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Commentary: Anthropogenic disturbances jeopardize biodiversity conservation within tropical rainforest reserves

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A commentary on

Anthropogenic disturbances jeopardize biodiversity conservation within tropical rainforest reserves

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In the new ecological order where less biodiversity inhabits human-modified landscapes we can split species into "winners" and "losers" (McKinney and Lockwood, 1999). Winner species proliferate in disturbed ecosystems, and can replace loser species through cascading effects (Tabarelli et al., 2012). In their long-term study of *Astrocaryum mexicanum* populations, Martínez-Ramos et al. (2016) conclude that habitat fragmentation and defaunation stimulated a demographic explosion of this native understory palm species in the Los Tuxtlas Station (640 ha), Veracruz State, Mexico (18°35′05.7″N, 95°04′30.4″W), with populations increasing from 1243 to 4058 adult individuals per hectare in 39 year. They argue that "faster gap formation increased understory light availability, enhancing seed production and the growth of immature palms, whereas release from mammalian herbivory and trampling increased survival of seedlings and juveniles" (Martínez-Ramos et al., 2016, p. 1). They also show, in a very convincingly way, that such demographic explosion of *A. mexicanum* led to the loss of local (alpha) tree species diversity, turning this palm into a typical winner species within the study area. Based on these findings, the authors argue that such a proliferation of a native palm species driven by anthropogenic disturbances occurring outside the Los Tuxtlas Station threatens biodiversity conservation within this rainforest reserve. We challenge that conclusion as this study is based on only eight relatively small (0.06 ha each) and spatially aggregated sampling plots (i.e., they covered an area of approximately 10 ha). In fact, based on two different studies of *A. mexicanum* populations (see below), we show a very different scenario for this palm species at the regional scale, as we found that *A. mexicanum* (1) is probably proliferating only in a few areas of the Los Tuxtlas Station; and (2) is rather a loser species in the Los Tuxtlas region as a whole. We therefore advocate for the need of assessing the impact of this and other winner species on biodiversity at a broader landscape or regional scale.

In 2003, we recorded adult individuals of *A. mexicanum* in ten 0.01-ha plots located randomly in the Los Tuxtlas Station, and found that palm density was highly variable, averaging 900 adult individuals per hectare (range = 400–1700; Arroyo-Rodríguez et al., 2007). More recently (2015), we recorded 1180 individuals per hectare (range = 400–2200) in 10 different 0.01-ha plots located in the Los Tuxtlas Station (18°34′41.7″N, 95°05′06.9″W), but 1 km away from the plots studied

by Martínez-Ramos et al. (2016) and Arroyo-Rodríguez et al. (2007). These numbers are similar to those recorded by Martínez-Ramos et al. (2016) before the demographic explosion of *A. mexicanum* in mid 1970's, and indicate that palm density is quite variable there, depending on gap dynamics and alternative factors not explored by the authors (e.g., topography and aspect). This spatially aggregated pattern of *A. mexicanum* populations may be related to dispersal limitation, as this species has large seeds that are mainly dispersed by gravity (Martínez-Ramos, 1997), although some rodents can act as secondary dispersers, moving seeds up to 15 m away from the parent plant (Eguiarte et al., 1993).

Outside this station, we also recorded in 2003 all adult palms in 450 plots (0.01 ha each) from 45 forest fragments (1–266 ha) distributed through the Los Tuxtlas region (i.e., within three landscapes of 5000 ha each), and found that smaller, and more isolated and irregularly shaped fragments harbor a smaller number of adult individuals of this species (Arroyo-Rodríguez et al., 2007). At the regional scale, palm density was positively—rather than negatively—correlated with species richness of old-growth forest species, but negatively correlated with richness of pioneer species (a proxy of local disturbance; Arroyo-Rodríguez et al., 2007). Therefore, habitat fragmentation has a negative, not positive, impact on *A. mexicanum*, as this understory palm is a shade-tolerant species that is drastically affected if exposed to the intense solar radiation that characterizes forest edges (Martínez-Ramos, 1997). We therefore argue that rather than being a "winner," *A. mexicanum* is amongst the several "loser" species that are vanishing as a result of human-caused disturbance.

Patterns and processes linked to negative cascading effects in human-modified landscapes are well known, but researchers must look for them at landscape or regional scales (Fahrig, 2005; Lindenmayer et al., 2008; Fahrig et al., 2011; Arroyo-Rodríguez et al., 2015). The case study reported by Martínez-Ramos et al. (2016) demonstrates that when dominant, this palm, as many other species, can cause severe negative effects on biodiversity at a local scale. Nevertheless, when assessed at the regional scale, we found that this species only dominates plant communities in only some areas of Los Tuxtlas Station and a few large forest fragments. Thus, we do not think that this species jeopardizes biodiversity conservation within Station or the Los Tuxtlas region as a whole. Rather we note that Martínez-Ramos et al. have demonstrated elegantly that this species can shape forest succession, thus contributing to explain, at least partially, the multiple successional pathways that forest patches may follow in human-modified tropical landscapes (Arroyo-Rodríguez et al., 2015), and the patterns of plant species turnover (β-diversity) within and among fragments in that particular region (Arroyo-Rodríguez et al., 2013). The main message of Martínez-Ramos et al. must be taken with caution and placed in context at the correct scale, in order to have a better understanding of the patterns and processes driving ecosystem functioning and biodiversity maintenance in forest reserves that are embedded within human-modified landscapes.

AUTHOR CONTRIBUTIONS

VAR analyzed data; VAR, FPLM conceived and wrote the commentary.

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