

Mahonia oiwakensis Hayata (= *Mahonia lomariifolia*) (Berberidaceae): A new species for the alien flora of South Africa

**Authors:**

Thulisile P. Jaca¹
Mbali A. Mkhize¹

Affiliations:

¹South African National
Biodiversity Institute,
Pretoria, South Africa

Corresponding author:

Thulisile Jaca,
t.jaca@sanbi.org.za

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Background: A first record of a naturalised population of *Mahonia oiwakensis* (= *Mahonia lomariifolia*) in South Africa is presented. The species is native to China and is cultivated in South Africa as an ornamental plant.

Objectives: To document a new record of *M. oiwakensis*, provide a brief description of its morphology and note its ecology and current distribution outside of cultivation in South Africa.

Method: Plants were studied in the field and herbarium vouchers were collected and compared with images of type specimens. Distribution data were collected by means of global positioning system coordinates for each plant, and vegetation and habitat types were recorded for the sites where *M. oiwakensis* was collected.

Results: Two populations of 16 plants were found in South Africa, Gauteng, Pretoria, in the Faerie Glen Nature Reserve and Moreleta Kloof Nature Reserve, in the natural savannah biome, in thornveld and bushveld vegetation.

Conclusions: *Mahonia oiwakensis* has naturalised in South Africa. Further research is paramount to determine whether the species poses a substantial threat and whether it should be regulated and prioritised for management. It is recommended that this species should be added to the species under surveillance for potential eradication or containment targeting.

Introduction

Mahonia Nutt. is a member of the Berberidaceae family section *Longibracteatae*, subsection *Siamenses* (Ahrendt 1961). The family comprises about 650 species in 17 genera and is widely distributed in northern temperate and subtropical mountainous regions (Chen, Li & Ying 2009). Within the Berberidaceae family, *Mahonia* is the second largest genus after *Berberis* (Ahrendt 1961). In his treatment, Ahrendt (1961) recognised 200 species in the genus *Mahonia*, divided into two groups (Orientales and Occidentales) and these groups were further divided into four sections and 14 subsections. The major groupings were primarily based on geographical distribution, that is, all Asian species and one North American species (*Mahonia nervosa* (Pursh) Natt.) are in the Orientales group, while all the North American species are in the Occidentales group. Sectional grouping was based on various characters, from vegetative to reproductive characters. Recent studies on the seed morphology (Wu et al. 2010) and phylogeny (Kim et al. 2004), however, do not support the treatment of the genus into two groups such that some authors often recognise the genus as part of *Berberis*. However, Ying, Boufford and Brach (2011) treated the genus *Mahonia* as distinct from *Berberis*, with about 60 species worldwide distributed mainly in the East; South-east Asia; West, South, North and Central America; and China. Out of the 60 species, 31 species occur in China of which 27 are endemic while six are insufficiently known (Ying et al. 2011). According to Randall (2017), a number of *Mahonia* species are listed as either environmental weeds, invasive, naturalised or casual aliens throughout the world, including *M. acanthifolia* (Mediterranean), *M. aquifolium* (worldwide), *M. x domestica* (Hungary and Europe), *M. leschenaultia* (Australia), *M. oiwakensis* (= *M. lomariifolia*) (New Zealand).

In August 2015, an unknown species occurring in the vicinity of Faerie Glen Nature Reserve (FGNR) was brought to the author's (T.P.J.) attention by the chairman of the Friends of FGNR, through the Southern African Plant Invaders Atlas. At the time, these plants had neither flowers nor fruit and in the following year (2016) the species did not flower probably because of drought. In October 2016, the authors made a botanical survey at the Moreleta Kloof Nature Reserve (MKNR), adjacent to the FGNR, and found a sparse population of these same plants with fruits. It was still not clear what these plants were until May 2017 when both populations flowered.

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Following field observations and a thorough specimen and literature examination, it became clear that the plants from these two reserves were *Mahonia oiwakensis*, a new addition to the naturalised flora of South Africa. Five *Mahonia* species are listed in the cultivated plants of southern Africa (*M. aquifolium*, *M. bealei*, *M. oiwakensis* [listed as *M. lomariifolia*], *M. pinnata* and *M. trifoliolata*) (Glen 2002).

Mahonia oiwakensis is an evergreen shrub or small tree (Figure 1) native to China (therefore, it is in the Orientales group according to Ahrendt [1961]) and is known from Hainan, Guizhou, Sichuan, Yunnan and Xizang Provinces (Pan 1998; Ying et al. 2011). The type specimen is from Taiwan. In its native range, the species occurs in scattered subpopulations in coniferous forests and woodlands (Pan 1998).

Materials and methods

Herbarium specimens collected for this study were deposited in the National Herbarium (PRE) of the South African National Biodiversity Institute in Pretoria. Morphological characters are described on the basis of material collected and compared with the relevant literature sources and images of type specimens available online at the Global Plants database (www.plants.jstor.org) and the Herbarium of the University of Tokyo (TI) specimen database (http://umdb.um.u-tokyo.ac.jp/DShokubu/herbarium/en_ver2/index.php). Herbarium acronyms are listed according to Thiers (2011). Herbarium records in South Africa (Moss, NBG, NH and PRE), as well as those in the neighbouring countries, were searched through online databases for Swaziland (Swaziland Alien Plants Database, <http://www.sntc.org.sz/alienplants/index.asp>) and Zimbabwe (Flora of Zimbabwe: Cultivated plant, http://www.zimbabweflora.co.zw/cult/genus.php?genus_id=1687) and through contacts with herbarium curators for Botswana, Lesotho, Mozambique and Namibia. Data about populations and habitats in South Africa are based on visual observations and information about the species' ecology, and habitat preferences are from the literature and the authors' personal observations. The invasion status was scored as per the proposed unified framework for biological invasions (Blackburn et al. 2011).

Results and discussion

Records of *M. oiwakensis* growing outside of cultivation were not found in any of the South African herbaria and those in the neighbouring countries, indicating that this is the first record of the species as an escapee from cultivation in the southern African region. In Zimbabwe, two species of *Mahonia* are listed in the manual of cultivated plants, *M. bealei* and *M. oiwakensis* (listed as *M. lomariifolia*) (Hyde et al. 2017).

In South Africa, the species was found to occur in two nature reserves, FGNR and MKNR in the Gauteng Province at elevations up to 1500 m above sea level (Figure 2). In these areas, the species occurs in the savannah biome, in two

vegetation types: the Gauteng shale mountain bushveld and Marikana thornveld (Mucina & Rutherford 2006). Observations in the surrounding suburbs indicated that the species is being sold in the local nurseries and is planted in gardens as an ornamental plant, and populations reported here could be a result of escape from garden. It is not clear how long these plants have been in these areas, but the annual growth rings on the stem indicated that mature plants might be more than 10 years old and thus these populations are here classified as naturalised, following the definition by Pysek and Richardson (2008), but not invasive.

Plants found at the FGNR were about 12 m away from the storm water drain, in moist soils under the canopy of indigenous trees, suggesting that they might have originated from bird-dispersed seeds (Pysek & Richardson 2008) and have germinated in the moist conditions. In this locality, one mature plant and 10 juveniles were recorded. Those discovered at the MKNR were observed 10 m from the stream (three mature plants) and also scattered along trails within the woodlands ridge (one mature plant and five juveniles). These habitats are in accordance with the native range habitats where it is reported that species in the Orientales group are commonly adapted to undergrowth in evergreen broad-leaved forests, temperate rain forests and occur along rivers in open disturbed areas along forest edges (Guner & Denk 2012).

The invasion risk of the species needs to be assessed as some members of the genus *Mahonia* can be aggressive invaders, for example, *M. aquifolium*, which is an aggressive invader in forest in central Germany (Auge & Brandl 1997). Some species of this genus exhibit both vegetative and sexual reproduction, and therefore the reproductive mechanism of the species needs to be investigated. According to the unified framework for biological invasions (Blackburn, et al. 2011), this species falls under the C3 category (i.e. individuals surviving in the wild in locations where introduced, reproduction occurring and population self-sustaining).

The extent of distribution of this species beyond the Gauteng Province is not yet known, and in an attempt to raise awareness, a short article was published in Southern African Plant Invaders Atlas newsletter (July 2017). We recommend further research on this species to determine the potential threats and whether the species should be regulated under the invasive species regulations.

Taxonomic treatment

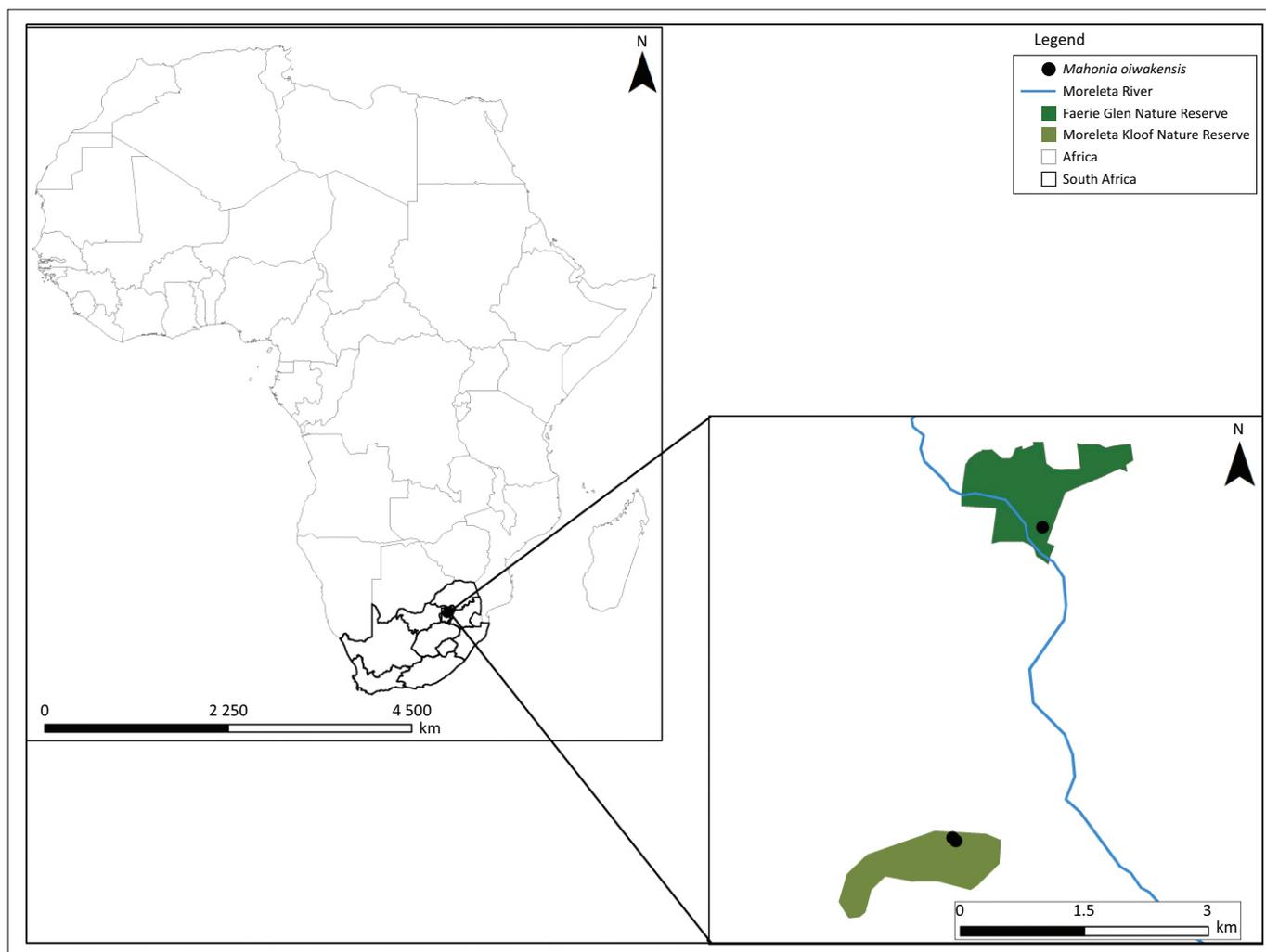
Mahonia oiwakensis Hayata, Icon. Pl. Formosan. 6: 1–2 (1916); Li, Woody Fl. Taiwan: 175 (1963); FTW 2(2): 583Pl.279, photo 254–255 (1996); FRPS 29: 220, pl. 42 (2001). Type: Taiwan, Musha Oiwake, May 1916, *Hayata s.n.* (TI, lecto.! designated by Hayata, 1916). [Complete synonymy in Ying et al. (2011)]

Mahonia lomariifolia Takeda, Notes R. Bd. Gard. Edinb. 6: 231(1917). Type: China, hills of north and east of Tengyueh, 15 November 1912, *Forrest 9244* (E, lecto.! designated by Takeda, 1917).



Source: Photos taken by T.P. Jaca

FIGURE 1: Morphology and habitat of *Mahonia oiwakensis*: (a) habit and habitat at Moreleta Kloof Nature Reserve in open woodlands and (b) habit and habitat at Faerie Glen Nature Reserve under tree canopy; (c) leaves, showing variation in size, adaxial and abaxial leaflets surface; (d) deeply furrowed bark; (e) petiole; (f) fascicled racemes; and (g) pruinose fruit.



Source: Authors' own work

FIGURE 2: Known distribution of *Mahonia oiwakensis* in South Africa.

Description (based on the South African specimens).

Evergreen shrub or small tree, 3 m–5 m tall. *Bark* whitish, deeply furrowed. *Leaves* dark green above, yellowish green below, oblong-elliptic, 30 cm–65 cm × 8 cm–15 cm, glabrous, imparipinnate; leaflets 11–15 pairs, lowest pair 0.5 cm–1.0 cm above base of petiole; rachis 2.0 mm–3.5 mm thick; lower internodes 4.5 cm–7.5 cm, mid internode 2 cm–4 cm decreasing in length apically; petiole 0.5 cm–1.5 cm, petiolute (0.5–)1.5 cm–2.4 cm; lower leaflets ovate to suborbicular 1.0 cm–2.5 cm × (0.5–)1.0 cm–2.0 cm, mid leaflets ovate lanceolate or lanceolate 5.6 cm–8.0 cm × 1.8 cm–2.5 cm, apical leaflets lanceolate to linear-lanceolate 7.5 cm–10.2 cm × 1.8 cm–2.5 cm; margins 5–11-spinose-serrate on each side increasing with the size of the leaf, bases rounded to cordate, midrib slightly impressed above and raised below, apex cuspidate-acuminate. *Inflorescence* 5–27-fascicled racemes, 10 cm–25 cm long; bracts of inflorescence broadly lanceolate to ovate, 1.5 cm–4.0 cm × 1 cm–2 cm. Pedicel (3.0–)5.0 mm–6.5 mm; floral bracts ovate to ovate lanceolate, 1.0 mm–2.0 mm × (0.7–)1.5 mm–2.0 mm. *Outer sepals* golden yellow, ovate to suborbicular, 1.6 mm–2.5 mm × (0.5–)1.1 mm–2.0 mm, median sepals elliptic to ovate, (2.4–)4.0 mm–5.0 mm × 1.5 mm–3.0 mm, inner sepals golden

yellow, elliptic to oblong, 5 mm–7 mm × 2.6 mm–4.0 mm. *Petals* golden yellow, oblong, 5.0 mm–6.5 mm × 2 mm–3 mm, sparsely glandular at the base, apex narrowly incised, subacute. *Stamens* 4.0 mm–4.5 mm; anther connective slightly prolonged, slightly rounded. Ovary 3 mm–4 mm; ovules 2–3; style 0.5 mm–1.0 mm. *Fruit* a berry, blue to bluish black or purple-black, pruinose, conical-ovoid, 6 mm–9 mm × 5 mm–6 mm; stylose. *Flowering time:* May–September in South Africa.

Specimens examined

SOUTH AFRICA. GAUTENG. – 2528 (Pretoria District): Moreleta Kloof Nature Reserve behind the bird hide (–CD), 11 October 2016, *Jaca & Mkhize 855* (PRE); about 50 m from the bird hide on Duiker hiking trail, 05 June 2017, *Jaca & Mkhize 885* (PRE). Faerie Glen Nature Reserve, at the vicinity of the big *Combretum* tree about 12 m from the storm water (–CD), 01 June 2017, *Jaca 894* (PRE).

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Competing interests

The authors declare that they have no financial or personal relationships that may have inappropriately influenced them in writing this article.

Authors' contributions

T.P.J. conceptualised and executed the study and compiled the manuscript. M.A.M. assisted in the field studies including collection of herbarium specimens.

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