Rapid Communication

Record of naturalized *Ipomoea hederifolia* (Linnaeus 1759) (Convolvulaceae), Scarlet morning-glory in South Africa

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Abstract

The present study reports on the occurrence of *Ipomoea hederifolia* L. in South Africa. The established populations of *Ipomoea hederifolia* were detected in 2019 and 2020 in different locations in the Limpopo Province, with herbarium records showing at least four other localities in the country. Further work is now needed to determine the impact of *Ipomoea hederifolia* on native biota and agricultural production.

Key words: invasive plant species, alien plant, Scarlet creeper, *Quamoclit luteola*, ivy-leaf morning glory, Thohoyandou

Introduction

The genus *Ipomoea* (Convolvulaceae) is a diverse, economically important genus of approximately 500 species, with primarily a pantropical distribution (Wood and Scotland 2017; Wood et al. 2020). At least 35 species are planted worldwide as ornamentals, while most have escaped cultivation, and became noxious weeds (Gunn 1969). *Ipomoea hederifolia* L. is a twining annual vine native to the tropical and subtropical America. It is considered to be an infesting weed for several crops, causing damage to and hampering the harvest of sugar cane, maize, and soybeans, among other crops (Beluci et al. 2018; Lopes Ovejero et al. 2013).

Ipomoea hederifolia has been introduced worldwide by cultivation as an ornamental plant and is naturalized in the paleotropics (Gunn 1969; Austin and Huáman 1996; Kissmann and Groth 1999). The proliferation of this species is linked to its utility in phytoremediation (Patil et al. 2016; Rane et al. 2016), its heat tolerance (Labonia et al. 2019), its resistance to herbicides (Girotto et al. 2012), and most importantly, its longer growth cycles (Barroso et al. 2017).

In order to effectively prevent the proliferation of invasive species it is crucial to understand how climate is likely to influence their current and future distributions. Species distribution models (SDMs) are useful tools to determine the distribution of species, under varying climatic conditions (Cobos et al. 2018). The SDMs are increasingly used as predictive tool for proactive management of invasive species, particularly for species with limited distributions (Papeş et al. 2016; Shivambu et al. 2020, Moshobane et al. *in press*). This supports Early Detection and Rapid Response (EDRR) efforts for emerging invaders such as *Ipomoea hederifolia* (Srivastava 2019). SDM models require occurrence records and environmental predictors, in this case bioclimatic variables (Porfirio et al. 2014; Wang et al. 2016). Here we report the occurrence of *Ipomoea hederifolia* in South Africa and provide the habitat suitability model for South Africa.

Materials and methods

On 2 July 2019, 21 individuals of *Ipomoea hederifolia* were found and recorded at Thohoyandou Landfill site (23°00′06.4″S; 30°28′10.0″E). A second population of 123 plants was found on 20 June 2020 on Casino boulevard (22°58′14.6″S; 30°27′09.2″E) near a stream and in Shayandima township (22°59′59.2″S; 30°25′51.4″E). These populations were found by the authors during routine surveys in Limpopo province for alien plants, specifically to find emerging invasive species, in order to record them and earmark them for management before the populations are established. The individual species was identified following Austin and Huáman (1996), and Wood et al. (2020). The Southern African Plant Invaders Atlas (SAPIA) (Henderson 1998, 2007) was searched for further records of *Ipomoea hederifolia* in South Africa. The following herbarium were searched for records of this species using herbaria codes: NBG, SAM (Acronyms according to Index Herbariorum).

Notes on species ID

A critical examination of the specimen (NBG), confirmed that the plant is a member of the Quamoclit clade of *Ipomoea*. This is a group of New World species with mostly red trumpet-shaped perianths. Several of these species have in the past either been formally sunk under the concept of *I. coccinea* L., or have been misidentified as such. The treatment of Wood et al. (2020) treats *I. coccinea* in the strict sense, i.e. invariably with entire leaf margins and confined to North America. Our plant has somewhat lobed leaves, and thus keys out in couplet ten of their key under the second option, thus eliminating *I. coccinea* as an option (Figure 1). The key contains a renumbering error in that it refers to couplet 18 at this point, whereas it should read “17”. Since the capsule is muticous (without a persistent style) rather than rostrate and has inner sepals under 4 mm long as opposed to 4–6 mm long, it is determined as *I. hederifolia* L. rather than either *I. rubriflora* O’Donell or *I. cristulata* Hallier f. of couplet 18 (not “19” as the lead suggests).

Figure 1. *Ipomoea hederifolia* collected from Thohoyandou landfill site (Limpopo Province, South Africa). Photograph by M.C. Moshobane.

Habitat suitability modelling

Occurrence records

Species occurrence records of *I. hederifolia* were extracted from the Global Biodiversity Information Facility (GBIF) (GBIF 2021; https://www.gbif.org) using R package "rgbif" version 3.6.0 (R Core Team 2020). A total of 6,303 species occurrence records were collected.

Bioclimatic variables

We extracted 19 bioclimatic variables in GIS grid format (1 km resolution) from the WorldClim global climate database 2.0 (www.worldclim.org) (Fick and Hijmans 2017). We used Spearman rank correlation to excluded variables that presented high collinearity (Dormann et al. 2013). After excluding collinear variables, nine variables were retained for the final model. R package "sdm" version 1.0–89 (Naimi and Araújo 2016), was used to produce habitat suitability maps. We followed the recommended modelling procedures, contained in "sdm" packgage such as the 100 boostrap replication (Naimi and Araújo 2016).

The threshold-independent indices of the area under the curve (AUC) of a receiver operating characteristic (ROC) (Fielding and Bell 1997), and the true skill statistic (TSS) (Allouche et al. 2006) and the randomised correlation (COR) (Thuiller et al. 2009) were used to validate the performance of the models produced. COR values closer to one indicated which predictor variables contributed highly to the respective species suitability using the selected six methods (Thuiller et al. 2009). AUC value greater than 0.7 represents reliable prediction accuracy (Pearce and Ferrier 2000). The five commonly used ecological niche model approaches we considered namely: boosted regression tree (BRT: Friedman 2001), generalised linear model (GLM: McCullagh 1989), random forest (RF: Breiman 2001), and support vector machine (SVM: Vapnik 1995), Maximum entropy (MaxEnt: Elith et al. 2006). As all these model algorithms require background data (pseudo-absence points).

Results and discussion

In this study, the species were found mostly along the roadside and in disturbed areas. Notably, one of the SAPIA spotters, Graham Grieve, reported *Ipomoea hederifolia* along the roadside (Supplementary material Table S1) and in sugar cane fields in KwaZulu-Natal. The location of the species is supported by several literature reports as a weed in sugar cane fields (Lopes Ovejero et al. 2013).

Ipomoea hederifolia is distributed across the America (Gunn 1969; Austin and Huáman 1996; Kissmann and Groth 1999). The species' successful establishment and naturalisation in Australia has also been confirmed in disturbed sites (Wagner et al. 1999). The discovery of *Ipomoea hederifolia* in the Limpopo province extends its known occurrence in the region from KwaZulu-Natal to much further north. *Ipomoea hederifolia* is one of several alien *Ipomoea* species recorded in South Africa (Henderson and Wilson 2017), with four species regarded as widespread and invasive in South Africa and regulated by law: *Ipomoea alba* L.; *Ipomoea carnea* subsp. *fistulosa* (Mart. ex Choisy) D.F. Austin; *Ipomoea indica* (J. Burman) Merr.; and *Ipomoea purpurea* (L.) Roth (Moshobane et al. 2019).

Finding of *Ipomoea hederifolia* in the Limpopo and KwaZulu-Natal provinces documents the species' suitability and possible geographical expansion into areas of suitable climate, as *Ipomoea hederifolia* was found to perform better in temperatures between 20 °C and 35 °C (Labonia et al. 2019). Furthermore, the invasiveness or the potential thereof is attributable to ecology (Lowell and Lucansky 1986). In its native range, the species is regarded as a weed of economic importance because *Ipomoea hederifolia* is known to have impacts on agricultural production (Beluci et al. 2018). Examples of this impact include how *Ipomoea hederifolia* interferes with and reduces the total sugar in the sugar cane OES of cultivar RB86-7515 (Plene PB®, Syngenta®, Itápolis, Brazil), as well as in common crops such as soybean (Lopes Ovejero et al. 2013). *Ipomoea hederifolia* also interferes with harvesting due to its twining nature (Labonia et al. 2019). *Ipomoea hederifolia* could have an impact on agricultural production in South Africa because sugar cane farming is one of the major agricultural crops produced in the KwaZulu-Natal Province.

The presence of *Ipomoea hederifolia* in South Africa also has the potential to disturb pollination networks (Lowell and Lucansky 1986; Brown and Eckenwalder 1990; Austin and Huáman 1996). This species' flowers typically open at dawn, are pollinated by hummingbirds (Sowell and Wolfe 2010), and then senesce the same day (Lowell and Lucansky 1986; Brown and

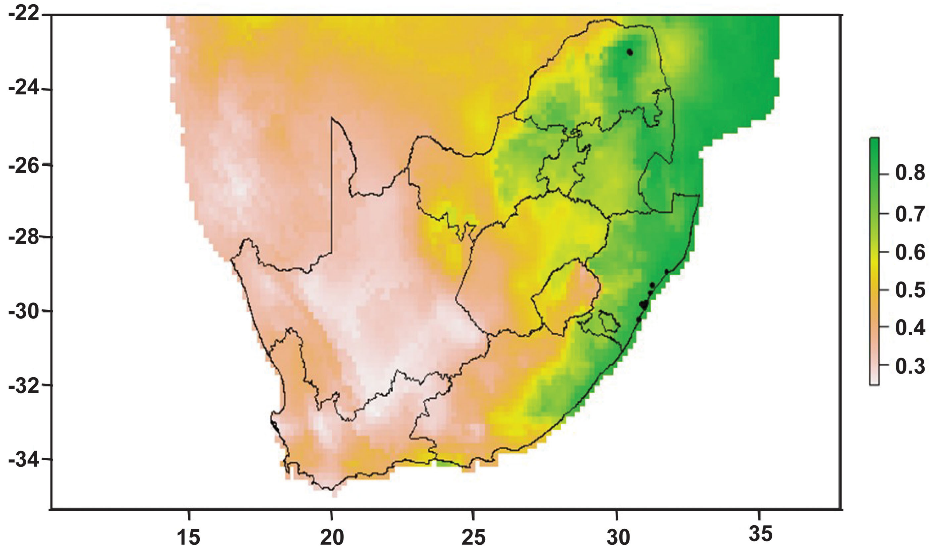

Figure 2. The climatic suitability of *I. hederifolia* in South Africa (colour scale, 0.1 less suitable 0.8 more suitable). The black dots indicate the known occurrence locations.

Eckenwalder 1990; Austin and Huáman 1996). In turn, this competition for pollinators could reduce seed production of native species and not for *Ipomoea hederifolia* itself (Lara and Ornelas 2001). *Ipomoea hederifolia* could further impact native species through acting as vector or reservoir of other noxious pests such as Sweetpotato Weevil, *Cylas formicarius elegantulus* (Coleoptera: Curculionidae) (Jansson et al. 1989), and *Cercospora* leaf (Nechet and Halfeld-Vieira 2019).

The spread of invasive species is a global problem and is correlated to the increase of global trade (Westphal et al. 2008; Bradley et al. 2012) that is perpetuated by human demands for their economic and aesthetic value (Moshobane et al. 2020). Therefore, public engagement is integral to curbing the spread of invasive species (Shackleton et al. 2019).

The climatic suitability model showed that *Ipomoea hederifolia* would most likely occur in areas that receive high summer rainfalls. Four provinces show high climatic suitability, those are KwaZulu Natal, Mpumalanga, Gauteng and Limpopo province. The areas shown as suitable tend to have high values of annual mean temperature (22 °C) during the hottest month (Figure 2). These habitats identified by habitat suitability models fit quite well with the known occurrence records for *Ipomoea hederifolia* in South Africa. The results of this study showed that South Africa face high potential for *Ipomoea hederifolia* invasion because of the existence of suitable habitats, coupled with the lack of natural enemies.

Conclusions and recommendations

The climatic suitability model showed that the species has high suitability in most parts of the country. While the present record increases the number of invasive plant species known to South Africa. We recommend further research on the species to ascertain and quantify the nature of impact it is likely to cause on native biota. Frameworks, such as the Australian Weed Risk Assessment (AWRA) system (Pheloung et al. 1999), adapted for South Africa, may be useful to assess the risk posed by *Ipomoea hederifolia*. Local biodiversity authorities should look into the possibilities of listing the species in the national list of invasive species (Moshobane et al. 2019). Possibly this should be followed by rapid response clearing program (Moshobane et al. *in press*).

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Disclaimer

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Supplementary material

The following supplementary material is available for this article:

Table S1. Records of *Ipomea hederifolia* in South Africa.

This material is available as part of online article from:
http://www.reabic.net/journals/bir/2022/Supplements/BIR_2022_Moshobane_etal_2_SupplementaryMaterial.xlsx