Agriculture, Ecosystems and Environment 222 (2016) 80–92

Contents lists available at ScienceDirect

Agriculture, Ecosystems and Environment

journal homepage: www.elsevier.com/locate/agee

Response of ground spiders to local and landscape factors in a Mexican coffee landscape

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ARTICLE INFO

Article history:
Received 6 February 2015
Received in revised form 26 January 2016
Accepted 29 January 2016
Available online 12 February 2016

Keywords:
Agroforestry
Inga
Shade
Araneae

ABSTRACT

In order to secure the provisioning of ecosystem services, detailed analyses of the relationship between biodiversity and agriculture are required. We studied ground spider diversity in a 52 km^2 coffee landscape in Southern Mexico, and asked the following questions. (1) How do coffee management variables and local microhabitat variables change among coffee agroecosystems and forest sites and across seasons? (2) How does coffee management affect ground spider richness, abundance, and composition? (3) How do local and landscape factors influence ground spider richness and abundance? and (4) What role does seasonality play in shaping ground spider communities? During the dry season and rainy season of 2011 we sampled ground active spiders using pitfall traps from high and low shade coffee agroecosystems (27 sites) and from forest (10 sites). On local scale, for each 20 m × 20 m site we measured leaf litter variables, invertebrate dry biomass, slope of the terrain and elevation, and management variables such as canopy cover, shade tree richness, shade tree density and proportion of *Inga* trees. At the landscape scale, we measured distance to the nearest forest and percent of forest in buffers of 500 m. Results show that agricultural management had a strong influence on spider richness and abundance. Across seasons, local spider richness and abundance had or tended to have higher values in the low-shade coffee. Spider richness and abundance were strongly influenced by physiographic and local predictors and weakly by landscape predictors. Furthermore, predictors varied with seasonality, with slope of the terrain being the strongest predictor in the dry season and canopy cover being the strongest predictor in the rainy season. We conclude that ground active spiders in this coffee landscape are greatly influenced by coffee management and local characteristics.

1. Introduction

Biodiversity provides us with important ecosystem services, such as pollination, pest control and food provisioning (Balvanera et al., 2006, 2014). Yet, we are facing great biodiversity losses and agriculture is considered as one of the main factors causing this loss (Foley et al., 2011). Agriculture and pastures cover up about 40% of the terrestrial surface of the Earth (Foley et al., 2005) and this percentage is not projected to decrease in the upcoming years, hence a more detailed analysis of the relationships between agriculture and biodiversity is needed. Indeed, over the last 20 years we have learned that the way in which agriculture is practiced affects the biodiversity present in agricultural fields, the persistence of biodiversity in the landscape (Donald et al., 2001, 2006; Tscharntke et al., 2005, 2012; Gonthier et al., 2014), and the provisioning of ecosystem services that biodiversity provides to the agricultural fields (e.g., pollination, biological control) (Power, 2010; Iverson et al., 2014). At the field level, agricultural intensification (e.g., monoculture implementation, use of pesticides and fertilizers, low canopy cover) negatively affects biodiversity (Holzschuh et al., 2008) and potentially affects the provisioning of ecosystem services (Gabriel and Tscharntke, 2007; Garibaldi et al., 2014). At the landscape level, agricultural intensification is represented by simplified landscapes, which are dominated by extensive and intensive monocultures (Tscharntke et al., 2005). Thus the effects of agricultural intensification need to be addressed at both local and landscape scales

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http://dx.doi.org/10.1016/j.agee.2016.01.051
0167-8809/

(Tscharntke et al., 2005, 2012). Most studies analyzing the landscape and local effects of agriculture on biodiversity and ecosystem services have been carried out in temperate zones of the United States and Europe (Thies et al., 2003; Purtauf et al., 2005; Tscharntke et al., 2007, 2012; Gardiner et al., 2010; Woltz et al., 2012) and relatively little is known about how these factors play out in tropical regions (but see Stenchly et al., 2011, 2012; Avelino et al., 2012; De la Mora et al., 2013; Pak et al., 2015).

Coffee agroecosystems are found in mountainous and in flat zones of the Neotropics and they play an extremely important role in biodiversity conservation (reviewed by Perfecto et al., 1996; Moguel and Toledo, 1999; Lin and Perfecto, 2012). As with many agricultural systems, coffee agroecosystems cover a full range of management practices. In Mexico, the most complex coffee agroecosystems are agroforestry systems that have high shade tree canopy cover and richness and tend toward organic management, whereas the most simplified systems are coffee monocultures without shade trees. However, in most mountainous regions with rugged topography, the most simplified systems have a low percent of canopy cover and few species of trees, most of them in a single genus (Moguel and Toledo, 1999). An extensive literature on biodiversity in coffee farms indicates that coffee systems with high shade cover and tree diversity (high-shade coffee) support higher species richness of associated biodiversity

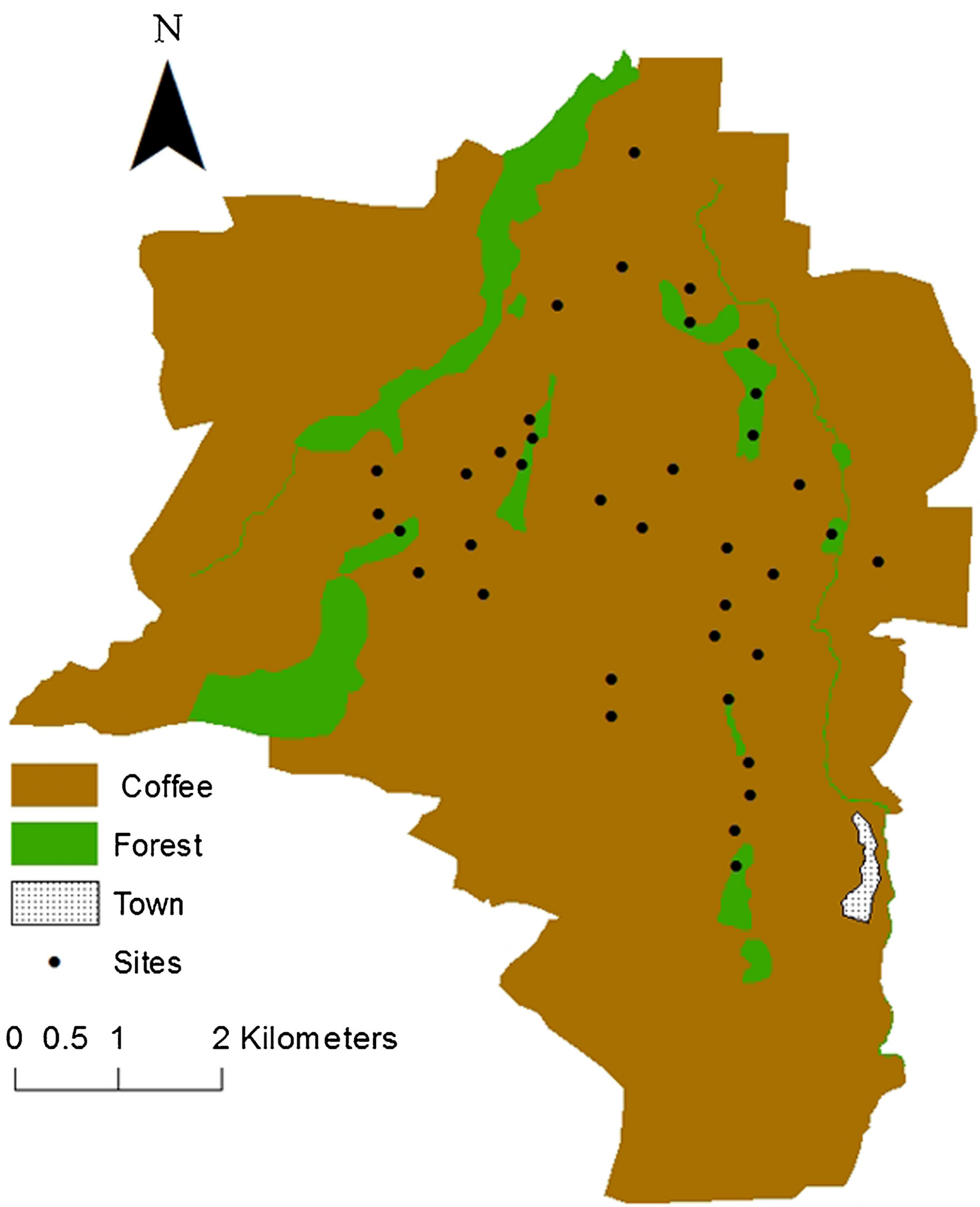

Fig. 1. Coffee landscape in the Soconusco region, in Chiapas, Mexico. Dots represent sampled sites.