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**A taxonomic revision of the genus
Noronhia Stadtm. ex Thouars (Oleaceae)
in Madagascar and the Comoro Islands**

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In loving memory of my parents

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Abstract

A taxonomic revision of the genus *Noronhia* Stadtm. ex Thouars (*Oleaceae*) in Madagascar and the Comoro Islands is presented. Using results from previous phylogenetic and morphometric analyses along with consideration of potential diagnostic features and eco-geographic characters, 87 species are recognized, 36 of which are described as new, a two-fold increase since the last treatment 60 years ago, resulting mainly from new botanical collections accumulated during the last three decades. In addition, three new combinations are proposed and 18 lectotypes are designated. The treatment includes also a synopsis of morphological variation of vegetative and reproductive structures, an identification key to the species as well as distribution maps of all species plus illustrations and field photographs of selected taxa. Preliminary conservation assessments following the IUCN Red List Criteria indicate that 54 species, representing 62% of the total number of species treated here, are threatened, of which five are considered Critically Endangered [CR], 22 Endangered [EN] and 27 Vulnerable [VU]. An evaluation of the biogeographic patterns of *Noronhia* in Madagascar shows that species richness is higher in mountainous areas of the north and south than elsewhere, supporting the idea that they are centers of diversification of the Malagasy flora as well as fauna. Of the 87 species recognized, 82 are endemic to Madagascar, three occur only in the Comoros, one is shared between Madagascar and the Comoros, and another is shared between the Comoros and Mascarenes.

Résumé

Une révision taxonomique du genre *Noronhia* Stadtm. ex Thouars (*Oleaceae*) à Madagascar et aux Comores est présentée. En utilisant les résultats obtenus à partir d'analyses phylogénétiques et morphométriques et en considérant des caractères diagnostiques potentiels ainsi que des éléments écogéographiques, 87 espèces sont reconnues, parmi lesquelles 36 sont décrites ici comme nouvelles. Ce chiffre correspond à un doublement du nombre d'espèces de *Noronhia* à Madagascar et aux Comores depuis le dernier traitement datant de 60 ans. Cet accroissement découle essentiellement de nouvelles collections botaniques accumulées durant les trois dernières décennies. De plus, trois nouvelles combinaisons sont proposées et 18 lectotypes sont désignés. Par ailleurs, ce traitement inclut un aperçu sur les variations morphologiques des structures végétatives et reproductrices, une clé d'identification des espèces, des cartes de distribution, des illustrations et des photos de terrain de quelques taxons. Une évaluation préliminaire du statut de conservation selon les Critères de la Liste Rouge de l'UICN indique que 54 espèces, représentant 62% des espèces traitées ici, sont menacées d'extinction, parmi lesquelles cinq sont En Danger Critique [CR], 22 En Danger [EN] et 27 Vulnérables [VU]. Une étude des caractéristiques biogéographiques de *Noronhia* à Madagascar montre aussi que la richesse spécifique est plus élevée dans les zones montagneuses du nord et du sud de l'île, appuyant ainsi l'idée que ces zones sont des centres de diversification de la flore et de la faune malgaches. Parmi ces 87 espèces, 82 sont endémiques de Madagascar, trois des Comores tandis qu'une espèce est commune entre les deux îles, et une autre est partagée entre les Comores et les Mascareignes.

Keywords

OLEACEAE – *Noronhia* – Madagascar – Comoros – Conservation – Endemism – Species Richness – Taxonomy

Introduction

The genus *Noronhia* Stadtm. ex Thouars (*Oleaceae*), formerly circumscribed to be endemic to Madagascar and the Comoro Islands, has recently been expanded to include species from the Mascarenes and continental Africa (HONG-WA & BESNARD, 2013, 2014). *Noronhia* was first recognized by Jean-Frédéric Stadtmann (1762-1807) based on *Olea emarginata* Lam. (\equiv *Noronhia emarginata* (Lam.) Stadtm. ex Thouars), but only validly published as a monotypic genus by DU PETIT-THOUARS (1806). Four additional species were described between 1890 and 1920, and a total of 41 species were included in the only taxonomic treatment of the genus (PERRIER DE LA BÂTHIE, 1949), which was later revised for the “Flore de Madagascar et des Comores” volume (PERRIER DE LA BÂTHIE, 1952). Four other species have been described since (BOSSER, 1973; LABAT et al., 1999; CALLMANDER et al., 2009). As currently circumscribed, *Noronhia* thus comprises these 45 species as well as species formerly recognized under *Chionanthus* L., namely those from Madagascar, the Comoros, the Mascarenes, and continental Africa (HONG-WA & BESNARD, 2013; HONG-WA et al., 2014). Two major clades can be distinguished within this broadly circumscribed *Noronhia*, one composed of species from continental Africa, the African clade, and another that includes species from the Malagasy Floristic Region, i.e. Madagascar, the Comoros and Mascarenes, and surrounding islands (TAKHTAJAN, 1986), referred to hereafter as the MFR clade. *Noronhia*, as currently circumscribed, is monophyletic and is sister to a clade composed of other members of the tribe Oleae (*Oleaceae*) (HONG-WA & BESNARD, 2013, 2014; ZEDANE et al., 2016).

In this paper, I present a taxonomic revision of the members of the MFR clade, specifically the species from Madagascar and the Comoro Islands. *Noronhia* has traditionally been divided into three sections based on the presence or absence of a corona and on the length of the corolla tube (PERRIER DE LA BÂTHIE, 1952). Sections *Linocierae* and *Noronhiae*, the latter referred to using the superfluous name *Genuinae* by PERRIER DE LA BÂTHIE (1952), are characterized by the presence of a corona but differ in the length of the corolla tube, which is longer than the corolla lobes in *Noronhiae* but shorter in *Linocierae*, whereas section *Ecoronulatae* lacks a corona. The recent phylogenetic study of the group (HONG-WA & BESNARD, 2014) has shown, however, that none of these sections is monophyletic, limiting the usefulness of this infrageneric classification. Moreover, nine of the species treated by PERRIER DE LA BÂTHIE (1949, 1952) lacked descriptions of floral characters, rendering this classification even less useful. Thus, not only did this focus on a few floral features make it difficult to distinguish between sections using only leaf and/or fruit features or other floral characters, it also made the identification of specimens quite a challenge when flowers are missing. Indeed, PERRIER DE LA BÂTHIE (1949, 1952) first provided a key separating the sections based solely on the length and shape of the corolla and the presence or absence of a corona, and then within each section, a key to the species, again mostly based on floral features.

Apart from these issues, species delimitation in these earlier treatments was also unclear. PERRIER DE LA BÂTHIE (1949, 1952) recognized species based mainly on the shape and size of flowers, the length of the corolla tube, the presence or absence of a corona, the shape of the corona lobe, the shape of the anthers as well as some vegetative features such as leaf arrangement, shape, size and apex. However, variation in

these features sometimes overlaps, blurring the limits between different species. In other instances, members of the same species are distinct enough to be recognized only as single entities. Therefore, to assess patterns of variation and species boundaries within *Noronhia*, an integrative approach, using molecular and morphological data, was applied (HONG-WA & BESNARD, 2014). A variety of qualitative features (e.g. plant habit, presence of indumentum, color of bark, leaf, flower and fruit, texture of leaf and fruit, leaf venation pattern, flower arrangement, inflorescence structure, and fruit shape, ornamentation and apex) was used to sort available specimens into narrowly defined groups considered as “species hypotheses” (HONG-WA & BESNARD, 2014), referred to hereafter simply as “entities”. Plastid (*trnL-F*, *trnT-L*, *trnS-G*, *trnK-matK*) and nuclear (ITS) DNA sequences obtained from 68 of the 87 entities recognized, many of which were represented by multiple individuals, were used to build a species-level phylogeny. Despite a number of unresolved relationships, especially at basal nodes, more than half of the analyzed entities were recovered as being reciprocally monophyletic, suggesting distinct evolutionary lineages (HONG-WA & BESNARD, 2014). Concomitant with the phylogenetic analyses, morphological characters from c. 1,000 specimens representing the 87 entities were analyzed using principal component and discriminant analyses. Quantitative measurements (e.g. length, width, and thickness) were obtained from leaves, flowers and fruits and included only continuous variables (HONG-WA & BESNARD, 2014).

Overall, three datasets were used to recognize species: the qualitative features to sort specimens into groups, the molecular data to identify monophyletic entities, and the quantitative morphological variables to assess patterns of morphological variation. Results from the quantitative analyses (molecular and morphological) were used in an integration-by-cumulation approach (PADIAL et al., 2010) to test the species hypotheses. This approach considers the additive value of each line of evidence in distinguishing species since these are taken to be separately evolving lineages that can be recognized based on multiple lines of evidence under the general lineage concept of species (DE QUEIROZ, 2007). A single form of evidence can be sufficient in any one case, however, given that each line of evidence, resulting from evolutionary processes affecting lineage splitting and divergence, may or may not appear at the same time in all the entities (DE QUEIROZ, 2007 ; PADIAL & DE LA RIVA, 2010). The integration-by-cumulation approach is more appropriate when diversification has occurred recently and/or over a relatively short period of time, which can be considered to be the case for *Noronhia* (HONG-WA & BESNARD, 2013, 2014 ; ZEDANE et al., 2016). Entities whose members formed a monophyletic and/or morphologically coherent group were considered as robust hypotheses of species and thus provided the basis for this treatment.

While at the time the analyses were being performed, some of these entities were known from only one or two specimens, additional material from Madagascar became available afterwards that confirmed their circumscription and/or expanded their known range. Similarly, although most specimens could be assigned to one of the 87 entities during initial sorting, some were difficult to place because of their incompleteness (e.g. being sterile) or their intermediate morphology (e.g. fitting the description of two or more entities). The additional material made it possible to characterize some of these

specimens and to assign them to one of the initially recognized entities or to consider them as new entities altogether. Lastly, newly available specimens also included entirely distinct novelties, which are described here.

The present treatment places 98% of the c. 1,800 examined specimens of *Noronhia* from Madagascar and the Comoro Islands in 87 species, of which 82 are endemic to Madagascar; three occur only in the Comoros; one is shared between Madagascar and the Comoros; and one between the Comoros and the Mascarenes. *Noronhia* is the largest member of the olive family in Madagascar, where only three other genera (*Jasminum* L., *Olea* L., and *Schrebera* Roxb.) are found since species formerly placed in *Chionanthus* are now included in *Noronhia* (HONG-WA & BESNARD, 2013) and *Comoranthus* Knobl. is being subsumed under *Schrebera* (G.E. Schatz, pers. comm.). *Noronhia* appears to have colonized Madagascar c. 23 million years ago from an African ancestor and subsequently dispersed to other surrounding small islands (HONG-WA & BESNARD, 2013; but see also ZEDANE et al., 2016). The bulk of its diversification started c. 15 million years ago (HONG-WA & BESNARD, 2013) and seems to have involved mechanisms related to adaptation to novel environments (HONG-WA & BESNARD, 2014). Natural hybridization, as suggested by material exhibiting intermediate morphologies between some species and incongruence patterns between plastid and nuclear-based phylogenies, may also have been an important mechanism of diversification for this genus. Polyploidy within *Noronhia*, though suspected (HONG-WA & BESNARD, 2013, 2014), remains to be documented as chromosome counts are still unavailable.

Madagascar is the current center of diversification of *Noronhia*. Species on this island have colonized a wide diversity of habitats from sea level to > 2000 m elevation. They commonly occupy dense forests of the humid east or the dry west as well as woodlands of the central high-plateau or scrublands of the south (cf. MOAT & SMITH, 2007). They occasionally occur in open habitats. Variation in substrate preference is equally significant, with species growing on diverse substrates such as lava, limestone, metamorphic rocks, quartzite, sandstone, and white sand. The distribution of the genus covers the entire island, although many species have narrow ranges. Areas with the highest species richness correspond to topographically complex regions of the north and the south (HONG-WA, 2012). Under-sampled areas in the north, from the Manongarivo massif to the Makira region, as well as much of the western domain, where endemism is also high, may harbor a higher diversity of *Noronhia* than is currently estimated based on available collections. Increased efforts to collect material from these areas would provide a fuller picture of species diversity and diversification of *Noronhia* in Madagascar. Comprehensive studies in continental Africa are also needed to document its diversity there. Furthermore, some species from West Malesia, currently placed in *Chionanthus*, present morphological affinities with *Noronhia* and may also belong to the genus, thus potentially extending its geographic range.

The updated treatment presented here, although far from being exhaustive, represents a first step to understanding species diversity within *Noronhia*. It also provides a framework for advancing studies on the systematics, biogeography, ecology and evolutionary biology of the genus as well as for promoting the conservation of its species in

Madagascar. Thus, in an effort to provide the best available information about *Noronhia* in Madagascar and the Comoros, this treatment includes an identification key, species descriptions, nomenclatural notes, an etymological section when relevant, distributional, habitat and phenological information, a list of selected specimens, a preliminary assessment of conservation status, illustrations, photos of living plants, and distribution maps. The terminology used in the species description generally follows that of STEARN (2004). Information on phenology and habitat obtained from herbarium specimens has been supplemented by personal observations. Phenological information may not accurately portray the reproductive season of each species due to a lack of all-year-round sampling. A delay in and/or shortening of reproductive season has also been observed and reported by local populations. Distribution maps use the five simplified bioclimatic zones of Madagascar (SCHATZ, 2000; after CORNET, 1974) as a basemap and include locality data that represent the known range of each species as of early 2015. A list of representative specimens observed includes detailed locality data, with geo-coordinates placed in brackets when assigned post-facto using maps and the MISSOURI BOTANICAL GARDEN'S GAZETTEER TO MALAGASY BOTANICAL COLLECTING LOCALITIES (2016). For each species, comprehensive specimen records along with photos of living plants taken in the field are available on the MADAGASCAR CATALOGUE (2016). Furthermore, high-resolution images of type specimens are available from MO (TROPICOS, 2016) and P (SONNERAT, 2016) as well as from JSTOR Plant Science [<http://plants.jstor.org>]. Herbaria are abbreviated according to INDEX HERBARIORUM (2016). CNARP is the acronym used for the herbarium of the Centre National d'Application de la Recherche Pharmaceutique in Antananarivo (Madagascar); and Daraina is used for the herbarium of the village of Daraina in Loky-Manambato region, west of Vohémar in northern Madagascar. In addition, the following abbreviations are also used: AP = Aire Protégée, FC = Forêt Classée, PN = Parc National, RNI = Réserve Naturelle Intégrale, RS = Réserve Spéciale, STF = Station Forestière.

Of the 87 species of *Noronhia* recognized in Madagascar and the Comoro Islands, 36 are new and three others are elevated from an infraspecific rank, thus requiring new combinations. In addition, three other species were recognized as new based on vegetative morphology and molecular data (HONG-WA & BESNARD, 2014) but are excluded from this treatment. Formal description of these novelties will await better material with flowers and/or fruits. In his treatments, PERRIER DE LA BÂTHIE (1949, 1952) rarely designated a holotype specimen. Therefore, a lectotype has been chosen among the syntypes based on various criteria as indicated in the "Notes" section wherever relevant. In total, 17 lectotypifications are made here. Moreover, the phylogenetic study of *Noronhia* and its relatives showed that *Chionanthus* species from Africa and the Madagascar Floristic Region (MFR) formed a monophyletic group, with *Chionanthus* from the latter region all embedded within *Noronhia* (HONG-WA & BESNARD, 2013). To accommodate this phylogeny, all species of *Chionanthus* from Africa and the MFR were systematically transferred to *Noronhia*, making new combinations regardless of their taxonomy (HONG-WA & BESNARD, 2013). The necessary taxonomic evaluation of the Malagasy taxa is done in this treatment, thus making yet other new combinations or establishing synonymies when needed.

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.

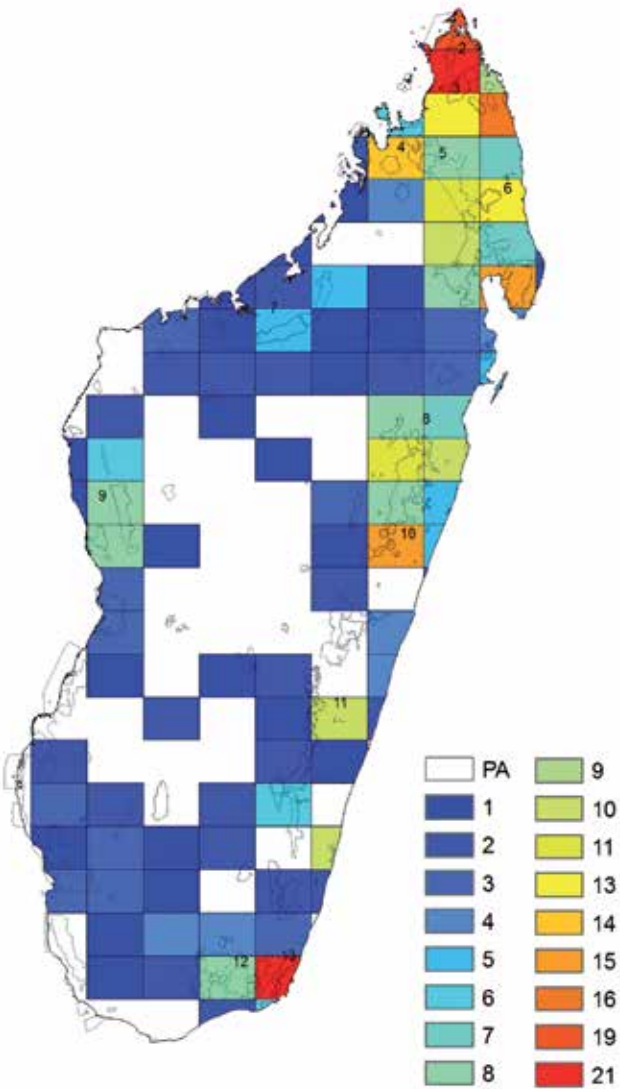


Fig. 1A. Spatial patterns of species richness quantified as the number of species present per grid cell.

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 = Marojeje, 7 = Ankarafantsika,
8 = Zahamena, 9 = Bemaraha, 10 = Andasibe, 11 = Ranomafana,
12 = Andohahela, 13 = Anosy-Vohimena. PA = Protected Areas.

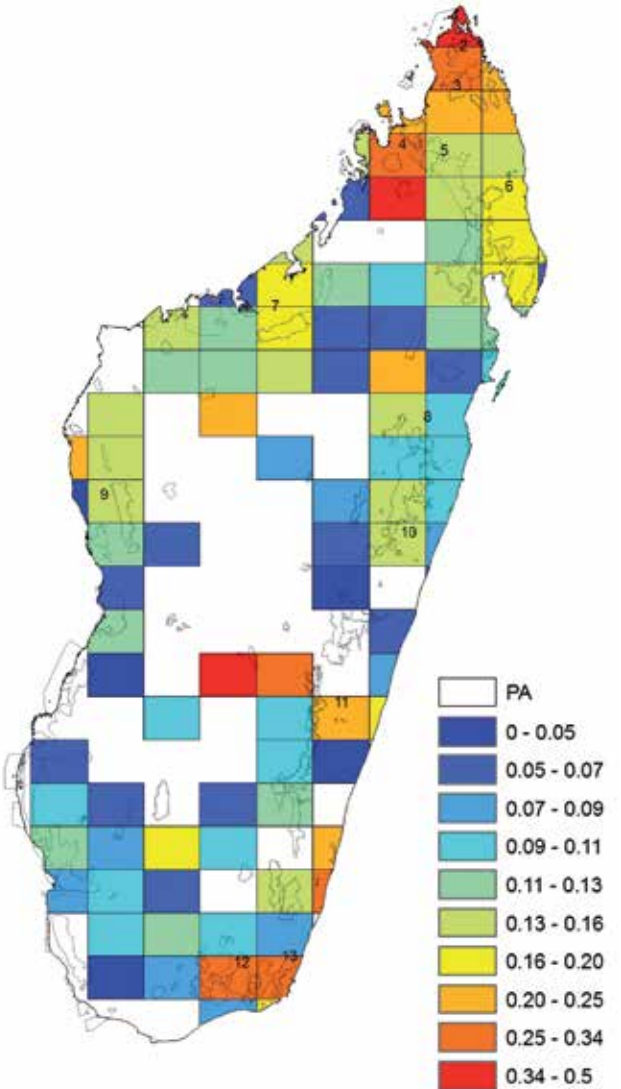


Fig. 1B. Patterns of endemism measured as the corrected weighted endemism, for which values close to zero and one indicate low and high levels of endemism, respectively.

Spatial patterns of species richness and endemism of *Noronhia* in Madagascar

Species of *Noronhia* grow over almost the entire island of Madagascar. To understand the spatial patterns of richness and endemism within this genus, occurrence data for all species in Madagascar were compiled based on field surveys (global positioning system [GPS] records) and georeferenced herbarium specimens. Madagascar was divided into grid cells of $82 \times 63 \text{ km} = 5,166 \text{ km}^2$, the scale at which ecological parameters are suggested to vary on the island (WOLLENBERG et al., 2008). The choice of grid cell size matters when identifying centers of species richness and endemism due to its biasing effects when either too small or too large (CRISP et al., 2001). For each grid cell, values of species richness and endemism were calculated (Fig. 1). Species richness was taken as the number of species per grid cell whereas endemism is scored to reflect the species range, i.e. the smaller the range, the higher the endemism score. Specifically, a score of 1 was given if the species occurs in a single grid cell, a score of 0.5 was given to each cell if it occurs in two grid cells, and so on. The weighted endemism for each grid cell was then calculated as the sum of the endemism scores for the species occurring in that grid cell. The corrected weighted endemism was obtained by dividing the weighted endemism score of a cell by the total number of species in the cell, thus reducing the sensitivity to the effect of species richness (CRISP et al., 2001). All spatial analyses were done using ArcGIS (ESRI Inc., Redlands, CA) and the ArcView extension “Endemicity Tools”.

Centers of species richness occurred mainly in the north and south of Madagascar (Fig. 1A). These centers tended to be confined to mountainous areas, e.g. in the north, Montagne d’Ambre, Montagne des Français, Manongarivo and Marojejy, and in the south, Andohahela and Anosy-Vohimena. By contrast, centers of endemism were more widespread and were found mainly in the north, west and southeast (Fig. 1B) at both high and low elevations. There was also a center of endemism in the Central Highlands, which had the highest value of corrected weighted endemism (0.5). Centers of species richness and centers of endemism corresponded only in the north and south. The west had low species richness but showed comparatively high scores for endemism, whereas the central east (the region around Andasibe) had higher species richness but low endemism (Fig. 1). While centers of species richness coincided mostly with mountainous regions, centers of endemism did not show any apparent topographic pattern (Fig. 1).

The biogeographic pattern indicated that northern Madagascar was the center of species richness for *Noronhia* (Fig. 1A). Although this pattern may reflect a collection bias towards well-sampled localities in the northern biogeographic region (e.g. Montagne d’Ambre, Montagne des Français, Ankarana), other well-sampled areas where the genus has been documented (e.g. Ankarafantsika, Ranomafana, Zahamena) harbored fewer species. The coincidence of species richness with topographically complex areas suggests a substantial role of mountainous areas in the diversification of *Noronhia*. This finding is not at all unique to this genus as similar patterns have been found in other groups of plants and animals such as vascular plants (HONG-WA et al., 2008), tree ferns (JANSSEN & RAKOTONDRAINIBE, 2008), cophyline frogs (WOLLENBERG et al., 2008), leaf chameleons (TOWNSEND et al., 2009), *Mamecylon* L. (STONE, 2012), palms (RAKOTOARINIVO et al., 2013), and reptiles and amphibians (BROWN et al., 2014). In particular, the northern

massifs of Madagascar, including Tsaratanana, Manongarivo, Marojejy and Montagne d'Ambre, as well as the southeastern massifs of Andohahela and Anosy-Vohimena, have been found to harbor high species richness in those various groups, supporting the idea that these areas act as species pumps, promoting adaptive and vicariant speciation (RAXWORTHY & NUSSBAUM, 1995; WOLLENBERG et al., 2008; VENCES et al., 2009).

The centers of endemism observed in *Noronhia* coincided with only a few centers of species richness, such as in the grid cells containing Montagne d'Ambre in the north, Manongarivo in the northwest, and Andohahela and Anosy-Vohimena in the south (Fig. 1). Overlapping centers of endemism and species richness may represent historical centers of cladogenesis (RICKLEFS & SCHLUTER, 1993; JETZ et al., 2004). Although it is unclear whether current species distributions reflect the original geography of speciation or post-speciation range shifts (LOSOS & GLOR, 2003), the coincidence of endemism and richness in Montagne d'Ambre, Manongarivo, Andohahela and Anosy-Vohimena supports the idea that these massifs are centers of diversification for *Noronhia*. Centers of endemism were also found in less known areas in the west and northeast of the island where the genus is mostly known from historical collections. Indeed, many species have been collected in only one or a few localities, thus potentially biasing the interpretation of their endemism. Nevertheless, the pattern of microendemism suggests recent and/or rapid evolution resulting from, e.g., isolation, specialization to particular environments or fine-scale environmental variables as with species growing on karst mountains in the north (Ankarana) and the west (Bemaraha), hybridization or polyploidization (PEARSON & RAXWORTHY, 2009; VENCES et al., 2009; HONG-WA & BESNARD, 2014).

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 m³ 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 (RAKOTONDRAINAIVO, 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).

Concluding notes

As botanical exploration continues in Madagascar, especially in remote and difficult to access areas, more material will no doubt become available, which will permit a better assessment of species diversity within *Noronhia* as well as an improved understanding of species distribution. Until then, the entities presented here represent a robust set of species hypotheses that are a major improvement over PERRIER DE LA BATHIE's treatment (1949, 1952). Moreover, although many new collections (c. 1,000) have been made in the last three decades, most of the new species described here had already been collected 50 years ago. In particular, the extensive collection of the "Service Forestier de Madagascar" from 1950s to 1970s includes much interesting material that can be referred to these new species, although some specimens have yet to be placed and may eventually need to be described. Such cases, where the study of long-held collections resulted in the description of new species, have also been documented for other taxa. For instance, a study of Malagasy *Memecylon* revealed that most of the specimens collected in the last 25 years represented undescribed entities, resulting in a 70% increase in the diversity of this genus (STONE, 2012). This supports the idea that most as yet undocumented plant species are already housed in various herbaria, though formal description may lag due to various reasons, including a lack of expertise in particular taxa (BEBBER et al., 2010).

Taxonomic treatment *Noronhia* Stadtm. ex Thouars, Gen. Nov. Madagasc. 8. 1806.

Typus: *N. emarginata* (Lam.) Stadtm. ex Thouars (\equiv *Olea emarginata* Lam.).

Shrubs to trees; bark dark gray to whitish, smooth to rugose; young twigs cylindrical, rarely quadrangular, often glabrous to sometimes covered with short indumentum; occasionally with white lenticels. *Leaves* simple, opposite, decussate, sometimes verticillate, persistent or deciduous; bud scales often persistent, rigid, coriaceous; blade entire, the upper surface usually darker colored than the lower, variably shaped from linear to lanceolate, oblong, ovate, obovate, rhombic, obtrullate, cordate, or oblate, coriaceous, sometimes chartaceous, usually glabrous, the lower surface sometimes covered with short indumentum, especially on the midvein, domatia sometimes present along the midvein and occasionally along secondary veins, base cordate to attenuate or sometimes truncate, margin flat to revolute and/or undulate, apex emarginate or rounded to acuminate, venation conspicuous to inconspicuous, secondary venation brochidodromous; petiole entirely woody, or woody only to the mid-point, or not at all, glabrous or glabrescent to pubescent. *Flowers* and thyrses axillary; solitary to fasciculate; thyrses diffuse to compact; a pair of glabrous or glabrescent to pubescent bracts present at the base of each peduncle and pedicel; calyx shortly connate at the base, with 4 triangular to rounded lobes, usually green, persistent, glabrous or glabrescent to pubescent; corolla 4-lobed, white to green, yellow, orange, pink, red, purple, or brown, the inside often tinted differently, urceolate to campanulate or rotate, thick and fleshy, rarely pubescent, tube 0.5-12 mm long; corona often present, not exceeding the corolla tube, undivided to 4-lobed; stamens 2, rarely 4, adnate to and slightly longer than the corona, filaments usually shorter than the anthers, often flattened, anthers obovate to lanceolate, oblong or square, longitudinally flattened, with 2 locules, opening by longitudinal slits; ovary superior, bilocular, style slender, short, often persistent in fruit, stigma capitate to bilobed. *Fruits* indehiscent, drupaceous, yellow to purple or black when mature, ellipsoid or ovoid to globose, surface smooth to ornamented, apex flat, apiculate, bluntly pointed or rostellate to rostrate, the rostellum or rostrum circular to longitudinally flattened and sometimes ridged, truncate to apiculate; pericarp thin to thick; endocarp crustaceous to woody; seed 1 per fruit.

Key to the species of *Noronhia* in Madagascar and the Comoros

[Numbers in parentheses indicate the previous couplet leading to the present one]

- 1. Leaves all or partly verticillate or subverticillate 2
- 1a. Leaves all distinctly opposite 9

- 2. Leaves verticillate at every node 3
- 2a. Leaves verticillate only at the tips of the branches 4

- 3. Leaf blades lanceolate, largest blade ≥ 25 cm long **62. *N. patricei***
- 3a. Leaf blades linear to lanceolate, largest blade < 25 cm long **87. *N. verticillata***

- 4. Largest leaf blade > 15 cm long, very coriaceous **19. *N. crassiramosa***
- 4a. Largest leaf blade ≤ 15 cm long, coriaceous to subcoriaceous 5

- 5. Leaf blades obovate to obtrullate; fruit surface verrucose **86. *N. verrucosa***
- 5a. Leaf blades oblanceolate to obovate; fruit surface smooth, punctate or rugose 6

- 6. Petiole entirely woody; leaf domatia present on abaxial surface; fruit surface smooth to rugose 7
- 6a. Petiole not woody; leaf domatia absent; fruit surface smooth or punctate 8

- 7. Leaf base acute to attenuate or truncate, surface sub-bullate; fruit surface smooth, sometimes rugose, apex flat **60. *N. orientalis***
- 7a. Leaf base rounded, surface flat; fruit surface rugose, apex bluntly pointed **70. *N. retusifolia***

- 8. Thyrses fasciculate; corolla white; corona absent; fruit surface smooth **57. *N. oblanceolata***
- 8a. Thyrses geminate; corolla yellow (tinged pinkish); corona present; fruit surface punctate **72. *N. rollandii***

- 9 (1). Indumentum present on petiole, leaf blade and/or lower midrib; peduncles and pedicels pubescent 10
- 9a. Indumentum absent from petiole, leaf blade and/or lower midrib; peduncles and pedicels glabrous or pubescent 14

- 10. Leaves persistent, blades ovate to obovate, base rounded to cordate; petiole entirely woody (rarely not so) 11
- 10a. Leaves deciduous, blades oblong to lanceolate, base acute to attenuate (sometimes rounded); petiole not woody (or rarely so) 12

- 11 (10). Leaf blades ovate, base cordate; corolla greenish tinged orange, cupuliform, the tube longer than the lobes **11. *N. capuronii***
- 11a. Leaf blades obovate, base rounded; corolla greenish white, subrotate, the tube shorter than or as long as the lobes **77. *N. similis***
- 12 (10). Leaf blades oblong to lanceolate, base rounded; flowers > 1 cm long **33. *N. humbertiana***
- 12a. Leaf blades lanceolate, base acute to attenuate; flowers < 1 cm long 13
13. Corolla red-brown, cupuliform, the tube longer than the lobes; corona present **76. *N. seyrigii***
- 13a. Corolla white, subrotate, the tube shorter than or as long as the lobes; corona absent **82. *N. tropophylla***
- 14 (9). Leaf blades chartaceous to subcoriaceous 15
- 14a. Leaf blades coriaceous to extremely coriaceous 43
15. Leaf blades chartaceous 16
- 15a. Leaf blades subcoriaceous 31
16. Petiole not woody 17
- 16a. Petiole woody 21
17. Thyrses fasciculate 18
- 17a. Thyrses geminate (to sometimes fasciculate) 19
18. Corolla yellowish, campanulate to subrotate, the tube shorter than the lobes, petals connate; corona present **7. *N. brevituba***
- 18a. Corolla white, rotate, the tube shorter than the lobes, petals almost free; corona absent **8. *N. broomeana***
19. Largest leaf blade \geq 15 cm long **42. *N. leandriana***
- 19a. Largest leaf blade < 15 cm long 20
20. Leaf blades oblong to elliptic; domatia present; corolla white pinkish, cupuliform to subrotate, the tube longer than or as long as the lobes **14. *N. cochleata***
- 20a. Leaf blades narrowly to broadly elliptic; domatia absent; corolla pale yellow, subrotate, the tube shorter than the lobes **44. *N. linocerioides***
21. Largest leaf blade < 15 cm long 22
- 21a. Largest leaf blade \geq 15 cm long 28
22. Leaf acumen at most 10 mm long; calyx lobes ovate **71. *N. richardii***
- 22a. Leaf acumen reaching at least 20 mm long; calyx lobes triangular to deltate 23

- 23 (22). Flowers (or uniflorous thyrses) fasciculate or geminate 24
- 23a. Thyrses solitary to geminate 26
24. Flowers geminate **63. *N. peracuminata***
- 24a. Flowers fasciculate 25
25. Corolla yellowish (tinged reddish), cupuliform; corona present **15. *N. comorensis***
- 25a. Corolla pink to purplish outside, cream inside, urceolate; corona absent or vestigial
..... **64. *N. perrieriana***
26. Leaf domatia present; peduncle reaching to more than 20 mm long **30. *N. gracilipes***
- 26a. Leaf domatia absent or very rare; peduncle less than 10 mm long 27
27. Pedicel < 5 mm long; corolla pink to white cream tinged pink; corona present
..... **79. *N. stevensiana***
- 27a. Pedicel \geq 5 mm long; corolla red; corona absent **74. *N. sambiranensis***
- 28 (21). Corolla urceolate 29
- 28a. Corolla subrotate 30
29. Pedicel < 15 mm long; fruit subglobose, sometimes glaucous **84. *N. urceolata***
- 29a. Pedicel \geq 15 mm long; fruit ovoid to subglobose, sometimes punctate
..... **22. *N. decaryana***
30. Corolla tube shorter than the lobes; fruit ellipsoid, surface ribbed; endocarp woody
..... **36. *N. insularis***
- 30a. Corolla tube as long as the lobes; fruit subglobose, surface smooth; endocarp crustaceous
..... **31. *N. grandifolia***
- 31 (15). Petiole not (or rarely) woody 32
- 31a. Petiole partially or entirely woody 35
32. Leaf base rounded; domatia absent; fruit oblong to ovoid, > 25 mm long at maturity
..... **67. *N. populifolia***
- 32a. Leaf base acute to attenuate; domatia present; fruit ovoid, \leq 25 mm long at maturity
..... 33
33. Leaf deciduous; secondary veins barely visible; fruit surface punctate; endocarp woody
..... **32. *N. greeniana***
- 33a. Leaf persistent; secondary veins conspicuous; fruit surface smooth to ribbed; endocarp
crustaceous to subcrustaceous 34

- 34 (33). Petiole rarely woody ; fruit surface smooth, apex bluntly pointed ; endocarp subcrustaceous **20. *N. cuspidata***
- 34a. Petiole not woody ; fruit surface smooth to slightly ribbed, apex rostrate ; endocarp crustaceous **73. *N. rostrata***
- 35 (31). Largest leaf blade ≥ 20 cm long 36
- 35a. Largest leaf blade < 20 cm long 37
36. Corolla pink to orange-red, oblong to campanulate, the tube longer than the lobes ; fruit ovoid to subglobose ; endocarp woody **38. *N. introversa***
- 36a. Corolla yellowish, cupuliform, the tube shorter than the lobes ; fruit subglobose ; endocarp subcrustaceous **39. *N. jeremii***
37. Petiole ≤ 10 mm long 38
- 37a. Petiole > 10 mm long 41
38. Leaf blades obovate **50. *N. maculata***
- 38a. Leaf blades (linear to) lanceolate 39
39. Flowers fasciculate **80. *N. tefyana***
- 39a. Thyrses geminate to fasciculate 40
40. Corolla purplish pink ; fruit surface smooth, sometimes punctate ; endocarp woody **52. *N. marinae***
- 40a. Corolla white tinged pink ; fruit surface smooth ; endocarp subcrustaceous ... **75. *N. schatzii***
41. Leaf blades ovate **29. *N. gautieri***
- 41a. Leaf blades oblong to obovate 42
42. Leaf domatia present ; fruit ellipsoid to ovoid, ≥ 30 mm long at maturity **2. *N. aminae***
- 42a. Leaf domatia absent ; fruit ovoid, < 30 mm long at maturity **49. *N. macrocarpa***
- 43 (14). Leaf blades thick and very coriaceous 44
- 43a. Leaf blades thinner but coriaceous 47
44. Leaf blades obovate 45
- 44a. Leaf blades oblong to elliptic 46
45. Leaf base acute to attenuate, apex mucronulate ; flowers fasciculate ; corolla urceolate, the tube longer than the lobes ; fruit ovoid, < 20 mm long at maturity **18. *N. crassinodis***
- 45a. Leaf base rounded, apex subcordate to rounded ; thyrses geminate to fasciculate ; corolla cupuliform, the tube longer than or as long as the lobes ; fruit oblong, ≥ 20 mm long at maturity **28. *N. emarginata***

- 46 (44). Largest leaf blade < 20 cm long; flowers fasciculate; corolla urceolate; corona present **10. *N. candicans***
- 46a. Largest leaf blade > 20 cm long; thyrses fasciculate; corolla globose; corona absent **23. *N. densiflora***
- 47 (43). Largest leaf blade \leq 10 cm long 48
- 47a. Largest leaf blade > 10 cm long 74
48. Petiole partially to entirely woody 49
- 48a. Petiole not woody 68
49. Secondary veins inconspicuous or just barely visible 50
- 49a. Secondary veins conspicuous on both sides or mostly on lower side only 59
50. Leaf blades linear to obovate, base rounded 51
- 50a. Leaf blades elliptic to cordiform, base acute to attenuate 53
51. Leaf blades linear to obovate; petiole light gray to whitish; endocarp woody **69. *N. ratovosonii***
- 51a. Leaf blades linear; petiole medium gray; endocarp crustaceous to woody 52
52. Leaf apex retuse; corolla reddish brown; endocarp woody **43. *N. linearifolia***
- 52a. Leaf apex acute and spiny; corolla cream white; endocarp crustaceous **78. *N. spinifolia***
53. Leaf blades cordiform **56. *N. obcordifolia***
- 53a. Leaf blades elliptic to obovate 54
54. Fruit < 10 mm long at maturity 55
- 54a. Fruit > 10 mm long at maturity 57
55. Leaf blades oblanceolate; fruit ovoid **17. *N. coriacea***
- 55a. Leaf blades oblong to lanceolate; fruit subglobose to globose 56
56. Leaf apex shortly cuspidate; corolla reddish-brown, urceolate, the tube longer than the lobes; fruit globose **4. *N. armandiana***
- 56a. Leaf apex acute to acuminate; corolla ivory white, cupuliform, the tube longer than or as long as the lobes; fruit subglobose **55. *N. myrtoides***
57. Leaf blades elliptic; flowers fasciculate or solitary to geminate 58
- 57a. Leaf blades obovate; thyrses solitary **45. *N. longipedicellata***

- 58 (57). Leaf blades narrowly elliptic; flowers fasciculate; corolla white; corona absent **1. *N. alleizettei***
- 58a. Leaf blades broadly elliptic; flowers solitary to geminate; corolla reddish, tinged yellowish inside; corona present **5. *N. boinensis***
- 59 (49). Leaf apex cuspidate 60
- 59a. Leaf apex acuminate 62
60. Leaf blades broadly oblong; domatia present; petiole partially woody; endocarp crustaceous **66. *N. planifolia***
- 60a. Leaf blades ovate to obovate or rhombic; domatia rare or absent; petiole entirely woody; endocarp crustaceous to woody 61
61. Leaf blades ovate; flowers fasciculate; corolla purplish pink outside, cream inside, cupuliform; endocarp woody **51. *N. mangorensis***
- 61a. Leaf blades obovate to rhombic; thyrses solitary to geminate; corolla red throughout, urceolate; endocarp crustaceous **12. *N. christenseniana***
62. Leaf blades elliptic to rhombic or obtrullate 63
- 62a. Leaf blades ovate to oblong 65
63. Leaf blades elliptic, apex retuse to acuminate; corolla yellow tinged red, tubular; fruit subglobose **83. *N. tubulosa***
- 63a. Leaf blades (oblong to) rhombic, apex acuminate; corolla pink to green, urceolate; fruit ovoid 64
64. Secondary veins whitish; pedicel < 10 mm long; corolla pinkish **13. *N. clarinerva***
- 64a. Secondary veins green; pedicel \geq 10 mm long; corolla greenish **37. *N. intermedia***
65. Leaf base truncate to cordate; thyrses geminate **16. *N. cordifolia***
- 65a. Leaf base rounded to acute; flowers fasciculate or solitary 66
66. Flowers solitary; corolla cupuliform; fruit subglobose **61. *N. ovalifolia***
- 66a. Flowers fasciculate; corolla urceolate; fruit ovoid to ellipsoid 67
67. Corolla red; fruit ovoid, surface smooth **9. *N. buxifolia***
- 67a. Corolla pink to red; fruit ellipsoid, surface slightly rugose **34. *N. humblotiana***
- 68 (48). Leaf apex rounded to obcordate 69
- 68a. Leaf apex acute to acuminate 72
69. Leaf base rounded; secondary veins inconspicuous; fruit pyriform **47. *N. lowryi***
- 69a. Leaf base attenuate; secondary veins barely visible to distinct; fruit ovoid to subglobose 70

- 70 (69). Fruit surface smooth, < 20 mm long at maturity **25. *N. divaricata***
 70a. Fruit surface smooth, punctate to ribbed, > 20 mm long at maturity 71
71. Corolla white, cupuliform, the tube shorter than or as long as the lobes; corona present; fruit surface smooth to punctate **3. *N. ankaranensis***
 71a. Corolla white, campanulate, the tube shorter than the lobes, petals almost free; corona absent; fruit surface smooth to ribbed **58. *N. obtusifolia***
- 72 (68). Leaf apex acute; secondary veins barely visible **40. *N. lanceolata***
 72a. Leaf apex acuminate; secondary veins conspicuous above or below 73
73. Leaf blades lanceolate; corolla white, subrotate, the tube shorter than the lobes, petals nearly free; corona absent **35. *N. incurvifolia***
 73a. Leaf blades ovate; corolla red, cupuliform, the tube as long as the lobes; corona present **68. *N. randrianaivoi***
- 74 (47). Petiole entirely woody 75
 74a. Petiole not woody (or rarely partially woody) 82
75. Leaf margin flat to slightly revolute; fruit subglobose 76
 75a. Leaf margin flat, revolute or undulate; fruit ovoid 79
76. Leaf apex acuminate; fruit endocarp woody 77
 76a. Leaf apex acute to slightly acuminate; fruit endocarp crustaceous 78
77. Leaf blades ovate to broadly elliptic; corolla red outside, white inside; fruit surface smooth **24. *N. disjuncta***
 77a. Leaf blades oblong; corolla pale yellow throughout; fruit surface punctate **53. *N. marojejyensis***
78. Leaf blades lanceolate, largest blade > 15 cm long; petiole > 10 mm long; fruit surface punctate **41. *N. latifolia***
 78a. Leaf blades elliptic, largest blade < 15 cm long; petiole < 10 mm long; fruit surface smooth **46. *N. louvelii***
79. Leaf apex cuspidate to mucronate; flowers fasciculate **6. *N. boivinii***
 79a. Leaf apex acuminate or retuse; thyrses geminate to fasciculate 80
80. Leaf base rounded to acute; peduncle < 5 mm long; fruit < 15 mm long at maturity, apex apiculate **21. *N. dauphinensis***
 80a. Leaf base acute to attenuate; peduncle > 5 mm long; fruit > 15 mm long at maturity, apex flat to rostellate 81

- 81 (80). Leaf blades elliptic to obovate, apex retuse (acuminate in seedlings and saplings); domatia absent; corolla white, sometimes tinged greenish, urceolate; fruit surface sometimes glaucous **27. *N. edentata***
- 81a. Leaf blades lanceolate, apex acuminate; domatia present; corolla white, sometimes tinged purplish at the base, rotate; fruit surface sometimes punctate **65. *N. pervilleana***
- 82 (74). Secondary veins barely visible or conspicuous only on lower side; fruit < 20 mm long at maturity 83
- 82a. Secondary veins conspicuous on both sides; fruit > 20 mm long at maturity 85
83. Leaf blades elliptic; domatia present; endocarp crustaceous **26. *N. domatifera***
- 83a. Leaf blades oblong to obovate; domatia absent; endocarp woody 84
84. Corolla white, subrotate; fruit apex flat **48. *N. luteola***
- 84a. Corolla white tinged greenish, urceolate; fruit apex rostellate **81. *N. tetrandra***
85. Leaf blades oblanceolate to obovate **54. *N. martiniana***
- 85a. Leaf blades elliptic or oblong to lanceolate 86
86. Leaf blades lanceolate; fruit surface smooth, sometimes verrucose, apex apiculate
..... **59. *N. olearia***
- 86a. Leaf blades elliptic to oblong; fruit surface smooth, apex flat **85. *N. variabilis***

Clé des espèces de *Noronhia* de Madagascar et des Comores

[Les chiffres entre parenthèses indiquent le renvoi au couplet précédent]

- 1. Feuilles verticillées ou subverticillées 2
- 1a. Feuilles distinctement opposées 9
- 2. Feuilles verticillées à chaque nœud 3
- 2a. Feuilles verticillées seulement à l'extrémité des branches 4
- 3. Limbe foliaire lancéolé, les plus grands ≥ 25 cm de long **62. *N. patricei***
- 3a. Limbe foliaire linéaire à lancéolé, les plus grands < 25 cm de long
..... **87. *N. verticillata***
- 4. Les plus grandes feuilles > 15 cm de long, très coriace **19. *N. crassiramosa***
- 4a. Les plus grandes feuilles ≤ 15 cm de long, coriace à subcoriace 5
- 5. Limbe foliaire obovale à obtrullé; fruits verruqueux **86. *N. verrucosa***
- 5a. Limbe foliaire oblancéolé à obovale; fruits lisses, ponctués ou rugueux 6
- 6. Pétiole entièrement ligneux; domaties foliaires présentes; fruits rugueux 7
- 6a. Pétiole non-ligneux; domaties foliaires absentes; fruits lisses ou ponctués 8
- 7. Base du limbe aiguë à atténuée ou tronquée, surface ondulée; fruits lisses, parfois rugueux, apex uniforme **60. *N. orientalis***
- 7a. Base du limbe arrondie, surface plane; fruits rugueux, apex émoussé
..... **70. *N. retusifolia***
- 8. Thyrses fasciculés; corolle blanche; couronne absente; fruits lisses
..... **57. *N. oblanceolata***
- 8a. Thyrses géminés; corolle jaune (teintée de rose); couronne présente; fruits ponctués
..... **72. *N. rollandii***
- 9 (1). Indument présent sur le pétiole, le limbe, le long de la veine principale inférieure; pédoncules et pédicelles pubescents 10
- 9a. Indument absent du pétiole, du limbe, de la veine principale inférieure; pédoncules et pédicelles glabres ou pubescents 14
- 10. Feuilles persistantes, limbe ovale à obovale, base arrondie à cordée; pétiole (généralement) entièrement ligneux 11
- 10a. Feuilles caduques, limbe oblong à lancéolé, base aiguë à atténuée (parfois arrondie); pétiole (généralement) non-ligneux 12

- 11 (10). Limbe foliaire ovale, base cordée ; corolle verdâtre teintée d'orange, cupuliforme, le tube corollin plus long que les lobes **11. *N. capuronii***
- 11a. Limbe foliaire obovale, base arrondie ; corolle blanc-verdâtre, subrotacée, le tube corollin plus court ou aussi long que les lobes **77. *N. similis***
- 12 (10). Limbe foliaire oblong à lancéolé, base arrondie ; fleurs épanouies > 1 cm de long **33. *N. humbertiana***
- 12a. Limbe foliaire lancéolé, base aiguë à atténuée ; fleurs épanouies < 1 cm de long 13
13. Corolle rouge-brun, cupuliforme, le tube corollin plus long que les lobes ; couronne présente **76. *N. seyrigii***
- 13a. Corolle blanche, subrotacée, le tube corollin plus court ou aussi long que les lobes ; couronne absente **82. *N. tropophylla***
- 14 (9). Limbe foliaire chartacé à subcoriace 15
- 14a. Limbe foliaire coriace à très coriace 43
15. Limbe foliaire chartacé 16
- 15a. Limbe foliaire subcoriace 31
16. Pétiole non ligneux 17
- 16a. Pétiole ligneux 21
17. Thyrses fasciculés 18
- 17a. Thyrses géminés (à parfois fasciculés) 19
18. Corolle jaunâtre, campanulée à subrotacée, le tube corollin plus court que les lobes, pétales soudés ; couronne présente **7. *N. brevītuba***
- 18a. Corolle blanche, rotacée, le tube corollin plus court que les lobes, pétales presque libres ; couronne absente **8. *N. broomeana***
19. Les plus grands limbes ≥ 15 cm de long **42. *N. leandriana***
- 19a. Les plus grands limbes < 15 cm de long 20
20. Limbe foliaire oblong à elliptique ; domaties foliaires présentes ; corolle blanc-rosâtre, cupuliforme à subrotacée, le tube corollin plus long ou aussi long que les lobes **14. *N. cochleata***
- 20a. Limbe foliaire étroitement à largement elliptique ; domaties foliaires absentes ; corolle jaune pâle, subrotacée, le tube corollin plus court que les lobes **44. *N. linocerioides***
21. Les plus grands limbes < 15 cm de long 22
- 21a. Les plus grands limbes ≥ 15 cm de long 28

- 22 (21). Acumen des feuilles au plus 10 mm de long; lobes des calices ovales **71. *N. richardii***
- 22a. Acumen des feuilles atteignant au moins 20 mm de long; lobes des calices triangulaires à deltoïdes 23
23. Fleurs (ou thyrses uniflores) fasciculées ou géminées 24
- 23a. Fleurs en thyrses solitaires à géminés 26
24. Fleurs géminées **63. *N. peracuminata***
- 24a. Fleurs fasciculées 25
25. Corolle jaunâtre (teintée de rouge), cupuliforme; couronne présente **15. *N. comorensis***
- 25a. Corolle rose à pourpre à l'extérieur, crème à l'intérieur, urcéolée; couronne absente ou vestigiale **64. *N. perrieriana***
26. Domaties foliaires présentes; pédoncule atteignant plus de 20 mm de long **30. *N. gracilipes***
- 26a. Domaties foliaires absentes ou très rares; pédoncule de moins de 10 mm de long 27
27. Pédicelle < 5 mm de long; corolle rose à blanc-crème teintée de rose; couronne présente **79. *N. stevensiana***
- 27a. Pédicelle \geq 5 mm de long; corolle rouge; couronne absente **74. *N. sambiranensis***
- 28 (21). Corolle urcéolée 29
- 28a. Corolle subrotacée 30
29. Pédicelle < 15 mm de long; fruit subglobuleux, parfois couvert d'une pellicule glauque ... **84. *N. urceolata***
- 29a. Pédicelle \geq 15 mm de long; fruit ovoïde à subglobuleux, parfois couvert de points **22. *N. decaryana***
30. Tube corollin plus court que les lobes; fruit ellipsoïde, surface côtelée; endocarpe ligneux **36. *N. insularis***
- 30a. Tube corollin aussi long que les lobes; fruit subglobuleux, surface lisse; endocarpe crustacé **31. *N. grandifolia***
- 31 (15). Pétiole non (ou rarement) ligneux 32
- 31a. Pétiole partiellement ou entièrement ligneux 35
32. Fruit oblong à ovoïde, > 25 mm de long à maturité **67. *N. populifolia***
- 32a. Fruit ovoïde, \leq 25 mm de long à maturité 33

33 (32).	Feuilles décidues ; veines secondaires à peine visibles ; fruits ponctués ; endocarpe ligneux	32. <i>N. greeniana</i>
33a.	Feuilles persistantes ; veines secondaires évidentes ; fruits lisses à côtelés ; endocarpe crustacé à subcrustacé	34
34.	Pétiole rarement ligneux ; fruits lisses, extrémité des fruits émoussée ; endocarpe subcrustacé	20. <i>N. cuspidata</i>
34a.	Pétiole non ligneux ; fruits lisses à légèrement côtelés, extrémité des fruits développée en un rostre distinct ; endocarpe crustacé	73. <i>N. rostrata</i>
35 (31).	Les plus grands limbes ≥ 20 cm de long	36
35a.	Les plus grands limbes < 20 cm de long	37
36.	Corolle rose à rouge orangé, oblongue à campanulée, le tube corollin plus long que les lobes ; fruit ovoïde à subglobuleux ; endocarpe ligneux	38. <i>N. introversa</i>
36a.	Corolle jaunâtre, cupuliforme, le tube corollin plus court que les lobes ; fruit sub-globuleux ; endocarpe subcrustacé	39. <i>N. jeremii</i>
37.	Pétiole ≤ 10 mm de long	38
37a.	Pétiole > 10 mm de long	41
38.	Limbe foliaire obovale	50. <i>N. maculata</i>
38a.	Limbe foliaire (linéaire à) lancéolé	39
39.	Fleurs fasciculées	80. <i>N. tefyana</i>
39a.	Fleurs en thyrses géminés à fasciculés	40
40.	Corolle rose pourpre ; fruit à peau lisse, parfois ponctuée ; endocarpe ligneux	52. <i>N. marinae</i>
40a.	Corolle blanche teintée de rose ; fruit à peau lisse ; endocarpe subcrustacé	75. <i>N. schatzii</i>
41.	Limbe foliaire ovale	29. <i>N. gautieri</i>
41a.	Limbe foliaire oblong à obovale	42
42.	Domaties foliaires présentes ; fruit ellipsoïde à ovoïde, ≥ 30 mm de long à maturité	2. <i>N. aminae</i>
42a.	Domaties foliaires absentes ; fruit ovoïde, < 30 mm de long à maturité	49. <i>N. macrocarpa</i>
43 (14).	Limbe foliaire épais et très coriace	44
43a.	Limbe foliaire plus mince mais coriace	47

44 (43).	Limbe foliaire obovale	45
44a.	Limbe foliaire oblong à elliptique	46
45.	Base du limbe aiguë à atténuée, extrémité mucronulée; fleurs fasciculées; corolle urcéolée, le tube corollin plus long que les lobes; fruit ovoïde, < 20 mm de long à maturité	18. <i>N. crassinodis</i>
45a.	Base du limbe arrondie, extrémité subcordée à arrondie; thyrses géminés à fasciculés; corolle cupuliforme, le tube corollin plus long ou aussi long que les lobes; fruit oblong, ≥ 20 mm de long à maturité	28. <i>N. emarginata</i>
46.	Les plus grands limbes < 20 cm de long; fleurs fasciculées; corolle urcéolée; couronne présente	10. <i>N. candicans</i>
46a.	Les plus grands limbes > 20 cm de long; thyrses fasciculés; corolle globuleuse; couronne absente	23. <i>N. densiflora</i>
47 (43).	Les plus grandes feuilles ≤ 10 cm de long	48
47a.	Les plus grandes feuilles > 10 cm de long	74
48.	Pétiole partiellement à entièrement ligneux	49
48a.	Pétiole non ligneux	68
49.	Veines secondaires presque ou complètement invisibles	50
49a.	Veines secondaires visibles sur les deux faces du limbe ou plus visible sur la face inférieure	59
50.	Limbe foliaire linéaire à obovale, base arrondie	51
50a.	Limbe foliaire elliptique à cordiforme, base aiguë à atténuée	53
51.	Limbe foliaire linéaire à obovale; pétiole d'un gris clair à blanchâtre; endocarpe ligneux	69. <i>N. ratovosonii</i>
51a.	Limbe foliaire linéaire; pétiole d'un gris moyen; endocarpe crustacé à ligneux	52
52.	Apex des feuilles rétus; corolle brun rougeâtre; endocarpe ligneux	43. <i>N. linearifolia</i>
52a.	Apex des feuilles aigu et acéré; corolle blanc-crème; endocarpe crustacé	78. <i>N. spinifolia</i>
53.	Limbe foliaire cordiforme	56. <i>N. obcordifolia</i>
53a.	Limbe foliaire elliptique à obovale	54
54.	Fruit < 10 mm de long à maturité	55
54a.	Fruit > 10 mm de long à maturité	57

- 55 (54). Limbe foliaire oblancéolé; fruit ovoïde **17. *N. coriacea***
55a. Limbe foliaire oblong à lancéolé; fruit subglobuleux à globuleux 56
56. Apex des feuilles courtement cuspidé; corolle brun rougeâtre, urcéolée, le tube corollin plus long que les lobes; fruit globuleux **4. *N. armandiana***
56a. Apex des feuilles aigu à acuminé; corolle blanc-ivoire, cupuliforme, le tube corollin plus long ou aussi long que les lobes; fruit subglobuleux **55. *N. myrtoïdes***
- 57 (54). Limbe foliaire obovale; thyrses solitaires **45. *N. longipedicellata***
57a. Limbe foliaire elliptique; fleurs fasciculées ou solitaires à gémées 58
58. Limbe foliaire étroitement elliptique; fleurs fasciculées; corolle blanche; couronne absente **1. *N. alleizettei***
58a. Limbe foliaire largement elliptique; fleurs solitaires à gémées; corolle rougeâtre, teintée de jaune à l'intérieur; couronne présente **5. *N. boinensis***
- 59 (49). Apex des feuilles cuspidé 60
59a. Apex des feuilles acuminé 62
60. Limbe foliaire largement oblong; domaties présentes; pétiole partiellement ligneux; endocarpe crustacé **66. *N. planifolia***
60a. Limbe foliaire ovale à obovale à rhombique; domaties rares ou absentes; pétiole entièrement ligneux; endocarpe crustacé à ligneux 61
61. Limbe foliaire ovale; fleurs fasciculées; corolle rose pourpre à l'extérieur, cupuliforme; endocarpe ligneux **51. *N. mangorensis***
61a. Limbe foliaire obovale à rhombique; thyrses solitaires à gémées; corolle rouge, urcéolée; endocarpe crustacé **12. *N. christenseniana***
62. Limbe foliaire elliptique à rhombique à obtrullé 63
62a. Limbe foliaire ovale à oblong 65
63. Limbe foliaire elliptique, apex rétus à acuminé; corolle jaune teintée de rouge, tubulaire; fruit subglobuleux **83. *N. tubulosa***
63a. Limbe foliaire (oblong à) rhombique, apex acuminé; corolle rose à vert, urcéolée; fruit ovoïde 64
64. Veines secondaires blanchâtres; pédicelle < 10 mm de long; corolle rosâtre **13. *N. clarinerva***
64a. Veines secondaires vertes; pédicelle ≥ 10 mm de long; corolle verdâtre **37. *N. intermedia***
65. Base du limbe tronquée à cordée; thyrses gémées **16. *N. cordifolia***
65a. Base du limbe arrondie à aiguë; fleurs fasciculées ou solitaires 66

- 66 (65). Fleurs solitaires; corolle cupuliforme; fruit subglobuleux **61. *N. ovalifolia***
66a. Fleurs fasciculées; corolle urcéolée; fruit ovoïde à ellipsoïde 67
67. Corolle rouge; fruit ovoïde lisse **9. *N. buxifolia***
67a. Corolle rose à rouge; fruit ellipsoïde légèrement rugueux
..... **34. *N. humblotiana***
- 68 (48). Extrémité des limbes arrondie à obcordée 69
68a. Extrémité des limbes aiguë à acuminée 72
69. Fruit pyriforme **47. *N. lowryi***
69a. Fruit ovoïde à subglobuleux 70
70. Fruit lisse, < 20 mm de long à maturité **25. *N. divaricata***
70a. Fruit lisse, ponctué ou côtelé, > 20 mm de long à maturité 71
71. Corolle blanche, cupuliforme, le tube corollin plus court ou aussi long que les lobes; couronne présente; fruit lisse à ponctué **3. *N. ankaranensis***
71a. Corolle blanche, campanulée, le tube corollin plus court que les lobes, pétales presque libres; couronne absente; fruit lisse à côtelé **58. *N. obtusifolia***
72. Apex des feuilles aigu; veines secondaires à peine visibles **40. *N. lanceolata***
72a. Apex des feuilles acuminé; veines secondaires visibles sur les deux faces du limbe
..... 73
73. Limbe foliaire lancéolé; corolle blanche, subrotacée, le tube corollin plus court que les lobes, pétales presque libres; couronne absente **35. *N. incurvifolia***
73a. Limbe foliaire ovale; corolle rouge, cupuliforme, le tube corollin aussi long que les lobes; couronne présente **68. *N. randrianaiivoi***
- 74 (47). Pétiole entièrement ligneux 75
74a. Pétiole non ligneux (ou rarement, partiellement ligneux seulement) 82
75. Marge des feuilles plane à légèrement révolutée; fruit subglobuleux 76
75a. Marge des feuilles plane, révolutée ou ondulée; fruit ovoïde 79
76. Apex du limbe acuminé; endocarpe des fruits ligneux 77
76a. Apex du limbe aigu à légèrement acuminé; endocarpe des fruits crustacé 78
77. Limbe foliaire ovale à largement elliptique; corolle rouge à l'extérieur, blanche à l'intérieur; fruit lisse **24. *N. disjuncta***
77a. Limbe foliaire oblong; corolle entièrement jaune pâle; fruit ponctué
..... **53. *N. marojejyensis***

- 78 (76). Limbe foliaire lancéolé, les plus grands limbes > 15 cm de long; pétiole > 10 mm de long; fruit ponctué **41. *N. latifolia***
- 78a. Limbe foliaire elliptique, les plus grands limbes < 15 cm de long; pétiole < 10 mm de long; fruit lisse **46. *N. louvelii***
- 79 (75). Apex du limbe cuspidé à mucroné; fleurs fasciculées **6. *N. boivinii***
- 79a. Apex du limbe acuminé ou rétus; thyrses géminés à fasciculés 80
80. Base du limbe arrondie à atténuée; pédoncule < 5 mm de long; fruit < 15 mm de long à maturité **21. *N. dauphinensis***
- 80a. Base du limbe aiguë à atténuée; pédoncule > 5 mm de long; fruit > 15 mm de long à maturité 81
81. Limbe foliaire elliptique à obovale, apex rétus (acuminé sur les plantules et jeunes arbres); domaties foliaires absentes; corolle blanche, parfois teintée de verdâtre, urcéolée; fruit parfois couvert d'une pellicule glauque **27. *N. edentata***
- 81a. Limbe foliaire lancéolé, apex acuminé; domaties foliaires présentes; corolle blanche, parfois teintée de pourpre à la base, rotacée; fruit parfois ponctué **65. *N. pervilleana***
- 82 (74). Veines secondaires à peine visibles ou évidentes seulement sur la face inférieure; fruit < 20 mm de long à maturité 83
- 82a. Veines secondaires visibles sur les deux faces; fruit > 20 mm de long à maturité 85
83. Limbe foliaire elliptique; domaties foliaires présentes; endocarpe crustacé **26. *N. domatifera***
- 83a. Limbe foliaire oblong à obovale; domaties foliaires absentes; endocarpe ligneux 84
84. Corolle blanche, subrotacée; apex des fruits uniforme **48. *N. luteola***
- 84a. Corolle blanc-verdâtre, urcéolée; apex des fruits développé en rostellum **81. *N. tetrandra***
85. Limbe foliaire oblancéolé à obovale **54. *N. martiniana***
- 85a. Limbe foliaire elliptique ou oblong à lancéolé 86
86. Limbe foliaire lancéolé; fruit lisse, parfois verruqueux, apex apiculé **59. *N. olearia***
- 86a. Limbe foliaire elliptique à oblong; fruit lisse, apex uniforme **85. *N. variabilis***

1. *Noronhia alleizettei* Dubard in Bull. Mus. Hist. Nat. 13: 551. 1907 (Fig. 2A).

Typus: MADAGASCAR. **Prov. Mahajanga:** Ouest, Morondava (Menabe), [20°17'S 44°17'E], s.d., *Grevé 217* (holo-: P [P00418079]!; iso-: K [K000233201, K000233202, K000233203] images seen, P [P00418078, P04046978, P04046979, P04046981, P04046982, P04046983]!).

= *Noronhia ecoronulata* H. Perrier in Mém. Inst. Sci. Madagascar, Sér. B, Biol. Vég. 2: 287. 1949. **Typus:** MADAGASCAR. **Prov. Mahajanga:** Ouest, lopy entre Andranomavo et Sitampiky (Ambongo), IX.1903, *Perrier de la Bâthie 1602* (holo-: P [P00418115]!; iso-: P [P00418116]!).

Description

Tree to 15 m tall, trunk to 12 cm diameter; young twigs cylindrical, 0.7-1.3 mm diameter, glabrous; bark dark to medium gray, smooth to rugose. *Leaves* opposite, deciduous; bud scales persistent; blades medium green above, lighter below, narrowly elliptic, 4-8.5 × 0.8-2.5 cm, coriaceous, glabrous, domatia absent, base acute, margin flat to slightly revolute, apex retuse to sometimes acuminate, the acumen 0-7 mm long, midrib slightly sunken above, raised below, secondary veins barely visible, 7-12 per side, 4-13 mm apart, looping 0.7-3 mm from the margin; petiole medium gray, 3-8 × 0.6-1.4 mm, entirely woody, glabrous. *Flowers* fasciculate; pedicel 1.5-6 mm long, sparsely pubescent; calyx moderately pubescent outside, glabrous inside, lobes triangular, 1-2.2 × 0.3-1.2 mm; corolla white, urceolate, 2-5 mm long, glabrous on both sides, the tube 1.5-4.5 mm long, lobes ovate, apex rounded; corona absent; stamens 1.4-2 mm long, anthers oblate to orbicular, 1.2-1.6 mm long; pistil 1.3-3.2 mm long, stigma capitate. *Fruiting* pedicel 3-12 × 0.6-1.5 mm; young fruits green, reddish black when mature, subglobose, 8.5-13.5 × 7-13.5 mm, surface smooth, sometimes covered with white dots, apex apiculate; dry pericarp 0.2-0.8 mm thick; endocarp woody; seed 5.5-8 × 4-6.5 mm.

Distribution, ecology and phenology

Noronhia alleizettei occurs in low-elevation dry forests in the west, from Ankarafantsika to Morondava (Fig. 3). It produces flowers and fruits all year except in September, with a peak between October and February.

Conservation status

There were 35 collections representing 25 localities available for analysis, which resulted in an Extent of Occurrence (EOO) of 61,385 km² and an Area of Occupancy (AOO) of 84 km² that is certainly much larger given the presence of uncollected areas of suitable habitat. Sixteen subpopulations representing 13 locations were estimated, of which six occur within the network of protected areas (Ankarafantsika, Beanka, Bemaraha, Corridor Bongolava, Menabe-Antanimena, and Namoroka). Therefore, *N. alleizettei* is assigned a preliminary status of "Least Concern".



Fig. 2. Photographs of *Noronhia* Stadtm. ex Thouars. **A.** *Noronhia alleizettei* Dubard [Hong-Wa 622]; **B.** *Noronhia aminae* Hong-Wa [Hong-Wa 555]; **C.** *Noronhia ankaranensis* (H. Perrier) Hong-Wa [Hong-Wa 551]; **D.** *Noronhia capuronii* Bossier [Trigui 536].

Photos: taken by respective collectors

Notes *Noronhia alleizettei* can be recognized by its narrow leaf blades, fasciculate, white flowers and small subglobose fruits. PERRIER DE LA BATHIE (1949, 1952) distinguished *N. ecoronulata* H. Perrier from *N. alleizettei* by the absence of a corona. However, none of the examined flowers of *N. alleizettei* had a corona and the original description mentioned only a simple rim at the base of the corolla (DUBARD, 1907) that may actually correspond to the thickening of the base of the corolla when the corona is absent (PERRIER DE LA BATHIE 1949, 1952). The two species, as recognized by PERRIER DE LA BATHIE (1949, 1952), are similar in all other aspects and are therefore synonymized, with *N. alleizettei* having priority.

The specimen labeled as *Alleizette* 4 (P [P00418078]) should be regarded as an isotype of *N. alleizettei* rather than a syntype since it is a duplicate of Grevé 217 as noted by H. Perrier de la Bathie: “part du précédent indiquée par erreur comme provenant de la forêt de la Mandraka (près de Tananarive), c’est à dire d’une forêt ombrophile du versant oriental, située à 1200-1400 m d’altitude, alors qu’elle provient en réalité du sous-bois, de forêt tropophylle, située sur le versant occidental, au voisinage de la mer, dans la partie sud du secteur «Menabe» du domaine occidental (18 Juillet 1948)”.

The specimen *Decary s.n.* (P [P03558887]) includes four fragments, of which three are assigned to *N. alleizettei* and the fourth to *N. tropophylla* (H. Perrier) Hong-Wa & Besnard.

Additional specimens examined

MADAGASCAR. Prov. Mahajanga: Beanka, Sarodrano, 18°03'34"S 44°31'00"E, 394 m, 23.II.2012, *Bolliger et al.* 245 (G, MO, TEF); Beanka, Andalaposa, 18°00'54"S 44°29'53"E, 237 m, 18.III.2012, *Bolliger et al.* 307 (BR, G, K, MO, P, TEF); Domaine occidental, s.d., *Decary s.n.* (P); Ampijoroa STF, c. 30 km N d'Andranofasika, 16°20'S 46°51'E, 200 m, 13.IV.1984, *Dorr & Koenders* 3026 (K, MO, P, TAN); Beanka, Sarodrano, 18°03'01"S 44°31'09"E, 450 m, 5.III.2012, *Hanitrarivo et al.* 263 (BR, G, K, MO, P, TEF); Ankarafantsika PN, 16°18'54"S 46°48'46"E, 154 m, 13.III.2009, *Hong-Wa* 622 (MO, P, TAN); *ibid. loc.*, 16°17'45"S 46°49'20"E, 160 m, 14.III.2009, *Hong-Wa* 628 (MO, P, TAN); *ibid. loc.*, 16°19'07"S 46°48'13"E, 198 m, 14.III.2009, *Hong-Wa* 631 (MO, P, TAN); Tsingy de Bemaraha, S of the Manambolo river, 19°09'S 44°49'E, 50 m, 13.XII.1996, *Jongkind et al.* 3524 (G, MO, P, TAN, WAG); Antsalova, Bevitiky, Kinanaoka, Tsingy de Bemaraha RN9, 18°38'44"S 44°42'24"E, 180 m, 6.III.1995, *Labat* 2667 (G, K, MO, P, TAN); Ampijoroa STF, 16°19'S 46°49'E, 7.IV.1988, *Leeuwenberg* 13864 (MO, P, TAN); *ibid. loc.*, 16°19'S 46°49'E, 150 m, 20.VI.1987, *Phillipson* 1911 (MO, P, TAN); Beanka, Kinahango, 18°01'34"S 44°30'27"E, 306 m, 14.III.2012, *Rakotozafy et al.* 80 (G, MO); Port Bergé, Bongolava, forêt de Marosely, 15°38'58"S 47°35'03"E, 217 m, 17.XI.2004, *Razakamalala et al.* 1716 (MO, P, TEF); Ambondromamy, forêt de Befotaka, 16°22'39"S 47°10'28"E, 17.IV.2007, *Razakamalala et al.* 3388 (MO, P, TAN); Maintirano, Ambinda, 18°04'S 44°30'E, 203 m, 19.X.2009, *Razakamalala et al.* 4426 (MO, P, TAN); Tsaramandroso, Bevazaha, [Ankarafantsika PN], [15°59'S 46°56'E], 5.X.1948, *Réserves Naturelles* 1671 (MO, P); Ankarafantsika, [16°11'S 47°06'E], 3.XI.1950, *Réserves Naturelles* 2020 (G, MO, P); Soalala, Andranomavo, [16°21'S 45°17'E], 71-227 m, 27.III.1954, *Réserves Naturelles* 6142 (P, TEF); Ankarafantsika, [16°11'S 47°06'E], *Service Forestier* 5bis (P); *ibid. loc.*, *Service Forestier* 55 (K, P); Route Morondava-Belo, Andranomena, 20°10'30"S 44°25'30"E, 10 m, 18.X.1962, *Service Forestier* 21073 (TEF).



Fig. 3. Distribution maps of species of *Noronhia* Stadtm. ex Thouars : *N. alleizettei* Dubard to *N. capuronii* Bosser.

2. *Noronhia aminae* Hong-Wa, spec. nova (Fig. 2B, 4).

Typus: MADAGASCAR. **Prov. Antsiranana:** DIANA, Diégo II, Anivorano-Nord, Tsarakibany, village d'Analabevato, 12°46'44"S 49°11'18"E, 428 m, 4.I.2009, *Hong-Wa et al.* 555 (holo-: MO-6615551!; iso-: G [G00341614]!, K!, P!, TAN!).

Diagnosis *Noronhia aminae* Hong-Wa can be distinguished from other members of the genus by its distinctly veined leaf blades, often with domatia, its cream-white, rotate flowers and its large, ellipsoid to ovoid fruits, terminated by a rostrum.

Description Trees to 16 m tall, trunk to 25 cm diameter; young twigs cylindrical, 0.7-2.1 mm diameter, glabrous; bark medium gray, smooth. Leaves opposite, semi-deciduous; bud scales rarely persistent; blades medium green above, lighter below, oblong, 4.5-14 × 1.5-4.5 cm, subcoriaceous, glabrous, domatia common, base acute to attenuate, margin flat, apex acute to acuminate, the acumen 1-8 mm long, midrib slightly sunken above, distinctly raised below, secondary veins conspicuous, 8-13 per side, 6-15 mm apart, looping 1-3.7 mm from the margin; petiole medium gray, 4-12 × 1-2.5 mm, partially to entirely woody, glabrous. Thyrses geminate to fasciculate, pauciflorous, diffuse; peduncle 15-30 mm long, glabrescent; pedicel 1.5-13 mm long, glabrescent; calyx sparsely pubescent outside, glabrous inside, lobes triangular, 1 × 1-1.7 mm; corolla cream-white, rotate, 3-4.5 mm long, glabrous on both sides, the tube 0.8-1.5 mm long, lobes lanceolate, apex acute; corona present, 1.3-2 mm long, undivided to slightly lobed; stamens 1.4-2.2 mm long, anthers obovate, 0.9-1.4 mm long; pistil 1.7-2.3 mm long, stigma capitate. Fruiting pedicel 3-15 × 1-2.5 mm; young fruits greenish, orange-yellow when mature, ellipsoid to ovoid, 15-33.5 × 10.5-24 mm, surface slightly rugose, apex rostrate, the rostrum slightly flattened, truncate, with the persistent style; dry pericarp 0.7-1.7 mm thick; endocarp woody; seed 12-25.5 × 7-14.5 mm.

Etymology This species is dedicated to a sweet matriarch, Amina, who was very helpful in the field and in finding the flowering material that serves as the type specimen.

Distribution, ecology and phenology *Noronhia aminae* occurs in low- to mid-elevation semi-deciduous forests in the north, from Montagne des Français to Daraina (Fig. 3). It produces flowers and fruits throughout the year except in April and May, with a peak between November and January.

Conservation status The assessment was based on 20 collections representing 19 localities and yielded an EOO of 3,393 km², an AOO of 64 km², and 15 subpopulations representing 13 locations, of which four occur within the network of protected areas (Ankarana, Loky-

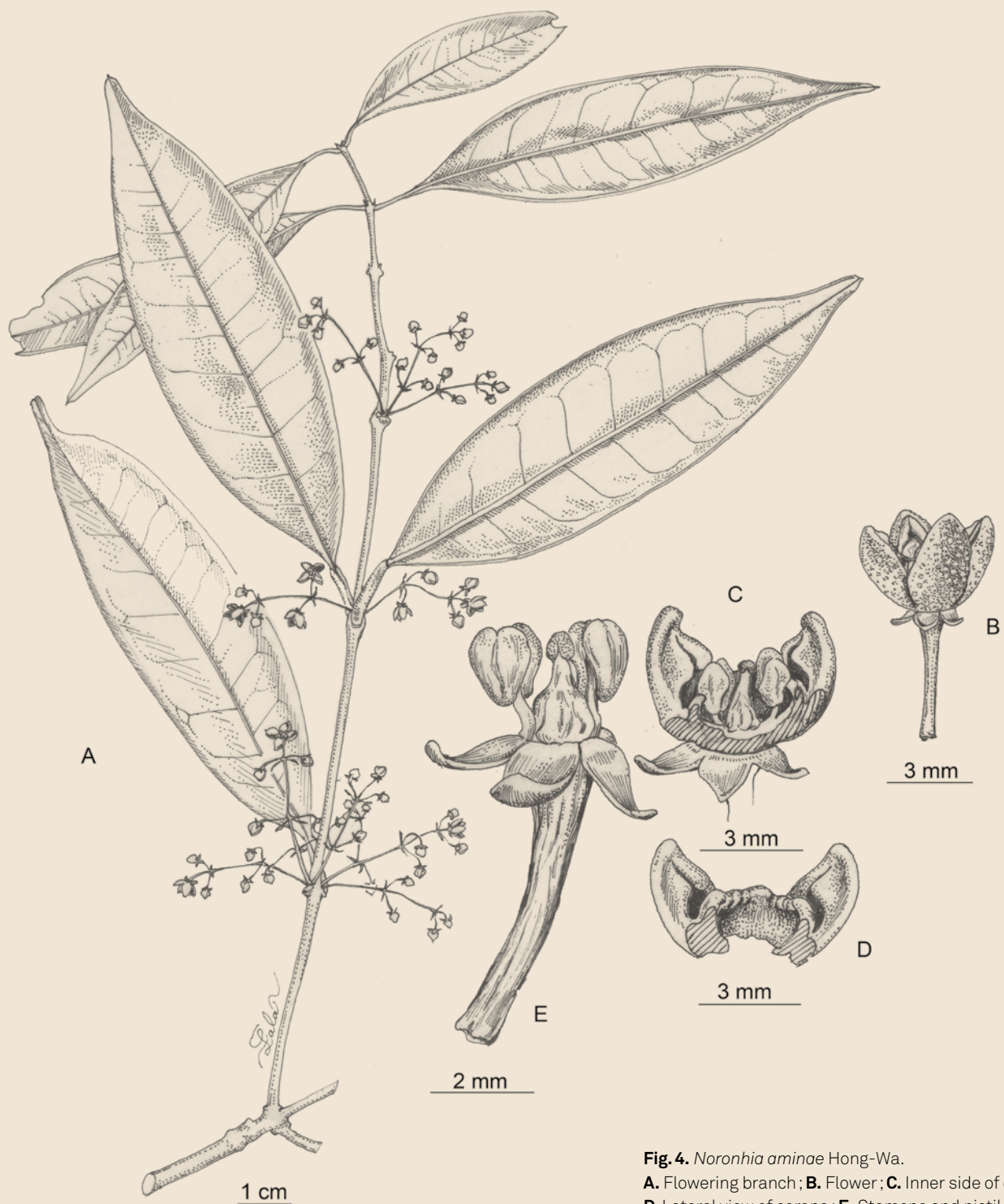


Fig. 4. *Noronhia aminae* Hong-Wa.

A. Flowering branch; **B.** Flower; **C.** Inner side of corolla; **D.** Lateral view of corolla; **E.** Stamens and pistil.

[Hong-Wa 555, TAN] Drawings: R.L. Andriamiarisoa

Manambato, Montagne d'Ambre, and Montagne des Français). Consequently, *N. aminae* is assigned a preliminary status of "Near Threatened" [NT] due to continuing decline in habitat quality in non-protected areas.

Notes *Noronhia aminae* most closely resembles *N. sambiranensis* H. Perrier, from which it differs by its cream-white (vs. red), rotate (vs. cupuliform) flowers, rostrate (vs. flat) fruit apex, and woody (vs. crustaceous) endocarp. The new species can be recognized by its distinctly veined leaf blades, often with domatia, its cream-white flowers and its large, ellipsoid to ovoid fruits.

Paratypes **MADAGASCAR. Prov. Antsiranana:** Mosorolava, Mahagaga, 12°46'36"S 49°01'37"E, 102 m, 22.IX.2007, *Andriamihajarivo et al.* 1366 (MO, P, TAN); Montagne d'Ambre PN, à 8 km de Bobakilandy, 12°37'37"S 49°06'40"E, 533 m, 11.VII.1995, *Andrianantoanina & Bezara* 851 (G, K, MO, P, TAN); *ibid. loc.*, 18-21.VI.1996, *Andrianantoanina & Bezara* 983 (K, MO, P); Matsaborimanga, Ankarana RS, 12°56'14"S 49°03'16"E, 50 m, 3.XI.1997, *Bardot-Vaucoulon* 943 (K, MO, P, TAN); Mahamasina, Massif de l'Ankarana, 12°57'S 49°09'E, 110 m, 26.I.2003, *Bardot-Vaucoulon et al.* 1339 (K, MO, P, TAN); Mahatsara, forêt d'Analamanga, près d'Andrafiatokana, 12°45'37"S 49°07'35"E, 446 m, 3.I.2009, *Hong-Wa et al.* 554 (MO, P, TAN); Marotaolana, forêt d'Analamahitsy, 12°50'10"S 49°13'42"E, 370 m, 30.I.2009, *Hong-Wa* 591 (MO, P, TAN); Sakaramy, Montagne d'Ambre PN, 12°26'28"S 49°13'58"E, 331 m, 1.VI.2010, *Hong-Wa* 702 (MO, P, TAN); Ampitiliantsambo, Montagne des Français, 12°21'34"S 49°21'30"E, 168 m, 5.X.2004, *Randriambololomamonjy* 25 (MO, P, TAN); Andranonankomba, Montagne des Français, 12°21'00"S 49°21'34"E, 112 m, 8.IX.2004, *Randrianaivo et al.* 1082 (CNARP, G, MO, P, TAN); Ampitiliantsambo, Montagne des Français, 12°23'15"S 49°23'04"E, 224 m, 24.VII.2004, *Randrianarivelo & Rasolofoson* 114 (G, MO, P, TAN); *ibid. loc.*, 12°21'39"S 49°21'34"E, 281 m, 24.IX.2004, *Randrianarivelo et al.* 140 (MO, P, TAN); Daraina, forêt de Binara, 13°14'22"S 49°36'26"E, 700 m, 28.III.2004, *Ranirison* 519 (Daraina, G, K, MO, P, TEF); Mosorolava, Ampombiantambo, forêt d'Antsoroby, 12°40'29"S 48°58'52"E, 23.IX.2007, *Razafitsalama et al.* 1224 (CNARP, G, MO, P, TAN); Montagne d'Ambre PN, [13°36'S 49°09'E], 27.VIII.1954, *Service Forestier* 10788 (P, TEF); Ambodimanga, 7.X.1955, *Service Forestier* 13033 (MO, P); Montagne des Français, [12°22'05"S 49°21'00"E], 1000 m, 24.III.1955, *Service Forestier* 13134 (P, TEF); Jardin botanique 19, [12°31'30"S 49°10'20"E], 1000-1100 m, 21.VII.1955, *Service Forestier* 14248 (P, TEF).

3. *Noronhia ankaranensis* (H. Perrier) Hong-Wa, **comb. & stat. nov.** (Fig. 2C).

- ≡ *Noronhia luteola* var. *ankaranensis* H. Perrier in Mém. Inst. Sci. Madagascar, Sér. B, Biol. Vég. 2: 298. 1949.
 ≡ *Noronhia luteola* subsp. *ankaranensis* (H. Perrier) H. Perrier, Fl. Madagascar Comores 166: 51. 1952.

Typus: MADAGASCAR. **Prov. Antsiranana:** Ankarana, [12°54'00"S 49°07'48"E], 10-250 m, XII.1937, *Humbert 18794* (holo-: P [P00573402]!; iso-: P [P00573403; P00573404]!; S [S09-36007] image seen, WAG [WAG0002492] image seen).

Description

Shrubs to trees to 8 m tall, trunk to 12 cm diameter; young twigs cylindrical, 0.6-2.1 mm diameter, glabrous; bark medium gray, smooth to rugose. *Leaves* opposite, semi-deciduous; bud scales persistent; blades dark green above, lighter below, obovate, 3.5-8.5 × 1-3.5 cm, coriaceous, glabrous, domatia abundant, base attenuate, margin flat to slightly revolute and undulate, apex rounded to obcordate, midrib flat above to slightly sunken above, flat to slightly raised below, secondary veins barely visible, 5-10 per side, 3-16 mm apart, looping 0.8-4 mm from the margin; petiole yellowish, 3-8 × 0.5-2.7 mm, not woody, glabrous. *Thyrse*s solitary, pauciflorous, compact; peduncle 1.5-5 mm long, sparsely pubescent; pedicel 3-8 mm long, sparsely pubescent; calyx glabrous on both sides, lobes triangular, 0.7-1 × 0.7-1.1 mm; corolla white, cupuliform, 3-5.5 mm long, glabrous on both sides, the tube 1-3 mm long, lobes lanceolate, apex acute; corona present, 1-1.4 mm long, undivided; stamens 1.2-1.9 mm long, anthers obtriangular, 0.8-1.3 mm long; pistil 1.2-2 mm long, stigma capitate. *Fruiting* pedicel 3-12 × 0.7-1.8 mm; young fruits green, dark brown when mature, ovoid to subglobose, 10-24 × 7-16.7 mm, smooth, sometimes covered with white dots, apex bluntly pointed to apiculate; dry pericarp 0.5-1.6 mm thick; endocarp woody; seed 7-16 × 5-10 mm.

Distribution, ecology and phenology

Noronhia ankaranensis occurs in low-elevation dry forests in the north, from Montagne des Français to Ankarana and Daraina (Fig. 3). It produces flowers and fruits throughout the year, with a peak between October and February.

Conservation status

With 37 collections representing 33 localities, the analysis resulted in an EOO of 12,445 km², an AOO of 112 km², and 23 subpopulations representing 19 locations, of which six occur within the network of protected areas (Ankarana, Ambodivahibe, Loky-Manambato, Montagne des Français, Nosy Mitsio, and Oronjia). *Noronhia ankaranensis* is thus assigned a preliminary status of "Near Threatened" due to ongoing habitat loss and degradation in non-protected areas.

Notes *Noronhia ankaranensis* can be recognized by its non-woody petiole, obovate leaf blades bearing domatia, pauciflorous, compact thyrses, and white corolla. This species differs from *N. luteola* H. Perrier by the shape of its leaves (obovate vs. oblong to obovate) and corolla (cupuliform vs. subrotate) and by the organization of its thyrses (solitary vs. geminate). Although previously considered as a subspecies of the latter, these entities are not sister and do not even belong to the same clade (HONG-WA & BESNARD, 2013, 2014).

**Additional specimens
examined**

MADAGASCAR. Prov. Antsiranana: Ankarana RS, [12°54'00"S 49°07'48"E], 50-409 m, 12-20.X.1993, *Andrianantoanina* 381 (K, MO); *ibid. loc.*, [12°54'00"S 49°07'48"E], 6.X.1990, *Bardot-Vaucoulon* 124 (P); Baie des Sakalava, 12°16'24"S 49°23'30"E, 0 m, 15.VIII.2004, *Be et al.* 77 (CNARP, G, MO, P, TAN); Ambolobozokely, Nosy Laliara, 12°25'55"S 49°33'05"E, 9 m, 17.VI.2005, *Be et al.* 142 (CNARP, MO, P, TAN); Daraina, forêt d'Antsahabe, 13°13'S 49°33'E, 580 m, 15.X.2004, *Callmander et al.* 225 (Daraina, G, K, MO, P, TEF); *ibid. loc.*, 13°12'51"S 49°33'01"E, 740 m, 3.XII.2004, *Gautier* 4811 (Daraina, G, K, MO, TEF); Sahafary, 12°34'36"S 49°27'41"E, 180 m, 24.VII.2004, *Guittou et al.* 40 (CNARP, G, MO, P, TAN); Sakaramy, Montagne des Français, [12°19'S 49°21'E], 8.XI.1944, *Homolle* 263 (P); Andavakoera, Montagne des Français, 12°19'57"S 49°21'19"E, 172 m, 4.VIII.2007, *Hong-Wa et al.* 545 (TAN); *ibid. loc.*, 12°19'18"S 49°20'16"E, 270 m, 29.XII.2008, *Hong-Wa* 551 (MO, P, TAN); Ankarana, [12°54'00"S 49°07'48"E], 30-350 m, 24.I-29.II.1960, *Humbert* 32554 (P); Ankarana RS near Campement des Anglais, 12°54'42"S 49°06'42"E, 240-260 m, 16.V.1993, *Jongkind & Rapanarivo* 941 (MO, P, TAN); Matsaborimanga, Ankarana RS, 12°55'26"S 49°05'10"E, 300 m, 20.XI.1996, *Labat* 2778 (K, MO, P, TAN, WAG); Daraina, forêt d'Ankaramy, 13°17'07"S 49°40'41"E, 245 m, 22.II.2004, *Nusbaumer & Ranirison* 1202 (Daraina, G, K, MO, P, TAN); *ibid. loc.*, 13°17'46"S 49°40'39"E, 640 m, 20.XII.2005, *Nusbaumer & Ranirison* 1819 (Daraina, G, K, MO, P, TEF); Daraina, Befarafara, forêt de Solanampilana, 13°05'26"S 49°34'32"E, 100 m, 15.XI.2005, *Rakotonandrasana et al.* 992 (CNARP, G, MO, P, TAN); Ampitiliantsambo, Montagne des Français, 12°23'13"S 49°22'53"E, 239 m, 11.IX.2004, *Randriambololomamonjy et al.* 14 (G, MO, P, TAN); Daraina, forêt d'Antsahabe, 13°10'50"S 49°33'17"E, 415 m, 30.IV.2004, *Ranirison* 750 (Daraina, G, K, MO, P, TEF); Andranovondronina, Anjiabe, forêt de Belamoty, 12°06'09"S 49°19'34"E, 85 m, 10.XI.2006, *Ratovoson et al.* 1152 (CNARP, MO, P, TAN); Vohémar, Manakana, 13°43'08"S 50°05'50"E, 13.III.2004, *Razakamalala* 1076 (G, MO, P, TEF); Anjiabe, Analabe, près du lac Sahaka, 13°04'43"S 49°54'04"E, 13.V.2004, *Razakamalala et al.* 1256 (MO, P, TEF); Vohémar, [13°26'S 50°00'E], 11.XII.1966, *Service Forestier* 27299 (G, MO, P); Massif de l'Ankarana (partie S du massif Mafokovo), 50-450 m, 17.XII.1966, *Service Forestier* 27360 (MO, P, TEF).

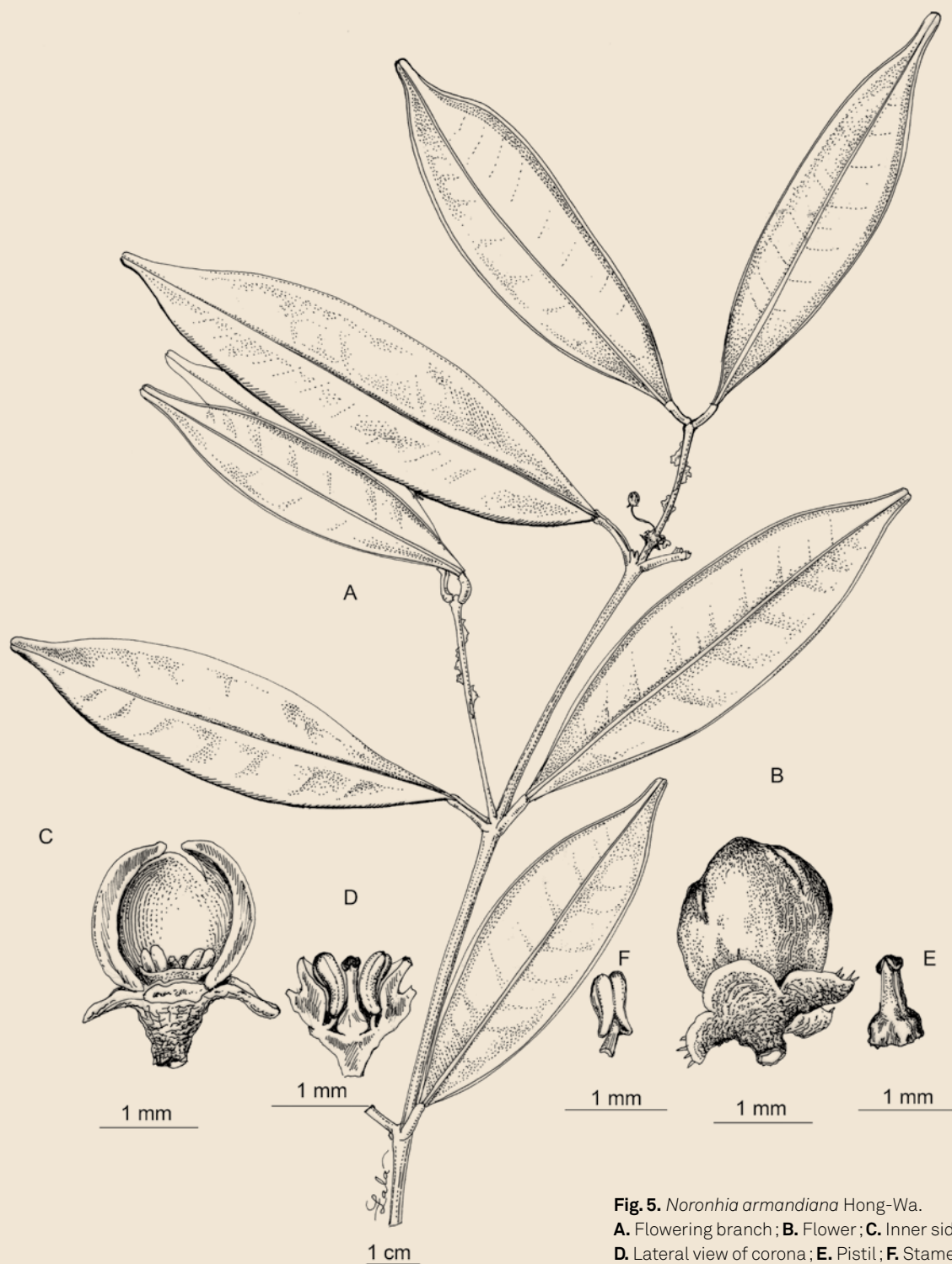


Fig. 5. *Noronhia armandiana* Hong-Wa.

A. Flowering branch; **B.** Flower; **C.** Inner side of corolla; **D.** Lateral view of corona; **E.** Pistil; **F.** Stamen.

[A-F: Ludovic 759, TAN] Drawings: R.L. Andriamiarisoa

4. *Noronhia armandiana* Hong-Wa, spec. nova (Fig. 5).

Typus: MADAGASCAR. **Prov. Fianarantsoa:** Atsimo-Atsinanana, Farafangana, Mahabo-Mananivo, forêt d'Agnalazaha, 23°08'42"S 47°42'18"E, 31 m, 22.IV.2004, Ludovic 759 (holo-: MO-6615572!; iso-: G, P, TAN).

Diagnosis *Noronhia armandiana* Hong-Wa can be distinguished from its congeners by its dense branching, its whitish bark, its oblong leaf blades and its rounded fruits.

Description Trees to 13 m tall, trunk to 15 cm diameter; young twigs cylindrical, 1-1.5 mm diameter, glabrous; bark light gray, smooth. Leaves opposite, persistent; bud scales persistent; blades dark green above, lighter below, oblong, 5.5-10.5 × 1.5-3.5 cm, coriaceous, glabrous, domatia rare, base attenuate, margin revolute, apex shortly cuspidate, the cusp 5-10 mm long, midrib slightly sunken above, distinctly raised below, secondary veins barely visible, 7-12 per side, 6-12 mm apart, looping 1-4 mm from the margin; petiole light gray, 4-8 × 1-2 mm, entirely woody, glabrous. Flowers fasciculate; pedicel 3-5 mm long, moderately pubescent; calyx moderately pubescent outside, glabrous inside, lobes triangular, 1 × 1.8 mm; corolla reddish brown, urceolate, 4.8 mm long, glabrous on both sides, the tube 3 mm long, lobes ovate, apex rounded; corona present, 1.5 mm long, undivided; stamens 1.8 mm long, anthers oblong, 1.2 mm long; pistil 1.8 mm long, stigma capitate. Fruiting pedicel 6-8 × 1.2-1.8 mm; young fruits green, dark brown when mature, globose, 12-15 × 12-15 mm, surface covered with white dots, apex flat to bluntly pointed; dry pericarp 0.9-1.6 mm thick; endocarp crustaceous; seed 7-8.7 × 5.5-8.3 mm.

Etymology This name honors Armand Randrianasolo, Curator at the Missouri Botanical Garden in St. Louis, for his dedication to the conservation of the Malagasy flora and particularly for his role in the conservation of Agnalazaha forest, where the type specimen was collected.

Distribution, ecology and phenology *Noronhia armandiana* occurs in littoral to low-elevation humid forests at Manombo in the east (Fig. 3). It produces flowers and fruits from November to April.

Conservation status *Noronhia armandiana* is currently known only from four collections representing four localities. With an EOO of 42 km², an AOO of 12 km², and three subpopulations representing three locations, none of which occurs in a protected area, although one is located just outside Manombo RS, *N. armandiana* is assigned a preliminary status of "Endangered" [EN B1ab(i,ii,iii,iv,v)+2ab(i,ii,iii,iv,v)]. Areas outside of Manombo RS have been gradually converted into agricultural land, reducing the suitable habitat

available to this species. In addition, wood harvesting and sporadic wildfire such as that of 2005, which burned 200 ha of forest (BIRKINSHAW et al., 2005), also constitute a substantial threat.

Notes *Noronhia armandiana* most closely resembles *N. marinae* Hong-Wa, from which it differs by its oblong (vs. linear to lanceolate) and shortly cuspidate (vs. acuminate) leaf blades. Its flowers are fasciculate, urceolate and reddish brown (vs. thyrsoïd, cupuliform and purplish pink) and its fruits have a flat (vs. apiculate) apex and crustaceous (vs. woody) endocarp. This species can be recognized by its dense branching, whitish bark, oblong leaf blades, and rounded fruits.

Paratypes **MADAGASCAR. Prov. Fianarantsoa:** Forêt Classée near Manombo RS, 23°03'16"S 47°40'28"E, 100 m, 15.XI.2001, *McPherson & Rabenantoandro 18419* (MO, TEF); Farafangana, Mananivo, Iabomary, 23°03'34"S 47°40'23"E, 0-50 m, 6.II.2001, *Rabenantoandro et al. 442* (G, MO, P, TAN); Mahatsinjoriaka, [23°02'10"S 47°44'50"E], 0-10 m, 28.II.1956, *Service Forestier 16264* (P, TEF).

5. *Noronhia boinensis* H. Perrier in Mém. Inst. Sci. Madagascar, Sér. B, Biol. Vég. 2: 303. 1949.

Lectotypus (designated here): **MADAGASCAR. Prov. Mahajanga:** Ankaladina, sur la Bet-siboka (Boiny), [16°22'S 46°32'E], XII.1901, *Perrier de la Bâthie* 1379 (P [P00418075]!); islecto-: K [K000233199] image seen, P [P00418076, P00418077]!). **Syntypi:** Tsingy de Namoroka (Ambongo), [16°34'S 45°34'E], I.1905, *Perrier de la Bâthie* 1802 (K [K000233200] image seen, P [P00701250, P04046996]!); Baie de Mahajamba (Boina), VII.1907, *Perrier de la Bâthie* 4495 (P [P00701252]!); Tsingy de Namoroka (Ambongo), [16°34'S 45°34'E], XII.1926, *Perrier de la Bâthie* 17817 (P [P04046994]!).

Description

Small trees to 7 m tall, trunk to 20 cm diameter; young twigs cylindrical, 0.7–1.3 mm diameter, glabrous; bark dark to medium gray, smooth to slightly rugose. Leaves opposite, persistent; bud scales persistent; blades dark green above, lighter below, widely elliptic, 5–8 × 2–3.5 cm, coriaceous, glabrous, domatia absent, base acute to attenuate, margin slightly revolute and undulate, apex slightly acuminate, the acumen 1–7 mm long, midrib flat to slightly sunken above, flat to raised below, secondary veins barely visible, 7–11 per side, 6–12 mm apart, looping 1–3 mm from the margin; petiole dark to medium gray, 4–8 × 1–1.6 mm, entirely woody, glabrous. Flowers solitary to geminate; pedicel 7–10 mm long, moderately pubescent; calyx moderately pubescent outside, glabrous inside, lobes deltate, 1–1.2 × 0.9–1 mm; corolla reddish outside, yellowish inside, urceolate, 4–5 mm long, glabrous on both sides, the tube 3–4 mm long, lobes deltate, apex acute; corona present, 1–1.5 mm long, undivided; stamens 1.5–1.8 mm long, anthers slightly obovate, 1.4 mm long; pistil 1.5–2.8 mm long, stigma capitate. Fruiting pedicel 7–20 × 0.6–0.9 mm; young fruits green, dark red when mature, subglobose, 11–15 × 9–11.5 mm, surface smooth, sometimes covered with a white pellicle, apex apiculate to flat with the persistent style; dry pericarp 0.6–1.1 mm thick; endocarp woody; seed 8–11 × 5–7 mm.

Distribution, ecology and phenology

Noronhia boinensis occurs in low-elevation dry forests in the west, from Ankarafantsika to Antsalova (Fig. 3). It produces flowers and fruits throughout the year, with a peak between October and March.

Conservation status

Based on 12 collections representing 12 localities, the assessment provided an EOO of 39,885 km², an AOO of 48 km², and 10 subpopulations representing nine locations, of which two occur within the network of protected areas (Beanka and Tsimembo). Although the AOO is very likely larger than 48 km², it is nonetheless probably less than 2,000 km². Moreover, most of the suitable habitats will experience continuing decline

in area as well as in quality due to deforestation, wildfire, and wood harvesting, all of which can result in the reduction of the number of mature individuals. *Noronhia boinensis* is therefore assigned a preliminary status of “Vulnerable” [VU B1ab(i,ii,iii,iv,v)+2ab(i,ii,iii,iv,v)].

Notes *Noronhia boinensis* can be recognized by its coriaceous, elliptic leaf blades and its solitary to geminate red-yellow flowers. It differs from *N. tubulosa* H. Perrier by its barely visible (vs. conspicuous) venation, urceolate (vs. tubular) flowers, and red-yellow (vs. yellow) corolla. It was described based on the following syntypes: *Perrier de la Bâthie* 1379, 1802, 4495 and 17817. A specimen of *Perrier de la Bâthie* 1379 is chosen as the lectotype because of the completeness and overall quality of the material and the number of duplicates available.

Additional specimens examined

MADAGASCAR. Prov. Mahajanga: Beanka, Anadabomanambaditsingilo, 18°02'15"S 44°28'36"E, 224 m, 10.III.2012, *Hanitrarivo et al.* 309 (G, MO); Bongolava (Boina), [15°40'S 47°16'E], X.1907, *Perrier de la Bâthie* 8830 (P); Antsalova, between Ambereny and Lac Masama, 18°51'S 44°27'E, 50 m, 26.VIII.1987, *Phillipson* 2277 (K, MO, P, TAN); Ambondromamy, forêt de Befotaka, 16°22'39"S 47°10'28"E, 17.IV.2007, *Razakamalala et al.* 3364 (MO, P, TAN); Maintirano, Ambinda, 18°04'S 44°30'E, 203 m, 19.X.2009, *Razakamalala et al.* 4423 (MO, P, TAN); Berivotra, [15°54'00"S 46°34'30"E], 100 m, 22.XI.1957, *Service Forestier* 18460 (P, TEF); Antsalova, Masoarivo, forêt de Tsimembo, [18°52'S 44°25'E], 50-100 m, 17.III.1961, *Service Forestier* 19865 (TEF); *ibid. loc.*, Tsimembo-Ambereny, [18°53'S 44°23'E], 0-50 m, 22.VIII.1962, *Service Forestier* 21054 (TEF); Beanka, Ambinda-Nord, 17°56'41"S 44°28'29"E, 246 m, 11.XI.2011, *Tahinarivony & Bolliger* 582 (G, MO).

6. *Noronhia boivinii* Dubard in Bull. Mus. Hist. Nat. 13: 550. 1907.

Typus: MADAGASCAR: [Cultivé au] Jardin botanique de Bourbon, s.d., *Boivin s.n.* (holo-: P [P00413215]!; iso-: P [P00413216]!).

Description *Shrubs* to trees to 11 m tall, trunk to 8 cm diameter; young twigs cylindrical, 0.7-1.7 mm diameter, glabrous; bark medium to light gray or whitish, smooth. *Leaves* opposite, persistent; bud scales persistent; blades dark green above, lighter below, oblong to elliptic, 4.5-13 × 1.6-4 cm, coriaceous, glabrous, domatia absent, base acute to attenuate, margin flat to slightly revolute, apex cuspidate to mucronate, the cusp or mucro (0-)2-17 mm long, midrib sunken above, raised below, secondary veins conspicuous, 6-12 per side, 6-16 mm apart, looping 1.2-4 mm from the margin; petiole grayish to whitish, 3-10 × 1-2.8 mm, entirely woody, glabrous. *Flowers* fasciculate; pedicel 2-22 mm long, glabrescent to glabrous; calyx sparsely pubescent outside, glabrous inside, lobes broadly triangular, 0.9-2 × 1-2.5 mm; corolla pink to reddish, sometimes whitish, urceolate to slightly campanulate, 3.5-9 mm long, glabrous on both sides, the tube 1.5-7 mm long, lobes deltate, apex obtuse; corona present, 1-2 mm long, undivided; stamens 1.3-2.5 mm long, anthers elliptic, apex rounded, 1-1.7 mm long; pistil 1.5-2.7 mm long, stigma capitate. *Fruiting pedicel* 2-12 × 0.8-2 mm; young fruits green, dark brown when mature, ovoid, 11.5-34 × 8-23.5 mm, surface smooth, apex flat to apiculate; dry pericarp 0.7-1.1 mm thick; endocarp woody; seed 11.5-14 × 4-7 mm.

Distribution, ecology and phenology *Noronhia boivinii* occurs in littoral to mid-elevation humid forests in the east, from Masoala to south of Fort-Dauphin (Taolagnaro) and towards Andohahela (Fig. 3). It produces flowers and fruits throughout the year except in June and July.

Conservation status The assessment was based on 23 collections representing 21 localities and resulted in an EOO of 54,801 km², an AOO of 84 km², and 16 subpopulations representing 12 locations, of which eight occur within protected areas (Andohahela, Betampona, Mandena, Manombo, Masoala, Nosy Mangabe, Petriky, and Ste Luce). The AOO is likely larger than estimated here; however, *N. boivinii* is mainly found on the littoral forests of eastern Madagascar, which now consist only of isolated patches that are affected by ongoing habitat degradation and destruction, resulting mainly from slash-and-burn agriculture and mining. *Noronhia boivinii* is assigned a preliminary status of “Near Threatened” [NT].

Notes *Noronhia boivinii* can be recognized by its oblong to elliptic leaf blades terminated by a short cusp or mucro and its fasciculate, pink to red flowers. It differs from *N. ovalifolia* H. Perrier by its oblong to elliptic (vs. ovate), cuspidate to mucronate (vs. acuminate) leaf blades, and fasciculate (vs. solitary) and urceolate (vs. cupuliform) flowers.

Additional specimens examined

MADAGASCAR. **Prov. Fianarantsoa:** Manombo RS, 23°00'S 47°42'E, 5.III.2009, *Hong-Wa* 614 (MO, P, TAN). **Prov. Toamasina:** Nosy Mangabe, 15°29'49"S 49°45'20"E, 0-320 m, 8.XII.1998, *Abdul-Salim et al.* 44 (MO); Maroantsetra, Anjahana, Ambanizana, 15°37'16"S 49°58'56"E, 200 m, 15.IX.2002, *Antilahimena et al.* 1392 (G, MO, P); Masoala PN, 15°38'S 49°58'E, 0-520 m, 8.XI.1999, *Aridy et al.* 316 (G, MO); Fénérive-Est, Tampolo STF, 17°17'10"S 49°25'16"E, 5 m, 15.IV.1995, *Gereau* 5720 (MO, TAN); Mahatsara STF, 17°38'18"S 49°29'07"E, 5-10 m, 24.IX.2002, *Hong-Wa et al.* 83 (MO, P, TAN, TEF); Ambila-Lemaitso, 18°54'S 49°07'E, 10 m, 17.I.1999, *Lowry* 5129 (MO, P); Forêt d'Analamazaotra, [18°55'48"S 48°25'48"E], 800 m, *Perrier de la Bâthie* 5133 (P); Brickaville, Ambinaninony, forêt de Vohibola, 18°35'33"S 49°14'05"E, 4 m, 13.II.2003, *Rabenantoandro et al.* 1267 (G, MO, P); Ambodiriana, [17°56'S 49°15'E], 250-500 m, 23.VIII.1957, *Service Forestier* 18123 (MO, P, TEF); Masoala PN, 15°38'12"S 49°58'20"E, 19.XI.1993, *van Nek* 2121 (MO, TAN, WAG). **Prov. Toliara:** Forêt de Mandena, 24°57'S 47°00'E, 10 m, 17.III.1985, *Dorr* 4012 (G, MO, P, TAN); *ibid. loc.*, 24°57'S 47°00'E, 0-10 m, 19.IV.1989, *Gereau et al.* 3394 (MO, P, TAN); Manantenina, on road to Manafiafy, 24°46'S 47°08'E, 0-10 m, 24.IV.1989, *Gereau et al.* 3421 (MO, P, TAN); Fort-Dauphin, Petriky, 25°04'S 46°51'E, 0-10 m, 10.IV.1989, *Rabevohitra et al.* 1819 (MO, P, TAN, TEF); Andohahela PN, Eminiminy, 24°40'30"S 46°48'30"E, 17.IX-30.X.1991, *Randriamanantena & Durbin* 137 (K, MO); Manambaro, Ambovo, forêt de Petriky, 25°03'57"S 46°51'18"E, 10 m, 11.II.2004, *Randriatafika et al.* 379 (MO, P, TEF); Iaboko, Antsotso, forêt d'Ivohibe, 24°33'52"S 47°14'25"E, 112 m, 26.XI.2005, *Razakamalala et al.* 2378 (G, MO, P, TAN).

7. *Noronhia brevituba* H. Perrier in Mém. Inst. Sci. Madagascar, Sér. B, Biol. Vég. 2 : 290. 1949 (Fig. 6A).

Typus: MADAGASCAR. **Prov. Toamasina:** Forêt d'Analamazaotra, [18°55'48"S 48°25'48"E], II.1912, *Perrier de la Bâthie* 8820 (holo-: P [P00573414]!; iso-: K [K000233197] image seen, P [P00573415, P00573416]!).

= *Noronhia ambrensis* H. Perrier in Mém. Inst. Sci. Madagascar, Sér. B, Biol. Vég. 2 : 297. 1949. **Lectotypus** (designated here): MADAGASCAR. **Prov. Antsiranana:** Ouest (Nord): camp d'Ambre, [12°30'S 49°14'E], 900 m, XI.1932, *Perrier de la Bâthie* 18839 (P [P00418074]!).

Description

Trees to 11 m tall, trunk to 15 cm diameter; young twigs cylindrical, 0.6-1.5 mm diameter, glabrous; bark medium to light gray, smooth, with scattered lenticels. *Leaves* opposite, persistent; bud scales rarely persistent; blades dark green above, lighter below, elliptic to obovate, 3-7.5 × 1.4-4.1 cm, chartaceous, glabrous, domatia absent, base acute to attenuate, margin flat to slightly undulate, apex cuspidate, the cusp 3-19 mm long, midrib flat above, raised below, secondary veins conspicuous mostly below, 5-10 per side, 5-16 mm apart, looping 1-4.5 mm from the margin; petiole yellow, 3-10 × 0.6-1.8 mm, not woody, glabrous. *Thyraxes* fasciculate, pauciflorous, diffuse; peduncle 5-15 mm long, glabrous; pedicel 6-30 mm long, glabrous; calyx glabrous on both sides, lobes triangular, 1-1.5 × 0.7-2 mm; corolla yellow to pale lime green, sometimes tinged orange-brown with age, campanulate to subrotate, 3.5-7.5 mm long, glabrous on both sides, the tube 0.5-2.5 mm long, lobes ovate, apex slightly acute; corona present, 1-2 mm long, undivided; stamens 1.4-3 mm long, anthers widely oblong to almost square, 0.9-1.8 mm long; pistil 1.4-2.3 mm long, stigma capitate. *Fruiting* pedicel 3-19 × 0.5-1.7 mm; young fruits green, dark red when mature ovoid, 13-16.5 × 8-13 mm, surface smooth, apex flat to apiculate; dry pericarp 0.2-0.6 mm thick; endocarp woody; seed 9-12 × 5-7.5 mm.

Distribution, ecology and phenology

Noronhia brevituba occurs in mid- to high-elevation humid forests from Montagne d'Ambre in the north to Ranomafana in the south (Fig. 3). It produces flowers and fruits from September to May.

Conservation status

The assessment was based on 28 collections representing 26 localities and yielded an EOO of 133,270 km², an AOO of 92 km², and 20 subpopulations representing 15 locations, of which 10 occur within protected areas (Analamazaotra, Anjanaharibe-Sud, Corridor Marojejy, Loky-Manambato, Makira, Manongarivo, Masoala, Montagne d'Ambre, Ranomafana, and Zahamena). Given these results and the likelihood that the AOO is much greater than the estimated 2,000 km², *N. brevituba* is assigned a preliminary status of "Least Concern".

Notes As currently circumscribed, *Noronhia brevītuba* can be recognized by its non-woody petioles, chartaceous leaf blades and short-tubed, yellowish corolla. It mainly differs from *N. linocerioides* H. Perrier by its cuspidate (vs. acuminate) leaves, campanulate (vs. sub-rotate) flowers, capitate (vs. bilobed) stigma and apiculate (vs. bluntly pointed to rostellate) fruits. These two species belong to the same clade and form a complex (HONG-WA & BESNARD, 2013, 2014), for which additional information (e.g. anatomical data) and broader molecular sampling (e.g. individuals from each population across their range) may be required to disentangle their patterns of variation and relationships.

PERRIER DE LA BATHIE (1949, 1952) distinguished *Noronhia ambrensis* H. Perrier from *N. brevītuba* based mainly on the length of the corolla tube, placing the first in the section *Noronhiae* and the latter in section *Linoceriae*. However, their range of morphological variation overlaps and material assignable to these two entities is interspersed within a single clade (HONG-WA & BESNARD, 2014), which precludes the recognition of two species. It should be noted that the accessions labeled as *N. ambrensis* on the phylogenetic tree of HONG-WA & BESNARD (2014) were incorrectly assigned a homonym, whose nomenclature is addressed later in this treatment under *N. olearia* Hong-Wa. Specimens assigned to *N. ambrensis* by PERRIER DE LA BATHIE (1949) were labeled as *N. brevītuba* in the phylogenetic tree. *Perrier de la Bathie* 18839 is chosen as the lectotype of *N. ambrensis* because it represents more complete material than the other syntype (*Richard* 192), which should be considered as an excluded syntype and is assigned to *N. olearia* (see p. 95).

Additional specimens examined

MADAGASCAR. Prov. Antananarivo: Andranofeno-Sud, forêt d'Ankafobe, 18°06'11"S 47°11'10"E, 1480 m, 14.XII.1999, *Lowry et al.* 5166 (MO, P); Anjozorobe, forêt de Saridrivotra, 18°16'S 47°54'E, 1570 m, 26.XII.2003, *Randrianaivo et al.* 1005 (CNARP, MO, P, TAN); Tampoketsa d'Ankazobe, forêt d'Antokomaro au PK 166/500 de la route de Majunga (au NO de Manerinerina), [17°57'S 47°07'E], 23.XII.1964, *Service Forestier* 24004 (G, MO, P, TEF). **Prov. Antsiranana:** Anjanaharibe-Sud RS, 10 km SW of Befingotra, 14°45'S 49°29'E, 1100-1300 m, 7.IX.1997, *Birkinshaw et al.* 487 (G, MO, P, TAN); Montagne d'Ambre PN, 12°32'19"S 49°09'32"E, 1219 m, 23.I.2009, *Hong-Wa* 579 (G, MO, P, TAN); Daraina, forêt d'Antsahabe, 13°12'37"S 49°33'27"E, 900 m, 17.I.2004, *Nusbaumer* 1023 (Daraina, G, K, MO, P, TEF); Manongarivo RS, Antsatrotro, 14°04'S 48°17'E, 1700-1846 m, 9-10.V.1993, *Rakotomalaza et al.* 79 (G, K, MO, P). **Prov. Fianarantsoa:** Ranomafana PN, 21°15'S 47°27'E, 1100 m, 11-15.XI.1991, *Malcomber et al.* 1060 (MO, P, TAN). **Prov. Mahajanga:** Befandriana Nord, Matsoandakana, Andranomena, 15°08'02"S 49°20'49"E, 1134 m, 12.II.2008, *Bernard* 789 (G, MO, P, TAN). **Prov. Toamasina:** Forêt au N de la route de Nickelville, 850 m, 29.XII.1994, *Cours* 2089, (P); Analamazaotra RS, 18°56'07"S 48°25'06"E, 910 m, 2.V.2010, *Hong-Wa & Ortiz* 638 (MO, P, TAN); Manakambahiny Est, Zahamena RNI, 17°40'34"S 48°45'31"E, 1100 m, 17.IX.2002, *Rakotondrajaona et al.* 233 (CNARP, MO, P, TEF); Ambatondradama (env. 10 km au NE d'Ankovona), Navana, 15°17'15"S, 50°01'07"E, 500 m, 1-6.X.1997, *Ralimanana et al.* 115 (G, K, MO, P, TAN); Ambatondrazaka, Antanandava, Antenina, 17°30'09"S 48°46'19"E, 917 m, 1.II.2002, *Randrianjanaka* 697 (CNARP, G, MO, P, TEF).

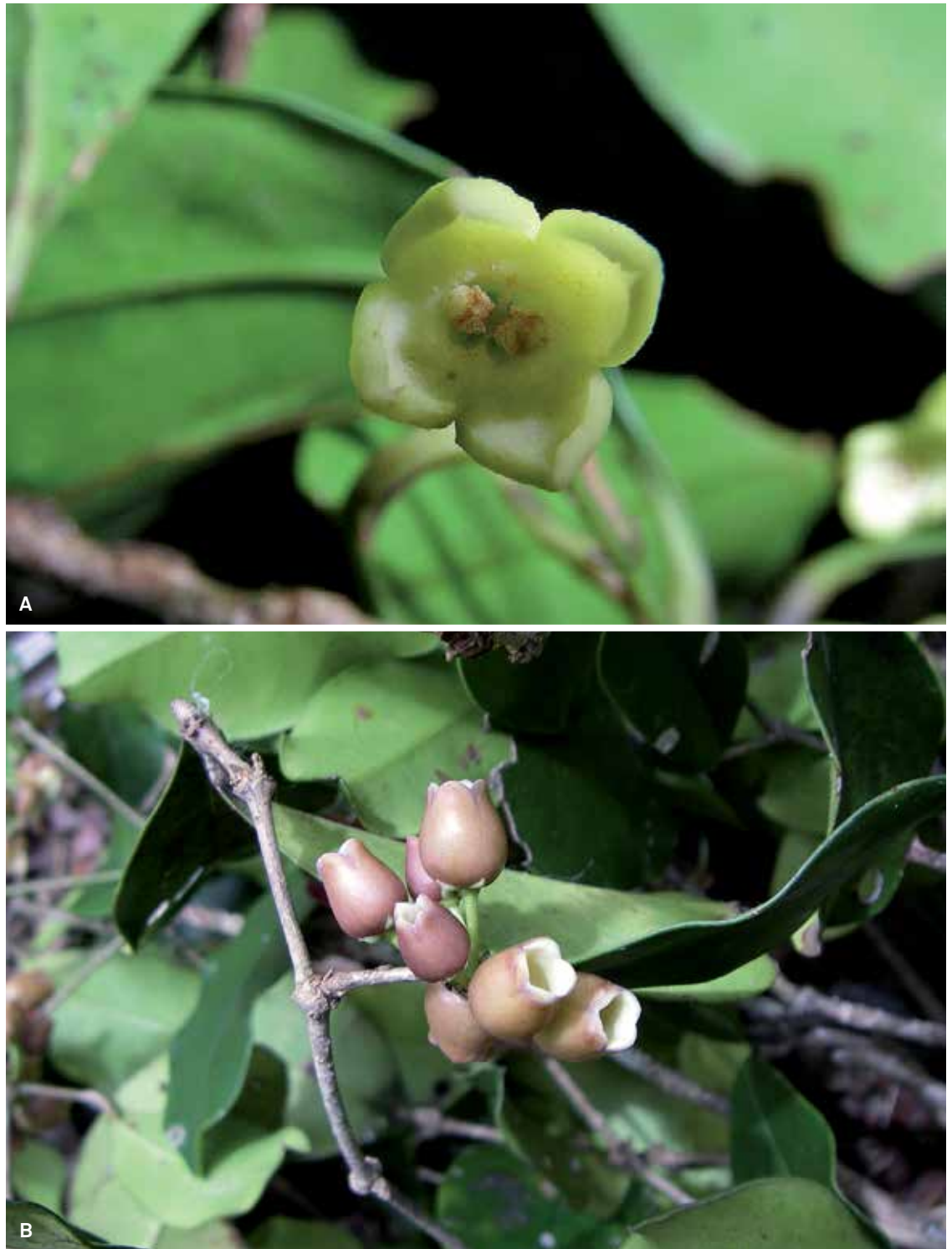


Fig. 6. Photographs of *Noronhia* Stadtm. ex Thouars.

A. *Noronhia breviflora* H. Perrier [Nusbaumer 1023]; **B.** *Noronhia candicans* H. Perrier [Ranirison 1066].

Photos: taken by respective collectors

8. *Noronhia broomeana* Horne ex Oliv. in Hooker's Icon. Pl. 14: tab. 1365. 1881.

≡ *Linociera broomeana* (Horne ex Oliv.) Knobl. in Notizbl. Bot. Gart. Berlin 11: 1028. 1934.

≡ *Chionanthus broomeana* (Horne ex Oliv.) A.J. Scott in Kew Bull. 33: 570. 1979.

Typus: MAURITIUS: Forests near Grand Bassin, [20°25'S 57°29'E], s.d., Horne s.n. (holo-: K [K000233208] image seen).

= *Linociera verrucosa* Soler. in Bot. Centralbl. 45: 399. 1891. ≡ *Mayepea verrucosa* (Soler.) Knobl. in Engler, Nat. Pflanzenfam. 4: 10. 1892. **Typus:** MAURITIUS: *sine loc.*, s.d., Sieber 125 (holo-: M [M0174392] image seen; iso-: E [E00193166] image seen, G [G00008578] image seen, K [K000233210] image seen, MO [MO2235287]!).

= *Linociera mayottensis* H. Perrier in Mém. Inst. Sci. Madagascar, Sér. B, Biol. Vég. 2: 280. 1949. ≡ *Noronhia mayottensis* (H. Perrier) Hong-Wa & Besnard in Mol. Phylogenet. Evol. 67: 376. 2013. **Typus:** MAYOTTE: *sine loc.*, between 1847 and 1852, Boivin 3196 (holo-: P [P00184542]!).

Description

Trees to 8 m tall; young twigs subquadrangular, 1.3-2.6 mm diameter, pubescent to glabrous at maturity; bark dark to medium gray, slightly rugose, with scattered lenticels. Leaves opposite, persistent; bud scales rarely persistent; blades light green to yellowish above and below, oblong, 6.5-12 × 2.5-5.5 cm, chartaceous, pubescent to glabrous at maturity, domatia casual, base acute, margin flat, apex acute to acuminate, the acumen 2-8 mm long, midrib flat above and distinctly raised below, secondary veins conspicuous, 8-10 per side, 8-17 mm apart, looping 2-6 mm from the margin; petiole yellowish to reddish, 6-13 × 1-1.5 mm, not woody, glabrous. Thyrses fasciculate, multiflorous, compact; peduncle 5-18 mm long, densely pubescent; pedicel 1-4 mm long, densely pubescent; calyx densely pubescent outside, glabrous inside, lobes triangular, 1.5 × 1.2-1.5 mm; corolla white, rotate, petals almost free, 5-6 mm long, glabrous on both sides, the tube 1 mm long, lobes oblong, apex obtuse; corona absent; stamens 3.5-3.8 mm long, anthers elongate, apiculate, 2.8 mm long; pistil 2.6 mm long, stigma bilobed. Fruiting pedicel 3-4 × 1.5-2 mm; young fruits green, dark brown when mature, ovoid, 22 × 9 mm, surface ribbed, apex rostellate, the rostellum flattened, ridged, apiculate; dry pericarp 0.4 mm thick; endocarp woody; seed 18 × 7 mm.

Distribution, ecology and phenology

Noronhia broomeana occurs in low- to mid-elevation forests in Mascarene (Réunion and Mauritius) islands (Fig. 3) and possibly also in the Comoro islands (see notes). It produces flowers and fruits from November to March.

Conservation status *Noronhia broomeana* has not been evaluated using the IUCN criteria in the Comoros and is assigned a preliminary status of “Not Evaluated”, although it appears to have a restricted distribution there and is very likely threatened. It is also possible that the species has been extirpated from the Comoros since it is known only there from a single collection made more than 150 years ago or that it has never occurred there, as discussed below. It has been evaluated as “Endangered” in Mauritius (HONG-WA et al., 2014) and as “Vulnerable” in Réunion (UICN-FRANCE et al., 2010).

Notes *Noronhia broomeana* can be recognized by its chartaceous, somewhat pubescent leaf blades, white flowers with almost free petals, and slightly ribbed fruits. *Noronhia mayottensis* (H. Perrier) Hong-Wa & Besnard, a doubtful species from the Comoros described and recognized by PERRIER DE LA BATHIE (1949, 1952) as *Chionanthus* (ex *Linociera*) *mayottensis*, is here included within *Noronhia broomeana*, which extends the range of the latter to this archipelago. Although *N. mayottensis* was accepted earlier (HONG-WA & BESNARD, 2013), this actually resulted from a systematic transfer of all names in *Chionanthus* to *Noronhia* for species from Africa and the Indian Ocean Islands based on phylogenetic results that found them to be embedded within *Noronhia* (HONG-WA & BESNARD, 2013). The study of *N. broomeana* in Mauritius (HONG-WA et al., 2014) along with the examination of other material from Réunion allows the inclusion of *N. mayottensis* within this group. To my knowledge, no other collection assignable to *N. mayottensis* is available from the Comoros, raising the question as to whether Boivin actually collected it there. In any case, the morphological characteristics of this specimen fit well with those of *N. broomeana* across its geographic range.

Additional specimens examined MAURITIUS: s.d., Bouton s.n. (MAU); Rivulet Bois Beau, near Rivière des Anguilles, 193 m, 20°27'57"S 57°33'25"E, 17.V.2010, V. Florens & Baider CB 2367 (MAU); Bassin Blanc, 550 m, 25.V.1976, Richardson 4165 (K, MAU). RÉUNION: Ile Bourbon, 1848, Boivin 1209 (P); Cirque de Hellbourg, Le Bélier, Sentier d'Aurère, 31.X.1972, Bosser 21444 (P); Dos d'Ane, 650 m, II.1972, Friedmann 1608 (P); Grand Coude, 900 m, III.1972, Friedmann 1652 (P); Grande Chaloupe, 400 m, XI.1972, Friedmann 1950 (P); Salazie, 1200 m, XII.1972, Friedmann 2028 (P); Mare Longue, St. Philippe, III.1974, Friedmann 2316 (MO, P); Cape Noire (Mafate), 10.III.1977, Friedmann 3079 (P); Mare Longue, St. Phillippe, 200 m, 16.XI.1966, Schlieben 10943 (MO); Dos d'Ane, 9.XI.1968, Service Forestier 28246 (P).

9. *Noronhia buxifolia* H. Perrier in Mém. Inst. Sci. Madagascar, Sér. B, Biol. Vég. 2: 302. 1949.

Typus: MADAGASCAR. **Prov. Toliara:** Forêt d'Analavelona (bassin du Fihirenana), [22°41'S 44°08'E], 1000-1200 m, 15-19.XII.1946, *Humbert 19719* (holo-: P [P00418069]!; iso-: LISC [LISC002881] image seen, P [P00418070]!, S [S09-36002] image seen, WAG [WAG0002490] image seen).

= *Noronhia buxifolia* var. *quadriloba* H. Perrier in Mém. Inst. Sci. Madagascar, Sér. B, Biol. Vég. 2: 302. 1949. **Typus:** MADAGASCAR. **Prov. Toliara:** E d'Ampandrandava, [24°05'S 45°42'E], 1200 m, XI.1943, *Seyrig 373* (= *Herb. Jard. Bot.* 5390) (holo-: P [P04046973]!; iso-: [P00701282]!).

Description

Trees to 15 m tall, trunk to 15 cm diameter; young twigs cylindrical, 0.7-1.5 mm diameter, glabrous; bark medium gray to yellowish, smooth to slightly rugose. *Leaves* opposite, persistent; bud scales persistent; blades dark green above, lighter below, ovate, 4-8.5 × 1.5-3.5 cm, coriaceous, glabrous, domatia absent, base rounded to acute, margin flat to slightly revolute and undulate, apex acuminate, the acumen 3-11 mm long, midrib flat to slightly sunken above, raised below, secondary veins conspicuous, 6-10 per side, 4.5-11 mm apart, looping 1-4 mm from the margin; petiole light gray, 3-9 × 1-1.5 mm, entirely woody, glabrous. *Flowers* fasciculate; pedicel 2.5-21 mm long, glabrous; calyx very sparsely pubescent outside, glabrous inside, lobes triangular, 0.8-3 × 0.7-2.5 mm; corolla red, urceolate, 2.5-9 mm long, glabrous on both sides, the tube 0.5-6 mm long, lobes triangular, apex obtuse; corona present, (0-)1-2 mm long, undivided to slightly 4-lobed; stamens 1.2-2.8 mm long, anthers obconical to orbicular, 0.7-1.9 mm long; pistil 1.2-2.7 mm long, stigma capitate. *Fruiting* pedicel 3-15 × 0.6-1.3 mm; young fruits green, dark red when mature, ovoid, 12-14.5 × 9.5-11.5 mm, surface smooth, apex apiculate to flat, with the persistent style; dry pericarp 0.5-0.7 mm thick; endocarp woody; seed 8.5-10.5 × 6.5-10 mm.

Distribution, ecology and phenology

Noronhia buxifolia occurs in low- to high-elevation dry forests from Antsalova in the west to Andohahela in the south (Fig. 3). It produces flowers and fruits from November to June.

Conservation status

Based on 21 collections representing 15 localities, the assessment indicated an EOO of 96,461 km², an AOO of 60 km² (although the true AOO is probably larger than 2,000 km²), and 11 subpopulations representing 10 locations, of which seven occur within protected areas (Amoron'i Onilahy, Analavelona, Andohahela, Behara-Tranomavo, Bemaraha, Corridor Parcel I-II Andohahela, and Menabe-Antanimena). Therefore, *N. buxifolia* is assigned a preliminary status of "Near Threatened".

Notes *Noronhia buxifolia* can be recognized by its ovate, acuminate leaf blades and fasciculate, long-pedicellate red flowers. It differs from *N. tefyana* Hong-Wa by its ovate (vs. broadly lanceolate) leaves and its urceolate (vs. cupuliform) and red (vs. pinkish tinged green) flowers. PERRIER DE LA BÂTHIE (1949, 1952) distinguished the variety *N. buxifolia* var. *quadriloba* H. Perrier based on differences in leaf, corolla and corona size and the margin of the corona. These differences, however, are only part of the range of variations within this species and do not justify the recognition of a distinct entity below the species level or at any other rank. Therefore, the variety *N. buxifolia* var. *quadriloba* is placed in synonymy.

**Additional specimens
examined**

MADAGASCAR. Prov. Mahajanga: Tsingy de Bemaraha N of Manambolo river, 19°09'S 44°49'E, 50 m, 28.XI.1996, *Jongkind et al.* 3262 (MO, TAN, WAG); Besaraha, [18°41'13"S 44°15'11"E], 0-20 m, 18.XII.1952, *Leandri et al.* 2257 (G, MO, P); Antsalova, [18°13'S 44°35'E], 150-750 m, 11.I.1959, *Réserves Naturelles 10210* (G, MO, P, TEF). **Prov. Toliara:** Morondava, forêt de Marosalaza, [20°02'S 44°33'E], 9.VI.1974, *Abraham* 79 (MO, P); Sakaraha, Mahaboboka, Marotsiraka-Betsileo, 22°38'36"S 44°10'17"E, 1285 m, 7.XI.2007, *Andriamihajarivo et al.* 1485 (MO, P, TAN); Ampandrandava, [24°05'S 45°42'E], 1200 m, XI.1943, *Herb. Jard. Bot. Tan.* 5390 (P); Forêt d'Analavelona (bassin du Fiherenana), [22°41'S 44°08'E], 1000-1200 m, 15-19.XII.1946, *Humbert 19754bis* (P); Massif de l'Andohahela et abords, au N de Imonty (RN XI), [24°49'S 46°41'E], 400-1900 m, 3.XII.1960, *Leandri & Saboureau* 4218 (P); Haut bassin de la Mananara et abords (SE), [24°46'S 46°43'E], 400-1900 m, 3.XII.1960, *Leandri & Saboureau* 4437 (G, MO, P); Forêt d'Analavelona, près d'Antanimena, 22°40'42"S 44°11'30"E, 1050 m, 12.III.1998, *Messmer* 597 (G, MO); Andranohinaly, [23°16'30"S 43°58'30"E], 20.VIII.1960, *Peltier* 2570 (P); Forêt d'Analavelona, près de la source de la rivière Manasay, 22°36'50"S 44°08'00"E, 1000-1348 m, 7.XI.2000, *Randriatafika* 220 (G, MO, P); *ibid. loc.*, *Randriatafika* 228 (G, MO); Analavelona, [22°36'50"S 44°08'00"E], 800-1348 m, 10.XII.1955, *Service Forestier* 15578 (P, TEF).

10. *Noronhia candicans* H. Perrier in Mém. Inst. Sci. Madagascar, Sér. B, Biol. Vég. 2 : 301. 1949 (Fig. 6B).

Lectotypus (designated here) : **MADAGASCAR. Prov. Mahajanga** : Bassin moyen du Bemarivo (Boina), [15°27'S 47°40'E], IX.1902, *Perrier de la Bâthie* 8829 (P [P00418071] !; isolecto- : P [P00418072] !). **Syntypus** : Bassin moyen du Bemarivo (Boina), [15°27'S 47°40'E], 500 m, IX.1902, *Perrier de la Bâthie* 8828 (P [P00418073] !).

Description *Shrubs* to small trees to 5 m tall, trunk to 10 cm diameter; young twigs cylindrical, 0.7-1.8 mm diameter, glabrous; bark medium gray, smooth to slightly rugose. *Leaves* opposite, persistent; bud scales persistent; blades dark green above, lighter below, oblong to broadly elliptic, 4-12 × 1.6-5.2 cm, very coriaceous, glabrous, domatia absent, base acute to truncate, margin flat to slightly undulate, apex acute to acuminate, the acumen 1-16 mm long, midrib sunken above, distinctly raised below, secondary veins barely visible, 7-12 per side, 5-15 mm apart, looping 1-6 mm from the margin; petiole medium to light gray, 3-10 × 1.1-2.7 mm, entirely woody, glabrous. *Flowers* fasciculate; pedicel 3-20 mm long, sparsely pubescent; calyx sparsely pubescent outside, glabrous inside, lobes triangular, 2-2.6 × 1.5-2 mm; corolla purplish brown, urceolate, 4.5-7 mm long, glabrous on both sides, the tube 3-5 mm long, lobes widely ovate, apex obtuse; corona present, 1.2-1.7 mm long, undivided; stamens 1.8-2 mm long, anthers oblong, 1.3-1.8 mm long; pistil 2.2-2.5 mm long, stigma capitate. *Fruiting* pedicel 4-25 × 1-1.5 mm; young fruits green, reddish when mature, ovoid, 10-17.5 × 6-10 mm, surface smooth, apex apiculate to rostellate, the rostellum flattened, rounded, style persistent; dry pericarp 0.3-1.3 mm thick; endocarp woody; seed 7.5-10.5 × 5-6 mm.

Distribution, ecology and phenology *Noronhia candicans* occurs in low- to mid-elevation dry forests from Montagne des Français and Daraina in the north to Sofia in the west (Fig. 3). It produces flowers and fruits from September to March.

Conservation status There were 28 collections representing 21 localities available for analysis, which resulted in an EOO of 27,250 km², an AOO of 68 km², and 14 subpopulations representing 10 locations, of which seven occur within protected areas (Andava-koera-Andrafiarena-Ambohipiraka, Ankarana, Loky-Manambato, and Montagne d'Ambre). The actual AOO is likely larger but would not exceed 2,000 km². In addition, the locations that are not encompassed within protected areas are affected by fire, land conversion, and illegal and/or artisanal mining resulting in habitat degradation and loss and reduction in the number of mature individuals. Therefore, *N. candicans* is assigned a preliminary status of "Vulnerable" [VU B1ab(i,ii,iii,iv,v)+2ab(i,ii,iii,iv,v)].

Notes *Noronhia candicans* can be recognized by its very coriaceous, oblong to elliptic leaf blades, with barely visible venation and its fasciculate, purplish-brown flowers. It differs from *N. crassinodis* H. Perrier by its oblong to elliptic (vs. ovate) leaf blades with an acute to acuminate (vs. mucronulate) apex, barely visible (vs. conspicuous) venation, and purplish brown (vs. reddish) flowers. This species was described based on two syntypes, *Perrier de la Bâthie* 8828 and 8829, of which a specimen of the latter was chosen as the lectotype as it has more reproductive organs.

Additional specimens examined

MADAGASCAR. Prov. Antsiranana: Ankarana RS, 12°54'43"S 49°06'39"E, 180 m, 19.II.1994, *Andrianarisata* 45 (MO, P); *ibid. loc.*, 12°54'36"S 49°06'25"E, 130 m, 16.X.1997, *Bardot-Vaucoulon* 775 (K, MO, P, TAN); *ibid. loc.*, tsingy close to Campement des Anglais, 12°50'47"S 49°06'18"E, 82 m, 25.V.1999, *De Block* 1013 (BR, MO, P, TAN); *ibid. loc.*, from Campement des Anglais towards Campement des Américains, 12°50'47"S 49°06'18"E, 82 m, 13.I.2002, *De Block* 1193 (BR, G, MO, P, TAN); Andrafiarena, Anjahankely, 12°55'00"S 49°20'25"E, 390 m, 27.XII.2010, *Burivalova et al.* 140 (G, MO); Daraina, forêt d'Antsahabe, 13°12'58"S 49°32'55"E, 830 m, 4.XII.2004, *Gautier* 4825 (Daraina, G, K, MO, TEF); Andrafiarena, Anjahankely, 12°54'46"S 49°19'37"E, 410 m, 10.XI.2010, *Gautier & Ranirison* 5382 (G, MO); Marivorahona, Betsimiranja, 12°56'27"S 49°07'21"E, 136 m, 18.I.2009, *Hong-Wa* 566 (MO, P, TAN); Sakaramy, Montagne d'Ambre PN, 12°26'41"S 49°13'45"E, 367 m, 30.V.2010, *Hong-Wa* 699 (MO, P, TAN); Andrafiabe, Mont Antsahabe, 12°54'50"S 49°19'41"E, 408 m, 3.VII.2010, *Hong-Wa* 723 (MO, TAN); Ankarana RS, near Campement des Anglais, 12°54'42"S 49°06'42"E, 240-260 m, 22.V.1993, *Jongkind & Rapanarivo* 964 (MO, P, TAN); Tanambao-Marivorahona, 13°02'54"S 49°09'30"E, 154 m, 4.VII.2005, *Leopold et al.* 119 (CNARP, G, MO, P, TAN); Daraina, forêt de Bekaraoka, 13°06'32"S 49°42'28"E, 216 m, 12.II.2004, *Nusbaumer & Ranirison* 1154 (Daraina, G, K, MO, TEF); *ibid. loc.*, Andranovaka, Ankijomantsina, 13°07'56"S 49°28'20"E, 75 m, 29.X.2005, *Rakotonandrasana et al.* 946 (CNARP, G, MO, P, TAN); *ibid. loc.*, forêt de Binara, 13°14'14"S 49°37'19"E, 310 m, 28.III.2004, *Ranirison* 506 (Daraina, G, K, MO, P, TEF); *ibid. loc.*, forêt d'Ambohitsitondroina, 13°07'56"S 49°28'08"E, 165 m, 7.I.2006, *Ranirison & Nusbaumer* 1057 (Daraina, G, K, MO, TEF); *ibid. loc.*, 13°08'19"S 49°27'58"E, 200 m, 8.I.2006, *Ranirison & Nusbaumer* 1066 (Daraina, G, K, MO, P, TEF); Analabe, [14°03'S 49°43'E], 200 m, 13.IX.1955, *Service Forestier* 15497 (TEF). **Prov. Mahajanga:** Antsohihy, Antonibe, Anjajavy, 15°01'26"S 47°15'34"E, 24 m, 19.VIII.2007, *Rasoafaranaivo et al.* 251 (MO, P, TAN).

11. *Noronhia capuronii* Bosser in *Adansonia* ser. 2, 13: 464. 1973 (Fig. 2D).

Typus: MADAGASCAR. **Prov. Antsiranana:** rive droite de la rivière des Makis, en aval de la traversée de cette rivière par la piste Joffreville-Andranofanjava, [12°30'S 49°05'E], 21.XI.1958, *Service Forestier* 20072 (holo-: P [P00413211]!; iso-: K [K000233198] image seen, P [P00413218, P00413219]!).

Description

Shrubs to 3 m tall, trunk to 2.5 cm in diam.; young twigs cylindrical, 0.7-1.3 mm diameter, glabrous; bark medium gray, smooth to slightly rugose. *Leaves* opposite, persistent; bud scales, rarely persistent; blades medium green above, lighter below, ovate, 5-15 × 1-4 cm, chartaceous, glabrous, domatia absent, base cordate, margin flat to slightly undulate, apex acuminate, the acumen 7-25 mm long, midrib flat to slightly sunken above, flat to raised below, secondary veins conspicuous, 7-12 per side, 7-14 mm apart, looping 1.5-5 mm from the margin; petiole light gray, 3-8 × 0.8-1.9 mm, entirely woody, pubescent. *Thyrse*s geminate to fasciculate, pauciflorous, diffuse; peduncle 3-8 mm long, moderately pubescent; pedicel 8-12 mm long, moderately pubescent; calyx moderately pubescent outside, glabrous inside, lobes ovate, 1.3 × 1.5 mm; corolla greenish tinged orange to reddish outside, yellowish inside, cupuliform, 6 mm long, glabrous on both sides, the tube 4 mm long, lobes ovate, apex obtuse; corona absent; stamens 3.5 mm long, anthers obovate, 2.5 mm long; pistil 2.5 mm long, stigma capitate to slightly bilobed. *Fruiting* pedicel 8-13 × 1-2 mm; young fruits yellowish, beige to purple when mature, globose, 15-23 × 15-23 mm, surface smooth, apex flat, style persistent; dry pericarp 0.2-2.6 mm thick; endocarp crustaceous; seed 12 × 13-15 mm.

Distribution, ecology and phenology

Noronhia capuronii occurs in low- to mid-elevation dry forests in the north, from Montagne des Français to Ankarana and Daraina (Fig. 3). It produces flowers and fruits from October to June.

Conservation status

With 14 collections representing 14 localities, the assessment resulted in an EOO of 4,885 km², an AOO of 52 km², and 12 subpopulations representing seven locations, of which five occur within protected areas (Ankarana, Loky-Manambato, Montagne d'Ambre, and Montagne des Français). *Noronhia capuronii* is assigned a preliminary status of "Vulnerable" [VU B1ab(i,ii,iii,iv,v)+2ab(i,ii,iii,iv,v)], due to continuing decline in AOO, number of both locations and mature individuals, and in habitat quality resulting from deforestation, charcoal production, and illegal and/or artisanal mining.

Notes

Noronhia capuronii can be recognized by its chartaceous, cordate leaf blades, pubescent petiole and midvein, thyrseoid inflorescences with green-orangish flowers and subglobose fruits. It differs from *N. jeremii* Hong-Wa & Callm. and *N. richardii* Hong-Wa by

its ovate (vs. linear to oblong in *N. jeremii* and lanceolate to oblong in *N. richardii*) leaf blades, pubescent (vs. glabrous) inflorescences and greenish tinged orange (vs. yellowish and red, respectively) flowers.

**Additional specimens
examined**

MADAGASCAR. Prov. Antsiranana: Mosorolava, Mahagaga, 12°45'43"S 49°01'48"E, 124 m, 22.IX.2007, *Andriamihajarivo et al.* 1375 (G, MO, P, TAN); Matsaborimanga, Ankarana RS, 12°55'S 49°03'E, 140 m, 11.I.2003, *Bardot-Vaucoulon* 1149 (K, MO, P, TAN); *ibid. loc.*, from Campement des Anglais towards Campement des Américains, 12°50'47"S 49°06'18"E, 82 m, 13.I.2002, *De Block* 1203 (BR, MO, NY, P, TAN, UPS, WAG); Daraina, forêt de Bobankora, 13°13'26"S 49°45'30"E, 120 m, 4.III.2003, *Gautier et al.* 4213 (Daraina, G, K, MO, P, TEF); Station des Roussettes à Ankazobe, [12°26'S 49°13'E], X. 1944, *Homolle* 140 (P); Sakaramy, Montagne d'Ambre PN, 12°26'25"S 49°13'49"E, 319 m, 2.VI.2010, *Hong-Wa* 706 (MO, P, TAN); Daraina, 13°12'S 49°46'E, 200 m, 18.XII.1989, *McPherson* 14693 (K, MO, P, TAN); Montagne d'Ambre PN, 12°29'11"S 49°10'15"E, 690 m, 20.XII.2011, *Ramandimbimanana* 194 (G, MO, TAN); Daraina, forêt de Bobankora, 13°12'28"S 49°46'23"E, 65 m, 16.XII.2007, *Randrianaivo et al.* 1532 (CNARP, G, MO, P, TAN); *ibid. loc.*, Ankarafa, Antsahabe Nord, 13°13'02"S 49°33'51"E, 550 m, 6.XI.2006, *S. Randrianasolo et al.* 572 (CNARP, G, MO, P, TAN); *ibid. loc.*, Ankijabe, forêt d'Ambohitsitondroina, 13°08'17"S 49°28'18"E, 200 m, 20.I.2006, *Ranirison & Nusbaumer* 1101 (Daraina, G, K, MO, TEF); Montagne des Français, [12°22'S 49°21'E], 24.IX.1980, *Service Forestier* 29959 (TEF); Montagne d'Ambre PN, 12°29'14"S 49°10'20"E, 650 m, 4.VI.2008, *Trigui et al.* 536 (G, MO, TEF); *ibid. loc.*, 12°29'03"S 49°10'03"E, 660 m, 13.X.1993, *van Nèk* 1874 (MO, P, TAN, WAG).



Fig. 7. Photographs of *Noronhia* Stadtm. ex Thouars. **A.** *Noronhia christenseniana* Hong-Wa [Ratovoson 1280]; **B.** *Noronhia clarinerva* Hong-Wa [Nusbaumer 821]; **C.** *Noronhia cochleata* Labat, M. Pignal & O. Pascal [Labat 3258]; **D.** *Noronhia comorensis* S. Moore [Barthelat 537]; **E.** *Noronhia cordifolia* (Labat, M. Pignal & O. Pascal) Hong-Wa & Besnard [Barthelat 788].

Photos : taken by respective collectors [© C, D, E : Muséum National d'Histoire Naturelle, Paris. Reproduced with permission]

12. *Noronhia christenseniana* Hong-Wa, *spec. nova* (Fig. 7A, 8).

Typus: MADAGASCAR. **Prov. Antsiranana:** DIANA, Diégo II, Ramena, env. 2 km à l'W d'Andavakoera, près de la grotte et du campement la Casa Aventura, 12°19'41"S 49°20'26"E, 76 m, 3.VIII.2007, Hong-Wa *et al.* 517 (holo-: MO-6615555!; iso-: CNARP!, G [G00341618]!, K!, P!, TAN!).

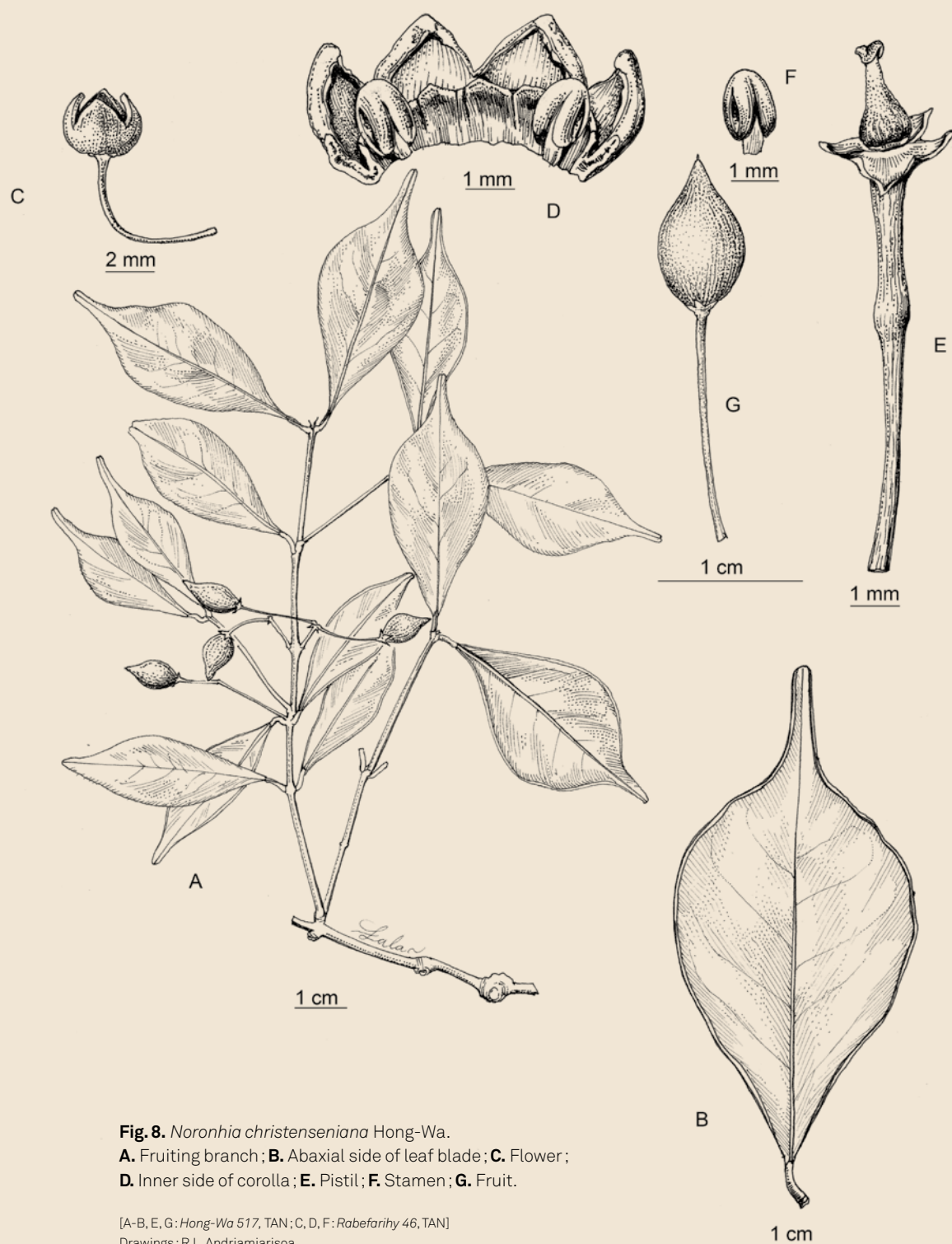
Diagnosis *Noronhia christenseniana* Hong-Wa can be distinguished from other members of the genus by its widely obovate to rhombic leaf blades, distinctly terminated by a long cusp and its diffuse inflorescences with red flowers.

Description Shrubs or trees to 10 m tall, trunk to 15 cm diameter; young twigs cylindrical, 0.7-1.2 mm diameter, glabrous; bark medium gray, smooth. *Leaves* opposite, persistent; bud scales deciduous; blades medium green above, lighter below, broadly obovate to rhombic, 3.5-7.5 × 1.5-4.5 cm, coriaceous, glabrous, domatia casual, base attenuate, margin flat to undulate, slightly revolute, apex cuspidate, the cusp 10-20 mm long, midrib slightly sunken above, distinctly raised below, secondary veins conspicuous only below, 6-10 per side, 4-9 mm apart, looping 1-3.2 mm from the margin; petiole light gray, 4-6 × 0.6-1.3 mm, entirely woody, glabrous. *Thyrses* solitary to geminate, pauciflorous, diffuse; peduncle 12-20 mm long, glabrous; pedicel 4-8 mm long, glabrous; calyx glabrous on both sides, lobes triangular, 1 × 1-2 mm; corolla red, urceolate, 2.5-4 mm long, glabrous on both sides, the tube 1.8-2 mm long, lobes deltate, apex acute; corona present, 0.8-1.5 mm long, slightly lobed; stamens 1.5-1.8 mm long, anthers oblong, 1.2 mm long; pistil 1.8-2 mm long, stigma bilobed. *Fruiting* pedicel 8-18 × 0.5-1 mm; young fruits green, purplish brown when mature, ovoid, 9-15.5 × 7.5-9 mm, surface smooth, apex apiculate to rostellate, the rostellum flattened, truncate, with the persistent style; dry pericarp 0.4-0.8 mm thick; endocarp crustaceous; seed 8-10 × 4-5.5 mm.

Etymology This name honors the founders of the Christensen Fund Graduate Fellowship Program in Plant Conservation, which provided me with support during my graduate studies at the University of Missouri-St. Louis, thus allowing me to carry out a comprehensive study of *Noronhia*.

Distribution, ecology and phenology *Noronhia christenseniana* occurs in low-elevation semi-deciduous forests in the north, from Montagne des Français to Ankarana (Fig. 9). It produces flowers and fruits from August to March.

Conservation status Based on 18 collections representing 13 localities, the assessment resulted in an EOO of 4,069 km², an AOO of 48 km², and seven subpopulations representing six locations, of which three occurs within the network of protected areas (Ankarana, Loky-Manam-



bato, and Montagne des Français). *Noronhia christenseniana* is narrowly distributed (although with an actual AOO that is likely larger than estimated here) in an area that is affected by deforestation, wood harvesting, charcoal production, and illegal and/or artisanal mining, resulting in habitat degradation and loss. It is therefore assigned a preliminary status of “Vulnerable” [VU B1ab(i,ii,iii,iv,v)+2ab(i,ii,iii,iv,v)].

Notes *Noronhia christenseniana* is in some ways similar to *N. clarinerva* Hong-Wa and *N. intermedia* Hong-Wa, but can be distinguished by its thyrsoid inflorescences (vs. fasciculate flowers), red corolla (vs. pinkish in *N. clarinerva* and pale green in *N. intermedia*) and crustaceous (vs. woody) endocarp. Distinctive features such as the widely obovate to rhombic leaf blades with a long cuspidate apex and diffuse inflorescences with red flowers make it easy to recognize *N. christenseniana*.

Paratypes **MADAGASCAR. Prov. Antsiranana:** Mahamasina, Ankarana RS, 12°56'56"S 49°07'39"E, 22.III.2007, *Bardot-Vaucoulon & Toly* 1528 (K, MO, P, TAN); Ramena, Andavakoera, 12°19'57"S 49°21'19"E, 172 m, 4.VIII.2007, *Hong-Wa et al.* 538 (TAN); *ibid. loc.*, *Hong-Wa et al.* 539 (TAN); Ankarana RS, [12°49'S 49°01'E], I.1969, *Morat* 3046 (P); Daraina, forêt d'Antsaharaingy, 12°54'52"S 49°39'25"E, 75-660 m, 3.III.2004, *Nusbaumer & Ranirison* 1533 (Daraina, G, K, MO, P); Antafiankoroka, Montagne des Français, 12°22'27"S 49°21'27"E, 204 m, 4.II.2005, *Rabefarihy* 46 (MO, P, TAN); Ampitiliantsambo, Montagne des Français, 12°22'55"S 49°23'05"E, 359 m, 25.I.2005, *Randrianarivelo et al.* 167 (MO, P, TAN); Daraina, forêt de Binara, 13°14'16"S 49°37'32"E, 250 m, 27.III.2004, *Ranirison* 500 (Daraina, G, K, MO, P, TEF); *ibid. loc.*, forêt d'Antsaharaingy, 12°54'34"S 49°39'57"E, 90 m, 18.IV.2004, *Ranirison* 691 (Daraina, G, K, MO, TEF); Andrafiabe, Mont Andrahona, 3 km au NE d'Andrafiabe, 12°28'49"S 49°26'56"E, 400 m, 31.I.2005, *Ratovoson et al.* 830 (CNARP, MO, P, TAN); Montagne des Français, forêt d'Antaolanaomby, 12°22'25"S 49°21'11"E, 385 m, 22.III.2007, *Ratovoson* 1280 (CNARP, G, MO, P, TAN); Mosorolava, Ampombiantambo, forêt d'Antsoroby, 12°42'13"S 48°58'12"E, 75 m, 23.IX.2007, *Ratovoson et al.* 1331 (CNARP, G, MO, P, TAN); Montagne des Français, Andavakoera, 12°21'10"S 49°21'06"E, 94 m, 12.VIII.2004, *Razafitsalama et al.* 606 (CNARP, MO, P, TAN); Ankarana RS, [12°49'S 49°01'E], 8.VIII.1952, *Service Forestier* 5419 (P, TEF); Montagne des Français, [12°22'S 49°21'E], 7.VIII.1978, *Service Forestier* 29260 (TEF); *ibid. loc.*, 12.XI.1979, *Service Forestier* 29597 (TEF); *ibid. loc.*, *Service Forestier* 29600 (TEF); *ibid. loc.*, 24.IX.1980, *Service Forestier* 29969 (TEF).



Fig. 9. Distribution maps of species of *Noronhia* Stadtm. ex Thouars. *N. christenseniana* Dubard to *N. domatifera* Bosser.

13. *Noronhia clarinerva* Hong-Wa, *spec. nova* (Fig. 7B, 10).

Typus: MADAGASCAR. **Prov. Antsiranana:** DIANA, Diégo II, Sakaramy, Montagne d'Ambre AP, 12°26'25"S 49°13'49"E, 319 m, 2.VI.2010, Hong-Wa 708 (holo-: MO-6400693!; iso-: P!, TAN!).

Diagnosis *Noronhia clarinerva* Hong-Wa can be distinguished from its congeners by its oblong to rhombic, coriaceous leaf blades, its light-colored venation and its fasciculate pinkish flowers.

Description Shrubs to 5 m tall, trunk to 3 cm diameter; young twigs cylindrical, 0.8-1.4 mm diameter, glabrous; bark whitish, smooth. Leaves opposite, persistent; bud scales persistent only on very young twigs; blades medium green above, lighter below, oblong to rhombic, $4.5\text{--}7.5 \times 1\text{--}2.5$ cm, coriaceous, glabrous, domatia absent, base acute, margin flat to slightly undulate, apex acuminate, the acumen 2-16 mm long, midrib sunken above, raised below, secondary veins conspicuous mostly below, 7-12 per side, 5-10 mm apart, looping 1-2 mm from the margin; petiole light gray to whitish, $3.5\text{--}7 \times 1\text{--}2.5$ mm, entirely woody, glabrous. Flowers fasciculate; pedicel 3-4 mm long, glabrous; calyx moderately pubescent outside, glabrous inside, lobes deltate, 2×1.5 mm; corolla pinkish, urceolate, 4.5 mm long, glabrous on both sides, the tube 3.5 mm long, lobes widely ovate, apex obtuse to acute; corona present, 1.7 mm long, undivided; stamens 2 mm long, anthers oblong, 1.8 mm long; pistil 2.5 mm long, stigma slightly bilobed. Fruiting pedicel $5\text{--}11 \times 0.8\text{--}1.6$ mm; young fruits green, brown when mature, ovoid, $10\text{--}13.5 \times 6.5\text{--}9$ mm, surface smooth, apex apiculate; dry pericarp 0.4-0.7 mm thick; endocarp woody.

Etymology *Noronhia clarinerva* has distinctively light-colored veins, which are almost white on dry specimens, thus the name of the species.

Distribution, ecology and phenology *Noronhia clarinerva* occurs in low- to mid-elevation dry forests in the north, from Montagne d'Ambre to Daraina (Fig. 9). It produces flowers and fruits from December to June.

Conservation status *Noronhia clarinerva* is currently known from nine collections representing eight localities, which are encompassed within an EOO of 1,066 km², an AOO of 28 km², and four subpopulations representing four locations. All but one location occur entirely within protected areas (Loky-Manambato and Montagne d'Ambre) whereas the fourth sits just at the border of Montagne d'Ambre PN, with some individuals actually found outside of it. With the gradual encroachment for crop cultivation, wood harvesting, illegal logging, and cattle grazing already taking place there, this



Fig. 10. *Noronhia clarinerva* Hong-Wa.

A. Fruiting branch; **B.** Abaxial side of leaf blade; **C.** Flower; **D.** Inner side of corolla; **E.** Stamen; **F.** Fruit.

[Hong-Wa 708, TAN] Drawings: R.L. Andriamiarisoa

location is susceptible to decline in habitat quality and loss of mature individuals in the near future. Therefore, *N. clarinerva* is assigned a preliminary status of “Endangered” [EN B1ab(iii,v)+2ab(iii,v)].

Notes *Noronhia clarinerva* closely resembles *N. crassinodis*, but differs by lacking bud scales at maturity and by having lighter-colored and more conspicuous venation, oblong to rhombic (vs. obovate), acuminate (vs. mucronulate) leaf blades, and pinkish (vs. red purplish) flowers.

Paratypes **MADAGASCAR. Prov. Antsiranana:** Daraina, Ankijabe, forêt de Bekaraoka, 13°10'02"S 49°42'38"E, 150 m, 15.III.2003, *Gautier et al.* 4386 (Daraina, G, K, MO, P, TEF); Montagne d'Ambre PN, 12°29'22"S 49°10'16"E, 670 m, 8.XII.2006, *Gautier & Chatelain* 5084 (G, K, MO, P, TAN, TEF); *ibid. loc.*, 12°25'40"S 49°13'56"E, 300 m, 29.V.2010, *Hong-Wa* 694 (MO, P, TAN); *ibid. loc.*, 12°26'40"S 49°13'56"E, 300 m, 29.V.2010, *Hong-Wa* 696 (MO, TAN); *ibid. loc.*, 12°26'28"S 49°13'58"E, 331 m, 1.VI.2010, *Hong-Wa* 704 (MO, P, TAN); Analamazava, part of Binara Range, SW of Daraina, 13°15'S 49°38'E, 200-1180 m, 20.IV.1990, *Meyers* 98 (G, MO, P, TAN); Daraina, forêt de Binara, 13°15'21"S 49°37'00"E, 340 m, 18.XII.2003, *Nusbaumer* 821 (Daraina, G, K, MO, TAN); Montagne d'Ambre, 12°29'16"S 49°10'21"E, 650 m, 4.VI.2008, *Trigui et al.* 535 (G, MO, TEF).

14. *Noronhia cochleata* Labat, M. Pignal & O. Pascal in Novon 9: 66. 1999 (Fig. 7C).

Typus: MAYOTTE: Mlima Combani, [12°50'S 45°10'E], 28.XII.1995, *Pascal* 281 (holo-: P [P00075025]!; iso-: K [K000691509] image seen, MO-5203140!, P [P00075026, P00075027]!).

Description

Trees to 15 m tall, trunk to 15 cm diameter; young twigs cylindrical, 0.6-2.3 mm diameter, glabrous; bark medium gray, smooth. *Leaves* opposite, persistent; bud scales deciduous; blades medium green above, lighter below, oblong to elliptic, 6-12 × 2-4 cm, chartaceous, glabrous, domatia common, base acute to attenuate, margin flat to slightly undulate, apex acuminate, the acumen 6-15 mm long, midrib flat to slightly sunken above, raised below, secondary veins conspicuous, 8-13 per side, 4-18 mm apart, looping 1.5-4 mm from the margin; petiole yellow, 5-12 × 0.7-2.4 mm, not woody or only partially, glabrous. *Thyrse*s geminate to fasciculate, pauciflorous, diffuse; peduncle 6-8 mm long, moderately pubescent; pedicel 1.5-9 mm long, moderately pubescent; calyx moderately pubescent outside, glabrous inside, lobes deltate, 0.5-1.2 × 0.8-1.4 mm; corolla pinkish outside, white inside, cupuliform to subrotate, 3-5.5 mm long, glabrous on both sides, the tube 1-3 mm long, lobes oblong to ovate, apex apiculate; corona present, 1-1.5 mm long, undivided; stamens 1.2-2 mm long, anthers oblong, 0.9-1.3 mm long; pistil 1.3-2 mm long, stigma capitate. *Fruiting* pedicel 3-10 × 0.8-1.2 mm; young fruits green, purplish black when mature, ovoid, 14-17 × 8-11 mm, surface smooth, covered with white dots, apex rostellate, the rostellum circular, rounded, with the persistent style; dry pericarp 0.3-0.5 mm thick; endocarp woody; seed 11.5-12 × 5-6 mm.

Distribution, ecology and phenology

Noronhia cochleata occurs in low- to mid-elevation humid forests on Mayotte in the Comoro Islands (Fig. 9). It produces flowers and fruits from September to April.

Conservation status

The assessment was based on 15 collections representing 13 localities and indicated an EOO of just 161 km², an AOO of 40 km², and five subpopulations representing five locations, of which four are encompassed within protected areas (Réserves forestières de Benara, des Crêtes du Sud, de Majimbini et de Songoro Mbili). Subpopulations of *N. cochleata* will likely experience continuing decline in habitat quality and habit loss due to land conversion, therefore the species is assigned a preliminary status of “Endangered” [EN B1ab(i,ii,iii,iv,v)+2ab(i,ii,iii,iv,v)].

Notes

Noronhia cochleata can be recognized by its non-woody petioles, oblong to elliptic leaf blades bearing domatia, diffuse inflorescences and distinctly rostellate fruits. It differs mostly from *N. comorensis* by its non-woody (vs. woody) petioles, thyrsoïd inflorescences (vs. fasciculate flowers), and pinkish-white (vs. yellow tinged reddish) corolla.

**Additional specimens
examined**

MAYOTTE: Grande Terre, Chiconi, réserve forestière de Sohoa, 21.XII.2000, *Barthelat* 148 (G, K, MO, P); Mamoudzou, Ilot Bouzi, 14.III.2001, *Barthelat* 327 (G, K, MO, P); Bandrele, Contreforts du Choungui kely, 17.IX.2001, *Barthelat* 503 (G, K, MO, P); Mamoudzou, La Convalescence, Réserve forestière de Majimbini, 12.I.2002, *Barthelat* 684 (G, K, MO, P); *ibid. loc.*, Mlima M'Tsapéré, 12°46'10"S 45°11'26"E, 300-400 m, 19.XI.2000, *Labat* 3258 (B, G, K, MO, P, WAG); Combani, base du Mlima Combani, 12°48'27"S 45°09'13"E, 20.XI.2000, *Labat* 3261 (K, MO, P); Réserve forestière du Benara, sommet du Bepilipli, 12°52'46"S 45°09'19"E, 550 m, 29.XI.2000, *Labat* 3308 (BR, G, K, MO, P); Sommet du Mlima Choungi, 12°57'20"S 45°07'55"E, 500-640 m, 1.XII.2000, *Labat* 3339 (G, K, MO, P, PRE); Shungui, 13.XI.1990, *Ménager* 15 (MO, P); Mlima Choungi, [12°57'S 45°07'E], 16.XI.1995, *Pascal* 205 (G, K, MO, P, WAG); Sohoa, 30.XI.1995, *Pascal* 257 (MO, P); *ibid. loc.*, 12°50'S 45°08'E, 160 m, 14.III.1996, *Pascal* 418 (MO, P); Dapani, 150 m, 7.I.1997, *Pascal* 857 (K, MO, WAG); Sazile Be, 12°58'39"S 45°12'01"E, 116.IV.1999, *Pignal* 1112 (MO, P).

15. *Noronhia comorensis* S. Moore in J. Bot. 58: 189. 1920 (Fig. 7D).

Typus: MAYOTTE: Forêt de Combani, [12°45'S 45°08'E], 3.XI.1884, *Humblot* 1376 (holo-: P [P00184551]!; iso-: BM [BM000021591] image seen, K [K000233196] image seen, P [P00184552, P00184553]!).

Description

Trees to 10 m tall, trunk to 10 cm diameter; young twigs cylindrical, 0.6-1.6 mm diameter, glabrous; bark light gray, smooth to slightly rugose. *Leaves* opposite, persistent; bud scales persistent; blades medium green above, lighter below, oblong to elliptic, sometimes obovate, 6.5-14 × 2-6 cm, chartaceous, glabrous, domatia absent, base acute to attenuate, margin flat to slightly undulate, apex acuminate, the acumen 6-20 mm long, midrib flat above, slightly raised below, secondary veins conspicuous, 8-12 per side, 7-17 mm apart, looping 1.5-4 mm from the margin; petiole medium to light gray, 3-7 × 1-1.8 mm, entirely woody, glabrous. *Flowers* fasciculate; pedicel 5-16 mm long, glabrous; calyx sparsely pubescent outside, glabrous inside, lobes triangular, 1-2 × 1-2.2 mm; corolla yellow tinged reddish, cupuliform, 5-7 mm long, glabrous on both side, the tube 3.5-6 mm long, lobes widely ovate, apex obtuse; corona present, 1.8-2.3 mm long, undivided; stamens 2-3.2 mm long, anthers widely obovate, 1.5-2.6 mm long; pistil 2-3 mm long, stigma capitate. *Fruiting* pedicel 7-23 × 0.8-1.6 mm; young fruits green, dark brown when mature, ovoid, 10-16 × 8-10 mm, surface smooth, apex rostellate, the rostellum flattened, rounded, with the persistent style; dry pericarp 0.2-0.4 mm thick; endocarp woody; seed 8.5-12 × 4-7 mm.

Distribution, ecology and phenology

Noronhia comorensis occurs in low- to mid-elevation humid forests in the Comoro Islands (Anjouan, Grande Comore, Mayotte, and Moheli) (Fig. 9). It produces flowers and fruits from September to May.

Conservation status

Based on 15 collections representing eight localities, the assessment provided an EOO of 966 km², an AOO of 32 km², and seven subpopulations representing seven locations, of which three occur within protected areas (Réserves forestières de Benara, des Crêtes du Nord et de Majimbini). A decline in EOO and AOO as well as in habitat quality will very likely occur due to land conversion affecting the subpopulations in Anjouan, Grande Comore and Moheli, which are not encompassed within protected areas. Therefore, *N. comorensis* is assigned a preliminary status of "Vulnerable" [VU B1ab(i,ii,iii,iv,v)+2ab(i,ii, iii,iv,v)].

Notes

Noronhia comorensis can be recognized by its chartaceous, oblong to elliptic leaf blades, fasciculate, yellow flowers, and distinctly rostellate fruits. It differs from *N. cochleata* by the features mentioned under that species.

**Additional specimens
examined**

COMOROS: Anjouan (Ndzouani), 1 km E of Lingoni, 200-200 m, 14.IX.1991, *Attoumane* 13 (MO); Anjouan (Ndzouani), *Lavanchie s.n.* (P); Grande Comore (Ngazidja), Iconi, 11°43'48"S 43°14'03"E, 27 m, 23.V.2006, *Labat* 3677 (K, MO, P); Moheli (Mwali), piste du Bajo au sommet du M'Ze, 12.XI.1970, *Jacquemin* 860J (P); Miringoni, Mdawnyombe Chalet Saint-Antoine, 12°17'18"S 43°39'51"E, 688 m, 29.V.2006, *Labat et al.* 3729 (K, MO, P). MAYOTTE: Chinconi, Grande Terre, Coconi, 5.II.2001, *Barthelat & M'Changama* 282 (G, MO, P); Dembeni, Réserve forestière de Benara, 7.IX.2001, *Barthelat* 486 (G, K, MO, P); Chembenyoumba, Hachirongou, 9.X.2001, *Barthelat* 537 (G, K, MO, P); Mamoudzou, La Convalescence, Réserve forestière de Majimbini, 11.I.2002, *Barthelat & Sifary* 673 (G, K, MO, P); *ibid. loc.*, 11.I.2002, *Barthelat & Sifary* 675 (G, K, MO, P); *ibid. loc.*, Réserve de Majimbini, Mlima M'Tsapere, 12°46'10"S 45°11'26"E, 300-400 m, 19.XI.2000, *Labat* 3257 (G, K, MO, P); *ibid. loc.*, 23.XI.2000, *Labat* 3281 (G, K, MO, P); Piste de Convalescence, 11.XII.1990, *Ménager* 552 (MO, P); Hachiroungou, [12°43'S 45°04'E], 450 m, 16.IV.1996, *Pascal* 507 (MO, P); Convalescence, 400 m, 18.IX.1996, *Pascal* 666 (BR, G, MO, NY, P, WAG).

16. *Noronhia cordifolia* (Labat, M. Pignal & O. Pascal) Hong-Wa & Besnard in Mol. Phylogenet. Evol. 67: 376. 2013 (Fig. 7E).

≡ *Chionanthus cordifolius* Labat, M. Pignal & O. Pascal in Novon 9: 68. 1999.

Typus: MAYOTTE: Mlima Choungi, [12°57'S 45°07'E], 29.XII.1995, *Pascal* 288 (holo-: P [P00075021]!; iso-: K [K000691510] image seen).

Description *Trees* to 6 m tall; young twigs 1-2.2 mm diameter, glabrous; bark medium gray, slightly rugose. *Leaves* opposite, persistent; blades dark green above, lighter below, ovate, 4.5-9 × 2-3.5 cm, coriaceous, glabrous, domatia absent, base truncate to cordate, margin flat, apex acuminate, the acumen 3-7 mm long, midrib flat above, flat to slightly raised below, secondary veins conspicuous, 8-10 per side, 6-14 mm apart, looping 1-3 mm from the margin; petiole medium gray to brownish, 0.8-5 × 1-2.3 mm, usually entirely woody, glabrous. *Thyrse*s geminate, pauciflorous, diffuse; peduncle 3-8 mm long, glabrous; pedicel 4-12 mm long, glabrous; calyx lobes ovate, 0.7-0.9 × 0.7-1 mm, glabrous on both sides; corolla yellow, subrotate to cupuliform, 2.2-2.5 mm long, glabrous on both sides, the tube 1.2-1.3 mm long; corona absent; stamens 1.8-1.9 mm long; pistil 1.6-1.8 mm long. *Fruiting* pedicel 5-7 × 1.5-2 mm; young fruits green, unseen mature, ovoid, 16.5-23 × 13.5-18 mm, surface smooth, apex flat to bluntly pointed, style persistent; dry pericarp 0.8 mm thick; endocarp woody; seed 10.7 × 10.3 mm.

Distribution, ecology and phenology *Noronhia cordifolia* occurs in mid-elevation humid forest in northwestern Madagascar and on Mayotte in the Comoro Islands (Fig. 9). It produces flowers and fruits from November to March.

Conservation status With only four collections representing two localities, the EOO cannot be calculated. However, it was estimated to have an AOO of 8 km² and two subpopulations representing two locations, of which only one occurs within a protected area (Réserve forestière des Crêtes du Sud, Mayotte). The subpopulation found in Madagascar is currently known only from three collections made in the 1950s-1960s in an area located between Manongarivo RS and Tsaratanana RNI in heavily degraded habitat. Therefore, *N. cordifolia* is assigned a preliminary status of "Endangered" [EN B2ab(iii)].

Notes *Noronhia cordifolia* can be recognized by its short-petiolate leaves, cordate to truncate leaf base, and diffuse inflorescences. It differs mainly from *N. boivinii* by its ovate (vs. oblong to elliptic), acuminate (vs. cuspidate to mucronate) leaf blades, thyrsoid inflorescences (vs. fasciculate flowers), and subrotate (vs. urceolate to

campanulate), yellowish (vs. pink to reddish) corolla, and by the absence (vs. presence) of a corona. This species was previously known only from the Comoro Islands (Mayotte). The Malagasy specimens are somewhat different from the type by having slightly shorter petioles that are seldom woody as well as relatively longer inflorescences. They may actually represent a distinct entity but exhaustive comparison with the Comorian specimens is currently unfeasible since the former include only fruits and the latter only flowers. Therefore, a broad *N. cordifolia* is retained here to accommodate this range of variations, pending additional material, from which molecular data could also be obtained.

**Additional specimens
examined**

MAYOTTE: Grande Terre, sommet du Mt Choungi, [12°57'20"S 45°07'55"E], 21.III.2002, *Barthelat & Labarthe* 788 (P). MADAGASCAR. Prov. Antsiranana: DIANA, Ambanja, Beankany, [14°04'S 48°42'E], 12.XII.1963, *Rakotozafy* 337 (P, TAN); *ibid. loc.*, 23.VI.1950, *Réserves Naturelles* 38 (TAN); *ibid. loc.*, *Saboureau* 41 (P).

17. *Noronhia coriacea* Hong-Wa, **spec. nova** (Fig. 11).

Typus: MADAGASCAR. **Prov. Toliara:** Anosy, Andohahela (parcel 3), Ankazofotsy, 25°01'S 46°38'E, 15.V.2001, *Randriamampionona* 1004 (holo-: MO-6615574!; iso-: BR!, G [G00341630]!, K!, MO-6616000!, P [P03533041]!, TAN!, US!, WAG!).

Diagnosis *Noronhia coriacea* Hong-Wa can be distinguished from other members of the genus by its white bark, its thick, coriaceous, shiny leaf blades and its ovoid and smooth fruits.

Description Trees to 6 m tall; young twigs flattened, 1.3-1.5 mm diameter, glabrous; bark whitish, smooth to rugose. Leaves opposite, persistent; bud scales rarely persistent; blades glossy green almost silvery above, dull green to yellowish below, oblanceolate to obovate, 6.5-9 × 1.8-2.2 cm, coriaceous, glabrous, domatia absent, base acute to attenuate, margin slightly revolute, apex retuse to rounded, midrib slightly sunken above, distinctly raised above, secondary veins inconspicuous, 9-11 per side, 7-10 mm apart, looping 1-2 mm from the margin; petiole whitish, 6-9 × 1.5-1.7 mm, entirely woody, glabrous. Flowers unseen, but infructescence thyrsoid. Fruiting pedicel 5-7 × 0.9-1.3 mm; young fruits green, unseen mature, ovoid, 11.5-11.8 × 9-10 mm, smooth, apex flat to bluntly pointed, ridged, style persistent; dry pericarp 1.2-1.5 mm thick; endocarp woody; seed 7-7.5 × 4-4.5 mm.

Distribution, ecology and phenology *Noronhia coriacea* occurs in low elevation transitional forest on basement rocks at Andohahela in the south (Fig. 9). It has been collected in fruits in May.

Conservation status With just a single collection known from a restricted forest (Andohahela Parcel 3), *N. coriacea* has an AOO of just 4 km² and one subpopulation, representing a single location. Despite its occurrence within a protected area (Andohahela), which theoretically provides protection, this species may nonetheless experience a decline in habitat quality in the near future due to the close proximity of the subpopulation to a national road (less than 100 m away), where forest clearance can be observed. Therefore, *N. coriacea* is assigned a preliminary status of "Vulnerable" [VU D2].

Notes *Noronhia coriacea* is somewhat similar to *N. retusifolia* Hong-Wa, but can be distinguished by having only opposite leaves (vs. opposite to verticillate at the tips of the branches), by the absence (vs. presence) of domatia on the abaxial surface of the leaf blades, and by having smooth (vs. rugose) fruits. The new species can be recognized by its white bark, thick, coriaceous, shiny leaf blades, and ovoid and smooth fruits.

Fig. 11. *Noronhia coriacea* Hong-Wa.
A. Fruiting branch; **B.** Abaxial side of leaf blade;
C. Adaxial side of leaf blade; **D.** Fruit.

[*Randriamampionona* 1004, MO] Drawings: R.L. Andriamiarisoa



18. *Noronhia crassinodis* H. Perrier in Mém. Inst. Sci. Madagascar, Sér. B, Biol. Vég. 2: 301. 1949 (Fig. 12A).

Typus: MADAGASCAR. **Prov. Antsiranana:** Ouest-Nord, près de Diégo-Suarez, Sakaramy, [12°26'S 49°16'E], 400-500 m, IX.1926, *Perrier de la Bâthie* 17673 (holo-: P [P00418100]!).

Description *Shrubs* to small trees to 7 m tall, trunk to 8 cm diameter; young twigs cylindrical, 0.7-1.8 mm diameter, glabrous; bark medium gray, smooth to rugose, with scattered lenticels. *Leaves* opposite, persistent; bud scales persistent; blades yellowish green, obovate, 3.5-6.5 × 1.5-4.5 cm, very coriaceous, glabrous, domatia absent, base acute to attenuate, margin flat to undulate, apex mucronulate, the mucro 2-9 mm long, midrib sunken above, flat to raised below, secondary veins conspicuous mostly below, 7-12 per side, 4-9 mm apart, looping 1-4 mm from the margin; petiole medium gray, 3.5-7 × 1-2.5 mm, entirely woody, glabrous. *Flowers* fasciculate; pedicel 8-20 mm long, glabrescent; calyx moderately pubescent outside, glabrous inside, lobes triangular, 2-2.5 × 1.5-2 mm; corolla red purplish, urceolate, 5.5-7 mm long, glabrous on both sides, the tube 5 mm long, lobes oblong, apex obtuse; corona present, 1.3-1.8 mm long, undivided; stamens 2-2.2 mm long, anthers oblong, 1.5-1.9 mm long; pistil 1.5-2.5 mm long, stigma capitate. *Fruiting* pedicel 3.5-13 × 1-2.5 mm; young fruits greenish, reddish-yellowish when mature, ovoid, 10.5-14 × 5-12.5 mm, covered with white dots, apex flat to bluntly pointed, style persistent; dry pericarp 0.6-0.8 mm thick; endocarp woody; seed 6-7.5 × 4.3-4.7 mm.

Distribution, ecology and phenology *Noronhia crassinodis* occurs in low- to mid-elevation dry forests in the north, from Montagne des Français to Ankarana and Daraina (Fig. 9). It produces flowers and fruits throughout the year.

Conservation status The assessment was based on 16 collections representing 16 localities and yielded an EOO of 3,849 km², an AOO of 52 km², and 12 subpopulations representing 10 locations, of which six occur within protected areas (Andavakoera-Andrafiarana-Ambohipiraka, Ankarana, Loky-Manambato, Montagne d'Ambre, and Montagne des Français). Decline in habitat quality as well as loss of habitat and mature individuals resulting from land conversion, charcoal production and illegal and/or artisanal mining are expected outside of protected areas. Therefore, *N. crassinodis* is assigned a preliminary status of "Vulnerable" [VU B1ab(i,ii,iii,iv,v)+2ab(i,ii,iii,iv,v)].

Notes *Noronhia crassinodis* can be recognized by its thick nodes often with rigid bud scales, very coriaceous, obovate leaf blades terminated by a short mucro, fasciculate, red-purplish flowers, and punctate fruits. It differs from *N. candicans* and *N. clarinerva* by the

features already discussed under these species, and differs from *N. intermedia* by its obovate (vs. obovate to obtrullate), mucronulate (vs. acuminate) leaves, red-purplish (vs. pale green) flowers, and punctate (vs. smooth to rugose) fruits.

**Additional specimens
examined**

MADAGASCAR. Prov. Antsiranana: Marotaolana, Ankarana RS, forêt du Mahoro Analamisakana, 12°49'32"S 49°15'08"E, 6.XI.1997, *Bardot-Vaucoulon & Andrianantoanina* 929 (K, MO, P, TAN); Tanambao-Marivorahona, 13°02'34"S 49°09'14"E, 45 m, 2.VII.2005, *Guittou et al.* 150 (CNARP, MO, P, TAN); Andranovondronina, Antsisikala, forêt d'Ankatokobe, 12°10'33"S 49°12'58"E, 50 m, 18.V.2005, *Leopold et al.* 66 (CNARP, G, MO, P, TAN); Ramena, Andavakoera, Montagne des Français, 12°21'01"S 49°21'32"E, 115 m, 11.IX.2004, *Rabefarihy & Guittou* 20 (MO, P, TAN); Vohémar, Tsaratanana, forêt d'Ampondrabe, 12°58'18"S 49°41'57"E, 200 m, 4.XI.2005, *Rakotonandrasana et al.* 954 (CNARP, G, MO, P, TAN); Ampitiliantsambo, 15 km à l'E d'Andranomanitra, 12°23'18"S 49°22'57"E, 233 m, 14.VI.2004, *Ramananjahary et al.* 20 (CNARP, G, MO, P, TAN); Montagne d'Ambre PN, 12°28'34"S 49°10'51"E, 682 m, 18.XII.2011, *Ramandimbimanana et al.* 175 (G, MO, P, TEF); Ampitiliantsambo, Montagne des Français, 12°23'13"S 49°22'53"E, 239 m, 11.IX.2004, *Randriambololomamonjy et al.* 9 (MO, P, TAN); Mahamasina, Ankarana RS, 12°58'S 49°08'E, 50 m, 15.VI.1995, *Razafimandimbison & Andrianantoanina* 96 (K, MO, P, TAN).



Fig. 12. Photographs of *Noronhia* Stadtm. ex Thouars. **A.** *Noronhia crassinodis* H. Perrier [Ramandimbimananana 175]; **B.** *Noronhia crassiramosa* H. Perrier [Rasoazanany et al. 326]; **C.** *Noronhia cuspidata* Hong-Wa [Hong-Wa 643]; **D.** *Noronhia divaricata* Scott-Elliot [Rakotovao 5500].

Photos : taken by respective collectors

19. *Noronhia crassiramosa* H. Perrier in Mém. Inst. Sci. Madagascar, Sér. B, Biol. Vég. 2: 296. 1949 (Fig. 12B).

Typus: MADAGASCAR. **Prov. Toamasina:** Est Centre, forêt d'Analamazaotra, [18°56'S 48°26'E], s.d., *Perrier de la Bâthie* 5085 (holo-: P [P00418098] !; iso-: P [P00418099] !).

Description

Trees to 25 m tall, trunk to 25 cm diameter; young twigs cylindrical to subquadrangular, 4-8 mm diameter, glabrous; bark medium gray, smooth to slightly rugose. *Leaves* opposite, verticillate at the tips of the branches, persistent; bud scales persistent; blades dark green above, lighter below, oblong, 13-38 × 3.5-12 cm, very coriaceous, glabrous, domatia absent, base acute to rounded, margin flat, apex acuminate, the acumen 1-14 mm long, midrib slightly sunken above, distinctly raised below, secondary veins very conspicuous below, 8-14 per side, 14-51 mm apart, looping 3-13 mm from the margin; petiole medium gray to brownish, 9-22 × 3-5.5 mm, entirely woody, glabrous. *Thyrse*s fasciculate, pauciflorous, diffuse; peduncle 8-25 mm long, glabrous; pedicel 6-10 mm long, glabrous; calyx glabrous on both sides, lobes deltate, 3-4 × 2-2.5 mm; corolla purplish red, cupuliform to subrotate, 5-6 mm long, glabrous on both sides, the tube 2-3 mm long, lobes widely ovate, apex acute; corona present, 2-3 mm long, undivided; stamens 3 mm long, anthers oblong, 2 mm long; pistil 2.5-3 mm long, stigma slightly bilobed. *Fruiting* pedicel 5-14 × 3-4 mm; young fruits green, reddish when mature, subglobose, 21-30 × 16.5-21.5 mm, surface smooth, apex flat to apiculate; dry pericarp 2-2.5 mm thick; endocarp woody; seed 14-22.5 × 9.5-14 mm.

Distribution, ecology and phenology

Noronhia crassiramosa occurs in mid- to high-elevation humid forests in the central east, from Analamazaotra to Ranomafana (Fig. 9). It produces flowers and fruits from October to March.

Conservation status

There were 11 collections representing nine localities available for analysis, which resulted in an EOO of 5,024 km², an AOO of 32 km², and six subpopulations representing five locations, four of which occur within protected areas (Analamazaotra, Corridor Ankeniheny-Zahamena, Mantadia, and Ranomafana). Subpopulations outside of protected areas are very likely to experience continuing decline in habitat quality as well as habitat loss resulting from wood harvesting, forest exploitation, slash-and-burn cultivation and industrial mining, thereby reducing also the number of mature individuals. Therefore, *N. crassiramosa* is assigned a preliminary status of "Vulnerable" [VU B1ab(i,ii,iii,iv,v)+2ab(i,ii,iii,iv,v)].

Notes *Noronhia crassiramosa* can be recognized by its thick twigs, large, coriaceous leaf blades with very conspicuous venation, and its fruits with thick pericarp. It differs from *N. patricei* Hong-Wa by its opposite to verticillate at the tips of the branches (vs. entirely verticillate), oblong (vs. lanceolate) leaves, and apiculate (vs. flat) fruit apex. This species seems to reproduce only at a later age and appears to be rare.

Additional specimens examined **MADAGASCAR. Prov. Fianarantsoa:** Ranomafana PN, Vatoharanana, Parcelle 3, 21°16'06"S 47°25'30"E, 923 m, 8.V.2010, *Hong-Wa & Ortiz* 669 (MO, P, TAN); *ibid. loc.*, 21°15'S 47°27'E, 900 m, 8-14.XI.1991, *Malcomber et al.* 1007 (G, MO, P, TAN). **Prov. Toamasina:** Moramanga, Ambatovy, 18°48'42"S 48°20'40"E, 1141 m, 27.VII.2008, *Antilahimena et al.* 6403 (MO, P, TAN); *ibid. loc.*, 18°50'25"S 48°18'16"E, 1090 m, 15.V.2010, *Bernard et al.* 1569 (MO, P, TAN); Analamazaotra RS, 18°56'12"S 48°25'09"E, 953 m, 2.V.2010, *Hong-Wa & Ortiz* 640 (MO, P, TAN); Andasibe, Analamay, 18°47'54"S 48°20'3"E, 1030 m, 1.XII.2010, *Mian-drimanana* 473 (MO, P, TAN); Ambatovy, Amboasary, 18°57'13"S 48°26'43"E, 1008 m, *Rasoazanany et al.* 326 (MO, P, TAN); Brickaville, Ankerana, 18°25'52"S 48°47'23"E, 842 m, 26.III.2011, *Ravelonarivo* 3892 (G, MO, P, TAN); Saharefina, Périnet, [18°56'S 48°26'E], 19.II.1955, *Service Forestier* 15015 (P, TEF).

20. *Noronhia cuspidata* Hong-Wa, spec. nova (Fig. 12C, 13).

Typus: MADAGASCAR. **Prov. Toamasina:** Alaotra-Mangoro, Zahamena PN, Antanan-dava, sur la piste entre Ankosy et Antenina, 17°29'03"S 48°44'48"E, 900 m, 13.VII.2000, *Rakotondrajaona et al.* 126 (holo-: MO-6615563!; iso-: CNARP, G [G00341624]!, K, P [P03559027]!, TEF).

Diagnosis *Noronhia cuspidata* Hong-Wa can be distinguished from other species of this genus by the presence of domatia on its stems, its reddish petioles, its broadly elliptic leaf blades terminated by a short cusp and its subcrustaceous, ovoid fruits.

Description Trees to 16 m tall, trunk to 20 cm diameter; young twigs cylindrical, 1-2 mm diameter, glabrous; bark medium gray, smooth. Leaves opposite, persistent; bud scales deciduous; blades medium green above, lighter below, broadly elliptic, 6-11 × 3-5 cm, subcoriaceous, glabrous, domatia casual, present also on stems, base attenuate, margin flat, apex cuspidate, the cusp 7-14 mm long, midrib slightly sunken above, distinctly raised below, secondary veins conspicuous, 8-12 per side, 6-16 mm apart, looping 2-4 mm from the margin; petiole red, 5-9 × 1-2.7 mm, rarely woody, glabrous. Flowers unseen, but infructescence thyrsoid. Fruiting pedicel 3-12 × 1.2-2.7 mm; young fruits green, purplish green when mature, ovoid, 17.5-23 × 14.5-19 mm, surface smooth, apex bluntly pointed; dry pericarp 0.6-1 mm thick; endocarp subcrustaceous; seed 12.5-16 × 7-14.5 mm.

Etymology A cuspidate leaf blade is one of the prominent features of this species, from which its name was derived.

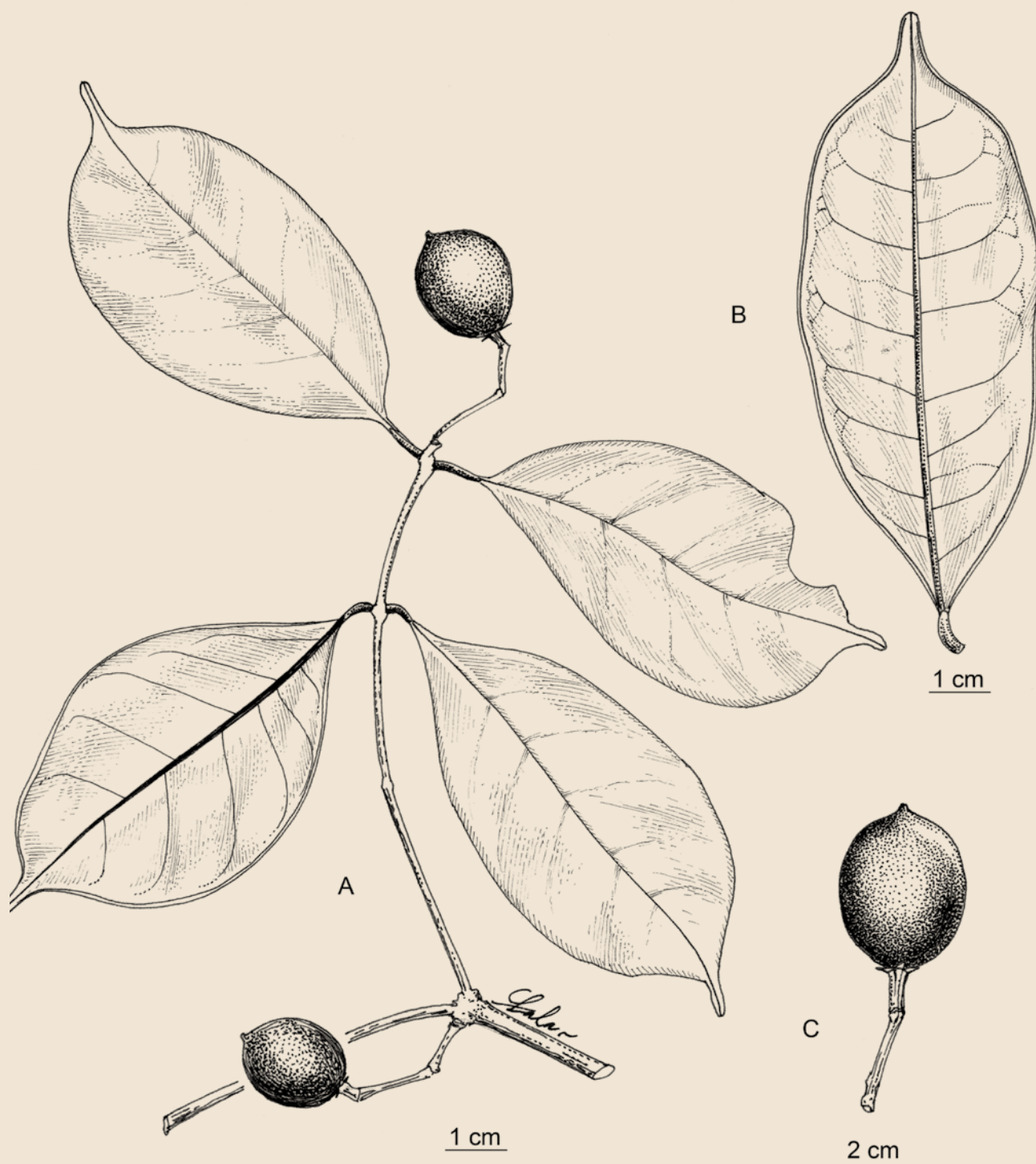
Distribution, ecology and phenology *Noronhia cuspidata* occurs in low- to high-elevation humid forests on basement rocks in the east, from Mangoro to Zahamena (Fig. 9). It fruits from July to October.

Conservation status *Noronhia cuspidata* is currently known only from three collections representing three localities. With an EOO of 6,658 km², an AOO of 12 km², and three subpopulations representing three locations, all of which occur within protected areas (Analamazaotra, Masoala, and Zahamena) where rapid continuing decline is not expected in the near future, *N. cuspidata* is assigned a preliminary status of "Least Concern".

Notes *Noronhia cuspidata* is similar to *N. decaryana* H. Perrier, but can be distinguished by its broadly elliptic (vs. oblong to elliptic) leaf blades, often covered with domatia (vs. rarely so) on the lower surface, and its subcrustaceous (vs. crustaceous) endo-

Fig. 13. *Noronhia cuspidata* Hong-Wa. **A.** Fruiting branch; **B.** Abaxial side of leaf blade; **C.** Fruit.

[*Ralimanana* 123, MO] Drawings: R.L. Andriamiarisoa



carp. Distinctive features of this new species include the presence of domatia on its stems, as well as its reddish petioles, broadly elliptic leaf blades terminated by a short cusp, and subcrustaceous, ovoid fruits.

Paratypes **MADAGASCAR. Prov. Toamasina:** Andasibe, Analamazaotra RS, 18°56'12"S 48°25'09"E, 953 m, 2.V.2010, *Hong-Wa & Ortiz* 643 (MO, P, TAN); Ambatondradama (env. 10 km au NE d'Ankovona), Navana, 15°17'08"S, 50°01'14"E, 400 m, 1-6.X.1997, *Ralimanana et al.* 123 (G, K, MO, P, TAN).

21. *Noronhia dauphinensis* Hong-Wa, spec. nova (Fig. 14).

Typus: MADAGASCAR. **Prov. Toliara:** Anosy, Fort-Dauphin, Iaboko, Antsotso, forêt Ivohibe, 24°33'52"S 47°14'25"E, 112 m, 26.XI.2005, Razakamalala et al. 2380 (holo-: MO-6615557!; iso-: G [G00341620]!, P [P06490461]!, TAN!).

Diagnosis *Noronhia dauphinensis* Hong-Wa can be distinguished from other congeneric species by its distichous, oblong to elliptic leaf blades subtended by a short petiole and its compact inflorescences.

Description Small trees to 8 m tall, trunk to 8 cm diameter; young twigs cylindrical to somewhat flattened, 1.2-1.7 mm diameter, glabrous; bark medium gray to brownish, smooth. Leaves opposite, persistent; bud scales deciduous; blades dark green above, lighter below, oblong to elliptic or lanceolate, 6-12.5 × 2.5-7 cm, coriaceous, glabrous, domatia absent, base rounded to acute, margin slightly revolute, apex acuminate, the acumen 3-7 mm long, midrib sunken above, raised below, secondary veins conspicuous, 8-12 per side, 10-20 mm apart, looping 1.5-4 mm from the margin; petiole medium gray to brownish, 2-7 × 1.5-3 mm, entirely woody, glabrous. Thyrses geminate, multiflorous, compact; peduncle 1-3 mm long, moderately pubescent; pedicel 1.5-3 mm long, moderately pubescent; calyx sparsely pubescent outside, glabrous inside, lobes triangular, 0.7-1 × 0.9-1.4 mm; corolla white, cupuliform, 3.5-4.2 mm long, glabrous on both sides, the tube 1.5-3 mm long, lobes oblong, apex obtuse; corona present, 1.2-1.5 mm long, undivided; stamens 1.2-1.7 mm long, anthers oblong, 0.9-1.2 mm long; pistil 1.3-1.8 mm long, stigma slightly bilobed. Fruiting pedicel 5-6 × 1-1.2 mm; young fruits green, dark brownish when mature, ovoid, 8.5-10 × 6.5-7.5 mm, surface smooth, apex flat, with the persistent style; dry pericarp 0.4 mm thick; endocarp woody.

Etymology This species is known only from the region of Fort-Dauphin, from which the epithet "dauphinensis" is derived.

Distribution, ecology and phenology *Noronhia dauphinensis* occurs in low-elevation humid forests on basement rocks north of Fort-Dauphin in the south (Fig. 9). It produces flowers and fruits from November to May.

Conservation status The assessment was based on six collections representing five localities and yielded an EOO of just 7 km² and two subpopulations representing a single location (Bemangidy-Ivohibe forest). Some of the collections are encompassed within the newly established protected area of Tsitongambarika (including Bemangidy-Ivohibe), which will gradually be less subject to threats. However, others are found outside of the new protected area and will likely experience continuing decline in habitat quality and in the number of mature individuals resulting from forest exploitation. Thus, *N. dauphinensis* is assigned a preliminary status of "Endangered" [EN B2ab(iii,v)].

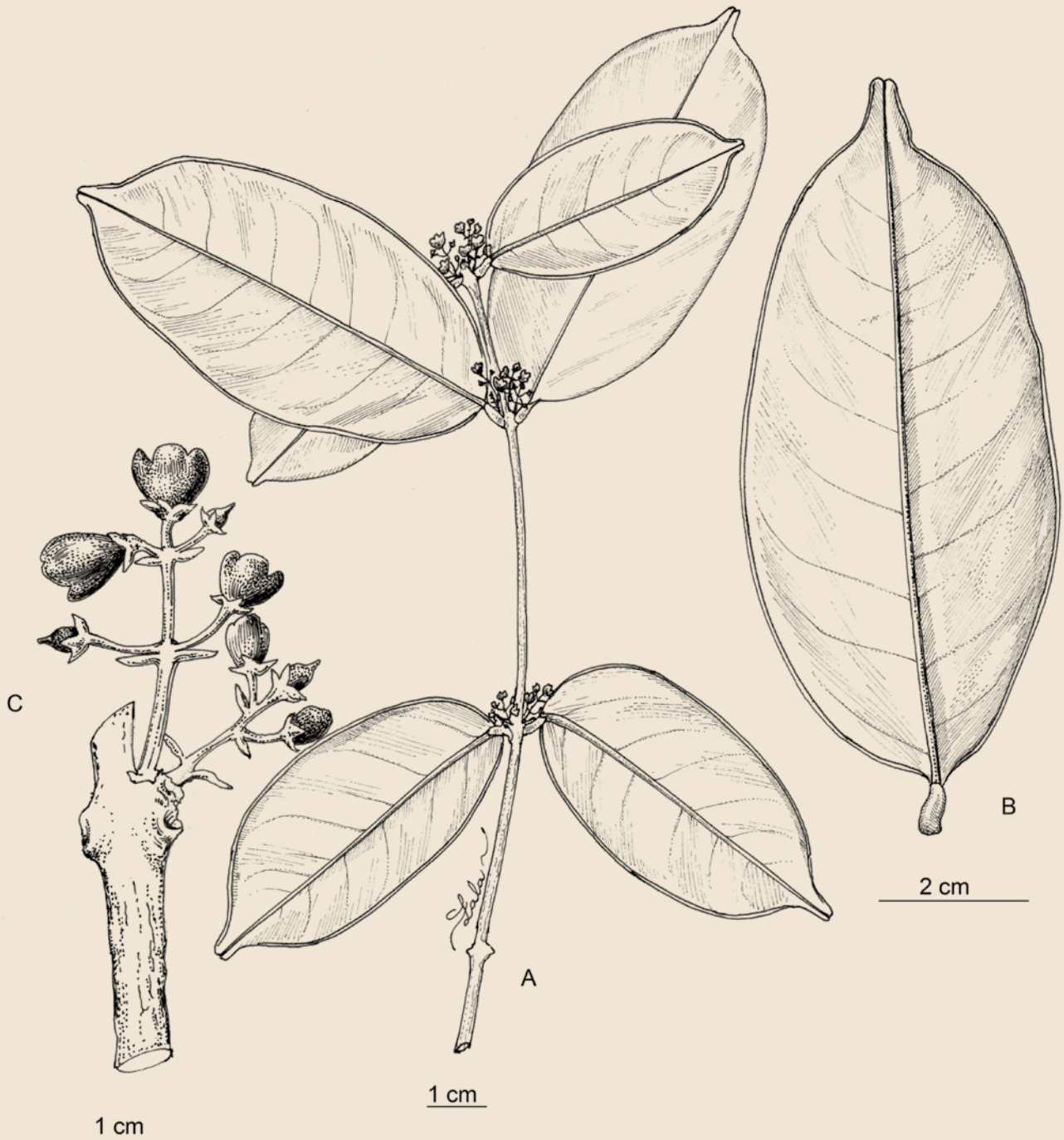


Fig. 14. *Noronhia dauphinensis* Hong-Wa.

A. Flowering branch; **B.** Abaxial side of leaf blade; **C.** Inflorescence.

[Razakamalala 2380, TAN] Drawings: R.L. Andriamiarisoa

Notes *Noronhia dauphinensis* most closely resembles *N. boivinii*, from which it differs mainly by its thyrsoïd inflorescences (vs. fasciculate flowers), cupuliform (vs. urceolate to campanulate), white (vs. pink to reddish) corolla, and bilobed (vs. capitate) stigma. The new species can be recognized by its distichous, oblong to elliptic leaf blades subtended by a short petiole and its compact inflorescences.

Paratypes **MADAGASCAR. Prov. Toliara :** Fort-Dauphin, Bemangidy Forest, 24°34'05"S 47°12'38"E, 100 m, 10.II.2006, *Lowry et al.* 6741 (G, MO, P); Iabakoho, Antsotso Avaratra, Ivohibe, 24°34'10"S 47°12'26"E, 105 m, 24.V.2006, *Birkinshaw* 1642 (MO, P, TAN); *ibid. loc.*, 24°35'33"S 47°12'52"E, 22.V.2006, *Rajoharison et al.* 156 (MO, P, TEF); *ibid. loc.*, 24°33'52"S 47°11'43"E, 386 m, 1.XI.2005, *Razakamalala et al.* 2463 (G, MO, P, TAN); *ibid. loc.*, *Razakamalala et al.* 2551 (MO, P, TAN).

22. *Noronhia decaryana* H. Perrier in Mém. Inst. Sci. Madagascar, Sér. B, Biol. Vég. 2 : 287. 1949.

Typus: MADAGASCAR. **Prov. Toamasina:** Est: S de Moramanga, [18°56'S 48°13'E], 900 m, 15.II.1930, *Decary* 7126 (holo-: P [P00413222]!; iso-: P [P00413223, P00413224]!).

Description

Trees to 12 m tall, trunk to 15 cm diameter; young twigs cylindrical, 0.7-2.6 mm diameter, glabrous; bark dark to medium gray, smooth to slightly rugose. *Leaves* opposite, persistent; bud scales persistent; blades dark green above, lighter below, oblong to elliptic, 5-17.5 × 2-7.5 cm, chartaceous, glabrous, domatia rare, base rounded to acute, margin slightly revolute and undulate, apex cuspidate, the cusp 4-21 mm long, midrib sunken above, raised below, secondary veins conspicuous, 6-14 per side, 7-30 mm apart, looping 2-7 mm from the margin; petiole medium to light gray, 3-11 × 0.7-2.7 mm, entirely woody, glabrous. *Thyrses* fasciculate, pauciflorous, diffuse; peduncle 6-18 mm long, glabrescent; pedicel 6-28 mm long, glabrescent; calyx moderately pubescent outside, glabrous inside, lobes triangular, 1-2.8 × 1-2 mm; corolla orangish-red outside, yellowish inside, urceolate, 4-8 mm long, glabrous on both sides, the tube 1-5 mm long, lobes ovate to triangular, apex acute; corona absent; stamens 1.3-2.8 mm long, anthers oblate to orbicular, 1-1.9 mm long; pistil 2-3.5 mm long, stigma capitate. *Fruiting* pedicel 4-29 × 0.5-2.2 mm; young fruits green, dark red when mature, ovoid to subglobose, 12.5-20.5 × 8.5-21 mm, surface smooth, sometimes covered with white dots, apex flat, style persistent; dry pericarp 0.4-1.7 mm thick; endocarp crustaceous; seed 6.5-13 × 5-15 mm.

Distribution, ecology and phenology

Noronhia decaryana occurs in low- to high-elevation humid forests, from Tsaratanana in the north to Ivohibe and Manombo in the south (Fig. 9). It produces flowers and fruits throughout the year.

Conservation status

Based on 21 collections representing 19 localities, the assessment resulted in an EOO of 89,050 km², an AOO of 76 km², and 19 subpopulations representing 14 locations, of which 10 occur within protected areas (Analamazaotra, Anjanaharibe-Sud, Corridor Ambositra-Vondrozo, Corridor Ankeniheny-Zahamena, Manombo, Mantadia, Ranomafana, Tsaratanana, Tsaratanana-Ambohimirahavavy-Corridor Marojejy, and Zahamena). Although some locations are not encompassed within protected areas and are subject to habitat degradation, *N. decaryana* is widespread, with an actual AOO likely much larger than 2,000 km², and is therefore assigned a preliminary status of "Least Concern".

Notes *Noronhia decaryana* can be recognized by its chartaceous, cuspidate leaf blades, long-pedunculate inflorescences with orangish-red flowers that lack a corona, and crustaceous fruits. It differs from *N. cuspidata* by the features discussed under that species and from *N. gracilipes* H. Perrier mainly by rarely (vs. frequently) having domatia on the abaxial leaf blades, and by its urceolate (vs. cupuliform to subrotate), orangish-red (vs. pinkish) flowers.

**Additional specimens
examined**

MADAGASCAR. Prov. Antsiranana: Beramanja, Anketrahe Belinta, forêt de Manongarivo-Kalobinono, 13°38'18"S 48°40'29"E, 520 m, 27.IX.2013, *Manjato et al.* 411 (DOV, G, MO, P, TAN); Tsaratanana RNI, Beangona, 14°02'50"S 48°47'09"E, 1100 m, 27.XI.2000, *Razakamalala et al.* 3 (MO, P, TAN). **Prov. Fianarantsoa:** Manombo RS, 23°00'S 47°42'E, 5.III.2009, *Hong-Wa et al.* 612 (MO, P, TAN); Ranomafana PN, Vatoharanana, Parcelle 3, 21°16'06"S 47°25'30"E, 923 m, 8.V.2010, *Hong-Wa & Ortiz* 671 (MO, P, TAN). **Prov. Toamasina:** Moramanga, Ambatovy, Analamay, 18°48'24"S 48°18'31"E, 1119 m, 22.X.2005, *Antilahimena et al.* 4106 (MO, P, TAN); Toamasina, [17°45'S 48°33'E], 1200 m, 29.XII.1944, *Cours* 2136 (G, MO, P); Analamazaotra RS, 18°56'12"S 48°25'09"E, 953 m, 2.V.2010, *Hong-Wa & Ortiz* 648 (MO, P, TAN); Ambatondrazaka, 18°52'S 48°30'E, 985 m, 6-7.III.1992, *Noyes et al.* 989 (MO, P); Ampitambe, forêt d'Analamay, 18°51'22"S 48°19'34"E, 1080 m, 29.VI.1997, *Rakotomalaza et al.* 1363 (MO, TAN); Manakambahiny Est, Zahamena RNI, 17°40'34"S 48°45'32"E, 1351 m, 14.IX.2002, *Randrianjanaka et al.* 725 (CNARP, MO, P, TEF); Brickaville, Maroseranana, Ambodilendemy, 18°25'35"S 48°47'17"E, 1019 m, 21.III.2011, *Ravelonarivo & Edmond* 3767 (MO, P, TAN); Fénérive-Est, Mandifikantsy, Sahatavy, [17°36'42"S 48°54'00"E], 19.I.1956, *Réserves Naturelles* 7832 (MO, P).

23. *Noronhia densiflora* Bosser in *Adansonia* ser. 2, 13: 461. 1973 (Fig. 15).

Typus: MADAGASCAR. **Prov. Fianarantsoa:** Route Farafangana-Vangaindrano, E de Madagascar, [22°49'S 47°49'E], XII.1963, Bosser 18739 (holo-: P [P00413225]!; iso-: MO-4407063!, P [P00413226, P00413227]!, TAN!).

Description *Shrubs* to trees to 8 m tall, trunk to 12 cm diameter; young twigs cylindrical to subquadrangular, 3.5-6.5 mm diameter, glabrous; bark light brown to whitish, flaky. *Leaves* opposite, persistent; bud scales persistent; blades dark green above, lighter below, oblong, 22.5-62 × 7-17 cm, extremely coriaceous, glabrous, domatia absent, base rounded to cordate, margin revolute, apex acute to mucronate, sometimes rounded, the mucro (0-)3-18 mm long, midrib sunken above, distinctly raised below, secondary veins very conspicuous, 11-18 per side, 25-64 mm apart, looping 7-17 mm from the margin; petiole light brown to white, 8-27 × 4-8 mm, entirely woody, with flaky bark, glabrous. *Thyrse*s fasciculate, pauciflorous, compact; peduncle 7-12 mm long, sparsely pubescent; pedicel 7-15 mm long, sparsely pubescent; calyx sparsely pubescent outside, glabrous inside, lobes widely ovate, 1-1.5 × 1.2-1.7 mm; corolla purple-red, globose, 4-5 mm long, glabrous on both sides, the tube 3.8-4.5 mm long, lobes acute to obtuse, sometimes dentate; corona absent; stamens 2-2.5 mm long, anthers oblong, 1.5 mm long; pistil 3-3.5 mm long, stigma bilobed. *Fruiting* pedicel 1.5-1.8 × 1.8-2.5 mm; young fruits green, blackish when mature, ovoid, 14-17 × 10-11.5 mm, smooth to rugose, apex apiculate; dry pericarp 0.5-0.9 mm thick; endocarp woody; seed 9 × 6 mm.

Distribution, ecology and phenology

Noronhia densiflora occurs in littoral to low-elevation humid forests in the east, from Mananjary to Vangaindrano (Fig. 9). It produces flowers and fruits from June to February.

Conservation status

The assessment, which used the 12 available collections representing 10 localities, indicated an EOO of 1,220 km², an AOO of 40 km², and seven subpopulations representing six locations, of which three occur within protected areas (Ankarabola-Agnakatrika and Manombo). In recent years, *Noronhia densiflora* has been mostly collected from around Farafangana and Vangaindrano, but it is known to occur around Mananjary as well. However, the latter subpopulation was only sampled once in 1967 and the area is currently highly degraded as a result of slash-and-burn agriculture and other forms of exploitation. With continuing decline in habitat quality and habitat loss, which also leads to loss of mature individuals, *N. densiflora* is therefore assigned a preliminary status of "Vulnerable" [VU B1ab(i,ii,iii,iv,v)+2ab(i,ii,iii,iv,v)].

Notes *Noronhia densiflora* differs from all other members of the genus by its somewhat lianescent habit when young, flaky bark, thickly coriaceous leaves measuring up to 75 cm long, compact intrapetiolar inflorescences, and globose red flowers.

Additional specimens examined MADAGASCAR. **Prov. Fianarantsoa**: Farafangana, Anankara, Manombo RS, 23°22'47"S 47°35'59"E, 100-200 m, 16.IV.2000, *Andrianjafy et al.* 40 (CNARP, MO, P); *ibid. loc.*, [23°02'S 47°44'E], *Friedmann* 164 (TAN); Anankara, Manombo AP, parcelle 2, 23°00'S 47°42'E, 5.III.2009, *Hong-Wa* 611 (MO, P, TAN); Vangaindrano, Antavikazaha, Androkabe forest, 23°30'47"S 47°30'23"E, 77 m, 14.VI.2011, *Letsara et al.* 1122 (CAS, MO); S of Farafangana, Manombo RS, 23°04'02"S 47°40'14"E, 50 m, 17.XI.2001, *McPherson & Rabenantoandro* 18442 (MO, P); Marofototra, Ankarabolava, Letomanga, 23°30'15"S 47°29'10"E, 50 m, 5.IX.2010, *Randrianarivony et al.* 178 (MO, P, TAN); Tsianofana, Tsararano, 23°26'47"S 47°30'31"E, 135 m, 19.X.2010, *Razafitsalama et al.* 1398 (MO, P, TAN); S de Farafangana, route de Manombo, PK 20-21, 14-17.X.1964, *Service Forestier* 23602 (P, TEF); *ibid. loc.*, 17.X.1964, *Service Forestier* 23643 (P, TEF); Mananjary, Ambodikijy, [21°13'S 48°21'E], 50 m, 25.II.1967, *Service Forestier* 26294 (G, P, TEF); Manombo RS, 23°00'51"S 47°43'41"E, 30 m, 4.II.2006, *Tosh* 339 (BR, MO, P, TAN).



Fig. 15. *Noronhia densiflora* Bosser [Razafitsalama 1398].

Photo: C. Birkinshaw

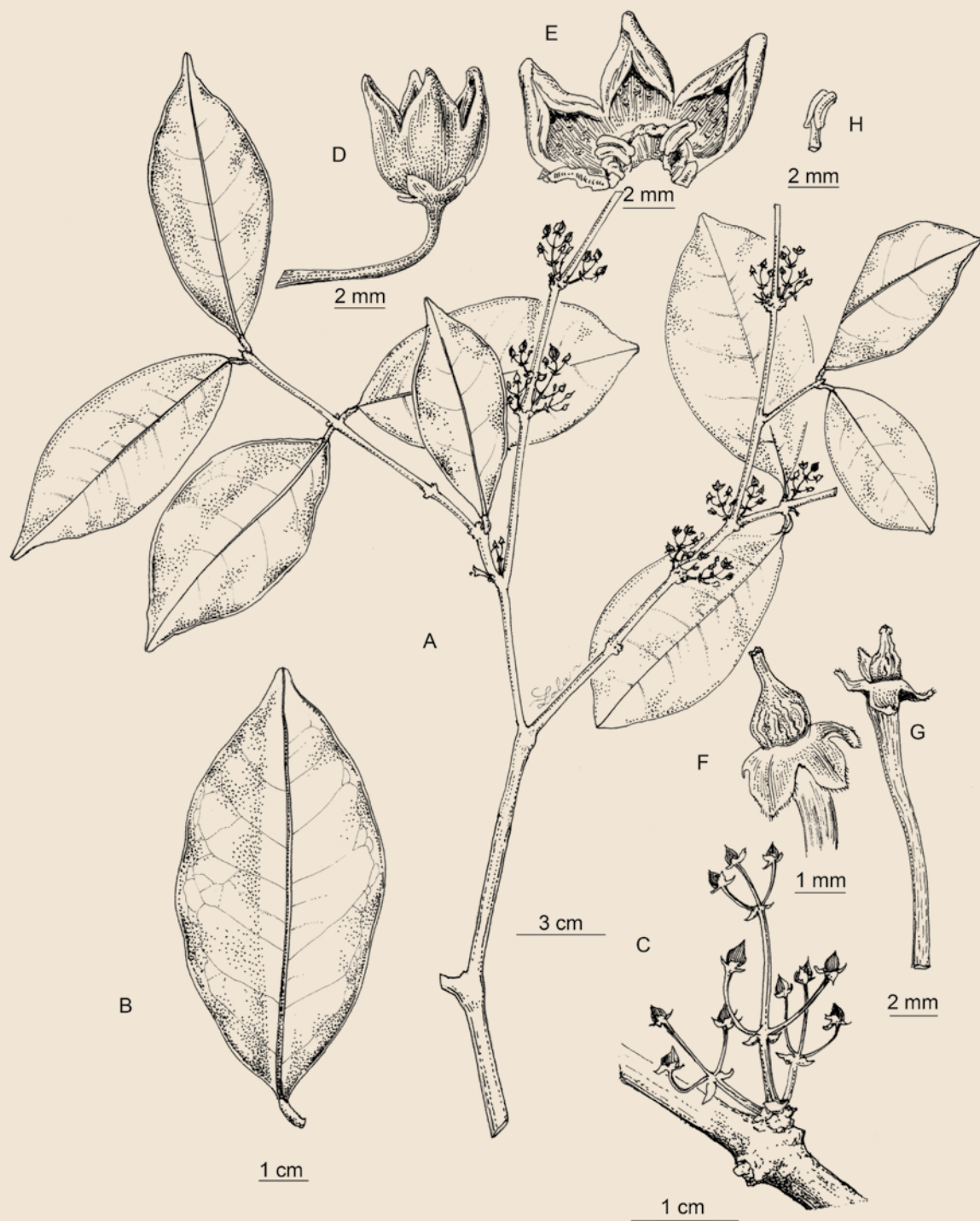


Fig. 16. *Noronhia disjuncta* Hong-Wa.

A. Flowering branch; **B.** Abaxial side of leaf blade; **C.** Inflorescence; **D.** Flower; **E.** Inner side of corolla; **F-G.** Pistil; **H.** Stamen.

24. *Noronhia disjuncta* Hong-Wa, *spec. nova* (Fig. 16).

Typus: MADAGASCAR. **Prov. Antsiranana:** DIANA, RNI No 4 Tsaratanana, Antsahamana, Beangona, 14°02'06"S 48°47'08"E, 1400 m, 28.XI.2000, *Randria et al.* 16 (holo-: MO-6615569!; iso-: G [G00341628]!, K!, P [P00641023]!, TAN!).

Diagnosis *Noronhia disjuncta* Hong-Wa can be distinguished from its congeners by its light gray to whitish bark, its ovate leaf blades and its compact inflorescences with red flowers.

Description Trees to 12 m tall, trunk to 17 cm diameter; young twigs cylindrical, 1.3-2.3 mm diameter, glabrous; bark light gray to whitish, smooth to somewhat rugose, with scattered lenticels. Leaves opposite, persistent; bud scales persistent; blades medium green above, lighter below, ovate to broadly elliptic, 8.5-13.5 × 3-5.5 cm, coriaceous, glabrous, domatia absent, base rounded to acute, margin flat to slightly undulate, apex acuminate, the acumen 4-9 mm long, midrib slightly sunken above, distinctly raised below, secondary veins mostly conspicuous below, 9-13 per side, 11-17 mm apart, looping 2.5-4.5 mm from the margin; petiole medium gray, 7-13 × 1.8-2.7 mm, entirely woody, glabrous. Thyrses geminate, multiflorous, compact; peduncle 6 mm long, moderately pubescent; pedicel 4-9 mm long, sparsely pubescent; calyx sparsely pubescent outside, glabrous inside, lobes triangular, 1.5 × 1-2 mm; corolla red outside, whitish inside, urceolate, 3-4.5 mm long, glabrous on both sides, the tube 1.5-2.7 mm long, lobes deltate, apex acute; corona present, 1.5-2.6 mm long, undivided; stamens 2-2.5 mm long, anthers obovate, 1.6 mm long; pistil 2.5-2.6 mm long, stigma capitate to slightly bilobed. Fruiting pedicel 4-13 × 1-2 mm; young fruits green, black when mature, subglobose to ovoid, 12.9-18.8 × 11.1-14.4 mm, surface smooth, apex flat to rostellate, the rostellum circular, obtuse, with the persistent style; dry pericarp 0.5-1.1 mm thick; endocarp woody; seed 7.6-12.2 × 6.4-8.7 mm.

Etymology The specific epithet refers to the somewhat disjunct distribution of this species.

Distribution, ecology and phenology *Noronhia disjuncta* occurs in mid- to high-elevation humid forests on basement rocks from Tsaratanana and Antalaha, in the north, to Ranomafana, in the south (Fig. 9). It produces flowers and fruits from November to January.

Conservation status Although *Noronhia disjuncta* is currently known only from nine collections representing nine localities, it has an EOO of 41,247 km², an AOO of 36 km², and six subpopulations representing six locations, all of which occur within protected areas (Anjanaharibe-Sud, Marojejy, Ranomafana, Tsaratanana, and Tsaratanana-Ambohi-

mirahavavy-Corridor Marojejy). With all the collections made at high elevations within these protected areas, little to no threat is expected to affect this species in the near future. Therefore, *N. disjuncta* is assigned a preliminary status of “Least Concern”.

Notes *Noronhia disjuncta* resembles both *N. humblotiana* (H. Perrier) Hong-Wa and *N. mangorensis* H. Perrier, but can be distinguished by its thyrsoïd inflorescences (vs. fasciculate flowers in both of the other species), smooth (vs. rugose) fruit surface, and flat to rostellate (vs. apiculate) fruit apex. The new species can be recognized by its light gray to whitish bark, ovate leaf blades, and compact inflorescences with red flowers.

Paratypes **MADAGASCAR. Prov. Antsiranana:** Marojejy PN, 14°28'57"S 49°38'12"E, 1100-1600 m, 19-24.I.1994, *Malcomber et al. 2701bis* (MO, TAN); Andapa, Ambodisatrana, 14°32'S 49°26'E, 1000-1100 m, 2.VIII.1997, *McPherson 17165* (MO, TAN); Bealampona, Anjanaharibe-Sud RS, 14°44'45"S 49°29'40"E, 890-1041 m, 14.IX.1994, *Ravelonarivo et al. 377* (MO, P, TAN); *ibid. loc.*, 14°43'42"S 49°27'57"E, 1570 m, 1.XII.2003, *Schmidt 4377* (MO). **Prov. Fianarantsoa:** Ranomafana PN, 21°15'S 47°27'E, 1100 m, 11-15.XI.1991, *Malcomber et al. 1077* (G, MO, P, TAN); *ibid. loc.*, 21°16'S 47°26'E, 1000-1100 m, 18-31.I.1993, *Malcomber et al. 2034* (MO, P); *ibid. loc.*, 21°15'30"S 47°25'00"E, 950-1150 m, 21.I.1993, *Turk & Randrianasolo 255* (G, MO, P, TAN). **Prov. Mahajanga:** Tsaratanana Massif, 1800-2000 m, 11.V.1974, *Gentry 11688* (MO, P, TAN).

25. *Noronhia divaricata* Scott-Elliot in J. Linn. Soc. Bot. 29: 32. 1891 (Fig. 12D).

Typus: MADAGASCAR. **Prov. Toliara:** woods near Fort-Dauphin, [25°03'S 47°00'E], s.d., Scott Elliot 2883 (holo-: K [K000233195] image seen; iso-: E [E00193160] image seen, P [P00418113]!).

Description *Shrubs* to small trees to 8 m tall, trunk to 15 cm diameter; young twigs cylindrical, 0.4-1.4 mm diameter, glabrous; bark light gray, smooth to slightly rugose. *Leaves* opposite, persistent; bud scales persistent; blades medium green above, lighter below, narrowly to widely elliptic to somewhat rhombic, 3-6.5 × 1-3 cm, coriaceous, glabrous, domatia casual, base attenuate, margin slightly revolute and undulate, apex rounded to acute, the point 0-2 mm long, midrib flat to slightly sunken above, raised below, secondary veins barely visible, 6-10 per side, 5-11 mm apart, looping 1-3 mm from the margin; petiole yellow, 3.5-11 × 0.5-1.2 mm, not woody, glabrous. *Thyrse*s solitary, pauciflorous, diffuse; peduncle 3 mm long, sparsely pubescent; pedicel 2.5-12 mm long, sparsely pubescent; calyx sparsely pubescent outside, glabrous inside, lobes triangular, 0.8-1.3 × 1-1.5 mm; corolla yellowish green, urceolate, 3.5-4.5 mm long, glabrous on both sides, the tube 2-3.5 mm long, lobes ovate, apex rounded; corona present, 1.2-1.8 mm long, undivided; stamens 1.8-2.5 mm long, anthers slightly obovate, 1.3-1.5 mm long; pistil 1.8-2.5 mm long, stigma capitate. *Fruiting* pedicel 2-10 × 1-1.5 mm; young fruits green, reddish when mature, ovoid to subglobose, 11.5-19 × 8-15 mm, smooth, apex flat to bluntly pointed, style persistent; dry pericarp 0.6-0.9 mm thick; endocarp woody; seed 6-12.5 × 4.5-10 mm.

Distribution, ecology and phenology *Noronhia divaricata* occurs in low- to mid-elevation dry forests and thickets in the south, from Ihorombe to Fort-Dauphin (Fig. 9). It produces flowers and fruits throughout the year except in August.

Conservation status With 20 collections representing 18 localities, the analysis resulted in an EOO of 16,342 km², an AOO of 64 km², and 14 subpopulations representing 10 locations, of which only two occur within protected areas (Andohahela and Extension Anko-dida-Tsimelaha). *Noronhia divaricata* is assigned a preliminary status of “Vulnerable” [VU B1ab(i,ii,iii,iv,v)+2ab(i,ii,iii,iv,v)] due to projected continuing decline in habitat quality, habitat loss, and reduction of the number of mature individuals resulting from fire, land conversion and industrial mining.

Notes *Noronhia divaricata* can be recognized by its elliptic to somewhat rhombic leaf blades and its long-pedunculate and pauciflorous inflorescences with yellow-green flowers. The isotype at Paris includes two fragments that are essentially identical,

but are labeled as *N. divaricata* (Scott Elliot 2883 [P00418113]) and *N. emarginata* (Scott Elliot 3050 [P00418114]), respectively, whereas the holotype at Kew, also with two fragments, is identified only as *N. divaricata* (Scott Elliot 2883 [K000233195]) and the isotype at Edinburgh as *N. emarginata* (Scott Elliot 3050 [E00193160]). A labeling error was apparently made on the sheets at P and E, which has since been corrected by Perrier de la Bâthie and others to read Scott Elliot 2883 and annotated as *N. divaricata*.

**Additional specimens
examined**

MADAGASCAR. Prov. Fianarantsoa: Ihorombe, Ampasimbe, [23°02'30"S 45°16'30"E], 500 m, 22.VII.1955, *Service Forestier 14844* (MO, P, TEF). **Prov. Toliara:** Manambaro, [24°40'12"S 46°44'24"E], 110 m, 21.II.1975, *Croat 31940* (MO, P, TAN); Cap Ranavalona, [25°04'S 46°58'E], 17.IX.1932, *Decary 10619* (P); Andohahela PN, parcelle 3, 25°00'S 46°40'E, 200-600 m, 17.XI.1990, *Dumetz 1421* (MO, P, TAN); bassin supérieur du Mandrare, [24°30'S 46°35'E], 700-1200 m, 20-22.XI.1928, *Humbert 6765* (P); Baie des Galions (Ranofotsy) au SO de Fort-Dauphin, [25°09'S 46°43'E], 1-100 m, 18- 21.II.1955, *Humbert & Capuron 29025* (MO, P); Andohahela PN, 25°00'S 46°40'E, 120-140 m, 27.I.1990, *McPherson 14921* (MO, P, TAN); Ranopiso, Ankilivalo, 25°07'28"S 46°40'04"E, 125 m, 20.VII.2010, *Rakotovao et al. 5500* (G, MO, P, TAN); Ambinanibe, Ehoala, 25°03'S 46°57'E, 24.XI.2007, *Ramison & Rabehevitra 465* (MO, P, TAN); Andohahela (parcel 3), Ankazofotsy, 25°01'S 46°38'E, 15.V.2001, *Randriamampionona 992* (G, MO, P); Andohahela (parcel 1), Tsimelahy, 24°50'20"S 46°32'17"E, 6.IV.1996, *Randriamampionona 1251* (MO, P); Ambatoabo, Ankoba, 24°47'12"S 46°42'25"E, 300 m, 25.II.2009, *Randrianaivo et al. 1761* (G, MO, P, TAN); Beroroha, Betorabato, Abotorabatorano, 21°34'02"S 45°03'42"E, 278 m, 13.I.2011, *Razakamalala & Pascal 6032* (MO, P, TAN); massif du Vohidava près d'Anadabolava (Moyen Mandrare), [24°09'S 46°15'E], 700-900 m, 6.XI.1963, *Service Forestier 22595* (MO, P, TEF); Fort-Dauphin, near the new port, 25°02'34"S 46°57'32"E, 50 m, 11.IV.2010, *Thulin & Razafindraibe 11848* (MO, UPS).

26. *Noronhia domatifera* Hong-Wa, *spec. nova* (Fig. 17).

Typus: MADAGASCAR. **Prov. Toamasina:** Ambohibary, Ampitambe, Ambatovy, Andranovery, clear zone 5, 18°51'50"S 48°18'35"E, 980 m, 11.II.2008, S. Randrianasolo *et al.* 645 (holo-: MO-6615573!; iso-: G, P [P06774030] image seen, TAN).

Diagnosis *Noronhia domatifera* Hong-Wa can be distinguished from other members of the genus by its non-woody petioles, its abundant leaf domatia and its diffuse inflorescences with purplish cream flowers.

Description Trees to 12 m tall, trunk to 10 cm diameter; young twigs cylindrical, 0.6-1.6 mm diameter, glabrous; bark brownish, smooth. Leaves opposite, persistent; bud scales deciduous; blades dark green above, lighter below, elliptic, 5-12 × 1.7-3.5 cm, coriaceous, glabrous, domatia common, base attenuate, margin flat, slightly revolute, apex cuspidate, the cusp 3.5-14 mm long, midrib slightly sunken above, distinctly raised below, secondary veins mostly conspicuous below, 5-14 per side, 6-15 mm apart, looping 1-4 mm from the margin; petiole reddish, 4-8 × 0.7-2 mm, not woody, glabrous. Thyrses geminate to fasciculate, pauciflorous, diffuse; peduncle 2-5 mm long, glabrous; pedicel 3-13 mm long, glabrous; calyx glabrous on both sides, lobes triangular, 0.5-1 × 0.6-1.3 mm; corolla purplish outside, yellowish inside, subrotate, 3-6 mm long, glabrous on both sides, the tube 1-3 mm long, lobes ovate, apex obtuse; corona present, 1.2-1.5 mm long, undivided; stamens 1.2-1.7 mm long, anthers oblong, 0.8-1 mm long; pistil 1-2 mm long, stigma capitate. Fruiting pedicel 5-14 × 0.6-1 mm; young fruits green, purplish when mature, ovoid, 13-14 × 9.5-11.5 mm, surface smooth, apex flat to bluntly pointed; dry pericarp 0.6-1 mm thick; endocarp crustaceous; seed 9-11 × 7.5-9.5 mm.

Etymology The presence of abundant domatia on the lower surface of leaf blades provided the basis for the name of this species.

Distribution, ecology and phenology *Noronhia domatifera* occurs in mid- to high-elevation humid forests in the Mangoro region in the east, with one specimen collected much further north at Makirovana (Fig. 9). It produces flowers and fruits from December to March.

Conservation status Fourteen collections representing 13 localities were available for analysis, which yielded an EOO of 16,099 km², an AOO of 44 km², and eight subpopulations representing eight locations, of which three occur within the network of protected areas (Corridor Ankeniheny-Zahamena, Makirovana-Tsihomanaomby, and

Zahamena). Due to ongoing habitat degradation and loss resulting from forest exploitation, shifting cultivation and industrial mining, *N. domatifera* is assigned a preliminary status of “Vulnerable” [VU B1ab(ii,iii,iv,v)+2ab(ii,iii,iv,v)], although the EOO is not expected to decline in the near future.

Notes *Noronhia domatifera* most closely resembles *N. disjuncta*, but differs by its non-woody (vs. woody) petiole, the presence (vs. absence) of domatia on the abaxial leaf blades, and its cuspidate (vs. acuminate) leaf apex, subrotate (vs. urceolate), purplish (vs. red) flowers, and crustaceous (vs. woody) endocarp. The new species can be recognized by its non-woody petioles, abundant leaf domatia, and diffuse inflorescences with purplish cream flowers.

Paratypes **MADAGASCAR. Prov. Antsiranana:** Anjagoveratra, Anamboaho, Forêt de Makirovana, 14°09'16"S 49°57'46"E, 404 m, 20.III.2013, *Rakotonirina et al.* 82 (MO, P, TAN). **Prov. Toamasina:** Antanandava, Zahamena PN, 17°29'47"S 48°45'35"E, 1000-1912 m, 2.II.2002, *Andrianjafy et al.* 281 (CNARP, G, MO, P, TEF); Moramanga, Ankerana, 18°25'33"S 48°47'11"E, 919 m, 24.III.2011, *Antilahimena* 7798 (MO, P, TAN); *ibid. loc.*, 18°25'28"S 48°47'17"E, 921 m, 25.III.2011, *Antilahimena* 7806 (MO, P, TAN); env. Lac Alaotra, [17°42'S 48°28'E], 900 m, I.1938, *Cours* 675 (P, syntypes of *Noronhia mangorensis*); Toamasina, 1450 m, 11.XII.1944, *Cours* 1828 (MO, P); Menaloha, [17°42'S 48°28'E], 850 m, 25.II.1952, *Cours* 4004 (MO, P); *ibid. loc.*, 1000 m, 15.II.1952, *Herb. Stat. Agric. Alaotra* 1647 (P, TAN); *ibid. loc.*, *Herb. Stat. Agric. Alaotra* 4004 (TAN); Moramanga, Berano, 18°50'36"S 48°19'53"E, 1000 m, 20.II.1997, *Rakotomalaza et al.* 1128 (MO, P, TEF); Ambatovy, 18°51'34"S 48°18'25"E, 1050 m, 3.III.1997, *Rakotomalaza et al.* 1212 (MO, P, TEF); Zahamena PN, 17°30'40"S 48°43'35"E, 1200 m, 26.XI.2002, *Rakotonandrasana et al.* 641 (CNARP, MO, P, TEF); Ambatovy, 18°51'51"S 48°18'49"E, 1005 m, 14.II.2008, *S. Randrianasolo et al.* 667 (MO, P, TAN); Brickaville, Ambodilendemy, 18°25'45"S 48°47'16"E, 919 m, 14.III.2011, *Ravelonarivo & Edmond* 3658 (G, MO, P, TAN); Didy, [18°07'S 48°32'E], [1100 m], 10.X.1950, *Service Forestier* 1701 (TEF).

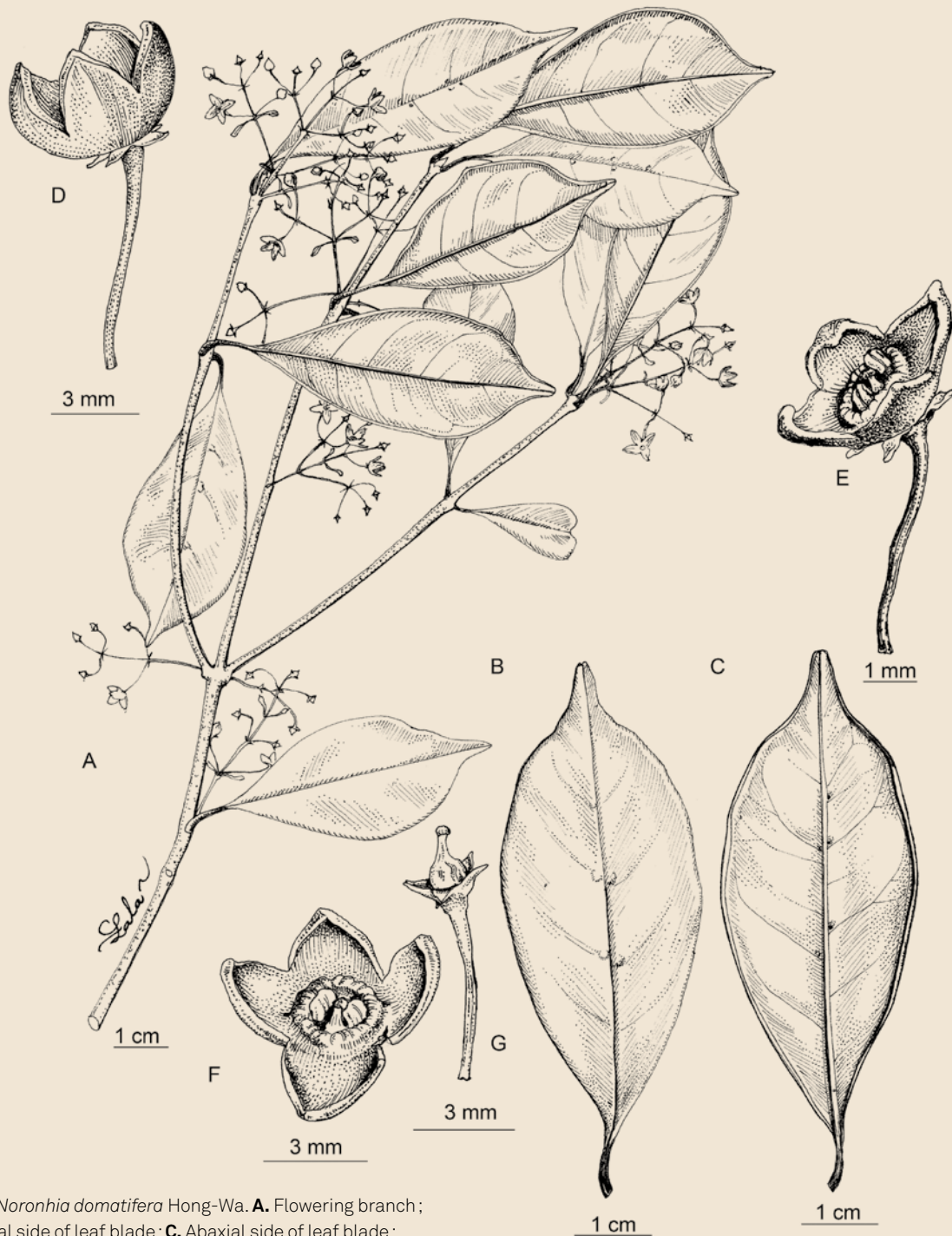


Fig. 17. *Noronhia domatifera* Hong-Wa. **A.** Flowering branch; **B.** Adaxial side of leaf blade; **C.** Abaxial side of leaf blade; **D.** Flower; **E-F.** Top and side views of corona; **G.** Pistil.

[Randrianasolo 645, TAN] Drawings: R.L. Andriamiarisoa

27. *Noronhia edentata* (H. Perrier) Hong-Wa, **comb. & stat. nov.** (Fig. 18A).

≡ *Noronhia emarginata* var. *edentata* H. Perrier in Mém. Inst. Sci. Madagascar, Sér. B, Biol. Vég. 2: 296. 1949.

Lectotypus (designated here): **MADAGASCAR. Prov. Toamasina**: Forêt d'Analamazaotra, [18°55'48"S 48°25'48"E], 800 m, s.d., *Perrier de la Bâthie* 8809 (P [P00791237]!; isolecto-: K [K000233192, K000233193] image seen; P [P03558849, P03558850]!).

Syntypi: **MADAGASCAR. Prov. Toamasina**: Analamazaotra RS, 2.IV.1905, *Thouvenot* 58 (K [K000233191] image seen, P [P00701239, P00701240]!); *ibid. loc.*, comm. 3.XII.1934, *Ursch* 82 (P [P03558851]!).

Description

Trees to 25 m tall, trunk to 35 cm diameter; young twigs cylindrical, 1-6 mm diameter, glabrous; bark medium to light gray, smooth to rugose. *Leaves* opposite, persistent; bud scales persistent; blades dark green above, medium green below, elliptic to obovate, 5-17 × 2-7.5 cm, coriaceous, glabrous, domatia absent, base acute to attenuate, margin slightly revolute, apex rounded to slightly acuminate, the acumen 0-5(-15) mm long, midrib sunken above, raised below, secondary veins conspicuous, 7-17 per side, 7-25 mm apart, looping 1.5-7 mm from the margin; petiole medium gray, 6-38 × 1.3-4 mm, entirely woody, glabrous. *Thyraxes* fasciculate, pauciflorous, compact; peduncle 8-9 mm long, moderately pubescent; pedicel 1.5-8 mm long, moderately pubescent; calyx moderately pubescent outside, glabrous inside, lobes triangular, 1-1.5 × 0.8-2 mm; corolla white sometimes tinged greenish, urceolate, 3-5.5 mm long, glabrous on both sides, the tube 1.2-3 mm long, lobes widely ovate, apex obtuse; corona present, 1.4-2.2 mm long, undivided; stamens 1.8-2.5 mm long, anthers widely oblong, 1.1-1.9 mm long; pistil 1.4-2.5 mm long, stigma capitate. *Fruiting* pedicel 2-9 × 1.8-3.6 mm; young fruits green, reddish black when mature, ovoid to subglobose, 12-31 × 8.5-26 mm, surface smooth, sometimes covered with a white pellicle, apex flat to bluntly pointed or apiculate; dry pericarp 1.3-4.2 mm thick; endocarp woody; seed 11.5-21.5 × 7-18 mm.

Distribution, ecology and phenology

Noronhia edentata occurs in low- to high-elevation humid forests in the east, from Sambava to Ambondrombe (Fig. 19). It produces flowers and fruits from September to May.

Conservation status

The assessment was based on 27 collections representing 19 localities, resulting in an EOO of 38,642 km², an AOO of 68 km², and 13 subpopulations representing 12 locations, of which six occur within protected areas (Analamazaotra, Betampona, Makira, Makirovana, Masoala, and Zahamena). Being widespread and present in many protected areas, *Noronhia edentata* is assigned a preliminary status of "Least Concern".



Fig. 18. Photographs of *Noronhia* Stadtm. ex Thouars. **A.** *Noronhia edentata* (H. Perrier) Hong-Wa [Razanatzima 266]; **B.** *Noronhia crassiramosa* (H. Perrier) Hong-Wa [A. Randrianasolo s.n.].

Photos: F. Rakotoarivony



Fig. 19. Distribution maps of species of *Noronhia* Stadtm. ex Thouars. *N. edentata* (H. Perrier) Hong-Wa to *N. insularis* (Labat, M. Pignal & O. Pascal) Hong-Wa & Besnard.

Notes *Noronhia edentata* can be recognized by its leaves, which have broadly elliptic blades and long, woody petioles, its white greenish flowers and its large fruits, with thick pericarp. There is a slight leaf heteroblasty in this species. In particular, the leaf base is narrower and the acumen longer (up to 15 mm long) in seedlings and saplings than in adult plants. This taxon was previously recognized as a variety of *N. emarginata*, from which it differs by its habit, leaf shape, and flower color and shape. Moreover, these two entities belong to separate clades (HONG-WA & BESNARD, 2013, 2014).

PERRIER DE LA BÂTHIE (1949) described *N. emarginata* var. *edentata* based on the following syntypes: *Perrier de la Bâthie* 8809, *Thouvenot* 58 and *Ursch* 820; the latter is a typographical mistake for *Ursch* 82. The overall quality and completeness of *Perrier de la Bâthie* 8809 justify the selection of one of the specimens at P as the lectotype.

**Additional specimens
examined**

MADAGASCAR. Prov. Antsiranana: Ambatobiribiry, [14°11'S 50°05'E], 50-345 m, 29-30.XI.1950, *Humbert & Capuron* 24423 (G, MO, P). **Prov. Toamasina:** Maroantsetra, Ambinanitelo, Ankirindro forest, 15°17'35"S 49°23'59"E, 664 m, 16.I.2003, *Antilahimena et al.* 1741 (G, MO, P); Manambolo, Amparihibe forest, 15°02'26"S 49°34'59"E, 800 m, 22.II.2003, *Antilahimena* 1919 (MO); Moramanga, Sahaevo, 18°50'38"S 48°16'54"E, 1006 m, 11.XI.2006, *Antilahimena & Edmond* 4944 (G, MO, P, TAN, TEF); Ambatovy, 18°51'43"S 48°17'39"E, 1049 m, 9.XII.2006, *Antilahimena & Edmond* 5092 (MO, P, TAN, TEF); *ibid. loc.*, 18°50'28"S 48°18'16"E, 1085 m, 13.V.2010, *Bernard* 1566 (MO, P, TAN); Analamazaotra RS, 18°56'12"S 48°25'09"E, 953 m, 2.V.2010, *Hong-Wa & Ortiz* 650 (MO, P, TAN); Betampona RNI, 17°51'S 49°12'E, 275-650 m, 30.IX.1993, *Lewis* 711 (K, MO, P, TAN); Analamazaotra RS, [18°56'S 48°26'E], 25.VII, *Louvel* 88 (P); Andasibe, 18°55'50"S 48°25'04"E, 963 m, 5.XII.2008, *Rakotondrafara et al.* 932 (MO, P, TAN); Moango, Zahamena RNI, 17°33'32"S 48°53'55"E, 800 m, 4.V.2003, *Rakotondrajaona et al.* 274 (CNARP, G, MO, P, TEF); Lakato, Ambodigavo, forêt d'Analanjahana, 19°07'57"S 48°24'00"E, 794 m, 31.V.2007, *Razanatsima et al.* 266 (G, MO, P, TAN); 32 km E of Moramanga, 18°57'S 48°27'E, 870 m, 29.I.1993, *Schatz* 3452 (MO, P, TAN); Maroantsetra, Farankaraina, [15°25'S 49°52'E], 20-25 m, 16.IX.1952, *Service Forestier* 6151 (P, TEF); Périnet, [18°56'S 48°26'E], 1000 m, 1.VI.1954, *Service Forestier* 10374 (P, TEF); Masoala Peninsula, Ambanizana, 15°40'24"S 49°57'51"E, 110-260 m, 28.X.1994, *Vasey & Velo* 83 (MO, P, TAN).

28. *Noronhia emarginata* (Lam.) Stadtm. ex Thouars., Gen. Nov. Madagasc. 88. 1806 (Fig. 20).

≡ *Olea emarginata* Lam., Tabl. Encycl. Méthod. 1: 29. 1791.

≡ *Noronhia binia* Roem. & Schult., Syst. Veg. 1: 72. 1817.

≡ *Noronhia chartacea* Stadtm. ex Hook. in Bot. Misc. 2: 167. 1831.

Lectotypus (designated here): **MADAGASCAR** [Cultivé à l'Isle de France (=Mauritius)]: *sine loc.*, s.d., *Stadtmann s.n.* (P-LA [P00356884, P00356885] images seen; isolecto-: G [G00439907] image seen). **Syntypi**: **MADAGASCAR**: cultivé à l'Isle de France, s.d., *Martin s.n.* (G [G00439908, G00439909] images seen). **MADAGASCAR**: *sine loc.*, *Noroña s.n.* (G [G00188773] image seen, P [P03558859, P03558865]! probable syntypes).

Description

Trees to 15 m tall, trunk to 30 cm diameter; young twigs cylindrical, 2-8 mm diameter, glabrous; bark gray to brownish, smooth, with scattered lenticels. *Leaves* opposite, persistent; bud scales persistent; blades dark green above, lighter below, obovate, 5.5-12 × 3-7.5 cm, very coriaceous, glabrous, domatia absent, base rounded, margin slightly revolute and undulate, apex obcordate to rounded (rarely mucronulate), the mucro 0-2 mm long, midrib flat above, distinctly raised below, secondary veins conspicuous, 5-11 per side, 10-21 mm apart, looping 1.5-4 mm from the margin; petiole dark gray to brown, 5-11 × 1.8-4.3 mm, entirely woody, glabrous. *Thyrse*s geminate to fasciculate, pauciflorous, diffuse; peduncle 5-20 mm long, glabrescent; pedicel 4.5-12 mm long, glabrescent; calyx sparsely pubescent outside, glabrous inside, lobes triangular, 0.7-2 × 0.9-2 mm; corolla yellow, cupuliform to subrotate, 5-8 mm long, glabrous on both sides, the tube 2-4.5 mm long, lobes widely ovate, apex obtuse; corona present, 1.5-2.5 mm long, undivided; stamens 2.5-2.8 mm long, anthers widely oblong, 2-2.4 mm long; pistil 2.5-3 mm long, stigma capitate. *Fruiting* pedicel 75-14 × 1.5-3 mm; young fruits greenish, purplish black when mature, oblong, 24.5-37 × 17.5-27 mm, smooth, sometimes covered with a white pellicle, apex flat to bluntly pointed or rostellate; dry pericarp 1.7-4.6 mm thick; endocarp woody; seed 14-25 × 8.5-15 mm.

Distribution, ecology and phenology

Noronhia emarginata occurs mostly in littoral to mid-elevation humid forests in the east, from Sambava to Fort-Dauphin (Fig. 19). It produces flowers and fruits all year long except in April and May.

Conservation status

With 34 collections representing 34 localities, the assessment indicated an EOO of 97,176 km², an AOO of 120 km², and 28 subpopulations representing 19 locations, of which 12 occur within protected areas (Agnalazaha, Ambohidena, Antetazana, Betampona, Loky-Manambato, Mandena, Manombo, Masoala, Petriky, Ste Luce, Vohibola, and Zahamena). Although the habitat in which *N. emarginata* is found exhibits some types of degradation, there is little likelihood that they will cause substantial decline in the near future. Therefore, *N. emarginata* is assigned a preliminary status of "Least Concern".

Notes *Noronhia emarginata* can be recognized by its coriaceous, obovate leaf blades, long-pedunculate inflorescences with yellow flowers, and large, oblong fruits with a thick pericarp. PERRIER DE LA BÂTHIE (1949) indicated that the type specimen [P03558857] was collected by Louis-Marie Aubert du Petit-Thouars in eastern Madagascar. However, du Petit-Thouars returned from the island with his herbarium in 1802 (ALLORGE, 2003), which certainly postdates Lamarck's description in 1791. Moreover, LAMARCK (1791: 29) clearly referred to a specimen collected by Joseph Martin (1788-1826), a French botanist from French Guiana, who also collected on Martinique and Mauritius (STAFLEU & COWAN, 1976-1988: 320), as "ex Insula Madagascar".

A thorough search of type specimens at G and P revealed several interesting collections. In particular, one of two specimens kept in the P-LA herbarium [P00356884, P00356885] bears the name Radtmann, which is undoubtedly a mistake for Jean Frédéric Stadtmann (1762-1807), who worked extensively in South Africa and the Malagasy Floristic Region (i.e. Madagascar, the Comoros, and the Mascarenes). Another collection found at G [G00439907] has the same handwriting and was annotated as "*Noronhia* Stadtman en l'honneur d'un naturaliste espagnol" (Fig. 20), which should thus be considered as a duplicate of the P-LA collection. Furthermore, two of Joseph Martin's collections were found at G [G00439908, G00439909] bearing a different handwriting and with only part of the same annotation as the P-LA material [P00356884]. These collections should also be considered as type material. The specimen *Stadtmann s.n.* (as *Radtman s.n.* in P-LA) is here designated as the lectotype since it is housed in Lamarck's original herbarium, and is thus certainly the one he used to describe the species. The specimens *Martin s.n.* are here considered as syntypes.

It is also interesting to note that one collection at G [G00188773] was made by Francisco Noroña (c. 1748-1788), which explains why Jean Frédéric Stadtmann chose to name this new genus after his Spanish botanist friend, who died in Mauritius shortly after he visited Madagascar (ALLORGE, 2003). During his visit to the Big Island, Noroña collected material that was later acquired by Delessert and is now kept at G (GUILLEMIN, 1833; STAFLEU & COWAN, 1976-1988: 773). Some of Noroña's duplicates are also housed at P, where they have been incorporated in various historical collections, and two collections from the Desfontaines herbarium at P may represent duplicates of the G sheet [P03558859, P03558865]. Noroña was very likely the first to collect *N. emarginata* in Madagascar and to bring the seeds back to the Jardin de Pamplemousse in Mauritius, where cultivated plants were subsequently sampled by various botanists such as Stadtmann and Martin. The cultivated plant sampled was used by LAMARCK (1791) as the type material for *Olea emarginata* before du Petit-Thouars validated the genus *Noronhia* in 1806.

Additional selected specimens examined

MADAGASCAR. Prov. Antsiranana: Sambava, [14°16'S 50°10'E], 9.IV.1967, *Service Forestier* 27697 (MO, P, TEF). **Prov. Fianarantsoa:** Mananjary, [21°13'S 48°21'E], III-IV.1909, *Geay* 7934 (P); Bassin inférieur de Matitana, X.1911, *Perrier de la Bâthie* 2382 (P); Nosy Varika, Ambahy, 20°46'57"S 48°28'54"E, 17.XI.2003, *Rabevohitra et al.* 4829 (MO, P, TEF); Manombo RS, 23°03'46"S 47°46'15"E, 14 m, 24.IX.2005, *Rakotonirina et al.* 464 (MO, P, TAN). **Prov. Toamasina:** Maroantsetra, Anjahana, Andranofotsy, 15°26'08"S 49°49'14"E,

10 m, 16.VII.2002, *Antilahimena* 1188 (G, MO); between Anantoraka and Manambia, 15°30'S 49°39'E, 10 m, 12.X.1997, *Birkinshaw et al.* 506 (MO, P, TAN); Sainte-Marie, [16°53'S 49°53'E], V.1847, *Boivin* 1776 (P); 1 km S of Ambila-Lemaitso, 18°48'S 49°09'E, 0-5 m, 7.XI.1988, *Miller* 3646 (K, MO, P, TAN); Sainte Marie, Lokintsy, forêt d'Ambohidena, 16°51'11"S 49°57'10"E, 1.VI.2004, *Rabehevitra et al.* 1206 (G, MO, P, TEF); Masoala PN, Antalavia, 15°47'S 50°02'E, 0 m, 20.XI.1994, *Rahajaso et al.* 948 (MO, P, TAN); 6-10 km S of Ambila-Lemaitso, 18°54'S 49°08'E, 0-20 m, 6.III.1988, *Schatz et al.* 1942 (MO, P, TAN); Brickaville, Ambila, Andranokoditra, [18°36'S 49°15'E], 24.XI.1983, *Service Forestier* 32510 (TEF); Andrafetana, Mahatsara, 17°38'S 49°29'E, 5.VI.1991, *Service Forestier* 34304 (MO, TEF). **Prov. Toliara:** Fort-Dauphin, Eoala, 25°04'S 46°57'E, 0-10 m, 10.III.1989, *Dumetz et al.* 551 (MO, P, TAN, TEF); Fort-Dauphin, entre le pic St Louis et la mer, 1-5 m, 20.IX-6.X.1928, *Humbert* 5977bis (P); *ibid. loc.*, 16.II.1955, *Humbert* 28962 (P); Petriky, 25°05'S 46°52'E, 10 m, 22.I.1990, *McPherson et al.* 14856 (G, MO, P, TAN, TEF); Mandena forest, 24°57'S 47°00'E, 2-15 m, 23.I.1990, *McPherson et al.* 14870D (MO); Ste. Luce, 24°46'S 47°09'E, 0-10 m, 17-18.I.1990, *Rabevohitra* 2162 (K, MO, P, TAN, TEF); Fort-Dauphin, *Scott-Elliot* 3050 (E, K, P); Manafiafy, 24°47'S 47°11'E, 17.I.1990, *Service Forestier* 33391 (TEF).

Noronhia emarginata* var. *garcinioides H. Perrier in Mém. Inst. Sci. Madagascar, Sér. B, Biol. Vég. 2: 296. 1949.

Typus: MADAGASCAR. **Prov. Mahajanga:** haut bassin du Bemarivo, Analamahitso, [16°11'S 48°14'E], 900 m, VIII.1907, *Perrier de la Bathie* 4497 (holo-: P [P00608379]!).

Distribution, ecology and phenology

Noronhia emarginata var. *garcinioides* occurs in mid-elevation humid forests in the northern High Plateau (Fig. 19). It has been collected in flowers and fruits in August.

Conservation status

Noronhia emarginata var. *garcinioides* is known only from a single location from within a remote protected area (Tampoketsa d'Analamaitso) that is difficult to access. Although degradation can be observed in the areas surrounding the reserve, disturbance is assumed to be minimal within it, with the closest village being 41 km away. Therefore, *N. emarginata* var. *garcinioides* is assigned a preliminary status of "Least Concern". It is, however, worth noting that this taxon has only been collected once, more than a century ago.

Notes

Noronhia emarginata var. *garcinioides* differs from the typical variety mostly by its oblong (vs. obovate) leaf blades and urceolate (vs. cupuliform to subrotate) flowers. It is morphologically intermediate between *N. emarginata* and *N. edentata* (formerly recognized as a variety of *N. emarginata* by PERRIER DE LA BATHIE, 1949, 1952), and more closely resembles the latter, except for the lack of woody petiole and the length of the corolla (8 vs. 5.5 mm). *Noronhia emarginata* var. *garcinioides* might be a hybrid between *N. emarginata* and *N. edentata* or a distinct species altogether. Additional material is needed to assess its pattern of variation and ascertain its status.

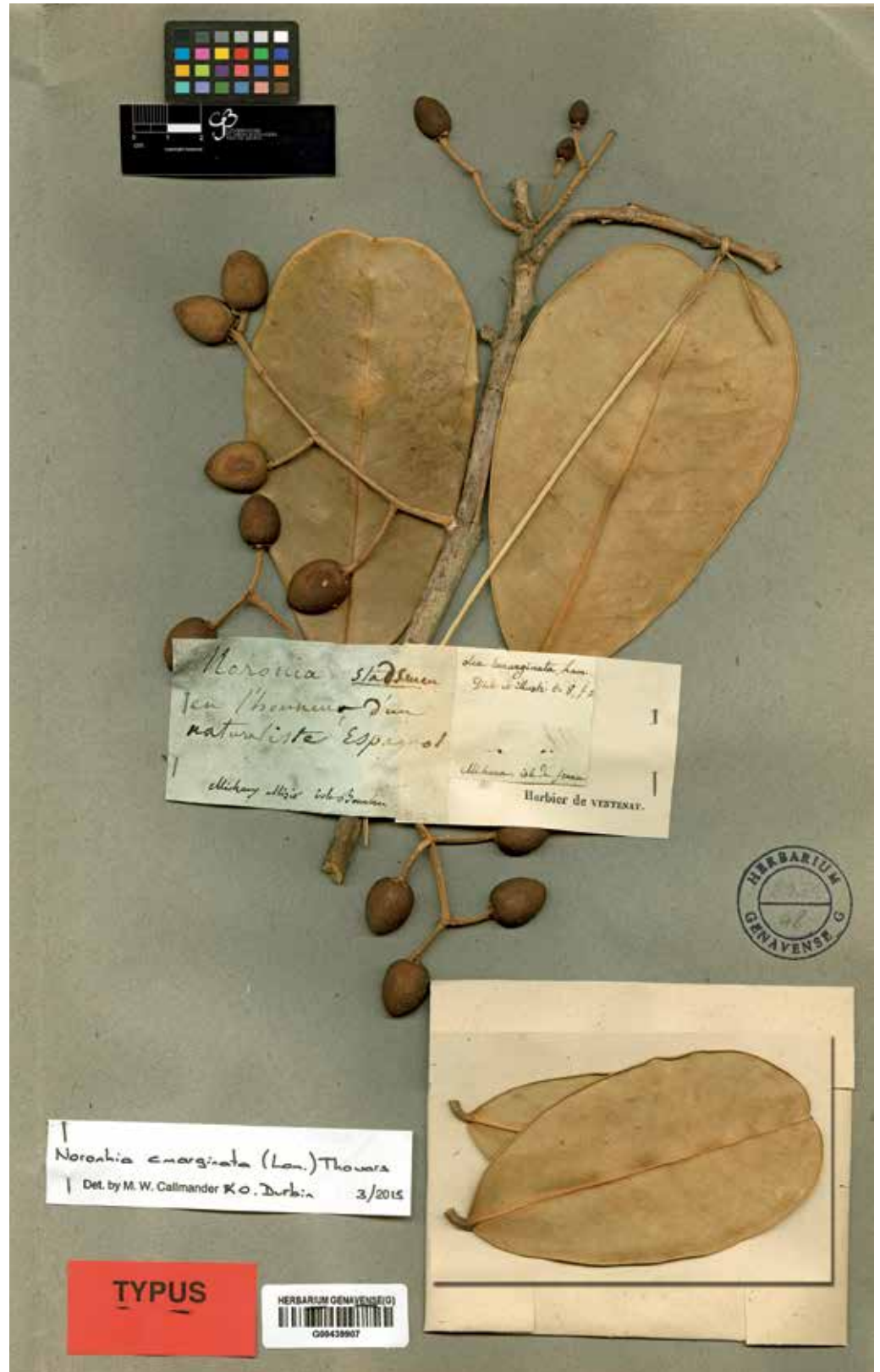


Fig. 20.
Isolectotype of *Noronhia*
emarginata (Lam.) Thouars

[Stadtman s.n., G]

29. *Noronhia gautieri* Hong-Wa, spec. nova (Fig. 21, 22A).

Typus: MADAGASCAR. **Prov. Antsiranana:** SAVA, Vohémar, Daraina, forêt d'Antsahabe, 13°13'03"S 49°32'51"E, 900 m, 6.XII.2004, *Gautier & Nusbaumer* 4839 (holo-: MO-6386608!; iso-: Daraina, G [G00019223] image seen, K, P [P00853025]!, TEF!).

Diagnosis *Noronhia gautieri* Hong-Wa can be distinguished from other members of the genus by its broadly ovate leaf blades, with rounded base, its long-pedicellate, subglobose fruits, with large persistent sepals, and its crustaceous endocarp.

Description Shrubs to 3.5 m tall, trunk to 3 cm diameter; young twigs cylindrical, 1.2-1.5 mm diameter, glabrous; bark yellowish, smooth, somewhat flaky. Leaves opposite, persistent; bud scales persistent; blades medium green above, lighter below, ovate, 7-13 × 2.5-5.5 cm, subcoriaceous, glabrous, domatia absent, base rounded, margin flat, apex acute to acuminate, the acumen 1-9 mm long, midrib flat above, distinctly raised below, secondary veins conspicuous, 10-14 per side, 7-23 mm apart, looping 2-6 mm from the margin; petiole light gray, 8-13 × 2-3 mm, entirely woody, glabrous. Flowers unseen, but infructescence thyrsoid. Fruiting pedicel 13-17 × 1.5-2.5 mm; young fruits green, yellowish when mature, subglobose, 11.5-20 × 10.5-18 mm, surface smooth, apex flat to slightly apiculate; dry pericarp 1-1.2 mm thick; endocarp crustaceous; seed 9-13 × 7-10 mm.

Etymology This species is dedicated to Laurent Gautier, Curator at the Conservatoire et Jardin botaniques de la Ville de Genève, who collected the type specimen and has contributed widely to the knowledge of the flora of northern Madagascar.

Distribution, ecology and phenology *Noronhia gautieri* occurs in semi-deciduous and humid forests at low elevation in northeastern Madagascar (Fig. 19). It fruits from October to December.

Conservation status The assessment was based on three collections representing three localities and provided an EOO of 10,027 km², an AOO of 12 km², and three subpopulations representing three locations, two of which occur within protected areas (Loky-Manambato and Tsaratanana-Ambohimirahavavy-Corridor Marojejy). With a restricted distribution and projected continuing decline in habitat quality resulting from illicit forest exploitation, *N. gautieri* is assigned a preliminary status of "Vulnerable" [VU B1ab(iii)+2ab(iii)].

Notes *Noronhia gautieri* is similar to *N. capuronii*, but can be distinguished by its glabrous (vs. pubescent) petiole, rounded (vs. cordate) leaf base, and flat to apiculate (vs. flat) fruit apex.

Paratypes MADAGASCAR. **Prov. Antsiranana:** Antongondriha, Mt Anjenabe, [14°18'S 49°45'E], 500-600 m, 3-7.XI.1950, *Humbert & Capuron* 24047 (MO, P); Antalaha, Ambohitralanana, [15°14'S 50°27'E], 9.X.1953, *Réserves Naturelles* 5716 (MO, P).

Fig. 21. *Noronhia gautieri* Hong-Wa. **A.** Fruiting branch; **B.** Abaxial side of leaf blade; **C.** Adaxial side of leaf blade; **D.** Fruit.

[Gautier 4839, MO] Drawings: R.L. Andriamiarisoa

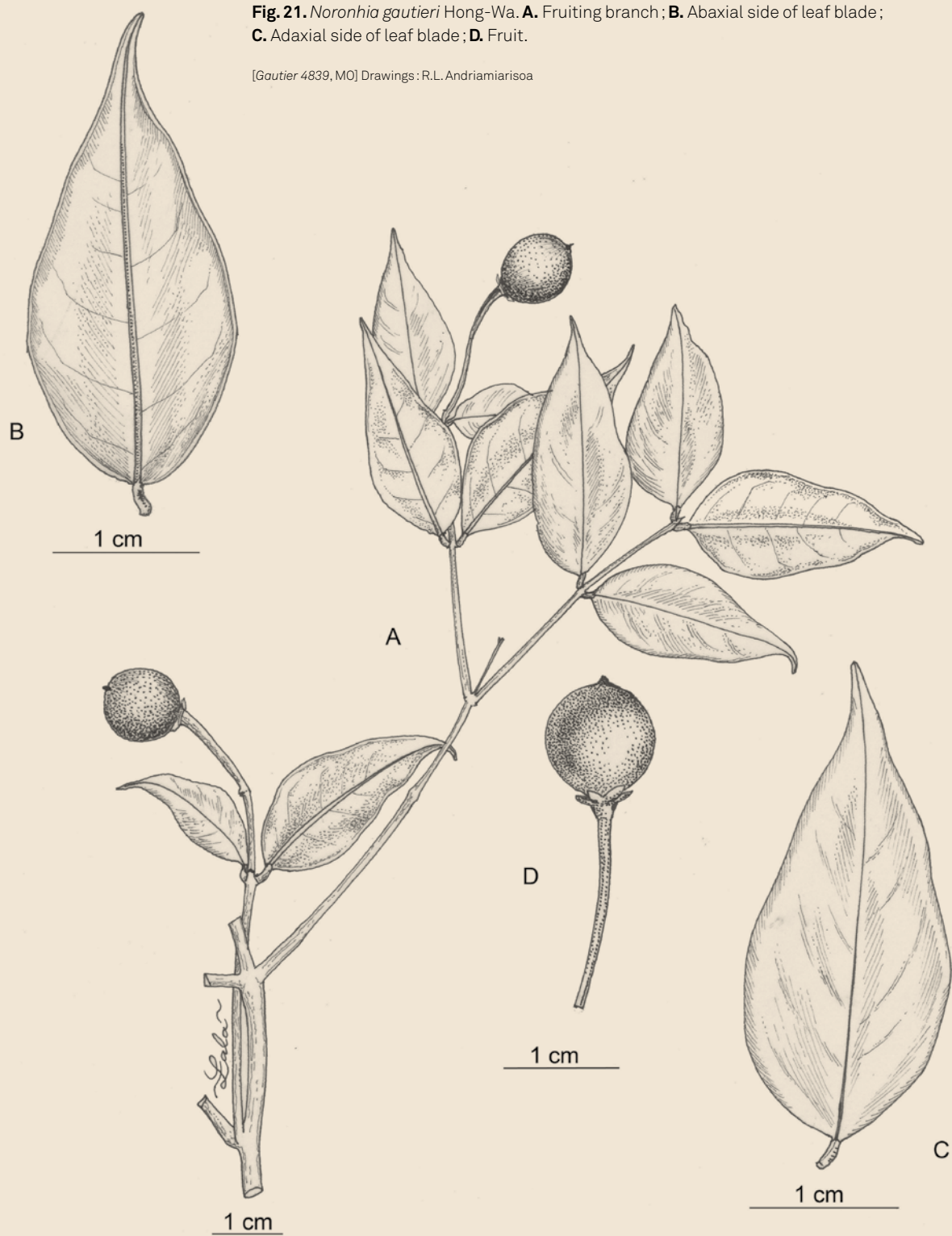




Fig. 22. Photographs of *Noronhia* Stadtm. ex Thouars.

A. *Noronhia gautieri* Hong-Wa [Gautier 4839]; **B.** *Noronhia gracilipes* H. Perrier [Antilahimena 7782];
C. *Noronhia grandifolia* H. Perrier [Gautier 4803]; **D.** *Noronhia greeniana* Hong-Wa [Ratovoson 1102].

Photos: taken by respective collectors

30. *Noronhia gracilipes* H. Perrier in Mém. Inst. Sci. Madagascar, Sér. B, Biol. Vég. 2 : 287. 1949 (Fig. 22B).

Typus: MADAGASCAR. **Prov. Toamasina:** env. d'Analamazaotra, [18°55'48"S 48°25'48"E], 700 m, s.d., *Perrier de la Bâthie* 8811 (holo-: P [P00413233]!; iso-: P [P00413234]!).

Description

Trees to 10 m tall, trunk to 15 cm diameter; young twigs cylindrical, 0.5–1.5 mm diameter, glabrous; bark light gray to whitish, smooth, sometimes lenticellate. *Leaves* opposite, persistent; bud scales persistent; blades dark green above, lighter below, lanceolate to elliptic, 5.5–11.5 × 2–4.6 cm, chartaceous, glabrous, domatia casual to common, base acute to attenuate, margin slightly revolute and undulate, apex acuminate to cuspidate, the acumen or cusp 6–23 mm long, midrib slightly sunken above, raised below, secondary veins conspicuous, 5–10 per side, 6–26 mm apart, looping 1–5 mm from the margin; petiole light gray to whitish, 2–9 × 0.7–2.2 mm, entirely woody, glabrous. *Thyrse*s fasciculate, pauciflorous, diffuse; peduncle 2–22 mm long, glabrescent; pedicel 14–36 mm long, glabrescent; calyx sparsely pubescent outside, glabrous inside, lobes triangular to deltate, 1.5–3 × 1–2 mm; corolla pinkish, cupuliform to subrotate, 4–6 mm long, glabrous on both sides, the tube 1.5–4 mm long, lobes lanceolate, apex acute; corona absent; stamens 1.5–2.7 mm long, anthers oblate to orbicular, 1.3–1.9 mm long; pistil 2.2–3.8 mm long, stigma capitate. *Fruiting* pedicel 10–37 × 0.5–2.3 mm; young fruits green, dark red when mature, subglobose, 13–24 × 12.5–22 mm, surface smooth, sometimes covered with white dots, apex apiculate; dry pericarp 0.3–1.1 mm thick; endocarp crustaceous; seed 9–19.5 × 7–15 mm.

Distribution, ecology and phenology

Noronhia gracilipes occurs in low- to high-elevation humid forests from Montagne d'Ambre in the north to Ranomafana in the south (Fig. 19). It produces flowers and fruits throughout the year except in March and April.

Conservation status

Based on 34 collections representing 28 localities, the assessment indicated an EOO of 86,638 km², an AOO of 100 km², and 15 subpopulations representing 12 locations, of which seven occur within protected areas (Ambalabe, Analamazaotra, Andringitra, Corridor Ankeniheny-Zahamena, Montagne d'Ambre, Pic d'Ivohibe, and Zahamena). With such a large EOO and presence in many protected areas, *N. gracilipes* is assigned a preliminary status of "Least Concern".

Notes

Noronhia gracilipes can be recognized by its chartaceous, acuminate leaf blades, long peduncles and pedicels, pinkish flowers, and subglobose, crustaceous fruits. This species closely resembles *N. decaryana*, from which it differs mainly by the color of its bark (whitish vs. gray) and flowers (pinkish vs. orangish-red), and by the shape of its corolla (cupuliform to subrotate vs. urceolate).

Additional specimens examined

MADAGASCAR. Prov. Antananarivo: Andreba, au voisinage d'Anjozorobe, [18°18'S 47°52'E], 1400-1500 m, 1.XI.1967, *Bernardi 11135* (G, P). **Prov. Antsiranana:** Montagne d'Ambre (Station des Roussettes), 12°33'S 49°08'E, 1000 m, 22.I.2009, *Hong-Wa 571* (MO, P, TAN); Antsalaka, Montagne d'Ambre PN, 12°37'17"S 49°10'46"E, 1038 m, 12.VI.2010, *Hong-Wa 713* (MO, P, TAN); *ibid. loc.*, 12°34'49"S 49°07'58"E, 20.I.2008, *Ramandimbimanana et al. 38* (G, MO, TEF); *ibid. loc.*, 12°36'11"S 49°11'28"E, 1030 m, 1.V.2008, *Ramandimbimanana 104* (G, MO, TEF); *ibid. loc.*, 12°30'49"S 49°09'51"E, 1040 m, 24.V.2008, *Ramandimbimanana et al. 128* (G, MO, TEF); Ambohitra (Joffreville), Montagne d'Ambre PN, 12°33'S 49°08'E, 1000 m, 13.IX.1987, *Schatz 1504* (G, MO, P, TAN); *ibid. loc.*, 12°36'12"S 49°11'55"E, 910 m, 5.V.2008, *Trigui et al. 335* (G, MO, TEF). **Prov. Fianarantsoa:** Andringitra RNI, Camp II, c. 43 km S of Ambalavao, 22°13'22"S 46°58'18"E, 1210 m, 1-7.XII.1993, *Lewis et al. 1011* (MO, P); Ivohibe RS, 22°29'00"S 46°58'06"E, 1200 m, 16.X.1997, *Rakotomalaza et al. 1431* (G, MO, P, TAN); Andrambovato, Fort-Carnot, [21°31'S 47°25'E], 878-1000 m, 24.VIII.1955, *Service Forestier 15400* (MO, TEF). **Prov. Toamasina:** Brickaville, Ambodilendemy, Ankerana, 18°25'40"S 48°47'17"E, 990 m, 24.III.2011, *Antilahimena 7782* (G, MO, P, TAN); Andasi-be-Périnet, 18°56'S 48°25'E, 1000 m, 2-5.XI.1984, *Dorr & Barnett 3183* (MO, P, TAN); Analamazaotra RS, 18°56'S 48°26'E, 9.VI.1938, *Herb. Jard. Bot. Tan. 3731* (MO); Ambatondrazaka, Antanandava, Antenina, 17°30'09"S 48°46'19"E, 917 m, 1.II.2002, *Randrianjanaka 696* (CNARP, G, MO, P, TEF); Vatomandry, Ambalabe, Ambinanindrano II, 19°09'47"S 48°34'37"E, 624 m, 12.VIII.2006, *Razanatsima 147* (MO, P, TAN); Ambodiriana, 17°53'24"S 49°13'48"E, 29.XI.1953, *Réserves Naturelles 5907* (MO).

31. *Noronhia grandifolia* H. Perrier in Mém. Inst. Sci. Madagascar, Sér. B, Biol. Vég. 2: 299. 1949 (Fig. 22C).

Typus: MADAGASCAR. **Prov. Toamasina:** Est, Masoala, [15°17'S 50°11'E], 300 m, X.1912, *Perrier de la Bâthie* 2167 (holo-: P [P00418111]!).

Description *Shrubs* to trees to 10 m tall, trunk to 20 cm diameter; young twigs cylindrical, 1-5 mm diameter, glabrous; bark light brown, smooth to slightly rugose. *Leaves* opposite, persistent; bud scales rarely persistent; blades dark green above, lighter below, oblong, 7-23 × 3-8 cm, chartaceous, glabrous, domatia absent, base acute to rounded, margin slightly undulate, apex acuminate, the acumen 2-19 mm long, midrib slightly sunken above, distinctly raised below, secondary veins conspicuous, 7-16 per side, 11-40 mm apart, looping 3-8 mm from the margin; petiole medium gray, 8-20 × 1.5-3.5 mm, entirely woody, glabrous. *Thyrse*s fasciculate, pauciflorous, diffuse; peduncle 5-23 mm long, densely pubescent; pedicel 7-12 mm long, densely pubescent; calyx densely pubescent on both sides, lobes triangular, 1.5-2 × 1.5-1.8 mm; corolla purplish, sometimes tinged yellow, subrotate, 4.5-6 mm long, sparsely pubescent outside, glabrous inside, the tube 2-3 mm long, lobes ovate, apex obtuse; corona absent; stamens 2-2.8 mm long, anthers obovate, 1.2-1.5 mm long; pistil 2.5-3 mm long, stigma capitate. *Fruiting pedicel* 8-28 × 1-3 mm; young fruits green, purple when mature, subglobose, 13.5-23.5 × 13-24.5 mm, surface smooth, apex apiculate; dry pericarp 0.4-2.2 mm thick; endocarp crustaceous; seed 10.5-20 × 7.5-14 mm.

Distribution, ecology and phenology *Noronhia grandifolia* occurs in low- to high-elevation humid forests from Daraina in the north to Andohahela in the south (Fig. 19). It produces flowers and fruits throughout the year, with a peak between October and February.

Conservation status With 23 collections representing 21 localities, the assessment indicated an EOO of 104,491 km², an AOO of 84 km², and 21 subpopulations representing 17 locations, of which 10 occur within protected areas (Andohahela, Anjanaharibe-Sud, Corridor Ambositra-Vondrozo, Loky-Manambato, Makira, Mantadia, Marojejy, Masoala, Ranomafana, and Tsaratanana-Ambohimirahavavy-Corridor Marojejy). Being so widespread and well represented within the network of protected areas, *N. grandifolia* is assigned a preliminary status of “Least Concern”.

Notes *Noronhia grandifolia* can be recognized by its large, chartaceous leaf blades, pubescent inflorescences, purplish-yellow flowers that lack a corona, and subglobose, crustaceous fruits subtended by long pedicels.

Additional specimens examined

MADAGASCAR. Prov. Antsiranana: Anjanaharibe-Sud RS, 10 km SW of Befingotra, 14°45'S 49°29'E, 1100-1300 m, 7.IX.1997, *Birkinshaw et al.* 468 (MO, P, TAN); Daraina, forêt d'Antsahabe, 13°13'08"S 49°33'04"E, 890 m, 2.XII.2004, *Gautier* 4803 (Daraina, G, MO, P, TEF); Andapa, Marojejy PN, 14°28'57"S 49°38'12"E, 1100-1600 m, 19-24.I.1994, *Malcomber et al.* 2701 (MO, P, TAN); Andapa, Ambodisatrana, 14°32'S 49°26'E, 1100-1200 m, 3.VIII.1997, *McPherson* 17197 (K, MO); Anjanaharibe-Sud RS, 14°44'42"S 49°27'42"E, 1185-1335 m, 3.XI.1994, *Ravelonarivo & Rabesonina* 494 (MO, TAN); *ibid. loc.*, 14°12'S 49°27'E, 1100 m, 13-18.IX.1996, *Ravelonarivo et al.* 1034 (MO, P, TAN); Sambava, Andratamarina, Bemanasy, 14°23'54"S 49°50'55"E, 892 m, 23.X.2010, *Ravelonarivo & Raharivelo* 3568 (MO, P, TAN); Ambatoharanana, [14°18'S 49°33'E], 460 m, 9.VII.1963, *Service Forestier* 21629 (MO, TEF). **Prov. Fianarantsoa:** Ranomafana PN, Parcelle 3, 21°16'06"S 47°25'30"E, 923 m, 8.V.2010, *Hong-Wa & Ortiz* 670 (MO, P, TAN); entre Ivohibe RS et Andringitra PN, 22°25'36"S 46°56'18"E, 955 m, 14.XI.1997, *Messmer et al.* 573 (G, MO, P). **Prov. Mahajanga:** Befandriana-Nord, Matsoandakana, Andranomena, forêt d'Anjiabe, 15°08'14"S 49°21'27"E, 1084 m, 12.II.2008, *Ravelonarivo et al.* 2798 (G, MO, P, TAN). **Prov. Toamasina:** Maroantsetra, Anjahana, Ambodivoangy, 15°25'30"S 49°50'50"E, 100 m, 20.VII.2002, *Antilahimena* 1226 (MO, P); Vinanibe, Andongona, Makira, 15°27'40"S 49°17'46"E, 1153 m, 28.XI.2003, *Antilahimena* 2420 (G, MO); Analamazaotra RS, 18°49'32"S 48°26'04"E, 941 m, 3.V.2010, *Hong-Wa & Ortiz* 662 (MO, TAN); Masoala Peninsula, 1-3 km S of Ambanizana, 15°38'S 49°58'E, 0-10 m, 7.XII.1990, *Schatz & Modeste* 3020 (G, MO, P, TAN). **Prov. Toliara:** Andohahela, path over Col Antanantana to Iminiminy, 24°44'S 46°47'E, 800 m, 7.XII.1989, *Du Puy et al.* MB525 (TAN); Andohahela (parcel 1), Marovoalavo (Ebaketra), 24°38'11"S 46°50'42"E, 16.V.1996, *Randriamampionona* 1125 (G, MO).

32. *Noronhia greeniana* Hong-Wa, *spec. nova* (Fig. 22D, 23).

Typus: MADAGASCAR. **Prov. Antsiranana:** DIANA, Diégo II, Ramena, Andavakoera, Montagne des Français aux env. du Fort, 12°19'18"S 49°20'16"E, 270 m, 29.XII.2008, Hong-Wa 549 (holo-: MO-6615558!; iso-: P!, TAN!).

Diagnosis *Noronhia greeniana* Hong-Wa can be distinguished from other congeneric species by its somewhat tortuous habit, its oblate leaf blades and its solitary, punctate and rostellate fruits.

Description Trees to 8 m tall, trunk to 20 cm in diam.; young twigs cylindrical, 0.6-1.2 mm in diam., glabrous; bark light gray, rugose. Leaves opposite, semi-deciduous; bud scales rarely persistent; blades light green above and below, oblate, $2.5-3.5 \times 1.5-3$ cm, subcoriaceous, glabrous, domatia common, base attenuate, margin flat, apex shortly cuspidate, the cusp 0.5-2 mm long, midrib slightly sunken above, distinctly raised above, secondary veins barely visible, 5-8 per side, 4-9 mm apart, looping 1.5-3 mm from the margin; petiole yellowish, $4-7 \times 0.7-1$ mm, not woody, glabrous. Flowers unseen, but fruits solitary. Fruiting pedicel $1-6 \times 1-3$ mm; young fruits green, purplish when mature, ovoid, $16-23 \times 10-15$ mm, surface covered with white dots, apex rostellate, the rostellum slightly flattened, ridged, truncate, with the persistent style; dry pericarp 0.9-1.6 mm thick; endocarp woody; seed $9-14.5 \times 5-9$ mm.

Etymology This name honors the late Peter S. Green, who was a Keeper and Deputy Director at the Royal Botanic Gardens, Kew for his contribution to the knowledge of the Malagasy *Oleaceae* and the olive family in general, most of which he completed after his retirement in 1982 until his passing in 2009.

Distribution, ecology and phenology *Noronhia greeniana* occurs in low-elevation dry forests on sandstones and basement rocks in the north, from Montagne des Français to Daraina (Fig. 19). It fruits from September to December.

Conservation status *Noronhia greeniana* is currently known only from four collections representing four localities and has an EOO of 765 km², an AOO of 16 km², and four subpopulations representing three locations, of which two occur within the network of protected areas (Loky-Manambato and Montagne des Français). These protected areas have just been established and are still subject to some types of degradation as a result of illicit exploitation. Continuing decline is also projected at one of the other locations due to wood harvesting, forest conversion and artisanal mining. Therefore, *N. greeniana* is assigned a preliminary status of "Endangered" [EN B1ab(iii)+2ab(iii)].

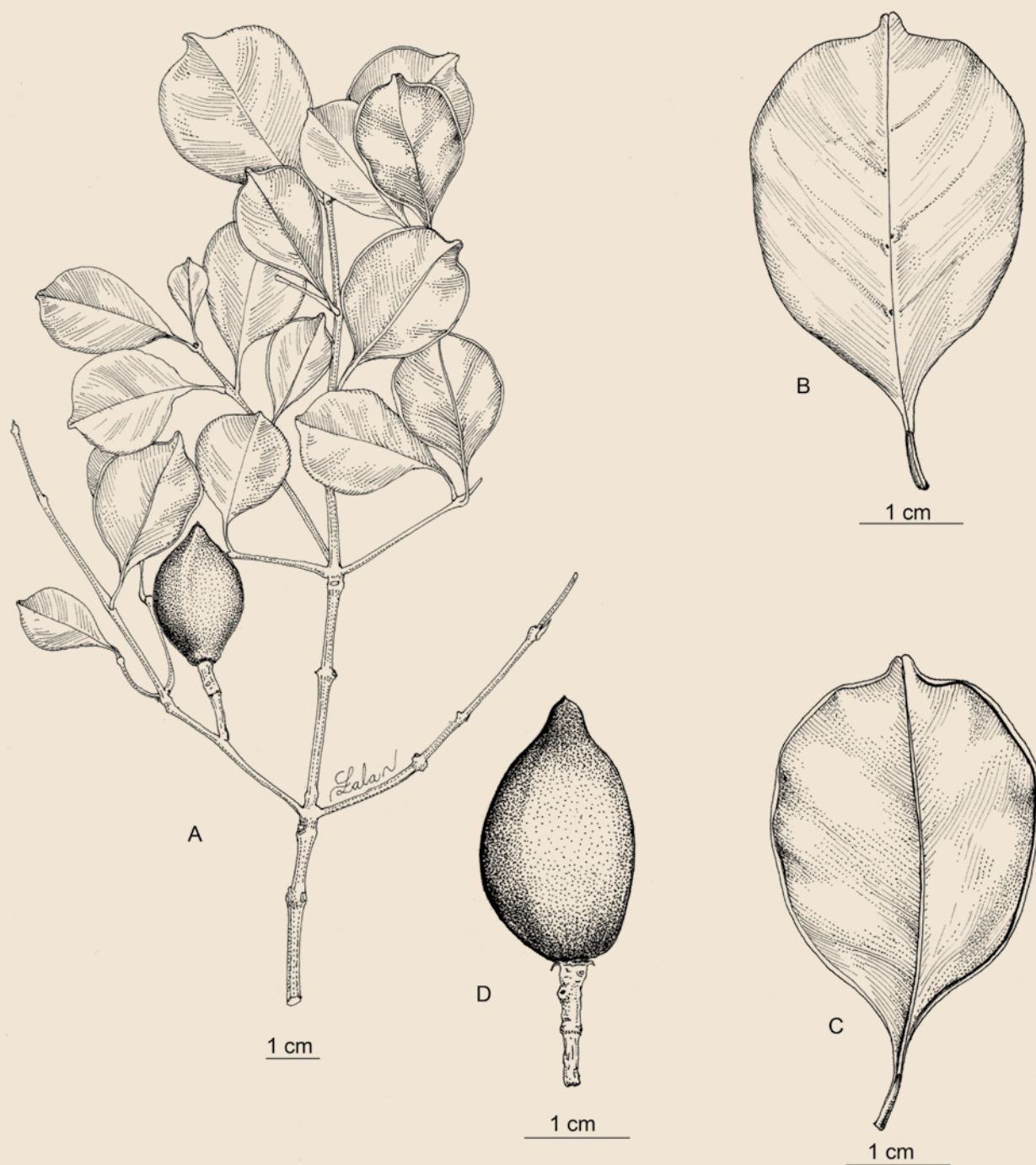


Fig. 23. *Noronhia greeniana* Hong-Wa.

A. Fruiting branch; **B.** Adaxial side of leaf blade; **C.** Abaxial side of leaf blade; **D.** Fruit.

[Randrianaivo 1085, TAN] Drawings: R.L. Andriamiarisoa

Notes *Noronhia greeniana* most closely resembles *N. divaricata*, from which it differs by its semi-deciduous (vs. persistent), oblate (vs. elliptic to rhombic) and cuspidate (vs. rounded to acute) leaves, and by its punctate and rostellate (vs. smooth and apiculate) fruits.

Paratypes **MADAGASCAR. Prov. Antsiranana:** Andavakoera, Andranonankomba, Montagne des Français, 12°21'00"S 49°21'34"E, 112 m, 8.IX.2004, *Randrianaivo et al.* 1085 (CNARP, MO, TAN); Daraina, forêt d'Ampondrabe, 12°57'40"S 49°42'19"E, 340 m, 8.IV.2004, *Ranirison* 581 (Daraina, G, K, MO, TEF); Daraina, Befarafara, Solanampilana, 13°05'56"S 49°35'29"E, 110 m, 16.XI.2005, *Ratovoson et al.* 1102 (CNARP, G, MO, P, TAN).

33. *Noronhia humbertiana* H. Perrier in Mém. Inst. Sci. Madagascar, Sér. B, Biol. Vég. 2 : 295. 1949 (Fig. 24).

Typus: MADAGASCAR. **Prov. Antsiranana:** Collines et plateaux calcaires de l'Ankarana, à l'O d'Ambondrofe, [12°54'S 49°09'E], 300 m, XII.1937-I.1938, *Humbert* 18948 (holo-: P [P00418108]!; iso-: K [K000233190] image seen, P [P00418109, P00418110]!, S [S09-36003] image seen, WAG [WAG0002491] image seen).

Description

Trees to 8 m tall, trunk to 20 cm in diam.; young twigs cylindrical, 0.7-4.2 mm in diam., pubescent; bark greenish, rugose, somewhat flaky. *Leaves* opposite, deciduous; bud scales persistent; blades medium green above, yellowish below, oblong to lanceolate, 6.5-23 × 3-9 cm, chartaceous, pubescent on lower midrib, domatia casual, base rounded to acute, margin undulate, apex acuminate, the acumen 3-22 mm long, midrib slightly sunken above, raised below, secondary veins conspicuous, 7-14 per side, 7-25 mm apart, looping 1.5-9 mm from the margin; petiole yellowish green, 7-20 × 1.2-2.4 mm, usually not woody, pubescent. *Thyrse*s geminate to fasciculate, pauciflorous, somewhat compact; peduncle 11-14 mm long, densely pubescent; pedicel 4-6 mm long, densely pubescent; calyx densely pubescent outside, only sparsely inside, lobes triangular, 5-9 × 1.8-2 mm; corolla reddish brown outside, yellowish inside, campanulate, 17-22 mm long, glabrous on both sides, the tube 9-12 mm long, lobes ovate to triangular, apex acute; corona present, 1.8-2 mm long, undivided; stamens 2-2.2 mm long, anthers widely oblong to somewhat square or cordiform, 1.5 mm long; pistil 1.8-2 mm long, stigma bilobed. *Fruiting* pedicel 5-22 × 1-2.6 mm; young fruits green, brownish when mature, subglobose, 13-23.5 × 11.5-21 mm, surface smooth, sometimes covered with white dots, apex flat to rostellate, the rostellum flattened, ridged, truncate; dry pericarp 1.6-2.9 mm thick; endocarp woody; seed 7.5-10 × 4-9 mm.

Distribution, ecology and phenology

Noronhia humbertiana occurs in low-elevation dry forests in northern Madagascar, from Ankotekona to south of Vohémar (Fig. 19). It produces flowers and fruits throughout the year.

Conservation status

Using 19 collections representing 17 localities, the assessment yielded an EOO of 5,633 km², an AOO of 60 km², and 14 subpopulations representing 10 locations, of which four occur within protected areas (Andavakoera-Andrafiarana-Ambhipiraka, Ankarana, Loky-Manambato, and Montagne d'Ambre). Except for those overlapping with protected areas, most of the habitats for *N. humbertiana* show signs of degradation that result from land conversion, leading also to habitat loss and reduction of the number of mature individuals. Consequently, *N. humbertiana* is assigned a preliminary status of "Vulnerable" [VU B1ab(i,ii,iii,iv,v)+2ab(i,ii,iii,iv,v)].



Fig. 24. *Noronhia humbertiana* H. Perrier [Nusbaumer 1895].

Photo: L. Nusbaumer

Notes *Noronhia humbertiana* can be recognized by its pubescent leaves, large campanulate flowers measuring up to 2.5 cm long, and subglobose to globose fruits with large sepals. It is the only species of *Noronhia* with such large flowers.

Additional specimens examined MADAGASCAR. **Prov. Antsiranana:** Mosorolava, forêt d'Antsoroby, 12°42'38"S 48°58'16"E, 58 m, 26.IX.2007, *Andriamihajarivo et al.* 1411 (MO, P, TAN); Ankarana RS, 13°00'46"S 49°03'03"E, 11-14 m, 7.V.1996, *Andrianantoanina & Bezara* 973 (G, K, MO, P); Ambohitsitondroina, 13°07'38"S 49°28'16"E, 100 m, 15.III.2004, *Gautier et al.* 4584 (Daraina, G, K, MO, P, TEF); Daraina, forêt d'Antsaharaingy, 12°53'07"S 49°40'06"E, 25 m, 18.XI.2006, *Gautier & Chatelain* 4851 (Daraina, G, K, MO, P, TEF); Tanambao-Marivorahona, 13°02'34"S 49°09'14"E, 45 m, 2.VII.2005, *Guittou et al.* 156 (CNARP, MO, P, TAN); Vohémar, Ampisikinana, forêt d'Ampondrabe, 12°58'13"S 49°41'56"E, 200 m, 3.XI.2005, *Guittou et al.* 198 (CNARP, G, MO, P, TAN); Sakaramy, Montagne d'Ambre PN, 12°26'40"S 49°13'56"E, 300 m, 29.V.2010, *Hong-Wa* 695 (MO, P, TAN); Daraina, forêt d'Ambohitsitondroina, 13°09'07"S 49°27'38"E, 177 m, 11.I.2006, *Nusbaumer & Ranirison* 1895 (Daraina, G, K, MO, P, TEF); Daraina, Andranovaka, Ankijomantsina, 13°07'56"S 49°28'20"E, 75 m, 29.X.2005, *Rakotonandrasana et al.* 935 (CNARP, G, MO, P, TAN); Marivorahona, Betsimiranja, forêt d'Andohan'Antsohihy, 13°02'31"S 49°09'19"E, 100 m, 17.VII.2005, *Randrianaivo et al.* 1204 (CNARP, MO, P, TAN); Daraina, forêt d'Ambohitsitondroina, 13°07'50"S 49°28'05"E, 150 m, 8.I.2006, *Ranirison & Nusbaumer* 1059 (Daraina, G, K, MO, P, TEF); Vohémar, Ankaramy, [13°32'30"S 49°48'00"E], 100 m, 26.VIII.1955, *Service Forestier* 14710 (P, TEF); Ankotekona, [12°20'S 49°05'E], 18.V.1956, *Service Forestier* 15921 (P, TEF); Ankarana, près de Marotaolana (Anivorano-Nord), [12°44'S 49°14'E], 25.XII.1963, *Service Forestier* 23119 (G, P, TEF); S de Marotaolana (Anivorano-Nord), [12°44'S 49°14'E], 23.XII.1963, *Service Forestier* 23125 (P, TEF).

34. *Noronhia humblotiana* (H. Perrier) Hong-Wa, **comb. & stat. nov.**

≡ *Noronhia mangorensis* var. *humblotiana* H. Perrier in Mém. Inst. Sci. Madagascar, Sér. B, Biol. Vég. 2: 303. 1949.

Typus: MADAGASCAR. **Prov. Antsiranana:** Antakare [Antakarana], [12°54'S 49°08'E], s.d., *Humblot 584* (holo-: P [P00701218]!; iso-: K [K000233185, K000233186] image seen, S [S09-36009] image seen).

Description

Trees to 10 m tall, trunk to 15 cm diameter; young twigs cylindrical, 0.6-1.3 mm diameter, glabrous; bark dark to medium gray, smooth. *Leaves* opposite, persistent; bud scales persistent; blades dark green above, lighter below, ovate to oblong, 4.5-6.5 × 1.5-4 cm, coriaceous, glabrous, domatia absent, base acute to attenuate, margin flat to slightly revolute, apex acuminate, the acumen 3.5-12 mm long, midrib slightly sunken above, distinctly raised below, secondary veins conspicuous, 6-10 per side, 4-12.5 mm apart, looping 1-3.5 mm from the margin; petiole dark to medium gray, 2-7 × 1-2 mm, entirely woody, glabrous. *Flowers* fasciculate; pedicel 10-25 mm long, moderately pubescent; calyx moderately pubescent outside, glabrous inside, lobes triangular, 1-2 × 0.9-2 mm; corolla pink to red, urceolate, 4-9.5 mm long, glabrous on both sides, the tube 2.5-6 mm long, lobes ovate, apex obtuse; corona present, 1.5-2.5 mm long, lobed; stamens 1.5-3.5 mm long, anthers obovate, 1.2-1.3 mm long; pistil 2-3.2 mm long, stigma capitate. *Fruiting* pedicel 12-14 × 0.9-1.1 mm; young fruits green, reddish black when mature, ellipsoid, 9.5 × 7.5 mm, surface rugose, apex flat, style persistent; dry pericarp 0.9 mm thick; endocarp woody.

Distribution, ecology and phenology

Noronhia humblotiana occurs in mid- to high-elevation humid forests in the north, from Marojejy to Bemafo (Fig. 19). It produces flowers and fruits from October to May.

Conservation status

Based on 17 collections representing 16 localities, the assessment yielded an EOO of 19,257 km², an AOO of 60 km², and 15 subpopulations representing 13 locations, of which eight occur within protected areas (Ampasindava, Galoko, Loky-Manambato, Makira, Makirovana-Tsihomanaomby, Marojejy, Tsaratanana, and Tsaratanana-Ambohimirahavavy-Corridor Marojejy). Despite a relatively narrow distribution and habitat degradation in some of areas, *N. humblotiana* occurs in more than 10 locations, most of which are encompassed within protected areas. Therefore, this species is assigned a preliminary status of "Near Threatened".

Notes *Noronhia humblotiana* can be recognized by its coriaceous leaf blades with lighter-colored venation, fasciculate, long-pedicellate flowers, and rugose fruits. It was described as a variety of *N. mangorensis* H. Perrier from which it differs by its flatter and less coriaceous, acuminate (vs. cuspidate) leaf blades, longer pedicels (10-25 mm vs. 5-13 mm), urceolate (vs. cupuliform) flowers, and ellipsoid (vs. ovoid) fruits.

Additional specimens examined

MADAGASCAR. Prov. Antsiranana: Andapa, Antsahamena, Ambodiangezoka, 14°57'58"S 49°42'54"E, 338 m, 9.XI.2003, *Antilahimena* 2308 (G, MO); Antongondriha, massif du Bet-somanga, [14°15'S 49°45'E], 700 m, 17.XI.1950-20.XI.1950, *Humbert & Capuron* 24271 (G, MO, P); Marojejy PN, 14°27'S 49°47'E, 380 m, 5.X.1988, *Miller et al.* 3369 (K, MO, P, TAN); *ibid. loc.*, 14°27'S 49°47'E, 300 m, 2.XII.1989, *Miller & Randrianasolo* 4645 (MO, P, TAN); *ibid. loc.*, 14°26'13"S 49°46'32"E, 460 m, 10.X.1996, *Rakotomalaza et al.* 729 (G, MO, P, TAN); Sambava, Anjagoveratra, Anamboaofo, forêt de Makirovana, 14°09'14"S 49°57'43"E, 481 m, 20.III.2013, *Rakotonirina et al.* 84 (MO, P, TAN); Vohémar, Analamazava, 8 km of Ankijabe village, 13°15'43"S 49°35'22"E, 840 m, 25.XI.2004, *Ranarivelo et al.* 455 (CAS, MO, TAN); Anjanaharibe-Sud RS, 14°32'45"S 49°35'15"E, 809-1364 m, 25.V-3.VI.1994, *Ravelonarivo* 138 (MO, P, TAN); Sambava, Bevontro, Morafeno, forêt d'Antsahandroboka, 14°10'22"S 49°17'54"E, 910 m, 6.II.2006, *Razakamalala et al.* 3197 (G, MO, P, TAN); Bet-somanga, Anjanabe, [14°15'30"S 49°44'00"E], 700 m, 18.XI.1950, *Service Forestier* 832 (P, TEF); Bemafo, [14°12'S 49°06'E], 2000 m, I.1951, *Service Forestier* 954 (P, TEF). **Prov. Mahajanga:** Ambohimiravavy, Bemafo, 1781 m, 1.X.2005, *Callmander et al.* 395 (G, MO, P, TAN); Tsaratanana Massif, [13°57'S 48°52'E], 1800-2000 m, 8.V.1974, *Gentry* 11581 (MO, P, TAN).



Fig. 25. *Noronhia incurvifolia* (H. Perrier) Hong-Wa & Besnard [*Ratovoson* 1361].

Photo: F. Ratovoson

35. *Noronhia incurvifolia* (H. Perrier) Hong-Wa & Besnard in Mol. Phylogenet. Evol. 67: 376. 2013 (Fig. 25).

≡ *Linociera incurvifolia* H. Perrier in Mém. Inst. Sci. Madagascar, Sér. B, Biol. Vég. 2: 280. 1949.

≡ *Chionanthus incurvifolius* (H. Perrier) Stearn in Bot. J. Linn. Soc. 80: 199. 1980.

Lectotypus (designated here): **MADAGASCAR. Prov. Antsiranana:** collines et plateaux calcaires de l'Ankarana, près d'Ambodimagodro, [13°01'S 49°08'E], 150-200 m, XII.1937-I.1938, *Humbert 19011* (P [P03559141]!; isolecto-: BR [BR0000006266523] image seen, G [G00014068] image seen, K [K000233205] image seen, P [P03559139, P03559142]!). **Syntypi:** **MADAGASCAR. Prov. Antsiranana:** env. de Diégo-Suarez, [12°16'S 49°19'E], *Alleizette s.n.* (P, not found); Ankarana, près d'Ambondrofe, [12°49'S 49°01'E], 250 m, XII.1937-I.1938, *Humbert 18912* (BR [BR0000006267841] image seen, G [G00014068] image seen, P [P00413212, P00413213]!).

Description

Shrubs to trees to 13 m tall, trunk to 15 cm diameter; young twigs cylindrical, 0.7-2.3 mm diameter, glabrous; bark medium brown, smooth, sometimes lenticellate. *Leaves* opposite, persistent; bud scales rarely persistent; blades medium green above, lighter below, lanceolate to ovate, usually abaxially folded along the mid-vein and curved, 6-10 × 1.5-3.5 cm, coriaceous, glabrous, domatia absent, base rounded to acute, margin flat to slightly undulate, apex acuminate, the acumen 4-15 mm long, midrib flat above, raised below, secondary veins conspicuous mostly below, 7-21 per side, 5-12 mm apart, looping 1-3 mm from the margin; petiole yellowish, 10-20 × 0.6-1.5 mm, not woody, glabrous. *Thyrse*s geminate, pauciflorous, somewhat diffuse; peduncle 16-22 mm long, sparsely pubescent; pedicel 0.7-3 mm long, sparsely pubescent; calyx sparsely pubescent outside, glabrous inside, lobes triangular, 0.7-1 × 0.7-1 mm; corolla white, subrotate, petals almost free, 3-4.5 mm long, glabrous on both sides, the tube 0.5-1 mm long, lobes ovate, apex slightly acute; corona absent; stamens 1.8-3 mm long, anthers oblong, 1.4-2.2 mm long; pistil 1.4-2.2 mm long, stigma bilobed. *Fruiting* pedicel 2.5-11 × 1-2.5 mm; young fruits green, brownish when mature, ovoid, 18.5-23 × 10.5-16 mm, surface slightly ribbed, sometimes covered with a white pellicle, apex rostrate, the rostrum flattened, ridged, truncate; dry pericarp 0.4-0.9 mm thick; endocarp woody; seed 13-14 × 7.5-11 mm.

Distribution, ecology and phenology

Noronhia incurvifolia occurs in low-elevation dry forests on lavas and limestones in northern Madagascar, from Antsisikala to Ankarana (Fig. 19). It produces flowers and fruits from September to March.

- Conservation status** Ten collections representing 10 localities were available for analysis, which resulted in an EOO of 912 km², an AOO of 36 km², and six subpopulations representing five locations, of which two occur within a protected area (Ankarana). *Noronhia incurvifolia* is now mostly found in heavily modified habitat as a result of expanding agriculture and traditional grazing. Therefore, with a restricted distribution and continuing decline in habitat quality as well as projected habitat loss in the near future, *N. incurvifolia* is assigned a preliminary status of “Endangered” [EN B1ab(i,ii,iii,iv,v)+2ab(i,ii,iii,iv,v)].
- Notes** *Noronhia incurvifolia* can be recognized by its non-woody petioles, folded and curved leaf blades, short pedicels, subrotate to rotate, white flowers that lack a corona, and distinctly rostrate fruits. This species was based on three syntypes (*Alleizette s.n.*, *Humbert 19011* and *19012*). However, the citation of *Humbert 19012* in the protologue was in fact a typographic error for *Humbert 18912*, which PERRIER DE LA BÂTHIE (1952) corrected in the “Flore des Madagascar et des Comores”. While he annotated the single sheet of *Humbert 18912* in the Paris herbarium as the type, because of the mistake in the protologue, I have chosen to designate one of the sheets of *Humbert 19011* as the lectotype in order to assure strict compliance with the Code (Art. 9.2 and 9.12; McNEILL et al., 2012). Both *Humbert 18912* and *19011* comprise good quality specimens and are represented by several duplicates.
- Additional specimens examined** **MADAGASCAR. Prov. Antsiranana:** Ankarana RS, 10 km E de Matsaborimanga, 12°54'59"S 49°06'24"E, 180 m, 6.VII.1994, *Andrianantoanina & Rabeharinosy 717* (K, MO, TAN); Mosorolava, Mahagaga, forêt d'Analabe, 12°45'46"S 49°00'42"E, 76 m, 23.IX.2007, *Andriamihajarivo et al. 1401* (G, MO, P, TAN); Ankarana, from Campement des Anglais towards Lac Vert, 12°50'47"S 49°06'18"E, 82 m, 26.V.1999, *De Block 1020* (BR, G, MO, P, TAN, WAG); Ankarana, near Mahamasina, from Perte d'Eau to Campement de Prince, 12°50'47"S 49°06'18"E, 82 m, 15.I.2002, *De Block 1243* (BR, G, MO, P, TAN, WAG); Ankarana, near Campement des Anglais, 12°54'S 49°08'E, 150 m, 29.I.1994, *Leeuwenberg 14340* (MO, TAN); Ankarana RS, 12°51'S 49°04'E, 100-200 m, 22-26.XI.1992, *Malcomber et al. 1904* (K, MO, P); Andranovondronina, Antsisikala, forêt d'Analabe, 12°11'49"S 49°11'51"E, 184 m, 11.XII.2005, *Randrianaivo et al. 1330* (CNARP, MO, P, TAN); Mosorolava, Ampombiantambo, 12°41'24"S 48°56'59"E, 75 m, 27.IX.2007, *Ratovoson et al. 1361* (CNARP, G, MO, P, TAN); Ankarana, [12°49'S 49°01'E], 11.III.1954, *Service Forestier 9387* (MO, TEF).

36. *Noronhia insularis* (Labat, M. Pignal & O. Pascal) Hong-Wa & Besnard in Mol. Phylogenet. Evol. 67: 376. 2013.

≡ *Chionanthus insularis* Labat, M. Pignal & O. Pascal in Novon 9: 69. 1999.

Typus: MAYOTTE: Bénara, 12°53'S 45°10'E, 350 m, 11.X.1996, *Pascal* 713 (holo-: P [P00075020]!; iso-: B [100150948] image seen, G [G00014072] image seen, K [K000691511] image seen, MA [MA631208] image seen, MO [MO176472]!, NY [NY00277616] image seen, P [P00075017, P00075018]!, WAG [WAG0004664] image seen).

Description

Trees to 15 m tall, trunk to 15 cm diameter; young twigs cylindrical, 1.5-2 mm diameter, glabrous; bark medium to light gray, slightly rugose, sometimes lenticellate. Leaves opposite, persistent; bud scales rarely persistent; blades dark green above, lighter below, lanceolate, 12.5-20 × 3-6 cm, chartaceous, glabrous, domatia rare, base acute, margin flat to slightly undulate, apex acuminate, the acumen 10-18 mm long, midrib flat above, raised below, secondary veins conspicuous, 11-14 per side, 13-22 mm apart, looping 2-4 mm from the margin; petiole light gray, 7-13 × 1.5-2 mm, entirely woody, glabrous. Thyrses geminate, pauciflorous, compact; peduncle 4 mm long, moderately pubescent; pedicel 6 mm long, moderately pubescent; calyx moderately pubescent outside, glabrous inside, lobes triangular, 1.5 × 2 mm; corolla yellow, subrotate, 6 mm long, glabrous on both sides, the tube 1 mm long, lobes deltate, apex acute; corona absent; stamens 2.3-2.6 mm long, anthers suborbicular, 1.3-1.6 mm long; pistil 2.7 mm long, stigma bilobed. Fruiting pedicel 12 × 2.2 mm; young fruits green, brownish when mature, ellipsoid, 42 × 20 mm, surface ribbed, apex rostrate, the rostrum flattened, ridged, truncate; dry pericarp 0.8 mm thick; endocarp woody; seed 33 × 16 mm.

Distribution, ecology and phenology

Noronhia insularis occurs in low- to mid-elevation humid forests on Mayotte and Grande Comore in the Comoro Islands (Fig. 19). It produces flowers and fruits from August to November.

Conservation status

Noronhia insularis is currently known from five collections representing five localities. The estimates provided an EOO of 1,535 km², an AOO of 20 km², and four subpopulations representing four locations, two of which occur within protected areas (Réserves forestières de Tchaourembo et de Bénara). The subpopulations in Grande Comore and those that are outside of protected areas in Mayotte are heavily impacted by habitat degradation and habitat loss resulting from land conversion, thereby reducing the number of mature individuals. Therefore, *N. insularis* is assigned a preliminary status of “Endangered” [EN B1ab(ii,iii,v)+2ab(ii,iii,v)].

Notes *Noronhia insularis* can be recognized by its lanceolate leaf blades, subrotate, yellow flowers lacking a corona, and elongate, ribbed and rostrate fruits. It differs from *N. aminae* by its rugose (vs. smooth) bark, lanceolate (vs. oblong) leaf blades, the absence (vs. presence) of a corona, and its ribbed (vs. rugose) fruits.

Additional specimens examined COMOROS: Grande Comore (Ngazidja), Nioumbadjou, chemin du capitaine Dubois en direction de N'Kourani, 9.X.1984, *Loup 71* (P). MAYOTTE: Grande Terre, Tsararano, RF des crêtes du centre Mont Bénara, 5.II.2006, *Barthelat et al. 1571* (BR, G, K, MO); Tchaourembo, Réserve Forestière de Tchaourembo, 113.XI.2002, *Barthelat et al. 1069* (G, K, MO, P); Bénara, 12°50'S 45°10'E, 575 m, 1.VIII.1996, *Pascal 617* (G, K, MO, P).

37. *Noronhia intermedia* Hong-Wa, spec. nova (Fig. 26).

Typus: MADAGASCAR. **Prov. Antsiranana:** SAVA, Vohémar, Daraina, forêt d'Ambohitsitondroina, 13°08'S 49°27'E, 210 m, 11.I.2006, *Ranirison & Nusbaumer 1073* (holo-: MO-6410087!; iso-: Daraina, G [G00090500], K, P [P04255368] image seen, TEF).

Diagnosis *Noronhia intermedia* Hong-Wa can be distinguished from other members of the genus by its obovate to obtrullate, distinctly acuminate and coriaceous leaf blades, and its geminate to fasciculate flowers with pale green corolla.

Description Shrubs to 6 m tall, trunk to 3 cm diameter; young twigs cylindrical, 0.9-1.3 mm diameter, glabrous; bark medium gray, somewhat rugose, with scattered lenticels. *Leaves* opposite, persistent; bud scales persistent; blades medium green above, lighter below, obovate to obtrullate, 5.1-6.7 × 2-3 cm, coriaceous, glabrous, domatia absent, base attenuate, sometimes acute, margin slightly revolute and undulate, apex acuminate, the acumens 7-12 mm long, midrib sunken above, raised below, secondary veins conspicuous, 7-9 per side, 7-9 mm apart, looping 1-3 mm from the margin; petiole medium gray, 3-7 × 1.1-1.6 mm, entirely woody, glabrous. *Flowers* geminate to fasciculate; pedicel 10-23 mm long, glabrous; calyx moderately pubescent outside, the pubescence being clustered at the tips, glabrous inside, lobes deltate, 2-3 × 1.8-2.5 mm; corolla pale green, urceolate, 5-6.5 mm long, glabrous on both sides, the tube 4-5 mm long, lobes deltate, apex obtuse; corona present, 1.7-2 mm long, undivided; stamens 2.2-2.5 mm long, anthers slightly obovate, 1.6-2 mm long; pistil 2.8-3.5 mm long, stigma capitate to slightly bilobed. *Fruiting pedicel* 14-25 × 0.8-1 mm; young fruits green, brownish when mature, ovoid, surface smooth to rugose, apex rostrate, the rostrum flattened, ridged, apiculate; endocarp woody.

Etymology *Noronhia intermedia* is somewhat intermediate between *N. candicans* and *N. crassinodis*. It is this condition that was used to derive its name.

Distribution, ecology and phenology *Noronhia intermedia* occurs in low- to mid-elevation transitional to humid forest around Daraina in the north (Fig. 27). It produces flowers and fruits from December to March.

Conservation status *Noronhia intermedia* is currently known only from the forests around Daraina, with an EOO of just 13 km² and an AOO of 12 km². Two subpopulations representing two locations can be recognized, all of which are encompassed within the newly established protected area of Loky-Manambato. However, despite benefiting from this new protection, the Loky-Manambato complex has the only large remaining patches of forest in an otherwise heavily degraded area, upon which the predominantly



Fig. 26. *Noronhia intermedia* Hong-Wa.

A. Flowering branch; **B.** Adaxial side of leaf blade; **C.** Abaxial side of leaf blade; **D.** Flower; **E.** Lateral view of corona; **F.** Pistil; **G.** Stamen.

[A-C: Ranirison 1073, TEF; D-G: Nusbaumer 869, MO] Drawings: R.L. Andriamiarisoa

farm-oriented and fast-growing surrounding human population depends. Therefore, it is reasonable to assume that the forests are still potentially subject to illicit exploitation and encroachment. Thus, with an AOO of less than 20 km², a small number of locations and some lingering threats, *N. intermedia* is assigned a preliminary status of “Vulnerable” [VU D2].

Notes *Noronhia intermedia* appears to be morphologically intermediate between *N. candicans* and *N. crassinodis*, with both of which it shares some leaf characters, but from which it differs by its obovate to obtrullate (vs. oblong to broadly elliptic in *N. candicans* and obovate in *N. crassinodis*), acuminate leaf blades (vs. acute to acuminate and mucronulate, respectively), greenish flowers (vs. reddish in both the other two species) borne on longer pedicels (10-23 mm vs. 3-20 mm and 8-20 mm), and smooth to rugose (vs. smooth and punctate, respectively) fruits. The new species can be recognized by its obovate to obtrullate, distinctly acuminate and coriaceous leaf blades, and geminate to fasciculate flowers with pale green corolla.

Paratypes **MADAGASCAR. Prov. Antsiranana:** Vohémar, Daraina, forêt d’Ambohitsitondroina, 13°07’55”S 49°28’13”E, 140 m, 22.III.2004, *Gautier et al.* 4676 (Daraina, G, K, MO, P, TEF); Daraina, forêt de Binara, 13°15’44”S 49°36’17”E, 715 m, 21.XII.2003, *Nusbaumer* 869 (Daraina, G, K, MO, TEF).



Fig. 27. Distribution maps of species of *Noronhia* Stadtm. ex Thouars. *N. intermedia* Hong-Wa to *N. macrocarpa* Hong-Wa.

38. *Noronhia introversa* H. Perrier in Mém. Inst. Sci. Madagascar, Sér. B, Biol. Vég. 2 : 295. 1949.

Typus: MADAGASCAR. **Prov. Toamasina:** Forêt d'Analamazaotra, [18°56'S 48°26'E], 1934, *Ursch* 46 (holo-: P [P00418117]!).

Description

Trees to 12 m tall, trunk to 15 cm diameter; young twigs cylindrical, 1.3-3.7 mm diameter, glabrous; bark white, sometimes very light gray, smooth. *Leaves* opposite, persistent; bud scales persistent; blades dark to medium green above, lighter below, oblong to elliptic, 7-27 × 2-7.5 cm, subcoriaceous, glabrous, domatia casual, base acute, margin slightly revolute and undulate, apex acute to acuminate, the acumen 1-20 mm long, midrib sunken above, distinctly raised below, secondary veins conspicuous, 7-16 per side, 8-26 mm apart, looping 2-8 mm from the margin; petiole light gray to white, 5-22 × 1.5-7 mm, entirely woody, glabrous. *Thyrses* fasciculate, pauciflorous, compact; peduncle 5-17 mm long, moderately pubescent; pedicel 5-10 mm long, moderately pubescent; calyx moderately pubescent outside, glabrous inside, lobes triangular, 1.5-3 × 1.2-2.5 mm; corolla pink, sometimes tinged orange-red, oblong to slightly campanulate, 3.5-8 mm long, glabrous on both sides, the tube 2-6 mm long, lobes deltate apex obtuse; corona absent; stamens 1.5-2.5 mm long, anthers obconical, 1-1.5 mm long; pistil 1.5-2.8 mm long, stigma bilobed. *Fruiting* pedicel 8-18 × 1.3-2.5 mm; young fruits green, dark red when mature, ovoid to subglobose, 13-27 × 10-25 mm, surface smooth, apex apiculate; dry pericarp 0.3-2.6 mm thick; endocarp woody; seed 11-18 × 9.5-13 mm.

Distribution, ecology and phenology

Noronhia introversa occurs in low- to high-elevation humid forests from the Masoala peninsula in the north to Midongy du Sud in the south (Fig. 27). It produces flowers and fruits from June to February.

Conservation status

Twenty-four collections representing 22 localities were available for the assessment, which resulted in an EOO of 49,227 km², an AOO of 88 km², and 16 subpopulations representing 13 locations, of which 10 occur within protected areas (Analamazaotra, Betampona, Corridor Ankeniheny-Zahamena, Mananara-Nord, Makira, Mantadia, Masoala, Midongy du Sud, Ranomafana, and Zahamena). With an actual AOO likely much larger than 2,000 km² and many locations scattered within a large EOO, *N. introversa* is assigned a preliminary status of "Least Concern".

Notes

Noronhia introversa can be recognized by its whitish bark, subcoriaceous leaf blades, and pink to red flowers that lack a corona. It differs from *N. grandifolia* by the color of its bark (white to light gray vs. light brown) and flowers (pink tinged orange-red vs. purplish tinged yellow), the shape of its corolla (oblong to campanulate vs. subrotate), and the texture of its endocarp (woody vs. crustaceous).

Additional specimens examined

MADAGASCAR. Prov. Fianarantsoa: Ranomafana PN, Parcelle 1, Ambatoharanana, 21°16'S 47°27'E, 800-1000 m, 28.XII.1993, *Kotozafy* 444 (G, K, MO, P); *ibid. loc.*, 21°16'S 47°26'E, 980 m, 5.XII.1994, *Kotozafy & Rasabo* 860 (K, MO, P, TAN); Befotaka-Midongy PN, 23°44'01"S 47°01'50"E, 714 m, 23.IX.2005, *Rakotovao et al.* 2286 (MO, TAN); Andrambovato, Parcelle B4, [21°31'S 47°25'E], 878-1000 m, 10.VI.1954, *Service Forestier* 14413 (MO, P, TEF). **Prov. Toamasina:** Nosy Mangabe, 15°29'49"S 49°45'20"E, 0-320 m, 5.XII.1998, *Abdul-Salim et al.* 30 (MO); Maroantsetra, Ambinanitelo, Marovovonana, 15°19'34"S 49°31'15"E, 298 m, 29.VIII.2004, *Antilahimena* 2628 (MO, P); Mananara, Anandrivola, Antsiraben'i Ariena, Ambitsy forest, 15°51'49"S 49°30'35"E, 659 m, 27.VII.2007, *Antilahimena* 5738 (MO, P, TAN); Andasibe-Mantadia PN, 18°50'16"S 48°25'54"E, 810 m, 20.VI.1996, *Birkinshaw et al.* 301 (G, MO, P); Analamazaotra RS, 18°56'S 48°25'E, 100 m, 5.XI.1985, *Dorr* 4344 (MO, P, TAN); Mananara-Nord, Ivontaka-Sud, 16°20'S 49°48'E, 150 m, 22.XI.1989, *Dumetz* 1026 (MO); Analamazaotra RS, 18°49'32"S 48°26'04"E, 941 m, 3.V.2010, *Hong-Wa & Ortiz* 656 (MO, TAN); Ambatovy, forêt d'Ambatomainty, 18°52'37"S 48°17'04"E, 1028 m, 2 6.II.2010, *Ravelonarivo et al.* 3385 (MO, P, TAN); Maintimbato - Fénérive, 14.XII.1955, *Réserves Naturelles* 7772 (MO, P, TEF); Nosy Mangabe, 15°30'S 49°06'E, 0-330 m, 13-19.XII.1989, *Schatz* 2846 (MO, P, TAN); Soanierana-Ivongo, [16°54'S 49°35'E], 27.XII.1949, *Service Forestier* 2494 (P, TAN, TEF); Masoala Peninsula, Ambanizana, 15°40'24"S 49°57'51"E, 110-260 m, 25.XI.1994, *Vasey & Velo* 138 (MO, P, TAN).

39. *Noronhia jeremii* Hong-Wa & Callm. in Candollea 64: 199. 2009 (Fig. 28A).

Typus: MADAGASCAR. **Prov. Antsiranana:** Ambanja, Beramanja, massif du Kalabenono, 13°38'38"S 48°40'07"E, 520 m, 25.XI.2007, *Callmander & Razafitsalama* 740 (holo-: MO-6406809!; iso-: G [G00165767]!, K!, P [P00727210]!, TAN!, WAG!).

Description *Shrubs* to 4 m tall, trunk to 2 cm diameter; young twigs cylindrical, 1.3-2.6 mm diameter, glabrous; bark medium to light gray, smooth. *Leaves* opposite, persistent; bud scales deciduous; blades medium green above, lighter below, linear to oblong, 10.5-27 × 2-7 cm, subcoriaceous, glabrous, domatia absent, base rounded to cordate, margin slightly undulate, apex acuminate, the acumen 6-23 mm long, midrib flat to slightly sunken above, raised below, secondary veins conspicuous, 10-21 per side, 6-22 mm apart, looping 1.5-5 mm from the margin; petiole light gray to brownish, 6-16 × 2-4 mm, entirely woody, glabrous. *Thyrses* solitary, pauciflorous, diffuse; peduncle 11-16 mm long, glabrous; pedicel 11-20 mm long, glabrous; calyx glabrous on both sides, lobes deltate, 2-2.6 × 1.4-1.7 mm; corolla yellowish, cupuliform, 5-6 mm long, glabrous on both sides, the tube 2-2.5 mm long, lobes triangular, apex acute; corona absent; stamens 2.2-2.5 mm long, anthers widely obovate, 1.5-1.6 mm long; pistil 2.3-3 mm long, stigma capitate. *Fruiting* pedicel 11-25 × 1-2 mm; young fruits green, brownish when mature, ampulliform to subglobose, 15.5-20 × 11-19 mm, surface smooth, apex apiculate; dry pericarp 0.3-1.1 mm thick; endocarp subcrustaceous; seed 9.5 × 11.5 mm.

Etymology *Noronhia jeremii* is named after Jérémie "Jimmy" Razafitsalama, a botanist working for the Missouri Botanical Garden in Madagascar, who collected the type material with the second author of this species. Jimmy was part of a team that undertook botanical inventories between 2005 and 2008 to explore the flora and vegetation in a long-neglected region of low- to high-elevation humid forest in northern Madagascar. These field expeditions led to the discovery of at least 20 new species in various families (CALLMANDER et al., 2008, 2009, 2012; WAHLERT, 2016).

Distribution, ecology and phenology *Noronhia jeremii* occurs in low- to mid-elevation humid forests on sandstones and basement rocks in northern Madagascar, from Makira in the east to Kalobinono [previously called Kalabenono] in the west (Fig. 27). It produces flowers and fruits from August to November.

Conservation status The assessment, which was based on six collections representing six localities, resulted in an EOO of 796 km², an AOO of 16 km², and three subpopulations representing two locations, of which only one occurs within a protected area (Galoko). The third location sits outside the new protected area of Makira, where

forests are potentially subject to exploitation leading to a reduction in habitat quality. Therefore, *N. jeremii* is assigned a preliminary status of “Endangered” [EN B1ab(iii)+2ab(iii)].

Notes *Noronhia jeremii* can be recognized by its long, broadly linear leaf blades, petioles that are attached to the lower surface of the leaf blades, flowers lacking a corona, and apiculate fruits. It differs from *N. capuronii* by its glabrous (vs. pubescent) petioles, linear to oblong (vs. ovate) leaf blades, and woodier endocarp.

Additional specimens examined **MADAGASCAR. Prov. Antsiranana:** Ambilobe, Beramanja, Anketrahe, forêt de Kalabenono, 13°38'20"S 48°40'16"E, 374 m, 19.XI.2006, *Callmander et al.* 537 (G, K, MO, P, TAN); *ibid. loc.*, 13°38'23"S 48°40'24"E, 550 m, 28.IX.2013, *Randriantsivory & Manjato* 396 (MO, TAN); *ibid. loc.*, forêt de Galoko, 13°35'28"S 48°43'14"E, 3.X.2013, *Randriantsivory et al.* 419 (G, MO, P, TAN); *ibid. loc.*, forêt de Kalabenono, 13°38'40"S 48°40'26"E, 700 m, 28.IX.2013, *Ratovoson* 2040 (G, MO, P, TAN). **Prov. Toamasina:** Maroantsetra, Ambinanitelo, Marovovonana, 15°19'42"S 49°31'49"E, 150 m, 29.VIII.2004, *Antilahimena* 2618 (G, MO, P).



Fig. 28. Photographs of *Noronhia* Stadtm. ex Thouars.

A. *Noronhia jeremii* Hong-Wa & Callm. [Callmander 740]; **B.** *Noronhia lanceolata* H. Perrier [Ratovoson 1475].

Photos: taken by respective collectors.

40. *Noronhia lanceolata* H. Perrier in Mém. Inst. Sci. Madagascar, Sér. B, Biol. Vég. 2: 286. 1949 (Fig. 28B).

Lectotypus (designated here): **MADAGASCAR. Prov. Toliara:** Sud-Ouest: Plateau Bara, bassin du Fiherenana, [22°57'S 44°19'E], V.1933, *Perrier de la Bâthie* 19243 (P [P00413230]!; isolecto-: BR [BR0000006265632] image seen, K [K000233189] image seen, P [P00413231, P00413232]!). **Syntypi:** **MADAGASCAR. Prov. Toliara:** Antanimora, [24°14'S 45°15'E], 13.VII.1926, *Decary* 4299 (P [P04078602]!); *ibid. loc.*, [24°14'S 45°15'E], 17.VII.1926, *Decary* 4522 (P [P04078608]!); Massif du Vohitsiombe, [24°25'S 46°08'E], 2.VIII.1926, *Decary* 4564 (P [P04078604, P04078605]!); *ibid. loc.*, 2.VIII.1926, *Decary* 4649 (P [P04078597]!); Ampandrandava, [24°05'S 45°42'E], VIII.1942, *Herb. Jard. Bot. Tan.* 5108 (P [P04078587, P04078588, P04078589, P04078591, P04078592, P04078593]!); Fiherenana, [22°57'30"S 44°19'00"E], 25-300 m, 2-3.VIII.1928, *Humbert* 5124 (G [G00188778] image seen, P [P04078582]!); Bassin supérieur du Mandrare, [24°30'S 46°35'E], 700-1200 m, 20-22.XI.1928, *Humbert* 6765 (P [P04078609 in part]!); Vallée de la Manambolo, [24°31'S 46°37'E], 300-400 m, XII.1933, *Humbert* 12792 (P [P04078594, P04078595, P04078596]!); *ibid. loc.*, [24°31'S 46°37'E], 400-600 m, XII.1933-I.1934, *Humbert* 12813 (P [P04078606]!); *ibid. loc.*, [24°31'S 46°37'E], 400-900 m, 1.XII.1933, *Humbert* 13012 (G [G00188777] image seen, P [P04078600, P04078601]!); Bords de la Linta, Plateau Mahafaly, [24°46'S 44°17'E], VI.1910, *Perrier de la Bâthie* 8821 (P [P04078610, P04078611]!); Ampandrandava, [24°25'S 45°42'E], VII.1943, *Seyrig* 23 (P [P04078590]!).

Description *Trees* to 8 m tall, trunk to 17 cm diameter; young twigs cylindrical, 0.4-1.2 mm diameter, glabrous; bark light gray to brownish, rugose. *Leaves* opposite, semi-deciduous; bud scales persistent; blades light green, lanceolate, 3.5-10 × 0.6-1.8 cm, coriaceous, glabrous, domatia absent, base attenuate, margin flat, apex acute to acuminate, the acumen 1-3 mm long, midrib flat to slightly raised above, distinctly raised below, secondary veins barely visible, 7-14 per side, 5.5-16 mm apart, looping 0.8-2.5 mm from the margin; petiole whitish to yellow, 5-15 × 0.3-1.1 mm, not woody, glabrous. *Thyrse*s geminate, pauciflorous, somewhat diffuse; peduncle 1.5-9 mm long, moderately pubescent; pedicel 2-7 mm long, moderately pubescent; calyx moderately pubescent outside, glabrous inside, lobes triangular, 0.7-1.6 × 0.6-1.3 mm; corolla white, cupuliform, 3-4 mm long, glabrous on both sides, the tube 2.5-3 mm long, lobes ovate, apex rounded; corona absent; stamens 2-2.7 mm long, anthers ovate, slightly apiculate, 1.7-1.8 mm long; pistil 2.2-3 mm long, stigma capitate. *Fruiting* pedicel 3-12 × 0.5-2.1 mm; young fruits green, purplish red when mature, ovoid to subglobose, 10-26.5 × 6-22.5 mm, surface smooth, sometimes covered with white dots, apex flat to rostellate, with the persistent style; dry pericarp 1.4-2.7 mm thick; endocarp woody; seed 6.5-19 × 4-12.5 mm.

Distribution, ecology and phenology

Noronhia lanceolata occurs in low- to high-elevation dry forests and thickets in the south, from Sakaraha to Andohahela (Fig. 27). It produces flowers and fruits throughout the year except in August and September.

Conservation status

There were 31 collections representing 29 localities available for analysis, which yielded an EOO of 26,232 km², an AOO of 104 km², and 20 subpopulations representing 17 locations, of which seven occurs within protected areas (Amoron'i Onilahy, Andohahela, Behara-Tranomaro, Beompa, Corridor Parcel I-Parcel II, Extension Ampalamora, and Vohidava-Betsimalaho). With an actual AOO likely much larger than 2,000 km², many locations and good representation within the network of protected areas, *Noronhia lanceolata* is assigned a preliminary status of "Least Concern".

Notes

Noronhia lanceolata can be recognized by its rugose bark, non-woody petiole, lanceolate leaf blades, and white flowers lacking a corona. It differs from *N. alleizettei* by its non-woody (vs. woody) petioles, lanceolate (vs. narrowly elliptic) leaf blades, thyrsoid inflorescences (vs. fasciculate flowers), cupuliform (vs. urceolate) corolla, and larger (26 × 22 mm vs. 13 × 13 mm) fruits. The description of this species was based on the following syntypes: Decary 4299, 4522, 4561, 4564 and 4649, *Herb. Jard. Bot. Tan.* 5108, Humbert 5124, 6765, 12792, 12813 and 13012, Perrier de la Bâthie 8821 and 19243, and Seyrig 23. The choice of a sheet of Perrier de la Bâthie 19243 at P as the lectotype is based on its completeness and quality as well as the presence of duplicates in various other herbaria.

The specimen Humbert 6765 ([P04078609]) includes three fragments, of which two are assigned to *N. lanceolata* and one to *N. divaricata*. Moreover, PERRIER DE LA BÂTHIE (1949) listed Decary 4561 as one of the syntypes of *N. lanceolata*, but no such specimen was found under *Noronhia* at the Paris herbarium. In fact, the only specimen found of Decary 4561 is clearly not a *Noronhia*, having been identified as *Desmodium repandum* (Vahl) DC. (P [P0009323]!). Besides, this specimen was collected in humid forest at Farafangana, far north from the range of *N. lanceolata* and outside of its natural habitat. However, it is possible that a numbering mistake was made since Decary 4561 was collected on August 8, 1926 in Farafangana, six days after Decary 4564 was collected in Fort-Dauphin, suggesting that perhaps another specimen bearing the number Decary 4561, truly representing *N. lanceolata*, exists. Nevertheless, in the absence of such a specimen and given the presence of material belonging to *Desmodium* Desv., Decary 4561 should be treated as an excluded syntype.

Additional specimens examined

MADAGASCAR. Prov. Toliara: Ambatoabo, Imonty-Evasia, Andohahela PN, 24°47'11"S 46°43'26"E, 680 m, 17.XII.2004, *Andriamihajarivo* 487 (MO, P, TAN); Amboasary Sud, Marotsiraka, Atsonjo Analamainty, Ankotsy, 24°17'30"S 46°07'48"E, 428 m, 10.XI.2008, *Andriamihajarivo et al.* 1547 (MO, P, TAN); Imanombo (Centre-Sud), 1.XI.1952, *Bosser* 4332 (MO, TAN); Imonty (Bassin de Mandrare), [24°49'S 46°41'E], 1.1962, *Bosser* 15718 (P, TAN); Behara à l'E d'Ambovombe, [24°57'S 46°23'E], 1.VIII.1931, *Decary* 9085 (G, P); Tsimelahy, Andohahela PN (Parcelle II), 24°57'25"S 46°36'26"E, 158 m,

21.II.2009, *Hong-Wa* 609 (MO, P, TAN); Ihazofotsy, Andohahela PN, 24°50'S 46°32'E, 100 m, 16.IV.1996, *Laha* 73 (K, MO, P, TAN); Ankoba, near E edge of Andohahela PN Park, Parcel 2, 24°47'19"S 46°42'07"E, 200 m, 23.I.2008, *Lowry et al.* 6942 (G, MO, P); Andohahela PN, Parcelle 2, 24°49'S 46°32'E, 30-50 m, 18.III.1994, *Rahajaso et al.* 214 (G, K, MO, P, TAN); Ambohimahavelona, Sept Lacs, Andranolahy, 23°31'24"S 44°09'10"E, 120 m, 4.IX.1998, *Rakotomalaza & Messmer* 1676 (G, P); Andohahela PN, Parcelle 3, 24°31'S 46°38'E, 600-1700 m, 5-22.VII.1993, *Randriamampionona* 507 (K, MO, P); Mont Trafonaomby, Andohahela PN, parcelle 1, 24°33'S 46°43'E, 1000-1957 m, 7.IV.1994, *Randriamampionona* 792 (G, MO, P, TAN); Andohahela (parcel 1), Tsimelahy, 24°50'20"S 46°32'17"E, 6.IV.1996, *Randriamampionona* 1228 (G, MO, P); Andohahela PN, Esomony, 24°31'S 46°37'E, 17.IX-30.X.1991, *Randriamanantena & Durbin* 37 (K, MO); Fort-Dauphin, Ambatoabo, Ankoba, 24°47'01"S 46°42'20"E, 298 m, 27.II.2009, *Randrianaivo et al.* 1762 (G, MO, P, TAN); Andohahela PN, Analamatsaka, 25°00'16"S 46°37'14"E, 180 m, 7-11.VI.1999, *Ratovoson et al.* 100 (MO, P, TAN); Ambatoabo, Evasia, 24°48'12"S 46°41'07"E, 200 m, 19.XI.2008, *Ratovoson* 1475 (G, MO, P, TAN); Behara Androy, [24°42'S 46°44'E], 30.XI.1953, *Réserves Naturelles* 5962 (G, P, TAN, TEF); Amboasary, Maromby, Sifotsy près d'Isomony, [24°40'S 46°44'E], 28.X.1962, *Réserves Naturelles* 12187 (P, TEF); entre Ranomainty et Bevilany, [25°00'S 46°34'E], 0-200 m, 7.XII.1961, *Service Forestier* 20483 (MO, P, TEF); Route Tuléar-Sakaraha, PK 28, [23°20'00"S 43°51'30"E], 300 m, 8.I.1962, *Service Forestier* 20780 (MO, P, TEF); Piste de Maromiandra (Tuléar) au plateau de Mikoboka, [22°45'S 44°04'E], 1.IV.1965, *Service Forestier* 24138 (G, MO, P, TEF).

41. *Noronhia latifolia* Hong-Wa, *spec. nova* (Fig. 29, 30A).

Typus: MADAGASCAR. **Prov. Antsiranana:** DIANA, Ambilobe, Beramanja, Anketrabe, forêt de Kalabenono, chaîne de Galoko, 9 km au SE d'Anketrabe, 13°38'30"S 48°40'53"E, 976 m, 23.XI.2006, *Razafitsalama 1102* (holo-: MO-6615570!; iso-: G [G00341579], P [P03533079] image seen, TAN!).

Diagnosis *Noronhia latifolia* Hong-Wa can be distinguished from other members of the genus by its whitish bark, its enlarged nodes, its thick woody petioles, its broad leaf blades, and its subglobose, punctate fruits.

Description Shrubs to 7 m tall, trunk to 6 cm diameter; young twigs cylindrical, 2.3-3.5 mm diameter, glabrous; bark whitish, smooth. Leaves opposite, persistent; bud scales deciduous; blades medium green above, lighter below, broadly lanceolate, 14-28.5 × 3.5-9.5 cm, coriaceous, glabrous, domatia absent, base acute, margin flat, apex acute, the point 10-14 mm long, midrib slightly sunken above, distinctly raised below, secondary veins conspicuous, 9-14 per side, 26-29 mm apart, looping 3.5-7 mm from the margin; petiole light gray, 13-20 × 3.6-4.7 mm, entirely woody, glabrous. Flowers unseen, but infructescence thyrsoïd. Fruiting pedicel 8-12 × 1.7-2.2 mm; young fruits green, brownish when mature, subglobose, 14.5-20.5 × 13-17 mm, covered with white dots, apex flat to apiculate; dry pericarp 0.7-1.1 mm thick; endocarp crustaceous; seed 10.5-14 × 9-11 mm.

Etymology This species derives its name from its broad leaves.

Distribution, ecology and phenology *Noronhia latifolia* occurs in mid-elevation humid forests in the Galoko mountain chain in northern Madagascar (Fig. 27). This species has been collected in fruits in November.

Conservation status *Noronhia latifolia* is currently known only from three collections made within the same forest (Kalobinono on the Galoko range) gathered within a distance of no more than 80 m from each other, and two were probably from adjacent individuals. With a distribution that is almost linear, EOO could not be calculated, AOO was estimated at 4 km², and the single subpopulation represents a single location that is now encompassed within the newly established protected area of Galoko. Although extensive clearing of the Kalobinono forest may now be slowing as a result of its new status, there is a reason to believe that anthropogenic pressure, such as illicit exploitation or encroachment, will not be entirely eliminated, especially in the context of a changing climate that modulates farming practices and

exploitation of natural resources, rapid population growth, and sustained immigration influx. Therefore, *N. latifolia* is assigned a preliminary status of “Vulnerable” [VU D2].

Notes *Noronhia latifolia* resembles *N. edentata*, but can be distinguished by its broadly lanceolate (vs. elliptic to obovate) and longer (14-28.5 cm vs. 5-17 cm) leaf blades, acute (vs. rounded to acuminate) leaf apex, and crustaceous (vs. woody) endocarp.

Paratypus **MADAGASCAR. Prov. Antsiranana:** Ambilobe, Beramanja, Anketrabe, forêt de Kalabenono, 13°38'41"S 48°40'27"E, 730 m, 26.XI.2006, *Callmänder et al.* 626 (G, MO, P, TAN); *ibid. loc.*, 13°38'40"S 48°40'26"E, 700 m, 28.IX.2013, *Ratovoson* 2041 (MO, P, TAN).

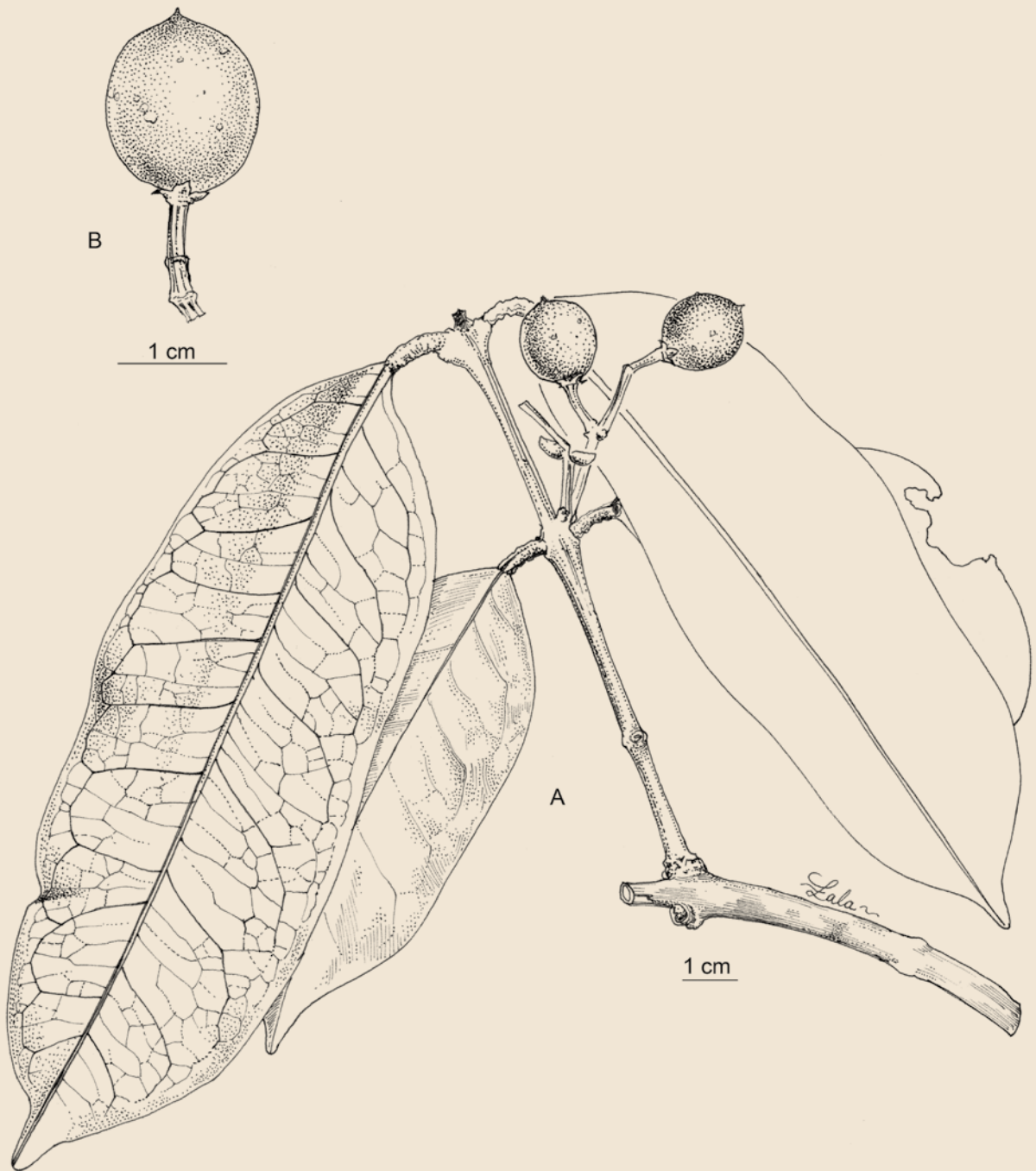


Fig. 29. *Noronhia latifolia* Hong-Wa.
A. Fruiting branch; **B.** Fruit.

[Razafitsalama 1102, TAN] Drawings: R.L. Andriamiarisoa

42. *Noronhia leandriana* H. Perrier in Mém. Inst. Sci. Madagascar, Sér. B, Biol. Vég. 2 : 289. 1949.

Typus: MADAGASCAR. **Prov. Mahajanga:** Ouest, Tsingy du Bemaraha (9e Réserve Naturelle), secteur du Menabe, [18°12'S 44°35'E], 1932-1933, *Leandri 1004* (holo-: P [P00413235]!; iso-: K [K000233188] image seen, P [P00413236, P00701476]!).

Description

Trees to 20 m tall, trunk to 35 cm diameter; young twigs cylindrical, 0.6-2.6 mm diameter, glabrous; bark dark to medium gray, smooth. *Leaves* opposite, persistent; bud scales persistent; blades light green, oblong, 9-20 × 2-5 cm, chartaceous, glabrous, domatia common, base attenuate, margin flat to slightly undulate, apex acute to acuminate, the acumen 1-15 mm long, midrib sunken above, raised below, secondary veins conspicuous, 7-17 per side, 7-19 mm apart, looping 1-4 mm from the margin; petiole yellow to orangish, 5-15 × 0.7-2.2 mm, not woody, glabrous. *Thyrse*s geminate to fasciculate, multiflorous, diffuse; peduncle 2-25 mm long, moderately pubescent; pedicel 2.5-13 mm long, moderately pubescent; calyx moderately pubescent outside, glabrous inside, lobes triangular, 0.9-1.4 × 1.2-1.8 mm; corolla yellowish-green, rotate, 3-4.5 mm long, glabrous on both sides, the tube 0.5-2 mm long, lobes ovate, apex acute; corona present, 1.2-2 mm long, slightly lobed; stamens 1.4-2.1 mm long, anthers widely oblong, 0.9-1.3 mm long; pistil 1.5-2 mm long, stigma capitate. *Fruiting* pedicel 5-18 × 0.6-1.7 mm; young fruits green, brownish when mature, ovoid, 13-26 × 9.5-16 mm, surface slightly rugose, apex bluntly pointed to rostellate, the rostellum flattened, ridged, truncate; dry pericarp 0.6-1 mm thick; endocarp woody; seed 9-20 × 7.5-11 mm.

Distribution, ecology and phenology

Noronhia leandriana occurs in low- to mid-elevation dry forests on limestones and base-ment rocks in the west, from Sofia to Antsalova (Fig. 27). It produces flowers and fruits throughout the year except in September and October.

Conservation status

Based on seven collections representing six localities, the assessment indicated an EOO of 13,337 km², an AOO of 24 km², and six subpopulations representing six locations, of which three occur within protected areas (Bemaraha and Corridor Bongolava). Continuing decline in habitat quality, AOO and number of mature individuals are expected outside these protected areas due to fire, wood harvesting, forest exploitation, land conversion and artisanal mining. Therefore, *N. leandriana* is assigned a preliminary status of "Vulnerable" [VU B1ab(ii,iii,iv,v)+2ab(ii,iii,iv,v)].

Notes

Noronhia leandriana can be recognized by its chartaceous, oblong leaf blades and large inflorescences with rotate flowers. It differs from *N. urceolata* H. Perrier by its non-woody (vs. woody) petioles, rotate (vs. urceolate) flowers, the presence (vs. absence) of a corona, and its woody (vs. crustaceous) endocarp.

**Additional specimens
examined**

MADAGASCAR. **Prov. Mahajanga:** Bekopaka, Antsalova, [19°08'S 44°47'E], 4.VII.1970, *Jacquemin* 754 (P); Antsingy, vers Bevary (E d'Antsalova), [18°37'S 44°48'E], 400-600 m, 27.I-5.II.1960, *Leandri & Saboureau* 2847 (G, MO, P); Bords de la Mahavavy, au-dessus de Itampika (Ambongo), [16°23'S 45°53'E], IX.1904, *Perrier de la Bâthie* 1757 (P); Causse d'Ankara (Boina), [17°13'S 46°16'E], VIII.1922, *Perrier de la Bâthie* 14827 (P); Melaky, Antsalova, [18°27'S 44°44'E], 25.II.1960, *Réserves Naturelles* 11116 (P, TEF); Ambondrona, Maevatanana, [16°57'S 46°50'E], 16.V.1955, *Service Forestier* 14938 (MO, P, TEF); Ambodiriana II, Port-Bergé, [15°55'S 47°29'E], 0-300 m, 24.XI.1958, *Service Forestier* 19236 (MO, P); 14 km E Antsalova, [18°30'S 44°45'E], 18.III.1993, *Villiers et al.* 4830 (P).

43. *Noronhia linearifolia* H. Perrier in Mém. Inst. Sci. Madagascar, Sér. B, Biol. Vég. 2 : 289. 1949.

Typus: MADAGASCAR. **Prov. Antsiranana:** N de Madagascar, baie de Rigny, Port Lewen, [12°45'S 49°43'E], III-IV.1849, Boivin 2451 (holo-: P [P00608381]!; iso-: P [P00608382]!).

Description *Shrubs* to small trees to 6 m tall, trunk to 7 cm diameter; young twigs cylindrical, 0.6-1.3 mm diameter, glabrous; bark medium gray, smooth to slightly rugose. *Leaves* opposite, persistent; bud scales persistent; blades medium green above, lighter below, linear, 3-8 × 0.5-1.3 cm, coriaceous, glabrous, domatia absent, base rounded, margin revolute, apex retuse (rarely mucronulate), the mucro 1-2.5 mm long, midrib flat to slightly sunken, raised below, secondary veins inconspicuous, 5-13 per side, 3-12 mm apart, looping 0.5-1.6 mm from the margin; petiole medium gray, 1.5-6 × 0.2-1.4 mm, entirely woody, glabrous. *Flowers* solitary; pedicel 2.5-5.5 mm long, glabrous; calyx sparsely pubescent outside, glabrous inside, lobes widely ovate, 1.1-1.8 × 1-2.1 mm; corolla reddish-brown tinged white, urceolate, 3.8-7 mm long, glabrous on both sides, the tube 3-5.5 mm long, lobes ovate, apex rounded; corona present, 1-2 mm long, lobed; stamens 1.7-2.4 mm long, anthers ovate, 1.3-1.8 mm long; pistil 2-3 mm long, stigma capitate. *Fruiting* pedicel 2-8 × 0.8-1.6 mm; young fruits green, reddish black when mature, ovoid, 7-14 × 5-11 mm, smooth, sometimes covered with a white pellicle, apex flat to apiculate; dry pericarp 0.5-1.9 mm thick; endocarp woody; seed 6.5-9.5 × 4-5.5 mm.

Distribution, ecology and phenology *Noronhia linearifolia* occurs in littoral to low-elevation dry forests in the north, from Orangéa (Oronjia) to Vohémar (Fig. 27). It produces flowers and fruits throughout the year except in March and April.

Conservation status The assessment was based on 21 collections representing 18 localities and resulted in an EOO of 1,825 km², an AOO of 56 km², and 12 subpopulations representing 10 locations, of which five occur within the network of protected areas (Analamerana, Loky-Manambato, Montagne des Français, and Oronjia). Conversion of land into agricultural fields and pastures, wood harvesting, charcoal production, and in some cases gradual sea level rise constitute threats to some of the subpopulations, thereby reducing the EOO, AOO, habitat quality and number of mature individuals. Thus, *N. linearifolia* is assigned a preliminary status of "Vulnerable" [VU B1ab(i,ii,iii,iv,v)+2ab(i,ii,iii,iv,v)].

Notes *Noronhia linearifolia* can be recognized by its coriaceous, linear leaf blades with barely visible venation and its solitary, red flowers. It differs from *N. alleizettei* by its linear (vs. narrowly elliptic) leaf blades, solitary (vs. fasciculate), reddish brown (vs. white) flowers, and the presence (vs. absence) of a corona.

Additional specimens examined

MADAGASCAR. Prov. Antsiranana: Analabolona, 3 km à l'W d'Irodo, 12°37'21"S 49°30'01"E, 102 m, 20.VII.2004, *Be et al.* 15 (CNARP, MO, P, TAN); Andrafiabe, Ambolobozokely, Ampasimena, 12°26'00"S 49°30'13"E, 35 m, 29.XII.2008, *Christian et al.* 83 (CNARP, G, MO, P, TAN); Analamerana RS, 12°40'25"S 49°32'40"E, 41 m, 8.I.2002, *De Block* 1128 (BR, G, K, MO, P, TAN, WAG); Ramena, Andavakoera, 12°19'57"S 49°21'19"E, 172 m, 4.VIII.2007, *Hong-Wa* 526 (CNARP, MO, P, TAN); Analamera, [12°47'24"S 49°30'00"E], 50-400 m, I.1938, *Humbert* 19114 (P); 40 km N of Vohémar, near N end of Lac Sahaka, 13°04'45"S 49°54'17"E, 20 m, 3.XI.2002, *McPherson* 18876 (MO, P, TEF); Orangéa, 12°15'01"S 49°21'39"E, 50 m, 20.I.2003, *Miller et al.* 10727 (G, MO); Vohémar, Anjiabe, Analabe, 13°04'50"S 49°54'07"E, 9.VII.2003, *Rabehevitra et al.* 208 (MO, P, TEF); Ramena, forêt d'Orangéa, 12°14'45"S 49°21'20"E, 13-25 m, 4.IX.2001, *Rabenantoandro & Razanatsoa* 631 (MO, P, TAN); Vohémar, Anjiabe, forêt d'Anaborano près du Lac Sahaka, 13°04'42"S 49°54'13"E, 25 m, 2.XI.2002, *Rabenantoandro et al.* 1103 (MO, P, TAN); *ibid. loc.*, 13°04'43"S 49°54'04"E, 10 m, 23.II.2003, *Rabenantoandro et al.* 1280 (G, MO, P); Ambolobozobe, Ankonahona, 12°31'S 49°32'E, 27.XI.2007, *Rakotonandrasana et al.* 1249 (CNARP, MO, TAN); Baie de Sakalava, 12°16'39"S 49°22'49"E, 21 m, 5.XI.2006, *Ranaivojaona et al.* 1506 (G, MO, P, TAN); Vohémar, Anjiabe, Anaborano, forêt d'Analabe, 13°04'09"S 49°54'08"E, 18 m, 21.VII.2004, *Randrianarivelo & Sola* 74 (MO, P, TAN); Andrafiabe, Sahafary, 12°35'43"S 49°26'54"E, 233 m, 11.IX.2004, *Razafitsalama et al.* 635 (CNARP, MO, P, TAN).



Fig. 30. Photographs of *Noronhia* Stadtm. ex Thouars. **A.** *Noronhia latifolia* Hong-Wa [Callmander 626]; **B.** *Noronhia linearifolia* Boivin ex Dubard [Hong-Wa 526]; **C.** *Noronhia linocerioides* H. Perrier [Ravelonarivo 3606] **D.** *Noronhia longipedicellata* H. Perrier [Razafitsalama 1231]

Photos: A: M. Callmander; B: F. Ratovoson; C: C. Birkinshaw; D: F. Ratovoson

44. *Noronhia linocerioides* H. Perrier in Mém. Inst. Sci. Madagascar, Sér. B, Biol. Vég. 2: 288. 1949 (Fig. 30C).

Typus: MADAGASCAR. **Prov. Toamasina:** Près de Vatomandry, [19°20'S 48°59'E], IX.1921, *Perrier de la Bâthie 14111* (holo-: P [P00701478]!; iso-: P [P00701477, P00418112]!).

Description *Trees* to 14 m tall, trunk to 20 cm diameter; young twigs cylindrical, 0.5-1.7 mm diameter, glabrous; bark medium gray, smooth. *Leaves* opposite, persistent; bud scales rarely persistent; blades medium green glossy above, lighter below, narrowly to broadly elliptic, 3.5-13 × 1.5-5.5 cm, chartaceous, glabrous, domatia absent, base acute, margin flat to slightly undulate, apex acuminate, the acumen (0-)2-17 mm long, midrib flat to slightly sunken above, distinctly raised above, secondary veins conspicuous, 5-14 per side, 5-21 mm apart, looping 1-5 mm from the margin; petiole orange to red, 4-15 × 0.6-2.5 mm, not woody, glabrous. *Thyrse*s geminate to fasciculate, pauciflorous, compact to somewhat diffuse; peduncle 3-18 mm long, moderately to sparsely pubescent; pedicel 1.5-24 mm long, sparsely pubescent; calyx sparsely pubescent to glabrous outside, glabrous inside, lobes triangular, 0.5-1.2 × 0.6-1.5 mm; corolla pale yellow, subrotate, 2.2-5 mm long, glabrous on both sides, the tube 0.5-2.3 mm long, lobes ovate, apex slightly acute; corona present, 1-1.8 mm long, undivided; stamens 1.2-2 mm long, anthers depressed obovate, 0.8-1.5 mm long; pistil 1.2-2.2 mm long, stigma slightly bilobed. *Fruiting* pedicel 3-23 × 0.4-2.5 mm; young fruits green, dark red when mature, ovoid, 8-17.5 × 6-15 mm, surface smooth, covered with white dots, apex bluntly pointed to rostellate; dry pericarp 0.2-1.6 mm thick; endocarp woody; seed 6-14 × 4-10 mm.

Distribution, ecology and phenology *Noronhia linocerioides* occurs in low- to high-elevation humid forests in the east, from Daraina to Fort-Dauphin, and in the Sambirano region in the northwest (Fig. 27). It produces flowers and fruits all year.

Conservation status *Noronhia linocerioides* is widely distributed, ranging throughout almost the entire eastern part of Madagascar, the northeast, and the Sambirano region. Ninety-one collections representing 73 localities were available for analysis. With an EOO of 193,559 km², an AOO estimated at 268 km² but that is certainly much larger, and 50 subpopulations representing 43 locations, of which 15 occur within protected areas (Analalava, Anjanaharibe-Sud, Lokobe, Loky-Manambato, Makira, Makirovana, Mandena, Manombo, Masoala, Ranomafana, Ste Luce, Tsaratanana, Tsaratanana-Ambohimirahavavy-Corridor Marojejy, Tsitongambarika, and Zahamena), *N. linocerioides* is assigned a preliminary status of "Least Concern".

Notes *Noronhia linocerioides* can be recognized by its reddish petioles, chartaceous leaf blades, and short-tubed, yellow flowers. It differs from *N. brevītuba* by the shape of its leaves and flowers and the apex of its fruits, as discussed under that species. Most specimens placed in *Olea ambrensis* H. Perrier by GREEN (2002) fall within the range of morphological variation of *N. linocerioides*. Among these, Schatz 3605 (erroneously cited as Schatz 3405 in GREEN (2002), which is actually a collection of *Sideroxylum betsimisarakum* Lecomte) is phylogenetically related to other specimens clearly belonging to *Noronhia. linocerioides* (HONG-WA & BESNARD, 2013, 2014). Thus, most specimens formerly recognized as *Olea ambrensis* are transferred here to *Noronhia linocerioides*, whereas others were also embedded within another clade comprising species of *Noronhia* (HONG-WA & BESNARD, 2013, 2014). Their placement is addressed below under *N. olearia*.

**Additional specimens
examined**

MADAGASCAR. Prov. Antsiranana : Vinanivao, Masoala PN, 15°41'33"S, 50°13'30"E, 12-100 m, 15.IX.1996, Bernard 323 (K, MO, P, TAN); Anjanaharibe-Sud RS, 10 km SW of Befingotra, 14°45'S 49°29'E, 1100-1300 m, 7.IX.1997, Birkinshaw *et al.* 467 (MO, P, TAN); Antalaha, between Sahantaha and Andongozabe, 15°02'S 50°20'E, 10 m, 20.IX.1997, Birkinshaw 492 (MO, P, TAN); Ambatobiribiry, [14°11'S 50°05'E], 50-345 m, 29-30.XI.1950, Humbert & Capuron 24420 (G, MO, P); Masoala PN, Sahamalaza, Vinanivao, 15°35'S 50°25'E, 0 m, 18.IX.1994, Rahajaso *et al.* 408 (K, MO, TAN); Masoala PN, Andrombazaha, 15°16'S 50°29'E, 4.X.1994, Rahajaso *et al.* 751 (K, MO, P, TAN); Marojejy RNI, 14°02'30"S 49°48'20"E, 805 m, 8-16.VII.1994, Rasoavimbahoaka 328 (K, MO, P, TAN); Marotolana, à 7 km à l'E de Beangona-Ambevy, 14°01'54"S 48°47'01"E, 700-1300 m, 26.XI.2000, Rato-vozon 347 (MO, P, TAN); Andapa, Bealampona, Anjanaharibe-Sud RS, 14°45'03"S 49°30'03"E, 875 m, 18.X.1994, Ravelonarivo *et al.* 394 (G, K, MO, P, TAN); Sambava, Anjangoveratra, Antanandava, forêt de Bevagnana, 14°10'38"S 49°57'11"E, 417 m, 5.II.2011, Ravelonarivo *et al.* 3606 (MO, P, TAN); Antalaha, Ambohitralanana, Sahafary, 15°17'27"S, 50°22'39"E, 29.IX.1997, Ravololonanahary & Zera 101 (G, K, MO, P, TAN); Nosy-Be, Lokobe RNI, [13°24'S 48°19'E], 20.V.1952, Réserves Naturelles 4323 (P, TAN); Andapa, Doany, Andranovola, [14°22'S 49°31'E], 0-400 m, 31.X.1967, Service Forestier 26451 (MO, P, TEF). **Prov. Fianarantsoa :** Manombo RS, 23°00'S 47°42'E, 5.III.2009, Hong-Wa *et al.* 613 (MO, P, TAN); Ranomafana PN, Parcelle 1, S of Ambohimiera, 21°04'S 47°29'E, 880-1100 m, 15-17.IX.1992, Malcomber *et al.* 1561 (MO, P, TAN); Ifanadiana, [21°18'S 47°37'E], 1000 m, 10.XII.1954, Service Forestier 13818 (P, TEF). **Prov. Mahajanga :** Matsandakana, Andasinanantsomanga Amparihy, 14°55'34"S 49°24'59"E, 1155 m, 24.II.2008, Bernard 929 (G, MO, P, TAN). **Prov. Toamasina :** Maroantsetra, Anjahana, Ambanizana, 15°37'02"S 49°58'10"E, 20 m, 8.VI.2002, Antilahimena 1064 (G, MO, P); Tampolo STF, 17°16'S 49°25'E, 0-10 m, 15.IV.1997, Birkinshaw *et al.* 421A (G, MO, P); Toamasina, [18°49'S 49°08'E], 3-5 m, 13.X.1946, Cours 2994 (G, MO, P); Maroantsetra, Hiaraka, 15°30'S 49°55'E, 100 m, 11.X.1986, Lowry *et al.* 4070 (MO, P, TAN); Masoala Peninsula, Ambanizana, 15°38'S 49°58'E, 5-10 m,

10.II.1999, *McPherson et al.* 17546 (G, K, MO, TAN); Soanierana-Ivongo, Manompana, forêt d'Andakibe, 16°47'06"S 49°44'18"E, 1.XI.2008, *Nikolov* 1780 (MO, P); Ambila-Lemaitso, 18°49'S 49°08'E, 10 m, 3.VII.1995, *Razafimandimbison* 172 (G, K, MO, P, TAN); 5-12 km SW of Maroantsetra, 15°30'S 49°39'E, 10 m, 28.XI.1987, *Schatz* 1796 (MO, P, TAN); Fénérive-Est, Ambodimanga, Tampolo STF, 17°16'52"S 49°24'44"E, 10 m, 25.XI.1994, *Schatz* 3605 (G, K, MO); Manakambahiny Est, Ranomainty, près de Nonokambo, [17°45'S 48°45'E], 24.XII.1967, *Service Forestier* 26558 (MO, P, TEF); Tampolo STF, 17°17'S 49°23'E, 8.XI.1981, *Service Forestier* 32269 (TEF); Ampasin' Onibe, Mahatsara STF, 17°38'S 49°29'E, 19.X.1990, *Service Forestier* 34124 (MO, TEF); 4 km S of Vatomandry, 18°53'49"S 49°07'43"E, 14 m, 10.I.2006, *Tosh et al.* 69 (BR, K, MO, P, TAN). **Prov. Toliara:** Fort-Dauphin, Lakandava, 24°58'13"S 46°57'47"E, 1.X.2000, *Rabevohitra et al.* 3723 (G, MO); Mahatalaky, Sainte Luce, 24°08'04"S 47°16'38"E, 5 m, 9.XI.2006, *Ramison et al.* 28 (G, MO, P, TEF).

45. *Noronhia longipedicellata* H. Perrier in Mém. Inst. Sci. Madagascar, Sér. B, Biol. Vég. 2: 300. 1949 (Fig. 30D).

Typus: MADAGASCAR. **Prov. Antsiranana:** collines et plateaux calcaires de l'Ankarana, partie N, au S d'Ampasimbengy, [12°54'S 49°08'E], 250 m, XII.1937-I.1938, *Humbert* 18904 (holo-: P [P00573412]!; iso-: P [P00573413]!).

Description

Small *trees* to 5 m tall, trunk to 5 cm diameter; young twigs cylindrical, 0.8-1.4 mm diameter, glabrous; bark medium to light gray, smooth to slightly rugose. *Leaves* opposite, persistent; bud scales persistent; blades dark green above, lighter below, narrowly to broadly obovate, 3.5-8 × 0.7-3.2 cm, coriaceous, glabrous, domatia absent, base acute to attenuate, margin slightly revolute and undulate, apex retuse to slightly mucronate, the mucro 1-6 mm long, midrib sunken above, raised below, secondary veins barely visible, 6-12 per side, 4-11 mm apart, looping 1-3.5 mm from the margin; petiole medium gray, 3-8 × 0.7-2.1 mm, entirely woody, glabrous. *Thyrse*s solitary, pauciflorous, diffuse; peduncle 2-15 mm long, glabrous; pedicel 7-17 mm long, glabrous; calyx very sparsely pubescent outside, glabrous inside, lobes triangular, 1-2 × 0.8-1.7 mm; corolla orange purplish outside, yellow inside, urceolate, 3.2-7.5 mm long, glabrous on both sides, the tube 2-5 mm long, lobes widely ovate, apex acute; corona present, 1.5-2 mm long, lobed; stamens 1.9-2.5 mm long, anthers widely ovate, 1.2-1.8 mm long; pistil 1.5-4 mm long, stigma slightly bilobed. *Fruiting* pedicel 11-28 × 0.7-1 mm; young fruits green, dark red when mature, ovoid, 10.5-14 × 7-10 mm, smooth, sometimes covered with a white pellicle, apex apiculate; dry pericarp 0.5-1.1 mm thick; endocarp woody; seed 6-8.5 × 4.5-5.5 mm.

Distribution, ecology and phenology

Noronhia longipedicellata occurs in low- to mid-elevation dry forests in the north, in and around Ankarana (Fig. 27). It produces flowers and fruits throughout the year except in August and September.

Conservation status

The assessment was based on 16 collections representing 11 localities and resulted in an EOO of 642 km², an AOO of 44 km², and eight subpopulations representing six locations, of which three occur within protected areas (Andavakoera-Andrafiame-na-Ambohipiraka and Ankarana). Areas not benefiting any form of protection exhibit continuing decline in habitat quality, EOO, AOO and number of mature individuals resulting from conversion of forested land into agricultural fields and pastures, and wood harvesting. Therefore, *N. longipedicellata* is assigned a preliminary status of "Vulnerable" [VU B1ab(i,ii,iii,iv,v)+2ab(i,ii,iii,iv,v)].

Notes

Noronhia longipedicellata can be recognized by its coriaceous, obovate leaf blades with barely visible venation, long pedicels, and orange-purplish flowers.

**Additional specimens
examined**

MADAGASCAR. **Prov. Antsiranana:** Ambilobe, Ankarana RS, 13°01'26"S 49°05'33"E, 32-143 m, 16.IV.1996, *Andrianantoanina & Bezara* 964 (K, MO, P); *ibid. loc.*, [12°49'S 49°01'E], 6.X.1990, *Bardot-Vaucoulon* 104 (P); Andrafiarena, Anjahankely, 12°55'38"S 49°17'34"E, 510 m, 12.XI.2010, *Gautier* 5415 (G, K, MO, P, TEF); Marivorahona, Betsimiranja, 12°56'27"S 49°07'21"E, 136 m, 17.I.2009, *Hong-Wa* 564 (MO, P, TAN); *ibid. loc.*, forêt d'Ambilomagodra, 13°01'24"S 49°08'07"E, 58 m, 30.I.2009, *Hong-Wa et al.* 592 (MO, P, TAN); Anivorano-Nord, Andrafiabe, Mt Antsahabe, 12°54'59"S 49°17'38"E, 502 m, 3.VII.2010, *Hong-Wa* 715 (MO, TAN); Marivorahona, Betsimiranjana, Ankarana, 12°57'32"S 49°07'12"E, 132 m, 8.XII.2006, *Ranaivojaona et al.* 1665 (CNARP, MO, P, TAN); Mosorolava, Ampombiantambo, 12°41'24"S 48°56'59"E, 75 m, 27.IX.2007, *Ratovoson et al.* 1381 (CNARP, MO, P, TAN); *ibid. loc.*, forêt d'Antsoroby, 12°40'29"S 48°58'52"E, 23.IX.2007, *Razafitsalama et al.* 1231 (CNARP, MO, P, TAN); PK 95 sur la route de Diégo-Suarez à Ambilobe, 13.IV.1954, *Service Forestier* 9725 (P, TEF).

46. *Noronhia louvelii* H. Perrier in Mém. Inst. Sci. Madagascar, Sér. B, Biol. Vég. 2 : 296. 1949 (Fig. 31A).

Typus: MADAGASCAR. **Prov. Toamasina:** Centre E, forêt d'Analamazoatra, [18°56'S 48°26'E], s.d., Louvel 79 (holo- : P [P00573411]!).

Description *Trees* to 30 m tall, trunk to 45 cm diameter; young twigs cylindrical, 0.8-2.1 mm diameter, glabrous; bark medium gray, slightly rugose. *Leaves* opposite, persistent; bud scales persistent; blades dark green above, lighter below, elliptic, 3-12 × 1.5-5 cm, coriaceous, glabrous, domatia rare, base acute to attenuate, margin flat to slightly revolute, apex acute to acuminate, the acumen 1-11 mm long, midrib slightly sunken above, slightly raised below, secondary veins conspicuous, 6-11 per side, 3-17 mm apart, looping 1-5 mm from the margin; petiole medium gray, 2.5-10 × 0.8-2.4 mm, entirely woody, glabrous. *Thyrse*s fasciculate, pauciflorous, compact; peduncle 2.5-10 mm long, moderately pubescent; pedicel 3-13 mm long, moderately pubescent; calyx moderately to sparsely pubescent outside, glabrous inside, lobes oblong, 1-2.5 × 1-2.5 mm; corolla red, cupuliform, 2-7 mm long, glabrous on both sides, the tube 1.5-4.5 mm long, lobes widely ovate, apex cucullate; corona present, (0-)1-2 mm long, undivided; stamens 1.2-2.8 mm long, anthers widely obovate, 1-1.3 mm long; pistil 1.5-3 mm long, stigma capitate. *Fruiting* pedicel 2-21 × 0.7-2.4 mm; young fruits green, dark red when mature, subglobose, 14-23 × 11-20.5 mm, surface smooth, apex flat to bluntly pointed, style persistent; dry pericarp 0.6-1.4 mm thick; endocarp crustaceous; seed 7-14 × 6-16 mm.

Distribution, ecology and phenology *Noronhia louvelii* occurs in low- to high-elevation humid forests in the east, from Daraina to Vatoman-dry and in the Centre-West near Tsiroanomandidy (Fig. 27). It produces flowers and fruits throughout the year except in March.

Conservation status Known from 61 collections representing 57 localities, *Noronhia louvelii* is quite widespread. With an EOO of 141,234 km², an AOO of 192 km², and 39 subpopulations representing 26 locations, of which 10 occur within protected areas (Analamazaotra, Anjanaharibe-Sud, Anjozorobe-Angavo, Betampona, Loky-Manambato, Makira, Marojejy, Masoala, Tsaratanana-Ambohimirahavavy-Corridor Marojejy, and Zahamena), it is assigned a preliminary status of "Least Concern".

Notes *Noronhia louvelii* can be recognized by its coriaceous, elliptic leaf blades, cupuliform, red flowers, and crustaceous, subglobose fruits subtended by short pedicels. It differs from *N. luteola* by its woody (vs. non-woody) petiole, elliptic (vs. oblong to ovate) leaf blades, cupuliform (vs. subrotate), red (vs. white) flowers, and crustaceous (vs. woody) endocarp. The collection Morat 4627 from humid forest around

Tsiroanomandidy in the Bongolava region extends the range of this species to the west. A collection of another species bears the same number as the type specimen of *N. louvelii*: viz. *Dalbergia maritima* R. Vig. (holo-: Louvel 79 [P00060529], from eastern Madagascar).

Additional specimens examined

MADAGASCAR. Prov. Antananarivo: Anjozorobe, 18°24'30"S 47°56'15"E, 1320 m, 9.IV.1993, *Harder 1544* (MO, P, TAN); Tsiroanomandidy, [18°11'S 45°16'E], 1300 m, VII.1974, *Morat 4627* (MO, P, TAN); c. 7 km E of Anjozorobe, 18°22'S 48°00'E, 1300 m, 11.V.1987, *Schatz 1387* (K, MO, P, TAN). **Prov. Antsiranana:** Marojejy PN, 14°26'S 49°37'E, 1080 m, 23.X.2001, *Gautier 3905* (G, MO); Daraina, Ankijabe, forêt de Binara, 13°15'S 49°37'E, 1050 m, 3.XI.2001, *Gautier & Ravelonarivo 3986* (Daraina, G, MO, P, TEF); Andapa, Ambodisatrana, 14°32'S 49°26'E, 1100-1200 m, 3.VIII.1997, *McPherson 17204* (K, MO, TAN); Anjanaharibe-Sud RS, 14°48'15"S 49°26'45"E, 1000-1100 m, 6.VIII.1997, *McPherson 17252* (K, MO, TAN); Andapa, Ambodiangezoka, Antanambe, forêt de Betaolana, 14°32'18"S 49°26'18"E, 875 m, 9.X.1999, *Rakotomalaza & Ravelonarivo 1911* (G, MO, P); Antalaha, Marofinarittra, Ampokafo, 15°16'49"S, 50°01'27"E, 610 m, 1-15.XII.1997, *Ranaivojaona et al. 198* (G, MO, P, TAN); Bealampona, Anjanaharibe-Sud RS, 14°44'45"S 49°29'40"E, 890-1041 m, 14.IX.1994, *Ravelonarivo et al. 378* (G, K, MO, P, TAN); Anjialavabe, Ankiakabe, Andohan'Anjialava, 14°10'47"S 49°22'01"E, 1567 m, 20.II.2007, *Ravelonarivo et al. 2198* (G, MO, P, TAN); Sambava, Andratamarina, Bemanasy, 14°23'54"S 49°50'55"E, 892 m, 23.X.2010, *Ravelonarivo & Raharivelo 3562* (MO, P, TAN); Sambava, [14°16'S 50°10'E], 21.IV.1956, *Réserves Naturelles 7954* (G, P, TAN). **Prov. Mahajanga:** Befandriana-Nord, Matsoandakana, Andranomena, forêt d'Anjiabe, 15°07'35"S 49°21'09"E, 1418-1446 m, 9.II.2008, *Ravelonarivo et al. 2704* (G, MO, P, TAN). **Prov. Toamasina:** Zahamena PN, 17°32'47"S 48°44'21"E, 1240-1400 m, 28.IX.2001, *Andrianjafy et al. 148* (CNARP, MO, P, TEF); Ambatovola, 18°55'13"S 48°30'49"E, 29.I.2005, *Andriatsiferana et al. 2584* (G, MO, P, TAN); Maroantsetra, Anjahana, Hiaraka, 15°28'42"S 49°54'32"E, 300 m, 1.IX.2002, *Antilahimena et al. 1287* (G, MO); Morafeno, Amboditavolo, 15°50'14"S 49°30'32"E, 326 m, 28.X.2003, *Antilahimena et al. 2207* (MO, P); Vinanibe, Andongona, Makira, 15°27'40"S 49°17'46"E, 1153 m, 27.XI.2003, *Antilahimena 2402* (MO); Ambinanitelo, Marovovonana, 15°18'57"S 49°25'04"E, 981 m, 1.IX.2004, *Antilahimena 2700* (G, MO); Ambatovy, 18°48'29"S 48°18'50"E, 1060 m, 16.XII.2004, *Antilahimena et al. 3012* (G, MO, P, TAN); *ibid. loc.*, 18°51'34"S 48°18'00"E, 1115 m, 8.VIII.2008, *Antilahimena et al. 6426* (G, MO, P, TAN); Andasibe, forêt d'Analaimay, 18°51'16"S 48°19'35"E, 1130 m, 8.VI.2007, *Bernard 549* (G, MO, P, TAN); Ambatovy 18°50'27"S 48°18'11"E, 1117 m, 17.V.2010, *Bernard et al. 1574* (MO, P, TAN); Analamazaotra RS, 18°56'12"S 48°25'09"E, 953 m, 2.V.2010, *Hong-Wa & Ortiz 642* (MO, P, TAN); Betampona RNI, 17°54'46"S 49°12'20"E, 427 m, 20.XI.2001, *Rabehevitra et al. 14* (G, MO, P); Moramanga, Ambatovy-Beroy, 18°49'44"S 48°19'59"E, 6.V.2011, *Rajaonary 121* (MO, P, TAN); Zahamena PN, Antanandava, Ankosy, 17°28'58"S 48°44'10"E, 997 m, 12.VII.2000, *Rakotonan-*

drasana et al. 417 (G, MO, P); Vavatenina, Savaharina, Zahamena PN, 17°41'08"S 48°59'43"E, 650 m, 12.VI.2001, *Rakotonandrasana et al.* 489 (G, MO, P); Manakambahiny Est, Sahamalaza, Zahamena RNI, 17°43'30"S 48°44'35"E, 800-900 m, 20.VII.2003, *Rakotonandrasana et al.* 695 (MO, P); Vavatenina, Ambodimangavalo, Antevibe-Sahandrazana, 17°32'S 48°48'E, 800-900 m, 30.VII.2003, *Rakotonandrasana et al.* 717 (G, MO, P); Lakato, Anivorano, Agnalatsara, 19°07'29"S 48°23'32"E, 815 m, 1.VI.2007, *Ranaivojaona et al.* 1723 (MO, P, TAN); Vatomandry, Ambalabe, 19°09'33"S 48°34'40"E, 21.XI.2004, A. *Randrianasolo et al.* 904 (G, MO, P); Lakato, 19°03'43"S 48°22'16"E, 1062-1100 m, 2.VI.2007, A. *Randrianasolo et al.* 1132 (MO, P); Zahamena PN, 17°28'28"S 48°44'12"E, 880 m, 16.VII.2000, *Randrianjanaka et al.* 562 (G, MO, P); Manakambahiny, Zahamena PN, 17°39'20"S 48°54'22"E, 750 m, 6.X.2001, *Randrianjanaka et al.* 649 (CNARP, G, MO, P, TEF); Analamay, 18°48'38"S 48°20'30"E, 1100 m, 9.XI.2008, *Ratolojanahary et al.* 155 (MO, P, TAN); Ambodimangavalo, Moango, 17°33'57"S 48°53'58"E, 740-1200 m, 25.X.2000, *Ratovoson et al.* 333 (CNARP, MO, P, TEF); Ambatovy, Menalamba, 18°48'28"S 48°20'57"E, 1000 m, 7.VI.2007, *Ravelonarivo* 2511 (G, MO, P, TAN); Ankeniheny, 19°07'50"S 48°32'10"E, 922 m, 3.VIII.2007, *Razanatsima et al.* 296 (G, MO, P, TAN); Ambalabe, Ambinanindrano II, forêt de Vohibe, 19°09'31"S 48°34'40"E, 536 m, 19.II.2009, *Razanatsima et al.* 664 (MO, TAN); Moramanga, Ampitambe, Sahaevo, 18°50'00"S 48°17'45"E, 1139 m, 11.XII.2006, J. *Razanatsoa & Marcellin* 285 (G, MO, P, TAN); Périnet, Beravina, [18°58'S 48°16'E], 8.VI.1951, *Service Forestier* 3779 (TEF); Moramanga, Ampasimazava, 10.VI.1954, *Service Forestier* 12224 (MO, P); Sandrangato, [19°06'30"S 48°14'30"E], 900 m, 18.XI.1965, *Service Forestier* 25491 (MO, P, TEF).



Fig. 31. Photographs of *Noronhia* Stadtm. ex Thouars.

A. *Noronhia louvelii* H. Perrier [Razanatsima 843]; **B.** *Noronhia lowryi* Hong-Wa [Lowry 5906].

Photos: A: A. Razanatsima; B: G. Schatz

47. *Noronhia lowryi* Hong-Wa, spec. nova (Fig. 31B, 32).

Typus: MADAGASCAR. **Prov. Fianarantsoa:** Amoron'i Mania, Itremo massif, W of Ambatofinandrahana, along road to Col d'Itremo, c. 2 km before (NE of) bridge over Ambalarangolana creek, 20°33'58"S 46°35'35"E, 1450 m, 10.XI.2002, *Lowry et al.* 5906 (holo-: MO-6615550!; iso-: BR!, G [G00341613]!, K!, P [P03532782]!, TAN!, US!, WAG!).

Diagnosis *Noronhia lowryi* Hong-Wa can be distinguished from other members of the genus in Madagascar by its small, elliptic leaf blades, its white, tubular flowers and its pear-shaped fruits.

Description Shrubs up to 1.5 m tall; young twigs 1-2 mm diameter, glabrous; bark light brown, rugose, with scattered lenticels. *Leaves* opposite, persistent; bud scales rarely persistent; blades medium green above, lighter below, elliptic, 2-5 × 1.5-2.5 cm, coriaceous, glabrous, domatia absent, base rounded, margin flat to slightly revolute, apex rounded, midrib slightly sunken above, flat below, secondary veins inconspicuous, 6-10 per side, 4-11 mm apart, looping 1-2.5 mm from the margin; petiole yellowish, 1-3 × 1-2 mm, not woody, glabrous. *Thyrse*s solitary to geminate, pauciflorous, compact; peduncle 1-3 mm long, moderately pubescent; pedicel 1.5-3 mm long, moderately pubescent; calyx moderately pubescent outside, glabrous inside, lobes triangular, 1.5-1.8 × 1.5-2 mm; corolla white, tubular, 8-13 mm long, glabrous on both sides, the tube 7-12 mm long, lobes triangular, apex acute; corona absent; stamens 1.5-2.2 mm long, anthers oblong to obovate, 1.2-1.4 mm long; pistil 1.6-2 mm long, stigma capitate. *Fruiting* pedicel 2-8 × 2-2.5 mm; young fruits green, brownish to blackish when mature, ovoid to pyriform, 21-27 × 15-18 mm, covered with white dots, apex flat to bluntly pointed; dry pericarp 0.8 mm thick; endocarp woody; seed 10 × 12.5 mm.

Etymology This species is dedicated to Porter P. Lowry II, Senior Curator at the Missouri Botanical Garden in St. Louis, who collected the type specimen and provided many detailed and helpful suggestions that improved this revision, and whose work and leadership continuously advance our knowledge of the Malagasy flora.

Distribution, ecology and phenology *Noronhia lowryi* occurs in high-elevation woodlands on marble-quartzite and basement rocks in the Itremo massif, in central Madagascar (Fig. 27). It produces flowers and fruits from October to November.

Conservation status *Noronhia lowryi* is currently known only from three collections representing three localities. With an EOO of 26 km², an AOO of 8 km², and two subpopulations representing two locations, it is assigned a preliminary status of "Endangered"

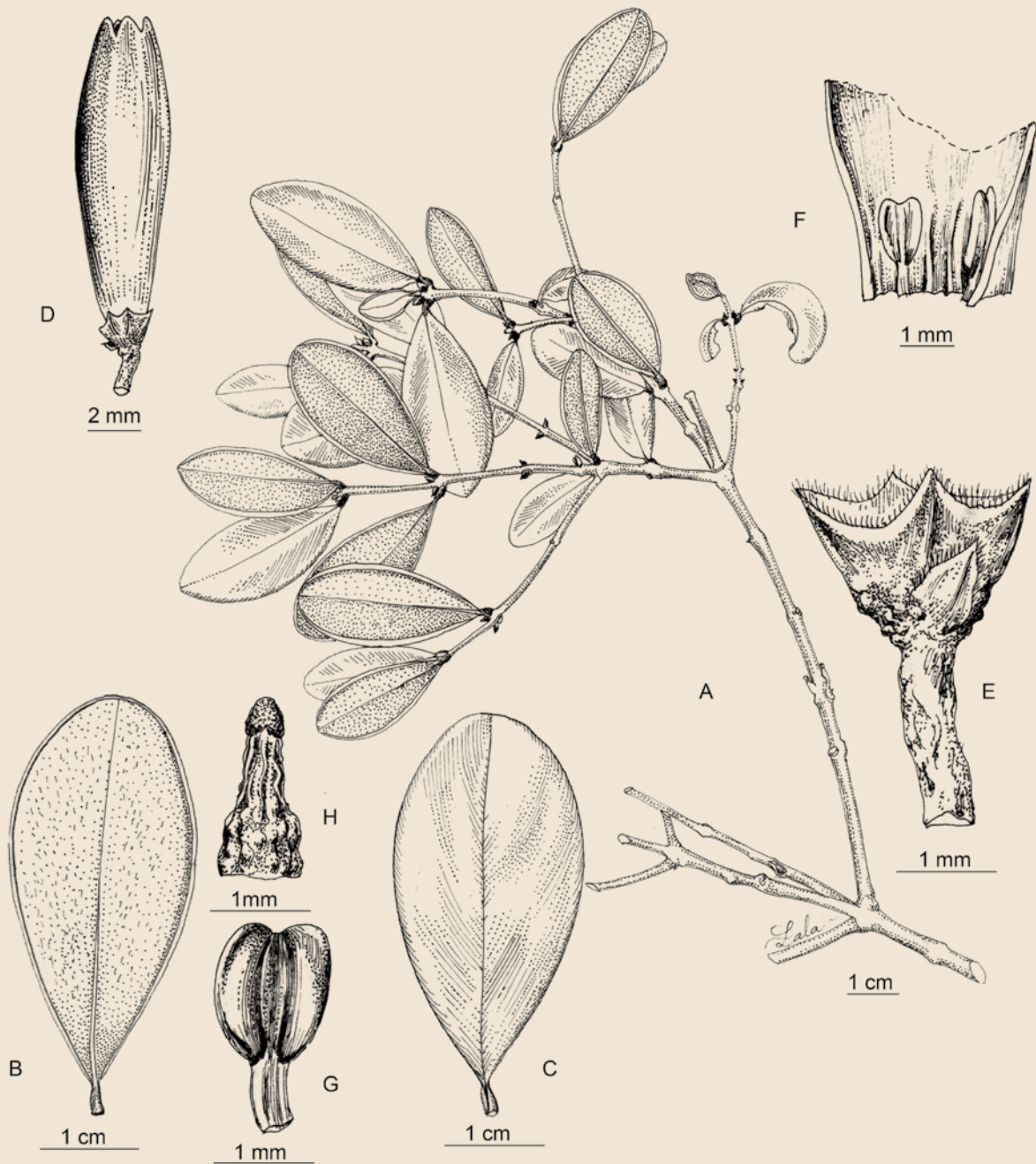


Fig. 32. *Noronhia lowryi* Hong-Wa.

A. Branch; **B.** Abaxial side of leaf blade; **C.** Adaxial side of leaf blade;
D. Flower; **E.** Calyx; **F.** Inner side of corolla; **G.** Stamen; **H.** Pistil.

[Andriamihajarivo 398, TAN] Drawings: R.L. Andriamiarisoa

[EN B1ab(i,ii,iii,iv,v)+2ab(i,ii,iii,iv,v)]. Although a new protected area has recently been established in the area where this species occurs (Itremo), it actually does not encompass the currently known subpopulations of *N. lowryi*, which are thus still subject to the effects of habitat degradation and habitat loss resulting from wildfires and grazing.

Notes *Noronhia lowryi* is very distinctive, generally resembling a *Comoranthus*, whose fruit is a capsule instead of a drupe. It has the second largest flowers within the genus, after *Noronhia humbertiana*, and differs from any other species of *Noronhia* by its long tubular corolla, the tube of which measures 7-12 mm long.

Paratypes **MADAGASCAR. Prov. Fianarantsoa:** Ambatofinandrahana, Andraikita, Saronara, Ambalambony, 20°29'25"S 46°49'10"E, 1443 m, 31.X.2004, *Andriamihajarivo* 398 (MO, TAN); Ambatofinandrahana, Ranomafana, 20°35'S 46°36'E, 1450 m, 6.X.1996, *A. Randrianasolo* 490 (K, MO).

48. *Noronhia luteola* H. Perrier in Mém. Inst. Sci. Madagascar, Sér. B, Biol. Vég. 2: 298. 1949 (Fig. 33A).

Lectotypus (designated here): **MADAGASCAR. Prov. Toliara:** Ampandrandava, entre Bekily et Tsivory, [24°05'S 45°52'E], 700 m, I.1944, *Seyrig 642b* (P [P0071219]!), isolecto-: P [P03558932, P03558933]!). **Syntypi:** **MADAGASCAR. Prov. Fianarantsoa:** Vallées de l'Isalo, Fanjahira, [23°29'S 44°44'E], 300 m, 9.X.1924, *Humbert 2760* (K [K000233187], P [P00701221, P00701273]!). **Prov. Toliara:** Mont Amboahangy près d'Esira, [24°15'S 46°39'E], 1000-1150 m, 25.XI.1928, *Humbert 6825* (G [00188779] image seen, P [P00701222]!); Mont Vohipolaka au N de Betroka (Centre-Sud), [23°08'S 46°05'E], 1100-1200 m, 1.XI.1933, *Humbert 11641* (P [P00701220, P03558930, P03558931]!); Mont Vohitrosy, Anadabolava, [24°15'S 46°43'E], 800 m, XII.1933, *Humbert 12656* (P [P03558938]!); Vallée de la Sakamalio, bassin du Mandrare [24°32'S 46°41'E], 900-1100 m, XII.1933, *Humbert 13370* (P [P03558934]!); Ampandrandava, entre Bekily et Tsivory, [24°05'S 45°52'E], 700 m, IV.1943, *Seyrig 642* (P [P03558935]!).

Description

Trees to 13 m tall, trunk to 25 cm diameter; young twigs cylindrical, 0.7-1.6 mm diameter, glabrous; bark medium gray, rugose. *Leaves* opposite, deciduous; bud scales persistent; blades medium green glossy above, lighter below, oblong to obovate, 3-12.5 × 1-3 cm, coriaceous, glabrous, domatia absent, base attenuate, margin slightly revolute, apex rounded to acute or slightly acuminate, the acumen 1-9 mm long, midrib slightly sunken above, slightly raised below, secondary veins barely visible, 7-16 per side, 4-13 mm apart, looping 0.8-3.5 mm from the margin; petiole yellow to reddish, 3-10 × 0.7-1.7 mm, not woody, glabrous. *Thyrses* geminate, pauciflorous, compact to somewhat diffuse; peduncle 2 mm long, glabrescent; pedicel 1.5-18 mm long, glabrescent; calyx sparsely pubescent outside, glabrous inside, lobes triangular, 0.7-1.3 × 1-1.5 mm; corolla white, subrotate, 3-4 mm long, glabrous on both sides, the tube 1-3 mm long, lobes widely ovate, apex rounded; corona present, 1-1.7 mm long, undivided; stamens 1.5-2.6 mm long, anthers transversely oblong, 1.1-1.8 mm long; pistil 1.5-2.2 mm long, stigma capitate. *Fruiting* pedicel 3-7 × 0.9-1.1 mm; young fruits green, brown when mature, ovoid, 11-19 × 8-12.5 mm, surface smooth, apex flat to rostellate, the rostellum flattened, with the persistent style; dry pericarp 0.6-1.2 mm thick; endocarp woody; seed 7-13 × 5.5-8.5 mm.

Distribution, ecology and phenology

Noronhia luteola occurs in littoral and low- to high-elevation dry forests and thickets in the south, from Fanjahira to Fort-Dauphin (Fig. 27). It produces flowers and fruits from October to June.

Conservation status The assessment included 23 collections representing 13 localities and resulted in an EOO of 21,499 km², an AOO of 44 km², and eight subpopulations representing seven locations, of which two occur within the newly established protected areas of Mandena and Petriky. Some of the subpopulations occur in an area that is frequently burned for grazing while others are currently affected by industrial mining in southern Madagascar. Because of observed and projected continuing decline in habitat quality as well as habitat loss, coupled with an actual AOO that is probably less than 2,000 km², *N. luteola* is assigned a preliminary status of “Vulnerable” [VU B2ab(ii,iii,iv,v)], although the EOO is not expected to decline in the near future.

Notes *Noronhia luteola* can be recognized by its coriaceous, oblong to obovate leaf blades, short-peduncles, and subrotate, white flowers. The following syntypes were cited in the protologue: *Humbert* 2760, 6825, 11641, 12656 and 13370, *Seyrig* 642 and 642b. Of these, *Seyrig* 642b is the only one with flowers and several duplicates, and one of the sheets at P has therefore been chosen as the lectotype.

Additional specimens examined **MADAGASCAR. Prov. Toliara:** Forêt de Petriky, 25°05'S 46°52'E, 0-10 m, 5.XII.1989, *Dumetz & McPershon* 1121 (MO, TAN); Ampasy Nampoana, forêt de Mandena, 24°57'10"S 47°00'10"E, 9 m, 12.II.2009, *Hong-Wa* 594 (MO, P, TAN); Mandena forest, 24°57'S 47°00'E, 25 m, 25.X.1989, *McPherson et al.* 14230 (MO, P, TAN, TEF); Manambaro, Ambovo, forêt de Petriky, 25°03'03"S 46°53'44"E, 6 m, 24.VI.2004, *Rabenantoandro et al.* 1606 (G, MO, P, TEF); Manafiafy, 24°46'S 47°12'E, 12.XI.1990, *Rabevohitra* 2434 (K, MO, P, TAN, TEF); Mahatalaky, Belavenoka, 24°50'S 47°04'E, 15.XI.2007, *Ramison & Rabevohitra* 400 (G, MO, P, TAN).



Fig. 33. Photographs of *Noronhia* Stadtm. ex Thouars. **A.** *Noronhia luteola* H. Perrier [Hong-Wa 594]; **B.** *Noronhia macrocarpa* Hong-Wa [Razakamalala 2941]; **C.** *Noronhia maculata* Hong-Wa [S. Randrianasolo 633]; **D.** *Noronhia mangorensis* H. Perrier [Antilahimena 6044].

Photos: taken by respective collectors except B: C. Rakotovao; C: C. Claude

49. *Noronhia macrocarpa* Hong-Wa, spec. nova (Fig. 33B, 34).

Typus: MADAGASCAR. **Prov. Antsiranana:** SAVA, Andapa, Doany, Andranomilolo, versant SE Anjanaharibe, 14°19'43"S 49°18'08"E, 1412 m, 12.XI.2006, *Razakamalala et al.* 2941 (holo-: MO-6615568!; iso-: G [G00341627]!, K!, P [P03533806]!, TAN).

Diagnosis *Noronhia macrocarpa* Hong-Wa can be distinguished from other congeneric species by its subcoriaceous, lanceolate to obovate leaf blades and its large, rugose fruits, with thick and woody endocarp.

Description Trees to 20 m tall, trunk to 30 cm diameter; young twigs cylindrical, 0.8-1.9 mm diameter, glabrous; bark brownish, slightly rugose. Leaves opposite, persistent; bud scales deciduous; blades medium green above, lighter below, lanceolate to obovate, 6.5-11 × 2-4 cm, subcoriaceous, glabrous, domatia absent, base acute, margin flat to slightly revolute and undulate, apex acuminate, the acumen 2-10 mm long, midrib slightly sunken above, raised below, secondary veins conspicuous, 8-15 per side, 7.5-18 mm apart, looping 1-4 mm from the margin; petiole medium gray, 8-13 × 1-2.5 mm, partially woody, glabrous. Flowers unseen, but infructescence thyrsoid. Fruiting pedicel 5-10 × 1.8-2.6 mm; young fruits green, blackish when mature, ovoid, 25-28 × 19.5-22.5 mm, surface rugose, apex flat to bluntly pointed; dry pericarp 1.2-2 mm thick; endocarp woody; seed 18.5-19.5 × 9-10 mm.

Etymology The specific epithet refers to the large fruits of this species.

Distribution, ecology and phenology *Noronhia macrocarpa* occurs in low- to high-elevation humid forests on basement rocks in the north, from Anjanaharibe- Sud RS to Nosy Be (Fig. 27). It fruits from September to November.

Conservation status *Noronhia macrocarpa* is known only from three collections representing three localities, all of which occur within protected areas (Anjanaharibe Sud, Lokobe, and Tsaratanana-Ambohimirahavavy-Corridor Marojejy). With an EOO of 1,875 km², an AOO of 12 km², and three subpopulations representing three locations, along with an exclusive known occurrence within protected areas, mostly at high elevations, *N. macrocarpa* is assigned a preliminary status of "Least Concern".

Notes *Noronhia macrocarpa* most closely resembles *N. verrucosa* H. Perrier, from which it differs by its partially (vs. entirely) woody petioles, lanceolate (vs. obovate to obtrullate), acuminate (vs. acute to mucronate) leaf blades, and ovoid (vs. subglobose), rugose (vs. areolate to verrucose) fruits. The new species can be recognized by its subcoriaceous, lanceolate to obovate leaf blades and its large fruit, with thick and woody pericarp.

Paratypes MADAGASCAR. **Prov. Antsiranana:** Nosy-Be, Lokobe RNI, 13°24'40"S 48°18'50"E, 40-80 m, 24.XI.1994, *Antilahimena* 195 (G, K, MO, P, TAN); Andapa, Anjanaharibe-Sud RS, 14°47'S 49°27'E, 1100 m, 13-18.IX.1996, *Ravelonarivo et al.* 1035 (G, MO, P, TAN).



50. *Noronhia maculata* Hong-Wa, *spec. nova* (Fig. 33C, 35).

Typus: MADAGASCAR. **Prov. Antsiranana:** DIANA, Diégo II, Ramena, env. 2 km à l'O d'Andavakoera, près de la grotte et du campement la Casa Aventura, 12°19'41"S 49°20'26"E, 76 m, 3.VIII.2007, Hong-Wa *et al.* 514 (holo-: MO-6386603!; iso-: CNARP!, G [G00341577]!, P!, TAN!).

Diagnosis *Noronhia maculata* Hong-Wa can be distinguished from other members of the genus by its partially woody petioles, its maculate leaf blades, its short pedicels, and its subrotate, yellow-green flowers.

Description Trees to 7 m tall, trunk to 10 cm diameter; young twigs cylindrical, 0.9-1.8 mm diameter, glabrous; bark medium gray, smooth. Leaves opposite, persistent; bud scales rarely persistent; blades medium green above, lighter below, obovate, 3.5-7 × 1.5-3 cm, subcoriaceous, glabrous, domatia casual, base attenuate, margin flat, apex retuse, midrib slightly sunken above, distinctly raised below, secondary veins conspicuous only below, 6-9 per side, 5-11 mm apart, looping 1-3 mm from the margin; petiole medium gray, 3-7 × 0.9-1.5 mm, partially to entirely woody, glabrous. Thyrses solitary to geminate, multiflorous, compact; peduncle 5-7 mm long, moderately pubescent; pedicel 2-3 mm long, moderately pubescent; calyx moderately to sparsely pubescent outside, glabrous inside, lobes deltate, 1-1.5 × 1-1.5 mm; corolla yellow-green, subrotate, 3-5 mm long, glabrous on both sides, the tube 1.4-1.5 mm long, lobes ovate, apex acute; corona present, 1.3-1.5 mm long, undivided; stamens 1.4-1.5 mm long, anthers obovate, 1.1-1.3 mm long; pistil 2.4-2.5 mm long, stigma capitate. Fruiting pedicel 2-10 × 0.8-1.7 mm; young fruits green, brownish to blackish when mature, ovoid, 11-17 × 7.5-11.5 mm, smooth, often covered with a pellicle, apex flat to rostellate, the rostellum flattened, slightly ridged, rounded, with the persistent style; dry pericarp 0.4-0.8 mm thick; endocarp woody.

Etymology *Noronhia maculata* has distinctively spotted to mottled leaves, for which the Latin word is used to form the specific epithet.

Distribution, ecology and phenology *Noronhia maculata* occurs in low-elevation dry forests from Montagne des Français to Ankarana in the north (Fig. 36). It produces flowers and fruits from December to August.

Conservation status There were 12 collections representing 12 localities available for analysis, which resulted in an EOO of 835 km², an AOO of 44 km², and six subpopulations representing five locations, of which three occur within protected areas (Ankarana, Mon-

tagne d'Ambre, and Montagne des Français). Land conversion, charcoal production, and forest exploitation currently affect non-protected areas, whereas those benefiting from protection suffer from encroachment and illegal logging, all of which will lead to continuing decline in habitat quality and habitat loss as well as loss of mature individuals. Therefore, *N. maculata* is assigned a preliminary status of "Endangered" [EN B1ab(i,ii,iii,iv,v)+2ab(i,ii,iii,iv,v)].

Notes *Noronhia maculata* is similar to *N. ankaranensis*, but can be distinguished by its woody (vs. non-woody) petioles, short (less than 3 mm vs. 3–8 mm long) pedicels, and subrotate (vs. cupuliform) flowers. Its distinctive features include partially woody petioles, maculate leaf blades, short pedicels and subrotate, yellow-green flowers.

The labels accompanying specimens of *De Block 1200* mention flowers that are reddish-brown outside and whitish inside, but the specimen is otherwise morphologically similar to the other specimens cited here. It is not clear whether the distinctive color of *De Block 1200* is related to the age of its flowers, as is sometimes the case in other species, or the result of hybridization. It might also indicate that this collection represents a different entity that is otherwise identical to *N. maculata* in all other macromorphological features. These specimens are best accommodated in *N. maculata* pending further studies of micromorphology, anatomy and/or genetics.

Paratype **MADAGASCAR. Prov. Antsiranana:** Ambilobe, Marivorahona, Andakoroa, Mahamasina, Ankarana RS, 12°56'34"S 49°07'01"E, 133 m, 7.XII.2006, *Andriamihajarivo et al.* 1044 (MO, P, TAN); *ibid. loc.*, Campement des Anglais, 12°54'59"S 49°06'24"E, 180 m, 6.VII.1994, *Andrianantoanina & Rabeharinosy* 718 (G, K, MO, P, TAN); *ibid. loc.*, from Campement des Anglais towards Campement des Américains (not beyond first savanna), 12°50'47"S 49°06'18"E, 82 m, 13.I.2002, *De Block 1200* (MO, B, BR, G, P, TAN, US); Marivorahona, Betsimiranja, 12°56'27"S 49°07'21"E, 136 m, 18.I.2009, *Hong-Wa* 570 (MO, P, TAN); Sakaramy, Montagne d'Ambre PN, 12°26'40"S 49°13'56"E, 300 m, 29.V.2010, *Hong-Wa* 698 (MO, TAN); Mahavanona, Andranomanitra, Ampitiliantsambo, 12°22'49"S 49°22'55"E, 418 m, 15.I.2005, *Rakotonandrasana et al.* 906 (CNARP, MO, P, TAN); Montagne des Français, 12°23'13"S 49°22'50"E, 291 m, 17.VI.2004, *Ramananjanahary et al.* 24 (CNARP, MO, P, TAN); *ibid. loc.*, 12°21'06"S 49°21'49"E, 170 m, 7.X.2004, *Randriambololomamonjy* 28 (MO, P, TAN); *ibid. loc.*, 12°22'05"S 49°19'37"E, 382 m, 8.II.2005, *Randrianarivelo et al.* 215 (G, MO, P, TAN); Marivorahona, Betsimiranjana, Ampondrabe, 5 km au SE de Mahamasina, Ankarana, 12°58'57"S 49°09'50"E, 127 m, 10.XII.2007, *S. Randrianasolo et al.* 633 (CNARP, G, MO, P, TAN); Ramena, Andavakoera, forêt d'Andranonakomba, 12°21'03"S 49°21'29"E, 50 m, 5.XII.2007, *Ratovoson et al.* 1436 (CNARP, G, MO, P, TAN).

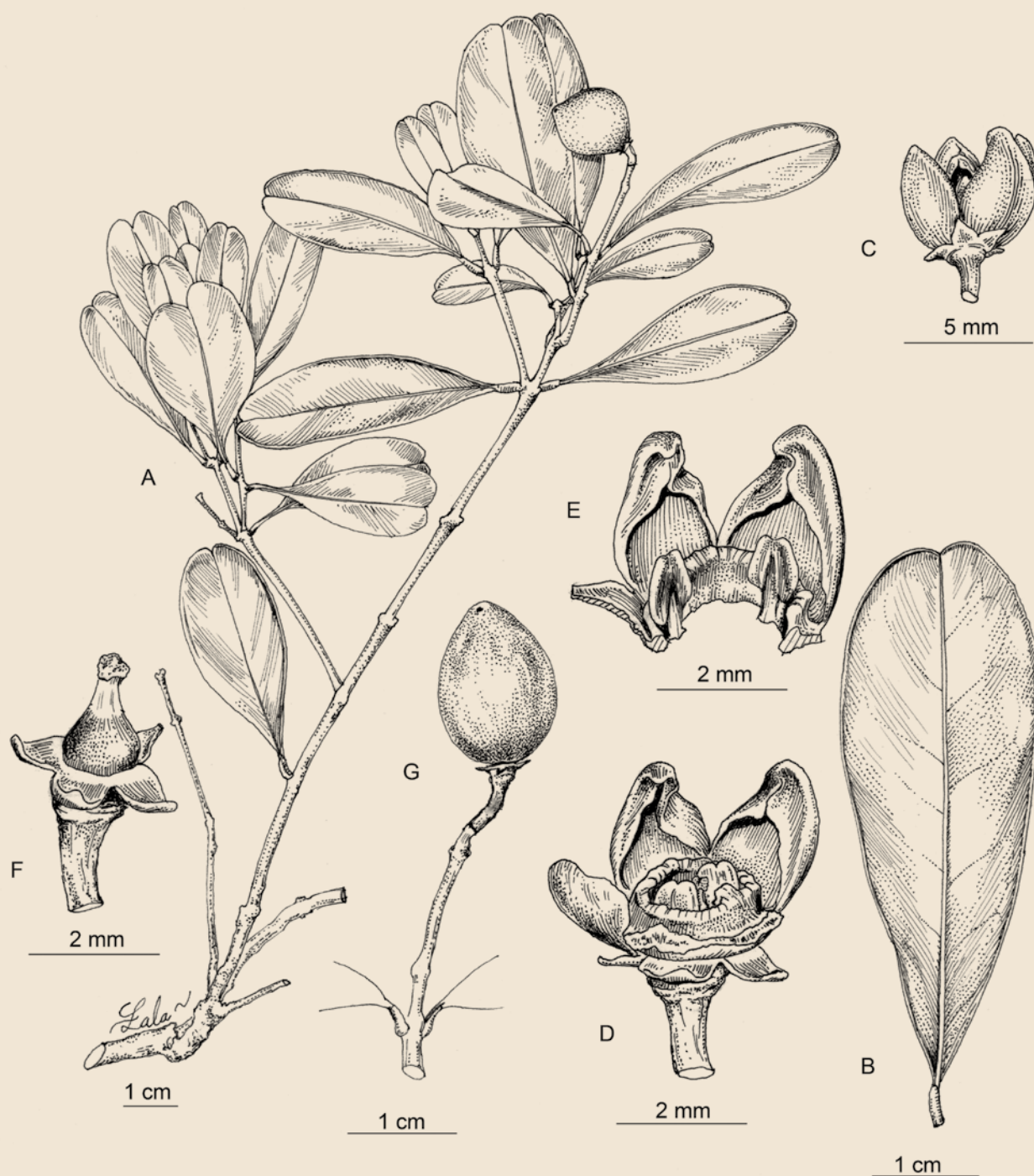


Fig. 35. *Noronhia maculata* Hong-Wa.

A. Fruiting branch; **B.** Abaxial side of leaf blade; **C** Flower;
D. Lateral view of corona; **E.** Inner side of corolla; **F.** Pistil; **G.** Fruit.

[Hong-Wa 514, TAN] Drawings: R.L. Andriamiarisoa

51. *Noronhia mangorensis* H. Perrier in Mém. Inst. Sci. Madagascar, Sér. B, Biol. Vég. 2: 302. 1949 (Fig. 33D).

Lectotypus (designated here): **MADAGASCAR. Prov. Toamasina:** Forêt au S de Moramanga, [18°56'S 48°13'E], s.d., Decary 7186 (P [P00573405]!; isolecto-: P [P00413246, P00573406]!).

Description *Trees* to 12 m tall, trunk to 10 cm diameter; young twigs cylindrical, 0.7-1.5 mm diameter, glabrous; bark medium gray, smooth. *Leaves* opposite, persistent; bud scales persistent; blades dark green above, lighter below, oblong to ovate, 4.5-8.5 × 2-4.5 cm, coriaceous, glabrous, domatia absent, base acute to attenuate, margin flat to slightly revolute, apex cuspidate, the cusp 3-11 mm long, midrib flat to slightly sunken above, slightly raised below, secondary veins conspicuous, 6-10 per side, 5-14 mm apart, looping 1.5-4 mm from the margin; petiole medium gray, 3-10 × 0.7-1.8 mm, entirely woody, glabrous. *Flowers* fasciculate; pedicel 5-13 mm long, very sparsely pubescent; calyx very sparsely pubescent outside, the pubescence being clustered at the tips, glabrous inside, lobes triangular, 1.2-2.5 × 1-2.5 mm; corolla purplish pink outside, cream inside, cupuliform, 4.5-7 mm long, glabrous on both sides, the tube 2.5-5 mm long, lobes widely ovate, apex obtuse cucullate; corona present, 0.8-2.1 mm long, undivided; stamens 1.3-2.8 mm long, anthers obtriangular, 1-1.8 mm long; pistil 1.7-2.5 mm long, stigma capitate. *Fruiting* pedicel 6-20 × 0.6-1.9 mm; young fruits green, dark red when mature, ovoid, 9-21 × 6-16.5 mm, surface rugose, apex flat, style persistent; dry pericarp 0.4-1.3 mm thick; endocarp woody; seed 11 × 9 mm.

Distribution, ecology and phenology *Noronhia mangorensis* occurs in mid- to high-elevation humid forests in the east, from Zahamena to Analamazaotra (Fig. 36). It produces flowers and fruits throughout the year except in March and April.

Conservation status The assessment included 22 collections representing 22 localities and yielded an EOO of 4,275 km², an AOO of 64 km², and nine subpopulations representing eight locations, of which three occur within two protected areas (Torotorofotsy and Zahamena). With ongoing habitat degradation and loss resulting from shifting agriculture, forest exploitation and industrial mining, *N. mangorensis* is assigned a preliminary status of "Vulnerable" [VU B1ab(ii,iii,iv,v)+2ab(ii,iii,iv,v)], although a reduction in EOO is not expected in the near future.

Notes *Noronhia mangorensis* can be recognized by its coriaceous, somewhat sub-bullate leaf blades, fasciculate, cupuliform and pinkish flowers, and rugose fruits. It differs from *N. disjuncta* and *N. humblotiana* by the features discussed under these two species, and from *N. ovalifolia* H. Perrier by its cuspidate (vs. acuminate) leaf blades, fasciculate

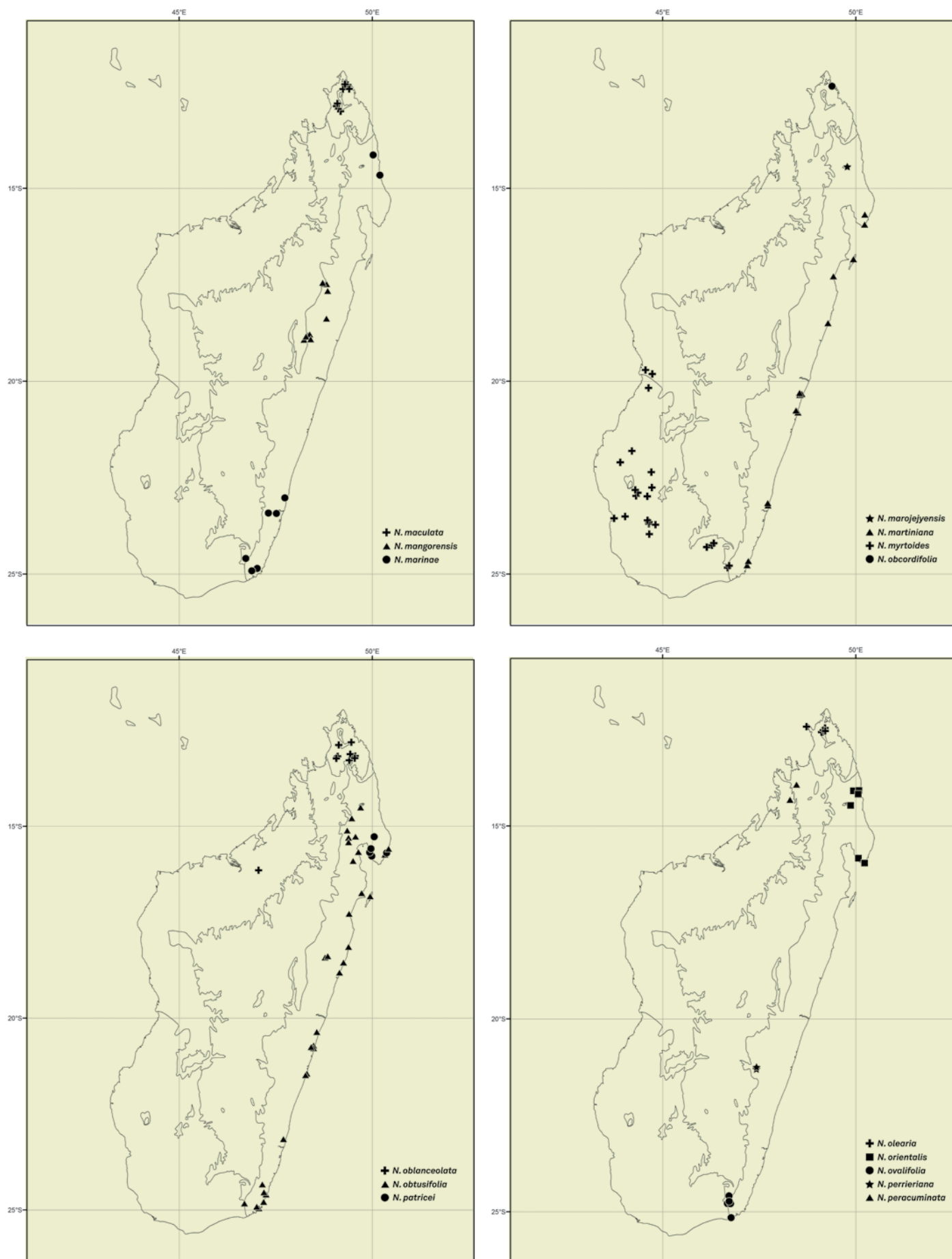


Fig. 36. Distribution maps of species of *Noronhia* Stadtm. ex Thouars. *N. maculata* Hong-Wa to *N. perrieriana* Hong-Wa.

(vs. solitary) flowers, and ovoid (vs. subglobose) and rugose (vs. smooth) fruits. This species was based on two syntypes (*Cours* 675 and *Decary* 7186), of which *Decary* 7186 (a sheet of which is selected here as the lectotype) belongs to *N. mangorensis* whereas *Cours* 675 is assigned to *N. domatifera*.

While two of the four fragments representing the specimen *Réserves Naturelles* 1966 deposited at P ([P00701311]) are assigned to *N. mangorensis*, the other two do not even belong to *Noronhia* and probably represent material of *Memecylon*, with which it is often confused because both have leaves that are opposite and coriaceous, and are sometimes also referred to using the same vernacular name. The specimen at TAN includes only a single fragment, which can be assigned to *Noronhia mangorensis*.

Additional specimens examined

MADAGASCAR. Prov. Toamasina: Ambatovy, 18°52'07"S 48°16'27"E, 1016 m, 28.X.2008, *Andriantiana et al.* 549 (MO, TAN); Moramanga, Ambohibary, Ampitambe, Ambohimamarivo forest, 18°51'51"S 48°18'49"E, 1001 m, 13.II.2008, *Antilahimena et al.* 6043 (G, MO, P, TAN, TEF); *ibid. loc.*, 18°51'50"S 48°18'48"E, 1005 m, 14.II.2008, *Antilahimena et al.* 6044 (MO, P, TAN, TEF); Brickaville, Maroseranana, Ambodilendemy, 18°22'56"S 48°47'16"E, 836 m, 13.III.2011, *Antilahimena* 7646 (MO, P, TAN); Périnet, 18°55'S 48°25'E, 980 m, 4.XI.1985, *Gentry et al.* 52558 (MO, P, TAN); Andasibe, Menalamba, Ambatovy, 18°48'47"S 48°20'34"E, 1101 m, 9.X.2008, *Miandri-manana et al.* 374 (MO, P, TAN); Zahamena PN, Antanandava, Ankosy, 17°28'58"S 48°44'10"E, 997 m, 12.VII.2000, *Rakotonandrasana et al.* 408 (G, MO, P); 1.5 km SE d'Ankasy, en dehors du Parc National de Zahamena, 17°29'38"S 48°43'50"E, 900 m, 25.I.2000, *Rakotondrajaona et al.* 119 (G, MO, P); Ambatovy, 18°51'44"S 48°18'34"E, 1025 m, 11.II.2008, *S. Randrianasolo et al.* 650 (G, MO, P, TAN); *ibid. loc.*, 18°51'04"S 48°18'58"E, 1129 m, 6.VI.2008, *S. Randrianasolo et al.* 717 (MO, P, TAN); Manakambahiny Est, Tsaralalana, [17°42'S 48°54'E], 18.II.1950, *Réserves Naturelles* 1966 (P, TAN); Moramanga, Torotorofotsy, 18°52'19"S 48°21'01"E, 950-1000 m, 4.I.2003, *Rogers et al.* 32A (MO, TAN).

52. *Noronhia marinae* Hong-Wa, **spec. nova** (Fig. 37).

Typus: MADAGASCAR. **Prov. Fianarantsoa:** Atsimo-Atsinanana, Manombo RS, parcelle I, circuit Reharatra, 23°00'39"S 47°44'08"E, 12 m, 15.IX.2005, *Rabarimanarivo et al.* 118 (holo-: MO-6615562!; iso-: G [G00341623]!, P [P03559025]!, TAN!).

Diagnosis *Noronhia marinae* Hong-Wa can be distinguished from other congeneric species by its narrow leaves, its purplish pink flowers borne into compact inflorescences clustered around the nodes.

Description Trees to 16 m tall, trunk to 24 cm diameter; young twigs cylindrical, 0.5-2.5 mm diameter, glabrous; bark brownish, somewhat rugose, with slight exfoliations. Leaves opposite, persistent; bud scales deciduous; blades dark green above, lighter below, linear to lanceolate, 4-10.5 × 1-3 cm, subcoriaceous, glabrous, domatia absent, base acute to attenuate, margin flat to slightly revolute, apex acuminate, the acumen 3-13 mm long, midrib sunken above, raised below, secondary veins barely visible, 7-13 per side, 5-10 mm apart, looping 1-3.5 mm from the margin; petiole brownish, 1.5-10 × 0.7-2.2 mm, entirely woody, glabrous. Thyrses geminate to fasciculate, pauciflorous, compact; peduncle 2-5 mm long, moderately pubescent; pedicel 2-7 mm long, moderately pubescent; calyx moderately pubescent outside, glabrous inside, lobes triangular, 0.7-1.3 × 0.8-1.5 mm; corolla purplish pink, cupuliform, 3-5 mm long, glabrous on both sides, the tube 1-2 mm long, lobes ovate, apex rounded; corona present, 1-1.7 mm long, undivided; stamens 1.3-2 mm long, anthers oblong, 0.8-1 mm long; pistil 1.5-2.2 mm long, stigma slightly bilobed. Fruiting pedicel 5-7 × 1-1.3 mm; young fruits green, blackish when mature, ovoid, 12.5-13 × 9.5-10 mm, surface smooth, sometimes covered with white dots, apex flat to bluntly pointed, style persistent; dry pericarp 0.5-0.8 mm thick; endocarp woody.

Etymology This species is dedicated to Marina Rabarimanarivo, a botanist at the Missouri Botanical Garden in Madagascar, for collecting the type specimen and for adding to the ranks of (the still too few) female Malagasy botanists.

Distribution, ecology and phenology *Noronhia marinae* occurs in littoral to mid-elevation humid forests along the east coast in two distinct areas: from Antsirabe Nord to Antalaha in the north and from Farafangana to Fort-Dauphin in the south (Fig. 36). It produces flowers and fruits from September to January.

Conservation status Based on nine collections representing nine localities, an EOO of 50,885 km², an AOO of 32 km², and eight subpopulations representing eight locations were obtained. Five of the locations occur within protected areas (Andohahela, Ankarabolava-Agnakatrika,

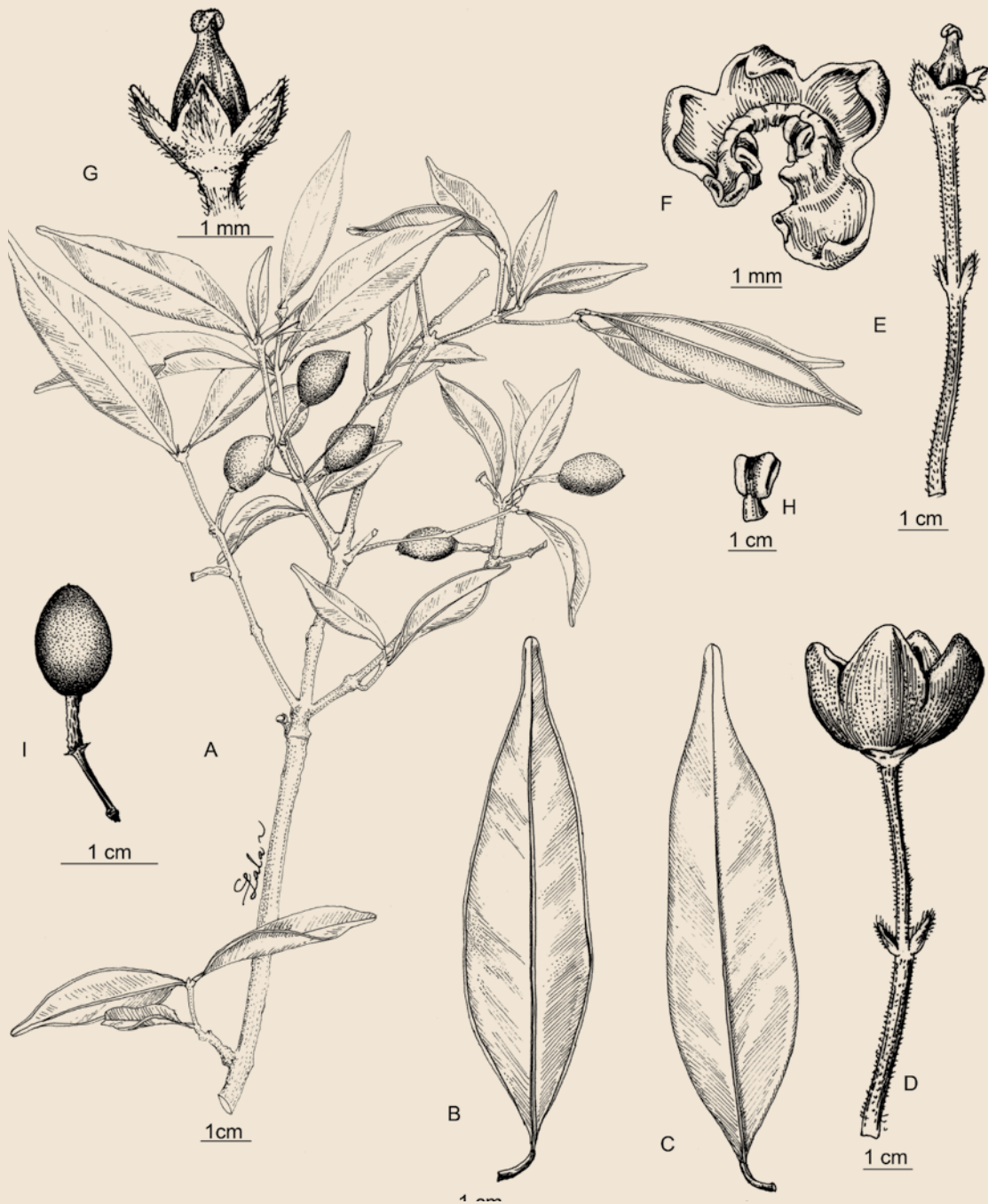


Fig. 37. *Noronhia marinae* Hong-Wa.

A. Fruiting branch; **B.** Abaxial side of leaf blade; **C.** Adaxial side of leaf blade; **D.** Flower; **E.** Inflorescence axis; **F.** Corolla on top view, showing the corona; **G.** Pistil; **H.** Stamen; **I.** Fruit.

[Razanatsima 723, TAN] Drawings: R.L. Andriamiarisoa

Makirovana-Tsihomanaomby complex, Manombo, and Tsitongambarika). With an EOO exceeding 20,000 km² and an actual AOO likely larger than 2,000 km², *N. marinae* is assigned a preliminary status of “Near Threatened” [NT].

Notes *Noronhia marinae* is similar to *N. linocerioides*, but can be distinguished by its woody (vs. non-woody) petioles, linear to lanceolate (vs. elliptic) leaf blades, cupuliform (vs. subrotate), purplish pink (vs. pale yellow) flowers, and apiculate (vs. rostellate) fruits. It can be recognized by its narrow leaves and purplish pink flowers borne in compact inflorescences clustered around the nodes.

Paratypes **MADAGASCAR. Prov. Antsiranana:** Vohémar, Antsirabe Nord, Andravinaambo, forêt de Tsihomanaomby, 14°06'S 50°02'E, 19.XI.2013, *Rakotonirina et al.* 273 (DOV, MO, P, TAN); Antalaha, Ambanitazana, près d'Andrapengy, [14°40'S 50°12'E], 22.X.1966, *Service Forestier* 24956 (G, MO, P, TEF). **Prov. Fianarantsoa:** Manombo RS, 23°00'39"S 47°44'07"E, 16 m, 12.IX.2005, *Rabarimanarivo et al.* 60 (G, MO, P, TAN); Vangaindrano, Sianofana, Ambatomalama, forêt de Vohipaho, 23°26'34"S 47°31'04"E, 40 m, 20.IX.2009, *Razanatsima & Zafindrafeno* 723 (MO, P, TAN); Farafangana, Morarano, [22°48'00"S 47°41'30"E], 0-50 m, 10.X.1953, *Service Forestier* 10161 (P, TEF). **Prov. Toliara:** Mahatalaky, Farafara Vatanibe, 24°51'02"S 47°00'20"E, 135 m, 14-18.XI.2009, *Rakotovao et al.* 4531 (MO, P, TAN); Enaniliha, forêt d'Andohahela-Trafonaomby, 24°35'40"S 46°44'18"E, 808 m, 28.X.2009, *Randrianaivo & Andriantiana* 1771 (MO, P, TAN); Fort-Dauphin, Ifarantsa, [24°54'S 46°52'E], 24.X.1956, *Réserves Naturelles* 8183 (P).

53. *Noronhia marojejyensis* Hong-Wa, *spec. nova* (Fig. 38).

Typus: MADAGASCAR. **Prov. Antsiranana:** SAVA, Marojejy RNI; along the southern edge of the reserve at the base of Mt. Beondroka, 14°27'S 49°47'E, 230 m, 28.XI.1989, *Miller & Randrianasolo* 4642 (holo-: MO-3759776!; iso-: MO-3759775!, P [P03532774, P03532775]!, TAN!).

Diagnosis *Noronhia marojejyensis* Hong-Wa can be distinguished from other members of the genus by its oblong leaf blades, turning glossy reddish-brown on drying, its compact, pale yellow inflorescences, and its punctate fruits, with woody endocarp.

Description Trees to 5 m tall; young twigs cylindrical, 1.2-1.9 mm diameter, glabrous; bark light brown, smooth to somewhat rugose, flaky. Leaves opposite, persistent; bud scales deciduous; blades dark green above and below, oblong, 9.4-16.1 × 2.6-4.5 cm, coriaceous, glabrous, domatia absent, base acute to attenuate, margin flat, apex acuminate, the acumen 8-17 mm long, midrib slightly sunken above, distinctly raised above, secondary veins conspicuous, 13-16 per side, 6-19 mm apart, looping 2-5 mm from the margin; petiole light brown, 8-9 × 2-2.5 mm, entirely woody, glabrous. Thyrses geminate to fasciculate, multiflorous, compact; peduncle 5 mm long, moderately pubescent; pedicel 5-8 mm long, moderately pubescent; calyx moderately pubescent outside, glabrous inside, lobes triangular, 0.8-1.3 × 1-1.3 mm; corolla pale yellow, urceolate, 4.5-5 mm long, glabrous on both sides, the tube 2.5-3 mm long, lobes widely ovate, apex rounded; corona present, 1.7-1.8 mm long, lobed; stamens 1.7-2 mm long, anthers widely obovate, 1.4 mm long; pistil 2 mm long, stigma capitate to slightly bilobed. Fruiting pedicel 4-7 × 1.5-2 mm; young fruits green, dark purple-brown when mature, subglobose, 19.5-21 × 18-20 mm, surface covered with white dots, apex flat; dry pericarp 0.8 mm thick; endocarp woody; seed 11 × 9 mm.

Etymology The specific epithet is derived from the name of the massif in northeastern Madagascar, the only place where the species is known to occur.

Distribution, ecology and phenology *Noronhia marojejyensis* occurs in low-elevation humid forests on quartzites on Marojejy in northeastern Madagascar (Fig. 36). It has been collected in flowers and fruits in November.

Conservation status This species is known only from a single collection from low-elevation within Marojejy PN. With an AOO of just 4 km², coupled with habitat degradation in this part of the protected area resulting from illicit exploitation of timber and non-timber forest products, *N. marojejyensis* is assigned a preliminary status of "Critically Endangered" [CR B2ab(iii,v)].

Notes *Noronhia marojejyensis* resembles *N. pervilleana* (Knobl.) H. Perrier, from which it differs by its entirely (vs. partially) woody petioles, oblong (vs. lanceolate) leaf blades, urceolate (vs. rotate), pale yellow (vs. white sometimes tinged purplish) corolla, and subglobose (vs. ovoid) fruits with a flat (vs. rostellate) apex.



Fig. 38. *Noronhia marojejyensis* Hong-Wa.

A. Fruiting branch; **B.** Adaxial side of leaf blade; **C.** Abaxial side of leaf blade; **D.** Flower; **E.** Lateral view of corona; **F.** Inflorescence axis; **G.** Inner side of corolla; **H.** Pistil; **I.** Stamen; **J.** Fruit.

[Miller 4642, TAN] Drawings: R.L. Andriamiarisoa

54. *Noronhia martiniana* Hong-Wa, **spec. nova** (Fig. 39).

- *Linociera obtusifolia* var. *minoriflora* H. Perrier in Mém. Inst. Sci. Madagascar, Sér. B, Biol. Vég. 2: 279. 1949 [nom. inval.].
- *Noronhia obtusifolia* var. *minoriflora* (H. Perrier) Hong-Wa & Besnard in Mol. Phylogenet. Evol. 67: 377. 2013 [nom. inval.].

Typus: MADAGASCAR. **Prov. Fianarantsoa:** Mahabo-Mananivo, forêt de Mahabo, 23°10'34"S 47°42'12"E, 24 m, 4.XI.2001, Rabenantoandro & McPherson 683 (holo-: MO-5587144!; iso-: K, P [P03559153]!, TEF).

Diagnosis *Noronhia martiniana* Hong-Wa can be distinguished from other species of the genus by its long, non-woody petioles, its oblanceolate to obovate leaf blades, its white, campanulate flowers lacking a corona, and its ovoid to oblong fruits.

Description Trees to 12 m tall, trunk to 28 cm diameter; young twigs cylindrical, 1.4-3.4 mm diameter, glabrous; bark medium gray to brown, smooth to rugose. Leaves opposite, persistent; bud scales rarely persistent; blades medium green above, darker below, oblanceolate to obovate, 5.5-16 × 2-7.5 cm, coriaceous, glabrous, domatia absent, base attenuate, margin revolute and slightly undulate, apex retuse to obcordate, midrib sunken above, raised below, secondary veins conspicuous, 9-15 per side, 6-21 mm apart, looping 1-4 mm from the margin; petiole yellowish to reddish, 4-28 × 1-4 mm, not woody, glabrous. Thyrses geminate, multiflorous, compact; peduncle 2-8 mm long, glabrous; pedicel 1-5 mm long, glabrous; calyx glabrous on both sides, lobes triangular, 1-1.7 × 0.9-1.5 mm; corolla white, campanulate, petals almost free, 4.5-6 mm long, glabrous on both sides, the tube 1-3 mm long, lobes ovate, apex obtuse; corona absent; stamens 2-2.5 mm long, anthers oblong, slightly apiculate, 1.7-2 mm long; pistil 1.5-2 mm long, stigma bilobed. Fruiting pedicel 2-9 × 0.9-2.4 mm; young fruits green, reddish black when mature, ovoid to oblong, 13-23.5 × 7.5-19.5 mm, smooth, sometimes covered with a white pellicle, apex flat to rostellate, the rostellum circular, truncate, with the persistent style; dry pericarp 0.2-1.2 mm thick; endocarp woody; seed 10.5-15 × 6-11.5 mm.

Etymology This species is named in honor of Martin Callmander, Head Curator of the Library and publications at the Conservatoire et Jardin botaniques de la Ville de Genève and former Technical Advisor for the Conservation and Research program of the Missouri Botanical Garden in Antananarivo, who played the detective to find hidden material of *Noronhia* at G and P, and whose help in nomenclature and historical collections greatly enhanced the quality of this revision.

Distribution, ecology and phenology

Noronhia martiniana occurs in littoral to low-elevation humid forests in the east, from the Masoala peninsula in the north to around Ste Luce in the south (Fig. 36). It produces flowers and fruits throughout the year except in April and May.

Conservation status

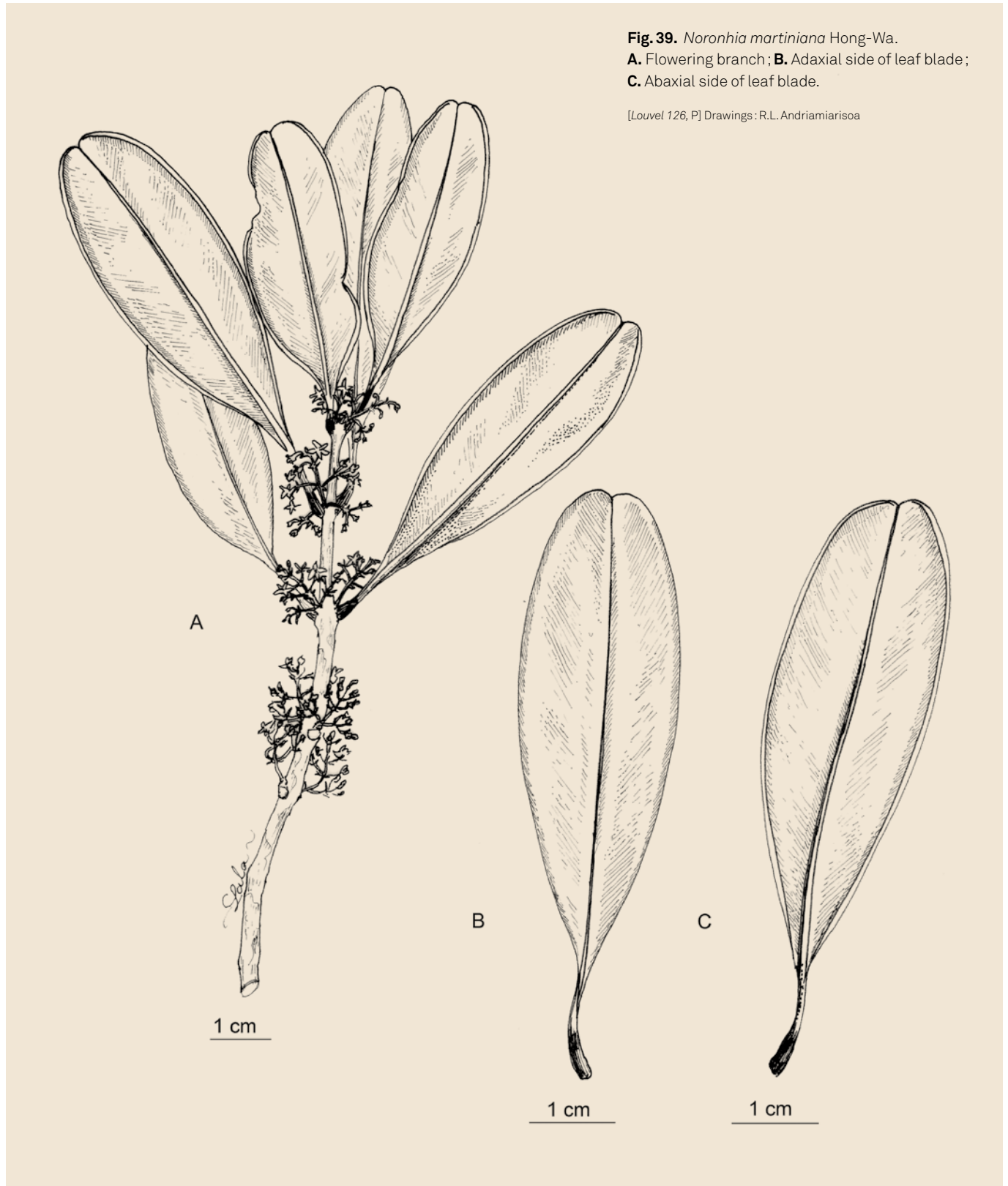
There were 22 collections representing 21 localities available for analysis, which yielded an EOO of 21,396 km², an AOO of 72 km², and 12 subpopulations representing 10 locations, of which four occur within the network of protected area (Agnalazaha, Ambohidena, Masoala, and Tampolo). *Noronhia martiniana* occurs mostly in the narrow band of littoral forests along the east coast of Madagascar and may have an actual AOO of less than 2,000 km². Decline in habitat quality and habitat loss will also very likely to continue as a result of forest exploitation, land conversion, and possibly also gradual sea level rise. Therefore, *N. martiniana* is assigned a preliminary status of “Vulnerable” [VU B2ab(i,ii,iii,iv,v)].

Notes

The taxon described here as *Noronhia martiniana* was first mentioned by PERRIER DE LA BATHIE (1949) as a variety of *N. obtusifolia*, but was not validly published as he failed to provide a Latin description or diagnosis, in violation of Art. 39.1 of the Code (McNEILL et al., 2012). *Noronhia martiniana* differs from *N. obtusifolia* by having large leaf blades (up to 16 cm vs. 10 cm long), long petioles (up to 28 mm vs. 20 mm long), small flowers (less than 6 mm long vs. more than 6 mm), and stamens that are oblong (vs. ovate). Molecular studies also placed these species in two different clades (HONG-WA & BESNARD, 2014). Therefore, the taxon initially recognized by PERRIER DE LA BATHIE (1949) is described here as a new species using a different epithet and a type specimen that is more widely distributed in various herbaria. The new species can be recognized by its long, non-woody petioles, oblanceolate to obovate leaf blades, white, campanulate flowers lacking a corona, and ovoid to oblong fruits.

Additional specimens examined

MADAGASCAR. Prov. Antsiranana: Ampanavoana, Vinanivao, Masoala PN, 15°41'33"S 50°13'30"E, 12-100 m, 15.IX.1996, Bernard 334 (K, MO, P, TAN); Masoala PN, Beankoraka, 15°57'S 50°13'E, 14.XI.1994, Rahajaso et al. 880 (K, MO, TAN). **Prov. Fianarantsoa:** Farafangana, Mahabo Mananivo, Nosiala, forêt d'Agnalazaha, 23°11'08"S 47°42'48"E, 50 m, 5.III.2009, Hong-Wa et al. 619 (MO, P, TAN); ibid. loc., 5.III. 2009, Hong-Wa et al. 620 (MO, P, TAN); Nosy Varika, Ambahy, 20°48'07"S 48°28'56"E, 9 m, 15.II.2004, Rabehevitra 881 (K, MO, P, TEF); Mahabo-Mananivo, forêt de Mahabo, 23°10'38"S 47°42'35"E, 20 m, 8.XI.2001, Rabenantoandro 717 (G, MO, P, TEF); Nosy Varika, Ampasimaneva, forêt d'Ambolo, 20°43'59"S 48°27'09"E, 13 m, 15.VI.2004, Razakamalala et al. 1452 (G, K, MO, P, TEF); Ambahy Forest, c. 20 km S of Nosy Varika, 20°46'09"S 48°28'46"E, 3 m, 22.IV.2004, Rogers et al. 300 (MO, P, TAN). **Prov. Toamasina:** Forêt de Tampina, [18°31'S 49°17'E], X.1923, Louvel 126 (P); Mahanoro, Ambalavontaka, forêt de Nankinana, 20°22'21"S 48°33'15"E, 41 m, 8.XI.2003, Rabehevitra et al. 685 (G, K, MO, P, TEF); Sainte Marie, Lokintsy, forêt d'Ambohidena,



16°51'11"S 49°57'10"E, 1.VI.2004, *Rabehevitra et al.* 1179 (K, MO, P, TEF); Fénérive-Est, Tampolo STF, 17°16'52"S 49°24'44"E, 0-150 m, 24.I.1995, *Raholivelo* 212 (MO); Mahanoro, Ambalavontaka, forêt d'Antaimby, 20°22'22"S 48°33'56"E, 13 m, 17.IV.2004, *Ranaivojaona et al.* 587 (K, MO, P, TEF); Mahanoro, Ambalavontaka, forêt d'Ampanamara, 20°22'48"S 48°33'23"E, 13 m, 12.VI.2004, *Ranaivojaona et al.* 707 (MO, P, TEF); Ambalavontaka, Nankinana Forest, c. 20 km N of Nosy Varika, 20°21'34"S 48°36'20"E, 10 m, 18.IV.2004, *Rogers et al.* 195 (MO, P, TAN). **Prov. Toliara:** Fort-Dauphin, Sainte Luce, 24°46'47"S 47°10'06"E, 14 m, 17.X.2012, *Ramananjanahary et al.* 784 (MO, P, TAN); Iaboakoho, Ambanihazao, forêt d'Analandrasambo, 24°40'55"S 47°11'56"E, 22 m, 22.X.2012, *Randrianaivo et al.* 2036 (MO, P, TAN).

55. *Noronhia myrtoides* H. Perrier in Mém. Inst. Sci. Madagascar, Sér. B, Biol. Vég. 2 : 302. 1949 (Fig. 40A).

Typus: MADAGASCAR. **Prov. Toliara:** Ampandrandava, dans les rochers de Pisopiso, [24°02'S 45°42'E], 750 m, XI.1943, Seyrig 299 (= *Herb. Jard. Bot. Tan.* 5392) (holo-: P [P03558897]!).

Description

Small *trees* to 5 m tall, trunk to 5 cm diameter; young twigs cylindrical, 0.6-1.3 mm diameter, glabrous; bark medium to light gray, smooth to slightly rugose. *Leaves* opposite, persistent; bud scales persistent; blades dark green above, lighter below, oblong to lanceolate, 4-8 × 1-2.5 cm, coriaceous, glabrous, domatia absent, base acute, margin slightly revolute, apex acute to acuminate, the acumen 1-8 mm long, midrib sunken above, slightly raised below, secondary veins barely visible, 7-11 per side, 3.5-11 mm apart, looping 0.5-3.5 mm from the margin; petiole light gray, 2.5-7.5 × 0.6-1.3 mm, entirely woody, glabrous. *Flowers* fasciculate; pedicel 3-7 mm long, glabrescent; calyx moderately pubescent to tomentose outside, glabrous inside, lobes deltate, 1-2 × 0.6-2 mm; corolla ivory white, cupuliform, 3.8-6 mm long, glabrous on both sides, the tube 2.5-4 mm long, lobes widely ovate, apex obtuse; corona present, 1-2 mm long, lobed; stamens 1.5-2.6 mm long, anthers widely ovate, 1.2-2.4 mm long; pistil 2-3.7 mm long, stigma capitate. *Fruiting* pedicel 4-9 × 0.7-1.4 mm; young fruits green, dark red when mature, ovoid to subglobose, 9-17 × 8.5-14.5 mm, surface smooth, sometimes covered with white dots, apex apiculate; dry pericarp 0.2-1.1 mm thick; endocarp woody; seed 5.5-11.5 × 4-9.5 mm.

Distribution, ecology and phenology

Noronhia myrtoides occurs in low- to mid-elevation dry forests and thickets from Bemahara in the west to Andohahela in the south (Fig. 36). It produces flowers and fruits throughout the year except in April and May.

Conservation status

The assessment included 20 collections representing 19 localities and resulted in an EOO of 78,840 km², an AOO of 92 km², and 21 subpopulations representing 17 locations, of which 11 occur within protected areas (Amoron'i Onilahy, Andohahela, Bemahara, Beza-Mahafaly, Complexe zones Mangoky, Menabe-Antanimena, Vohidava-Betsimalaho, and Zombitsy). With a large EOO, an actual AOO that is likely larger than 2,000 km², and many locations that are well represented within the network of protected areas, *N. myrtoides* is assigned a preliminary status of "Least Concern".

Notes

Noronhia myrtoides can be recognized by its habit (a small tree), oblong to lanceolate leaf blades with barely visible venation, and fasciculate white flowers. It differs from *N. alleizettei* by the shape of its leaves (oblong to lanceolate vs. narrowly elliptic) and the presence of a corona, and from *N. buxifolia* by the shape of its leaves (oblong to lanceo-

late vs. ovate) and fruits (ovoid to subglobose vs. ovoid) and by the color of its flowers (white vs. red). The specimen of *Humbert* 5236 deposited at P, with duplicates housed in several other herbaria, bears the annotation "type". However, in the protologue, PERRIER DE LA BATHIE (1949) designated *Seyrig* 299 (= *Herb. Jard. Bot. Tan.* 5392) as the type and *Humbert* 12949 as a "co-type"; the former is therefore recognized here as the type and the latter as a paratype.

Additional specimens examined

MADAGASCAR. Prov. Toliara: Ambatoabo, Andohahela PN, Mt Apiky, 24°47'19"S 46°43'04"E, 647 m, 18.I.2007, *Andriamihajarivo et al.* 1165 (MO, P, TAN); Amboasary Sud, Marotsiraka, Ankotsy, 24°17'13"S 46°08'24"E, 513 m, 11.XI.2008, *Andriamihajarivo et al.* 1559 (MO, P, TAN); c. 10 km N of Befandriana-Sud, 150 m, 21.XII.1961, *Appert* 51 (MO); Befandriana-Sud, 150 m, 15.V.1905, *Appert* 201 (MO); Vallée de la Sakoa, 23°42'S 44°46'E, 22.X.1940, *Decary* 16020 (G, MO, P); vallée du Fiherenana, [23°18'S 43°38'E], 10-200 m, 14.IX.1924, *Humbert & Perrier de la Bâthie* 2575 (P); vallée inférieure de l'Onilahy, [23°30'S 44°01'E], 10-50 m, 12.VIII.1928, *Humbert & Swingle* 5236 (BR, K, P, WAG); de Tsivory à Anadabolava, [24°12'S 46°19'E], 300-400 m, XII.1933, *Humbert* 12329 (P); Zombitsy (Sakaraha), 600-850 m, 26-29.III.1955, *Humbert et al.* 29649 (G, MO, P); Anadabolava, Betsimilaho, 24°13'06"S 46°17'16"E, 299 m, 1.VII.2011, *Letsara et al.* 1287 (CAS, MO); entre Tuléar et St. Augustin, 23°28'S 43°47'E, 31.III.1966, *Peltier & Peltier* 5827 (MO, P); env. de Soahanina, [18°35'S 44°14'E], s.d., *Perrier de la Bâthie* 8812 (P); sur la Sakoa, bassin de l'Onilahy, [23°43'S 44°47'E], VIII.1925, *Perrier de la Bâthie* 17363 (P); Beza Mahafaly RS near Betioky, 23°40'S 44°39'E, 180 m, 26.X.1987, *Phillipson* 2455 (MO, P, TAN); Near Beza Mahafaly RS, 23°58'S 44°39'E, 150 m, 28.XI.1987, *Phillipson* 2618 (MO, P, TAN); Sakaraha, Mahaboboka, Ankasy forest, 22°49'03"S 44°16'47"E, 581 m, 22.II.2011, *A. Randrianasolo et al.* 1441 (G, MO, P, TAN); Amboasary Sud, Mahaly, Anadabolava, 24°14'38"S 46°18'25"E, 263 m, 24.X.2007, *Randriatsivory et al.* 248 (MO, P, TAN); Manja, Beharoana, Vondrove, 21°48'03"S 44°10'43"E, 86 m, 20.IX.2007, *Rasoafaranaivo et al.* 267 (MO, P, TAN); Ambatoabo, Ankoba, 2 km E d'Imonty, 24°47'56"S 46°40'24"E, 160 m, 17.XI.2009, *Ratovoson* 1496 (G, MO, P, TAN); Zombitsy PN, [22°46'S 44°42'E], 600 m, 21.III.1951, *Service Forestier* 3387 (P, TAN, TEF); Ankaraobato, Morondava, [20°10'30"S 44°37'50"E], 0-50 m, 13.XI.1952, *Service Forestier* 6063 (MO, P, TEF); Menabe, Andoharano, [19°42'S 44°33'E], 16.XII.1957, *Service Forestier* 17866 (G, P, TEF); Betioky, near Analafaly, 23°39'S 44°38'E, 1.VI.1987, *Sussman* 153 (MO).



Fig. 40. Photographs of *Noronhia* Stadtm. ex Thouars.

A. *Noronhia myrtooides* H. Perrier [Ratovoson 1496]; **B.** *Noronhia oblanceolata* H. Perrier [Ranirison 1053].

Photos: taken by respective collectors

56. *Noronhia obcordifolia* Hong-Wa, spec. nova (Fig. 41).

Typus: MADAGASCAR. **Prov. Antsiranana:** DIANA, Diégo II, Ramena, env. 2 km à l'O d'Andavakoera, près de la grotte et du campement la Casa Aventura, 12°19'57"S 49°21'19"E, 172 m, 4.VIII.2007, *Hong-Wa et al.* 535 (holo-: MO-6615565!; iso-: CNARP!, G [G00341625]!, P!, TAN!).

Diagnosis *Noronhia obcordifolia* Hong-Wa can be distinguished from its congeners by its coriaceous, heart-shaped leaves and its apiculate fruits, somewhat covered with a white pellicle.

Description Shrubs to 4 m tall; young twigs cylindrical, 1-1.3 mm diameter, glabrous; bark dark gray, smooth. Leaves opposite, persistent; bud scales persistent; blades medium gray, cordiform, 3-4 × 2-3 cm, coriaceous, glabrous, domatia absent, base acute, margin slightly revolute, apex obcordate, midrib slightly sunken above, raised below, secondary veins barely visible, 5-6 per side, 5-7 mm apart, looping 1.5-2 mm from the margin; petiole medium gray, 4 × 1.2-1.6 mm, entirely woody, glabrous. Flowers unseen, but fruits solitary. Fruiting pedicel 7-8 × 1-1.2 mm; young fruits green, reddish when mature, ovoid, 12.2-12.6 × 7.4-7.8 mm, smooth, sometimes covered with a white pellicle, apex apiculate, with the persistent style; dry pericarp 0.4 mm thick; endocarp woody.

Etymology The specific epithet refers to the inverted heart-shaped leaf blade, with its distinctive obcordate apex.

Distribution, ecology and phenology *Noronhia obcordifolia* occurs in low-elevation dry forests on limestones on Montagne des Français in the north (Fig. 36). It has been collected in fruits in August.

Conservation status *Noronhia obcordifolia* is known only from three collections from the newly established protected area of Montagne des Français. Because of its close proximity to the city of Diégo-Suarez, the forest on Montagne des Français has played an important role in supplying the population with charcoal and other products, providing refuge to fugitive criminals, and favoring other illegal activities such as small-scale cannabis cultivation. This rocky outcrop has also become a favorite destination for rock climbers in recent years. Although its new status as a protected area should gradually reduce the impacts of these threats, habitat degradation as well as habitat alteration resulting from illicit exploitation and invasive species will likely persist. Therefore, *N. obcordifolia* is assigned a preliminary status of "Critically Endangered" [CR B2ab(iii,v)].

Fig. 41.*Noronhia obcordifolia* Hong-Wa.**A.** Fruiting branch; **B.** Fruit.

[Hong-Wa 535, TAN]

Drawings: R.L. Andriamiarisoa



Notes *Noronhia obcordifolia* most closely resembles *N. lowryi*, from which it differs by its smooth (vs. rugose) bark, woody (vs. non-woody) petioles, cordiform (vs. elliptic) leaf blades, and ovoid (vs. pyriform) fruits with an apiculate (vs. flat) apex. Distinctive features include coriaceous, inverted heart-shaped leaves with an obcordate apex, and apiculate fruits somewhat covered with a white pellicle.

Paratypes **MADAGASCAR. Prov. Antsiranana:** Ramena, Andavakoera, 12°19'41"S 49°20'26"E, 76 m, 3.VIII.2007, *Hong-Wa et al.* 524 (CNARP, MO, P, TAN); *ibid. loc.*, 12°19'57"S 49°21'19"E, 172 m, 4.VIII.2007, *Hong-Wa et al.* 544 (TAN).

57. *Noronhia oblanceolata* H. Perrier in Mém. Inst. Sci. Madagascar, Sér. B, Biol. Vég. 2: 284. 1949 (Fig. 40B).

Lectotypus (designated here): **MADAGASCAR. Prov. Antsiranana:** près de la cîme du Mt Mahabenofa (N), bassin de la Loky, [13°16'S 49°26'E], 1932, *Perrier de la Bâthie* 2316 (P [P00701217]!). **Syntypus:** **MADAGASCAR. Prov. Mahajanga:** Boeny, 7e Réserve [Ankarafantsika PN], chemin Ankorika-Sainte Marie, [16°09'S 47°04'E], 150 m, *Service Forestier* 82 (P [P00413237]!).

Description *Shrubs* to small trees to 6 m tall, trunk to 11 cm diameter; young twigs cylindrical, 0.5-1.2 mm diameter, glabrous; bark medium gray, smooth to slightly rugose. *Leaves* opposite, verticillate at the tips of the branches, semi-deciduous; bud scales persistent; blades dark green above, lighter below, oblanceolate, 1.5-5 × 0.5-1.5 cm, coriaceous, glabrous, domatia absent, base acute to attenuate, margin flat to slightly revolute, apex retuse, midrib sunken above, slightly raised below, secondary veins inconspicuous, 5-11 per side, 2-6 mm apart, looping 0.4-1.5 mm from the margin; petiole yellow to brownish, 2-5 × 0.4-1.1 mm, not woody, glabrous. *Thyrse*s fasciculate, pauciflorous, compact to diffuse; peduncle 2-5 mm long, moderately pubescent; pedicel 1.5-4 mm long, moderately pubescent; calyx moderately pubescent outside, glabrous inside, lobes triangular, 1.5-2.2 × 0.9-1.2 mm; corolla white, oblong, 3.3-5.5 mm long, glabrous on both sides, the tube 1.5-2 mm long, lobes deltate, apex obtuse; corona absent; stamens 1.6-2.1 mm long, anthers ovate to lanceolate, 1.3-1.6 mm long; pistil 1.4-2 mm long, stigma slightly bilobed. *Fruiting* pedicel 4-11 × 1.1-1.9 mm; young fruits green, dark red when mature, globose to subglobose, 11.5-23 × 9.5-17 mm, smooth, apex apiculate to rostellate, the rostellum circular, apiculate; dry pericarp 0.7-2.2 mm thick; endocarp woody; seed 9-12.5 × 7-10 mm.

Distribution, ecology and phenology *Noronhia oblanceolata* occurs in low-elevation dry forests in the north (Analamera to Daraina) and the west (Ankarafantsika) (Fig. 36). It produces flowers and fruits from October to March.

Conservation status The assessment used 12 collections representing 12 localities and resulted in an EOO of 12,991 km², an AOO of 40 km², and eight subpopulations representing seven locations, of which five occur within protected areas (Analamerana, Ankarafantsika, Ankarana, and Loky-Manambato). Because of forest exploitation, land conversion and artisanal mining, habitat degradation and loss will likely persist outside of protected areas, although a reduction in EOO is not expected in the near future. Therefore, *N. oblanceolata* is assigned a preliminary status of "Vulnerable" [VU B1ab(ii,iii,iv,v)+2ab(ii,iii,iv,v)].

Notes *Noronhia oblanceolata* can be recognized by its oblanceolate leaf blades that are verticillate at the tips of the branches and its globose to subglobose, apiculate fruits. It differs from *N. maculata* by its non-woody (vs. woody) petioles, oblanceolate (vs. obovate) leaf blades, oblong (vs. subrotate), white (vs. pale green) corolla lacking a corona, and globose to subglobose (vs. ovoid) fruits.

PERRIER DE LA BÂTHIE (1949, 1952) used *Service Forestier* 82 (from Ankarafantsika in the west) as the flower-bearing syntype and *Perrier de la Bâthie* 2316 (from Analamera in the north) as the fruit-bearing syntype. The flowers of *Service Forestier* 82 are clustered into diffuse inflorescences and were described as subcampanulate, the corolla being wider than long, with a thick corona as long as the corolla tube. Flowers of specimens recently collected in the north and corresponding to *Perrier de la Bâthie* 2316 are clustered into compact inflorescences, are oblong, have only a short corolla tube, and lack a corona. The northern and western plants may thus represent two different entities. However, because the western entity is known only from a single specimen that may simply represent an extreme in variation, it is preferable to await more collections from this area to determine their respective identities. In the meantime, a broad definition of *N. oblanceolata* is retained but in order to avoid ambiguity regarding the use of the name *N. oblanceolata* and to associate it permanently with populations from the north, *Perrier de la Bâthie* 2316 has been selected here as the lectotype.

**Additional specimens
examined**

MADAGASCAR. Prov. Antsiranana: Daraina, forêt d'Antsahabe, 13°12'55"S 49°33'00"E, 750 m, 3.XII.2004, *Gautier* 4820 (Daraina, G, MO, P, TEF); Analamera, [12°42'S 49°20'E], 50-400 m, 1.I.1938, *Humbert* 19137 (P); Ambohipiraka, [13°11'S 49°06'E], 1.X.1932, *Perrier de la Bâthie* 18757 (P); 3 km E d'Ambilobe, 13°11'57"S 49°04'44"E, 72 m, 23.I.2007, *Rakotonandrasana et al.* 1069 (CNARP, G, MO, P, TAN); Daraina, forêt d'Antsahabe, 13°10'51"S 49°33'13"E, 415 m, 1.V.2004, *Ranirison* 756 (Daraina, G, K, MO, P, TEF); Daraina, forêt d'Ambohitsitondroina, 13°07'56"S 49°27'16"E, 230 m, 6.I.2006, *Ranirison & Nusbaumer* 1053 (Daraina, G, K, MO, P, TEF); Daraina, forêt d'Antsahabe, 13°12'32"S 49°33'15"E, 560 m, 3.XI.2005, *Razafitsalama et al.* 757 (CNARP, MO, P, TAN); *ibid. loc.*, 13°12'32"S 49°33'15"E, 560 m, 3.XI.2005, *Razafitsalama et al.* 760 (CNARP, MO, P, TAN); *ibid. loc.*, 13°12'32"S 49°33'15"E, 560 m, 3.XI.2005, *Razafitsalama et al.* 765 (CNARP, MO, P, TAN); Ankarana RS, [12°49'S 49°01'E], 50-409 m, *Service Forestier* 10421 (P, TEF).

58. *Noronhia obtusifolia* (Lam.) Hong-Wa & Besnard in Mol. Phylogenet. Evol. 67: 376. 2013 (Fig. 42).

≡ *Olea obtusifolia* Lam., Tabl. Encycl. Méthod. 1: 28. 1791.

≡ *Linociera obtusifolia* (Lam.) H. Perrier in Mém. Inst. Sci. Madagascar, Sér. B, Biol. Vég. 2: 279. 1949.

≡ *Chionanthus obtusifolius* (Lam.) Stearn in Bot. J. Linn. Soc. 80: 203. 1980.

Lectotypus (designated here): **MADAGASCAR:** *sine loc.*, s.d., *Commerson s.n.* (P-JU n° 4900 [P00657336] image seen; isolecto-: G [G00007660] image seen, P [P00413214] !, P-LA [P00356887] image seen).

– *Linociera obtusifolia* var. *thouarsii* H. Perrier in Mém. Inst. Sci. Madagascar, Sér. B, Biol. Vég. 2: 279. 1949 [nom. inval.] ≡ *Noronhia obtusifolia* var. *thouarsii* (H. Perrier) Hong-Wa & Besnard in Mol. Phylogenet. Evol. 67: 376. 2013 [nom. inval.].

Description

Trees to 20 m tall, trunk to 25 cm diameter; young twigs cylindrical, 1-2.5 mm diameter, glabrous; bark dark to medium gray, smooth to slightly rugose. *Leaves* opposite, persistent; bud scales rarely persistent; blades dark green above, lighter below, obovate, 3.5-10.5 × 1.5-4 cm, coriaceous, glabrous, domatia absent, base attenuate, margin slightly revolute, apex obtuse to rounded or obcordate, midrib slightly sunken above, raised below, secondary veins distinct to barely visible, 7-13 per side, 5-10 mm apart, looping 1-2 mm from the margin; petiole yellow to brownish, 6-20 × 0.5-2.3 mm, not woody, sometimes only partially, glabrous. *Thyrse*s geminate, multiflorous, compact; peduncle 8-14 mm long, glabrous; pedicel 1.5-4 mm long, glabrous; calyx glabrous on both sides, lobes triangular, 1-1.3 × 0.8-1.2 mm; corolla white, campanulate, petals almost free, 5-7 mm long, glabrous on both sides, the tube 1-4 mm long, lobes ovate, apex obtuse; corona absent; stamens 2-2.8 mm long, anthers ovate, apiculate, 1.5-1.8 mm long; pistil 1.5-2.5 mm long, stigma bilobed. *Fruiting* pedicel 1-1.7 × 1.3-1.6 mm; young fruits green, reddish black when mature, ovoid to subglobose, 16-21 × 6-16.5 mm, smooth to ribbed, apex flat to rostellate, with the persistent style; dry pericarp 0.2-1.2 mm thick; endocarp woody; seed 14-15 × 5-12 mm.

Distribution, ecology and phenology

Noronhia obtusifolia occurs in low- to high-elevation humid forests in eastern Madagascar, from around Anjanaharibe-Sud in the north to around Fort-Dauphin in the south (Fig. 36). It produces flowers and fruits all year.

Conservation status

Based on 52 collections representing 43 localities, the analyses indicated an EOO of 97,820 km², an AOO of 132 km², and 26 subpopulations representing 26 locations, of which 12 occur within protected areas (Agnalazaha, Ambohidena, Andohahela, Anjanaharibe-Sud, Corridor Ankeniheny-Zahamena, Makira, Mandena, Marojejy,

Ste Luce, Tampolo, Tsitongambarika, and Vohibola). With a large EOO and an actual AOO likely exceeding 2,000 km², *N. obtusifolia* is assigned a preliminary status of “Least Concern”.

Notes *Noronhia obtusifolia* can be recognized by its elliptic to narrowly or very widely obovate leaf blades terminated by an obtuse to obcordate apex, compact inflorescences, white flowers with barely connate petals, and ovoid, almost elongate, smooth to ribbed fruits. The variation in the shape of the leaf blades and fruits as well as fruit ornamentation may be sufficient to distinguish different entities within this species. Indeed, PERRIER DE LA BATHIE (1949, 1952) recognized three varieties, of which two were, however, invalidly published due to a lack of Latin diagnosis (Art. 39.1; McNEILL et al., 2012). Consequently, the combinations *N. obtusifolia* var. *minoriflora* (H. Perrier) Hong-Wa & Besnard and *N. obtusifolia* var. *thouarsii* (H. Perrier) Hong-Wa & Besnard are also invalid as they were based on these names.

The taxon referred to as *N. obtusifolia* var. *minoriflora* is here recognized as distinct at the species level and described as new (see p. 179) using the name *N. martiniana*. By contrast, *N. obtusifolia* var. *thouarsii*, based on a very poor material, is better treated as *N. obtusifolia* (without recognition at an infraspecific level) until additional specimens become available. The collection in P-JUS is here designated as lectotype as it is more complete than the material in P-LAM. Furthermore, the latter collection bears the indication “ex-Juss” meaning that Lamarck had received the collection from Jussieu. LAMARCK (1791) indicated Mauritius as the origin of the type by error; it is in fact a Commerson collection from Madagascar.

Additional specimens examined

MADAGASCAR. Prov. Antsiranana: Ambatosoratra, [14°34'S 49°44'E], 400 m, 5.I.1949, Cours 3292 (MO, P); Mt Ambatosoratra, [14°25'48"S 49°43'48"E], 1500-1540 m, 4-8.I.1949, Humbert & Cours 22941 (P); Anjanaharibe-Sud RS, 14°48'15"S 49°26'45"E, 1000-1100 m, 6.VIII.1997, McPherson 17254 (K, MO). **Prov. Fianarantsoa:** Nosy Varika, Ambahy, 20°48'07"S 48°28'56"E, 22 m, 13.XI.2003, Rabehevitra et al. 741 (K, MO, P, TEF). **Prov. Mahajanga:** Befandriana-Nord, Matsoandakana, Andranomena, forêt d'Anjiabe, 15°08'10"S 49°21'08"E, 1085 m, 11.II.2008, Ravelonarivo et al. 2775 (G, MO, P, TAN). **Prov. Toamasina:** Maroantsetra, Ambinanitelo, Marovovonana, Ankirindro forest, 15°17'34"S 49°32'46"E, 690 m, 13.I.2003, Antilahimena 1711 (G, MO, P); Antsirabe Sahatany, Anjiahely, 15°24'45"S 49°22'29"E, 1201 m, 19.VI.2004, Antilahimena 2529 (MO); Ambinanitelo, Marovovonana, 15°19'03"S 49°24'06"E, 800 m, 4.IX.2004, Antilahimena 2767 (MO); Mananara, Vanono, Lohan'i Ambitsy forest, 15°53'27"S 49°28'57"E, 846 m, 26.VII.2007, Antilahimena 5706 (MO, P, TAN); Mahanoro, Ambodibonara, Ambalavontaka, forêt de Nankinana, 20°22'21"S 48°33'15"E, 16 m, 12.II.2004, Rabehevitra 801 (MO, P, TEF); Brickaville, Ambila-Lemaitso, 18°49'S 49°08'E, 0-5 m, 11.XI.1999, A. Randrianasolo & Ranaivojaona 650 (G, MO, P); Brickaville, Maroseranana, Ambodilendemy, 18°24'49"S 48°47'32"E, 1175 m, 24.III.2011, Ravelonarivo et al. 3848 (G, MO, P, TAN); Sainte Marie, Lokintsy, Sahasifotra, forêt d'Ambohidena, 16°50'25"S 49°57'09"E, 10 m, 19.II.2004, Razakamalala 943 (K, MO, P, TEF); Ambila-Lemaitso, [18°49'S 49°08'E], 30 m, 8-10.VIII.1957, Service Forestier 18067 (MO). **Prov. Toliara:**

Fort-Dauphin, Mt Vohimavo, 24°19'32"S 47°08'11"E, 836-837 m, 4.XII.2001, *Hong-Wa* 29 (G, MO, P, TAN); Ampasy Nampoana, forêt de Mandena, 24°57'10"S 47°00'10"E, 9 m, 12.II.2009, *Hong-Wa* 599 (MO, P, TAN); Ambatoabo, forêt d'Ankoba, 24°46'44"S 46°43'17"E, 660 m, 19.VII.2011, *Randrianaivo et al.* 1888 (G, MO, P, TAN); Iabakoho, Antsotso, forêt de Bemangidy, 24°35'33"S 47°12'52"E, 22.V.2006, *Randriatafika et al.* 655 (G, MO, P, TEF); *ibid. loc.*, 24°34'10"S 47°12'01"E, 651 m, 2008, *Randriatafika* 903 (G, MO, P, TEF); Ampasy Nampoana, forêt de Mandena, 24°57'26"S 47°01'34"E, 90 m, 13-15.VI.1999, *Ratovoson et al.* 106 (MO, P, TAN); Iaboko, Antsotso Avaratra, 24°33'42"S 47°12'02"E, 662 m, 11.XII.2007, *Razakamalala et al.* 3989 (G, MO, P, TAN); Fort-Dauphin, Manafiafy, 24°47'S 47°10'E, 15 m, 13.XI.1990, *Schatz et al.* 3009 (G, MO, TAN); Vataza, au SE d'Imonty, [24°36'S 46°42'E], 16.I.1963, *Service Forestier* 22458 (G, MO). **Sine loc.**: s.d., *du Petit-Thouars s.n.* (P).



Fig. 42. *Noronhia obtusifolia* (Lam.) Hong-Wa & Besnard [Schatz 3009].

Photo: G. Schatz

59. *Noronhia olearia* Hong-Wa, **nom. nov.** (Fig. 43A).

≡ *Olea ambrensis* H. Perrier in Mém. Inst. Sci. Madagascar, Sér. B, Biol. Vég. 2: 277. 1949 [non *Noronhia ambrensis* H. Perrier in Mém. Inst. Sci. Madagascar, Sér. B, Biol. Vég. 2: 277. 1949].

Typus: MADAGASCAR. **Prov. Antsiranana:** Centre (Nord): Montagne d'Ambre, près de Diégo-Suarez, [12°33'S 49°08'E], 1000-1200 m, IX.1926, *Perrier de la Bâthie* 17706 (holo-: P [P00162996]!).

Description *Trees* to 10 m tall, trunk to 30 cm diameter; young twigs cylindrical, 0.5-2 mm diameter, glabrous; bark medium gray, smooth, sometimes lenticellate. *Leaves* opposite, persistent; bud scales persistent; blades dark green above, lighter below, lanceolate, 4-11 × 1.6-4.3 cm, coriaceous, glabrous, domatia absent, base acute to attenuate, margin flat to slightly undulate, apex acute to acuminate, the acumen 1-9 mm long, midrib slightly sunken above, raised below, secondary veins conspicuous, 7-12 per side, 4-19 mm apart, looping 1-5 mm from the margin; petiole yellow, 4-14 × 0.9-2 mm, usually not woody, sometimes only partially, glabrous. *Flowers* unseen, but infructescence thyrsoïd. *Fruiting pedicel* 4-13 × 0.5-2 mm; young fruits green, reddish brown when mature, ovoid, 11-22.5 × 8-16 mm, surface smooth, sometimes verrucose, apex apiculate; dry pericarp 0.4-0.6 mm thick; endocarp woody; seed 11-16 × 6.5-12 mm.

Distribution, ecology and phenology *Noronhia olearia* occurs in low- to mid-elevation transitional forests in the north, from Cap St. Sébastien to Montagne d'Ambre (Fig. 36). It fruits from January to June.

Conservation status The assessment included 10 collections representing eight localities and resulted in an EOO of 377 km², an AOO of 28 km², and four subpopulations representing three locations, of which two occur within a protected area (Montagne d'Ambre). One of the subpopulations occurs in an area that is now highly degraded as a result of land conversion for agriculture and pasture, and other forms of forest exploitation. The subpopulations within Montagne d'Ambre PN, especially those at the periphery, also suffer from illicit exploitation of wood and other forest products as well as encroachment for crop and khat cultivation. All these threats will lead to decline in habitat quality and number of individuals as well as habitat loss. Therefore, *Noronhia olearia* is assigned a preliminary status of "Endangered" [EN B1ab(i,i,i,iii,iv,v)+2ab(i,ii,iii,iv,v)].

Notes *Noronhia olearia* can be recognized by its yellow to reddish petioles and apiculate to rostrate fruits, which are often covered with a white pellicle. It differs from *N. linocerioides* by its lanceolate (vs. elliptic), coriaceous (vs. chartaceous) leaf blades, and smooth to verrucose (vs. smooth to punctate) fruits with an apiculate to rostrate (vs. rostellate) apex. This species was first described as *Olea ambrensis*, whose type (Perrier de la Bâthie 17706) morphologically resembles the following specimens: *Andrianantoanina* 130, 313 and 366, *Hong-Wa* 573 and 693, *Leeuwenberg* 14309 and *Schatz* 1501. Another collection, *Richard* 192 [P00701261, P04046974], identified by PERRIER DE LA BÂTHIE as *Noronhia ambrensis*, also belongs to this group. Molecular studies placed material of *Hong-Wa* 573 and 693 deep within *Noronhia* (HONG-WA & BESNARD, 2013, 2014) rather than within *Olea*. Similarly, other specimens recognized as *O. ambrensis* by GREEN (2002) fell elsewhere within *Noronhia*, close to collections to which they resemble (e.g. *Schatz* 3605 in *N. linocerioides*). Since the binomial *Noronhia ambrensis* is already occupied and no other validly published names are available for the entity described as *Olea ambrensis*, a new name is proposed here.

**Additional specimens
examined**

MADAGASCAR. Prov. Antsiranana: Joffreville, Montagne d'Ambre PN, 12°31'S 49°09'E, 700-900 m, 3-11.V.1993, *Andrianantoanina et al.* 130 (G, MO, P, TAN); *ibid. loc.*, 12°27'S 49°13'E, 250-500 m, 3-10.VIII.1993, *Andrianantoanina & Rochscohlher* 269 (K, MO, P); *ibid. loc.*, 12°35'S 49°09'E, 1475 m, 26.VIII-IX.1993, *Andrianantoanina* 313 (K, MO, P, TAN); *ibid. loc.*, 12°27'S 49°13'E, 250-500 m, 29.IX-5.X.1993, *Andrianantoanina* 366 (K, MO); *ibid. loc.*, 12°33'S 49°08'E, 1000 m, 22.I.2009, *Hong-Wa* 573 (G, MO, P, TAN); *ibid. loc.*, 12°31'43"S 49°10'21"E, 993 m, 18.V.2010, *Hong-Wa & Ortiz* 693 (G, MO, P, TAN); *ibid. loc.*, near Station des Roussettes, 12°31'S 49°10'E, 1000 m, 23.I.1994, *Leeuwenberg* 14309 (MO, P, WAG); Cap St. Sébastien, [12°26'S 48°44'E], 1837, *Richard* 192 (P); Ambohitra (Joffreville), Montagne d'Ambre PN, 12°33'S 49°08'E, 1000 m, 13.IX.1987, *Schatz* 1501 (MO, P, TAN); *ibid. loc.*, [12°33'S 49°08'E], 19.V.1987, *Service Forestier* 31599 (TEF).



Fig. 43. Photographs of *Noronhia* Stadtm. ex Thouars.

A. *Noronhia olearia* Hong-Wa [Hong-Wa 573] ; **B.** *Noronhia orientalis* Hong-Wa [Hong-Wa 636].

Photos: C. Hong-Wa

60. *Noronhia orientalis* Hong-Wa, *spec. nova* (Fig. 43B, 44).

Typus: MADAGASCAR. **Prov. Antsiranana:** SAVA, Sambava, Anjangoveratra, Ambavala, forêt d'Antsahakasaka, 2 km au NO du village Ambavala, 14°05'39"S 50°02'42"E, 146 m, 16.II.2006, *Andrianjafy et al.*1599 (holo-: MO-6615571!; iso-: G [G00341629]!, P!, TAN!).

Diagnosis *Noronhia orientalis* Hong-Wa can be distinguished from other members of the genus by its terminally verticillate leaves, its obovate leaf blades, with very conspicuous venation and its compact inflorescences with white flowers.

Description Trees to 10 m tall, trunk to 10 cm diameter; young twigs cylindrical, 1.5-3.1 mm diameter, glabrous; bark dark gray, smooth to rugose, sometimes lenticellate. Leaves opposite, sometimes verticillate at the tips of the branches, persistent; bud scales persistent; blades medium green above, lighter below, oblong to obovate, 7-15 × 2.5-5 cm, subcoriaceous, glabrous, domatia casual to abundant, base acute to attenuate, sometimes truncate, margin flat, slightly revolute, apex retuse to shortly cuspidate, the cusp 1-6 mm long, midrib sunken above, distinctly raised below, secondary veins conspicuous, 10-15 per side, 8-16 mm apart, looping 2-5 mm from the margin; petiole light gray to brownish, 6-22 × 1.5-3 mm, entirely woody, glabrous. Thyrses geminate to fasciculate, pauciflorous, compact; peduncle 5-10 mm long, glabrous; pedicel 3-4 mm long, glabrous; calyx glabrous on both sides, lobes triangular, 0.7-1.2 × 1-1.2 mm; corolla white, cupuliform, 3-4.5 mm long, glabrous on both sides, the tube 1.5-3 mm long, lobes ovate, apex acute; corona present, 1.6-2 mm long, undivided; stamens 1.5-2 mm long, anthers oblong, 0.7-1.3 mm long; pistil 2-2.3 mm long, slightly bilobed. Fruiting pedicel 8-10 × 3-3.5 mm; young fruits green, unseen mature, ovoid to oblong, 18-21 × 14-15 mm, surface smooth, sometimes glaucous and slightly rugose, apex flat; dry pericarp 1 mm thick; endocarp woody; seed 10-15 × 6-10 mm.

Etymology The specific epithet refers to its strictly eastern distribution, specifically northeastern Madagascar.

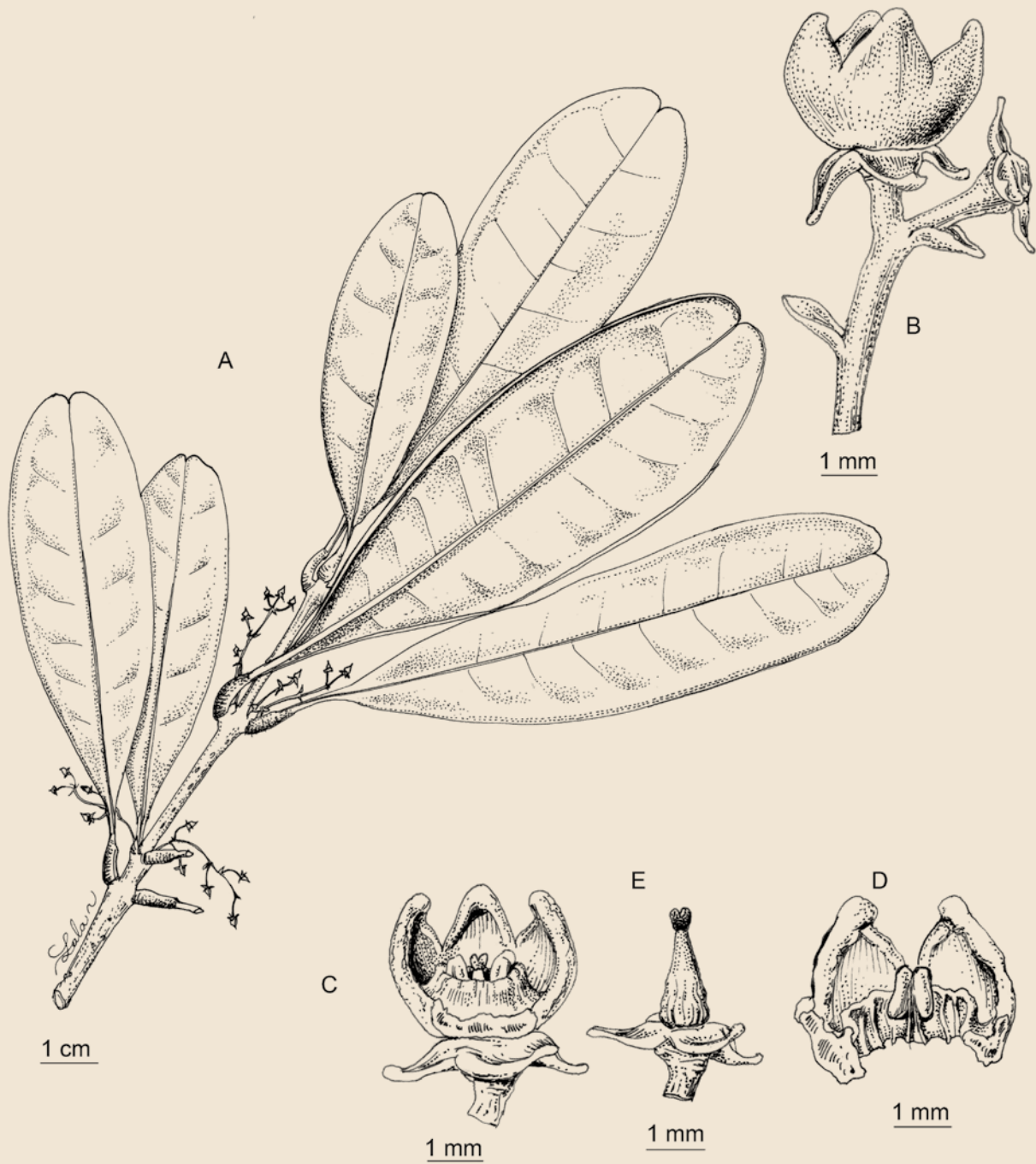
Distribution, ecology and phenology *Noronhia orientalis* occurs in littoral to low-elevation humid forests in the northeast, from Antsirabe Nord to the Masoala peninsula (Fig. 36). It has been collected in flowers and fruits in February.

Conservation status *Noronhia orientalis* is currently known from seven collections representing seven localities. With an EOO of 4,012 km², an AOO of 28 km², and five subpopulations representing five locations, of which four occur within protected areas (Makirovana-Tsi-

homanaomby, Marojejy, and Masoala), *N. orientalis* is assigned a preliminary status of “Endangered” [EN B1ab(ii,iii,v)+2ab(ii,iii,v)] because habitat loss as well as continuing decline in habitat quality and number of mature individuals is projected both outside and inside of protected areas due to wood harvesting, land conversion and illicit exploitation.

Notes *Noronhia orientalis* and *N. retusifolia* Hong-Wa are similar in appearance but can be distinguished from each other by the shape of their leaves (oblong to obovate in *N. orientalis* vs. oblanceolate to obovate in *N. retusifolia*), the length of their petioles (up to 22 mm vs. less than 11 mm), and the surface (smooth to sometimes slightly rugose vs. rugose) and apex (flat vs. bluntly pointed) of their fruits. Features such as terminally verticillate leaves, obovate leaf blades, with very conspicuous venation and compact inflorescences with white flowers characterize this species.

Paratypes **MADAGASCAR. Prov. Antsiranana:** Sambava, Anjangoveratra, forêt d’Andalibe, 14°07’35”S 50°03’07”E, 115 m, 23.III.2009, *Hong-Wa* 636 (MO, P, TAN); Vohémar, Antsirabe Nord, Andravinaambo, forêt d’Antsaolatra, 14°06’24”S 49°58’39”E, 328 m, 31.I.2014, *Martial et al.* 432 (DOV, MO, P, TAN); Sambava, Anjangoveratra, Ambavala, forêt de Tsihomanaomby, 14°06’36”S 50°02’41”E, 330 m, 15.II.2014, *Martial et al.* 498 (MO, P, TAN); Masoala PN, Beankoraka, 15°57’S 50°13’E, 14.XI.1994, *Rahajaso et al.* 888 (MO, TAN); Sambava, Andratamarina, 14°25’48”S 49°50’45”E, 451 m, 19.X.2010, *Ravelonarivo & Raharivelo* 3516 (MO, P, TAN). **Prov. Toamasina:** Masoala PN, Antalavia, 15°47’S 50°02’E, 0 m, 27.XI.1994, *Rahajaso et al.* 1078 (MO).

**Fig. 44.***Noronhia orientalis* Hong-Wa.**A.** Flowering branch; **B.** Flower; **C.** Lateral view of corona; **D.** Inner side of corolla; **E.** Pistil.

[Andrianjafy 1599, TAN] Drawings: R.L. Andriamiarisoa

61. *Noronhia ovalifolia* H. Perrier in Mém. Inst. Sci. Madagascar, Sér. B, Biol. Vég. 2 : 301. 1949 (Fig. 45A).

Typus: MADAGASCAR. **Prov. Toliara:** bassin de réception de la Mananara, affluent du Mandrare, pentes occidentales des montagnes entre l'Andohahela et l'Elakelaka, Mont Apiky au-dessus de Mahamavo, 800-900 m, I-II.1934, *Humbert 13822* (holo-: P [P00418097]!; iso-: K [K000233183] image seen, P [P00418095, P00418096]!, WAG [WAG0002495] image seen).

Description *Shrubs* to 3 m tall, trunk to 3 cm diameter; young twigs cylindrical, 0.8-1.6 mm diameter, glabrous; bark medium to light gray, smooth. *Leaves* opposite, persistent; bud scales persistent; blades dark green above, yellowish below, ovate, 3.5-9.5 × 2-4.5 cm, coriaceous, glabrous, domatia absent, base rounded, margin slightly revolute, apex acuminate, the acumen 1-9 mm long, midrib flat to slightly raised above, flat below, secondary veins conspicuous mostly below, 7-10 per side, 4-13 mm apart, looping 2-5.5 mm from the margin; petiole medium to light gray, 3-7 × 1-2 mm, entirely woody, glabrous. *Flowers* solitary; pedicel 3-12 mm long, glabrous; calyx glabrous on both sides, lobes deltate to obovate, 1.5-2 × 2.1-2.6 mm; corolla pink, sometimes tinged white outside, cupuliform, 6.5-10 mm long, glabrous on both sides, the tube 4.5-8.5 mm long, lobes widely ovate, apex obtuse; corona present, 2.5-3 mm long, slightly lobed; stamens 2.8-3 mm long, anthers obovate, 1.8-2.2 mm long; pistil 2.5-2.8 mm long, stigma capitate. *Fruiting* pedicel 12-16 × 1-1.5 mm; young fruits green, reddish black when mature, subglobose to ovoid, 19-19.5 × 15-17.5 mm, surface smooth, apex flat to apiculate; dry pericarp 0.6-0.9 mm thick; endocarp woody; seed 16 × 10.5 mm.

Distribution, ecology and phenology *Noronhia ovalifolia* occurs in low- to mid-elevation transitional forests on basement rocks and alluvial deposits in and around Andohahela PN in the south (Fig. 36). It produces flowers and fruits from October to March.

Conservation status The assessment included eight collections representing eight localities and resulted in an EOO of 93 km², an AOO of 20 km², and three subpopulations representing three locations, of which two occur within a protected area (Andohahela). The subpopulation outside of the protected area occurs in an area that is now heavily degraded and has been converted into agriculture fields and pastureland, and will therefore likely experience continuing decline, potentially leading to extirpation. Therefore, *N. ovalifolia* is assigned a preliminary status of “Endangered” [EN B1ab(i, ii, iii, iv, v)+2ab(i, ii, iii, iv, v)].

Notes *Noronhia ovalifolia* can be recognized by its short petioles, ovate leaf blades with light-colored venation, and solitary flowers with a pink to orangish corolla. It differs from *N. boivinii* and *N. mangorensis* by its ovate (vs. oblong to elliptic in *N. boivinii* and oblong to ovate in *N. mangorensis*), acuminate (vs. cuspidate to mucronate and cuspidate, respectively) leaf blades, solitary (vs. fasciculate) flowers, and subglobose (vs. ovoid) fruits.

Additional specimens examined **MADAGASCAR. Prov. Toliara:** Fort-Dauphin, Ambatoabo, Evasia, Andohahela PN, parcelle 1, 24°47'10"S 46°43'33"E, 681 m, 16.I.2007, *Andriamihajarivo et al.* 1097 (MO, P, TAN); Ankoba, near E edge of Andohahela PN Park, 24°46'46"S 46°43'11"E, 600 m, 22.I.2008, *Lowry et al.* 6955 (MO, P); *ibid. loc.*, 24°47'34"S 46°41'55"E, 200 m, 24.I.2008, *Lowry et al.* 6977 (MO, P); Fort-Dauphin, Ambatoabo, forêt d'Ankoba, 24°46'56"S 46°42'14"E, 228 m, 1.III.2008, *Randrianaivo et al.* 1548 (G, MO, P, TAN); *ibid. loc.*, 24°47'12"S 46°42'25"E, 300 m, 25.II.2009, *Randrianaivo et al.* 1760 (MO, P, TAN); Amboasary, Behara, [24°36'S 46°42'E], 11.X.1958, *Réserves Naturelles 10060* (P, TEF); Italy (baie de Ranofotsy), [25°09'00"S 46°45'30"E], 0-25 m, 10.I.1963, *Service Forestier 22371* (G, P, TEF).



Fig. 45. Photographs of *Noronhia* Stadtm. ex Thouars.

A. *Noronhia ovalifolia* H. Perrier [Lowry 6977]; **B.** *Noronhia pervilleana* (Knobl.) H. Perrier [Bolliger 223].

Photos: taken by respective collectors

62. *Noronhia patricei* Hong-Wa, spec. nova (Fig. 46).

Typus: MADAGASCAR. **Prov. Toamasina:** Analanjirofo, Ambanizana, along path between Ambanizana-Andranobe, 15°38'29"S 49°57'54"E, 7 m, 25.X.2004, *Antilahimena* 2959 (holo-: MO-6615553!; iso-: G [G00341616]!, K!, P [P03532773]!, TAN!).

Diagnosis *Noronhia patricei* Hong-Wa can be distinguished from its congeners by its three-verticillate, large leaves, its fasciculate infructescences, and its large fruits characterized by a thick pericarp.

Description Trees to 11 m tall, trunk to 16 cm diameter; young twigs subquadrangular to cylindrical, 5.5-8.6 mm diameter, glabrous; bark medium gray, rugose. Leaves verticillate, persistent; bud scales persistent; blades medium green above, lighter below, lanceolate, 26-36 × 4.5-9.5 cm, very coriaceous, glabrous, domatia absent, base acute, margin flat, apex acuminate, the acumen 5-12 mm long, midrib deeply sunken above, distinctly raised below, secondary veins conspicuous, 14-20 per side, 19-40 mm apart, looping 2-7 mm from the margin; petiole medium to dark gray, 16-20 × 4-6.5 mm, entirely woody, glabrous. Flowers unseen, but infructescence thyrsoid, fasciculate. Fruiting pedicel 5-11 × 3.5-5 mm; young fruits green, yellow when mature, ovoid to oblong, 25-38 × 19.5-24 mm, surface smooth, sometimes covered with white dots, apex flat to bluntly pointed; dry pericarp 2.2-3 mm thick; endocarp woody; seed 15 × 20 mm.

Etymology This species is dedicated to Patrice Antilahimena, a botanist at the Missouri Botanical Garden in Madagascar, for collecting the type specimen and for keeping an eye out for *Noronhia* during his extensive fieldwork.

Distribution, ecology and phenology *Noronhia patricei* occurs in low-elevation humid forests and basement rocks and unconsolidated sands in the Masoala region in northeastern Madagascar (Fig. 36). It fruits from October to June.

Conservation status *Noronhia patricei* is currently known only from five collections representing five localities. The assessment resulted in an EOO of 1,023 km², an AOO of 20 km², and four subpopulations representing four locations, of which two occur within a protected area (Masoala). With decline in habitat quality, habitat loss and reduction of the number of mature individuals likely to continue outside of the protected area as a result of wood harvesting and land conversion, the small EOO and AOO as well as the small number of locations, *N. patricei* is assigned a preliminary status of "Endangered" [EN B1ab(i,ii,iii,iv,v)+2ab(i,ii,iii,iv,v)].



Fig. 46.

Noronhia patricei Hong-Wa.

A. Branch; **B.** Fruit with pedicel; **C.** Fruit.

[Antilahimena 2959, TAN] Drawings: R.L. Andriamiarisoa

Notes *Noronhia patricei* is similar to *N. crassiramosa* but can be distinguished by its entirely verticillate (vs. verticillate only at the tips of the branches), lanceolate (vs. oblong) leaves, and its ovoid to oblong (vs. subglobose) fruits with a flat (vs. apiculate) apex. Its three-verticillate, large leaves, fasciculate infructescences, and large fruits characterized by a thick pericarp allow for the unambiguous identification of this species.

Paratypes **MADAGASCAR.** **Prov. Antsiranana:** Maroantsetra, Anjahana, Ambanizana, 15°37'03"S 49°58'36"E, 200 m, 11.VI.2002, *Antilahimena 1090* (G, MO, P); Antalaha, Ampanavoana, forêt de Faho, [15°41'S 50°21'E], 24.IV.1951, *Service Forestier 87R140* (TEF). **Prov. Toamasina:** Ambatondradama (env. 10 km au NE d'Ankovona), Navana, 15°17'13"S 50°01'10"E, 500 m, 27.IX-6.X.1997, *Ralimanana et al. 111* (MO, P, TAN); Maroantsetra, Anjahana, Ambanizana, Tampolo (Masoala), 15°43'45"S 49°57'38"E, 10 m, 19.X.2001, *Randrianaivo 710* (MO, P, TAN).

63. *Noronhia peracuminata* H. Perrier in Mém. Inst. Sci. Madagascar, Sér. B, Biol. Vég. 2: 299. 1949.

Typus: MADAGASCAR. **Prov. Antsiranana:** base des montagnes bordant la vallée du Sambirano, [14°19'00"S 48°17'30"E], VIII.1907, *Perrier de la Bâthie* 8823 (holo-: P [P00418094]!; iso-: P [P00418093]!).

Description

Trees to 9 m tall, trunk to 15 cm diameter; young twigs cylindrical, 0.6-0.8 mm diameter, glabrous; bark medium gray, smooth. *Leaves* opposite, persistent; bud scales persistent; blades medium green, lighter below, lanceolate, 6.5-7.5 × 2 cm, chartaceous, glabrous, domatia absent, base acute to attenuate, margin slightly undulate, apex acuminate, the acumens 14-19 mm long, midrib slightly sunken above, flat to raised below, secondary veins conspicuous, 7-8 per side, 8-9.5 mm apart, looping 1.5-2.2 mm from the margin; petiole light gray to brownish, 4-6 × 0.7-0.8 mm, partially to entirely woody, glabrous. *Flowers* geminate, sometimes solitary; pedicel 5-12 mm long, glabrous; calyx glabrous on both sides, lobes triangular, 1-1.5 × 1 mm; corolla red tinged yellowish, cupuliform, 5 mm long, glabrous on both sides, the tube 3.5 mm long, lobes ovate, apex acute; corona present, 2 mm long, undivided; stamens 2 mm long, anthers obovate, 1.6 mm long; pistil 2.2 mm long, stigma capitate. *Fruiting* pedicel 13-20 0.8-1.2 mm; young fruits green, brownish when mature, ovoid, 18 × 8 mm, surface smooth, apex apiculate to rostrate, the rostrum flattened, apiculate; dry pericarp 0.3 mm thick; endocarp crustaceous; seed 8 × 5 mm.

Distribution, ecology and phenology

Noronhia peracuminata occurs in low- to mid-elevation riparian and rupicolous vegetation on sandstones in the Sambirano region in northwestern Madagascar (Fig. 36). It has been collected in flowers and fruits in August and November.

Conservation status

Noronhia peracuminata is currently known only from two collections representing two localities. With an AOO of 8 km², two subpopulations representing two locations, of which one occurs within a protected area (Manongarivo), and a projected continuing decline in habitat quality and number of mature individuals as well as habitat loss resulting from forest exploitation and land conversion, *N. peracuminata* is assigned a preliminary status of "Endangered" [EN B1ab(i,ii,iii,iv,v)+2ab(i,ii,iii,iv,v)].

Notes

Noronhia peracuminata can be recognized by its chartaceous leaf blades with a long acumens, geminate, sometimes solitary, red flowers, and apiculate, crustaceous fruits. It differs from *N. rostrata* by its woody (vs. non-woody) petioles, red (vs. white) flowers, and apiculate (vs. rostrate) fruits.

Additional specimens examined

MADAGASCAR. **Prov. Antsiranana:** Ambahatra (cours moyen), Manongarivo RS, 13°55'43"S 48°27'19"E, 230 m, 19.XI.2000, *Wohlhauser* 327 (G, MO, P).

64. *Noronhia perrieriana* Hong-Wa, spec. nova (Fig. 47).

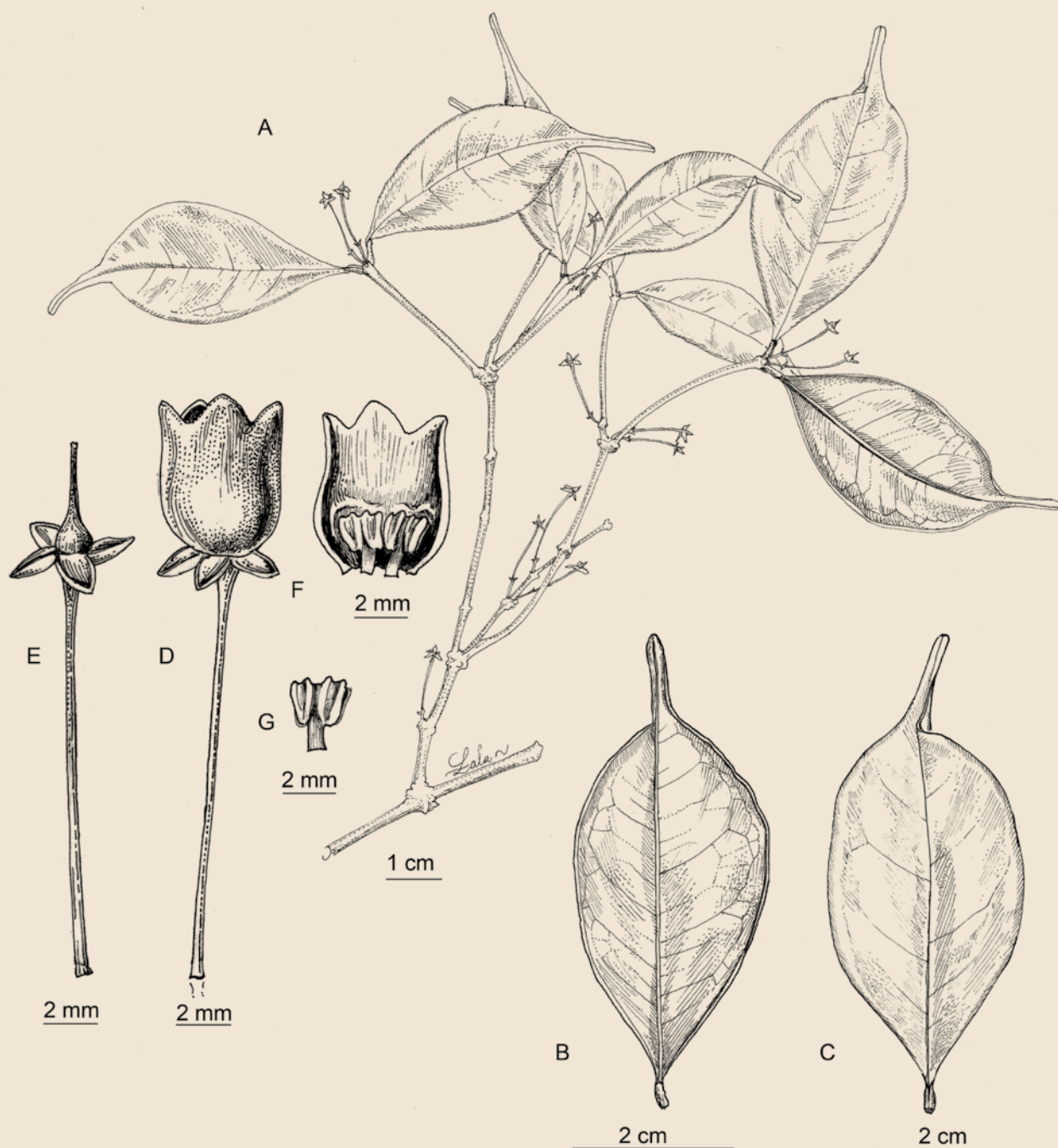
Typus: MADAGASCAR. **Prov. Fianarantsoa:** Vatovavy-Fitovinany, Ranomafana PN, c. 7 km W of town of Ranomafana, 21°16'S 47°25'E, 950-1000 m, 17.V.1990, Lowry 4534 (holo-: MO-3850549!; iso-: P [P03532690]!, TAN!).

Diagnosis *Noronhia perrieriana* Hong-Wa can be distinguished from other species of the genus by its chartaceous, ovate leaf blades, with long acumen, its long pedicels, its fasciculate pinkish flowers, and its subglobose fruits without a distinct apex.

Description Small trees to 6 m tall, trunk to 10 cm diameter; young twigs cylindrical, 0.7-1.8 mm diameter, glabrous; bark light gray to whitish, smooth. Leaves opposite, persistent; bud scales rarely persistent; blades medium green above, lighter below, ovate, 5.5-8.5 × 1.7-3 cm, chartaceous, glabrous, domatia absent, base acute, margin flat, apex acuminate, the acumen 8-20 mm long, midrib flat above, slightly raised below, secondary veins conspicuous only below, 6-8 per side, 6-14 mm apart, looping 1.5-3.2 mm from the margin; petiole light gray to whitish, 4-6 × 0.7-1 mm, entirely woody, glabrous. Flowers fasciculate; pedicel 8-21 mm long, sparsely pubescent; calyx sparsely pubescent outside, glabrous inside, lobes triangular, 1.5-1.8 × 1.5-2.4 mm; corolla pink to purplish outside, cream inside, urceolate, 4-8.5 mm long, glabrous on both sides, the tube 2.5-5 mm long, lobes deltate, apex obtuse; corona absent or vestigial, 0-1 mm long; stamens 1.8-2.4 mm long, anthers obovate, 1.4-1.6 mm long; pistil 2.2-2.8 mm long, stigma capitate. Fruiting pedicel 5-20 × 0.6-1.2 mm; young fruits green, purplish black when mature, subglobose, 15.5-17 × 16-19 mm, surface smooth, apex flat, style persistent; dry pericarp 1.1-1.3 mm thick; endocarp woody; seed 8.5-9.5 × 9-12 mm.

Etymology This name honors Joseph Marie Henry Alfred de Perrier de la Bâthie (1873-1958), who initiated the taxonomic study of *Noronhia* and much of the Malagasy flora. He published numerous volumes on the flora and vegetation of the island, including prominent works such as "La végétation malgache" (1921), "Biogéographie des plantes de Madagascar" (1936), "Flore de Madagascar et des Comores" (1946-1952: 76 families out of the 190 originally recognized). He also made a rich collection of c. 20,000 Malagasy plants that included many new species, and contributed to the creation of the first ten protected areas in Madagascar (HUMBERT, 1958; LÉANDRI, 1962).

Distribution, ecology and phenology *Noronhia perrieriana* occurs in mid- to high-elevation humid forests in Ranomafana in central Madagascar (Fig. 36). It produces flowers and fruits from December to May.

**Fig. 47.***Noronhia perrieriana* Hong-Wa.**A.** Flowering branch; **B.** Abaxial side of leaf blade; **C.** Adaxial side of leaf blade; **D.** Flower; **E.** Pistil; **F.** Inner side of corolla; **G.** Stamen.

[Lowry 4534, TAN] Drawings: R.L. Andriamiarisoa

- Conservation status** Currently known from four collections representing three localities, *Noronhia perrieriana* occurs only within the protected area of Ranomafana PN, at mid- to high-elevation. Despite a very restricted range (AOO = 8 km²) and a single location, *N. perrieriana* can be assigned a preliminary status of “Least Concern” because of its exclusive occurrence within a protected area, where decline is projected to be minimal.
- Notes** *Noronhia perrieriana* resembles *N. brevituba*, from which it differs by its woody (vs. non-woody) petioles, ovate (vs. elliptic to obovate), acuminate (vs. cuspidate) leaf blades, fasciculate flowers (vs. thyrsoid inflorescences), urceolate (vs. campanulate to rotate), purplish-pink tinged cream (vs. yellow tinged orange) flowers, and subglobose (vs. ovoid) fruits, with a flat (vs. apiculate) apex. Chartaceous, ovate leaf blades, with long acumen, long pedicels, fasciculate pinkish flowers, and subglobose fruits without a distinct apex characterize this species.
- Paratypes** **MADAGASCAR. Prov. Fianarantsoa:** Ifanadiana, Ranomafana PN, 21°16'S 47°26'E, 980 m, 5.XII.1994, *Kotozafy & Rasabo* 848 (K, MO, P); *ibid. loc.*, Talatakely, 21°16'S 47°25'E, 800-1000 m, 18.V.1992, *Rakoto* 36 (MO); *ibid. loc.*, Parcelle 3, 21°15'30"S 47°25'00"E, 950-1150 m, 14.IV.1993, *Turk* 406 (K, MO, P, TAN).

65. *Noronhia pervilleana* (Knobl.) H. Perrier in Mém. Inst. Sci. Madagascar, Sér. B, Biol. Vég. 2: 299.1949 (Fig. 45B, 48).

≡ *Olea pervilleana* Knobl. in Notizbl. Bot. Gart. Berlin 11: 1027. 1934.

Lectotypus (designated here): **MADAGASCAR. Prov. Antsiranana:** Ile Nossi Bé, 24.I.1841, *Pervillé* 447 (L [L0005393] image seen; isolecto-: K [K000233182] image seen, P [P03559304, P03559305]!). **Syntypi:** **MADAGASCAR. Prov. Antsiranana:** Ile Nossi Bé, I.1841, *Pervillé* 281 (P [P03559290, P03559291, P03559292, P03559293]!); *ibid. loc.*, I.1841, *Pervillé* 459 (P not found).

Description

Trees to 18 m tall, trunk to 60 cm diameter; young twigs cylindrical to slightly flattened, 0.7-2.6 mm diameter, glabrous; bark medium gray to brown, smooth to slightly rugose, sometimes with scattered lenticels. *Leaves* opposite, persistent; bud scales persistent; blades medium green glossy above, lighter below, lanceolate to elliptic, 5-17 × 3-6.5 cm, coriaceous, glabrous, domatia common, base acute to attenuate, margin undulate, apex acuminate, the acumen 2-22 mm long, midrib slightly sunken above, distinctly raised below, secondary veins conspicuous, 6-14 per side, 6-22 mm apart, looping 1.5-6 mm from the margin; petiole yellow tinged red, 5-21 × 0.8-2.6 mm, partially woody, glabrous. *Thyrses* geminate, multiflorous, compact; peduncle 6-11 mm long, moderately pubescent; pedicel 2.5-4.5 mm long, moderately pubescent; calyx moderately pubescent outside, glabrous inside, lobes deltate, 0.7-1.7 × 1-1.5 mm; corolla white, sometimes tinged purplish at the base, rotate, 4-5 mm long, glabrous on both sides, the tube 1-3 mm long, lobes ovate, apex rounded; corona present, 1.5-1.8 mm long, undivided; stamens 1.5-1.7 mm long, stamens obovate, 0.9-1 mm long; pistil 1.8-2 mm long, stigma capitate. *Fruiting pedicel* 2-13 × 0.6-2.9 mm; young fruits green, dark red somewhat glaucous when mature, ovoid, 10.5-23.5 × 7-18 mm, surface smooth, sometimes covered with white dots, apex rostrate, the rostrum flattened, ridged, truncate; dry pericarp 0.5-2 mm thick; endocarp woody; seed 7-15 × 4.5-9.5 mm.

Distribution, ecology and phenology

Noronhia pervilleana occurs in low- to high-elevation dry to humid forests from around Anivorano-Nord in the north to around Bemaraha in the west (Fig. 49). It produces flowers and fruits year-round.

Conservation status

There were 40 collections representing 30 localities available for analysis, which resulted in an EOO of 114,822 km², an AOO of 112 km², and 21 subpopulations representing 20 locations, of which 11 occur within protected areas (Andavakoera-Ambohipiraka, Ankarana, Bemaraha, Galoko, Lokobe, Loky-Manambato,

Manongarivo, Marojejy, and Tsaratanana). With a large EOO, an actual AOO that likely exceeds 2,000 km², and several locations, half of which are in protected areas, *N. pervilleana* is assigned a preliminary status of “Least Concern”.

Notes *Noronhia pervilleana* can be recognized by its partially woody petiole, glossy leaf blades, with undulate margins, rotate, white corolla, and rostrate fruits. It differs from *N. marojejyensis*, as discussed under that species, mainly by the texture of their petioles, the shape of their leaves, flowers and fruits, the color of their corolla, and the apex of their fruits.

This species was based on three syntypes (*Pervillé* 281, 447 and 459), none of which is extant at the herbarium in Berlin (B). Although no holotype was designated in the protologue, a sheet of *Pervillé* 447 in Berlin was apparently annotated as the type, according to a handwritten note on the sheet at L ([L0005393])(Fig. 48). The annotation may not be that of Knoblauch himself, but it is nonetheless very likely that this specimen was part of the original material he used for the species description. Since it is also a more complete specimen and is represented by more duplicates than *Pervillé* 281, it has therefore been chosen as the lectotype. There is some confusion regarding *Pervillé* 459, which has been annotated as the type in some herbaria. However, this specimen is actually numbered *Pervillé* 459ter or even *Pervillé* 459 quater (459 4ter [sic]), with duplicates distributed from Paris to a dozen herbaria long after the species was described. Thus, it is by no means certain that Knoblauch saw specimens of *Pervillé* 459ter and 459 4ter, or that the material numbered *Pervillé* 459, 459ter and 459 4ter is all the same thing. Given these uncertainties, the choice of *Pervillé* 447 as the lectotype seems appropriate.

Additional specimens examined

MADAGASCAR. Prov. Antsiranana: Nosy Be, Lokobe RNI, 13°25'15"S 48°18'15"E, 0-20 m, 3.III.1994, *Antilahimena* 34 (P, TAN); Ambanja, Ambato FC, 13°26'42"S, 8°33'18"E, 21.XI.1996, *Antilahimena et al.* 328 (MO, P, TAN); Antsahabe, Tsaratanana RNI, 13°52'03"S 48°50'43"E, 557 m, 13.XI.2001, *Antilahimena* 795 (G, MO, TAN); *ibid. loc.*, 13°51'53"S 48°50'48"E, 550 m, 17.XI.2001, *Birkinshaw* 1101 (G, MO, TAN); Anivorano-Nord, Andrafiabe, Mont Antsahabe, 12°54'59"S 49°17'38"E, 502 m, 3.VII.2010, *Hong-Wa* 718 (MO, TAN); Vallée de l'Andalangy, [14°18'S 49°43'E], 200-800 m, 12-14.XI.1950, *Humbert & Capuron* 24168 (G, MO, P); Vohémar, Daraina, 13°12'S 49°46'E, 200-250 m, 19.XII.1989, *McPherson* 14716 (K, MO, P, TAN); north of the island, I.1841, *Pervillé* 459 ter (P); *ibid. loc.*, I.1841, *Pervillé* 459 4ter (B, BR, G, HK, K, L, MO, NY, P, PRE, S, TAN, TEF, WAG); Nossi Be, I.1841, *Pervillé* 503 (P); Manongarivo RS, Ankaramibe, Bekolosy, 14°03'05"S 48°17'07"E, 600-800 m, 10.XII.1993, *Rakotomalala* 75 (MO, P); Daraina, forêt d'Antsaharaingy, 13°09'40"S 49°38'33"E, 470 m, 20.XII.2004, *Ranirison & Nusbaumer* 867 (Daraina, G, K, MO, P, TEF); Antongodriha, Marojejy PN, 14°20'S 49°43'E, 720-800 m, 19-28.X.1994, *Rasoavimbahoaka* 385 (MO, P, TAN); Tsaratanana RNI, Mandrizavona, Antsaharatsy, 13°48'35"S 48°47'36"E, 400-1000 m, 13.IV.2000, *Ratovoson* 208 (G, MO, P, TAN); Ambanja, Marovato, [13°49'S 48°44'E], 24.IX.1950, *Réserves Naturelles* 2233 (MO,

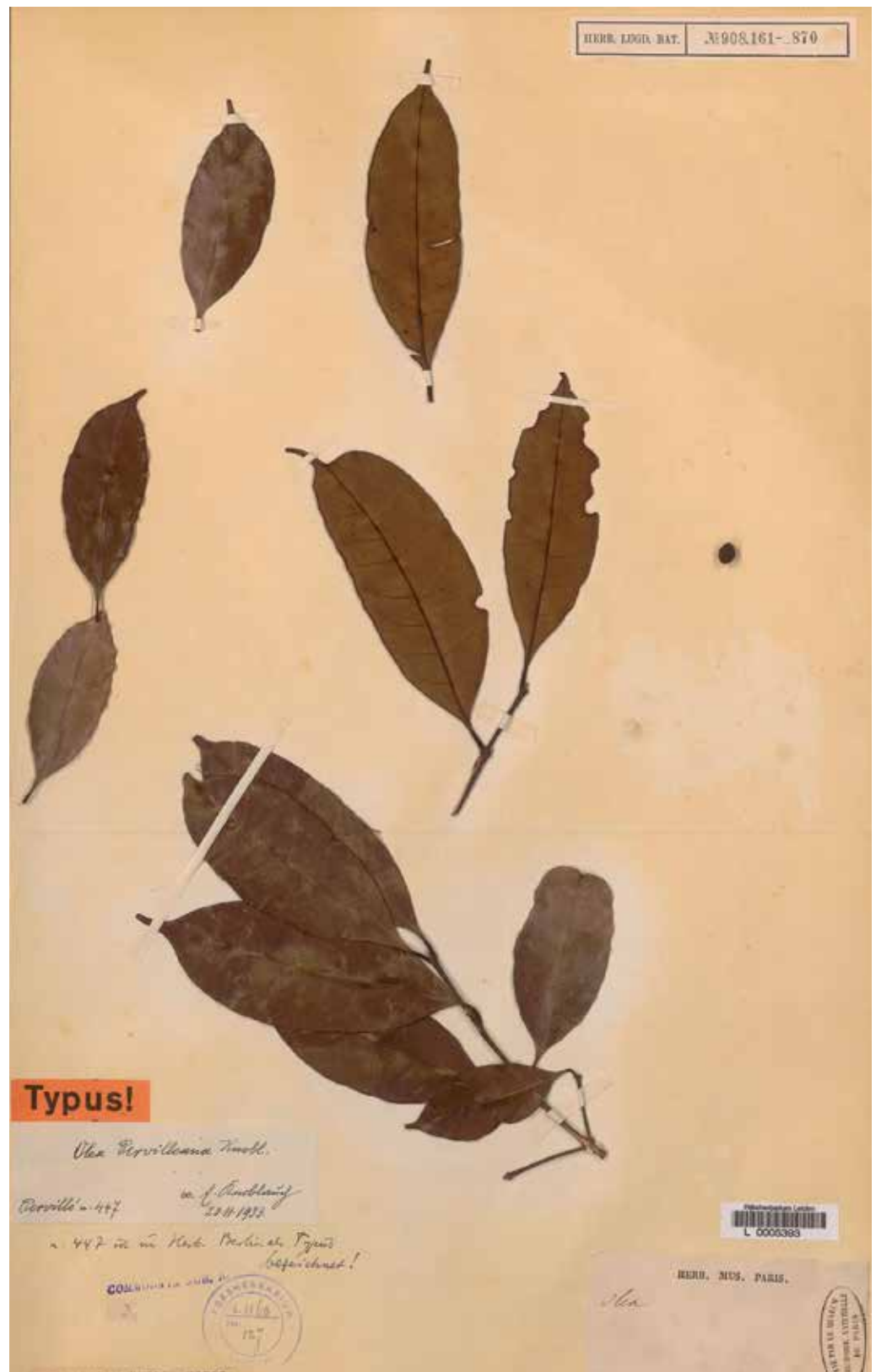


Fig. 48.

Lectotype of
Noronhia pervilleana
(Knobl.) H. Perrier

[Perville 447, L.]
[© Naturalis Biodiversity Center, Leiden.
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P); Ambanja, [13°58'S 48°50'E], 3.XII.1955, *Réserves Naturelles* 7374 (P, TEF); Antongondriha, [14°18'S 49°33'E], 16.IV.1956, *Réserves Naturelles* 7873 (G, P); c. 10 km S of Anivorano-Nord, 12°50'10"S 49°13'42"E, 350-375 m, 10.XI.2006, *Rogers et al.* 1164 (G, MO, P, TAN); 10 km from Anivorano-Nord, 12°44'S 49°14'E, 29.V.1987, *Seigler* 12867 (MO, P, TAN). **Prov. Mahajanga:** Beanka, Sarodrano, 18°03'20"S 44°31'46"E, 453 m, 20.II.2012, *Bolliger et al.* 223 (G, MO); Bongolava, près d'Ankavandra, [18°16'S 45°16'E], 15.VII.1930, *Decary* 7958 (P); Beanka, Kimanambolo, 18°06'16"S 44°33'15"E, 230 m, 3.XII.2012, *Gautier* 5924 (G, K, MO, P, TEF); *ibid. loc.*, Sarodrano, 18°04'20"S 44°31'24"E, 240 m, 24.II.2012, *Hanitrarivo et al.* 199 (G, K, MO, P, TEF); *ibid. loc.*, 18°03'43"S 44°31'21"E, 303 m, 8.XII.2011, *Nusbaumer et al.* 3031 (G, K, MO, P, TEF); Kimanambolo, Belitsaka, 18°02'09"S 44°19'28"E, 18.X.2009, *Rakotonasolo et al.* 1394 (MO, P, TAN); 22 km SSE Antsaholova, 18°51'S 44°41'E, 29.III.1993, *Villiers et al.* 4974 (MO, P).

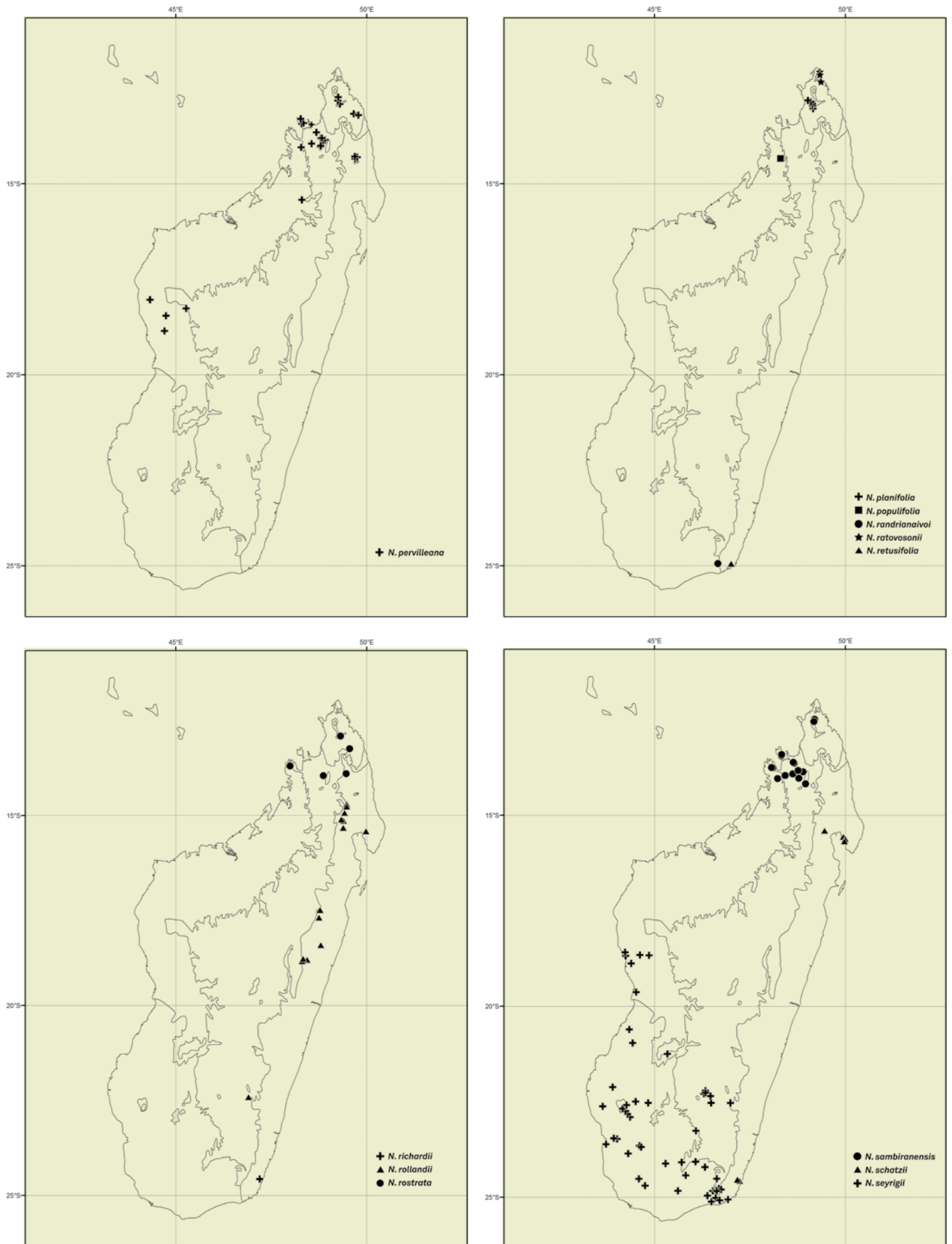


Fig. 49. Distribution maps of species of *Noronhia* Stadtm. ex Thouars. *N. pervilleana* (Knobl.) H. Perrier to *N. seyrigii* H. Perrier.

66. *Noronhia planifolia* H. Perrier ex Hong-Wa, **spec. nova** (Fig. 50).

- *Linociera incurvifolia* var. *planifolia* H. Perrier in Mém. Inst. Sci. Madagascar, Sér. B, Biol. Vég. 2 : 280. 1949 [nom. inval.].
- *Noronhia incurvifolia* var. *planifolia* (H. Perrier) Hong-Wa & Besnard in Mol. Phylogenet. Evol. 67 : 376. 2013 [nom. inval.].

Typus : MADAGASCAR. **Prov. Antsiranana :** Collines et plateaux calcaires de l'Ankarana, à l'E et NE d'Ambondrofe, [12°54'S 49°08'E], 300-350 m, XII.1937-I.1938, *Humbert 18966* (holo- : P [P03559156]!; iso- : K [K000233204] image seen, P [P03559158]!, WAG [WAG0004663] image seen).

Diagnosis *Noronhia planifolia* H. Perrier ex Hong-Wa can be distinguished from other members of the genus by its coriaceous, widely oblong leaf blades, bearing abundant domatia, its rostellate fruits, and crustaceous endocarp.

Description Trees to 10 m tall; young twigs cylindrical, 0.6-1.6 mm diameter, glabrous; bark medium gray, slightly rugose. Leaves opposite, persistent; bud scales deciduous; blades medium green above, lighter below, broadly oblong, 4-9 × 2-5.5 cm, coriaceous, glabrous, domatia abundant, base attenuate, margin flat, apex cuspidate, the cusp 3-10 mm long, midrib slightly sunken above, distinctly raised below, secondary veins conspicuous, 5-9 per side, 5-15 mm apart, looping 1-5 mm from the margin; petiole light gray, 4-15 × 0.8-1.6 mm, partially woody, glabrous. Flowers unseen, but infructescence thyrsoid. Fruiting pedicel 4-13 × 1.1-2.2 mm; young fruits green, brownish when mature, ovoid, 8.5-19 × 8.5-15 mm, surface smooth, apex flat to rostellate, with the persistent style; dry pericarp 0.5-0.8 mm thick; endocarp crustaceous; seed 6.5-12 × 5-10 mm.

Etymology The specific epithet refers to the flat leaf blades of this species as opposed to the folded leaves of *Noronhia incurvifolia*, within which *N. planifolia* was originally considered to be a variety.

Distribution, ecology and phenology *Noronhia planifolia* occurs in low-elevation dry forests at Ankarana in the north (Fig. 49). It fruits from October to May.

Conservation status *Noronhia planifolia* is currently known only from six collections representing six localities. The estimates indicated an EOO of 111 km², an AOO of 20 km², and five sub-populations representing five locations, of which one occurs within a protected area (Ankarana). Conversion of forested areas into agricultural field and pastureland and

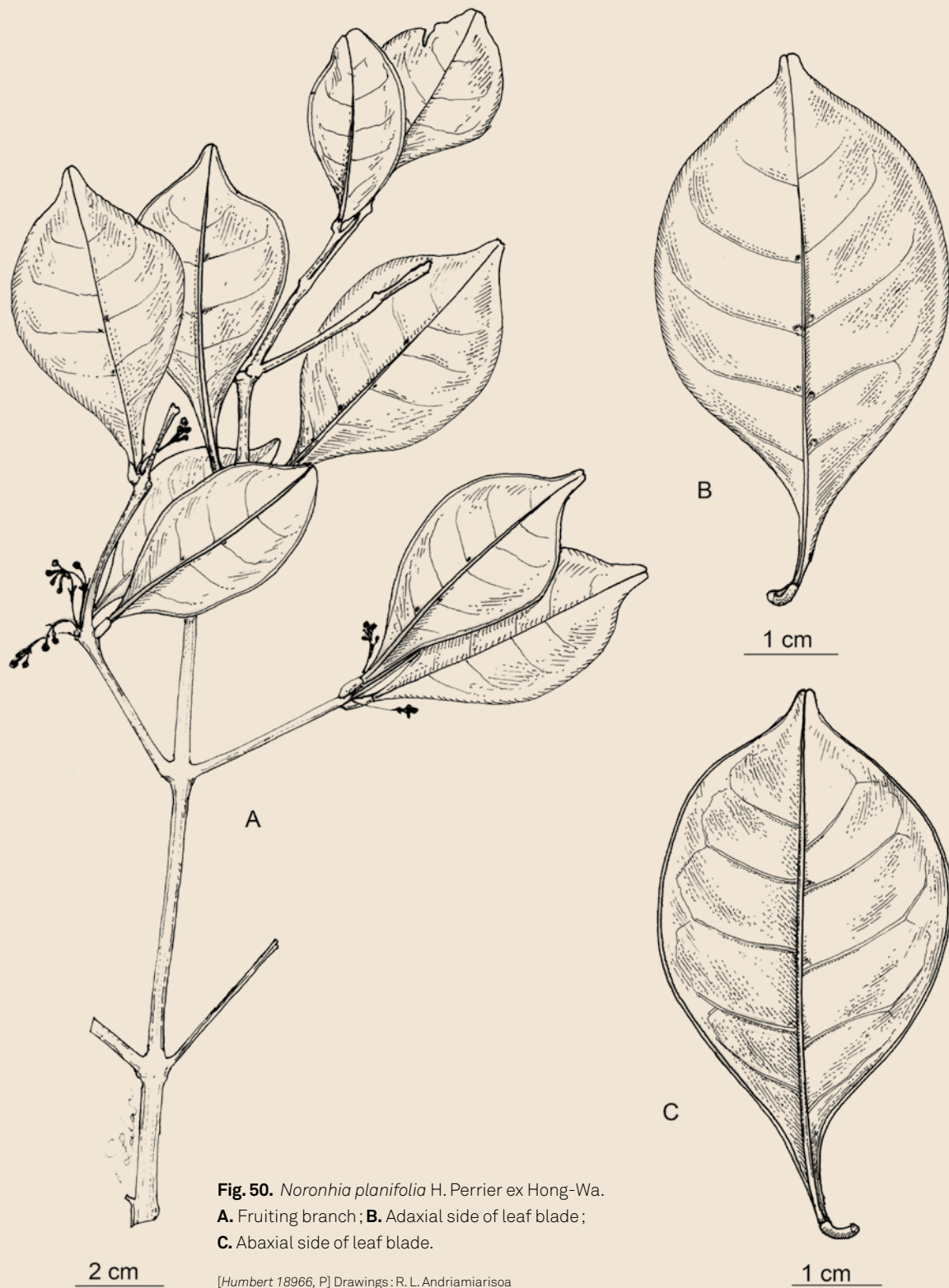


Fig. 50. *Noronhia planifolia* H. Perrier ex Hong-Wa.

A. Fruiting branch; **B.** Adaxial side of leaf blade;
C. Abaxial side of leaf blade.

[Humbert 18966, P] Drawings: R. L. Andriamiarisoa

exploitation of forest products, resulting in habitat loss and degradation and loss of mature individuals, impact the subpopulations outside of protected areas. Therefore, *N. planifolia* is assigned a preliminary status of “Endangered” [EN B1ab(i,ii,iii,iv,v)+2ab (i,ii,iii,iv,v)].

Notes *Noronhia planifolia*, originally recognized as a variety of *N. incurvifolia*, differs from it by its woody (vs. non-woody) petioles, flat (vs. folded and curved) leaf blades, and crustaceous (vs. woody), rostellate (vs. rostrate) fruits. A corona may also be present in this species although no flowering material has so far been collected. *Noronhia planifolia* also resembles *N. cuspidata*, from which it differs by having broadly oblong (vs. broadly elliptic), coriaceous (vs. subcoriaceous) leaf blades, longer petioles (15 mm vs. 9 mm), rostellate (vs. apiculate) fruit, and crustaceous (vs. subcrustaceous) endocarp. PERRIER DE LA BATHIE’S (1949) description of *Linociera incurvifolia* var. *planifolia* is invalid because he did not provide a Latin diagnosis (Art. 39.1 ; McNEILL et al., 2012). Consequently, this entity, which is recognized here as a distinct species, is described here as new, retaining the original epithet and type collection.

Paratypes **MADAGASCAR. Prov. Antsiranana:** Ankarana RS, [12°49’S 49°01’E], 50-409 m, 12-20.X.1993, *Andrianantoanina* 383 (K, MO, TAN); *ibid. loc.*, à l’W de Mahamasina, 12°57’25”S 49°07’35”E, 161 m, 31.V.1995, *Andrianantoanina et al.* 801 (G, K, MO, P, TAN); *ibid. loc.*, tsingy close to Campement des Anglais, 12°50’47”S 49°06’18”E, 82 m, 25.V.1999, *De Block et al.* 1012 (BR, MO, P, TAN); *ibid. loc.*, [12°58’S 49°08’E], X.1964, *Morat* 891 (P, TAN); *ibid. loc.*, 12°58’S 49°08’E, 50 m, 15.VI.1995, *Razafimandimbison & Andrianantoanina* 98 (G, K, MO, P); Ankara, jardin botanique 8, [12°49’S 49°01’E], 50-409 m, 24.VII.1954, *Service Forestier* 10423 (MO, P, TEF).

67. *Noronhia populifolia* H. Perrier in Mém. Inst. Sci. Madagascar, Sér. B, Biol. Vég. 2 : 298. 1949 (Fig. 51).

Typus: MADAGASCAR. **Prov. Antsiranana:** Sambirano, bord de l'Andranomalaza, [14°19'00"S 48°17'30"E], VIII.1907, *Perrier de la Bâthie* 8825 (holo-: P [P00418101]!).

Description *Trees* to 16 m tall; young twigs cylindrical, 2-2.5 mm diameter, glabrous; bark medium to light gray, smooth to slightly rugose. *Leaves* opposite, persistent; bud scales persistent; blades light green, oblong to ovate, 10.5-22 × 5.5-8 cm, subcoriaceous, glabrous, domatia absent, base rounded, margin flat to undulate, apex acuminate, the acumen 13-36 mm long, midrib slightly sunken above, raised below, secondary veins conspicuous, 9-14 per side, 13-16 mm apart, looping 3-4 mm from the margin; petiole yellowish to brown, 10-16 × 1.9-2.6 mm, not woody, glabrous. *Thyrse*s geminate to fasciculate, pauciflorous, compact; peduncle 8-11 mm long, moderately pubescent; pedicel 4-8 mm long, moderately pubescent; calyx moderately pubescent outside, glabrous inside, lobes triangular, 1-2.5 × 1.4-2 mm; corolla pink, cupuliform, 5-5.5 mm long, glabrous on both sides, the tube 2.5-3 mm long, lobes widely ovate; corona present, 1.7-2 mm long, undivided; stamens 2-2.5 mm long, stamens widely obovate, 1.5-1.6 mm long; pistil 2.2-2.5 mm long, stigma capitate. *Fruiting* pedicel 5 × 3 mm; young fruits green, blackish when mature, oblong to subglobose, 28.5-35 × 24-30 mm, surface verrucose, apex apiculate; dry pericarp 1.7-2.2 mm thick; endocarp woody; seed 25 × 23 mm.

Distribution, ecology and phenology *Noronhia populifolia* occurs in mid-elevation humid forests and sandstones in the Sambirano region in the northwest (Fig. 49). It has been collected in flowers and fruits in October.

Conservation status With just a single collection made in 1907 from an area that is not protected and that has been gradually degraded as a result of agriculture and wood harvesting, *N. populifolia* is assigned a preliminary status of "Critically Endangered", and could possibly be extinct [CR(PE) B2(iii)].

Notes *Noronhia populifolia* can be recognized by its non-woody petiole, broadly ovate leaf blades with a long apex, somewhat compact inflorescences bearing pink flowers, and large, verrucose fruits with a thick pericarp. It differs from *N. pervilleana* by its non-woody (vs. woody) petioles, cupuliform (vs. rotate), pink (vs. white) flowers, and oblong to subglobose (vs. ovoid), verrucose (vs. smooth to punctate) fruits. This species is known only from the type specimen, collected over a century ago close to a current protected area (Manongarivo). Despite numerous botanical explorations in the surrounding areas over the last five decades, no other material is available, suggesting perhaps a very small and restricted population or that the species is now extinct.



Fig. 51.
Holotype of
Noronhia populifolia
H. Perrier.

[Perrier de la Bâthie 8825, P]
[© Muséum national d'Histoire naturelle,
Paris. Reproduced with permission.]

68. *Noronhia randrianaivoi* Hong-Wa, spec. nova (Fig. 52, 53).

Typus: MADAGASCAR. **Prov. Toliara:** Anosy, Fort-Dauphin, Ankarara, Tsimelaky, à 6 km à l'E du gite (bureau de l'ANGAP), 24°56'37"S 46°39'10"E, 227 m, 4.III.2008, *Randrianaivo et al.* 1564 (holo-: MO-6615567!; iso-: G [G00341626]!, P, TAN).

Diagnosis *Noronhia randrianaivoi* Hong-Wa can be distinguished from other congeneric species by its short, non-woody petioles, its ovate leaves, its long, diffuse inflorescences, with cupuliform, red flowers.

Description *Shrubs*; young twigs cylindrical, 0.7-0.8 mm diameter, glabrous; bark medium gray, smooth. *Leaves* opposite, persistent; bud scales deciduous; blades dark green above, lighter below, ovate, 4-6.5 × 2-3 cm, coriaceous, glabrous, domatia absent, base cordate, margin slightly revolute, apex acuminate, the acumen 3-4 mm long, midrib flat above, slightly raised below, secondary veins conspicuous mostly above, 6-8 per side, 5-10 mm apart, looping 2-3 mm from the margin; petiole green, 2 × 1-1.6 mm, not woody, glabrous. *Thyrse* solitary, pauciflorous, diffuse; peduncle 11-21 mm long, glabrous; pedicel 8-11 mm long, glabrous; calyx sparsely pubescent outside, glabrous inside, lobes triangular, 1-1.5 × 1-1.3 mm; corolla red, cupuliform, 5-7 mm long, glabrous on both sides, the tube 2-3 mm long, widely ovate, apex acute; corona present, 1.5 mm long, lobed; stamens 2 mm long, anthers widely oblong, 1.5 mm long; pistil 2.8 mm long, stigma capitate to bilobed. *Fruits* unseen.

Etymology This name honors Richard Randrianaivo, a botanist at the Missouri Botanical Garden in Madagascar, for collecting the type specimen and for contributing to the knowledge of the Malagasy flora.

Distribution, ecology and phenology *Noronhia randrianaivoi* occurs in mid-elevation transitional forests and basement rocks in Andohahela PN in southern Madagascar (Fig. 49). It has been collected in flowers in March.

Conservation status *Noronhia randrianaivoi* is currently known only from a single collection made outside a protected area, where decline in habitat quality resulting from forest exploitation continues. With an AOO of just 4 km², a single location and projected continuing decline, *N. randrianaivoi* is assigned a preliminary status of "Critically Endangered" [CR B2(iii)].

Notes *Noronhia randrianaivoi* is similar to *N. ovalifolia*, but can be distinguished by its non-woody (vs. woody) petioles, thyrseoid inflorescences (vs. solitary flowers), and red (vs. pink) corolla. Distinguishing features of this species include short, non-woody petioles, ovate leaf blades, long, diffuse inflorescences, and cupuliform, red flowers.

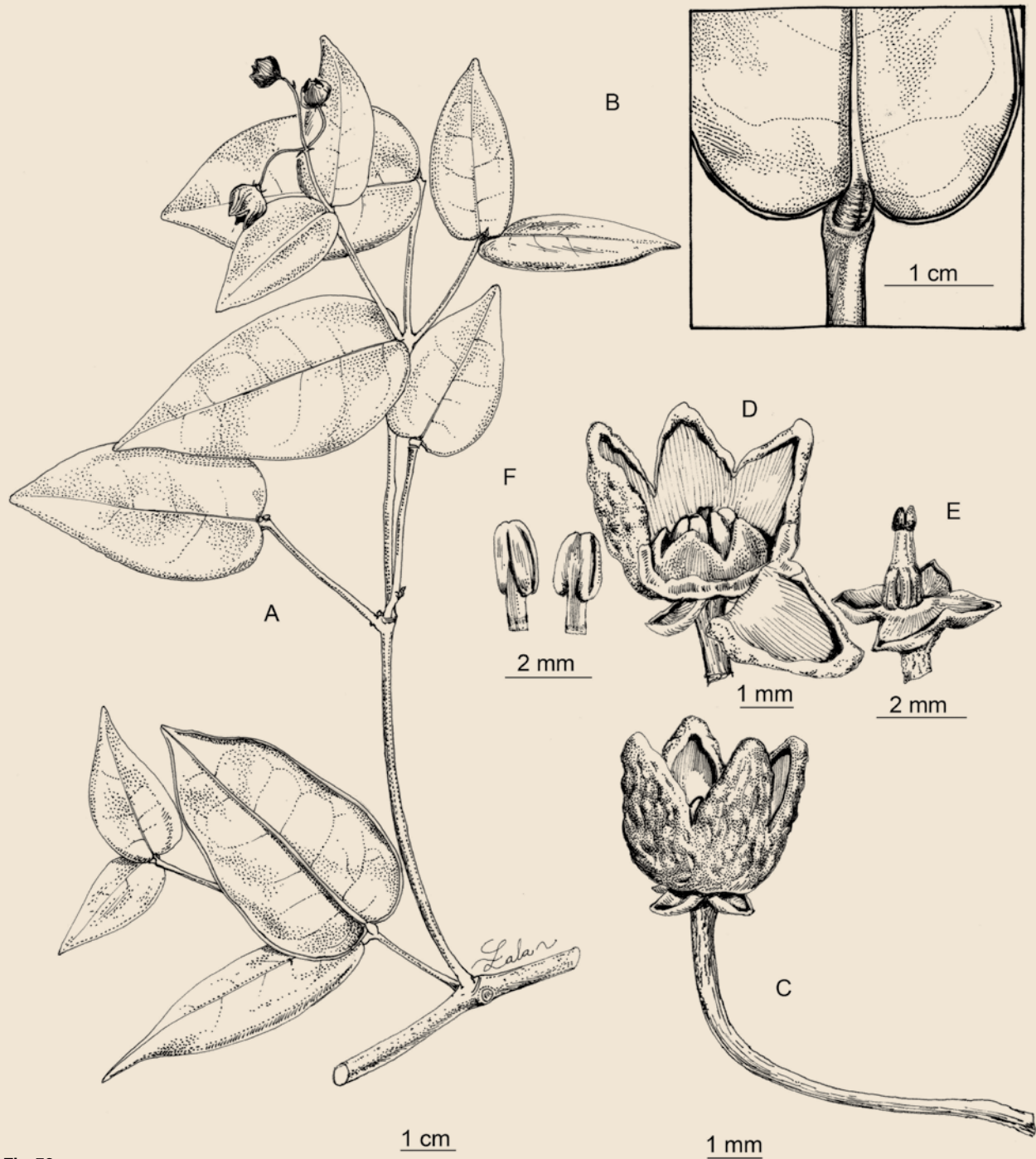
**Fig. 52.***Noronhia randrianaivoi* Hong-Wa.**A.** Flowering branch; **B.** Abaxial side of leaf blade; **C.** Flower; **D.** Lateral view of corona; **E.** Pistil; **F.** Stamen.[*Randrianaivo* 1564, TAN] Drawings: R. L. Andriamiarisoa



Fig. 53. *Noronhia randrianaivoi* Hong-Wa [Randrianaivo 1564].

Photo : F. Ratovoson

69. *Noronhia ratovosonii* Hong-Wa, spec. nova (Fig. 54).

Typus: MADAGASCAR. **Prov. Antsiranana:** DIANA, Andranovondronina, Anjiabe, forêt de Belamoty, à 3 km au NE, 12°06'09"S 49°19'34"E, 85 m, 10.XI.2006, *Ratovoson et al.* 1153 (holo-: MO-6615566!; iso-: CNARP, G, P [P04254202] image seen, TAN).

Diagnosis *Noronhia ratovosonii* Hong-Wa can be distinguished from other members of the genus by its coriaceous, linear to obovate leaf blades, with a retuse to obcordate apex, and its ovoid, somewhat rugose fruits.

Description Shrubs to 2 m tall, trunk to 5 cm diameter; young twigs cylindrical, 1-1.5 mm diameter, glabrous; bark medium gray, smooth to slightly rugose. Leaves opposite, persistent; bud scales persistent; blades medium green above, lighter below, linear to obovate, 4-6 × 1-2.5 cm, coriaceous, glabrous, domatia absent, base rounded, margin revolute, apex retuse to obcordate, sometimes slightly acuminate, the acumens 0-3 mm long, midrib sunken above, raised below, secondary veins inconspicuous, 6-8 per side, 5-12 mm apart, looping 1-2 mm from the margin; petiole light gray to whitish, 2.5-5 × 1-1.3 mm, entirely woody, glabrous. Flowers unseen, but fruits solitary. Fruiting pedicel 4-8 × 1-1.5 mm; young fruits green, brownish when mature, ovoid, 8.5-17.5 × 7-10 mm, surface smooth to rugose, sometimes covered with a white pellicle, apex rostellate, the rostellum flattened, ridged, rounded, with the persistent style; dry pericarp 0.7 mm thick; endocarp woody.

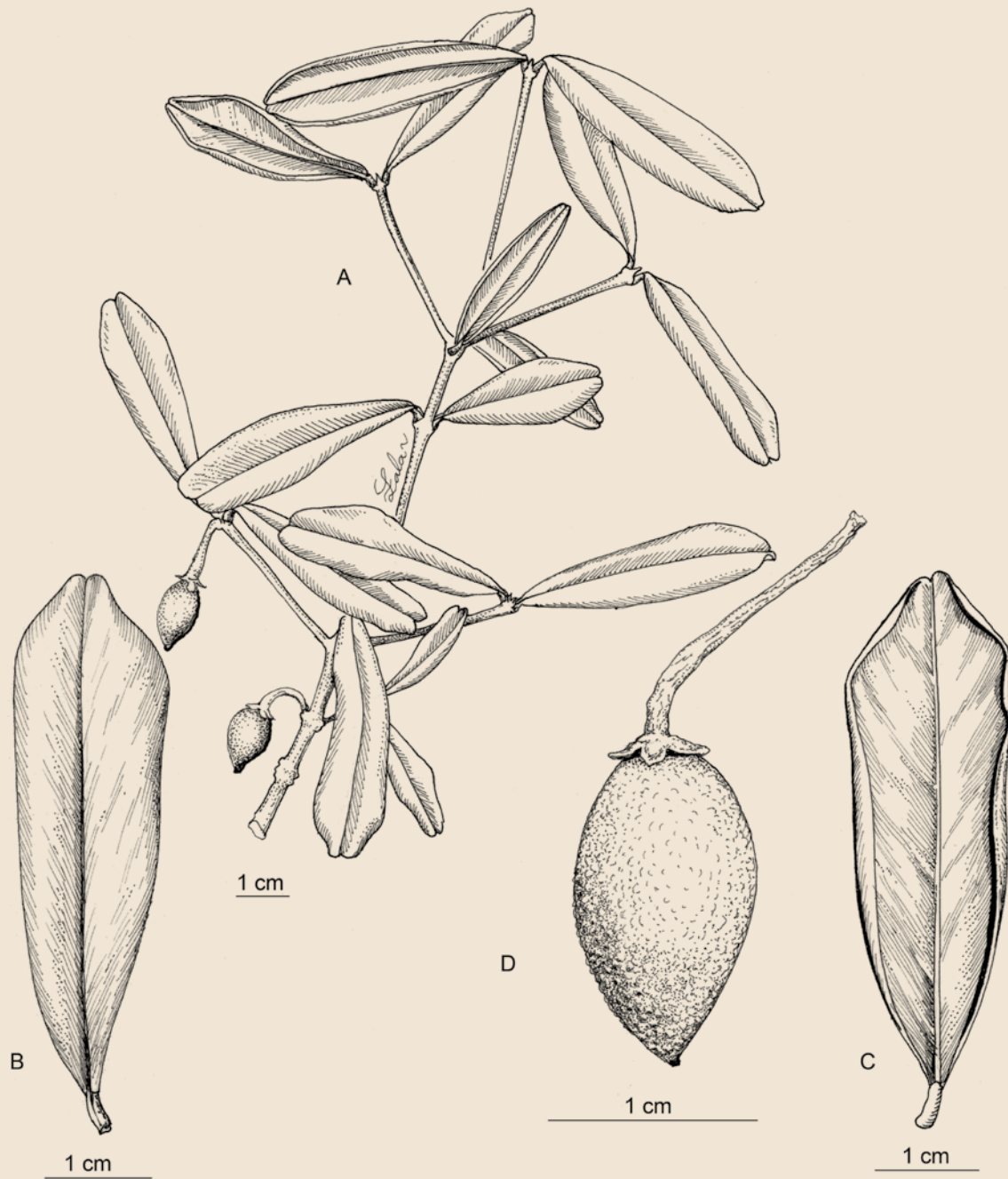
Etymology This species is dedicated to Fidisoa “Fidy” Ratovoson, a botanist at the Missouri Botanical Garden in Madagascar, for collecting the type specimen and other numerous materials of *Noronhia*, for helping to locate specimens deposited at CNARP, TAN and TEF, and otherwise for assisting with various aspects of this work.

Distribution, ecology and phenology *Noronhia ratovosonii* occurs in low-elevation dry forests on limestones and unconsolidated sands in the north, around Montagne des Français (Fig. 49). Its flowering period is unknown, and it fruits from August to November.

Conservation status Based on four collections representing three localities, the assessment yielded an EOO of 74 km², an AOO of 12 km², and three subpopulations representing three locations, of which only one occurs within a protected area (Montagne des Français). Suitable habitat, both outside and inside of protected areas, will likely continue to experience some form of degradation and loss resulting from [illicit] forest exploitation, invasive species, and expansion of agricultural fields. Consequently, *N. ratovosonii* is assigned a preliminary status of “Endangered” [EN B1ab(i,ii,iii,iv,v)+2ab(i,ii,iii,iv,v)].

Notes *Noronhia ratovosonii* is similar to *N. longipedicellata*, but can distinguished by its habit (shrubs vs. trees), retuse to obcordate (vs. retuse to mucronate) leaf blades, and shorter pedicels (less than 1 cm vs. 1-3 cm long). The new species can be recognized by its coriaceous, linear to obovate leaves and ovoid, somewhat rugose fruits.

Paratypes **MADAGASCAR. Prov. Antsiranana:** Andranovondronina, Anjiabe, Antsaravy, forêt Antafian'i Tsirambaza, 12°08'53"S 49°20'31"E, 8 m, 17.III.2006, *Guittou 318* (CNARP, MO, P, TAN); Ramena, Andavakoera, 12°19'57"S 49°21'19"E, 172 m, 4.VIII.2007, *Hong-Wa et al. 525* (CNARP, MO, P, TAN); *ibid. loc.*, *Hong-Wa et al. 548* (TAN).

**Fig. 54.***Noronhia ratovosonii* Hong-Wa.**A.** Fruiting branch; **B.** Adaxial side of leaf blade; **C.** Abaxial side of leaf blade; **D.** Fruit.

[Hong-Wa 525, TAN] Drawings: R. L. Andriamiarisoa

70. *Noronhia retusifolia* Hong-Wa, *spec. nova* (Fig. 55, 56A).

Typus: MADAGASCAR. **Prov. Toliara:** Anosy, Fort-Dauphin, Ampasy Nampoana, forêt de Mandena, 24°57'10"S 47°00'10"E, 9 m, 13.II.2009, Hong-Wa 600 (holo-: MO-6615559!; iso-: G [G00341621]!, P!, TAN!).

Diagnosis *Noronhia retusifolia* Hong-Wa can be distinguished from its congeners by its rugose bark, its oblanceolate, distinctly veined leaf blades that are verticillate at the tips of the branches, its retuse leaf apex, and its rugose fruits.

Description Trees to 12 m tall, trunk to 13 cm diameter; young twigs cylindrical to subquadrangular, 2-2.7 mm diameter, glabrous; bark medium gray, rugose. Leaves opposite, verticillate at the tips of the branches, persistent; bud scales rarely persistent; blades medium green above, lighter below, oblanceolate to obovate, 6.5-9 × 2-3 cm, subcoriaceous, glabrous, domatia common, base rounded, margin slightly revolute, apex retuse, midrib sunken above, raised below, secondary veins conspicuous, 9-14 per side, 9-12 mm apart, looping 2-3 mm from the margin; petiole medium gray, 8-11 × 1.5-2.5 mm, entirely woody, glabrous. Flowers unseen, but infructescence thyrsoid. Fruiting pedicel 5-8 × 2-2.5 mm; young fruits green, reddish brown when mature, ovoid, 14.5-17 × 11-12 mm, rugose, apex flat to bluntly pointed; dry pericarp 1.7-2 mm thick; endocarp woody; seed 9-10 × 4-8 mm.

Etymology The specific epithet refers to the distinctly retuse apex of the leaf blade, which characterizes this species.

Distribution, ecology and phenology *Noronhia retusifolia* occurs on unconsolidated sands in the littoral forest of Mandena, north of Fort-Dauphin in the south (Fig. 49). It has been collected in fruits in February.

Conservation status *Noronhia retusifolia* is known only from a single collection from a small remnant of littoral forest (Mandena) in southeastern Madagascar, which has just received a permanent protection status that does not, however, preclude continued habitat degradation resulting from illicit exploitation in the context of a growing population. The surrounding areas are also being converted for ilmenite exploitation, leaving this littoral forest patch even more isolated from such other patches. Although the individual sampled appears growing close to the QMM-Rio Tinto nursery where GPS data were recorded for a group of specimens, it actually occurs farther in an area that is probably not under constant surveillance. In addition, this species appears to be rare as discussed below. Therefore, *N. retusifolia* is assigned a preliminary status of "Critically Endangered" [CR B2(iii); D].

Fig. 55.*Noronhia retusifolia* Hong-Wa.**A.** Fruiting branch; **B.** Fruit.

[Hong-Wa 600, TAN] Drawings: R. L. Andriamiarisoa



Notes *Noronhia retusifolia* most closely resembles *N. orientalis*, from which it differs by having leaves that are oblanceolate to obovate (vs. oblong to obovate), flat (vs. sub-bullate), and 9×3 cm (vs. 15×5 cm), shorter petioles (less than 11 mm vs. up to 22 mm), and fruits that are rugose (vs. smooth to sometimes slightly rugose). The rugose bark, oblanceolate, distinctly veined leaf blades that are verticillate at the tips of the branches, retuse leaf apex, and rugose fruits characterize this species.

Noronhia retusifolia is known only from the type specimen and appears to be rare. This is rather surprising given the level of botanical inventory done within the small littoral forest of Mandena since the late 1940s. Indeed, more than 2,000 plant collections have been made from this site, of which about 20 are identified as *Noronhia*. It is, however, possible that the numerous unidentified [and unfiled] collections of the *Service Forestier de Madagascar* held in the Paris herbarium include other representatives of this species.



Fig. 56. Photographs of *Noronhia* Stadtm. ex Thouars. **A.** *Noronhia retusifolia* Hong-Wa [Hong-Wa 600]; **B.** *Noronhia rostrata* Hong-Wa [Ammann 484]; **C.** *Noronhia sambiranensis* H. Perrier [Callmander 535]; **D.** *Noronhia seyrigii* H. Perrier [Andriamihajarivo 1100].

Photos: taken by respective collectors except D: F. Rakotoarivony

71. *Noronhia richardii* Hong-Wa, **spec. nova** (Fig. 57).

Typus: MADAGASCAR. **Prov. Toliara:** Anosy, Fort-Dauphin, Iaboko, Antsotso, forêt Ivohibe, 24°34'26"S 47°11'42"E, 261 m, XII.2005, Razakamalala *et al.* 2666 (holo-: MO-6615556!; iso-: G [G00341619]!, P [P06490472] image seen, TAN).

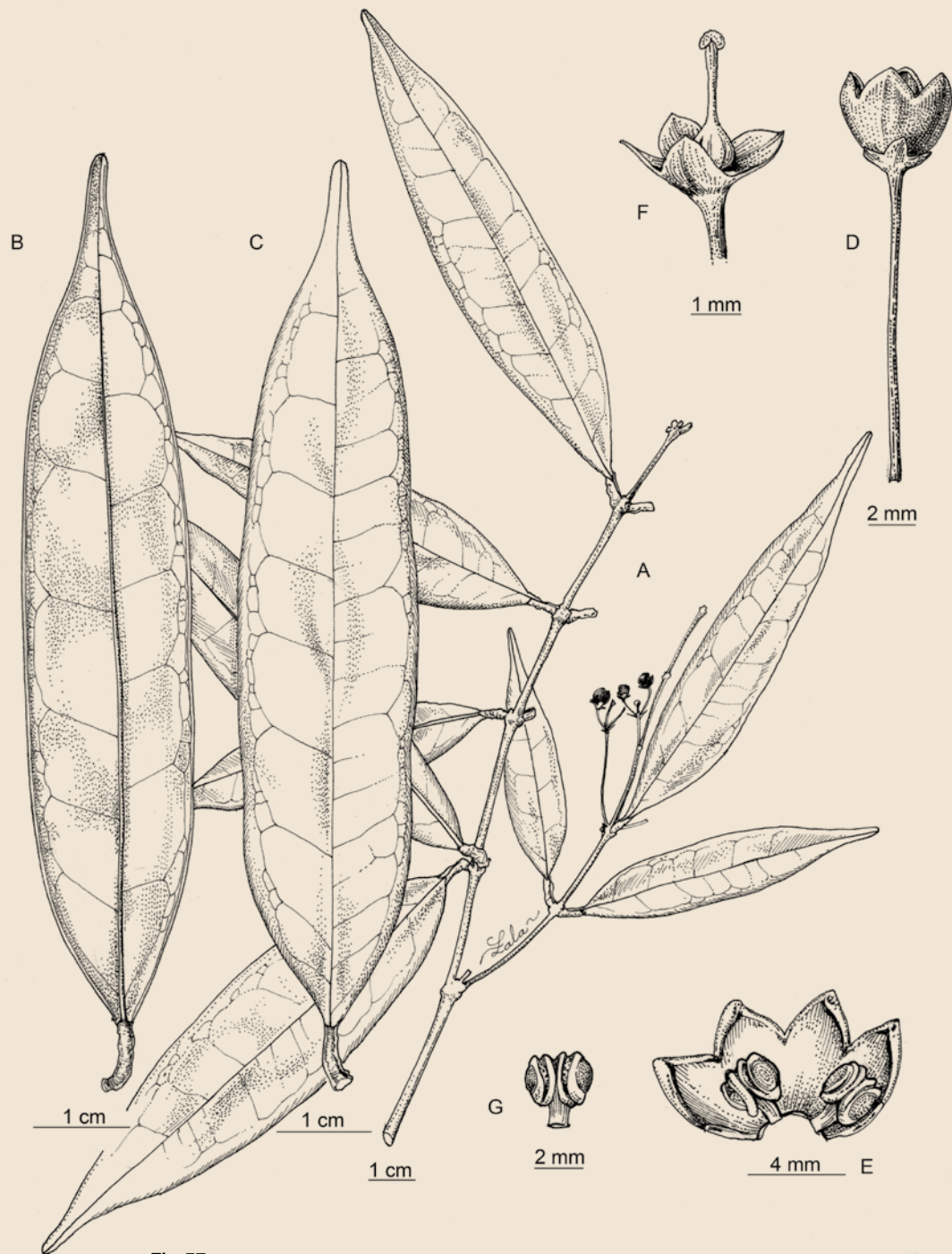
Diagnosis *Noronhia richardii* Hong-Wa can be distinguished from other congeneric species by its lanceolate leaves, and its long and diffuse inflorescences with red flowers.

Description Small trees to 7 m tall; young twigs cylindrical, 0.7-1.4 mm diameter, glabrous; bark medium gray, smooth. Leaves opposite, persistent; bud scales rarely persistent; blades medium green above, yellowish below, lanceolate to oblong, 9-11 × 2-4 cm, chartaceous, glabrous, domatia absent, base acute to rounded, margin slightly revolute, apex acuminate, the acumen 5-9 mm long, midrib flat above, slightly raised below, secondary veins conspicuous, 9-12 per side, 9-17 mm apart, looping 1.3-3 mm from the margin; petiole medium gray, 6-11 × 1-2.5 mm, entirely woody, glabrous. Thyrses geminate, pauciflorous, diffuse; peduncle 4-30 mm long, glabrous; pedicel 11-25 mm long, glabrous; calyx sparsely pubescent to glabrescent outside, glabrous inside, lobes ovate, 1-2.5 × 1-2 mm; corolla red, cupuliform, 3-7 mm long, glabrous on both sides, the tube 1-5 mm long lobes widely ovate, apex acute; corona absent; stamens 2-3 mm long, anthers widely oblong to almost square, 1.6-1.9 mm long; pistil 2.2-3.5 mm long, stigma capitate. Fruits unseen.

Etymology This name honors Richard Razakamalala, a botanist at the Missouri Botanical Garden in Madagascar and one of the most knowledgeable Malagasy field botanists, for collecting the type specimen and for providing invaluable preliminary identification on countless field collections.

Distribution, ecology and phenology *Noronhia richardii* occurs in low-elevation humid forests on basement rocks at Bemanidy-Ivohibe north of Ste Luce in the south (Fig. 49). It has been collected in flowers in November and December.

Conservation status Only three collections, representing three localities, were available and were all obtained from a single location within the recently established protected area of Tsitongambarika. The subpopulation occurs on the northeastern edge of the protected area, where significant human activities still put some pressure on the forest, resulting in continuing decline in habitat quality. Thus, with an AOO of just 8 km², a single location, and lingering threats that could rapidly affect the area, *N. richardii* is assigned a preliminary status of "Vulnerable" [VU D2].

**Fig. 57.**

Noronhia richardii Hong-Wa. **A.** Flowering branch; **B.** Abaxial side of leaf blade; **C.** Adaxial side of leaf blade; **D.** Flower; **E.** Inner side of corolla; **F.** Pistil; **G.** Stamen.

[Razakamalala 2424, TAN] Drawings: R.L. Andriamiarisoa

Notes *Noronhia richardii* closely resembles *N. capuronii*, from which it differs by its glabrous (vs. pubescent) petioles, lanceolate to oblong (vs. ovate) leaf blades with an acute to rounded (vs. cordate) base, long peduncles and pedicels (up to 30 mm vs. 8 mm), and red (vs. greenish) flowers. It can be recognized by its lanceolate leaves and long, diffuse inflorescences with red flowers.

Paratypes **MADAGASCAR. Prov. Toliara:** Fort-Dauphin, Iaboko, Antsotso, forêt d'Ivohibe, 24°34'14"S 47°12'04"E, 265 m, 28.XI.2005, *Razakamalala et al.* 2424 (G, MO, P, TAN); *ibid. loc.*, 24°34'16"S 47°12'06"E, 271 m, 8.XII.2007, *Razakamalala et al.* 3777 (MO, P, TAN).

72. *Noronhia rollandii* Hong-Wa, spec. nova (Fig. 58).

Typus: MADAGASCAR. **Prov. Toamasina:** Alaotra-Mangoro, Moramanga, Ambatovy, Ampitabe, piste direction S du campement Dynatec, 18°51'34"S 48°17'13"E, 1080 m, 18.I.2005, Ranaivojaona et al. 1151 (holo-: MO-6615552!; iso-: G [G00341615]!, K!, P!, TAN!).

Diagnosis *Noronhia rollandii* Hong-Wa can be distinguished from other members of the genus by its non-woody petioles, its opposite to verticillate, oblong leaf blades, its urceolate, yellow flowers, and its ovoid, punctate fruits.

Description Trees to 15 m tall, trunk to 24 cm diameter; young twigs cylindrical to somewhat flattened, 1.1–2.3 mm diameter, glabrous; bark dark gray, smooth, with scattered lenticels. Leaves opposite, verticillate at the tips of the branches, persistent; bud scales deciduous; blades light green above, darker below, oblong, 4–10 × 1.5–3 cm, coriaceous, glabrous, domatia absent, base attenuate, margin flat, apex retuse, midrib slightly sunken above, distinctly raised below, secondary veins inconspicuous, 7–12 per side, 5–15 mm apart, looping 1–3.5 mm from the margin; petiole brown, 4–10 × 1–3 mm, not woody or only up to mid-length, glabrous. Thyrses geminate, multiflorous, compact; peduncle 5–10 mm long, moderately pubescent; pedicel 2–8 mm long, moderately pubescent; calyx moderately pubescent outside, glabrous inside, lobes triangular, 0.8–1.5 × 1–1.8 mm; corolla yellow tinged pinkish outside, yellow inside, urceolate, 3–4.5 mm long, glabrous on both sides, the tube 1–2 mm long, lobes widely ovate, apex acute; corona present, 1.7–2.3 mm long, undivided; stamens 2–2.5 mm long, anthers oblong to obovate, 1.5–1.8 mm long; pistil 2–2.7 mm long, stigma capitate. Fruiting pedicel 2–8 × 1–2.5 mm; young fruits green, brownish to blackish when mature, ovoid, 12–24 × 8–17 mm, covered with white dots, apex bluntly pointed to apiculate; dry pericarp 0.3–1.4 mm thick; endocarp woody; seed 9–15.5 × 7–11.5 mm.

Etymology This name honors the late Rolland Ranaivojaona, a botanist at the Parc Botanique et Zoologique de Tsimbazaza (TAN), for collecting the type specimen and for sharing his knowledge of the Malagasy flora.

Distribution, ecology and phenology *Noronhia rollandii* occurs in mid- to high-elevation humid forests in the east, from Anjanaharibe-Sud to Mangoro (Fig. 49). It produces flowers year-round except in December.

Conservation status The assessment included 29 collections representing 28 localities and yielded an EOO of 38,636 km², an AOO of 84 km², and 13 subpopulations representing 11 locations, of which seven occur within protected areas (Anjanaharibe-Sud, Corridor Ankeniheny-Zahamena, Makira, Mantadia, Masoala, Torotorofotsy, and Zahamena). Although the estimated AOO is rather small, the actual AOO is likely much larger and may well exceed 2,000 km². That, along with a large EOO, a high number of locations, and good representation within the network of protected areas, indicates a preliminary status of “Least Concern” for *N. rollandii*.

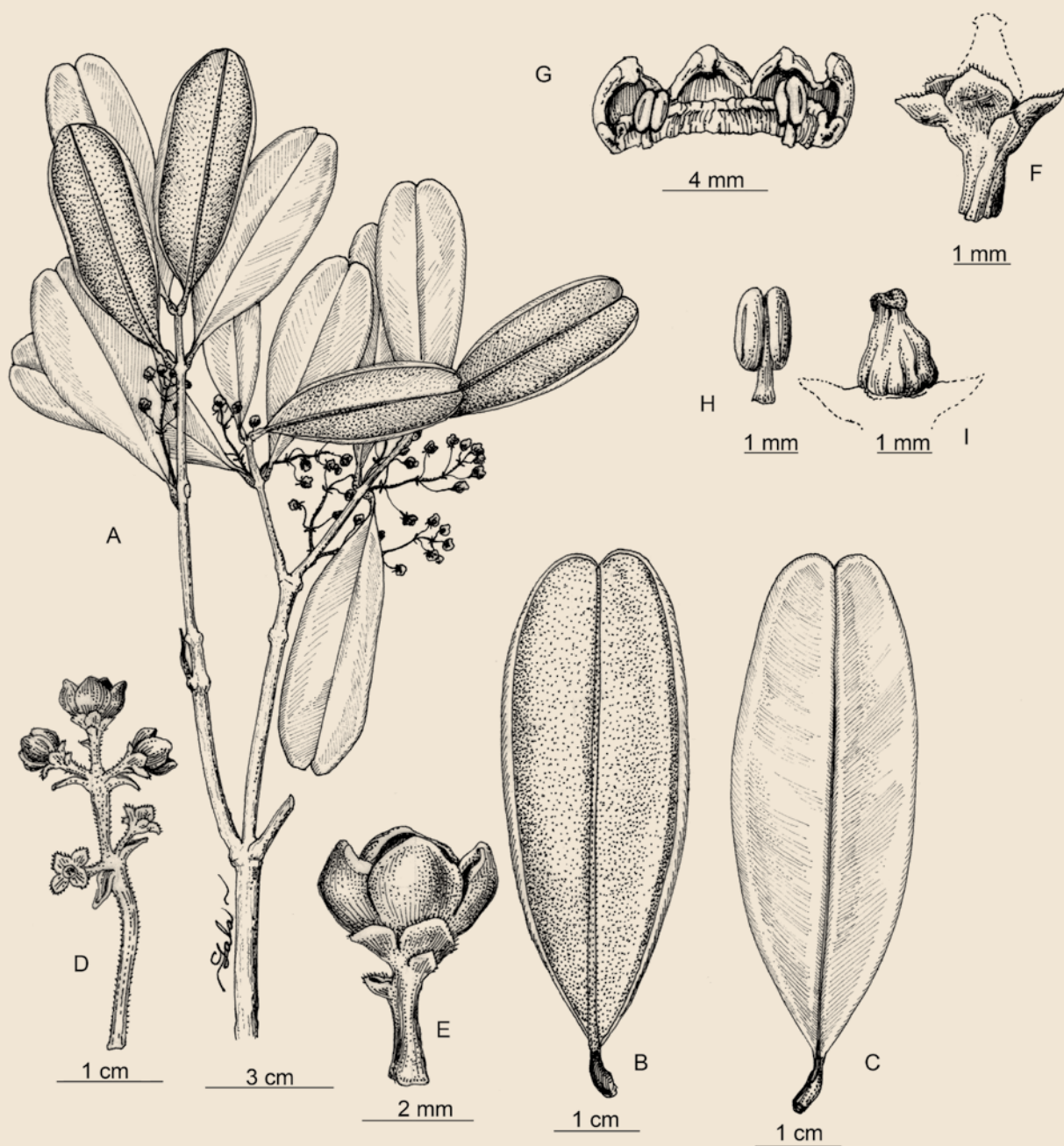


Fig. 58. *Noronhia rollandii* Hong-Wa.

A. Flowering branch; **B.** Abaxial side of leaf blade; **C.** Adaxial side of leaf blade;
D. Inflorescence; **E.** Flower; **F.** Calyx; **G.** Inner side of corolla; **H.** Stamen; **I.** Pistil.

[Ranaivojaona 1151, MO] Drawings: R.L. Andriamiarisoa

Notes *Noronhia rollandii* is similar to *N. obtusifolia*, but can be distinguished by its opposite to verticillate (vs. entirely opposite), oblong (vs. obovate) leaves, urceolate (vs. campanulate), yellow tinged pinkish (vs. white) flowers, the presence (vs. absence) of a corona, and its punctate (vs. smooth to ribbed) fruits. The new species can be recognized by its non-woody petioles, opposite to verticillate, oblong leaf blades, urceolate, yellow flowers, and ovoid, punctate fruits.

Paratypes **MADAGASCAR. Prov. Antsiranana:** Andapa, Anjanaharibe-Sud RS, 14°46'15"S 49°28'E, 1161-1424 m, 21.III-7.IV.1994, *Ravelonarivo et al.* 91 (K, MO, TAN); *ibid. loc.*, 14°44'42"S 49°27'42"E, 1185-1335 m, 3.XI.1994, *Ravelonarivo & Rabesonina* 484 (G, K, MO, P, TAN). **Prov. Fianarantsoa:** Ivohibe RS, 22°25'18"S 46°53'54"E, 1200 m, 10.XI.1997, *Rakotomalaza* 1526 (G, MO). **Prov. Mahajanga:** Befandriana-Nord, Matsoandakana, Ambotaharanana, Andranomena, 15°08'16"S 49°20'55"E, 1077 m, 12.II.2008, *Bernard* 770 (G, MO, P, TAN); *ibid. loc.*, Andasinanantsomanga, Amparihy, 14°55'34"S 49°24'59"E, 25.II.2008, *Bernard* 938 (G, MO, P, TAN); *ibid. loc.*, Ambotaharanana, Andranomena, forêt d'Anjiabe, 15°08'19"S 49°21'50"E, 1208 m, 14.II.2008, *Ravelonarivo et al.* 2831 (MO, P, TAN); *ibid. loc.*, 15.II.2008, *Ravelonarivo et al.* 2865 (MO, P, TAN); Tsaravilona, Amparihy, Androva, 14°55'36"S 49°25'40"E, 1154-1178 m, 22.II.2008, *Ravelonarivo* 2893 (MO, P, TAN). **Prov. Toamasina:** Antanandava, Zahamena PN, 17°29'47"S 48°45'35"E, 1000-1912 m, 2.II.2002, *Andrianjafy et al.* 289 (CNARP, K, MO, P, TEF); Maroantsetra, Mahalevona, Masoala PN, 15°25'47"S 49°57'33"E, 1198 m, 8.X.2003, *Antilahimena et al.* 2152 (MO, P); Ambinanitelo, Ambalamahogo, Maimborondro, 15°18'39"S 49°22'43"E, 1100 m, 6.IX.2004, *Antilahimena* 2835 (MO, P); Moramanga, Ambatovy, 18°49'19"S 48°20'08"E, 1094 m, 3.II.2005, *Antilahimena et al.* 3299 (MO, P, TAN); *ibid. loc.*, 18°48'24"S 48°19'51"E, 1102 m, 10.XI.2005, *Antilahimena & Edmond* 4182 (G, MO, P, TAN); *ibid. loc.*, 18°51'34"S 48°18'00"E, 1129 m, 8.VIII.2008, *Antilahimena et al.* 6425 (MO, P, TAN); Brickaville, Maroseranana, Ambodilendemy, Ankerana, 18°25'56"S 48°47'11"E, 854 m, 18.III.2011, *Antilahimena & Randrimitantsoa* 7637 (G, MO, P, TAN); Ambatovy, 18°50'30"S 48°18'11"E, 1111 m, 19.V.2010, *Bernard et al.* 1573 (MO, P, TAN); Analamazaotra RS, 18°49'32"S 48°26'04"E, 941 m, 3.V.2010, *Hong-Wa & Ortiz* 663 (MO, P, TAN); Ambatovy, 18°51'17"S 48°19'02"E, 1117 m, 8.IX.2008, *Miandrimanana et al.* 320 (G, MO, P, TAN); *ibid. loc.*, 18°51'48"S 48°18'26"E, 1022 m, 27.I.2008, *Phillipson & Antilahimena* 6094 (G, MO); Moramanga, Antanambao, Analamay, 18°49'26"S 48°20'16"E, 1000 m, 26.I.1997, *Rakotomalaza et al.* 998 (MO, P); *ibid. loc.*, 18°51'22"S 48°19'34"E, 1080 m, 29.VI.1997, *Rakotomalaza et al.* 1364 (G, MO, TAN); Ambatovy, 18°51'08"S 48°17'48"E, 1127 m, 16.II.2005, *Rakotovao et al.* 1191 (G, MO, P, TAN); Zahamena RNI, à 1 km au S du village d'Antenina, 17°30'30"S 48°46'15"E, 900 m, 13.VIII.1994, *Randrianjanaka & Zafy* 190A (G, K, MO, P, TAN); Manakambahiny-Est, Zahamena RNI, 17°40'17"S 48°45'13"E, 1350 m, 16.IX.2002, *S. Randrianasolo et al.* 304 (G, MO, P, TEF); *ibid. loc.*, 17°40'17"S 48°45'13"E, 1350 m, 16.IX.2002, *S. Randrianasolo et al.* 307 (G, MO, P, TEF); Brickaville, Maroseranana, Ambodilendemy, 18°25'57"S 48°46'52"E, 727 m, 14.III.2011, *Ravelonarivo & Edmond* 3645 (G, MO, P, TAN); *ibid. loc.*, 18°25'24"S 48°47'06"E, 896 m, 22.III.2011, *Ravelonarivo et al.* 3787 (G, MO, P, TAN); Analamay, 18°50'49"S 48°18'30"E, 1124 m, 10.II.2005, *Razafindraibe & Antilahimena* 76 (MO, P, TAN).

73. *Noronhia rostrata* Hong-Wa, **spec. nova** (Fig. 56B, 59).

Typus: MADAGASCAR. **Prov. Antsiranana:** DIANA, Ampasindava, forêt de Andranomataavy, 13°41'41"S 47°59'02"E, 150 m, 8.XII.2009, *Ammann et al.* 484 (holo-: MO-6410025!; iso-: G [G00180614], K, P [P00853026], TEF, US).

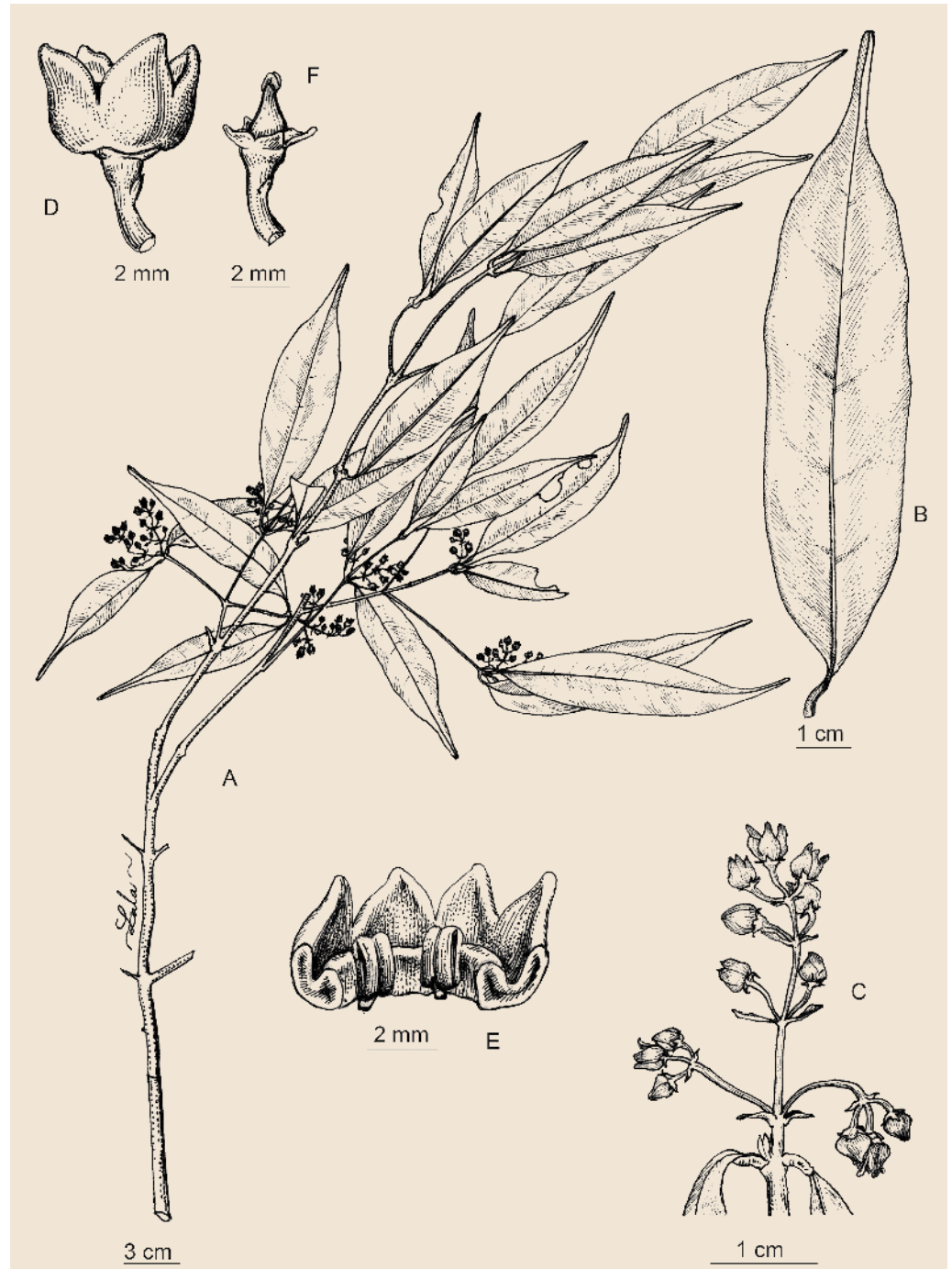
Diagnosis *Noronhia rostrata* Hong-Wa can be distinguished from its congeners by its non-woody petioles, its lanceolate leaf blades, terminated by a long acumen, and often bearing domatia, and its sharply rostrate fruits.

Description Trees to 17 m tall, trunk to 25 cm diameter; young twigs cylindrical, 0.7-1.4 mm diameter, glabrous; bark medium gray, smooth. Leaves opposite, persistent; bud scales rarely persistent; blades medium green above, lighter below, lanceolate to oblong, 6.5-11.5 × 1.5-3.2 cm, subcoriaceous, glabrous, domatia abundant, base acute to attenuate, margin slightly undulate, apex acuminate, the acumen 10-20 mm long, midrib flat to slightly sunken above, raised below, secondary veins conspicuous, 8-14 per side, 6-12 mm apart, looping 1-2.7 mm from the margin; petiole yellow, 6-15 × 0.9-1.5 mm, not woody, glabrous. Thyrses solitary to geminate, pauciflorous, compact; peduncle 4-6 mm long, moderately pubescent; pedicel 2-4 mm long, moderately pubescent; calyx sparsely pubescent outside, glabrous inside, lobes triangular, 0.9-1 × 0.5-1.2 mm; corolla cream white, cupuliform, 3.2-4.5 mm long, glabrous on both sides, the tube 1-2.8 mm long, lobes ovate, apex acute; corona present, 1.2-1.5 mm long, undivided; stamens 1.5-2.2 mm long, anthers obovate, 1-1.5 mm long; pistil 1.5-2 mm long, stigma capitate. Fruiting pedicel 5-19 × 1-1.3 mm; young fruits green, brownish red when mature, ovoid, 17-24 × 10.5-17.5 mm, surface smooth to slightly ribbed, apex rostrate, the rostrum flattened, ridged, apiculate; dry pericarp 0.3-1.2 mm thick; endocarp crustaceous; seed 10.5-12.5 × 6-7 mm.

Etymology The specific epithet refers to the distinctive rostrum terminating the fruit apex.

Distribution, ecology and phenology *Noronhia rostrata* occurs in rupicolous forests from Ampasindava to Analamerana and Daraina in northern Madagascar (Fig. 49). It produces flowers and fruits from November to July.

Conservation status The assessment was based on six collections representing five localities, and yielded an EOO of 10,926 km², an AOO of 20 km², and five subpopulations representing five locations, all but one occurring within the network of protected areas (Ampasindava, Andavakoera-Ambohipiraka, Loky-Manambato, and Tsaratanana). Decline in habitat quality resulting from wood harvesting, forest exploitation, and

**Fig. 59.***Noronhia rostrata* Hong-Wa.

A. Flowering branch; **B.** Abaxial side of leaf blade; **C.** Inflorescence axis;
D. Flower; **E.** Inner side of corolla; **F.** Pistil.

[Ammann 484, MO] Drawings: R.L. Andriamiarisoa

encroachment will likely continue in the areas not benefiting from protection as well as inside some of the protected areas. With an AOO that is likely less than or equal to 500 km², five locations, and a projected continuing decline in habitat quality and in the number of mature individuals, *N. rostrata* is assigned a preliminary status of “Endangered” [EN B2ab(iii,v)].

Notes *Noronhia rostrata* resembles *N. incurvifolia*, from which it differs by its flat (vs. folded) leaf blades, bearing domatia (vs. none) on the abaxial side, its cupuliform (vs. subrotate) corolla, the presence (vs. absence) of a corona, and its crustaceous (vs. woody) endocarp. Distinctive features include non-woody petioles, lanceolate leaf blades, terminated by a long acumen, and often bearing domatia, and sharply rostrate fruits.

Paratypes **MADAGASCAR. Prov. Antsiranana:** Andrafiarena, Anjahankely, 12°54'49"S 49°19'40"E, 433 m, 6.XI.2010, *Burivalova et al.* 11 (G, MO); Ampasindava, forêt de Betsitsika, 13°46'28"S 47°59'24"E, 161 m, 9.XI.2009, *Gautier et al.* 5354 (G, MO, TEF); Andrafiarena, Anjahankely, 12°54'46"S 49°19'37"E, 410 m, 10.XI.2010, *Gautier & Ranirison* 5381 (G, MO); Anivorano-Nord, Andrafiabe, Mont Antsahabe, 12°54'50"S 49°19'41"E, 408 m, 3.VII.2010, *Hong-Wa* 719 (MO, P, TAN); *ibid. loc.*, *Hong-Wa* 720 (MO, TAN); Vohémar, Daraina, forêt d'Antsahabe, 13°12'53"S 49°31'50"E, 460 m, 25.I.2006, *Ranirison & Nusbaumer* 1111 (Daraina, G, K, MO, TEF); Ambanja, Marovato, 13°57'S 48°33'E, 12.XII.1952, *Réserves Naturelles* 4750 (P); Ambahatra (cours inférieur), 13°54'31"S 49°27'56"E, 80 m, 5.VII.2001, *Wohlhauser* 457 (G, MO, P).

74. *Noronhia sambiranensis* H. Perrier in Mém. Inst. Sci. Madagascar, Sér. B, Biol. Vég. 2: 289. 1949 (Fig. 56C).

Lectotypus (designated here): **MADAGASCAR. Prov. Antsiranana**: forêt de la vallée du Sambirano, [13°54'30"S 48°37'30"E], s.d., *Perrier de la Bâthie* 8826 (P [P00418092] !).
Syntypus: **MADAGASCAR. Prov. Antsiranana**: Diégo-Suarez, forêt d'Antsakoakely, *Ursch* 146 (P [P03559317] !).

Description

Trees to 15 m tall, trunk to 15 cm diameter; young twigs cylindrical, 0.8–2.4 mm diameter, glabrous; bark medium to light gray, smooth. *Leaves* opposite, semi-deciduous; bud scales persistent; blades medium green above, lighter below, oblong to lanceolate, 8–14.5 × 2.5–5 cm, chartaceous, glabrous, domatia rare, base acute to attenuate, margin flat to slightly undulate, apex acuminate, the acumen 2–22 mm long, midrib flat to slightly sunken above, raised below, secondary veins conspicuous, 7–14 per side, 9–26 mm apart, looping 1.5–7 mm from the margin; petiole light gray to yellowish, 5–16 × 1.3–2.2 mm, partially to entirely woody, glabrous. *Thyrse*s solitary to geminate, pauciflorous, diffuse; peduncle 5–7 mm long, moderately pubescent; pedicel 2–14.5 mm long, moderately pubescent; calyx moderately pubescent outside, glabrous inside, lobes triangular to deltate, 1.3–2.5 × 0.9–2.2 mm; corolla red, cupuliform, 3.5–5 mm long, glabrous on both sides, the tube 1–3 mm long, lobes ovate slightly acute; corona absent; stamens 1.5–2.8 mm long, anthers oblate to orbicular, 1.1–1.9 mm long; pistil 2–3 mm long, stigma capitate. *Fruiting* pedicel 6–38 × 0.8–1.7 mm; young fruits greenish, purplish somewhat glaucous when mature, subglobose, 14–26.5 × 12–24 mm, surface smooth, apex flat, style persistent; dry pericarp 0.3–1.1 mm thick; endocarp crustaceous; seed 8.5–13.5 × 8–12 mm.

Distribution, ecology and phenology

Noronhia sambiranensis occurs in low- to high-elevation humid forests on basement rocks and lavas in the northwest (Fig. 49). It produces flowers and fruits from November to June.

Conservation status

Based on 21 collections representing 19 localities, the assessment resulted in an EOO of 11,043 km², an AOO of 72 km², and 12 subpopulations representing 12 locations, of which 10 occur within protected areas (Galoko, Lokobe, Manongarivo, Montagne d'Ambre, and Tsaratanana). Decline in habitat quality resulting from wood harvesting and forest exploitation will continue to affect the subpopulations that are outside and on the edge of protected areas. *Noronhia sambiranensis* is thus assigned a preliminary status of "Near Threatened".

Notes

Noronhia sambiranensis can be recognized by its chartaceous, oblong to lanceolate leaf blades, cupuliform, red flowers, and subglobose, crustaceous fruits. It differs from *N. urceolata* by its semi-deciduous (vs. persistent) leaves, cupuliform (vs. urceolate) flow-

ers, and ovate to acute (vs. widely ovate rounded) corolla lobes. This species was based on two syntypes (*Perrier de la Bâthie* 8826 and *Ursch* 146), the first of which bears both flowers and fruits, and has thus been chosen here as the lectotype.

**Additional specimens
examined**

MADAGASCAR. Prov. Antsiranana: Ampasindava, forêt de Betsitsika, 13°45'36"S 48°04'21"E, 436 m, 3.XII.2008, *Ammann et al.* 129 (G, MO, TEF); *ibid loc.*, 13°45'53"S 48°04'22"E, 470 m, 12.XII.2008, *Ammann et al.* 191 (G, MO, P, TEF); Nosy Be, Lokobe RNI, 13°25'S 48°19'E, 30-100 m, 14.VII.1994, *Antilahimena* 142 (K, MO, TAN); Tsaratanana RNI, Beangona, 14°01'S 48°47'E, 1200-1400 m, 31.VII.2000, *Antilahimena et al.* 530 (G, K, MO, P, TAN); Ambilobe, Beramanja, Anketrabe, forêt de Kalabenono, 13°38'20"S 48°40'16"E, 374 m, 19.XI.2006, *Callmander et al.* 535 (G, MO, P, TAN); Manongarivo RS, Ambahatra, 13°59'S 48°26'E, 600 m, 8.VI.2000, *Gautier* 3766 (G, MO, P); Ampasindava, forêt de Bongomihiravavy, 13°45'38"S 48°05'29"E, 430 m, 24.XI.2008, *Madiomanana et al.* 149 (G, MO, P, TEF); Montagne d'Ambre, 12°28'36"S 49°10'51"E, 687 m, 18.XII.2011, *Ramandimbimanana et al.* 173 (G, MO); Tsaratanana RNI, Mandrizavona, 13°50'33"S 48°46'35"E, 545 m, 10.X.1998, *Randrianaivo* 267 (G, MO, P, TAN); Montagne d'Ambre, station des Roussettes, [12°28'S 49°10'E], 12.XI.1954, *Service Forestier* 11033 (P, TEF); Ambahatra, cours moyen, 13°57'40"S 48°26'40"E, 350 m, 21.VI.1999, *Wohlhauser* 60168 (G, MO, P, TEF); Ambahatra, cours supérieur, 13°59'S 48°26'E, 330 m, 4.VI.2000, *Wohlhauser* 60289 (G, MO, P). **Prov. Mahajanga:** Tsaratanana massif, N of Mangindrano, 14°10'24"S 48°56'43"E, 1675 m, 21.X.2001, *Lowry et al.* 5449 (MO, P).

75. *Noronhia schatzii* Hong-Wa, spec. nova (Fig. 60).

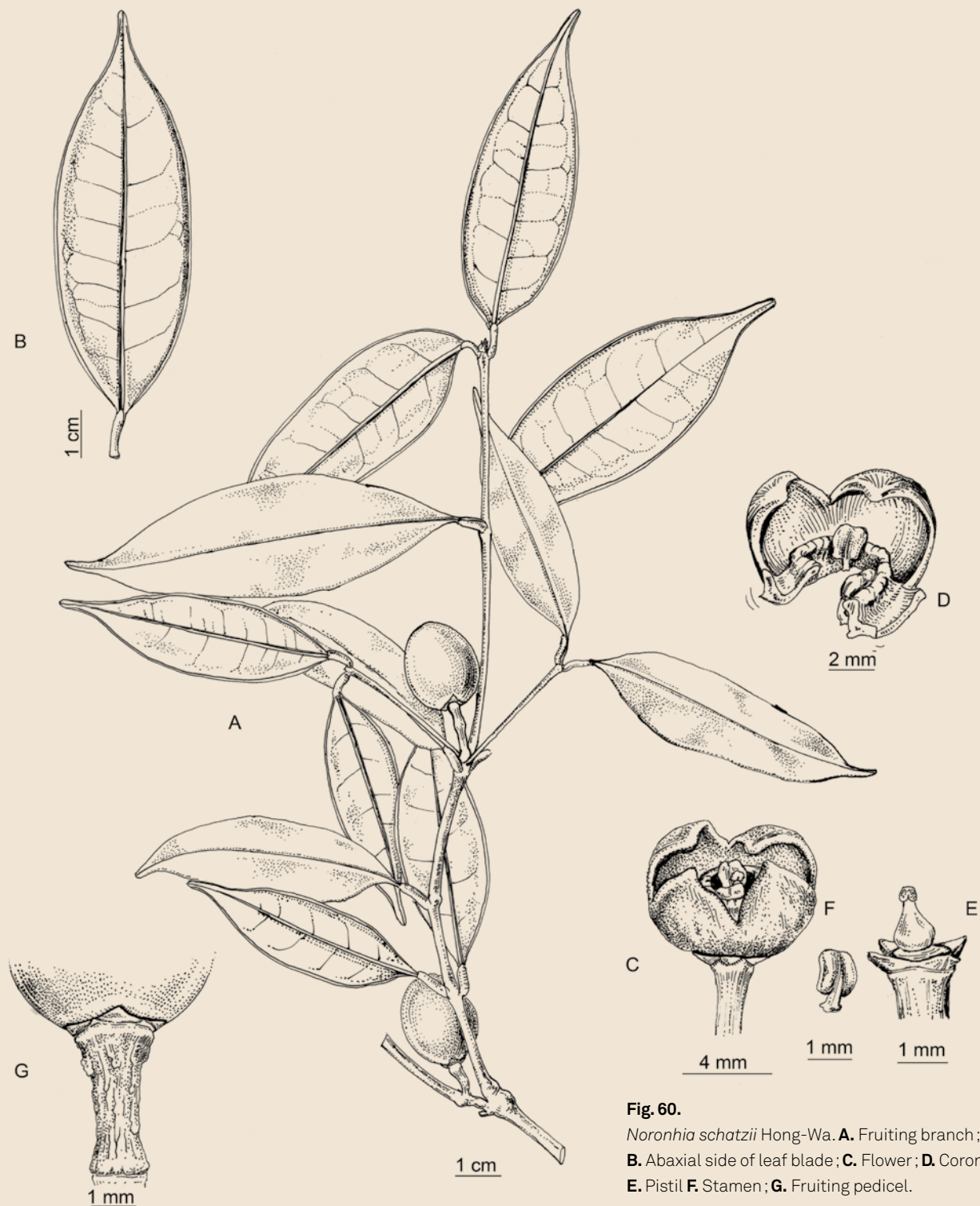
Typus: MADAGASCAR. **Prov. Toamasina:** Analanjirofo, Masoala Peninsula, Ambanizana, “S Trail” (S of Androka River) climbing into hills SE of Ambanizana, 15°38’S 49°59’E, 500 m, 29.X.1992, Schatz 3354 (holo-: MO-4670844!; iso-: G [G00341576], K, P [P03532856]!, TAN).

Diagnosis *Noronhia schatzii* Hong-Wa can be distinguished from other members of the genus by its whitish bark, its lanceolate somewhat discolored leaf blades, and its white to light yellow tinged pink flowers.

Description Trees to 14 m tall, trunk to 15 cm diameter; young twigs cylindrical, 0.7–1.4 mm diameter, glabrous; bark light gray to whitish, smooth, with scattered lenticels. Leaves opposite, persistent; bud scales rarely persistent; blades medium green above, lighter below, lanceolate, 7–11.5 × 2–5 cm, subcoriaceous, glabrous, domatia absent, base attenuate, margin flat, apex acuminate, the acumen 7–16 mm long, midrib slightly sunken above, distinctly raised below, secondary veins conspicuous only below, 7–11 per side, 8–15 mm apart, looping 2–5 mm from the margin; petiole light gray to whitish, 5–10 × 1–2 mm, entirely woody, glabrous. Thyrses geminate to fasciculate, multiflorous, compact; peduncle 3–8 mm long, glabrescent to glabrous; pedicel 3–6 mm long, glabrescent to glabrous; calyx sparsely pubescent outside, glabrous inside, lobes triangular, 0.5–1 × 0.8–1.5 mm; corolla white to light yellow tinged pink to mauve, cupuliform, 3–4.5 mm long, glabrous on both sides, the tube 1–2 mm long, lobes oblong to obovate; corona present, 1–1.5 mm long, undivided; stamens 1.3–1.7 mm long, anthers oblong, 0.7–1 mm long; pistil 1.3–1.8 mm long, capitate. Fruiting pedicel 4–20 × 0.7–1.7 mm; young fruits green, brownish when mature, ovoid, 14.5–19.5 × 8–13 mm, surface smooth, apex flat; dry pericarp 0.3–1 mm thick; endocarp subcrustaceous; seed 10.5–12 × 5–6 mm.

Etymology This species is dedicated to George E. Schatz, Curator at the Missouri Botanical Garden, who collected the type specimen and who has tremendously advanced the knowledge of the Malagasy flora through various projects, including the “Generic Tree Flora of Madagascar” (SCHATZ, 2001), a rich source of botanical information.

Distribution, ecology and phenology *Noronhia schatzii* occurs in low- to mid-elevation humid forests on basement rocks along the east coast from the Masoala peninsula to Fort-Dauphin (Fig. 49). It produces flowers and fruits from October to June.

**Fig. 60.**

Noronhia schatzii Hong-Wa. **A.** Fruiting branch; **B.** Abaxial side of leaf blade; **C.** Flower; **D.** Corona; **E.** Pistil **F.** Stamen; **G.** Fruiting pedicel.

[*Antilahimena* 2493, TAN] Drawings: R.L. Andriamiarisoa

- Conservation status** *Noronhia schatzii* is known from eight collections representing eight localities, and exhibits an EOO of 33,332 km², an AOO of 28 km², and five subpopulations representing five locations, of which four occur within protected areas (Makira, Masoala, and Tsitongambarika). It is very likely that the actual AOO is much larger than 2,000 km². Thus, *N. schatzii* is assigned a preliminary status of “Least Concern”.
- Notes** *Noronhia schatzii* is similar to *N. stevensiana* Hong-Wa, but can be distinguished by its entirely (vs. partially) woody petioles, multiflorous (vs. pauciflorous), compact (vs. compact to diffuse) thyrses, glabrescent to glabrous (vs. pubescent) peduncles and pedicels, and ovoid (vs. subglobose to ovoid) fruits. The whitish bark, lanceolate somewhat discolor leaf blades, and white to light yellow tinged pink flowers characterize this species.
- Paratypes** **MADAGASCAR. Prov. Toamasina:** Maroantsetra, Antsirabe Sahatany, Anjiahely, 15°24'03"S 49°27'14"E, 725 m, 12.VI.2004, *Antilahimena* 2493 (MO, P); Masoala PN, near Andranobe, 15°40'54"S 49°57'28"E, 0 m, 6.X.1997, *Malcomber* 2811 (K, MO); Masoala, 1-2 km E of Ambanizana, 15°36'S 49°57'E, 340 m, 9.V.1989, *Schatz et al.* 2709 (MO, P, TAN). **Prov. Toliara:** Fort-Dauphin, Iaboko, Antsontso, Ivohibe forest, 24°34'13"S 47°12'01"E, 286 m, 23.V.2006, *Antilahimena et al.* 4820 (G, MO, P, TAN, TEF); Bemangidy Forest, 24°35'02"S 47°12'44"E, 100-250 m, 7.II.2006, *Lowry et al.* 6685 (G, MO, P, TAN); Iabakoho, Antsotso, 24°34'S 47°11'E, 9.XII.2007, *Rabenantoandro et al.* 1870 (G, MO, P, TAN); *ibid. loc.*, 24°34'16"S 47°12'06"E, 271 m, 8.XII.2007, *Razakamalala et al.* 3810 (MO, P, TAN).

76. *Noronhia seyrigii* H. Perrier in Mém. Inst. Sci. Madagascar, Sér. B, Biol. Vég. 2: 297. 1949 (Fig. 56D).

Lectotypus (designated here): **MADAGASCAR. Prov. Toliara:** env. d'Ampandrandava (entre Bekily et Tsivory), [24°05'S 45°42'E], 1000 m, XII.1943, *Seyrig 22b* (P [P00413240]!; isolecto-: P [P00413239]!). **Syntypi:** **MADAGASCAR. Prov. Toliara:** vallée moyenne du Mandrare, Anadabolava, [24°39'S 46°26'E], 200-250 m, XII.1933, *Humbert 12375* (G [G00188783, G00188784] image seen, K [K000233176] image seen, P [P03559312, P03559313, P03559314]!); *ibid. loc.*, [24°39'S 46°26'E], 200-250 m, XII.1933, *Humbert 12445* (P [P03559311]!); Mts Kotriha et Isomonobe, vallée de la Manambolo, [24°32'S 46°34'E], 400-600 m, XII.1933-I.1934, *Humbert 12808* (P [P03559307, P03559309]!); vallée de la Manambolo, env. d'Isomono, [24°30'S 46°35'E], 400-900 m, XII.1933, *Humbert 12955* (K [K000233177] image seen, P [P03559275, P03559276]!); Mt Morahariva (Mahamena), vallée de la Manambolo, env. d'Isomono, [24°32'S 46°38'E], 1000-1400 m, XII.1933, *Humbert 13227* (P [P03559308, P03559310]!); env. de Benenitra, Onilahy, [23°27'S 45°05'E], VII.1909, *Perrier de la Bâthie 12715* (P [P03559267, P03559268]!); bords de la Sakoa, Onilahy, [23°43'S 44°48'E], VIII.1925, *Perrier de la Bâthie 17362* (P [P03559274]!); vallée de l'Onilahy, [23°34'S 44°46'E], VIII.1925, *Perrier de la Bâthie 19259* (P [P03559269]!); Ampandrandava, [24°05'S 45°42'E], 700-1000 m, II.1943, *Seyrig 22* (= *Herb. Jard. Bot. Tan. 6101*) (K [K000233178] image seen, P [P03559277, P03559278, P03559280]!); *ibid. loc.*, VIII.1944, *Seyrig 22c* (P [P03559270]!).

Description

Trees to 30 m tall, trunk to 60 cm diameter; young twigs cylindrical, 0.4-1.7 mm diameter, pubescent; bark light gray to yellowish, slightly rugose. *Leaves* opposite, deciduous; bud scales persistent; blades medium green above, lighter below, lanceolate to oblong, 4.5-12 × 1-3 cm, chartaceous, glabrous, domatia casual, base acute to attenuate, margin flat to slightly undulate, apex acute to acuminate, the acumen 1-13 mm long, midrib sunken above, raised below, secondary veins conspicuous, 6-17 per side, 5-15 mm apart, looping 1-6 mm from the margin; petiole green, 4-15 × 0.4-1.2 mm, not woody, pubescent. *Thyraxes* geminate to fasciculate, multiflorous, compact to somewhat diffuse; peduncle 2-4 mm long, moderately to densely pubescent; pedicel (0-)0.4-9 mm long, moderately to densely pubescent; calyx moderately to densely pubescent outside, glabrous inside, lobes triangular, 0.5-1.6 × 0.7-1.6 mm; corolla red-brown tinged green outside, red-brown inside, cupuliform, 2.5-5 mm long, glabrous on both sides, the tube 1-3 mm long, lobes widely ovate, apex rounded; corona present, 1-2 mm long, undivided; stamens 1-2.6 mm long, anthers transversely oblong, 0.6-1.8 mm long; pistil 1.2-2.5 mm long, stigma bilobed. *Fruiting pedicel* 1-8 × 0.8-2 mm; young fruits green, reddish brown when mature, subglobose to ovoid, 11-21.5 × 7-19 mm, surface smooth, apex bluntly pointed to rostellate, the rostellum circular, rounded; dry pericarp 0.4-1.9 mm thick; endocarp woody; seed 7-17 × 5.5-12.5 mm.

Distribution, ecology and phenology

Noronhia seyrigii occurs in low- to mid-elevation transitional forests and thickets, from Antsalova in the west to Fort-Dauphin in the south (Fig. 49). It produces flowers and fruits throughout the year except in May.

Conservation status

Sixty-seven collections representing 58 localities were available for analysis, which yielded an EOO of 168,756 km², an AOO of 216 km², and 48 subpopulations representing 37 locations, of which 11 occur within protected areas (Amoron'i Onilahy, Analavelona, Andohahela, Behara-Tranomaro, Bemaraha, Beompa, Beza-Mahafaly, Pic d'Ivohibe, Tsimembo, and Zombitsy). Being widespread and occurring in many protected areas, *N. seyrigii* is assigned a preliminary status of "Least Concern".

Notes

Noronhia seyrigii can be recognized by its non-woody, pubescent petioles, chartaceous, lanceolate leaf blades, red-brown tinged greenish flowers, and subglobose fruits with woody endocarp. This species closely resembles *N. tropophylla* from which it differs mainly by the flower color (red vs. white) and the presence of a corona. Because of the high degree of similarity between these two species and their partially overlapping distribution, identification of non-flowering material is difficult and often inaccurate.

Noronhia seyrigii was based on the following syntypes: *Humbert* 12375, 12445, 12808, 12955 and 13227, *Perrier de la Bâthie* 12715, 17362 and 19259, *Seyrig* 22a, 22b, 22c and 22 (=Herb. Jard. Bot. Tan. 6101). Of these specimens, *Humbert* 12375 and *Seyrig* 22b have the most complete material and are represented by the most duplicates, therefore one of the sheets of *Seyrig* 22b at P has been chosen as the lectotype since the species is named after André Seyrig (1897-1945), a French civil engineer and renowned naturalist who worked extensively in southern Madagascar.

PERRIER DE LA BÂTHIE (1949) mentioned *Humbert* 1322 as one of the syntypes in the protologue. However, this is a typographical error for *Humbert* 13227, which he later corrected in the "Flore de Madagascar et des Comores" volume (PERRIER DE LA BÂTHIE, 1952). Likewise, *Seyrig* 22a is listed as a syntype but it could not be located at the Paris herbarium. Interestingly, there are two specimens numbered *Seyrig* 22 (P [P03559277, P03559278]!), of which only one bears the mention "ex *Herbier du Jardin Botanique* 6101" (P [P03559277]), yet there is also another specimen explicitly numbered *Herb. Jard. Bot. Tan.* 6101 (P [P03559280]!). It is thus possible that both duplicates of *Seyrig* 22 correspond to *Seyrig* 22a, as listed by PERRIER DE LA BÂTHIE (1949), or at least the duplicate without any reference to *Herb. Jard. Bot. Tan.* 6101, namely *Seyrig* 22 (P [P03559278]). Given these facts, *Seyrig* 22a should not be regarded as a syntype.

Additional specimens examined

MADAGASCAR. **Prov. Fianarantsoa:** Ihosy Menaraka, [22°13'S 46°20'E], 21.III.1952, *Herb. Stat. Agric. Alaotra* 4515 (TAN); Ivohibe, Antambohobe, Analavory, [22°31'S 46°59'E], 10.XII.1957, *Réserves Naturelles* 9574 (P, TAN); Ihosy, Kitranga, [22°17'S 46°18'E], 750 m, 28.IV.1954, *Service Forestier* 10126 (MO, P, TEF); Ihosy, Sahalalina, Analovoky, Menarahaka, [22°32'S 46°29'E], 28.III.1955, *Service Forestier* 13792 (P, TEF); Ihosy, [22°14'00"S 46°20'30"E], 0-700 m, 24.VII.1955, *Service Forestier* 14683 (P, TEF); Zazafotsy, Ankazobetroka, [22°21'S 46°28'E], 700 m, 26.VIII.1955, *Service For-*

estier 15490 (MO, P, TEF). **Prov. Mahajanga:** Basaraha, 0-20 m, 23.XII.1952, *Leandri et al.* 2237 (G, MO); Antsalova, [18°53'S 044°23'E], 20-130 m, 1.X.1954, *Service Forestier* 11175 (P, TEF); Antsingy, Antsalova, [18°40'S 44°52'E], 150-750 m, 27.X.1954, *Service Forestier* 12010 (P, TEF); Maintirano, route d'Antsalova, [18°39'S 44°37'E], 7.VII.1956, *Service Forestier* 16340 (G, TEF). **Prov. Toliara:** Fort-Dauphin, Ambatoabo, Andohahela PN, parcelle 2, 24°47'10"S 46°43'33"E, 681 m, 16.I.2007, *Andriamihajarivo et al.* 1100 (MO, P, TAN); Andohahela PN, 24°49'49"S 46°32'15"E, 30-50 m, 16.III.1994, *Andrianarisata et al.* 82 (G, MO, P); 30 km après Betroka, [23°15'S 46°05'E], 1.XII.1959, *Bosser* 13901 (P, TAN); Along banks of Onilahy river, 23°51'S 44°19'E, 60 m, 14.II.1975, *Croat* 31176 (MO, P, TAN); Fort-Dauphin, forêt de Vinanibe, 25°03'S 46°56'E, 100 m, 17.X.1990, *Dumetz* 1308 (MO, P, TAN); de Tsivory à Anadabolava, Mandrare moyen, [24°39'S 46°26'E], 300-400 m, 1.XII.1933, *Humbert* 12340 (MO, P); Ankoba, near E edge of Andohahela PN Park, 24°47'26"S 46°42'02"E, 175 m, 23.I.2008, *Lowry et al.* 6940 (G, MO, P); Beza Mahafaly RS near Betioky, 23°39'S 44°38'E, 130 m, 20.IV.1987, *Phillipson* 1692 (MO, TAN); Makay Massif, 21°14'04"S 45°20'07"E, 450 m, 25.XI.2010, *Phillipson et al.* 6227 (G, K, MO, P, TAN); Ambohimahavelona, Sept Lacs, 23°26'59"S 43°56'25"E, 150 m, 9.II.2000, *Randrianaivo et al.* 494 (MO, P, TAN); Sakaraha, Mahaboboka, forêt d'Analaraty, 22°49'15"S 44°17'17"E, 520 m, 16.XI.2010, *Randrianarivony et al.* 235 (G, MO, P, TAN); Sakaraha, Ambovondrisaro, 22°40'34"S 44°11'40"E, 1075 m, 7.XII.2009, *A. Randrianasolo* 1233 (MO, P); Imanombo, [24°26'00"S 45°49'30"E], 300 m, 25.IX.1950, *Service Forestier* 1506 (P, TAN, TEF); 45 km de Tuléar, 30.I.1952, *Service Forestier* 4557 (P, TAN, TEF); Ampasindava, Behara, [25°07'S 46°29'E], 0-50 m, 19.IV.1952, *Service Forestier* 5296 (MO, P, TAN, TEF); Dabara, Mahabo, [20°24'S 44°47'E], 100 m, 14.XI.1952, *Service Forestier* 6146 (TEF); Bekily, Ambahitra, forêt d'Analabe, [24°07'S 45°18'E], 15.II.1954, *Service Forestier* 9252 (P, TEF); Antanimiheva, Befandriana-Morombe, [22°16'S 43°18'E], 300 m, 29.VII.1954, *Service Forestier* 10499 (P); Mikoboka, Fanjakana, Analavelona, [22°40'S 44°10'E], 600 m, 28.XI.1954, *Service Forestier* 12111 (MO, P, TEF); Morondava, Befasy, Marotavilo-Ankazofotsy, [20°58'S 44°26'E], 10.X.1955, *Service Forestier* 15023 (MO, P, TEF); de Tuléar à Sarodrano, [23°37'S 43°44'E], 0-100 m, 26.III.1961, *Service Forestier* 20179 (P, TEF); Androy, à l'O d'Imanombo, [24°26'S 45°49'E], 24.I.1963, *Service Forestier* 22512 (MO, P, TEF); 20 km sur la route Ampanihy-Tuléar, [24°41'S 44°45'E], 22.VII.1954, *Service Forestier* 167-R-18 (TEF).

77. *Noronhia similis* Hong-Wa, spec. nova (Fig. 61).

Typus: MADAGASCAR. **Prov. Antsiranana:** DIANA, Massif du Tsaratanana, [13°49'S 48°44'E], 2100 m, XI.1966, Morat 2264 (holo-: MO-6149642!; iso-: P [P00701309, P03559031]!, TAN!).

Diagnosis *Noronhia similis* Hong-Wa can be distinguished from other members of the genus by its obovate leaf blades that are somehow tinged golden, sericeous to glabrescent at maturity, and its compact inflorescences with greenish white flowers.

Description Trees to 10 m tall; young twigs flattened, 1.5-4.5 mm diameter, glabrous; bark light gray, rugose. Leaves opposite, persistent; bud scales deciduous; blades dark green above, lighter below, obovate, 5-11.5 × 3-5.5 cm, subcoriaceous, glabrous to sericeous, domatia casual, base rounded, margin flat, apex rounded to slightly acute, the point 1-3 mm long, midrib slightly sunken above, distinctly raised below, secondary veins conspicuous, 7-10 per side, 8-20 mm apart, looping 2-9 mm from the margin; petiole brownish, 5-13 × 1-2.5 mm, usually entirely woody, glabrous. Thyrses solitary to geminate, multiflorous, compact; peduncle 5-10 mm long, moderately to sparsely pubescent; pedicel 2-10 mm long, moderately to sparsely pubescent; calyx moderately to sparsely pubescent outside, glabrous inside, lobes triangular, 1-2 × 1-2.5 mm; corolla greenish white, subrotate, 3.5-5 mm long, glabrous on both sides, the tube 0-2.5 mm long, lobes oblong, apex obtuse; corona absent; stamens 2-4 mm long, anthers oblong to ovate, 1.7-2.8 mm long; pistil 2-3 mm long, stigma capitate. Fruiting pedicel 1-2 × 1-1.5 mm; young fruits green, unseen mature, ovoid, 10-11 × 7-8 mm, smooth to rugose, apex bluntly pointed, dry pericarp 0.5 mm thick; endocarp woody.

Etymology The resemblance between *Noronhia similis* and *N. broomeana* was used as the basis for the specific epithet of the new species described here.

Distribution, ecology and phenology *Noronhia similis* occurs in mid- to high-elevations humid forests on basement rocks and quartzites from the Tsaratanana massif to Makira in the north and from Ivohibe RS to Andohahela in the south (Fig. 62). It has been collected in flowers from October to December.

Conservation status Based on six collections representing six localities, the assessment indicated an EOO of 68,364 km², an AOO of 24 km², and six subpopulations representing six locations, all of which occur within protected areas (Analamazaotra, Andohahela, Corridor Ambositra-Vondrozo, Makira, Tsaratanana, and Tsaratanana-Ambohipiraka-Corridor Marojejy). Given the large distribution, number of locations and AOO, whose actual value is likely to exceed the estimated value, *N. similis* is assigned a preliminary status of "Least Concern".

Notes *Noronhia similis* most closely resembles *N. broomeana*, but differs from it mainly by its woody (vs. non-woody) petiole, oblong (vs. obovate) leaf blades, and connate (vs. almost free) petals. Obovate leaf blades that are somehow tinged golden, sericeous to glabrescent at maturity, and compact inflorescences with greenish white flowers characterize this new species.

Paratypes **MADAGASCAR. Prov. Antsiranana:** Massif du Tsaratanana, vallon d'Ambatoafy, [13°49'S 48°44'E], XI.1966, *Morat* 2431 (P, TAN); *ibid. loc.*, haut bassin de la Maevarano, [13°58'12"S 48°50'24"E], 1750-2000 m, 6.XI.1966, *Service Forestier* 24980 (P, TEF). **Prov. Fianarantsoa:** Ivohibe RS, 22°28'12"S 46°57'36"E, 900 m, 9.X.1997, *Rakotomalaza et al.* 1393 (G, MO, P, TAN). **Prov. Mahajanga:** Befandriana-Nord, Matsoandakana, Ambotaharanana Andranomena, 15°07'48"S 49°20'38"E, 1146 m, 15.II.2008, *Bernard* 836 (MO, P, TAN). **Prov. Toamasina:** Analamazaotra RS, [18°56'S 48°26'E], 15.X.1953, *Service Forestier* 8566 (P, TEF); *ibid. loc.*, [18°56'S 48°26'E], 10.XI.1954, *Service Forestier* 12162 (P, TEF). **Prov. Toliara:** Andohahela PN, 24°33'S 46°52'E, 700-850 m, 2.XII.1989, *McPherson* 14577 (K, MO, P, TAN).

Fig. 61. *Noronhia similis* Hong-Wa.

A. Flowering and fruiting branch;
B. Abaxial side of leaf blade;
C. Adaxial side of leaf blade;
D. Flower; **E.** Inner side of corolla;
F. Pistil; **G.** Stamen.

[Morat 2264, MO] Drawings: R.L. Andriamiarisoa

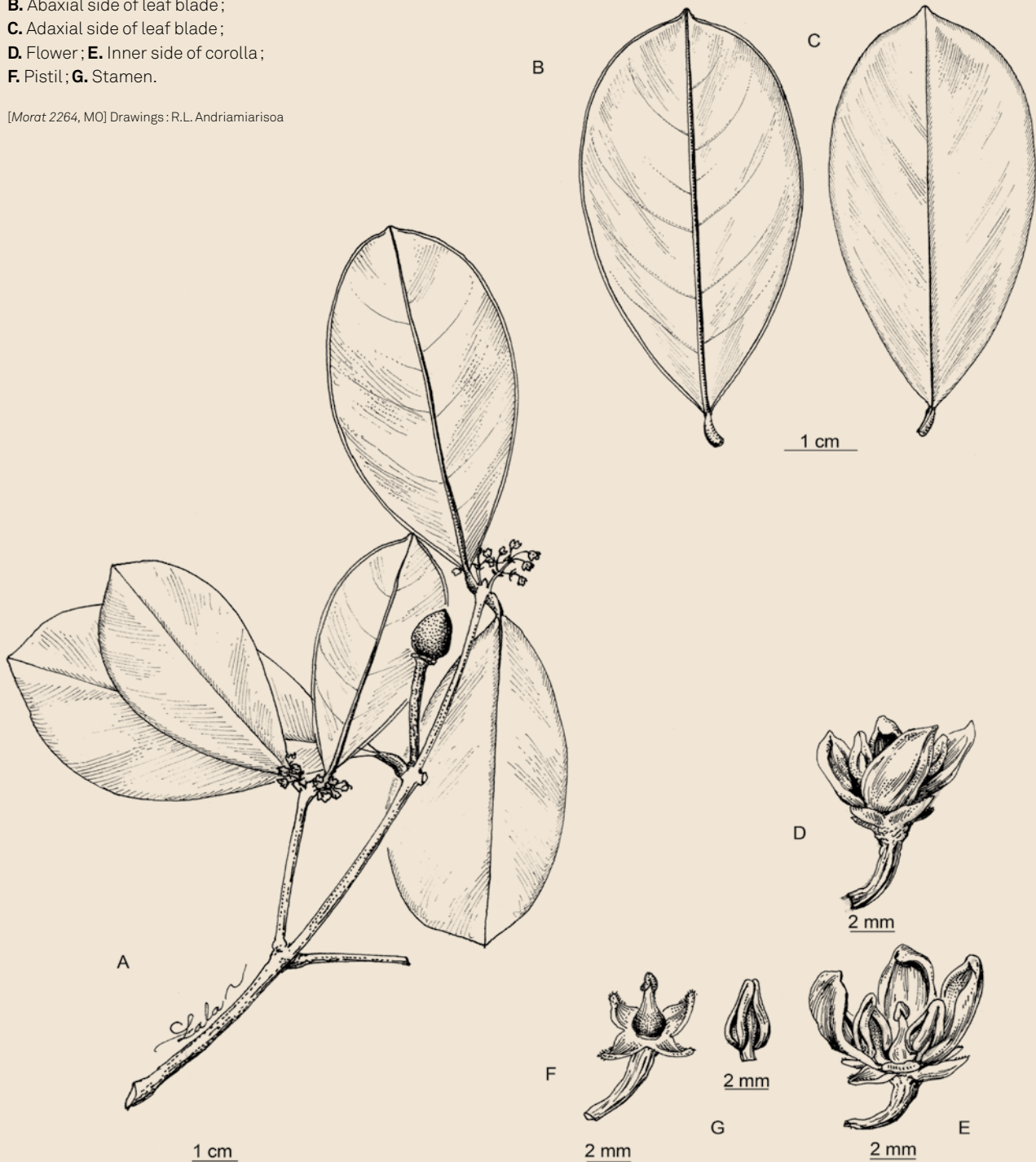




Fig. 62. Distribution maps of species of *Noronhia* Stadtm. ex Thouars. *N. similis* Hong-Wa to *N. tubulosa* H. Perrier.

78. *Noronhia spinifolia* Hong-Wa, *spec. nova* (Fig. 63).

Typus: MADAGASCAR. **Prov. Antsiranana:** SAVA, Vohémar, Daraina, Bekaraoka Sud, 13°10'17"S 49°42'12"E, 149 m, 31.V.2005, *Hong-Wa et al.* 278 (holo-: MO-6615554!; iso-: CNARP!, G [G00341617]!, K!, P [P04254208]!, TAN!).

Diagnosis *Noronhia spinifolia* Hong-Wa can be distinguished from other congeneric species by its narrowly linear leaf blades that are terminated by a spiny apex.

Description Shrubs to 6 m tall, trunk to 8 cm diameter; young twigs cylindrical, 0.6-1.4 mm diameter, glabrous; bark medium gray, smooth. Leaves opposite, persistent; bud scales rarely persistent; blades light green above, darker below, linear, 4-9.5 × 0.3-0.7 cm, coriaceous, glabrous, domatia absent, but can be present on stems, base rounded, margin revolute, apex acute and spiny, the point 1-2 mm long, midrib flat above, slightly raised below, secondary veins inconspicuous, 8-14 per side, 3-13 mm apart, looping 0.4-1 mm from the margin; petiole medium gray, 1-4 × 0.5-1.5 mm, entirely woody, glabrous. Flowers solitary to geminate; pedicel 5-14 mm long, glabrous; calyx glabrous on both sides, lobes triangular, 1-1.7 × 0.4-0.7 mm; corolla cream-white, urceolate, 5-7 mm long, glabrous on both sides, the tube 4-6 mm long, lobes deltate, apex truncate; corona present, 1.4-2 mm long, slightly lobed; stamens 1.7-2.3 mm long, anthers oblong to obovate, 1.1-1.6 mm long; pistil 3-3.5 mm long, stigma bilobed. Fruiting pedicel 6-12 × 0.5-1 mm; young fruits green, reddish when mature, ovoid, 8-10 × 6-7 mm, smooth to rugose, apex apiculate; dry pericarp 0.3 mm thick; endocarp crustaceous; seed 7 × 5 mm.

Etymology The leaf blade is terminated by a sharp, spine-like apex, which characterizes this species and was used as the basis for the specific epithet.

Distribution, ecology and phenology *Noronhia spinifolia* occurs in low-elevation semi-deciduous forests on basement rocks and limestones in the north, particularly around Daraina and Montagne des Français (Fig. 62). It produces flowers and fruits from October to May.

Conservation status The assessment included 11 collections representing 10 localities and indicated an EOO of 708 km², an AOO of 36 km², and seven subpopulations representing five locations, of which three occur within the newly established protected areas of Loky-Manambato and Montagne des Français. Forest exploitation and land conversion will cause decline in habitat quality and loss of mature individuals at some of the locations. Therefore, *N. spinifolia* is assigned a preliminary status of "Endangered" [EN B1ab(iii,v)+2ab(iii,v)].

Notes *Noronhia spinifolia* closely resembles *N. linearifolia*, from which it differs by its acute and spiny (vs. retuse) leaf apex, cream-white (vs. reddish brown) flowers, and crustaceous (vs. woody) endocarp. It can be recognized by its narrowly linear leaf blades with a spiny apex, solitary to geminate cream-white flowers, and apiculate fruits.

Paratypes **MADAGASCAR. Prov. Antsiranana:** Vohémar, Daraina, Mahatsara, Ambilondambo, 13°09'55"S 49°38'52"E, 292 m, 17.XI.2005, *Be et al.* 297 (CNARP, G, MO, P, TAN); Mahavanona, Andranomanitra, Montagne des Français, 12°22'07"S 49°20'54"E, 195 m, 14.XII.2006, *Be et al.* 324 (CNARP, MO, P, TAN); Daraina, Ankijabe, forêt de Binara, 13°15'S 49°37'E, 500 m, 6.XI.2001, *Gautier & Ravelonarivo* 4077 (Daraina, G, K, MO, TEF); Daraina, forêt de Solaniampilana-Maroadabo, 13°05'53"S 49°34'51"E, 100 m, 6.III.2004, *Gautier et al.* 4444 (Daraina, G, K, MO, TEF); Daraina, forêt de Bekaraoka, 13°04'58"S 49°42'04"E, 140 m, 22.XI.2006, *Gautier & Chatelain* 4897 (Daraina, G, K, MO, TEF); Daraina, Ambararatabe, 13°04'50"S 49°41'44"E, 80 m, 26.X.2004, *Maraia* 13 (Daraina, G, K, NEU, P, TEF); Daraina, Mantamena, part of Bekaraoka Range, 7 km NE of Daraina, 14°60'S 49°42'E, 112-330 m, 14.XII.1990, *Meyers* 235 (K, MO, P, TAN); *ibid. loc.*, 13°08'S 49°42'E, 112-330 m, 1991, *Meyers* 292 (MO, P, TAN); Daraina, Befarafara, forêt de Solaniampilana, 13°05'26"S 49°34'32"E, 100 m, 15.XI.2005, *Rakotonandrasana et al.* 991 (CNARP, G, MO, P, TAN); *ibid. loc.*, Ampasimbe, 13°06'02"S 49°34'39"E, 186 m, 11.XII.2006, *Rakotondrajaona et al.* 403 (CNARP, MO, P, TAN); Vohémar, versant E du massif de l'Ankerana (partie S du massif de Mafokovo), 50-450 m, 17.XII.1966, *Service Forestier* 27353 (P, TEF).



Fig. 63. *Noronhia spinifolia* Hong-Wa.
A. Fruiting branch;
B. Abaxial side of leaf blade; **C.** Flower;
D. Pistil; **E.** Inner view of corolla; **F.** Fruit.

[Hong-Wa 278, TAN] Drawings: R.L. Andriamiarisoa

79. *Noronhia stevensiana* Hong-Wa, *spec. nova* (Fig. 64, 65A).

Typus: MADAGASCAR. **Prov. Antsiranana:** DIANA, Diégo II, Antsalaka, Montagne d'Ambre AP, 12°37'17"S 49°10'46"E, 1038 m, 12.VI.2010, Hong-Wa 711 (holo-: MO-6615564!; iso-: P!, TAN!).

Diagnosis *Noronhia stevensiana* Hong-Wa can be distinguished from other members of the genus by its partially woody petioles, its chartaceous and lanceolate leaf blades, its somewhat compact inflorescences, with cupuliform, cream-white pinkish flowers, and its crustaceous, subglobose fruits without a distinct apex.

Description Trees to 14 m tall, trunk to 20 cm diameter; young twigs flattened to cylindrical, 0.5-2 mm diameter, glabrous; bark dark gray, smooth to rugose. Leaves opposite, persistent; bud scales deciduous; blades medium green above, lighter below, lanceolate to oblong, 6-14 × 1.5-4 cm, chartaceous, glabrous, domatia absent, base acute, margin flat to slightly undulate, apex acuminate, the acumen 5-22 mm long, midrib flat to slightly sunken above, raised below, secondary veins conspicuous, 8-15 per side, 6-16 mm apart, looping 1.5-4 mm from the margin; petiole medium gray, 4-12 × 1-1.7 mm, partially woody, glabrous. Thyrses solitary to geminate, pauciflorous, compact to somewhat diffuse; peduncle 5-10 mm long, moderately pubescent; pedicel 2-5 mm long, moderately pubescent; calyx moderately pubescent outside, glabrous inside, lobes triangular, 0.8-1.5 × 1-2 mm; corolla pink fading to white cream tinged pink, cupuliform, 2.5-3.5 mm long, glabrous on both sides, the tube 1.3-2.5 mm long, lobes widely ovate, apex obtuse; corona present, 1-1.5 mm long, undivided; stamens 1.5-1.7 mm long, anthers obovate, 1-1.1 mm long; pistil 1.3-2.2 mm long, stigma capitate. Fruiting pedicel 4-5 × 1.6-1.8 mm; young fruits green, purplish black when mature, subglobose to ovoid, 17.5-21 × 14.5-19 mm, surface smooth to rugose, sometimes covered with a white pellicle, apex flat; dry pericarp 0.7-0.8 mm thick; endocarp crustaceous; seed 19 × 8.5 mm.

Etymology This name honors Peter F. Stevens for his contribution to the knowledge of the Malagasy flora, for his invaluable mentorship, and for sharing his passion for plants.

Distribution, ecology and phenology *Noronhia stevensiana* occurs in mid- to high-elevation humid forests on lavas on the Montagne d'Ambre in the north (Fig. 62). It produces flowers and fruits from January to June.

Conservation status *Noronhia stevensiana* is currently known only from nine collections representing seven localities. With an EOO of 33 km², an AOO of 24 km², and three subpopulations representing three locations, all included within Montagne d'Ambre PN, which is still sub-

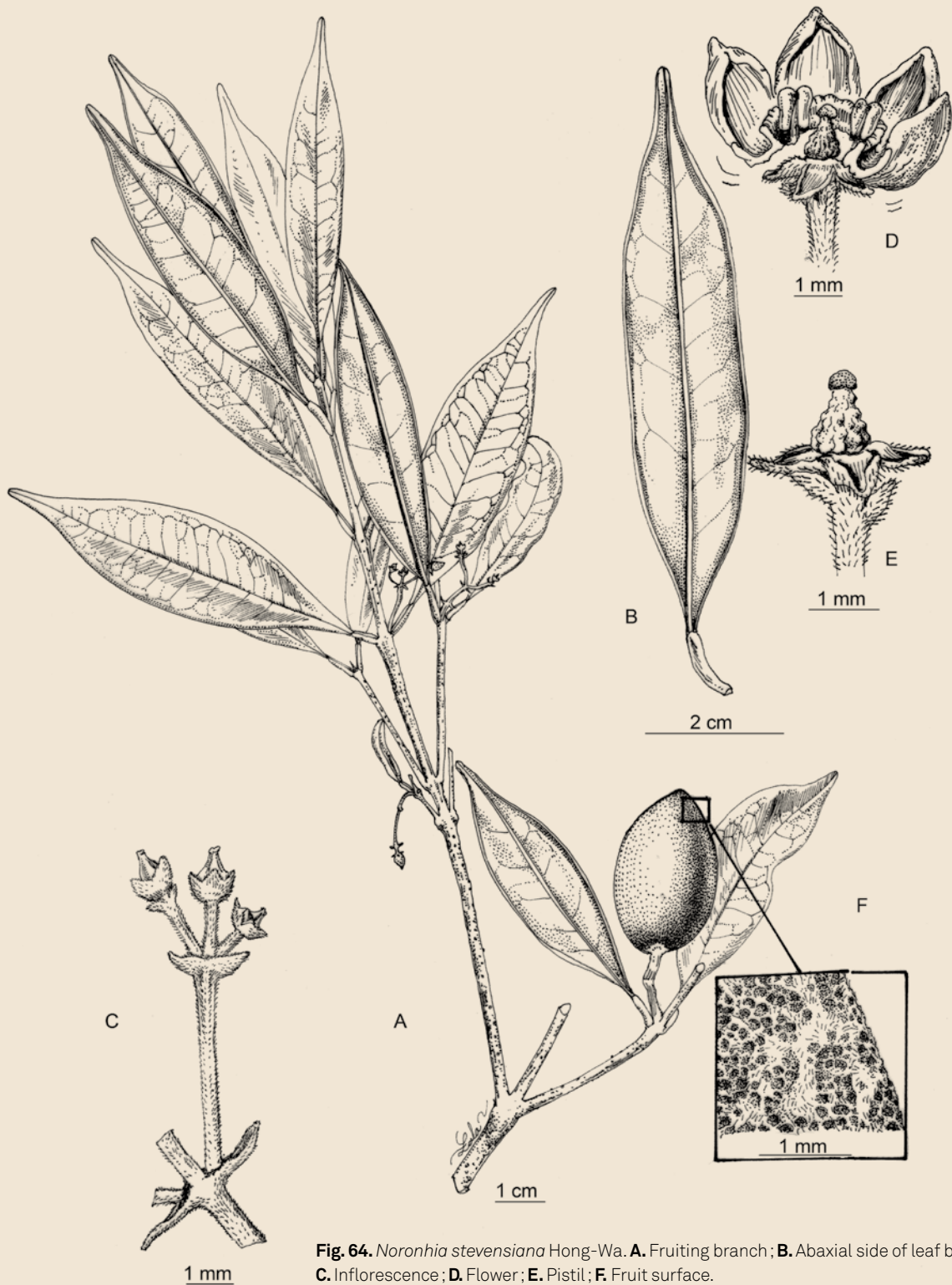


Fig. 64. *Noronhia stevensiana* Hong-Wa. **A.** Fruiting branch; **B.** Abaxial side of leaf blade; **C.** Inflorescence; **D.** Flower; **E.** Pistil; **F.** Fruit surface.

[Hong-Wa 711, TAN] Drawings: R. L. Andriamiarisoa

ject to continuing decline in habitat quality and loss of mature individuals as a result of illicit exploitation and encroachment for crop and khat cultivation, *N. stevensiana* is assigned a preliminary status of “Endangered” [EN B1ab(iii,v)+2ab(iii,v)].

Notes *Noronhia stevensiana* resembles *N. schatzii*, but these two taxa can be distinguished by the texture of their petioles, the density of their inflorescences, the pubescence of their peduncles and pedicels, and the shape of their fruits. Identifying features include partially woody petioles, chartaceous and lanceolate leaf blades, somewhat compact inflorescences, with cupuliform, cream-white pinkish flowers, and crustaceous, subglobose fruits without a distinct apex.

Paratypes **MADAGASCAR. Prov. Antsiranana:** Joffreville, Montagne d'Ambre PN, 12°32'19"S 49°09'32"E, 1219 m, 23.I.2009, *Hong-Wa* 577 (MO, P, TAN); *ibid. loc.*, *Hong-Wa* 578 (MO, P, TAN); *ibid. loc.*, *Hong-Wa* 580 (MO, P, TAN); *ibid. loc.*, 12°30'55"S 49°10'34"E, 891 m, 24.I.2009, *Hong-Wa* 590 (MO, P, TAN); *ibid. loc.*, 12°30'56"S 49°10'40"E, 931 m, 16.V.2010, *Hong-Wa & Ortiz* 680 (MO, P, TAN); *ibid. loc.*, 12°32'35"S 49°08'46"E, 1315 m, 17.V.2010, *Hong-Wa & Ortiz* 685 (MO, TAN); *ibid. loc.*, 12°36'17"S 49°11'22"E, 1035 m, 9.V.2008, *Trigui et al.* 383 (G, MO, TEF); *ibid. loc.*, 12°37'48"S 49°10'44"E, 1030 m, 16.VI.2008, *Trigui et al.* 543 (G, MO, TEF).



Fig. 65. Photographs of *Noronhia* Stadtm. ex Thouars.

A. *Noronhia stevensiana* Hong-Wa [Trigui 383]; **B.** *Noronhia tefyana* Hong-Wa [Gautier 5662].

Photos: taken by respective collectors.

80. *Noronhia tefyana* Hong-Wa, spec. nova (Fig. 65B, 66).

Typus: MADAGASCAR. **Prov. Mahajanga:** Melaky, Maintirano, village d'Ambinda, 18°04'S 44°30'E, 203 m, 19.X.2009, Razakamalala et al. 4440 (holo-: MO-6615561!; iso-: G [G00341622]!, P [P00722508] image seen, TAN).

Diagnosis *Noronhia tefyana* Hong-Wa can be distinguished from other species of the genus by its lanceolate leaf blades, its long acumen, its fasciculate, pink flowers, and its slightly rugose, apiculate fruits.

Description Trees to 5 m tall; young twigs cylindrical, 0.5-1.5 mm diameter, glabrous; bark light gray, smooth. Leaves opposite, semi-deciduous; bud scales persistent; blades dark green above, lighter below, broadly lanceolate, 5-10.5 × 1.5-3.5 cm, subcoriaceous, glabrous, domatia absent, base attenuate, margin flat, apex acuminate, the acumen 8-20 mm long, midrib slightly sunken above, distinctly raised below, secondary veins conspicuous only below, 8-13 per side, 5-11 mm apart, looping 1-5 mm from the margin; petiole light gray, 4-7 × 1-1.5 mm, entirely woody, glabrous. Flowers fasciculate; pedicel 7-9 mm long, glabrous; calyx moderately to sparsely pubescent outside, glabrous inside, lobes triangular, 1.5-2 × 1.3-1.7 mm; corolla pinkish with green lobes, cupuliform, 4-4.5 mm long, glabrous on both sides, the tube 2.5-3.5 mm long, lobes deltate, apex acute; corona present, 1.5 mm long, undivided; stamens 2-2.5 mm long, anthers obovate, 1.5-2 mm long; pistil 1.8-2 mm long, stigma capitate. Fruiting pedicel 9-15 × 0.8-1.1 mm; young fruits green, brownish when mature, ovoid to subglobose, 12-13 × 9-10 mm, surface smooth to slightly rugose, covered with a white pellicle, apex rostrate, the rostrum flattened, apiculate; dry pericarp 0.4 mm thick; endocarp woody; seed 7 × 5 mm.

Etymology This name honors Tefy Andriamihajarivo, a botanist at the Missouri Botanical Garden in Madagascar, for contributing to the knowledge and conservation of the Malagasy flora, for collecting *Noronhia* in the field, and for helping with various requests during this study.

Distribution, ecology and phenology *Noronhia tefyana* occurs in low-elevation dry forests in and around the Bemaraha PN in the west (Fig. 62). It produces flowers and fruits from October to March.

Conservation status *Noronhia tefyana* is currently known only from nine collections representing eight localities. With an EOO of 1037 km², an AOO of 28 km², and four subpopulations representing four locations, of which two occur within protected areas (Beanka and Bemaraha), *N. tefyana* is assigned a preliminary status of "Endangered"



[EN Blab(i,ii,iii,iv)+2ab(i,ii,iii,iv,v)]. Indeed, decline in habitat quality and habitat loss will persist in most of its range because of wildfire, forest exploitation, nomadic grazing, and conversion of forested area into agricultural fields.

Notes *Noronhia tefyana* is similar to *N. buxifolia*, but these two taxa can be distinguished by the shape of their leaves and flowers, the length of their pedicels, and the color of their corolla. The new species can be recognized by its lanceolate leaf blades with a long acumens, fasciculate, pink flowers, and slightly rugose, apiculate fruits.

Paratypes **MADAGASCAR. Prov. Mahajanga:** Beanka, Kinahango, 18°01'28"S 44°30'16"E, 172 m, 19.XI.2011, *Gautier 5662* (G, K, MO, P, TEF); *ibid. loc.*, Sarodrano, 18°03'51"S 44°31'46"E, 333 m, 10.XII.2011, *Hanitrarivo et al. 6* (G, K, MO, P, TEF); *ibid. loc.*, 18°03'45"S 44°31'05"E, 296 m, 4.III.2012, *Hanitrarivo et al. 253* (G, K, MO, P, TEF); *ibid. loc.*, 18°02'51"S 44°31'29"E, 499 m, 8.III.2012, *Hanitrarivo et al. 281* (G, K, MO, P, TEF); Tsingy de Bemaraha, S of the Manambolo river, 19°09'S 44°49'E, 50 m, 18.XII.1996, *Jongkind et al. 3590* (G, MO, P, TAN, WAG); Belitsaka, 17°32'27"S 44°16'53"E, 23.X.2009, *Rakotonasolo et al. 1433* (CAS, K, MO, P, TAN); Maintirano, Ambinda, 18°04'S 44°30'E, 203 m, 19.X.2009, *Razakamalala et al. 4459* (MO, TAN); Melaky, 14 km E Antsalova, 18°41'S 44°43'E, 18.III.1993, *Villiers et al. 4824* (P).

81. *Noronhia tetrandra* H. Perrier in Mém. Inst. Sci. Madagascar, Sér. B, Biol. Vég. 2 : 282. 1949 (Fig. 67A).

Typus : MADAGASCAR. **Prov. Toliara :** Est : Bassin de Mananara, SE, [24°54'S 46°32'E], 700 m, VI.1919, *Perrier de la Bâthie* 12642 (holo- : P [P00413241] !; iso- : P [P00413242] !).

Description

Trees to 18 m tall, trunk to 25 cm diameter; young twigs cylindrical, 0.8-3.6 mm diameter, glabrous; bark medium gray, smooth. *Leaves* opposite, persistent; bud scales persistent; blades medium green above, lighter below, elliptic to obovate, 4-13 × 2-4.5 cm, coriaceous, glabrous, domatia absent, base attenuate, margin revolute, apex retuse to slightly acuminate, the acumen 1-2 mm long, midrib sunken above, raised below, secondary veins conspicuous mostly below, 6-11 per side, 6-23 mm apart, looping 1-5 mm from the margin; petiole yellow to reddish, 4-17 × 1.5-4.5 mm, not woody, glabrous. *Thyrse*s geminate, multiflorous, compact to somewhat diffuse; peduncle 2-15 mm long, moderately pubescent; pedicel 2-7 mm long, moderately pubescent; calyx moderately pubescent outside, glabrous inside, lobes triangular, 0.8-1.7 × 1-2 mm; corolla white tinged greenish, urceolate to subrotate, 3.5-6.5 mm long, glabrous on both sides, the tube 1-3 mm long, lobes oblong, apex obtuse; corona present, 1.3-2.2 mm long, undivided; stamens 1.8-3 mm long, anthers oblong, 1.3-1.9 mm long; pistil 1.6-3.5 mm long, stigma bilobed. *Fruiting* pedicel 2.5-12 × 0.7-2.4 mm; young fruits greenish, brownish when mature, ovoid, 10-24 × 7-18.5 mm, surface smooth, apex rostellate, with the persistent style; dry pericarp 0.6-1.6 mm thick; endocarp woody; seed 8.5-17.5 × 6-12 mm.

Distribution, ecology and phenology

Noronhia tetrandra occurs in littoral to mid-elevation humid forests from Sambava in the north to Fort-Dauphin in the south (Fig. 62). It produces flowers and fruits throughout the year except in May.

Conservation status

With 30 collections representing 25 localities, the assessment indicated an EOO of 72,134 km², an AOO of 72 km², and 14 subpopulations representing 12 locations, of which six occur within protected areas (Behara-Tranomaro, Manombo, Ste Luce, Tampolo, Tsitongambarika, and Vohibola). Given the large EOO, an actual AOO that likely well exceeds 2,000 km², and the number of locations, *N. tetrandra* is assigned a preliminary status of "Least Concern".

Notes

Noronhia tetrandra can be recognized by its non-woody petioles, elliptic to obovate leaf blades, revolute margins, compact inflorescences with white flowers, and ovoid, rostellate fruits. Although four stamens have occasionally been found within this species, they only represent a rare character state that appears to be a teratology. This species differs from *N. martiniana* by its elliptic to obovate (vs. oblanceolate to obovate) leaf blades, its urceolate to subrotate (vs. campanulate) flowers, the presence (vs. absence) of a corona, and its rounded (vs. truncate) rostellum.

Additional specimens examined

MADAGASCAR. **Prov. Antsiranana:** Antsirabe-Nord, forêt d'Analamateza, [13°58'S 49°58'E], 25-27.III.1967, *Service Forestier* 27570 (MO, P, TEF). **Prov. Fianarantsoa:** Mahabo Mananivo, Nosiala, forêt d'Agnalazaha, 23°11'08"S 47°42'48"E, 50 m, 5.III.2009, *Hong-Wa et al.* 616 (G, MO, P, TAN); *ibid. loc.*, Baboaka, 23°10'40"S 47°42'41"E, 23 m, 19.IV.2004, *Ludovic & Soazafy* 725 (MO); *ibid. loc.*, forêt d'Ampitavananima, 23°11'10"S 47°43'02"E, 30 m, 5.VIII.2004, *Ludovic et al.* 855 (G, MO, P, TAN); *ibid. loc.*, 23°10'51"S 47°42'29"E, 30 m, 5.XI.2001, *McPherson & Rabenantoandro* 18339 (G, MO, P, TEF); *ibid. loc.*, 23°10'20"S 47°42'23"E, 29 m, 23.IX.2002, *Rabenantoandro* 968 (MO, P, TEF); Farafangana, Ankarana, Manombo RS, 23°03'46"S 47°46'15"E, 14 m, 24.IX.2005, *Rakotonirina et al.* 452 (MO, TAN); Anosiala-Analamena, 23°11'07"S 47°42'06"E, 23 m, 19.VI.2004, *A. Randrianasolo et al.* 874 (G, MO, P); Analazaha, [22°51'S 47°38'E], 0-200 m, 30.VIII.1955, *Service Forestier* 15382 (P, TEF); Tohakandra, [23°02'10"S 47°44'50"E], 0-10 m, 8.IX.1955, *Service Forestier* 15408 (MO, P, TEF). **Prov. Toamasina:** Brickaville, Ambinaninony, forêt de Vohibola, 18°33'55"S 49°15'22"E, 3-10 m, 29.X.2002, *Ludovic et al.* 202 (G, MO, P, TAN, TEF); Fénérive-Est, Tampolo STF, 17°16'52"S 49°24'44"E, 0-10 m, 23.XI.1994, *Raholivelo & Schatz* 30 (MO); Antananala, Ambila-Lemaitso, [18°49'S 49°08'E], 30 m, 10.II.1954, *Service Forestier* 8315 (P, TEF); Maroantsetra, Vohilava, [15°38'30"S 49°34'00"E], 600 m, 9.III.1954, *Service Forestier* 9135 (P, TEF); Tampolo STF, [17°17'00"S 49°23'30"E], 10 m, 4.I.1955, *Service Forestier* 15328 (P, TEF); Andasin'Onibe, Andranotsara, Mahatsara STF, 17°38'18"S 49°29'04"E, 5 m, 23.VI.1993, *Service Forestier* 33903 (TEF). **Prov. Toliara:** Fort-Dauphin, Mahatalaky, forêt de Sainte Luce (SD17), 24°50'34"S 47°08'12"E, 5 m, 14.II.2009, *Hong-Wa* 604 (MO, P, TAN); Massif du Vohitsiandriana, au N du Cap Andrahomana, [25°10'S 46°38'E], 400 m, III.1955, *Service Forestier* 11840 (MO).

82. *Noronhia tropophylla* (H. Perrier) Hong-Wa & Besnard in Mol. Phylogenet. Evol. 67: 377. 2013 (Fig. 67B).

≡ *Linociera tropophylla* H. Perrier in Mém. Inst. Sci. Madagascar, Sér. B, Biol. Vég. 2: 280. 1949.

≡ *Chionanthus tropophyllus* (H. Perrier) Stearn in Bot. J. Linn. Soc. 80: 205. 1980.

Lectotypus (designated here): **MADAGASCAR. Prov. Mahajanga:** Plateau d'Antanimena (Boina), [16°29'S 46°11'E], VI.1919, *Perrier de la Bâthie* 12340 (P [P03559134]!); isolecto-: P [P03559129, P03559133]!. **Syntypi:** **MADAGASCAR. Prov. Fianarantsoa:** à l'E d'Ihosi, [22°23'S 46°07'E], 27.VII.1928, *Humbert & Swingle* 4895 (G [G00188829] image seen, P [P03559100, P03868244]!); vallée d'Ihosi, [22°23'S 46°07'E], 700 m, X.1924, *Perrier de la Bâthie* 16564 (P [P03559093, P03559103, P03559104]!). **Prov. Mahajanga:** Bemaraha, [18°41'S 44°46'E], VIII.1943, *Herb. Jard. Bot. Tan.* 6145 (P [P03559126, P03559271]!); Besafotra (Menavava), [17°05'S 46°44'E], X.1899, *Perrier de la Bâthie* 1010 (P [P03559095, P03559096, P03559097, P03559098]!); Manongarivo (Ambongo), [16°16'S 45°22'E], V.1904, *Perrier de la Bâthie* 1725 (P [P03559094, P03559119, P03559120]!); Mahavavy (Ambongo), [16°05'S 46°01'E], VII.1904, *Perrier de la Bâthie* 1791 (P [P03559124, P03559132]!); Manongarivo (Ambongo), [16°16'S 45°22'E], IX.1904, *Perrier de la Bâthie* 8830 (P [P03559131]!); Bongolava, [15°46'S 47°30'E], VI.1907, *Perrier de la Bâthie* 8831 (P [P03559125, P03559127, P03559136]!); bassin moyen du Bemarivo (Boina), II.1907, *Perrier de la Bâthie* 8832 (P [P03559092, P03559102], syntypes); Manongarivo (Ambongo), [16°16'S 45°22'E], VII.1904, *Perrier de la Bâthie* 8833 (P [P03559135]!); Basaka sur le causse d'Ankara (Boina), [17°06'S 46°06'E], X.1901, *Perrier de la Bâthie* 8834 (P [P03559130]!); Ankarafantsika PN, [16°11'S 47°10'E], *Service Forestier* 5 (P [P03559101, P03868248]!); *ibid. loc.*, borne n° 9, [16°11'S 47°10'E], 100-150 m, 7.IX, *Service Forestier* 8 (P [P03559121]!) [as *Service Forestier* 28].

– *Linociera tropophylla* var. *angustata* H. Perrier in Mém. Inst. Sci. Madagascar, Sér. B, Biol. Vég. 2: 281. 1949 [nom. inval.]. ≡ *Noronhia tropophylla* var. *angustata* (H. Perrier) Hong-Wa & Besnard in Mol. Phylogenet. Evol. 67: 377. 2013 [nom. inval.].

Description Trees to 10 m tall, trunk to 25 cm diameter; young twigs cylindrical, 0.4-1.7 mm diameter, pubescent; bark medium gray, smooth. Leaves opposite, deciduous; bud scales rarely persistent; blades medium green above, lighter below, lanceolate to oblong, 5-14 × 1-3 cm, chartaceous, pubescent on lower midrib when young, domatia abundant, base acute to attenuate, margin flat to undulate, apex acute to acuminate, the acumen 1-15 mm long, midrib slightly sunken above, distinctly raised below, secondary veins conspicuous, 7-20 per side, 5-14 mm apart, looping 1-3.5 mm from the margin; petiole yellow, 5-30 × 0.5-1.3 mm, not woody, pubescent when young. Thyrses geminate, multiflorous, com-

pact; peduncle 3-15 mm long, moderately to densely pubescent; pedicel 2-5 mm long, moderately to densely pubescent; calyx moderately to densely pubescent outside, glabrous inside, lobes triangular, 0.8-1 × 0.8-1.2 mm; corolla white, subrotate, petals almost free, 4.5-6 mm long, glabrous on both sides, the tube 1.5 mm long, lobes oblong, apex slightly obtuse; corona absent; stamens 1.6-1.8 mm long, anthers oblong, 1.1-1.2 mm long; pistil 1.6-2 mm long, stigma bilobed. *Fruiting* pedicel 2-7 × 0.7-1.8 mm; young fruits green, light to dark brown when mature, subglobose, 9.5-22 × 7-20 mm, surface smooth, sometimes covered with white dots, apex flat to bluntly pointed, style persistent; dry pericarp 0.6-1.8 mm thick; endocarp woody; seed 6.5-11.5 × 5.5-12 mm.

Distribution, ecology and phenology

Noronhia tropophylla occurs in low- to mid-elevation dry forests and woodlands from the Sofia region in the northwest to Ihosy in the south (Fig. 62). It produces flowers and fruits throughout the year except in September.

Conservation status

Noronhia tropophylla is a widespread species occurring at 29 localities scattered from the northwest to the south. With an EOO of 250,483 km², an AOO of 112 km², and 25 subpopulations representing 22 locations, of which eight occur within protected areas (Ankarafantsika, Baie de Baly, Beanka, Bemaraha, Corridor Bongolava, Menabe-Antanimena, and Sahamalaza-Iles Radama), *N. tropophylla* is assigned a preliminary status of “Least Concern”.

Notes

Noronhia tropophylla can be recognized by its non-woody petioles, oblong to lanceolate leaf blades often bearing domatia, white, subrotate flowers that lack a corona, and subglobose fruits. It closely resembles *N. seyrigii* but differs from it by features discussed earlier under that species, mainly flower color and presence/absence of a corona. *Noronhia tropophylla* exhibits slight variations in the narrowness and texture of the leaf blades that may be linked to different environments. PERRIER DE LA BÂTHIE (1949, 1952) used these variations as a basis for recognizing two varieties, which are not adopted here. In any case, the varietal name *Linociera tropophylla* var. *angustata* was not validly published because it was not accompanied by a Latin diagnosis (Art. 39.1; McNEILL et al., 2012).

The following syntypes were used as a basis for *Noronhia tropophylla*: *Herb. Jard. Bot. Tan.* 6145, *Humbert & Swingle* 4895, *Perrier de la Bâthie* 1010, 1725, 1791, 8830, 8831, 8832, 8833, 8834, 12340 and 16564, and *Service Forestier* 5 and 28, the latter probably a mistake for *Service Forestier* 8. One of the sheets of *Perrier de la Bâthie* 12340 at P has been chosen as the lectotype because of its overall completeness and quality.

Two collections bearing the same number *Perrier de la Bâthie* 8830, probably due to a numbering mistake, are recognized respectively as *Linociera tropophylla* (P [P03559131]!) and *Noronhia boinensis* (P [P007010251, P04046995]). Similarly, P has two duplicates of *Herb. Jard. Bot. Tan.* 6145 (P [P03559126, P03559271]), one of which was identified as *L. tropophylla* (P [P03559126]) and the other as *N. seyrigii* (P [P03559271]), although the number is cited as *L. tropophylla* in the protologue (PERRIER DE LA BÂTHIE, 1949). In addition, while the labels indicate Bemaraha (western Madagascar) as the place of collection, *Perrier de la Bâthie* corrected the locality on the one he identified as *N. seyrigii* (P [P03559271]), indicating that it was in fact collected at Ampandrandava (southern Mad-

agascar): “Localité probablement erronée – spécimen provenant probablement d’Ampandrandava et des récoltes de Seyrig”. He nevertheless again cited Bemaraha as the place of collection for this number in both the protologue and the “Flore de Madagascar et des Comores” volume (PERRIER DE LA BÂTHIE, 1949, 1952).

Additional specimens examined

MADAGASCAR. Prov. Fianarantsoa: entre Ambalavao et Ihosy PK 528, [22°23'S 46°07'E], 1.II.1963, *Bosser 17535* (MO, TAN); 35 km S of Ambalavao, 21°52'S 46°48'E, 890 m, 1.IV.1991, *Miller & Randrianasolo 6265* (MO, TAN); Ambalavao, [21°50'S 46°56'E], 11.VIII.1960, *Réserves Naturelles 11199* (MO, P). **Prov. Mahajanga:** Belitsaky, Ankilimanarivo, 17°52'09"S 44°29'14"E, 156 m, 25.X.2009, *Andriamihajarivo et al. 1809* (G, MO, P, TAN, TEF); Beanka, Ambinda-Nord, 18°02'40"S 44°30'07"E, 246 m, 1.XII.2011, *Bolliger 44* (BR, G, K, MO, P, TEF); *ibid. loc.*, 17°56'26"S 44°28'08"E, 172 m, 14.II.2011, *Gautier et al. 5592* (G, K, MO, P, TEF); *ibid. loc.*, Sarodrano, 18°03'01"S 44°31'09"E, 450 m, 5.III.2012, *Hanitrarivo et al. 265* (G, MO); *ibid. loc.*, Andalaposa, 18°00'27"S 44°29'55"E, 291 m, 16.III.2012, *Hanitrarivo et al. 345* (G, MO); *ibid. loc.*, 18°02'42"S 44°30'11"E, 259 m, 27.III.2012, *Hanitrarivo et al. 396* (G, MO); Marovoay, Ampijoroa STF, 16°19'07"S 46°48'13"E, 198 m, 14.III.2009, *Hong-Wa 630* (MO, P, TAN); Tsingy de Bemaraha N of the Manambolo river, 19°09'S 44°49'E, 50 m, 5.XII.1996, *Jongkind et al. 3393* (G, MO, P, WAG); Antsalova, 1 km à l'E d'Ambinda, 18°38'S 44°42'E, 100-200 m, 4.XII.1992, *Labat & Deroin 2302* (MO, P); Port-Bergé, Tsiningia, Marosely, 15°38'58"S 47°35'03"E, 217 m, 16.XI.2004, *Ramananjahary et al. 68* (G, MO, P, TEF); Mampikony, Betaramahamay, Ambohimanga, 15°57'05"S 47°26'09"E, 232 m, 4.XII.2004, *Ramananjahary et al. 226* (G, MO, P, TEF); Ambolobozo, Analalava, 14°19'27"S 47°54'36"E, 275 m, 23.VII.1999, *Ranaivojaona et al. 241* (MO, P, TAN); Belobaka, Antsahanitra STF, 15°35'23"S 46°26'00"E, 40 m, 27.XI.2003, *Randrianaivo et al. 958* (CNARP, G, MO, P, TAN); Tsaratanana, Bekapaika, Ambalafary, forêt de Koakala, 16°48'09"S 47°28'58"E, 400 m, 8.XII.2003, *Randrianaivo et al. 998* (CNARP, G, MO, P, TAN); Port Bergé, Bongolava, forêt de Marosely, 15°38'58"S 47°35'03"E, 217 m, 17.XI.2004, *Razakamalala et al. 1691* (MO, P, TEF); *ibid. loc.*, forêt d'Andranomena II, 15°34'00"S 47°29'55"E, 115 m, 28.XI.2004, *Razakamalala et al. 1778* (G, MO, P, TEF); Ampijoroa, [16°18'S 46°49'E], 15.VII.1970, *A. Richard 340* (MO); Maintirano, Ambinda, 18°04'S 44°30'E, 203 m, 19.X.2009, *Razakamalala et al. 4450* (MO, P, TAN); Tsaramandroso, Bevazaha, [Ankarafantsika PN], [16°00'S 46°56'E], 15.X.1947, *Réserves Naturelles 1100* (MO, P); *ibid. loc.*, Lac Tsimaloto, [16°11'S 47°10'E], 80 m, *Service Forestier 22* (P); *ibid. loc.*, *Service Forestier 49* (P); Soalala, Antsakoamileka, forêt Marovitika, [16°08'S 45°27'E], 18.IV.1956, *Service Forestier 15917* (P, TEF); Mandritsara, Andohajango, Ambavaranobe, au bord de la Manambendrana, [16°08'S 48°38'E], 14.V.1966, *Service Forestier 25929* (MO, P). **Prov. Toliara:** Zazafotsy, PK 573, II.1962, *Bosser 15822* (MO, P, TAN); Ankirijifotsy, Belo-Tsiribihina, [19°42'S 44°33'E], 27.XI.1953, *Service Forestier 7988* (MO, P).



Fig. 67. Photographs of *Noronhia* Stadtm. ex Thouars. **A.** *Noronhia tetrandra* H. Perrier [Hong-Wa 616]; **B.** *Noronhia tropophylla* (H. Perrier) Hong-Wa & Besnard [Bolliger 44]; **C.** *Noronhia tubulosa* H. Perrier [Hong-Wa 629]; **D.** *Noronhia verticillata* H. Perrier [Hong-Wa 634].

Photos: taken by respective collectors

83. *Noronhia tubulosa* H. Perrier in Mém. Inst. Sci. Madagascar, Sér. B, Biol. Vég. 2: 295. 1949 (Fig. 67C).

Lectotypus (designated here): **MADAGASCAR. Prov. Mahajanga:** env. de Majunga, [15°43'S 46°19'E], XII.1918, *Perrier de la Bâthie* 12325 (P [P00418102]!; isolecto-: K [K000233180, K000233181] images seen, P [P00573407, P00573408]!). **Syntypus:** **MADAGASCAR. Prov. Mahajanga:** env. de Majunga, s.d., *Alleizette* s.n. (P, not found).

Description

Small *trees* to 8 m tall, trunk to 19 cm diameter; young twigs cylindrical, 0.6–1.4 mm diameter, glabrous; bark medium gray to brownish, slightly rugose. *Leaves* opposite, persistent; bud scales persistent; blades light green above, yellowish below, elliptic, 3.5–7 × 1–2.5 cm, coriaceous, glabrous, domatia absent, base attenuate, margin flat to slightly revolute, apex retuse to slightly acuminate, the acumen 1–6 mm long, midrib slightly sunken above, distinctly raised below, secondary veins conspicuous mostly below, 5–12 per side, 4.5–11 mm apart, looping 1–2 mm from the margin; petiole medium gray, 3.5–6 × 0.7–1.5 mm, entirely woody, glabrous. *Flowers* fasciculate; pedicel 4–12 mm long, very sparsely pubescent; calyx very sparsely pubescent outside, glabrous inside, lobes triangular, 1–1.2 × 0.6–1.5 mm; corolla yellow tinged reddish, tubular, somewhat campanulate, 5–10 mm long, glabrous on both sides, the tube 4–8 mm long, lobes deltate, apex acute; corona present, 1.2–2 mm long, slightly lobed; stamens 1.7–2.5 mm long, anthers obovate, 1.3–1.7 mm long; pistil 1.8–2 mm long, stigma capitate. *Fruiting* pedicel 3–14 × 0.6–1 mm; young fruits green, dark red when mature, subglobose, 9–17 × 7–12 mm, surface smooth, apex apiculate; dry pericarp 0.3–0.8 mm thick; endocarp woody; seed 5–13 × 4–7.5 mm.

Distribution, ecology and phenology

Noronhia tubulosa occurs in low-elevation dry forests in the Boina and Melaky regions in the west (Fig. 62). It produces flowers and fruits from November to May.

Conservation status

There were seven collections representing six localities available for analysis, which yielded an EOO of 20,371 km², an AOO of 20 km², and four subpopulations representing four locations, of which two occur within protected areas (Ankarafantsika and Mahavavy-Kinkony). The actual AOO, although surely larger than the estimated value given above, is likely less than 2,000 km². Moreover, due to wildfire, forest exploitation, grazing, and land conversion, subpopulations of *N. tubulosa* are projected to experience continuing decline in habitat quality as well as habitat loss. Therefore, it is assigned a preliminary status of “Vulnerable” [VU B2ab(i,ii,iii,iv,v)].

Notes

Noronhia tubulosa can be recognized by its coriaceous, elliptic leaf blades, fasciculate, yellow tinged red flowers with a tubular to somewhat campanulate corolla, and small, subglobose fruits. It differs from *N. boinensis*, as previously discussed, by the conspicuousness of its leaf venation and the color and shape of its flowers.

This species was based on two syntypes (*Perrier de la Bâthie* 12325 and *Alleizette* s.n.). However, PERRIER DE LA BÂTHIE (1949, 1952) mentioned that *Alleizette* s.n. is in fact just a part of his own collection (*Perrier de la Bâthie* 12325), writing “même localité, simple part probable du précédent [i.e. *Perrier de la Bâthie* 12325]” in 1949 and “même localité, exemplaire qui n’est évidemment qu’une simple part du précédent [i.e. *Perrier de la Bâthie* 12325]” in 1952, which seems odd. In any case, *Alleizette* s.n. could not be located in the Paris herbarium, therefore a specimen of *Perrier de la Bâthie* 12325 has been chosen as the lectotype and *Alleizette* s.n. has not been listed as an isolectotype.

**Additional specimens
examined**

MADAGASCAR. **Prov. Mahajanga:** Ankarafantsika PN, 16°19'S 46°49'E, 60-200 m, 8.IV.1988, *Gentry & Schatz* 62153 (MO, P, TAN); *ibid. loc.*, 16°17'45"S 46°49'20"E, 116 m, 14.III.2009, *Hong-Wa* 629 (MO, P, TAN); Maintirano, Ampasimandro, [18°04'E 44°01'S], s.d., *Service Forestier* 16313 (TEF); près de Benetsy, [15°56'S 45°47'E], 21.XI.1965, *Service Forestier* 24268 (MO, P, TEF); Marovoay, Ampijoroa STF, 16°18'S 46°49'E, 200 m, 14-15.XII.1991, *Service Forestier* 34329 (MO, TEF).

84. *Noronhia urceolata* H. Perrier in Mém. Inst. Sci. Madagascar, Sér. B, Biol. Vég. 2 : 300. 1949.

Lectotypus (designated here): **MADAGASCAR. Prov. Mahajanga:** Ankaizina, [14°30'S 48°55'E], 1200 m, s.d., *Perrier de la Bâthie* 8827 (P [P00418103]!). **Syntypus:** Massif du Manongarivo, [14°00'S 48°23'E], 800 m, V.1909, *Perrier de la Bâthie* 8824 (P [P03559253, P03559254]!).

Description *Shrubs* to small trees to 4 m tall, trunk to 6 cm diameter; young twigs cylindrical, 1-2 mm diameter, glabrous; bark light gray to whitish, smooth. *Leaves* opposite, persistent; bud scales persistent; blades medium green above, lighter below, oblong to elliptic, 8.5-18 × 2-4 cm, chartaceous, glabrous, domatia casual, base acute to attenuate, margin flat to slightly revolute, apex acuminate, the acumen 4-12 mm long, midrib slightly sunken above, distinctly raised below, secondary veins conspicuous, 8-14 per side, 11-17 mm apart, looping 1-4.5 mm from the margin; petiole light gray, 5-10 × 1.2-2 mm, entirely woody, glabrous. *Thyrse*s fasciculate, multiflorous, diffuse; peduncle 2-17 mm long, very sparsely pubescent; pedicel 7-14 mm long, very sparsely pubescent; calyx very sparsely pubescent outside, glabrous inside, lobes deltate, 1.4-2.2 × 1.3-2 mm; corolla dark brown on dry material, urceolate, 3.5-5 mm long, glabrous on both sides, the tube 2-3.5 mm long, lobes widely ovate, apex rounded; corona absent; stamens 1.2-2.8 mm long, anthers widely ovate to cordiform; pistil 2-3 mm long, stigma capitate. *Fruiting* pedicel 8 × 1.3-1.4 mm; young fruits green, brown when mature, subglobose, 23.5-27 × 23-24.5 mm, surface smooth, sometimes covered with a white pellicle, apex flat to slightly apiculate; dry pericarp 0.8 mm thick; endocarp crustaceous; seed 11.5 × 9.5 mm.

Distribution, ecology and phenology *Noronhia urceolata* occurs in low- to mid-elevation transitional forests from Sambirano in the northwest to Antsalova in the west (Fig. 68). It produces flowers and fruits from October to May.

Conservation status Based on six collections representing five localities, the assessment indicated an EOO of 59,126 km², an AOO of 20 km², and five subpopulations representing five locations, of which only one occurs within a protected area (Bemaraha). Given that the actual AOO is probably larger than estimated but likely does not exceed 2,000 km², along with the small number of locations and projected continuing decline in habitat quality and in the number of mature individuals as well as habitat loss resulting from wildfire, grazing, expansion of agricultural fields, and forest exploitation, *N. urceolata* can be assigned a preliminary status of "Vulnerable" [VU B2ab(i,ii,iii,iv,v)].

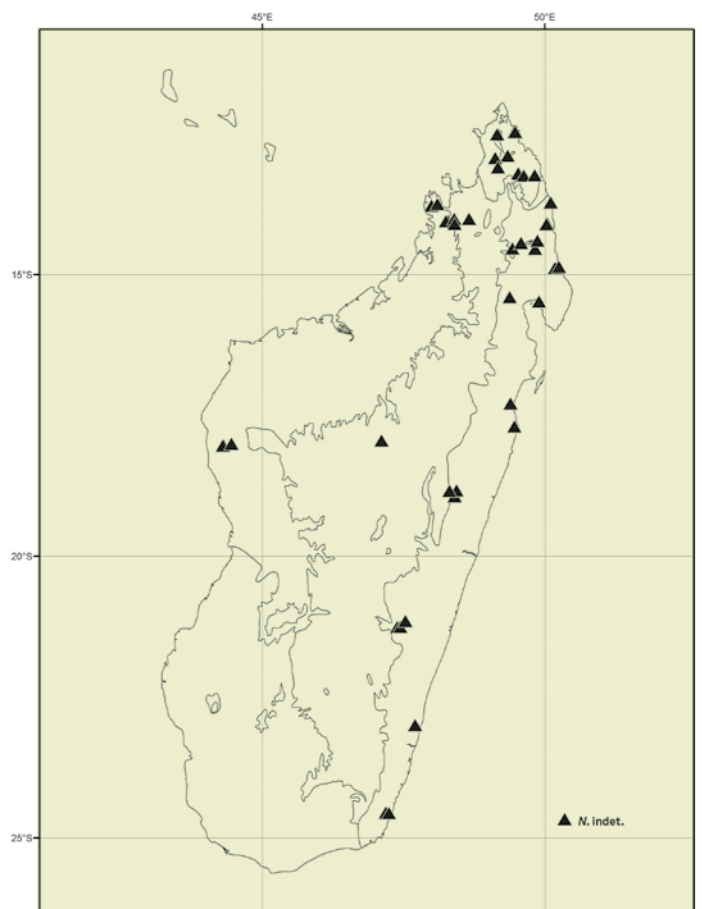
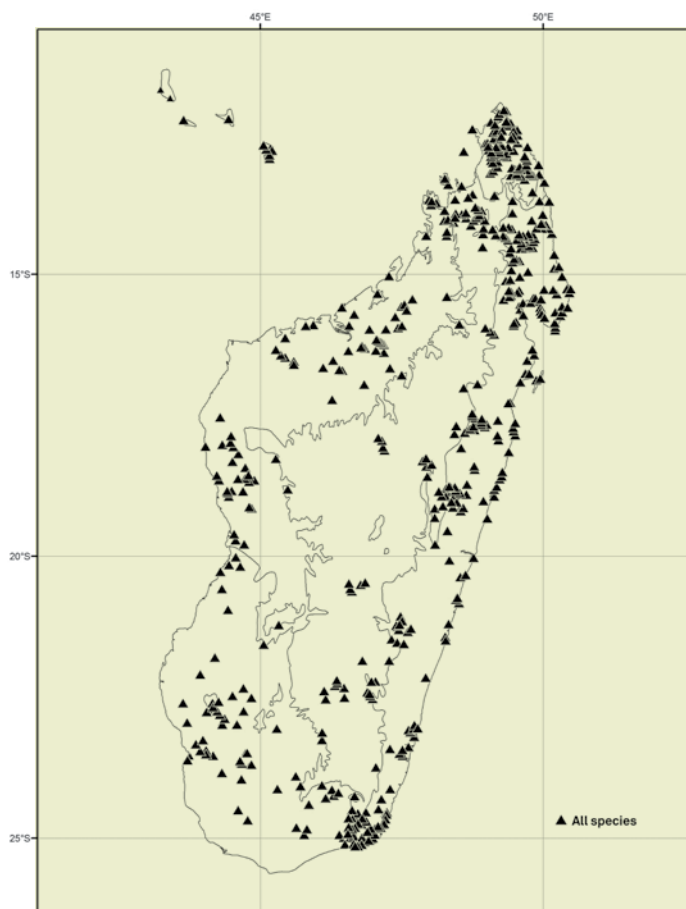
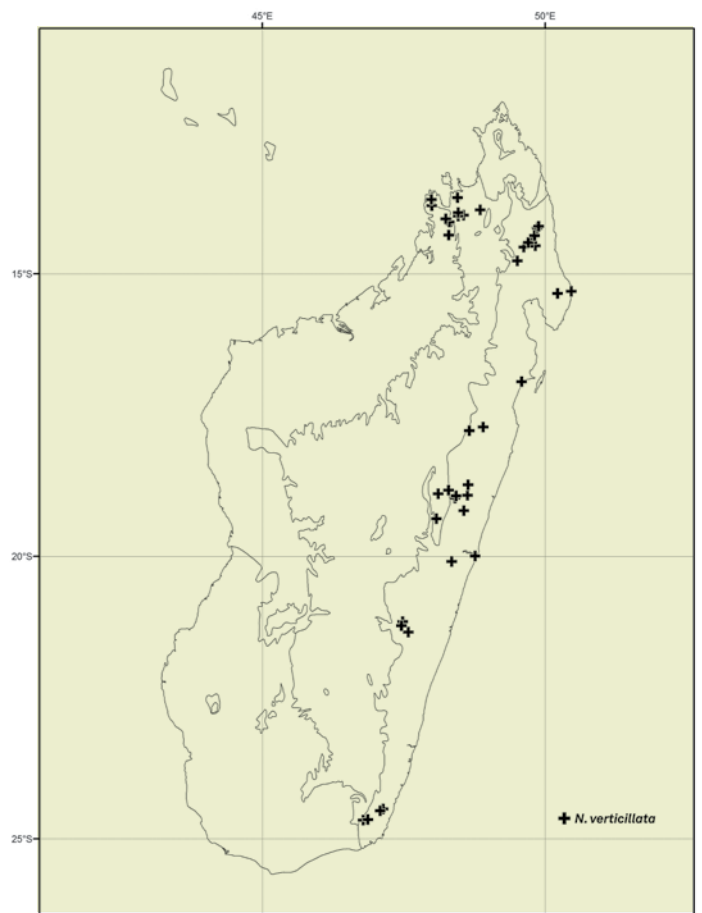
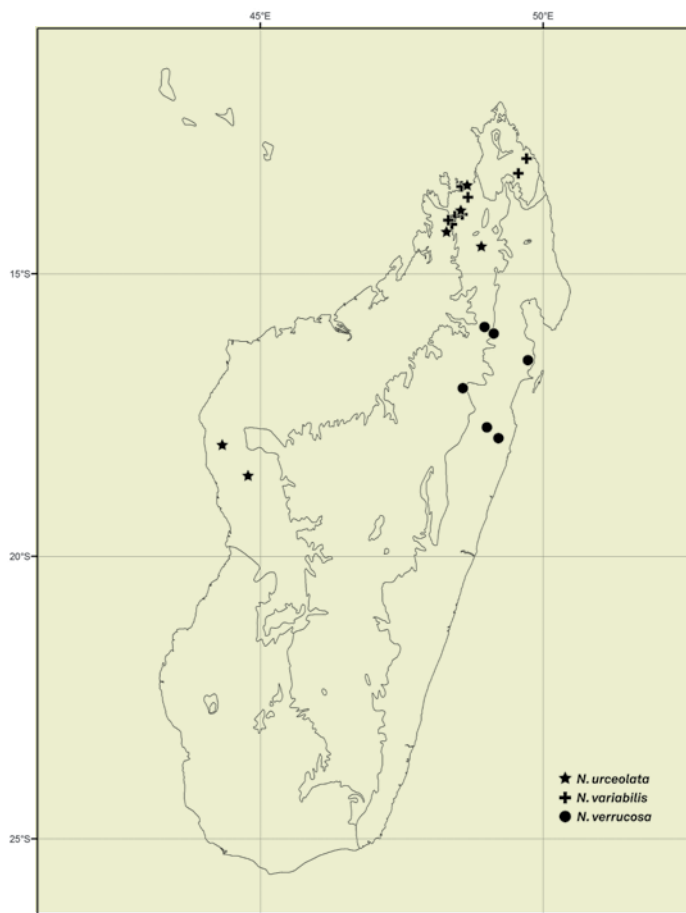


Fig. 68. Distribution maps of species of *Noronhia* Stadtm. ex Thouars. *N. urceolata* H. Perrier to *Noronhia verticillata* H. Perrier.

Notes *Noronhia urceolata* can be recognized by its chartaceous, oblong to elliptic leaf blades, large inflorescences with urceolate flowers, and subglobose fruits with crustaceous endocarp. It differs from *N. leandriana* by its woody petioles, the shape of its flowers and fruits, and the absence of a corona. *Noronhia urceolata* was based on two syntypes (*Perrier de la Bâthie* 8824 and 8827), the latter of which has better material and is thus chosen as the lectotype.

Additional specimens examined **MADAGASCAR.** **Prov. Antsiranana:** Ambanja, Marovato, [13°57'S 48°33'E], 16.XII.1951, *Saboureau* 3275 (MO, P); Ambanja, forêt Bemanasy, [13°47'S 48°37'E], 14.XI.1953, *Service Forestier* 7900 (MO, P, TEF). **Prov. Mahajanga:** Antsingy, vers Bevary (E d'Antsalova), [18°37'S 44°48'E], 400-600 m, 27.I.1960-5.II.1960, *Leandri & Saboureau* 2837 (G, MO, P); vers Ambondro, Antsingy, [18°40'S 44°52'E], 400-600 m, 2.II.1960, *Leandri & Saboureau* 2912 (MO, P); Kimanambolo, Belit-saka, 18°02'09"S 44°19'27"E, 18.X.2009, *Rakotonasolo et al.* 1401 (MO, P, TAN).

85. *Noronhia variabilis* Hong-Wa, spec. nova (Fig. 69, 70).

– *Noronhia* sp. 2, sp. 4 in GAUTIER (2002 : 202).

Typus: MADAGASCAR. **Prov. Antsiranana:** DIANA, Ambato FC, à 40 km au N d'Ambanja sur le versant S de la Montagne d'Ambato, 13°26'S 48°33'E, 90-459 m, 22.XI.1996, *Randrianaivo et al.* 27 (holo-: MO-6615560!; iso-: G, NY, P [P03559017]!, TAN!).

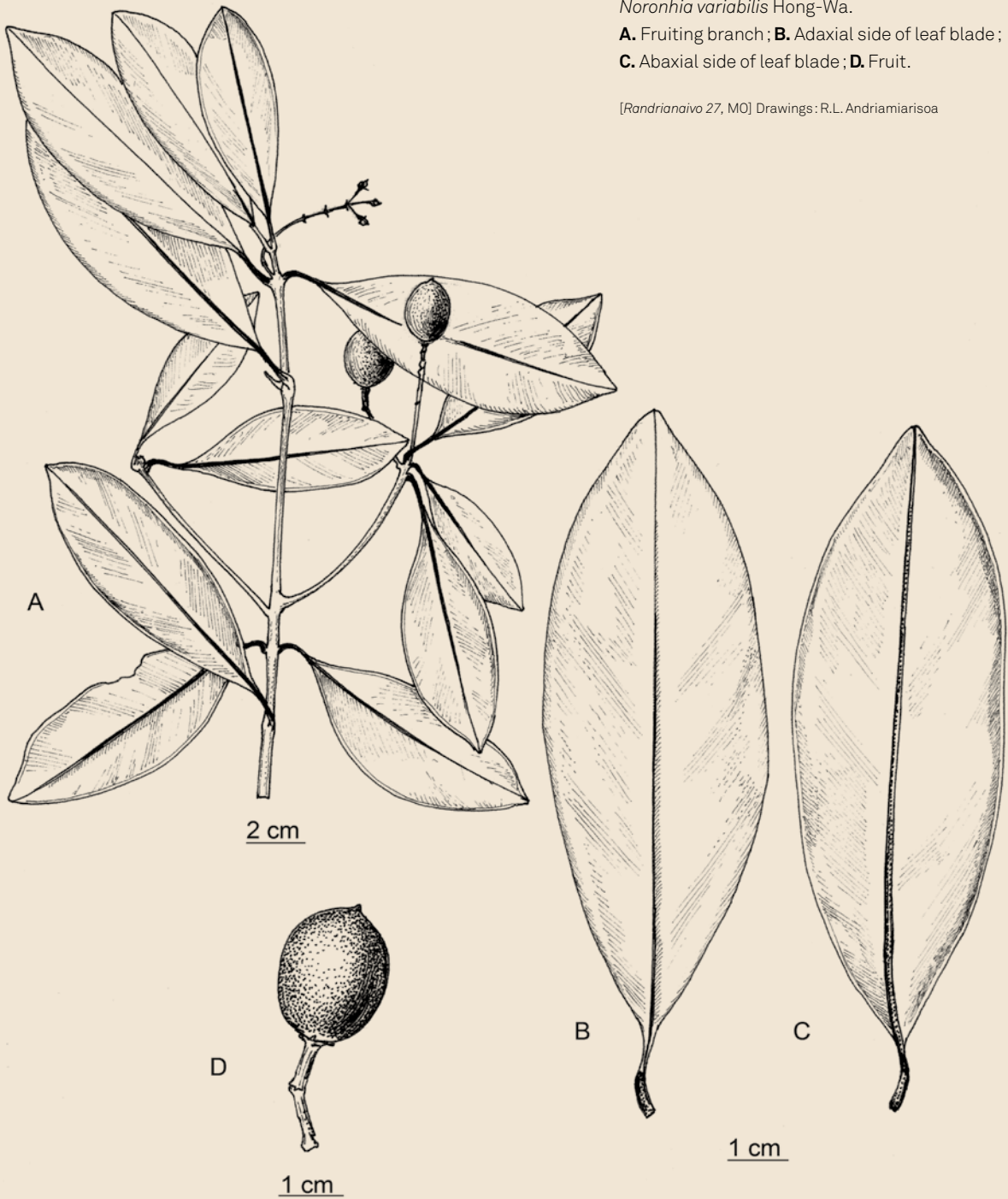
Diagnosis *Noronhia variabilis* Hong-Wa can be distinguished from other members of the genus by its often non-woody, reddish petioles, its coriaceous, elliptic to oblong leaf blades, and its ovoid to subglobose fruits, with smooth surface and woody endocarp.

Description Trees to 15 m tall, trunk to 12 cm diameter; young twigs cylindrical to flattened, 1-2.7 mm diameter, glabrous; bark dark gray, smooth. Leaves opposite, persistent; bud scales persistent to deciduous; blades light green above, yellowish below, elliptic to oblong, 4.5-13 × 2-5 cm, coriaceous, glabrous, domatia absent, base attenuate, margin flat, apex acute, the point 1-5 mm long, midrib slightly sunken above, distinctly raised below, secondary veins slightly conspicuous, 5-12 per side, 6-19 mm apart, looping 2-5 mm from the margin; petiole reddish, 4-15 × 1-2.5 mm, usually not woody, glabrous. Flowers unseen, but infructescence thyrsoïd. Fruiting pedicel 2-11 × 1.5-6.5 mm; young fruits green, purple black when mature, ovoid to subglobose, 12-26 × 10.5-22 mm, smooth, apex flat to apiculate; dry pericarp 0.6-1.6 mm thick; endocarp woody; seed 13.5-21 × 10-15 mm.

Etymology The specific epithet refers to the variability found within this taxon, especially in the shape and size of its leaves.

Distribution, ecology and phenology *Noronhia variabilis* occurs in low- to high-elevation humid forests in the northern region, from Daraina to Manongarivo (Fig. 68). It fruits from May to August.

Conservation status The assessment included 13 collections representing 12 localities and resulted in an EOO of 5,196 km², an AOO of 36 km², and eight subpopulations representing seven populations, of which five occur within protected area (Galoko, Loky-Manambato, and Manongarivo). Wood harvesting, illicit exploitation, and land conversion are projected to lead to continuing decline in habitat quality, AOO and number of mature individuals in the near future. Therefore, *N. variabilis* is assigned a preliminary status of "Vulnerable" [VU B1ab(ii,iii,v)+2ab(ii,iii,v)].



Notes *Noronhia variabilis* resembles *N. macrocarpa*, from which it differs by its elliptic to oblong (vs. lanceolate to obovate) leaves with an acute (vs. acuminate) apex, and its ovoid to subglobose (vs. ovoid) and smooth (vs. rugose) fruits with a flat to apiculate (vs. flat to bluntly pointed) apex. The new species can be recognized by its often non-woody, red-dish petioles, coriaceous, elliptic to oblong leaf blades, and ovoid to subglobose fruits.

Paratypes **MADAGASCAR. Prov. Antsiranana:** Antsatrotro, Manongarivo RS, 14°04'57"S 48°22'49"E, 1350 m, 17.VIII.1994, *Andriatsiferana et al.* 1695 (G, MO, TAN); *ibid. loc.*, 14°04'57"S 48°22'49"E, 1350 m, 17.VIII.1994, *Andriatsiferana et al.* 1704 (MO); Ambilobe, Beramanja, Anketrabe, forêt de Kalabenono, 13°38'31"S 48°40'25"E, 700 m, 25.XI.2006, *Callmander et al.* 607 (G, MO, P, TAN); Ambahatra, cours supérieur, 13°59'S 48°26'E, 850 m, 28.II.1999, *Gautier* 3432 (G, MO); Daraina, forêt d'Antsahabe, 13°13'23"S 49°32'47"E, 1030 m, 24.XI.2004, *Gautier* 4740 (Daraina, G, K, MO, TEF); Manongarivo Massif, E of Ankaramy, 14°05'S 48°20'E, 1100-1175 m, 19.X.1994, *McPherson & van der Werff* 16419 (G, K, MO, TAN); Manongarivo RS, Ankaramibe, Antsatrotro, 14°04'57"S 48°22'53"E, 1350 m, 13.VIII.1994, *Rahajaso et al.* 384 (K, MO, P); *ibid. loc.*, 14°05'S 48°24'E, 679-1876 m, 12.I.1994, *Rakotomalala* 120 (G, MO, P); Vohémar, Daraina, forêt d'Ampondrabe, 12°57'29"S 49°41'50"E, 580 m, 11.IV.2004, *Ranirison* 634 (Daraina, G, K, MO, TEF); Ambilobe, Beramanja, Anketrabe, forêt de Kalabenono, 13°38'40"S 48°40'26"E, 700 m, 28.IX.2013, *Ratovoson* 2042 (G, MO, P, TAN); *ibid. loc.*, 13°39'01"S 48°40'26"E, 800 m, 27.XI.2006, *Razafitsalama* 1180 (MO, TAN); Ambanja, Marovato, [13°58'S 48°50'E], 15.VII.1953, *Réserves Naturelles* 5740 (P, TEF).



Fig. 70. *Noronhia variabilis* Hong-Wa [Razafitsalama 1180]

Photo: J. Razafitsalama.

86. *Noronhia verrucosa* H. Perrier in Mém. Inst. Sci. Madagascar, Sér. B, Biol. Vég. 2: 283. 1949.

Typus: MADAGASCAR. **Prov. Toamasina:** N d'Andilamena, [17°01'S 48°35'E], 900 m, XI.1922, *Perrier de la Bâthie 15026* (holo-: P [P00418104]!).

Description

Trees to 8 m tall, trunk to 18 cm diameter; young twigs cylindrical to subquadrangular, 1.6-2.2 mm diameter, glabrous; bark medium gray to brownish, smooth to slightly rugose. *Leaves* opposite, verticillate at the tips of the branches, persistent; bud scales persistent; blades dark green above, lighter below, obovate to obtrullate, sometimes oblong, 5.5-9.5 × 2-4 cm, coriaceous, glabrous, domatia common, base acute to attenuate, margin flat to slightly undulate, apex acute to mucronate, the mucro 2-6 mm long, midrib sunken above, raised below, secondary veins conspicuous, 8-12 per side, 5-12 mm apart, looping 1.5-4 mm from the margin; petiole medium gray, 5-11 × 2-2.5 mm, entirely woody, glabrous. *Thyrses* geminate, pauciflorous, compact; peduncle 6-12 mm long, moderately pubescent; pedicel 4-7 mm long, moderately pubescent; calyx moderately pubescent outside, glabrous inside, lobes triangular, 1.5-1.8 × 0.5-1.3 mm; corolla probably white to yellow, cupuliform, 3-4 mm long, glabrous on both sides, the tube 1.5-2 mm long, lobes oblong, apex rounded; corona present, 1.5-2 mm long, undivided; stamens 1.8-2.1 mm long, anthers oblong, 1.1-1.5 mm long; pistil 1.5-2.3 mm long, stigma capitate. *Fruiting* pedicel 5-16 × 1.7-2.2 mm; young fruits whitish green, yellowish when mature, subglobose, 17.5-19 × 14.5-15.5 mm, areolate to verrucose, apex flat; dry pericarp 1.8 mm thick; endocarp woody; seed 11 × 7 mm.

Distribution, ecology and phenology

Noronhia verrucosa occurs in low- to mid-elevation humid forests on basement rocks in the east, between Mandritsara, Andilamena and Betampona (Fig. 68). It produces flowers and fruits from November to April.

Conservation status

Based on six collections representing six localities, the assessment yielded an EOO of 14,382 km², an AOO of 24 km², and six subpopulations representing six locations, of which three occur within protected areas (Betampona, Mananara-Nord, and Zahamena). The forests outside of these protected areas still experience much disturbance, resulting in continuing decline in habitat quality, AOO and number of mature individuals. These disturbances are mostly in the form of wood harvesting and shifting agriculture. *Noronhia verrucosa* is, therefore, assigned a preliminary status of "Vulnerable" [VU B1ab(ii,iii,v)+2ab(ii,iii,v)].

Notes

Noronhia verrucosa can be recognized by its obovate to obtrullate leaf blades that are verticillate at the tips of the branches, its compact inflorescences, and its areolate to verrucose fruits. It differs from *N. macrocarpa*, as previously discussed, by the texture of its petioles, the shape of its leaves and fruits, and the surface of its fruits.

**Additional specimens
examined**

MADAGASCAR. **Prov. Mahajanga:** Mandritsara, Marotandrano, Antsiatsiaka, Ambendraria, 16°03'34"S 49°06'45"E, 764 m, 9.XI.2004, *Lehavana* 200 (G, MO, P, TAN); Mandritsara, Antsirabe, forêt d'Angijombarika, [15°57'30"S 48°58'00"E], 1100 m, 17.VIII.1954, *Service Forestier* 10605 (P, TEF). **Prov. Toamasina:** Betampona RNI, 17°55'S 49°13'E, 15.IV.1999, *Iambana* 201 (G, MO, P); Manambato forest, N of riv. Anove between Mananara and Manompana, 16°32'S 49°43'E, 125 m, 25.II.1987, *Nicoll* 510 (MO, TAN); Zahamena RNI, Mt d'Amboditamenaka, 17°43'S 48°59'E, 700 m, 20.XII.1993, *Randrianjanaka & Be Maxime* 46 (MO, TAN).

87. *Noronhia verticillata* H. Perrier in Mém. Inst. Sci. Madagascar, Sér. B, Biol. Vég. 2 : 284. 1949 (Fig. 67D).

Typus: MADAGASCAR. **Prov. Antsiranana:** Forêt du Sambirano, à la base du massif de Manongarivo, [18°54'30"S 48°37'30"E], 500 m, VI.1909, *Perrier de la Bâthie* 4596 (holo-: P [P00418105]!).

= *Noronhia cruciata* H. Perrier in Mém. Inst. Sci. Madagascar, Sér. B, Biol. Vég. 2 : 285. 1949. **Lectotypus** (designated here): MADAGASCAR. **Prov. Toamasina:** Rapides de l'Anosivola, 300 m, X.1927, *Perrier de la Bâthie* 18082 (P [P00413220]!; isolecto-: P [P00413221]!). **Syntypi:** MADAGASCAR. **Prov. Toamasina:** Ambatondrazaka, Onibe, [17°50'S 48°25'E], 1000 m, XI.1938, *Cours* 1027 (P [P00701245]!); Analamazaotra RS, [18°55'48"S 48°25'48"E], 800 m, s.d., *Perrier de la Bâthie* 8810 (P [P00701244]!). Anivorano, Andovoranto, bords de la Sahantandra, [18°55'S 48°30'E], 600 m, 16.X.1912, *Viguiet & Humbert* 750 (P [P03559261]!).

= *Noronhia verticilliflora* H. Perrier in Mém. Inst. Sci. Madagascar, Sér. B, Biol. Vég. 2 : 284. 1949. **Typus:** MADAGASCAR. **Prov. Antsiranana:** Haut bassin du Mananjéby, 300 m, VII.1913, *Perrier de la Bâthie* 8814 (holo-: P [P00418106]!; iso-: K [K000233179] image seen, P [P00418107]!).

Description

Shrubs to trees to 8 m tall, trunk to 20 cm diameter; young twigs subquadrangular to quadrangular, 1.7-5.7 mm diameter, glabrous; bark medium gray to brownish, smooth to rugose. *Leaves* verticillate, persistent; bud scales persistent; blades dark green above, lighter below, linear to lanceolate, 5.5-22 × 0.8-4.2 cm, coriaceous, glabrous, domatia casual, base acute, margin flat to slightly revolute, apex retuse to acute, the point 1-8 mm long, midrib slightly sunken above, distinctly raised below, secondary veins conspicuous, 9-24 per side, 5-17 mm apart, looping 0.8-3 mm from the margin; petiole medium gray, 5-21 × 1.2-3 mm, entirely woody, glabrous. *Thyrse*s geminate to fasciculate, multiflorous, somewhat diffuse; peduncle 5-38 mm long, very sparsely pubescent; pedicel 2-15 mm long, very sparsely pubescent; calyx very sparsely pubescent outside, glabrous inside, lobes deltate, 0.7-2 × 0.6-1.6 mm; corolla yellow, sometimes greenish, cupuliform to subrotate, 2.5-5.5 mm long, slightly tomentose outside, glabrous inside, the tube 1-2.5 mm long, lobes ovate, apex slightly acute; corona present, 1-2.2 mm long, undivided; stamens 1.6-2.8 mm long, anthers obconical, 1.1-1.7 mm long; pistil 1.5-2.8 mm long, stigma capitate. *Fruiting* pedicel 5-45 × 0.7-3.1 mm; young fruits green, brownish to dark red when mature, ovoid to subglobose, 9-22 × 6.5-18 mm, covered with white dots, apex flat to apiculate; dry pericarp 0.4-1.5 mm thick; endocarp woody; seed 6.5-14.5 × 3-11 mm.

Distribution, ecology and phenology

Noronhia verticillata occurs in low- to mid-elevation humid forests in the Sambirano region and along the east, from Vohémar to Fort-Dauphin (Fig. 68). It produces flowers and fruits throughout the year except in April and May.

Conservation status

The assessment included 52 collections representing 45 localities and indicated an EOO of 195,817 km², an AOO of 164 km², and 36 subpopulations representing 27 locations, of which 13 occur within protected areas (Ampasindava, Analamazaotra, Andohahela, Anjanaharibe-Sud, Corridor Ankeniheny-Zahamena, Manongarivo, Marojejy, Masoala, Ranomafana, Tsaratanana, Tsitongambarika, and Zahamena). With such a large distribution and presence within many protected areas, *N. verticillata* is assigned a preliminary status of “Least Concern”.

Notes

Noronhia verticillata can be recognized by its verticillate leaves and somewhat punctate fruits. Although *Noronhia cruciata* and *N. verticilliflora*, both of which have verticillate leaves, were distinguished from *N. verticillata* by PERRIER DE LA BÂTHIE (1949, 1952) based on a rotate corolla and verticillate flowers, respectively, they are placed here in synonymy because these character states fall within the range of variation of *N. verticillata*, as circumscribed here. PERRIER DE LA BÂTHIE (1949, 1952) also mentioned the presence of four stamens and the absence of a corona in *N. verticilliflora*, which he only knew from the type specimen, but these features were not observed in any other collections and their presence is ambiguous in the type. *Noronhia cruciata* was based on four syntypes: Cours 1027, Perrier de la Bâthie 8810 and 18082, and Viguiet 750. Perrier de la Bâthie 18082 has been chosen as the lectotype as it comprises the best material.

Additional specimens examined

MADAGASCAR. Prov. Antsiranana: Antalaha, Ambohitralalana (Cap-Est), Tanandavahely, 15°18'S 50°29'E, 0-15 m, 8.IX.1994, Bernard *et al.* 5 (K, MO, P, TAN); Tsaratanana Massif, 13°52'03"S 48°50'43"E, 557 m, 13.XI.2001, Birkinshaw 1024 (MO, TAN); Besinkara, Ambalafary, 350 m, 24.IV.1994, Gautier 2436 (G, P, TAN); Ampasindava, 13°47'17"S 47°59'04"E, 242 m, 6.XI.2009, Gautier *et al.* 5323 (G, K, MO, P, TEF, WAG); Maroambihy, Mandena, Marojejy PN, 14°26'13"S 49°46'32"E, 460 m, 20.III.2009, Hong-Wa *et al.* 634 (MO, P, TAN); Massif du Marojejy, [14°18'S 49°33'E], 100-300 m, 14-15.III.1949, Humbert 23398 (MO, P); Antongondriha, [14°12'S 49°52'E], 100-250 m, 1-24.XI.1951, Humbert & Capuron 23957 (G, P); Marojejy PN, base of Mt. Beondroka, 14°27'S 49°47'E, 180-230 m, 20.X.1989, Miller & Randrianasolo 4306 (MO, P, TAN); Ambodimanga, Tsaratanana RNI, 13°52'04"S 48°50'39"E, 900 m, 5.X.1998, Rabenantoandro & Birkinshaw 43 (G, K, MO, P, TAN); Marojejy PN, Mandena, Maroambihy, 14°26'13"S 49°46'32"E, 460 m, 9.X.1996, Rakotomalaza *et al.* 720 (G, K, MO, P); Anketrakabe, Manongarivo RS, 13°55'03"S 48°27'04"E, 180 m, 23-25.VII.1998, Ranaivojaona *et al.* 211 (G, MO, P, TAN); Andapa, Marojejy PN, 14°31'S 49°38'E, 603 m, 1-3.II.1994, Rasoavimbahoaka *et al.* 61 (MO, P, TAN); Anjanaharibe-Sud RS, 14°46'S 49°30'E, 985 m, 10.VII.1996, Razafimandimbison *et al.* 237 (K, MO, P, TEF); Ambanja, Marovato, [13°58'S 48°50'E], 15.VII.1953, Réserves Naturelles 5739 (P, TAN, TEF); Sambava, Andrah-

anjo, [14°18'30"S 49°49'00"E], 200 m, 3.XI.1950, *Service Forestier* 741 (P, TEF); Ambanja, Ankaramy, Antsambalahy-Beraty, [14°01'30"S 48°14'40"E], 100-200 m, 4.XI.1950, *Service Forestier* 1612 (P, TAN, TEF); Sambava, Antelimena, [14°27'30"S 49°42'30"E], 75-2123 m, 26.III.1953, *Service Forestier* 7251 (MO, P, TEF); Beampongy, [13°40'30"S 48°27'00"E], 0-100 m, 4.X.1953, *Service Forestier* 7714 (MO, P, TEF); Andapa, Doany, Androranga, bord de Bemarivo, [14°11'30"S 49°52'00"E], 100 m, 20.X.1953, *Service Forestier* 7781 (P, TEF); Antsahalava, [14°04'30"S 48°16'00"E], 360 m, 19.VII.1954, *Service Forestier* 10455 (P, TEF); Andapa, Doany, Androranga, 14°27'30"S 49°42'30"E, 75-2123 m, 23.VII.1988, *Service Forestier* 34007 (TEF); Ampasindava, forêt de Betsistsika, 13°40'37"S 47°59'16"E, 110 m, 24.I.2009, *Tahinarivony et al.* 279 (G, MO, TEF); Ambahatra, cours supérieur, 13°57'S 48°26'E, 350 m, 11.VIII.1998, *Wohlhauser* 60024 (G, MO, P, TEF). **Prov. Fianarantsoa:** Ranomafana PN, [21°10'S 47°29'E], 1955, *Rauh* 689 (TAN); Ambohimanga, Antanjona, [21°20'S 47°35'E], 30.IX.1955, *Service Forestier* 16292 (P, TEF). **Prov. Toamasina:** Ambatovy, 18°50'24"S 48°18'15"E, 1092 m, 16.V.2010, *Bernard et al.* 1570 (MO, P, TAN); Androrangabe, 1200 m, 9.X.1945, *Cours* 2776 (MO, P); Analamazaotra RS, 18°55'21"S 48°25'23"E, 876 m, 3.V.2010, *Hong-Wa & Ortiz* 654 (MO, P, TAN); Andasibe, 18°56'S 48°25'E, 860 m, 20.X.1996, *Miller* 8747 (K, MO, TAN); Vatomandry, Ambalabe, Tobin'i Foara, 19°11'18"S 48°33'08"E, 500 m, 17.III.2005, *Razanatsima et al.* 14 (MO, P, TAN); Ambatondrazaka, Manakambahiny Est, [17°46'S 48°39'E], 21.X.1963, *Réserves Naturelles* 12629 (TEF); Soanierana Ivongo, [16°54'30"S 49°35'00"E], 0-50 m, 27.XII.1949, *Service Forestier* 2347 (P, TEF); Andriantantely, Brickaville, [18°44'S 48°38'E], 200-300 m, 21.IV.1955, *Service Forestier* 13177 (TEF). **Prov. Toliara:** Andohahela PN, Parcelle 3, 24°40'S 46°48'E, 200-700 m, 9-26.VIII.1993, *Randriamampionona* 589 (K, MO, P); Bevoay, Fenoambany, Androranga, 24°29'39"S 47°05'39"E, 171 m, 15.XI.2009, *Razakamalala et al.* 4532 (G, MO, P, TAN); Fort-Dauphin, Enaniliha, [24°39'S 46°52'E], 15.VII.1956, *Service Forestier* 17334 (TEF).

Unplaced material

The following specimens mapped on Fig. 68, could not be confidently accommodated within any of the species recognized here due to intermediate morphologies and/or incompleteness of material, which is mostly problematic for specimens taken from young individuals that exhibit juvenile morphology. Some of these specimens were initially analyzed statistically (HONG-WA & BESNARD, 2014) but were subsequently removed for being uninformative due to insufficient sampling and/or missing data. The collection of additional specimens and molecular data may help to clarify their identity. It is likely that some of this unplaced material represents new species.

MADAGASCAR. Prov. Antananarivo: Ankazobe, Manerinerina, 17°57'31"S 47°07'35"E, 1470 m, 19.XI.2006, *Ranaivojaona et al.* 1624 (MO, P, TAN). **Prov. Antsiranana:** Ampasindava, forêt de Bongomihiravavy, 13°45'26"S 48°05'34"E, 400 m, 26.XI.2008, *Ammann et al.* 87 (G, MO, TEF); Ampasindava, Tsarabanja, 13°45'42"S 48°05'32"E, 411 m, 10.XI.2008, *Bernard et al.* 1185 (G, MO, P, TAN); Andranomalaza, Manongarivo RS, 14°02'S 48°25'E, 1660 m, 1.VI.2000, *Gautier* 3729 (G, MO); Daraina, forêt de Binara, 13°16'15"S 49°35'56"E, 1030 m, 29.XI.2006, *Gautier & Chatelain* 4956 (Daraina, G, K, MO, TEF); Montagne d'Ambre PN, 12°30'55"S 49°10'34"E, 891 m, 24.I.2009, *Hong-Wa* 588 (MO, P, TAN); Anjangoveratra, forêt d'Andalibe, 14°07'35"S, 50°03'07"E, 115 m, 23.III.2009, *Hong-Wa* 635 (MO, P, TAN); Anivorano-Nord, Andrafiabe, Mont Antsahabe, 12°54'50"S 49°19'41"E, 408 m, 3.VII.2010, *Hong-Wa* 724 (TAN); Vallée de la Lokoho (NE), [14°39'S 49°44'E], 250-550 m, 11.I.1949, *Humbert* 22983 (P); Andapa, Ambodisatrana, 14°32'S 49°26'E, 1100-1200 m, 3.VIII.1997, *McPherson* 17201 (K, MO, TAN); 35 km S of Vohémar, 13°42'56"S, 50°06'11"E, 5 m, 25.X.2002, *McPherson et al.* 18811 (G, MO, P, TEF); Daraina, forêt d'Antsahabe, 13°14'02"S 49°33'11"E, 950 m, 15.I.2004, *Nusbaumer* 980 (Daraina, G, K, MO, P, TAN); Ampasindava, 13°46'34"S 47°59'54"E, 250 m, 1.XI.2008, *Nusbaumer & Tahirivony* 2958 (G, MO, TEF); Manongarivo RS, Ankaramibe, Bekolosy, 14°03'05"S 48°17'07"E, 600-800 m, 8.XII.1993, *Rakotomalala* 66 (G, MO, P); Ambilobe, Marivorahona, Ankatsaka, forêt d'Andavakoera, 13°06'01"S 49°10'36"E, 50 m, 13.IX.2004, *Randrianaivo et al.* 1092 (CNARP, MO, P, TAN); Anjangoveratra, Ambavala, 14°05'40"S, 50°02'37"E, 160 m, 21.IV.2008, *Randrianarivony et al.* 145 (MO, P, TAN); Andapa, Marojejy PN, 14°27'30"S 49°34'54"E, 920-1040 m, 15-29.V.1995, *Rasoavimbahoaka* 690 (MO, P, TAN); Andrafiabe, Mont Andrahona, 3 km au NE d'Andrafiabe, 12°28'49"S 49°26'56"E, 400 m, 31.I.2005, *Ratovoson et al.* 809 (CNARP, MO, P, TAN); Sambava, Andratamarina, Bemanasy, 14°24'04"S 49°51'40"E, 418 m, 20.X.2010, *Ravelonarivo & Raharivelo* 3535 (MO, P, TAN); Tsaratanana RNI, Beangona, 14°01'33"S 48°39'05"E, 1487-1550 m, 1.XII.2000, *Razakamalala et al.* 43 (MO, P, TAN); Marosena, Ampanovoana, [15°17'S 50°11'E], 4.II.1955, *Réserves Naturelles* 6938 (MO, P, TEF); Antalaha, Andrakaraka, [14°53'S 50°15'E], 90 m, 24.VI.1953, *Service Forestier* 7436 (MO, TEF); Massif de l'Ankarana (partie S du massif de Mafokovo), [13°15'S 49°50'E], 50-450 m, 17.XII.1966, *Service Forestier* 27384 (MO, TEF); Massif de Manongarivo, Maitsamalaza, Antsatrotro, 14°04'17"S 48°23'48"E, 1600 m, 27.XI.2000, *Wohlhauser* 408 (G,

MO); *ibid. loc.*, 14°04'28"S 48°23'34"E, 1570 m, 27.XI.2000, *Wohlhauser* 413 (G, MO). **Prov. Fianarantsoa:** Anankara, Manombo RS, 23°00'S 47°42'E, 5.III.2009, *Hong-Wa et al.* 615 (MO, P, TAN); Ranomafana PN, Vatoharanana, 21°16'06"S 47°25'30"E, 923 m, 8.V.2010, *Hong-Wa & Ortiz* 668 (MO, TAN); Ranomafana PN, Parcelle 1, near village of Miaranony, Anosimasina, 21°09'S 47°32'E, 900-100 m, 22.IX.1992, *Malcomber et al.* 1620 (K, MO, P, TAN); Ranomafana PN, Vatoharanana, 21°16'S 47°26'E, 1000-1100 m, 18-31.I.1993, *Malcomber et al.* 2063 (MO, TAN); Ranomafana PN, Vohiparara, 21°16'S 47°24'E, 1300 m, 20.IV.1993, *Malcomber & Randriamanantena* 2391 (K, MO, TAN). **Prov. Mahajanga:** Maintirano, Belitsaky, Ankilimanarivo, forêt de Beanka, 18°00'07"S 44°27'43"E, 210 m, 20.X.2009, *Andriamihajarivo et al.* 1785 (MO, P, TAN, TEF); Kimanambolo, Belitsaka, 18°02'09"S 44°19'28"E, 18.X.2009, *Rakotonasolo et al.* 1390 (MO, P, TAN). **Prov. Toamasina:** Maroantsetra, Anjahana, Hiaraka, 15°28'43"S 49°54'07"E, 200 m, 3.IX.2002, *Antilahimena* 1319 (MO, P); Antsirabe Sahatany, Anjiahely, 15°24'45"S 49°22'29"E, 1201 m, 19.VI.2004, *Antilahimena* 2526 (MO, P); Ambatovy, 18°50'27"S 48°18'17"E, 1084 m, 13.V.2010, *Bernard et al.* 1567 (MO, P, TAN); Analamazaotra RS, 18°56'12"S 48°25'09"E, 953 m, 2.V.2010, *Hong-Wa & Ortiz* 646 (TAN); *ibid. loc.*, 18°49'32"S 48°26'04"E, 941 m, 3.V.2010, *Hong-Wa & Ortiz* 664 (MO, P, TAN); Tampolo STF, [17°17'00"S 49°23'30"E], 10 m, 1-2.XI.1963, *Service Forestier* 22814 (MO, P, TEF); Foulpointe, Analalava, 17°42'18"S 49°27'17"E, 30.V.2005, *Skema et al.* 69 (MO, P, TAN). **Prov. Toliara:** Iabakoho, Antsotso Avaratra, Ivohibe, 24°34'10"S 47°12'26"E, 105 m, 24.V.2006, *Birkinshaw* 1646 (MO, P, TAN); *ibid. loc.*, 24°33'52"S 47°14'25"E, 112 m, 26.XI.2005, *Razakamalala et al.* 2314 (MO, P, TAN); *ibid. loc.*, 24°33'52"S 47°11'43"E, 386 m, 1.XI.2005, *Razakamalala et al.* 2565 (MO, P, TAN); Iaboko, Antsotso Avaratra, 24°33'54"S 47°11'55"E, 432 m, 11.XII.2007, *Razakamalala et al.* 3900 (MO, P, TAN); *ibid. loc.*, forêt de Tsitongambarika, 24°34'16"S 47°12'05"E, 271 m, 1.IV.2008, *Razakamalala et al.* 4122 (MO, TAN).

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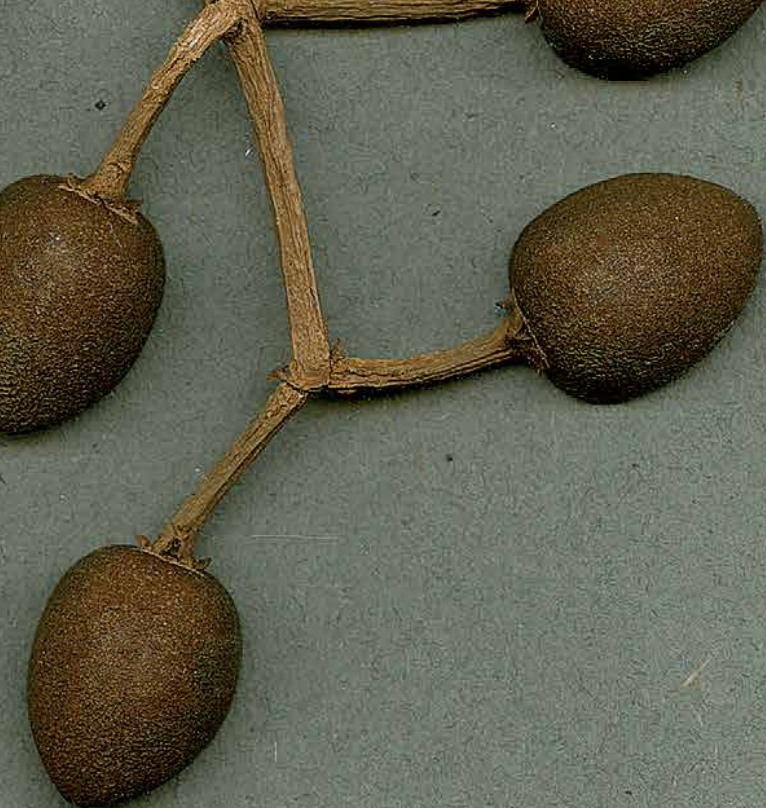
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Index	
<i>Chionanthus broomeana</i> (Horne ex Oliv.) A. J. Scott	56
<i>Chionanthus cordifolius</i> Labat, M. Pignal & O. Pascal	76
<i>Chionanthus incurvifolius</i> (H. Perrier) Stearn	127
<i>Chionanthus insularis</i> Labat, M. Pignal & O. Pascal	129
<i>Chionanthus obtusifolius</i> (Lam.) Stearn	191
<i>Chionanthus tropophyllus</i> (H. Perrier) Stearn	263
<i>Linociera broomeana</i> (Horne ex Oliv.) Knobl.	56
<i>Linociera incurvifolia</i> H. Perrier	127
<i>Linociera incurvifolia</i> var. <i>planifolia</i> H. Perrier	215
<i>Linociera mayottensis</i> H. Perrier	56
<i>Linociera obtusifolia</i> (Lam.) H. Perrier	191
<i>Linociera obtusifolia</i> var. <i>minoriflora</i> H. Perrier	179
<i>Linociera obtusifolia</i> var. <i>thouarsii</i> H. Perrier	191
<i>Linociera tropophylla</i> H. Perrier	263
<i>Linociera tropophylla</i> var. <i>angustata</i> H. Perrier	263
<i>Linociera verrucosa</i> Soler.	56
<i>Mayepea verrucosa</i> (Soler.) Knobl.	56
<i>Noronhia alleizettei</i> Dubard	37
<i>Noronhia ambrensis</i> H. Perrier	53
<i>Noronhia aminae</i> Hong-Wa	41
<i>Noronhia ankaranensis</i> (H. Perrier) Hong-Wa	44
<i>Noronhia armandiana</i> Hong-Wa	47
<i>Noronhia binia</i> Roem. & Schult.	108
<i>Noronhia boinensis</i> H. Perrier	49
<i>Noronhia boivinii</i> Dubard	51
<i>Noronhia brevituba</i> H. Perrier	53
<i>Noronhia broomeana</i> Horne ex Oliv.	56
<i>Noronhia buxifolia</i> H. Perrier	58
<i>Noronhia buxifolia</i> var. <i>quadriloba</i> H. Perrier	58
<i>Noronhia candicans</i> H. Perrier	60
<i>Noronhia capuronii</i> Bosser	62
<i>Noronhia chartacea</i> Stadtm. ex Hook.	108
<i>Noronhia christenseniana</i> Hong-Wa	65
<i>Noronhia clarinerva</i> Hong-Wa	69
<i>Noronhia cochleata</i> Labat, M. Pignal & O. Pascal	72
<i>Noronhia comorensis</i> S. Moore	74
<i>Noronhia cordifolia</i> (Labat, M. Pignal & O. Pascal) Hong-Wa & Besnard	76
<i>Noronhia coriacea</i> Hong-Wa	78
<i>Noronhia crassinodis</i> H. Perrier	80
<i>Noronhia crassiramosa</i> H. Perrier	83
<i>Noronhia cruciata</i> H. Perrier	277
<i>Noronhia cuspidata</i> Hong-Wa	85

<i>Noronhia dauphinensis</i> Hong-Wa	88
<i>Noronhia decaryana</i> H. Perrier	91
<i>Noronhia densiflora</i> Bosser	93
<i>Noronhia disjuncta</i> Hong-Wa	97
<i>Noronhia divaricata</i> Scott-Elliot	99
<i>Noronhia domatifera</i> Hong-Wa	101
<i>Noronhia ecoronulata</i> H. Perrier	37
<i>Noronhia edentata</i> (H. Perrier) Hong-Wa	106
<i>Noronhia emarginata</i> (Lam.) Thouars	108
<i>Noronhia emarginata</i> var. <i>edentata</i> H. Perrier	104
<i>Noronhia emarginata</i> var. <i>garcinioides</i> H. Perrier	110
<i>Noronhia gautieri</i> Hong-Wa	112
<i>Noronhia gracilipes</i> H. Perrier	115
<i>Noronhia grandifolia</i> H. Perrier	117
<i>Noronhia greeniana</i> Hong-Wa	119
<i>Noronhia humbertiana</i> H. Perrier	122
<i>Noronhia humblotiana</i> (H. Perrier) Hong-Wa	125
<i>Noronhia incurvifolia</i> (H. Perrier) Hong-Wa & Besnard	127
<i>Noronhia incurvifolia</i> var. <i>planifolia</i> (H. Perrier) Hong-Wa & Besnard	215
<i>Noronhia insularis</i> (Labat, M. Pignal & O. Pascal) Hong-Wa & Besnard	129
<i>Noronhia intermedia</i> Hong-Wa	131
<i>Noronhia introversa</i> H. Perrier	135
<i>Noronhia jeremii</i> Hong-Wa & Callm.	137
<i>Noronhia lanceolata</i> H. Perrier	140
<i>Noronhia latifolia</i> Hong-Wa	143
<i>Noronhia leandriana</i> H. Perrier	146
<i>Noronhia linearifolia</i> Boivin ex Dubard	148
<i>Noronhia linocerioides</i> H. Perrier	151
<i>Noronhia longipedicellata</i> H. Perrier	154
<i>Noronhia louvelii</i> H. Perrier	156
<i>Noronhia lowryi</i> Hong-Wa	160
<i>Noronhia luteola</i> H. Perrier	163
<i>Noronhia luteola</i> var. <i>ankaranensis</i> H. Perrier	44
<i>Noronhia luteola</i> subsp. <i>ankaranensis</i> H. Perrier	44
<i>Noronhia macrocarpa</i> Hong-Wa	166
<i>Noronhia maculata</i> Hong-Wa	168
<i>Noronhia mangorensis</i> H. Perrier	171
<i>Noronhia mangorensis</i> var. <i>humblotiana</i> H. Perrier	125
<i>Noronhia marinae</i> Hong-Wa	174
<i>Noronhia marojejyensis</i> Hong-Wa	177
<i>Noronhia martiniana</i> Hong-Wa	179
<i>Noronhia mayottensis</i> (H. Perrier) Hong-Wa & Besnard	56

<i>Noronhia myrtoides</i> H. Perrier	183
<i>Noronhia obcordifolia</i> Hong-Wa	186
<i>Noronhia oblanceolata</i> H. Perrier	189
<i>Noronhia obtusifolia</i> (Lam.) Hong-Wa & Besnard	191
<i>Noronhia obtusifolia</i> var. <i>minoriflora</i> (H. Perrier) Hong-Wa & Besnard	179
<i>Noronhia obtusifolia</i> var. <i>thouarsii</i> (H. Perrier) Hong-Wa & Besnard	191
<i>Noronhia olearia</i> Hong-Wa	194
<i>Noronhia orientalis</i> Hong-Wa	197
<i>Noronhia ovalifolia</i> H. Perrier	200
<i>Noronhia patricei</i> Hong-Wa	203
<i>Noronhia peracuminata</i> H. Perrier	206
<i>Noronhia perrieriana</i> Hong-Wa	207
<i>Noronhia pervilleana</i> (Knobl.) H. Perrier	210
<i>Noronhia planifolia</i> H. Perrier ex Hong-Wa	215
<i>Noronhia populifolia</i> H. Perrier	218
<i>Noronhia randrianaivoi</i> Hong-Wa	220
<i>Noronhia ratovosonii</i> Hong-Wa	223
<i>Noronhia retusifolia</i> Hong-Wa	226
<i>Noronhia richardii</i> Hong-Wa	230
<i>Noronhia rollandii</i> Hong-Wa	233
<i>Noronhia rostrata</i> Hong-Wa	236
<i>Noronhia sambiranensis</i> H. Perrier	239
<i>Noronhia schatzii</i> Hong-Wa	241
<i>Noronhia seyrigii</i> H. Perrier	244
<i>Noronhia similis</i> Hong-Wa	247
<i>Noronhia spinifolia</i> Hong-Wa	251
<i>Noronhia stevensiana</i> Hong-Wa	254
<i>Noronhia tefyana</i> Hong-Wa	258
<i>Noronhia tetrandra</i> H. Perrier	261
<i>Noronhia tropophylla</i> (H. Perrier) Hong-Wa & Besnard	263
<i>Noronhia tropophylla</i> var. <i>angustata</i> (H. Perrier) Hong-Wa & Besnard	263
<i>Noronhia tubulosa</i> H. Perrier	267
<i>Noronhia urceolata</i> H. Perrier	269
<i>Noronhia variabilis</i> Hong-Wa	272
<i>Noronhia verrucosa</i> H. Perrier	275
<i>Noronhia verticillata</i> H. Perrier	277
<i>Noronhia verticilliflora</i> H. Perrier	277
<i>Noronhia unplaced</i>	280
<i>Olea ambrensis</i> H. Perrier	194
<i>Olea emarginata</i> Lam.	108
<i>Olea obtusifolia</i> Lam.	191
<i>Olea pervilleana</i> Knobl.	210



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