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Assessing the invasiveness of *Berberis aristata* and *B. julianae* (Berberidaceae) in South Africa: Management options and legal recommendations

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ABSTRACT

The detection of two alien species spreading in natural ecosystems, namely *Berberis julianae* and *Berberis aristata*, prompted investigation into the risk that they pose as invasive plants to South Africa. Here we determined their distribution in South Africa, assessed population structure and reproductive size, determined seed germinability, evaluated the risks posed by the species by conducting weed risk assessments, and provide recommendations for control. We also assessed the extent of current and historic cultivation. *B. julianae* was found to be widely cultivated while but *B. aristata* was not found in cultivation. Only a single naturalized population was found for each species, with *B. julianae* occupying an area of 14 ha (0.02 ha condensed canopy) and *B. aristata* occupying an area 180 ha (1.58 ha condensed canopy). Given its very limited known distribution, there is an opportunity to eradicate *B. aristata*, although this would need to be reviewed if further surveys find new populations; we recommend that it be classified as category 1a invasive according to the National Environmental Management: Biodiversity Act. We do not yet recommend that *B. julianae* be regulated particularly given its horticultural popularity. However, it is clearly a species that needs to be monitored.

1. Introduction

Invasive species pose the second largest threat to global biodiversity after direct habitat destruction (Vitousek et al., 1997; Mack et al., 2000). Historically, management responses have been reactive or preventative pre-border, but in recent times there has been a shift to pro-active post-border management (Groves, 1999; Wilson et al., 2013). The exponential costs of control as invasive species range sizes increase (Rejmánek and Pitcairn, 2002) means that there is much long term benefit to be obtained from controlling invasive species from as early as possible after the first populations are found. An opportunity has arisen to take such an approach following the detection of two species naturalized in South Africa, namely *Berberis aristata* DC. and *B. julianae* C.K.Schneid. No study has yet been done to investigate the distribution, cultivation status and risks posed by any members of the genus *Berberis* in South Africa.

The genus *Berberis* L. (Berberidaceae), more commonly referred to as barberry, consists of ca. 500 species (Ulloa, 2011). Several species of *Berberis* are popular in the horticultural industry (Morris, 2009; Gilman, 2011; MNFI, 2012). Other well-known members of the family are the garden plants *Nandina domestica* Thunb. (Nandina or heavenly bamboo), *Mahonia* Nutt. and *Epimedium* L. (Morris, 2009). About seven species of *Berberis* have become invaders elsewhere in the world (D' Appollonio, 1997; Ehrenfeld, 1997; DeGasperis and Motzkin, 2007; McAlpine and Jesson, 2007; Ward et al., 2010; Randall, 2012; Speith, 2012). Only three species of *Berberis* occur naturally in Africa, namely *Berberis vulgaris* L., *Berberis hispanica* Boiss. & Reut. and *Berberis holstii* Engl., the latter being endemic to the mountains of eastern and south-eastern Africa (Harber, 2010; Maliwichi-Nyirenda et al., 2011). However no species in the family Berberidaceae occur naturally in South Africa.

Invasive *Berberis* species can have considerable negative environmental and economic impacts. These include altering soil chemistry, lowering land carrying capacity and preventing access to watercourses when occurring in dense thickets (D' Appollonio, 1997; Ehrenfeld, 1997; DeGasperis and Motzkin, 2007; Speith, 2012). They can also replace indigenous vegetation, to the detriment of native fauna and the ecosystem as a whole (Speith, 2012).

Several *Berberis* species also serve as alternate hosts for stem rust of wheat where sexual recombination takes place to give rise to new virulent strains (Jin, 2011). Stem rust, or black rust, is a disease caused by the fungal pathogen *Puccinia graminis* Pers. f. sp. *tritici* Eriks. & E. Henn. and destroys wheat crops (Singh et al., 2008); it has been a problem since

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ancient times (Peterson, 2001). New virulent rust strains that develop on *Berberis* plants are able to overcome the barriers posed by rust-resistant wheat cultivars. Of the *Berberis* species previously recorded to be cultivated in South Africa (Glen, 2002), *B. holstii* and *B. vulgaris* are known to be susceptible to stem rust. However, it is thought that there are many more rust susceptible species still to be found (Jin, 2011) and the potential existence of other susceptible *Berberis* species in South Africa cannot be excluded. The presence of such susceptible invasive stands of *Berberis* could seriously threaten wheat production in South Africa.

About 24 species of Berberidaceae (18 for *Berberis*, 5 for *Mahonia* and 1 for *Nandina*) have previously been documented to be cultivated in South Africa (Glen, 2002). There are only four records of *Berberis* documented in the SAPIA database (Southern African Plant Invaders Atlas, accessed May 2013). This includes one record that is only indicated as *Berberis* sp., one for *Berberis* cf. *chitria* Buch.-Ham. ex Ker Gawl. (which is a synonym for *B. aristata* (Adhikari et al., 2012)) and two for *Berberis julianae*. *Berberis thunbergii* DC. has been listed as category 3 (sterile cultivars exempted) under the National Environmental Management: Biodiversity Act (South African Department of Environmental Affairs and Tourism, 2014). Also, *B. julianae* has recently been placed under the SUSPECT list (Species Under Surveillance — Possible Eradication or Containment Targets) (Wilson et al., 2013). The fact that certain *Berberis* species have shown potential to naturalize in South Africa led us to investigate the potential invasive threats that these species may pose and to determine which steps to take, if necessary, in order to eradicate them.

In this study we aim to: 1) determine the current distributions and population sizes of *B. aristata* and *B. julianae* in South Africa as well as relevant historical records, 2) determine population dynamics of naturalized populations, 3) determine potential current distributions, and 4) provide recommendations for national management strategies and define feasibility of extirpation.

2. Methods

2.1. Study species

B. aristata, also known as the Indian barberry or tree turmeric, is a deciduous, perennial multi-stemmed shrub that can grow up to 5 m in height and is native to the Himalayas in Nepal (Fig. 1) (being one of the commonest *Berberis* species there) (Adhikari et al., 2012). Like many other barberries, it has three-branched thorns that are about 1.5 cm long. The leaves are light green above, dark green below, leathery and have a toothed margin. The inflorescence has 10 to 20 yellow flowers. The fruits are round to ovoid (sometimes asymmetric) and purple in colour. In its natural habitat it is commonly found at an altitude of 1300–3400 m, frequenting forest clearings and disturbed vegetation along forest edges and roadsides (Adhikari et al., 2012). *B. aristata* has been recorded as naturalized in Australia (Randall, 2001, 2012).

B. julianae, also known as the Wintergreen barberry, is a dense, spiny, perennial, multi-stemmed evergreen shrub between 1 and 3 m tall (Fig. 1) (Junsheng et al., 2011). The leaves are shiny dark green above, leathery and with the margin heavily spined (Ulloa, 2009); they develop a red colour in the winter months. The species also bears the very characteristic three-branched spines that occur just below the leaf clusters. The flowers are small and yellow and are numerous, occurring in clusters in the leaf axils. The fruits are bluish-black berries

Fig. 1. Photos of *Berberis aristata* and *B. julianae*. a) flowers of *B. aristata*, b) part of the plantation at Woodbush State Forest that is invaded, c) seedling of *B. julianae*, d) dense stand of *B. aristata*, e) individual of *B. julianae* growing through the canopy of a native species (*Leucosidea sericea*), f) fruits of *B. julianae*.