Cloud forest plant endemism persistence within crop–fallow systems in a Mesoamerican hotspot area.

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INTRODUCTION

Tropical montane cloud forests (TMCF) under natural disturbance events have shown high endemism in early successional vegetation (Kessler and Kluge 2008). However, little is known about the relationship between anthropogenic disturbance and plant endemism in TMCF under ancient agricultural management. In this sense, I assessed the number of species, abundance, and frequency of endemic vascular plants in temporary plots of cultivated and young fallow areas from two maize-based systems: milpa shifting cultivation (MS) and semi-permanent cropping (SP) in Oaxaca, México.

METHODS

Study area

The study was conducted in Juquila Vijanos municipality (17°18'–17°22'N, 96°15'–96°22'W) , in the Sierra Norte mountain range of Oaxaca State, Mexico.

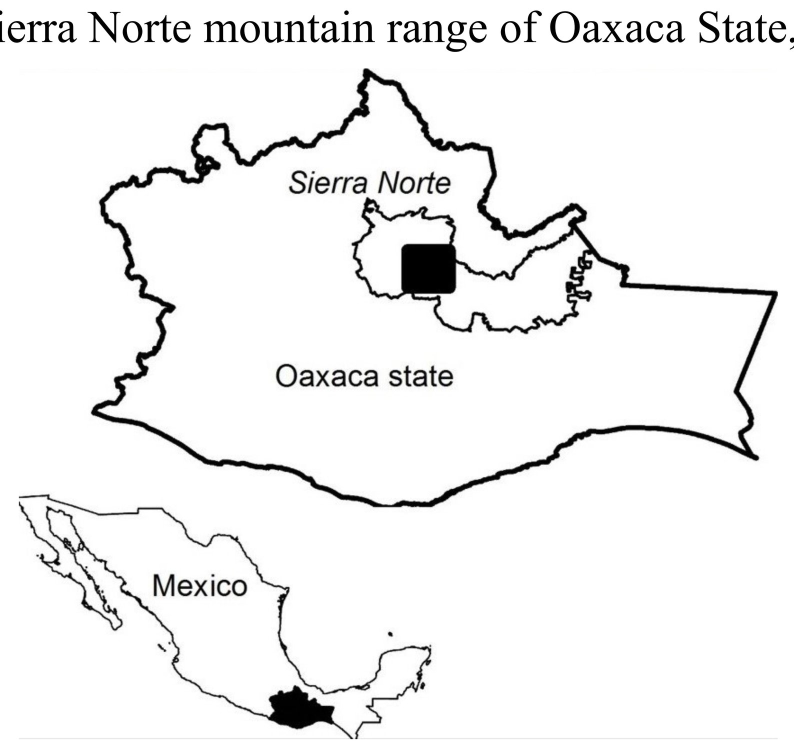

Fig. 1. The study area location: Juquila Vijanos municipality, Oaxaca, State, Mexico.

Field methods

I studied 68 smallholder maize fields, 30 of which were in cultivated fields and 38 in 2–3-year-old fallows. Within the cropping and fallow stages, fields were equally distributed into two cropping systems, i.e., milpa shifting cultivation (MS) and semi-permanent (SP) maize-based systems (Table 1).

Table 1. Farm management of the milpa shifting cultivation and the semi-permanent system of the surveyed plots in Juquila Vijanos, Oaxaca, Mexico (derived from Pérez-García and del Castillo 2016, 2017).

Management	Cropping systems	
	Milpa shifting cultivation (MS)	Semi-permanent (SP)
Land preparation	Slash (December to April) and burn (May) of secondary forest	Plowing soil two times in April using a team of two oxen
Maize sowing	May	May
Period of cultivation	Normally 3 years	Normally 5-6 years
Weed control	Pulled by hand and/or cut with a machete	Hoeing
Crop nutrition	From ashes, soil organic matter, and N-fixing crops (Phaseolus spp.)	From synthetic fertilizers: urea and diammonium phosphate
Harvesting	November or December	November or December
Fallow period	20-25 years	2-3 years

A 10 × 10 m temporary plot was placed at the center of each cultivated field. Within each temporary plot, I placed five 50 × 50 cm quadrats to assess herbaceous weed species (Fig. 2a). In fallows, trees > 1.3 m height were sampled within a 10 × 40 m plot placed at the center of each site (Fig 2b). Shrubs, vines, herbs and tree seedlings were also assessed.

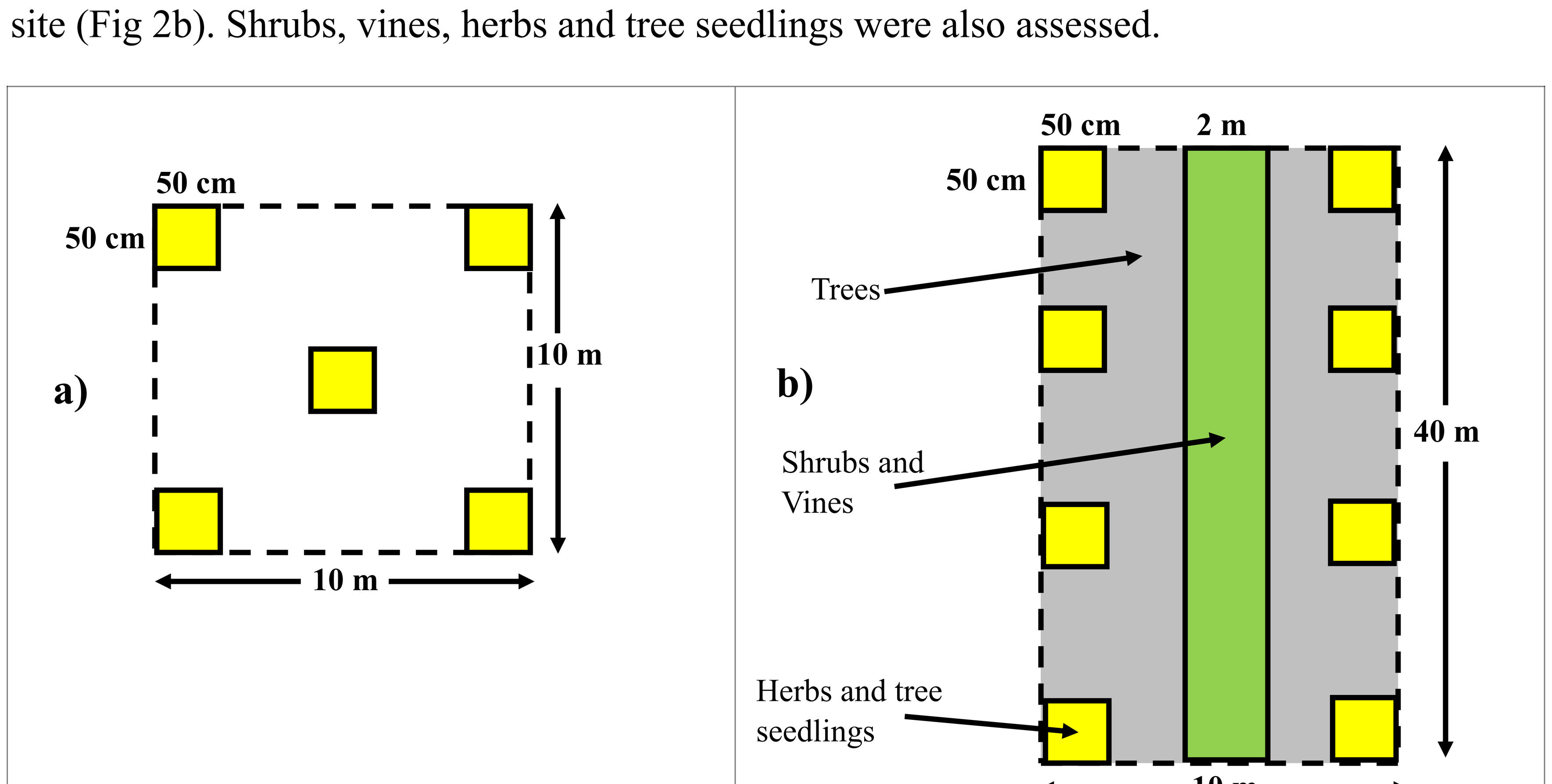

Fig 2. a). Endemic plants sampling design in cultivated fields b). Endemic plants sampling design in fallows.

RESULTS

Overall both agricultural stages and systems harbored endemic species, seven in total, but most of such species were found in the fallow stage than in the cropping stage, and in the MS system than in the SP system (Table 2). A single Asteraceae herbaceous endemic species (*Melampodium mimulifolium*) was commonly recorded in cultivated fields, but almost exclusive to the SP cropping system (Fig 3a). Seven species were recorded in fallows, where the narrow-range endemic tree species *Clethra integerrima* (Clethraceae) was the most abundant and frequent, but almost exclusive to the MS cropping system (Fig 3b).

Table 2. Country-level endemic plant species and their abundance and frequency recorded in Juquila Vijanos, Oaxaca, Mexico

Endemic species	Life form[a]	Abundance (number of individuals)				Frequency (% of plots in which the species were present)			
		Cultivated fields[b]		Fallows[c]		Cultivated fields		Fallows	
		MS (n = 15)	SP (n = 15)	MS (n = 19)	SP (n = 19)	MS	SP	MS	SP
Melampodium mimulifolium (Asteraceae)	H	2	45	0	2	6.7	46.7	0	5.3
Roldana oaxacana (Asteraceae)	S	0	0	31	6	0	0	42.1	15.8
Clethra integerrima (Clethraceae)	T	0	0	138	3	0	0	89.5	15.8
Clethra kenoyeri (Clethraceae)	T	0	0	2	0	0	0	5.3	0
Inga latibracteata (Fabaceae)	T	0	0	1	0	0	0	5.3	0
Magnolia dealbata (Magnoliaceae)	T	0	0	4	3	0	0	15.8	10.5
Pinus chiapensis (Pinaceae)[d]	T	0	0	13	31	0	0	31.6	52.6

[a] *Definitions: H, herb; S, shrub and T, tree.*

[b,c] *Acronyms of cropping systems: MS, milpa shifting cultivation and SP, semipermanent system.*

[d] *Endemic to Mexico and western Guatemala.*

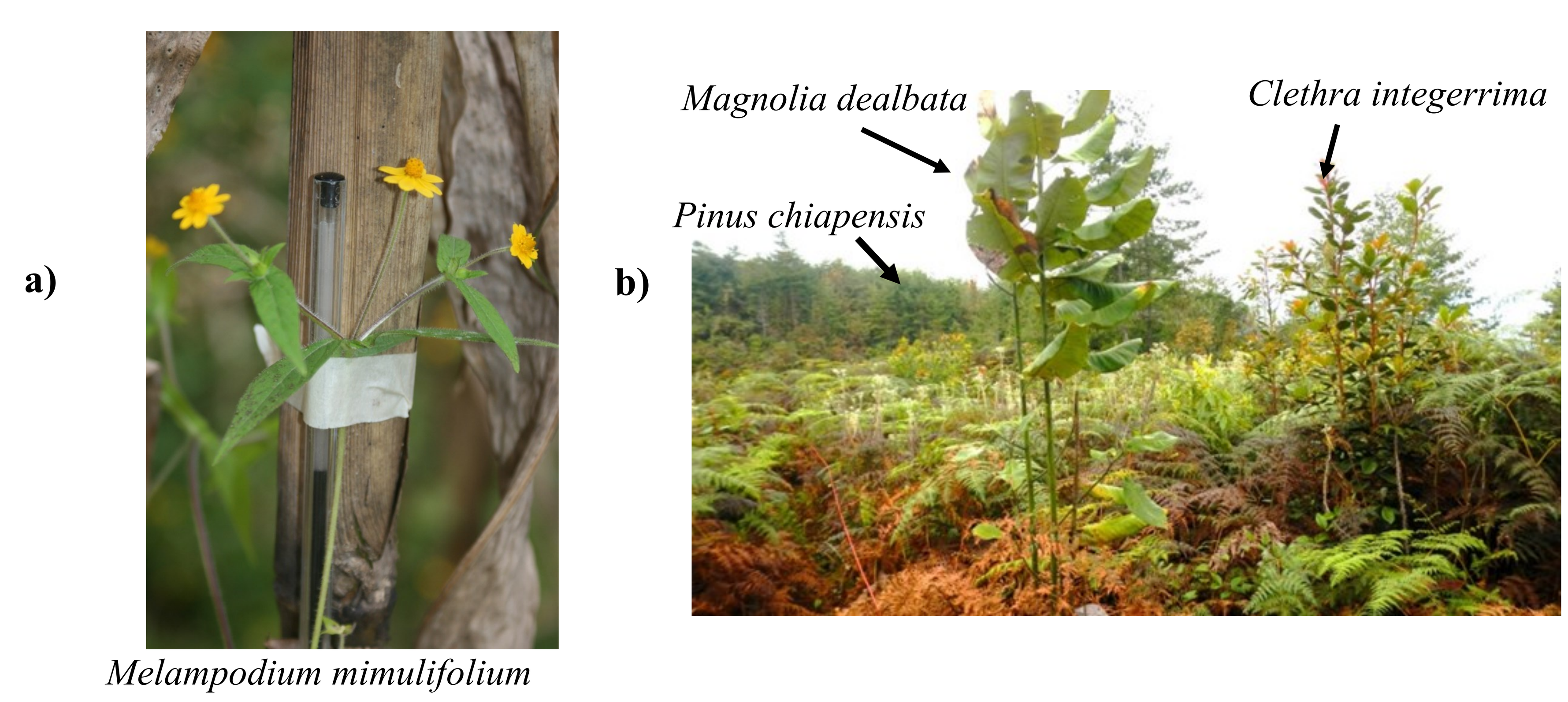

Fig. 3. a). Common endemic herbaceous species in cultivated fields of the SP system. b). Common endemic tree species in fallows of the MS system.

DISCUSSION

The results suggest that in agricultural systems with frequent cropping cycles, in biodiversity hotspots, only endemic herbaceous species with ruderal strategies can persist as suggested by Holmgren and Poorter (2007) and Gómez-Díaz et al. (2017). In contrast, in low intensity managed agricultural systems, like indigenous shifting cultivation, not only can endemic tree species prosper, but also narrow-range endemic tree species can be found (see Holmgren and Porter 2007).

In contrast to the SP system (Table 1), the relative importance of MS fallows to maintain endemic species can be related to the relatively low intensity of management of this cropping system. The absence of tillage and the ephemeral agricultural land use (Table 1) allow for the early recovery of some tree and shrub species in fallows mainly through a resprouting mechanism, as usually happens in shifting cultivation agriculture (Pérez-García and del Castillo, 2017).

CONCLUSIONS

In more permanent and intensified agricultural systems within biodiversity hotspots, only ruderal endemic herbaceous species can persist. In contrast, in low intensity managed agricultural systems, like ancient agroforestry, not only can endemic tree species prosper, but also restricted endemic trees can be found.

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