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Morphological variation

Noronhia is a morphologically very diverse group within which seemingly distinct features are often part of a continuum. Vegetative and reproductive characters are equally important to distinguish species. Regarding vegetative characters, the most informative ones are leaf arrangement, the size, shape and texture of the leaf blade, the presence and length of the acumen, the conspicuousness of the veins, the woodiness of the petiole, and the presence and type of indumentum. Reproductive features that are important for species recognition include flower arrangement, the structure, size and density of the inflorescence, the shape, size and color of the corolla, the length of the corolla tube, the presence of a corona, and the shape, texture, apex and ornamentation of the fruit. In some cases, a single character or character state can be sufficient to identify a species. For instance, leaf size or texture alone permits the unambiguous identification of *N. densiflora* Bosser, whose leaves are > 50 cm long and thickly coriaceous. However, several species can exhibit the same character state (e.g. verticillate leaves) and thus distinguishing between them must often be achieved by using a combination of characters. Indeed, convergent or homoplastic morphologies are not uncommon among independently evolved groups within *Noronhia* and may be related to its rapid diversification in novel environments (HONG-WA & BESNARD, 2014). Intraspecific variation can also be observed and is often related to life stage but may represent ecotypes as well. In contrast, individuals exhibiting intermediate morphologies between species are more problematic, especially when the differences are not clear enough to allow them to be recognized as distinct entities. These may be the result of hybridization that can only be identified with further studies and/or more material. Some of these intermediates were tentatively assigned to the species to which they seem to resemble closely; the remainders are listed at the end of this treatment as unplaced material, along with incomplete specimens that could not be assigned confidently to any entity.

Vegetative morphology

Species of *Noronhia* are woody shrubs to large trees, although younger individuals of *N. densiflora* are also lianescent. The young twigs, generally circular to quadrangular in cross-section, are glabrous, except in a few species, and may be covered with white lenticels. Their diameter, measured at the last internode, though quite variable among species, is not a reliable diagnostic feature. Vegetative and flower buds are generally surrounded by rigid and coriaceous scales. The leaves are usually opposite-decussate, sometimes verticillate, and may be persistent or deciduous. They are simple and often have distinctly woody petioles that resemble the stems. The leaf blades are entire and vary considerably in shape, size and texture. Lamina shape varies from linear to lanceolate, oblong, ovate, obovate, rhombic, obtrullate, cordate, or oblate, with the apex obcordate to emarginate, acute, mucronulate, cuspidate, or acuminate, the base attenuate to cordate or truncate, and the margins flat to undulate and/or revolute. The length of the lamina varies from < 5 cm to > 50 cm within the genus. Variation also occurs in lamina texture and thickness, which ranges from thinly chartaceous to thickly coriaceous. Leaf shape, size and texture are useful diagnostic characters despite some intraspecific variation. The secondary veins are sometimes inconspicuous, especially in species from dry areas. Domatia, present in many species, are found mostly on the abaxial surfaces of the leaf blades but can also occur on the stems of some species. Indumentum is uncommon but is diagnostic for some species.

Reproductive morphology

There is much complexity in the structure of the reproductive units of *Noronhia*. These may be simple (hereafter referred to as “flowers”; the main stalk bearing only a single flower head, in which case only the pedicel is mentioned in the species description) or compound (hereafter referred to as “thyrses”; the main stalk bearing multiple flower heads, in which case both the peduncle and pedicels are mentioned in the species description). In some instances, each “thyse” can be falsely considered as a “flower”, having only a single flower head, but the presence of bracts at the mid-section of the stalk suggests that there is a single pedicel resulting from the abortion of other flowers. Flowers and thyrses are thus considered as two distinct floral units, and each one can be either axillary or falsely terminal, i.e. axillary to the terminal leaves, and may be solitary, geminate or fasciculate. The thyrses may be few- to multi-flowered and diffuse (i.e. long-branched) to compact (i.e. shortly branched). The flowers of *Noronhia* are hermaphroditic and tetramerous. The petals, typically almost entirely connate, are nearly free in some species or joined only at their base by the staminal filaments in others. The corolla varies in color from white to greenish, yellow, orange, pink, red, purple or brown, with the outside often tinged differently from the inside. It is fleshy and may be urceolate, rotate, cupuliform, or campanulate in shape. The corolla tube varies in length and may or may not include an inner corona that surrounds the stamens and ovary. The corolla lobes are rounded to acute. There are usually two stamens, but four, although rare, have been observed in some specimens and are apparently abnormalities. The stamens are typically short, with flattened filaments bearing wide anthers that vary in shape from oblong to almost square. Details of the pistil, characterized by an ovoid, bilocular ovary, a slender style and a capitate to bilobed stigma, are of little taxonomic value. The fruits are characteristically drupaceous but vary greatly in shape from globose to ovoid, pyriform or ellipsoid, and in size from c. 7 mm to 45 mm long. Their surface may be smooth, areolate, verrucose, rugose, ribbed or punctate. There is also a wide range of variation in the shape of the fruit apex, which may be flat, apiculate, bluntly pointed or distinctly rostellate to rostrate. The rostellum or rostrum (when present) may be more or less circular or longitudinally flattened, and sometimes ridged; the very tip may be truncate to apiculate. The endocarp is thin to thick and crustaceous to woody.

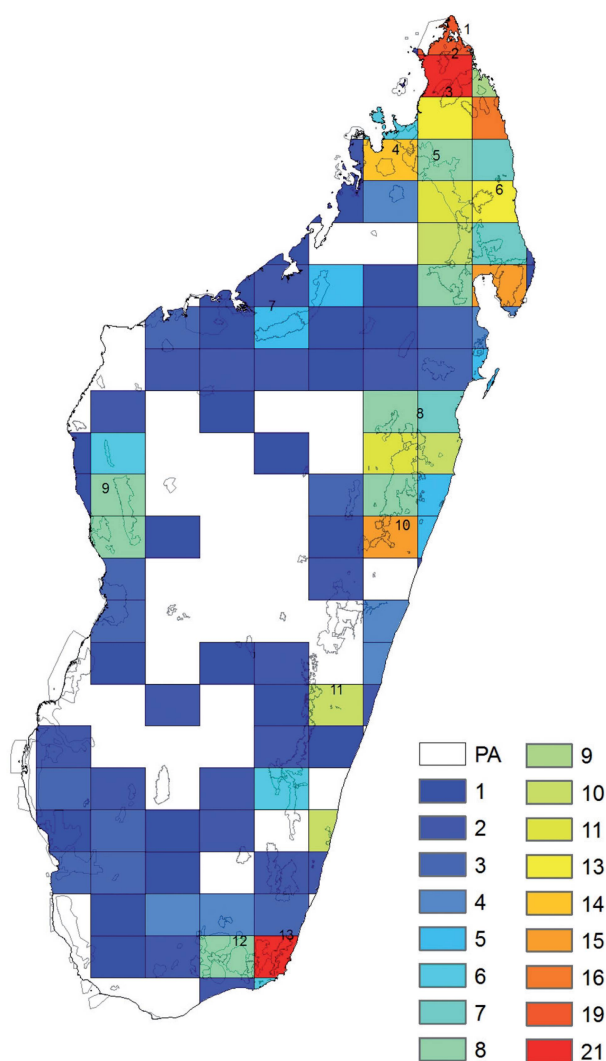


Fig. 1A. Spatial patterns of species richness quantified as the number of species present per grid cell.

Numbers on maps refer to areas discussed in the text:
 1 = Montagne des Français, 2 = Montagne d'Ambre, 3 = Ankarana,
 4 = Manongarivo, 5 = Tsaratanana, 6 = Marojejy, 7 = Ankarafantsika,
 8 = Zahamena, 9 = Bemaraha, 10 = Andasibe, 11 = Ranomafana,
 12 = Andohahela, 13 = Anosy-Vohimena. PA = Protected Areas.

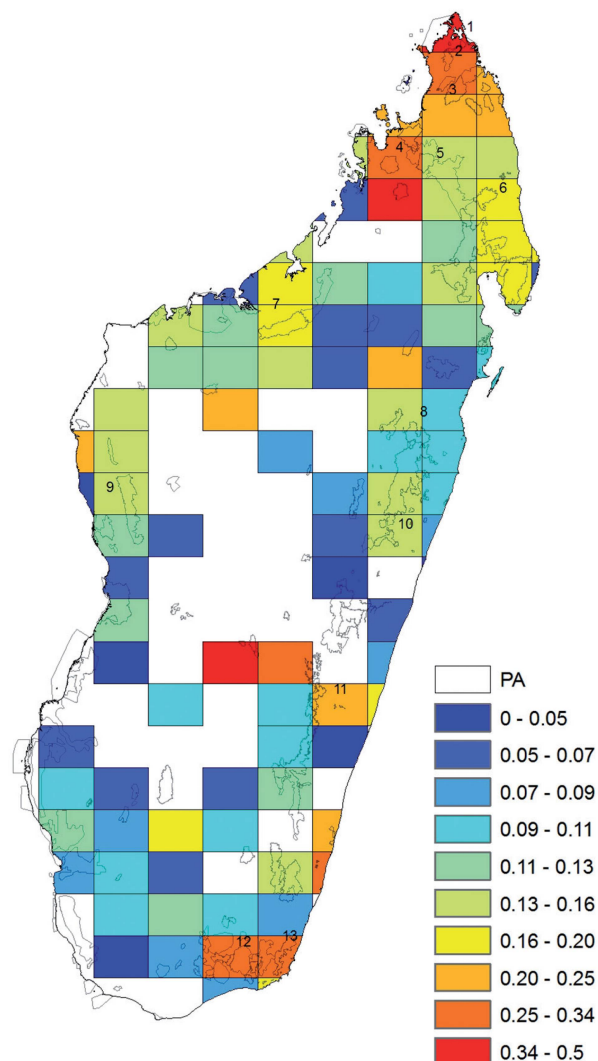


Fig. 1B. Patterns of endemism measured as the corrected weighted endemism, for which values close to zero and one indicate low and high levels of endemism, respectively.