

# Impacts of *Mimosa pigra* on native plants and soil insect communities in Tram Chim National Park, Vietnam

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## Abstract

We assessed the impacts of mimosa, *Mimosa pigra* L., on native plants and soil insects in the wetlands of Tram Chim National Park, Dong Thap Province, Vietnam. Species composition, and the abundance of native plants and soil insects, were compared across three mimosa densities based on mimosa canopy cover: dense (70% to 100% coverage), sparse (10–30% coverage), and none (no mimosa present). Mimosa stands replaced areas of seasonally inundated grasslands with shrub-land, a vegetation type not previously present in Tram Chim. Those plants in shallow water such as *Panicum repens* L. community and *Ischaemum rugosum* Salisb. community were the first to be replaced. Mimosa then invaded areas of deeper water such as those occupied by *Eleocharis dulcis* (Burm. F.) Hensch. and *Oryza rufipogon* Griff. Forty-five plant species were identified; 26 of these species were found in sites under dense mimosa canopy. The study suggested some native plants species that may be suitable for revegetation following the removal of mimosa. Fifty-one soil insect taxa were identified. No statistically significant differences in abundance, species richness and diversity index were detected among three different mimosa densities. Large-scale mimosa infestations, however, may lead to changes in soil insect species composition.

**Keywords:** invasion impacts, Mekong Delta, wetland invasion.

## Introduction

Tram Chim National Park is a 7,600 ha wetland complex consisting of a mosaic of freshwater swamp forests dominated by *Melaleuca cajuputi* Powell, seasonally inundated grasslands and permanent herbaceous swamps. Tram Chim was officially designated a national park by the Vietnam Government in December 1998. Located on one of the deepest basins of the Mekong Delta floodplain, Tram Chim wetlands are subject to

four to five months of flooding every year, with an average inundation depth of three to four metres (Thin 1998). Seasonally inundated grassland is the endangered type of habitat of the Mekong basin. Natural grasslands once occurred in vast areas in the Mekong Delta, but have been mostly converted into farmlands in the last century. Three major grassland communities can be identified in Tram Chim: (1) *Panicum repens*-*Eragrostis atrovirens* (Desf.) Trin. ex Steud. community located on sand ridges and old-alluvium uplands, (2) *Oryza rufipogon*-*Eleocharis dulcis* community located on the most depressed areas, and (3) *I. rugosum* community in areas of medium elevation between the deepest basins and uplands. The diversity of the avifauna is one of the important

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conservation values of Tram Chim wetlands. Of the 175 species of birds identified, 13 species are endangered, threatened, or of special concern: Comb Duck, Grass Owl, Bengal Florican, Eastern Sarus Crane, Greater Spotted Eagle, Oriental Darter, Black-headed Ibis, Black-faced Spoonbill, Painted Stork, Asian Openbill, Lesser Adjutant, Greater Adjutant, and Black-necked Stork (Buckton *et al.* 1999).

Tram Chim wetlands are seriously infested by the exotic weed mimosa, *Mimosa pigra* L. The first mimosa plants were seen in Tram Chim around 1984–1985. By the year 2000 the area infested by mimosa was 490 ha, which increased to 940 ha in 2001 and 1,900 ha in 2002 (Triet *et al.* 2004). Mimosa invasion became a major concern for biodiversity conservation at Tram Chim. Mimosa invasion has quickly reduced native vegetation, especially grassland, consequently affecting faunal communities which depend on the native vegetation. The management of mimosa in Tram Chim National Park has not been effective for several reasons, most importantly because of the lack of sufficient funding, expertise and baseline information (Triet *et al.* 2001, Storrs *et al.* 2002).

This study aimed at providing a preliminary assessment of the impacts of mimosa invasion on native plants and soil insects of the wetlands of Tram Chim. Field surveys and sample collection was conducted in Tram Chim from January to May 2002, during the dry season.

## Methods

The diversity and abundance of native flora and soil insect biota were measured under three densities of mimosa. Mimosa densities were defined by canopy cover as: dense (70% to 100% coverage), sparse (10–30% coverage) and none (no mimosa present).

The abundance and diversity of native plants was sampled at 10 sites in each density. At each sampling site, a 5 × 5 m plot was set up and all vascular plants that occurred in the plot were recorded. A collection of plant specimens was deposited at the herbarium of the Department of Botany and Ecology, University of Natural Sciences, Ho Chi Minh City.

Soil insects were sampled at 15 sites in each density. Insects were collected from a composite sample consisting of three soil samples of size 10 × 10 × 10 cm, collected randomly within an area 15 m in diameter. Insects were extracted from the samples with a Berlese-Tullgren funnel. Another composite soil sample was collected at each site for chemical analysis. Organic matter content, total nitrogen and pH were measured for each soil sample.

The two-sided Kruskal-Wallis rank sum test was used to evaluate the statistical differences between means of species richness and diversity index of both native plants and soil insects in different mimosa densities. The pattern of distribution of soil insect species was explored by a detrended correspondence analysis.

## Results and discussion

### Impacts on native plants

In areas heavily infested by mimosa, few native plants can grow under the mimosa canopy. It was observed, however, that mimosa did not absolutely exclude native plants. Though sporadic, some native plants were found living in dense mimosa stands. Among 45 vascular plant species recorded in 30 sampling plots, 26 species were found in plots which had 70% to 100% cover by mimosa canopy (Table 1).

The loss of native vegetation, especially grasslands, to mimosa invasion negatively affects native animal communities. Grasslands in Tram Chim provide shelter and food sources for several endangered and threatened bird species. The invasion of mimosa is considered one of the direct causes of the reduction of the Eastern Sarus Crane (*Grus antigone sharpii*) population in Tram Chim (Triet and Bao Hoa 2002, 2003). *Eleocharis* sedge beds in the core zone of Tram Chim were the main feeding areas of the Eastern Sarus Crane. These areas are now heavily infested by mimosa and abandoned by cranes. Mimosa invasion also threatens the survival in Tram Chim of a very rare grassland bird, the Bengal Florican (*Houbaropsis bengalensis*).

The control of mimosa invasion will not be successful without the restoration of native vegetation. Revegetation of infested areas is an important step in the mimosa management strategy for Tram Chim. Besides natural revegetation, planting of selected native species may be an effective tool to help restore native vegetation at the early stage of restoration. The results of this study suggested several native plant species that may be used for revegetation after the removal of mimosa. On elevated grounds such as earth dikes in and around Tram Chim, the tall grasses *Phragmites vallatoria* (L.) Veldk., *Saccharum spontaneum* (L.) and *Saccharum arundinaceum* Retz. are good candidates. On water edges, the legume *Sesbania sesban* (L.) Merr. would be suitable. *Sesbania* blooms from September to November, and the flower is used by local people as a vegetable. In areas in the buffer zone of Tram Chim, where *Sesbania* was grown in high density by local people for flower harvesting, few mimosa plants occurred. Other

species that can be considered for planting along water edges include *Commelina diffusa* Burm. F. (Commelinaceae), *Hymenachne acutigluma* Steud. (Poaceae), *Polygonum tomentosum* Shrank (Polygonaceae), and *Coix aquatica* Roxb. (Poaceae). On grasslands, the following grasses may be planted: *Ischaemum rugosum* and *Paspalum scrobiculatum* L. on dry grasslands, *Oryza rufipogon* Griffiths and *Eleocharis dulcis* on wet grasslands. Other species that may be considered for planting on grasslands include *Eragrostis atrovirens* (Desf.) Trin. ex Steud. (Poaceae), *Eleocharis ochrostachys* Steud. and *Eleocharis atropurpurea* (Retz.) J. & K. Presl. (Cyperaceae). Further studies are necessary to find out suitable germination conditions and the capacity of these plants in competition with mimosa.

### Impacts on soil insects

There is no record of soil insect communities in Tram Chim prior to mimosa infestation; therefore the analysis of the impact of mimosa on native soil

insects is difficult. This study tried to compare soil insect composition and abundance in different stages of mimosa infestation and also to provide a first account of the soil insect fauna of Tram Chim wetlands.

Soil samples where insects were collected were quite acidic. The mean pH value was 4.0 (ranging from 3.4 to 4.4). This was expected since Tram Chim's soils are mostly active acid-sulphate soils. Mean value of organic matter content is 9.60% (ranging from 5.39% to 13.83%). Mean total nitrogen is 0.38% (ranging from 0.23% to 0.52%). The non-parametric Kruskal-Wallis tests did not discern significant difference in soil pH, organic matter content, or total nitrogen between the three stages of mimosa invasion.

Fifty-one insect taxa, belonging to 13 orders, were identified from 45 soil samples (Table 2). Collembola (19 taxa) and Coleoptera (18 taxa) are the two orders from which most soil insect taxa were found. These two orders collectively contributed 72% of all insect taxa recorded in this study. Of those insect taxa recorded in all sampling sites,

**Table 1.** Plant species found in dense *Mimosa pigra* stands in Tram Chim National Park.

Species	Family	Life form
<i>Altenanthera sessilis</i>	Amaranthaceae	Herb
<i>Aniseia martinicensis</i>	Convolvulaceae	Herb
<i>Coix aquatica</i>	Poaceae	Grass
<i>Coldenia procumbens</i>	Boraginaceae	Herb
<i>Commelina diffusa</i>	Commelinaceae	Herb
<i>Cynodon dactylon</i>	Poaceae	Grass
<i>Cyperus digitatus</i>	Cyperaceae	Sedge
<i>Eclipta prostrata</i>	Asteraceae	Herb
<i>Eichhornia crassipes</i> <sup>a</sup>	Pontederiaceae	Aquatic herb
<i>Eleocharis dulcis</i>	Cyperaceae	Sedge
<i>Fimbristylis griffithii</i>	Cyperaceae	Sedge
<i>Glinus oppositifolius</i>	Aizoaceae	Herb
<i>Grangea maderaspatana</i>	Asteraceae	Herb
<i>Gymnopetalum cochinchinensis</i>	Cucurbitaceae	Climber
<i>Heliotropium indicum</i>	Boraginaceae	Herb
<i>Hymenachne acutigluma</i>	Poaceae	Grass
<i>Ipomoea aquatica</i>	Convolvulaceae	Aquatic herb
<i>Ischaemum rugosum</i>	Poaceae	Grass
<i>Ludwigia octovalvis</i>	Onagraceae	Herb
<i>Merremia hederacea</i>	Convolvulaceae	Climber
<i>Panicum repens</i>	Poaceae	Grass
<i>Paspalum scrobiculatum</i>	Poaceae	Grass
<i>Polygonum tomentosum</i>	Polygonaceae	Herb
<i>Saccharum spontaneum</i>	Poaceae	Grass
<i>Sacciolepis myuros</i>	Poaceae	Grass
<i>Sphaeranthus africanus</i> <sup>a</sup>	Asteraceae	Herb

<sup>a</sup> Note: *Eichhornia crassipes* and *Sphaeranthus africanus* are non-native plants (Triet 2000).

34 taxa were found in dense mimosa stands, 41 taxa in sparse stands and 34 taxa in stands with no mimosa present (Figure 1).

**Table 2.** Orders of soil insects recorded in mimosa-infested areas in Tram Chim National Park.

Order	Number of taxa
Coleoptera	18
Collembola	19
Dermaptera	1
Diptera	5
Hemiptera	1
Homoptera	1
Hymenoptera	1
Lepidoptera	1
Protura	1
Psocoptera	1
Strepsiptera	1
Thysanoptera	1

Dense mimosa stands seemed to host more species of insects per soil sample than sparse or non-mimosa stands; the index of species diversity is also slightly higher (Table 3). Results of Kruskal-Wallis tests showed, however, that the differences were not highly significant statistically. There is also no significant difference in insect abundance between different stages of mimosa invasion (Table 4).

Soil insects found in Tram Chim can be divided into two groups: (I) insects which spend their entire life cycle in soil, and (II) insects which spend part of their life cycle (often the larval stage) in soil. When mature, insects of Group II will often live in the vegetation above. Most of the seventeen taxa that did not occur in dense mimosa stands are

insects of Group II. The ratio of Group II to Group I taxa is different between the three different stages of mimosa invasion. In areas without mimosa invasion, there are more insect taxa of Group II than of Group I. In areas of dense mimosa, the number of Group I taxa was slightly higher than Group II taxa (Figure 1). It was also observed that mimosa foliage is not used by any native insects as a source of food. The ordination plot of sampling sites, as a result of de-trended correspondence analysis, showed that species compositions of sites sampled on dense mimosa stands are somewhat different from those of other sites, forming a distinct group located on the upper left corner of the ordination plane (Figure 2). Results of this study suggest that large-scale mimosa infestation in Tram Chim may lead to a shift in insect species composition.

**Table 4.** Results of two-sided Kruskal-Wallis test for the comparison of species richness, Shannon-Weiner index and insect abundance among sampling sites.

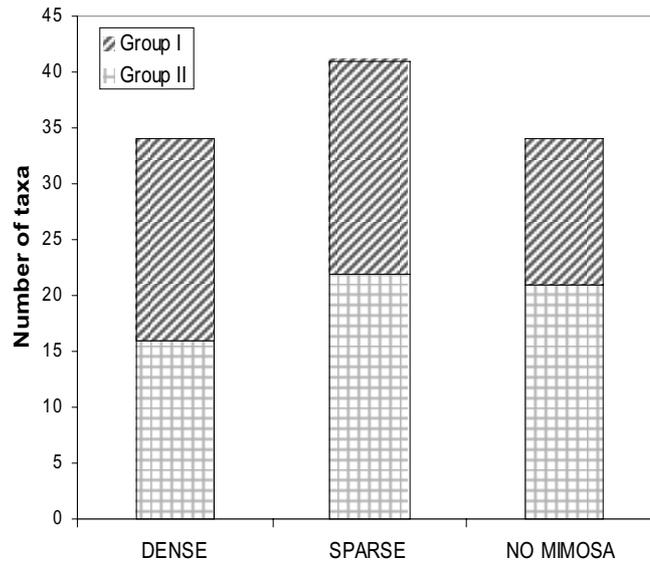
Index	df	Chi-square	p-value
Species richness	2	4.5626	0.10
Shannon-Weiner index	2	4.3765	0.11
Abundance	2	1.1840	0.55

## Acknowledgements

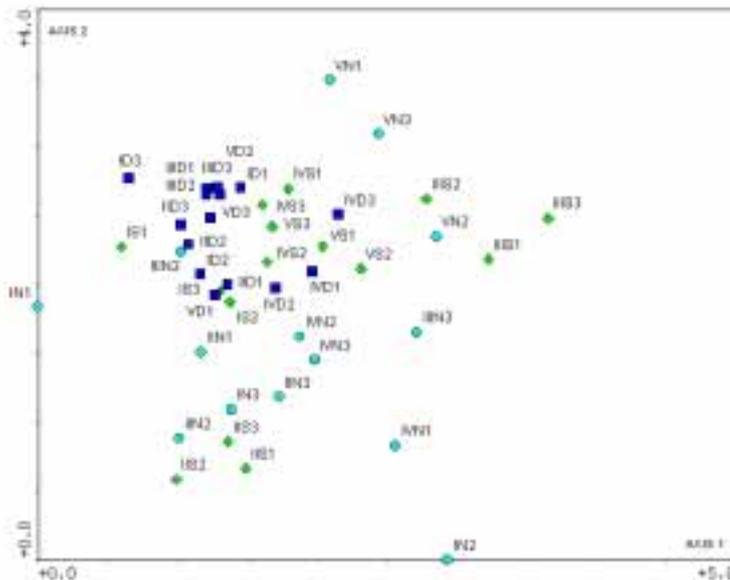
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**Table 3.** Values of species richness (number of insect taxa found in each sampling site), Shannon-Weiner index and insect abundance (number of individuals found in each sampling site) of sampling sites collected in three stages of mimosa invasion: dense (70–100% coverage), sparse (10–30% coverage), and none (no mimosa present).

Property	Number of observations	Mean	Standard error of mean	Minimum value	Maximum value
Species richness					
dense	15	10.60	1.07	4	16
sparse	15	8.00	0.93	2	15
no mimosa	15	7.53	0.94	1	13
Shannon-Weiner index					
dense	15	1.86	0.11	1.00	2.58
sparse	15	1.49	0.10	0.64	2.10
no mimosa	15	1.62	0.16	0.00	2.41
Abundance					
dense	15	29.46	6.35	1	98
sparse	15	58.73	16.15	5	206
no mimosa	15	52.33	14.69	3	190



**Figure 1.** Number of insect taxa found in three stages of mimosa invasion in Tram Chim National Park. Insect taxa are separated in two groups: Group I includes insects that spend their entire life cycle in soil, and Group II includes insects that spend only part of their life cycle in soil



**Figure 2.** De-trended correspondence analysis plot of sites sampled in three different stages of mimosa invasion. SQUARES indicate sites sampled on dense mimosa stands; DIAMONDS indicate sites sampled on sparse mimosa stands and CIRCLES indicate sites sampled on stands with no mimosa present.

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