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Artikel: A taxonomic revision of the genus Noronhia Stadtm. ex Thouars (Oleaceae) in Madagascar and the Comoro Islands
Autor: Hong-Wa, Cynthia
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Implications for conservation

The evaluation of the biogeographic patterns of *Noronhia* in Madagascar highlights the importance of protected areas, most of which overlap with areas with high species richness (Fig. 1). Although this may reflect a bias in sampling effort towards protected areas, it may also suggest that, given the current level of habitat degradation in Madagascar, where deforestation at an average annual rate of 1% has already claimed about 90% of the island's natural forest (Harper et al., 2007), species will in the future be found primarily in areas benefiting from some kind of protection. Unfortunately, most narrow endemic species of *Noronhia* are not represented within the current network of protected areas (Fig. 1B), probably making them more prone to extinction, thereby leading to a potential loss of phylogenetic diversity, which has been found to be higher for young and fast-evolving plant lineages (Davies et al., 2011). Given the patterns of richness and endemism in *Noronhia*, conservation strategies should use both as guiding criteria to ensure a higher representation of taxonomic, ecological and evolutionary diversity within this group. Indeed, *Noronhia*, the most successful evolutionary radiation of the olive family in Madagascar, is an important component of its flora, having evolved to occur in a wide range of habitats and thriving in most of them. It is also an ecologically important genus, forming part of the diet of several lemur and bird species (Donati et al., 1999 ; Birkinshaw, 2001 ; Simmen et al., 2006 ; Radespiel, 2007). Moreover, its pattern of diversification, while unlikely unique among Malagasy plant lineages (see, e.g., Malcomber, 2002 ; Jansen et al., 2008 ; Koopman & Baum, 2008 ; Anthony et al., 2010), highlights some geographic areas of evolutionary importance (e.g., Tsaratanana and Anosy-Vohimena massifs), which are thus of conservation value across a broad taxonomic spectrum.

While spatial analysis is useful for an all-encompassing approach to protecting species of *Noronhia*, individual assessments of each species' risk of extinction can be used to target and prioritize them in a conservation planning. Specifically, it allows the identification of actual or potential threats to each species, which range from subsistence wood harvesting to the loss of an entire habitat resulting from forest clearing, wildfire, or industrial mining. Additionally, climate change may reduce the species' geographic range due to habitat loss and may affect the species' reproductive cycle due to a shortened or delayed rainy season. Specifically, climate change has already altered the landscape of the northern part of Madagascar, where many species of *Noronhia* occur, through a series of severe climate abnormalities not only affecting the natural vegetation but also inducing behavioral changes among local populations in terms of land use, exploitation of natural resources, agricultural practice, and water management (Hong-Wa, 2016). Such impacts are certainly not restricted to the northern region of the island alone, and, while climate change may not cause a rapid decline by itself, its indirect effects, especially the increased anthropogenic pressures, can certainly quickly affect the condition, structure and composition of the already fragile forests where some species are only known to occur. Moreover, charcoal and firewood extraction remains a significant threat to the forests of Madagascar. For instance, 24,560 tons of charcoal and 187,757 tons

of firewood are consumed annually in the DIANA region in northern Madagascar, of which only 2,600 tons and 1,500 tons, respectively, are legally exploited (Jorez et al., 2009). Currently, the national consumption for wood energy is 23.6 million m^3 per year, of which 80% (i.e. 1.6 million tons) is used for charcoal alone (GIZ/PAGE, 2015) and 70% is extracted from natural forests (Myers et al., 2009). Indeed, charcoal is the principal source of energy used for cooking in more than 90% of urban households. Surprisingly, the increasingly deforested nation also exports charcoals to other countries (Rakotondranaivo, 2015). Although reforestation programs, encouraging the use of exotic species such as *Eucalyptus* L'Hér. and *Acacia* Miller are well established in Madagascar and provide, for instance, up to 4,200 tons of charcoal annually to the urban center of Diégo-Suarez alone, which represent 30% of the consumption of its population (Ranoarison, 2015), satisfying the national demand takes, nonetheless, a serious toll on the remaining 10% of natural forests on the island.

Thus, to guide future conservation planning, the results of a preliminary evaluation of conservation status using the IUCN Red List Categories and Criteria (IUCN, 2012) are provided for each species following their respective taxonomic treatment. For these assessments, the IUCN recommended grid cell size of 2 × 2 km was used to calculate the area of occupancy (AOO), a measure of geographic range size. However, a cell size of 10 × 10 km as used by Schatz et al. (2000) would probably reflect better the biology of *Noronhia* species. Indeed, they are shrubs to large trees, bearing fleshy fruits that are dispersed by birds and lemurs (Donati et al., 1999; Birkinshaw, 2001; Simmen et al., 2006; Radespiel, 2007), and thus can presumably be dispersed within a distance of 10 km. In any case, only occupied, non-contiguous cells that are at least 2 km away from each other were counted towards the number of subpopulations, a proxy for the likelihood of gene flow. Although each of the five IUCN Red List Criteria (A to E) was considered, more emphasis was placed on Criterion B (geographic range) due to the nature of the data available. In addition, species occurrence within protected areas was taken into consideration, which plays an important role in reducing habitat loss, thereby deferring future decline (Schatz et al., 2000). The preliminary evaluations of conservation status were based on known specimens at the time of analysis and indicated that 62% of the species treated here can be regarded as "Threatened", i.e. Critically Endangered (5), Endangered (22) or Vulnerable (27).