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Influence of the density of scattered trees in pastures on the structure and species composition of tree and grass cover in southern Tabasco, Mexico

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ABSTRACT

The rapid deforestation of Tabasco due to extensive livestock farming has resulted in a decrease in the original forest cover. Silvopastoral systems represent an option for reversing this problem. A comparative study was conducted to determine the influence of tree density on the structure and species composition of scattered trees in pastures (STP) as well as the herbaceous coverage. A total of 16 livestock systems with 3 STP densities were selected: low (from 24 to 49 individuals ha^{-1}), medium (from 53 to 85 individuals ha^{-1}) and high (from 129 to 212 individuals ha^{-1}. The diameter at breast height, total height, clear bole height and crown area of all trees in each plot were measured. Shannon's and Simpson's index values were determined along with the relative importance values (RIVs), and the herbaceous cover under the tree canopy was measured in dry and rainy seasons. A total of 64 species representing 31 botanical families were found. The structure and composition of the STPs are correlated with arboreal density, and thus, species diversity was greater under low and medium densities. The tree species with the highest RIVs were *Ceiba pentandra* (L.) Gaertn., *Guazuma ulmifolia* (Lam.), and *Tabebuia rosea* (Bertol.) DC. in low-density STPs; *Cordia alliodora* (Ruiz & Pav.) Oken., *Schizolobium parahyba* (Vell.) S.F. Blak., and *T. rosea* in medium-density STPs and *Swietenia macrophylla* (King.), *Gmelina arborea* (Roxb.), and *C. alliodora* in high-density STPs. The herbaceous cover was lower under high arboreal densities in both seasons. The STPs at high densities are inferred to be more specialized because they present less arboreal species diversity and structure than low-density STPs, and these properties also affect the coverage of the associated herbaceous component.

1. Introduction

Until the mid-1950s, the state of Tabasco was largely covered by sylvan vegetation, but extensive livestock farming has resulted in the elimination of the primary vegetation (Toledo et al., 1995). However, over the last five decades, government policies have continued to encourage the development of extensive livestock farming, particularly on ejido lands (Sánchez Merlos et al., 2005), which has reduced natural forest cover from 49% in 1940 to 8% in 1992 (Palacio-Prieto et al., 2000) to only 4% in the early 21st century (INEGI, 2005). This forest cover is mainly concentrated in the Sierra region. However, given the continued advancement of livestock, including the southern mountains of Tabasco, the remnants of the native rainforest dominated by *Blepharidium mexicanum* (Standl.), *Cedrela odorata* (L.), *C. alliodora* (Ruiz & Pav.) Oken, *Dialium guianense* (Aubl.) Sandwith, *S. macrophylla*, *T. rosea*, *Spondias mombin* (L.), *C. pentandra*, *Calophyllum brasiliense* (Cambess), *Enterolobium cyclocarpum* (Jacq.) Griseb), *Castilla elástica* (Cerv.), *Sabal mexicana* (Mart), *S. parahyba*, *Bursera simaruba* (L.), *Cupania dentata* (Glaz.), *Cecropia obtusifolia* (Bertol), *Diphysa robinioides* (Benth. ex Benth. & Oerst), *Parmentiera aculeata* (Kunth), *Platymiscium yucatanum* (Standl.), *Astronium graveolens* (Jacq.), *Sapindus saponaria* (L.), and *Sickingia salvadorensis* (Standl.) (Grande et al., 2010; Martínez-Encino et al., 2013; Villanueva-López et al., 2016), among others, might be converted to pasture,

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despite the technical and financial problems related to livestock systems.

One alternative to reverse deforestation is the implementation of silvopastoral systems (SPS), which are a form of land use in which woody perennials are biologically integrated with prairies and/or livestock; the fundamental principle is to diversify and optimize production while respecting the principles of sustainability, such as energy efficiency, increased biodiversity, nutrient cycling and competence reduction (Casanova-Lugo et al., 2014), and providing many services and goods to producers, defined as "Livestock Plus" (Rao et al., 2015). In this context, scattered trees in pastures (STPs) are the second most abundant and widespread vegetation type in Sierra de Tabasco (Grande et al., 2010). This system refers to the presence of trees and/or shrubs in pastures with irregular spacing between trees, i.e., scattered trees in pastures. Trees in this system perform several functions for the producers and the environment, such as offering shade, posts for walls, fine woods and construction, firewood, and a source of food for livestock. Furthermore, studies in Costa Rica have demonstrated that this system can provide ecological benefits and habitats for certain species of animals, which are important for the dispersal of tree seeds for natural regeneration and improved connectivity between arboreal landscapes (Esquivel-Mimenza et al., 2011; Harvey and González Villalobos, 2007). In addition, the presence of woody perennials can help improve soil productivity and thus promote the development of the herbaceous layer, further ameliorating micro-climatic conditions within the pasture matrix for forest-dependent species. Dispersed trees therefore play both productive and environmentally protective roles within the agricultural landscape and can contribute to both sustainable development and conservation initiatives (Harvey et al., 2011). In addition, recent studies in South America have documented that STPs play a key role in climate change mitigation by conserving and removing carbon (Chacón-León and Harvey, 2013; McGroddy et al., 2015) and in water conservation (Jose, 2009).

The importance played by STPs in the Sierra de Tabasco (Grande et al., 2010) should inform decisions and provide direction for management strategies, conservation and the implementation of STPs. Therefore, the objective of this study was to determine the influence of tree density on the structure and composition of STPs as well as herbaceous cover (pasture) during the dry and the wet seasons in two municipalities of the Sierra de Tabasco region.

2. Methods

2.1. Study area

This study was conducted between August and December 2013 in the localities of Villa Luz and Zunu-Patastal in the municipality of Tacotalpa (Sierra sub-region) and in Santo Tomás, Nuevo Progreso and Ignacio Allende in the municipality of Tenosique. These five localities are in the mountain region of Tabasco, which is part of the Provincia de Sierras de Chiapas y Guatemala (Chiapas y Guatemala physiographical zone), between 17°15′ and 17°45′N and 90°38′ and 93°46′W with altitudes ranging from 50 to 1000 m (Fig. 1). The Tacotalpa and Tenosique zones are located on the margins of the Sierra de Tabasco Reserve and the Cañón of Usumacinta Reserve, respectively, which border the state of Chiapas. Furthermore, the Tenosique zone is adjacent to the Guatemalan territories, where the condition of the native forest is

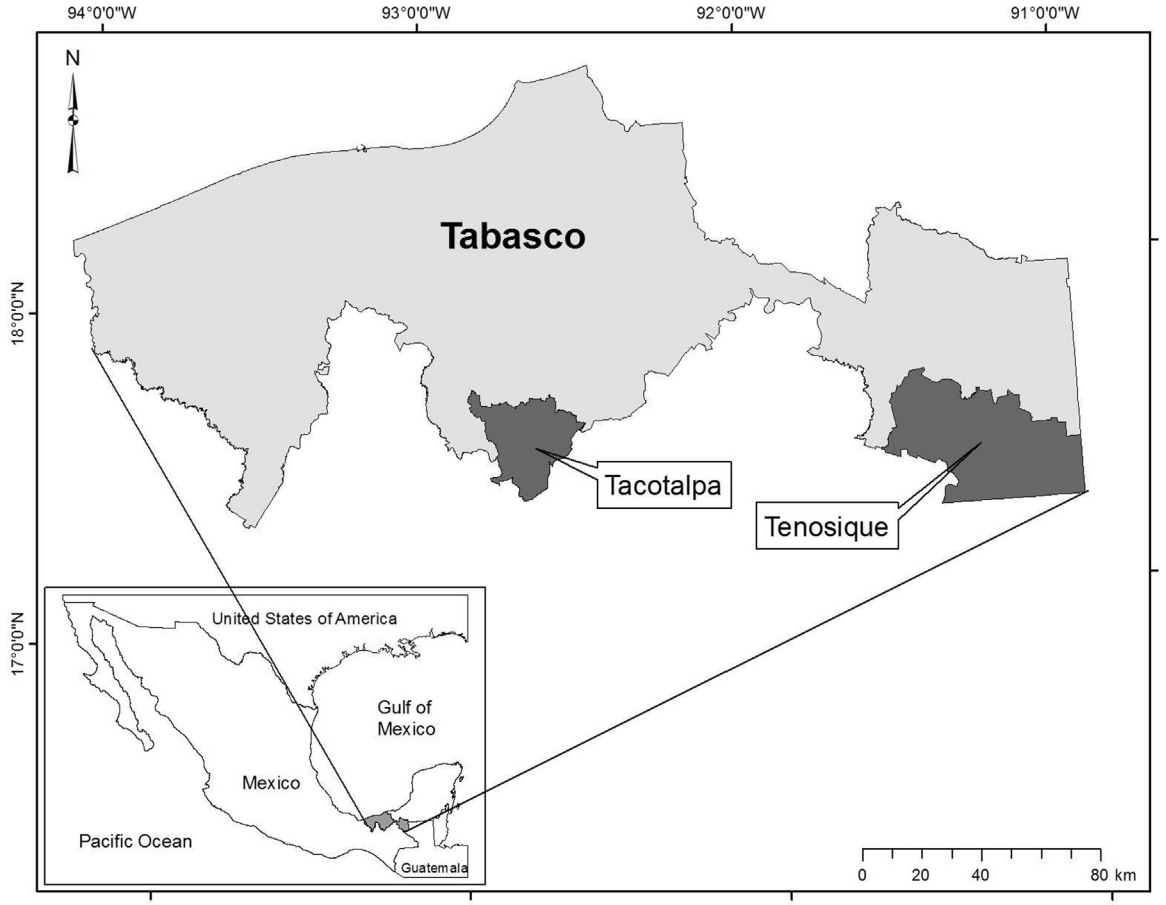

Fig. 1. Locations of the study region.