or even threaten their survival (Mack et al., 2000). Although the impacts of plant invasions on native plants have been well documented (Steenkamp and Chown, 1996; Sousa et al., 2000; Angelica and Dudley, 2003), the impacts on ground-dwelling insect assemblages are more complex and less-well known. Previous studies investigating such impacts have reached differing conclusions. While most studies discovered a decrease in arthropod diversity following plant invasions due to a decreasing plant species richness and habitat heterogeneity (Beerling and Dawah, 1993; Steenkamp and Chown, 1996; Greenwood et al., 2004), results from other studies indicated an increase in density and diversity of arthropods (O'Hare and Dalrymple, 1997; Philippa et al., 1998; Hedge and Kriwoken, 2000). Hence, the question of how plant invasions affect invertebrate assemblages is still open for debate.

Originating from Mexico, Crofton weed (*Ageratina adenophora* R.M. King & H. Rob) is a highly invasive and

* Corresponding author. Tel.: +86 10 62836278; fax: +86 10 82599519.
E-mail addresses: guweibin@ibcas.ac.cn (W. Gu), swg@ibcas.ac.cn (W. Sang).

0167-8809/$ – see front matter © 2007 Elsevier B.V. All rights reserved.
doi:10.1016/j.agee.2007.09.004

noxious weed reaching pest status in many tropical and subtropical areas (Auld, 1969; Qiang, 1998). It has also expanded rapidly in South China (Liu et al., 1985; Xie et al., 2001). This resulted in alterations of many native ecosystems because of the fast growth rate and allelopathic properties of this invader (Liu et al., 1989; Qiang, 1998). Although many studies have been conducted to evaluate its potential damage to plant community composition (Liu et al., 1985), its ecological characteristics and eradication methods (Alan, 1961), information on how Crofton weed affects arthropod diversity in Southern China is widely lacking.

To study this question, carabid assemblages under Crofton weed were compared to assemblages under pastures, with a detailed investigation on species abundance and composition and their spatial distribution.

2. Materials and methods

This study was carried out at a pasture research station (22°33′N, 100°0.5′E) in the Lancang County of the Yunnan Province, South China. The area is characterized by a subtropical monsoon climate with a mean annual temperature of 18.6 °C, varying between mean temperatures of 12.5 °C in January and 23.1 °C in June. Annual precipitation amounts to 1600 mm, 89% of which occurs between July and September.

The vegetation in this region is dominated by secondary forests and grasslands, which have replaced the natural forests after their destruction by the local residents. In the middle of the last century, Crofton weed invaded the native grasslands in this region and formed monodominant plant communities. In 1996, this neophyte was widely eradicated using herbicides, and native pastures were restored. Nevertheless, some areas were reinvaded by Crofton weed.

In this study, eight Crofton weed dominated and eight native grassland sites were chosen, with four of the native grassland sites being dominated by *Setaria* sp. and the four remaining sites by *Echinochloa* sp. Each site was 1 ha in size and had an inclination of less than 20°. In Crofton weed dominated sites, Crofton weed reached coverage of up to 80%. The native grasslands (*Echinochloa* sp. and *Setaria* sp.) were sown for seed production. There were no cutting and fertilizer applications in Crofton weed, while the native weed was cut once a year to harvest seeds, and fertilizer applications were 750 kg (N:P:K = 1:1:1) per ha. The main characteristics of the three vegetation types are listed in Table 1. All sites were located within a radius of 50 km at altitudes between 1600 and 1800 m. The distance between any two plots was larger than 1 km.

Eight groups of pitfall traps were placed on each study site. Each of these groups consisted of five traps, with four traps located at the corners and one in the center of a 1 m^2 quadrat. The quadrats were placed 20 m apart in a straight line crossing the site center. At each pitfall trap, a PVC pipe with a diameter of 10 cm and a length of 20 cm was used to support the trap in the ground, minimizing the interference with the surrounding vegetation during sampling. A disposable cup with a diameter of 9 cm and a depth of 10 cm containing 75% alcohol was placed inside each pipe to collect the beetles so that the upper edge was level with the soil surface. Traps were protected from water by circular polyethylene covers of 15 cm diameter positioned approximately 6 cm above the ground surface.

The carabid beetles were collected each month for a 16-month period from October 2003 to January 2005, with sampling occurring during a 5-day period each month. Most carabid beetles caught in pitfall traps could be identified to species level, while some were identified only to the genus level due to a lack of detailed references.

Environmental conditions of the sampling sites were examined to explore whether any of these conditions could be used to predict the abundance of the dominant carabids and the species richness of carabid assemblages. The depth of the leaf litter layer and the coverage and average height of the vegetation were measured within each of the 1 m × 1 m quadrats. Fresh weight of the above-ground biomass was also measured. Soils were sampled to a depth of 10 cm and their pH, organic matter, total nitrogen, phosphorus and potassium contents were measured using standard methods (Liu, 1996).

Various indices were used in the statistical analysis, including the Berger–Parker index to demonstrate differences in the dominance structure, the Simpson index to emphasize differences in the evenness of the distribution, and *Chao* 1 to further evaluate changes in alpha-diversity between communities. Simpson's Reciprocal index and *Chao* 1 were calculated using the software package *EstimateS* (Colwell, 2005). The Bray–Curtis index was used to determine the similarity of carabid assemblages in any two plots within or between *Echinochloa* and *Setaria* pastures. To investigate differences in carabid assemblages

Table 1
Mean values and standard deviation of vegetation height, vegetation coverage, fresh weight of the above-ground biomass and depth of the leaf litter layer of the three vegetation types investigated in this study

Vegetation type	*Echinochloa* pasture	*Setaria* pasture	Crofton weed
Mean vegetation height (m)	0.40 ± 0.27	1.01 ± 0.10	1.00 ± 0.30
Vegetation coverage (%)	69 ± 16	89 ± 6	90 ± 7
Fresh weight of above-ground biomass (kg/m^2)	0.98 ± 0.57	2.48 ± 0.55	2.79 ± 0.70
Depth of leaf litter layer (cm)	0.15 ± 0.06	0.40 ± 0.14	2.36 ± 0.87