A DEMOGRAPHIC STUDY OF NATIVE AND INTRODUCED POPULATIONS OF *MIMOSA PIGRA*

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Summary. The demographic characteristics of *Mimosa pigra* were studied in part of its native (Mexican) and introduced (Thai and Australian) ranges. Mature Mexican populations were denser, smaller in stature, and had a much smaller seed bank, than the alien populations. It is argued that the large amount of herbivory in the native range may be largely responsible for these differences.

INTRODUCTION

Mimosa, *Mimosa pigra L.*, a prickly shrub originating from tropical America (3), first arrived in northern Australia in the twenty years prior to 1871 (5). It persisted as an occasionally troublesome but minor weed for a hundred years, until it underwent a dramatic population explosion in the late 1970's. It now infests some 45 000 ha of wetlands in the Northern Territory (Lonsdale, unpublished data), much of it in dense, impenetrable, practically monospecific stands. It shades out the native vegetation of the wetlands, alters their faunal composition (Braithwaite *et al.*, unpublished data), and hinders agriculture and the control of feral animals (4).

As part of a continuing, joint biological control program with Thailand (1), where huge areas of land are infested, natural enemies specific to the plant have been imported from Mexico, part of its native range (1), where it is much less of a problem (1). Prior to any significant effect of the control agents on the performance of the plant, however, one can make comparative studies of the plant in its native and introduced ranges. These studies may throw some light on the kinds of control agents which may have an impact on this plant.

This paper summarizes a preliminary study carried out in 1985 in Mexico and in climatically very similar parts of Australia and Thailand, to examine the differences between native and introduced populations of mimosa.

METHODS

Populations of mimosa were studied in detail in Australia and Mexico, with supplementary information obtained on a short visit to Thailand. The Australian population was on the edge of a lagoon in the Darwin region, on black-cracking clay, and was typical of infestations in the wetlands of northern Australia. The lagoon was on the sub-coastal plains of the Adelaide River (12°37'S, 131°19'E). In Mexico, populations were very diverse both in habitat and associated vegetation and three sites were studied, all in the vicinity of Acapulco (16°50'N, 99°56'W). These were at, Puerto Marquez, (sandy loam in a roadside ditch), Barra Vieja, (sandy loam in a roadside ditch), and El Carrizal, (sandy loam in a wet pasture close to a stream). In Thailand, the study population was growing on sandy clay in an abandoned rice field on the outskirts of Chiang Mai (18°47'N, 98°59'S). The mean annual rainfall and temperature in the three regions were very similar: 1330 mm and 27.7°C for Darwin, 1377 mm and 28.0°C for Acuputco, and 1217 mm and 25.8°C for Chiang Mai (6).

To investigate the size of the buried seed population, 10 cm deep soil cores were taken at random under mature, healthy canopies, and the seeds extracted after breaking down the soil using a solution of 30 g of sodium pyrophosphate, 15 g of sodium hydrogen carbonate, and 75 g of hydrated magnesium sulphate in 1 litre of water. The number of whole seeds was then counted. About 90% of whole buried seeds in Australia are viable during the dry season (Lonsdale, unpublished data).

The numbers of outwardly healthy seeds per pod, and pods per infructescence, were counted in a random sample of about 40 infructescences in each region.

Size-density relationships were studied as follows: in Australia, twelve 5x5 m quadrats were sampled in mature stands, along with twenty-four 0.5x0.5 m quadrats in junvenile stands; in Thailand, only two 5x5 m quadrats were sampled in mature stands; and in Mexico, twenty-six 2x2 m quadrats were studied, in mature stands only, since no stands of junveniles were found. Note that, as part of a separate study in Australia, the quadrats in the mature stands were laid out on three replicate transects. The transects lay along a gradient of soil moisture, up the slope from the edge of the lagoon, with four contiguous quadrats per transect. The total number of plants in each quadrat was counted, and the circumference at 1 m above ground level (C), and the length of the largest stem on each plant were measured. Junvenile plants in Australia, and mature plants in Mexico, were cut at gound level, dried for 48 h at 70°C, and weighed. The mature plants in Australia and Thailand were too large to be weighed conveniently, so their weight was determined from a significant (P = 0.0001) relationship between stem dry weight in g (W) and C in cm (Lonsdale, unpublished data), where

$$\log W = 0.29 + 2.713 \log C.$$

RESULTS AND DISCUSSION

The buried seed population under mature mimosa canopies was very similar in Australia and Thailand, but at least two orders of magnitude higher than the seed bank in Mexican populations (Table 1). This is only partially explained by the seed production figures: Australian and Thai populations produced twice as many pods per infructescence as the Mexican populations, and the number of seeds per pod was about 50% higher in Australia and Thailand than in Mexico (Table 1).

Mean stem circumference did not differ significantly between Thai and Mexican populations, but was half that of the Australian population (Table 1). Although age can sometimes be a poor predictor of plant size (9), the differences in stem size between Australia and Thailand can be readily explained by the comparative ages of the stands. It is not possible to be precise about the age of the Thai population, but, growing in an abandoned, rain-fed rice field, the population was probably two, and almost certainly no more than three, years old (cf. Ref. 8). The population in Australia, however, was 4-5 years old at the time of the study. The stem circumference of the Australian population was significantly more variable ($P<0.0001$) than either the Mexican or Thai populations. This probably resulted from the pooling of Australian data from along the soil moisture gradient. Certainly, plants were denser and smaller in circumference at the wetter end of the gradient (Lonsdale, unpublished data).

Table 1. Characteristics of native (Mexican) and introduced populations of *Mimosa pigra*[1].

Characteristic	Australia	Thailand	Mexico
Soil seed density (m^{-2})	12380[a]	12610[a]	117.5[b]
Pod production (pods/infructescence)	7.1 [a]	5.7 [b]	3.0 [c]
Seed production (seeds/pod)	21.0 [a]	20.1 [b]	14.2 [c]
Stem circumference (cm)	9.9 [a]	5.9 [b]	5.9 [b]
Stem length (m)	3.4 [a]	3.5 [a]	2.4 [b]
Mature stand density (m^{-2})	1.1 [a]	2.0 [a]	6.5 [b]
Plant dry weight at 1 plant m^{-2} (kg)	1.97		0.90

[1]Values with the same letter are not significantly different at the 5% level by Student's t-test.

The density of mature stands was much lower in the Australian and Thai populations than in Mexico, where the plants were between three and six times as dense, but about 1 m shorter (Table 1). A regression of logarithmically transformed values of mean plant weight on plant density (N) for the combined Australian and Thai data (30 quadrats of mature and juvenile populations) proved highly significant (P = 0.0001). The regression model was

$$\log W = 3.29 - 1.24 \log N.$$

Similarly, the model

$$\log W = 2.96 - 1.28 \log N$$

gave a significant fit (P = 0.0001) to the data for Mexico. An F-test for the equality of the slopes indicated that they were not significantly different (P=0.49). However, the intercepts did differ significantly (P=0.02), suggesting that, at any given density, the mean weight of plants in Australia and Thailand is more than double (i.e. antilog [3.29 - 2.96]) that of plants in Mexico (see Table 1).

When compared with the alien populations, then, mature stands in the Acapulco region Mexico are dense, stunted and of low biomass; they produce fewer pods per infructescence and fewer seeds per pod, and the seed population in the soil was far smaller. What are the reasons for this? One cannot argue that there is a shortage of suitable habitats in Mexico; mimosa infests disturbed places such as reservoirs, canal and river banks, roadside ditches, agricultural land and floodplains in the introduced range (3, 7), but such habitats are also common in Mexico. Nevertheless, the Mexican populations studied here were not growing on floodplains, the main habitat in Australia, and we are unwilling to exclude the habitat explanation until we have studied populations growing on floodplains in the Veracruz region. Nor can we discount the possibility that we are dealing with particularly vigorous biotypes of mimosa in Australia and Thailand. Electrophoretic studies should throw some light on this.

The wetland flora of Australia is somewhat impoverished as compared to that of Central America. For example, a botanical study of the Alligator Rivers Region of the Northern Territory revealed a total of only 21 woody species in a total area of 3.84 ha of swamps and *Melaleuca* swamp forest (calculated from data in Ref. 10), whereas 115 woody species occurred in just 2 ha of swamp forest in Costa Rica (2). It is therefore possible that plant competition and parasitism are responsible for the poor performance of mimosa in the native range. However, this in unsupported by the scant experimental evidence: for example, in Mexico there is a clear positive relationship between the dry matter yield of epiphytes and that of mimosa (Lonsdale, unpublished data).

Human population density is high in Mexico, and the availability of cheap labour means that manual control of mimosa is economical and practised on a wide scale. However, human population density is higher still in Thailand, so this seems an unlikely explanation for the differences between native and introduced populations of mimosa.

Australian mimosa populations support 38 species of phytophagous insect, whereas 76 are found in Honduran populations (G. Flanagan, unpublished data). There are almost three times as many leaf-feeders, and twice as many seed-feeders and flower-feeders in Honduras as in Australia. It is hard to escape the conclusion from Table 1 that herbivory has a major impact on the demography of mimosa. If that is the case, it bodes well for biological control (1).

ACKNOWLEDGMENTS

This research was funded by the Government of the Northern Territory of Australia. We thank C.M. Beurle and S. Buranapanichpan for technical assistance, and I.L. Miller and K.L.S. Harley for useful discussion of this work. W.M.L. thanks the Australian Centre for International Agricultural Research for funding his travel to Mexico and Thailand. I.L. Miller and C.G. Wilson commented on an earlier draft of the manuscript. This is contribution number 529 of the CSIRO Tropical Ecosystems Research Centre.

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