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Essays & Perspectives

Thinking about super-dominant populations of native species – Examples from Brazil

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ABSTRACT

The subject of biological invasions is well-recognized, especially due to the associated impacts, but different interpretations exist about the concept of invasive species. These are usually known as exotic species that proliferate intensely, spread rapidly and persist as dominant in the new community. However, some native species may behave the same way and bring serious ecological and economical losses. Nonetheless these native species may not attract management efforts and specific policies, partially because of the assumption that native species are harmless. We review the concepts of invasive species and show the potential harm of overabundant populations of native species, which we name “super-dominant” species. Based on literature review we demonstrated the lack of information on the Brazilian super-dominant plant species. Considering all kinds of published material and knowledge from our own experience we selected 16 Brazilian native terrestrial plants that most frequently show unexpectedly intense growth and dominance in their original habitats. We discuss the factors that may have triggered atypical dominance, negative impacts of these species on the native biodiversity and ecosystems, and future trends. Anthropogenic disturbances are the main drivers of the explosive population growth of these native species, especially habitat fragmentation, forest gap formation, and wildfires. The absence of legal support to deal with super-dominant native species is probably the main reason for the lack of disclosure of the subject. In the future scenario of climate change we expect the intensification of the phenomenon. Strategies for early detection and control need to be fast developed.

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Why thinking about overabundant populations of native species?

In the last decades the scientific community has given great attention to exotic invasive species due to the huge ecological, economic and social impacts they may cause (Mooney and Cleland, 2001; CBD, 2002; Charles and Dukas, 2008). However, there are also native species whose populations are released from controlling mechanisms, proliferate intensely and disproportionately, and may result in serious damages similarly to the exotic invasives

(Garrott et al., 1993). Disturbances resulting from land use changes are the primary causes of unusual overabundance of native plants; future global scenarios point to the intensification of habitat disturbances, due to both land uses and climate change, thus further increasing the emergence of overabundant plant populations.

Although the impacts caused by overabundant native species are perceived by environmental managers, the scientific literature on the subject as well as researches devoted to their study are still scarce (Carey et al., 2012). Even a framework of these species in the context of biological invasions is lacking. In this sense, the main purposes of this paper are: (i) to point the existing diversity in the interpretation of the concept of invasive species and the need to consider the super-dominant natives into the context of biological invasions; (ii) to reflect about reasons that cause the release of native plant populations; (iii) taking the Brazilian case, to show the paucity of published information regarding native species that

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became overabundant; (iv) to highlight main species of Brazilian terrestrial plants that have established overabundant populations and the factors that may have triggered their atypical dominance, as well as their negative impacts; (v) to emphasize the potential of native super-dominant species on causing negative impacts on ecosystems, and therefore, to stimulate policy-makers, scientists and managers of protected areas to develop specific policies and management actions for them based on solid research, in order to maintain natural biodiversity and ecological processes.

Different definitions for invasive species

Charles Darwin in *The Origin of Species* (Darwin, 1859) already recognized that some species can show explosive growth and the ability to spread rapidly over great distances, but the concept of invasive species became explicit only after the publication of Elton's book *Ecology of Invasions by Animals and Plants* (Elton, 1958). The understanding of the meaning of invasive species, however, remained very inconsistent for several more decades (see Richardson et al., 2000), perhaps because the notion of invasive species brings together a series of concepts from different fields, such as biogeography, demography, ecological succession, and community ecology. Still, a utilitarian sense of good/useful or bad/harmful has usually been associated to such species.

An initiative to organize the concepts, definitions and terminology related to the processes of biological invasion came only in a conceptual paper published in 2000 (Richardson et al., 2000). Focusing on plants, the authors define *invasive species* as being necessarily exotic (alien, non-native), with a great ability to reproduce and self-sustain populations over many life cycles, spread individuals/propagules over large areas, and whose introduction or process of spreading in the novel environment is human-mediated. This definition is currently adopted by most plant ecologists. Although a number of cases show that invasive species can transform the environment, change the community composition and structure, and alter ecosystems processes (Vitousek et al., 1997; Pimentel et al., 2005; Hejda et al., 2009), Richardson et al. (2000) did not require an implication of impact in their definition, and they possibly avoided the term "harmful" because of the judgement of values implicit in it.

There is currently common agreement in the academic domain that to be named "invasive" a given species must reproduce and spread fast, disproportionately when compared to the native species amongst which it now finds itself, hence may rapidly come to dominate the community. However, controversies concerning a precise definition of invasive species still exist in the current literature of biological invasions: despite the above mentioned initiative of Richardson et al. (2000), there is no complete consensus regarding the inclusion of species geographic origin (exotic or native) in the concept definition, or its transport vector to the novel environment (human-mediated or not), nor the potential to cause impacts in the novel habitat(s). For example, authors and especially environmental organizations and instruments of administration (IUCN, 2000; CBD, 2002; GISP, 2016) state in their definition of invasive species the requirements of causing, or having the potential to cause, severe negative impacts – ecological, economic or social – besides the requirement of necessarily being exotic to the environment, and introduced by humans. Others (Simberloff, 2011; Carey et al., 2012; Heger et al., 2013) defend the use of the term "invasive" for every species – exotic or native – that spreads and dominates human mediated disturbed habitats in an unexpected way, where they cause negative impacts. Yet another group of authors (e.g., Valéry et al., 2008, 2013; Webber and Scott, 2012) support the minimum criteria for defining invasive species: they proliferate intensely, spread very fast, have competitive advantage

and dominate the "invaded" community. For these last authors what really matters are the ecological mechanisms involved and the outcomes; the species geographic origin is not relevant as both native and non-native species can develop similar "invasive" behaviour. The impacts they may cause should not come as prerequisite, but as a consequence of the species ecological and demographic characteristics. Thus, the discrepancy in the perceptions of the concept held by researchers, managers and politicians remains considerable.

We believe (as do Heger et al., 2013) that these different points of view derive from the wide variety of interests and perspectives encompassed by the theme of biological invasion, from pure ecological science to environmental management. However, good policies and suitable management practices emerge from the perfect understanding of science, and for that, both scientists and practitioners must count on precise definitions and unmistakable meanings. We also consider that from the perspective of biological conservation it is necessary to focus on every species – being either exotic or native – that threatens the environment, the biological community and ecological processes. In the case of the native species that behave as exotic invasives, several terms have been used: *native-invasives* (e.g., Valéry et al., 2008, 2013), *weeds* (e.g., Richardson et al., 2000), *overabundant* (e.g., Jose et al., 2016) or *super-dominant* species (e.g., Callaghan et al., 2005; Silva Matos and Pivello, 2009). We chose the term *super-dominant* to name the native species whose populations are released from controlling mechanisms, so they proliferate intensely and unexpectedly, causing negative impacts by changing the community composition or structure, transforming the environment, or altering ecosystem processes. Even though less frequently used, this term does not involve anthropogenic implicit judgement (as *weed*, a "harmful" species) and it best reflects a strong demographic imbalance of the community (stronger than *overabundant*) instead of suggesting an external origin of the species (as *native-invasive*).

Why a native population becomes super-dominant?

Compared to exotics, native species are much less likely to develop invasive behaviour in a community. In North America and Europe, for example, it has been verified that non-native species are much more prone to become invasive and cause impacts than native species (Simberloff et al., 2012; Hassan and Ricciardi, 2014). Likewise, biotic interactions generally prevent uncommonly high dominance of native species, as the co-evolutionary history shared with other species of the community – including the coexisting with natural enemies (herbivores, pathogens) – tends to shape species requirements and attenuate competition (Callaway and Aschehoug, 2000; Rausher, 2001; Paolucci et al., 2013). However, anthropogenic disturbances may trigger population explosions of native species. As well as co-evolution, recurrent mild disturbances are important vectors on regulating species populations, by shaping ecological niches and structuring species distribution in the community (Sheil, 2016). However, when the magnitude of disturbances (characterized by frequency, duration, intensity, spatial extent), timing or variability (Catford et al., 2012) are different than usual or normal conditions, and promote uncommon changes in habitat conditions or biotic interactions they may generate outbreaks and unusual proliferation of some native species, which may completely disrupt community interactions, generating new dynamics.

The association of invasive exotic species to disturbances not usually experienced by the system – especially the anthropogenic ones – has been extensively discussed (Vitousek et al., 1996; Mack et al., 2000; Byers, 2002; Gurevitch and Padilla, 2004; MacDougall and Turkington, 2005; Pyšek and Richardson, 2010; Sheil, 2016),

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