



First record of *Robinia hispida* L. (Fabaceae) in South Africa

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Abstract The shrub, *Robinia hispida* L., commonly known as the bristly locust, is a native to southeastern United States. It has, however, expanded its range within North America, and established invasive native-alien populations in several American states and Canada. Outside of North America, *R. hispida* has been introduced to Europe and Asia, where it has naturalised and is considered invasive. Notably, the presence of this shrub has never been reported outside of cultivation in Africa. Despite receiving little scientific attention compared to its congeneric species such as the global invader *Robinia pseudoacacia* L., *R. hispida* shares morphological and growth characteristics including rapid growth and a suckering habit. It occupies similar environmental niches in both native and introduced ranges, thriving in thin upland woodlands, woodland edges, thickets, fence rows, roadside embankments, banks of drainage canals, vacant lots, and overgrown waste areas. In South Africa, *R.*

hispida was first recorded in a garden in Polokwane in 1986, while the first record outside of cultivation was near the town of Bethlehem in the Free State Province in 2023, and further surveys were conducted locating additional populations near the towns of Zastron and Clarens in 2024. The potential distribution of *R. hispida* in South Africa was modelled in MaxEnt using areas climatically representative of the species, based on the Koppen-Geiger climate classifications. The potential distribution includes areas of central South Africa, the east and south coast and the Mediterranean climates of the southern Cape. Management strategies suggested for *R. hispida* in South Africa, considering the small size of the populations, should include eradication efforts using mechanical and chemical means, followed by continuous monitoring to prevent re-emergence.

Keywords Alien species · Bristly locust · Habitat suitability · Grasslands · Management

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Introduction

Robinia hispida L. (Fabaceae), also known as the bristly locust, rose-acacia, or moss locust, is a shrub native to the southeastern United States (Isely and Peabody 1984). The shrub has expanded its range within North America where it established invasive native-alien populations in Michigan, New Jersey, Ohio, Pennsylvania, and Washington as well as

Nova Scotia and Ontario in Canada. Outside of North America, *R. hispida* has been introduced to several countries in Europe as well as China and Japan where it has naturalised and also considered invasive (Loeb 2012; Burda and Koniakin 2019; DAISIE 2024). There are also a couple records from South America however there are no indications of it being invasive there yet (GBIF 2024). There is currently only 1 record of the species in Africa that was noted in 1986 as an ornamental species growing in a garden in Polokwane formerly known as Pietersburg (−23.875, 29.375) Limpopo Province, South Africa. The specimen is no longer present at that location and until this study no other locations were known from Africa. This study aims to document the current known occurrence and potential distribution of *R. hispida* in South Africa. In addition, suggested management interventions are discussed for the species before it has an environmental impact in South Africa.

Taxonomic classification

Robinia hispida belongs to the pea family Fabaceae, sub-family Faboideae. The shrub is deciduous and open branched and can grow to a height of three metres with characteristically glandular bristly brown hairs on the stems, branches and petioles. The leaves are compound bearing 3–6 pairs of rounded leaflets

which come to a slight point. The shrub produces 2.5–3 cm, pea-shaped rose-pink coloured flowers, in hanging racemes (Chmielewski and Kraysky 2012). Seed is produced in the bristle-covered pods, 5–12 cm long (Rhoads and Block 2000). Seeds are about 0.5 cm in size, dark brown, and very hard with roughly 40,000 seeds per kilogram (USDA). It spreads rapidly on some sites by root suckers, particularly those soils light in texture. Root suckers may appear in the first year, and the thicket forming growth habit will begin by the second year. Spreading by seed is secondary to root suckers. Leaf litter accumulates early and is held in place by the many small stems that develop from the roots.

Current and potential distribution for *Robinia hispida* in South Africa

In South Africa, the first record of *R. hispida* outside of cultivation was observed near the town of Bethlehem in the Free State Province in 2023 when the plants were in flower. Plant specimens were photographed and collected for identification at the University of the Free State, South Africa. Based on available identification tools, field images and botanical experts, the specimens collected were confirmed to be *R. hispida* (Fig. 1). This was followed by further



Fig. 1 *Robinia hispida* flower, leaf and fruit morphology (left) and growth characteristics (right) from specimens collected in the Free State Province. Photos: Grant Martin, 2023

roadside surveys within the Free State Province to identify further populations (Table 1).

The potential distribution of *R. hispida* in South Africa was modelled using MaxEnt, a machine learning algorithm that applies the principle of maximum entropy to predict the potential distribution of species from presence-only data and environmental variables (Phillips et al. 2006). The model was run on areas climatically representative of the species based on the Köppen-Geiger climate classifications, as recommended by Webber et al. (2011) and Hill and Terblanche (2014). Plant occurrence records were downloaded from the Global Biodiversity

Information Facility (GBIF 2024) and appropriately refined by removing duplicates, correction of coordinate errors where possible, removal of coordinates lacking sufficient fine-scale precision, and coordinates older than 50 years with no new locations near them were removed (Fig. 2). Furthermore, localities that appeared to have locational error or potentially growing under artificial conditions (garden records, golf courses, cultivated fields, university campuses, botanical gardens, etc.) were removed. The occurrence records from South Africa were also used in the model. Only Köppen-Geiger climate zones that contained at least one *R. hispida* occurrence

Table 1 Presence locations for *Robinia hispida* in South Africa from roadside surveys conducted in 2023 and 2024

Province	Location	Biome	Latitude	Longitude	Altitude (m)	Number of Adults	Saplings present
Free State	Bethlehem	Grassland	−28.2347	28.31791	1641	100	Y
		Grassland	−28.2353	28.3178	1651	75	Y
		Grassland	−28.239	28.3207	1659	1	Y
	Clarens	Grassland	−28.525	28.460	1807	100	Y
	Zastron	Grassland	−28.235	27.07566	1587	100	Y

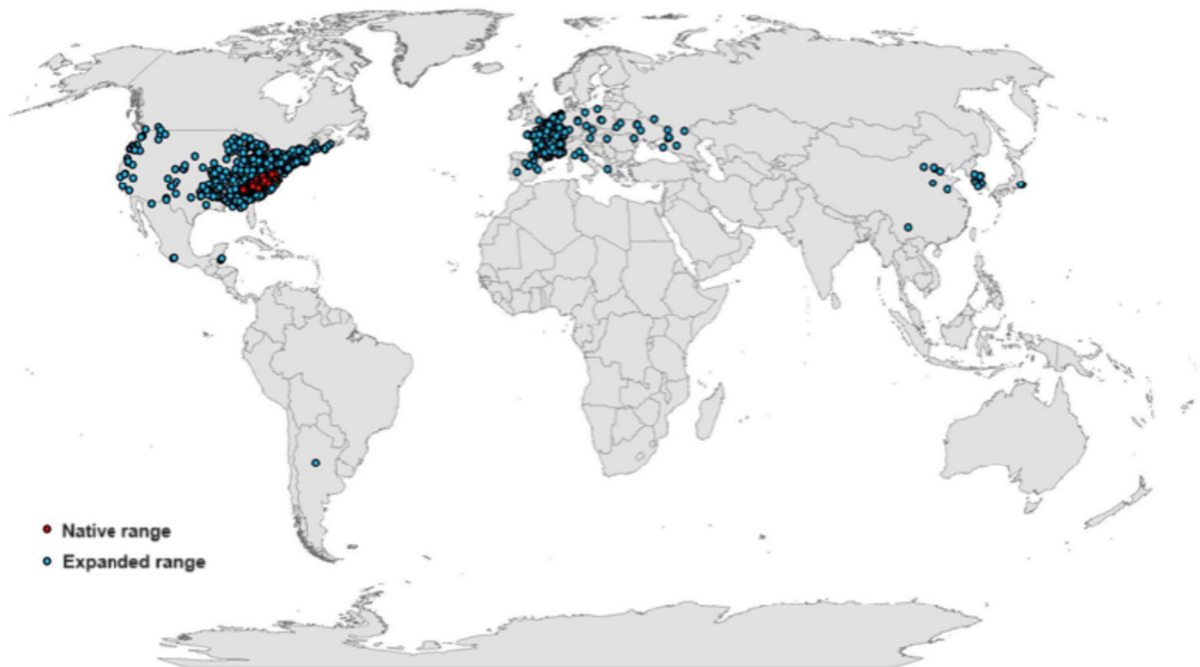


Fig. 2 Global distribution of *Robinia hispida*. Red dots indicate area of origin and green dots indicate range expansion and alien populations. Data source: Global Biodiversity Information Facility 2024

record were used as the background area from which pseudo-absences were drawn for model calibration. Environmental covariates based on temperature and precipitation were downloaded from the WorldClim v.2 database (www.worldclim.org; Fick and Hijmans 2017). The selection of predictor variables used in the model was based on the initial jack-knife test where variables that had the least training gain when used in isolation were dropped. As a result, eight predictor variables namely mean annual temperature, isothermality, temperature seasonality, mean temperature of the warmest quarter, mean temperature of the coldest month, mean annual precipitation, precipitation of the driest month and precipitation of the driest quarter were used to build the final model.

MaxEnt parameters were set at 500 iterations and 0.00001 convergence threshold were used when running the program's "logistic output," which creates a continuous, linear-scaled map that allows fine-scale distinctions to be made between the modelled probabilities of habitat suitability. To avoid overfitting, a regularisation value of 1, which restricts the number of occurrence points to 1 per grid cell, was used. There can be considerable variation in the performance of models when choosing a particular random selection of points for the training and testing sets (Anderson et al. 2003). Therefore, we created six random bootstrap data sets for each model set that were randomly partitioned into a "testing data set," consisting of 30% of the species occurrences, and a "training data set," consisting of the remaining 70% of the species occurrences. The testing data set was used to assess the accuracy of the model through jack-knife testing (Trethowan et al. 2011). The final model produced for each set of models was the mean of the six model replicates. The minimum training presence used the minimum threshold from the set of six models. This threshold avoids ignoring any "known" risk areas, which is important in risk management for invasive species.

Currently, only four populations of *R. hispida* are known in South Africa. These are all located in the grassland biome of the Free State Province (Fig. 3A). Two of the populations are located close to the town of Bethlehem and likely from the same potential source population. The second site is near the town of Clarens in the Free State Province the origin of this site is undetermined, while the other population is located 320 km away near the town of Zastron

(Fig. 3D) and is probably from being planted as an ornamental at the entrance to a farm driveway.

The habitat suitability model suggests a potentially broad distribution of the species in South Africa (Fig. 3A). Highly suitable habitats for *R. hispida* are located mainly along the coastal areas, expanding inland to the eastern and north-eastern parts of the country. The semi-arid parts northwest on the country had very low habitat suitability indices for *R. hispida*. Based on the known distribution of the congeneric species *R. pseudoacacia* in South Africa and the current location of the recorded populations of *R. pseudoacacia* it is assumed the MaxEnt model for *R. hispida* is an under estimate of the species potential distribution in South Africa. This underestimation is probably from a lack of records from similar climates in the southern hemisphere and the few locations currently in South Africa. As the species is known to come from and share similar habitats to *R. pseudoacacia* in both the native and invaded range, it is assumed it will follow a similar distribution in South Africa suggesting *R. hispida* can potentially occur throughout South Africa, with suitable climates also including the cold interior or highveld including the eastern Free State, Western KwaZulu-Natal, northern Eastern Cape, Gauteng and southern Limpopo provinces (see Humphrey et al. 2019).

Discussion

This is the first documented record of *R. hispida* in South Africa and provides insights on potential spread within the country. The study further showed that the species can potentially have a wide coverage in South Africa. However, due to the lack of records in the southern hemisphere the actual distribution could be wider than observed, hence, surveys should be extended to all potential habitats, especially those invaded by *R. pseudoacacia*. Moreover, the study also highlighted a serious data paucity on the species both in the native and invaded ranges, further compounding decision making. While inferences can be drawn from available information on other well studied species within the genus, this is not ideal for management options such as biological control since genetic variation often has an influence on host selection by biological control agents. Moreover, *R. hispida* is known to hybridise with *R. pseudoacacia* which may

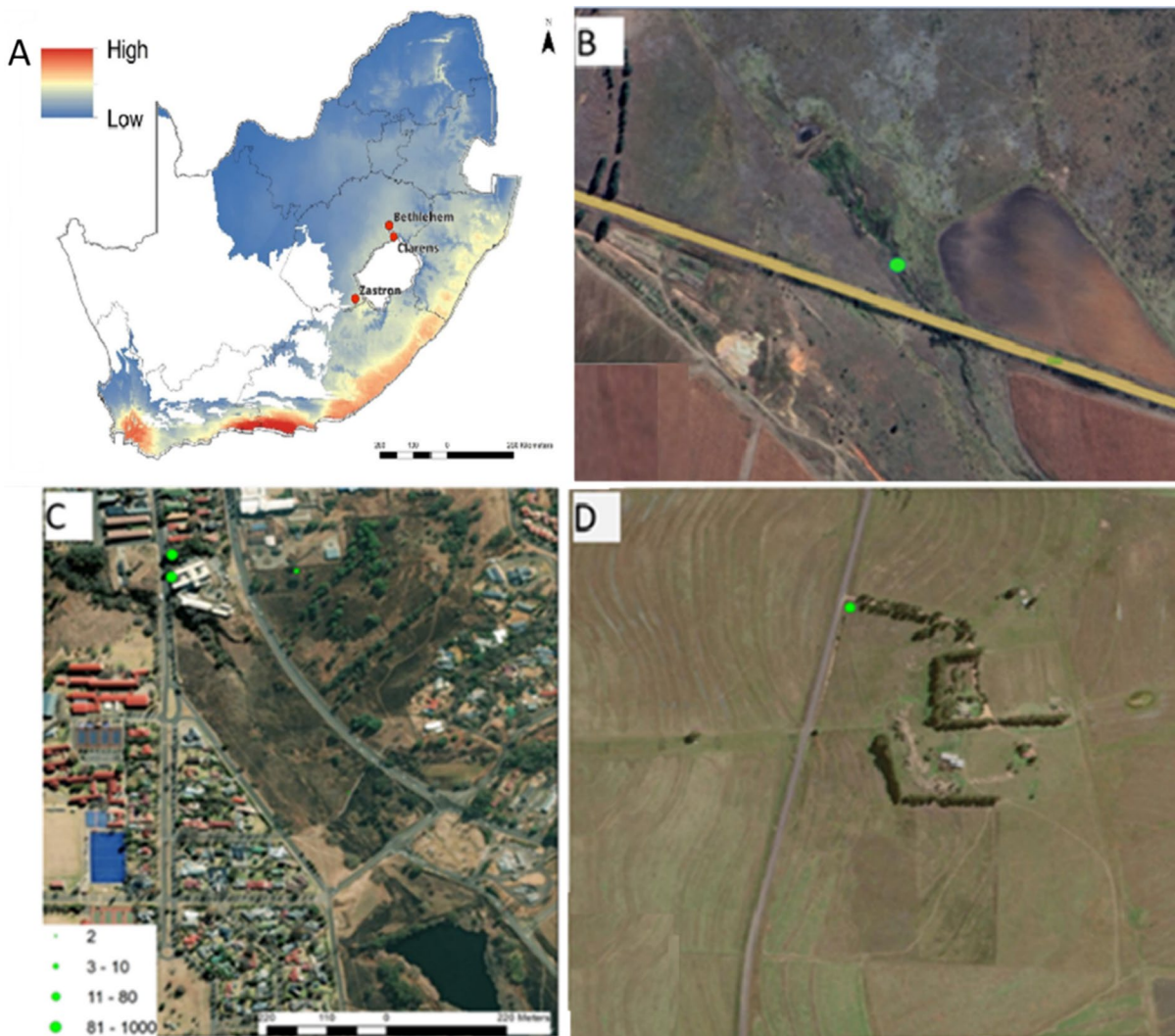


Fig. 3 Potential distribution and presence locations for *Robinia hispida* populations in South Africa **A** Clarens **B** Bethlehem **C** and Zastron **D** following roadside surveys conducted in 2023 and 2024. Size of the green dots indicate the number of plants at each site

have implications for the planned biological control programme of the latter (Martin 2019). Hybridisation is well known in the Robinoid clade, for example kelsey locust (*Robinia hispida* var. *kelseyi* (Hutch.) Isely), New Mexico locust (*Robinia neomexicana*), clammy locust (*R. viscosa*) and bristly locust (*R. hispida*) (Isely 1982; Isely and Peabody 1984; Huntley 1990). All hybrids were first recorded from garden plants, although *R. ×ambigua* (the hybrid between *R. pseudoacacia* and *R. viscosa*) and *R. ×slavinii* (the hybrid between *R. pseudoacacia* and *R. hispida* var. *kelseyi*) are also known in wild populations in their native range (Isely and Peabody 1984; Martin 2019).

Therefore, should eradication no longer be possible genetic analysis should be conducted to confirm the exact makeup of the populations of invasive species from the Robinoid clade as it might affect possible management options including biological control.

In South Africa, invasive alien plant management strategies are primarily driven by government legislation, in particular the National Environmental Management: Biodiversity Act (NEM: BA) (Act no.10 of 2004), which provides a framework for assessment, listing, and management of invasive species. Under the regulation, invasive plant species under Category 1(a) are mainly assigned herbicide

application, mechanical and manual removal with the aim of eradicating the species. As a precautionary measure due to the severe impacts of *R. pseudoacacia* in South Africa, the rapid spread in the USA and Europe where invasive, *R. hispida* should at this stage be listed as Category 1 (a) species. However, should more and larger populations be recorded the species should then be listed as Category 1(b). Category 1(b) invasive plants are those that cause considerable environmental and/or economic damage but have spread to such an extent that the likelihood of eradicating the species is negligible and therefore the goal is to manage the species and not focus on eradication.

There are no specific management recommendations for *R. hispida* because of a lack of information on the species in both the native and invaded ranges. Considering similarities in traits to *R. pseudoacacia*, some generic management principles may apply. Generally, plants that spread by suckering are difficult to manage as any disturbance tends to fuel further spread and aggressive mechanical means such as the use of bulldozers create further ecological damage opening up vacant niches for secondary invasion (Martin 2019). Thus, the most feasible approach would be integrating biological control into any management attempts. However, currently there are no biological control agents released in South Africa for the congener, *R. pseudoacacia* although prospects are high (Martin 2021). Hence, the only course of action available for South Africa at the moment is to try and contain further spread of the species into grasslands and eradicate the currently small populations. This approach is based on the assumption that *R. hispida* invasion in the country is still in its incipient stages and the species can still be eradicated (Booy et al. 2020).

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Declarations

Conflict of interest The authors have not disclosed any competing interests.

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