

STUDENT PROJECT Missing Maddenia: A review of *Rhododendron* subsection Maddenia at Logan Botanic Garden

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Abstract

Rhododendron subsection Maddenia has long been cultivated at Logan Botanic Garden, one of three Regional Gardens of the Royal Botanic Garden Edinburgh (RBGE). Half of RBGE's subsection Maddenia accessions grow outdoors in Logan's relatively mild climate that suits these tender plants.

The subsection is one of Logan's representation themes. As a collection, it was known not to be maximally representative. This study's aim was therefore to investigate how greater representation might be achieved. Existing literature and known specialists were consulted to compile a list of taxa, although this remains unresolved. Using RBGE's database and an observational survey of Logan's living collection, it is estimated that 24 taxa are absent from the collection. Their native occurrence, *ex situ* cultivation and IUCN Red List criteria were researched. Using this information, a simple value system was created in order to prioritise acquisitions that might best serve conservation. This article is revised from the author's specialist project, completed in candidature for the HND in Horticulture with Plantsmanship.

Introduction

Background

The genus *Rhododendron* has been used ornamentally in UK gardens since 1600. Initially, introductions were of North American species, followed in the mid-1800s by much material from Asia (Cox, 1998). *Rhododendron* occurs across temperate northern hemisphere regions, extending through tropical SE Asia into Australia. A recent molecular study suggests origin in NE Asia and greatest diversity in the tropics and subtropics of SE Asia (Shrestha et al., 2018).

This large genus of c. 1,100 species is split into some 70 groupings at different taxonomic levels (BGCI, 2022a; McQuire &

Robinson, 2009). One group, subsection Maddenia, is the subject of this study.

Subsection Maddenia comprises free-growing and epiphytic shrubs from across Asia. They are tender in the UK and have large, often fragrant flowers (Fig. 1). The latter makes them desirable to growers and the former means they are often grown under glass. Not so at Logan Botanic Garden, where an outdoor collection thrives in the mild climate of south-west Scotland.

Rhododendron at the Royal Botanic Garden Edinburgh

The importance of the genus *Rhododendron* to horticulture is widely recognised. It has been thoroughly collected and studied. A

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Fig. 1 *Rhododendron nuttallii*, native to India, China, Myanmar and Vietnam. Despite its tender rating, it grows outdoors at Logan Botanic Garden. This species has distinctively large, rugose leaves. Photo: R. Baines.

glance through the library catalogue of the Royal Botanic Garden Edinburgh (RBGE) reveals the evolution of those studies from early Victorian literature; and thereafter from single taxonomic descriptions to classifications, catalogues and encyclopedias; field notes; field guides; illustrations; horticultural advice; societies' registers and yearbooks; guides to nomenclature and pronunciation; assessments of key *Rhododendron* gardens; biographies of important figures; and finally to the more recent floristic, ecological, chemotaxonomic and genetic studies by more diverse authors. RBGE has led much of this work since the 19th century (Gibbs et al., 2011).

The *Rhododendron* connection to RBGE was secured thanks to two factors. The first was the weather, Edinburgh's climate then suiting the plants' requirements. The Garden's glasshouses, as well as the acquisition in

the 20th century of the Regional Gardens, Benmore, Logan and Dawyck, extended RBGE's horticultural and scientific capacity. Consequently, it now holds a National Collection comprising c. 75 per cent of all known species (RBGE, 2022).

The second factor was the involvement of Sir Isaac Bayley Balfour, RBGE's Regius Keeper from 1888 to 1922, and collector George Forrest. Balfour created a 'stop-gap' classification that served horticultural needs and made sense of the vast number of specimens arriving in Edinburgh. Many of these were sent by Forrest from China (Cullen, 1980), having been collected by a team of Naxi people from U-lu-kay in Yunnan, led by Zhao Chengzhang (Harvey & Paterson, 2021).

Professor Hermann Sleumer published a modernised classification in 1949, yet the Balfourian system prevailed until Sleumer's system was finally developed by Cullen (1980)

and Chamberlain (1982). Their work has been called the 'Edinburgh system' (Argent et al., 1998), indicative of their expertise and that of their RBGE colleagues.

Subsection Maddenia

Taxonomic history

Rhododendron maddenii (Fig. 2), first described in 1849 (Hooker, 1849), became the type species for Hutchinson's Maddeni series, into which he grouped 39 species. These he split into three 'natural' groups: Eumaddenia, Megacalyx and Ciliicalyx (1919).

Cullen's (1980) is, however, the most recent review. It describes 12 new species and lumps 18 of the others together. It settles on thirty-six species plus two unresolved and is the basis for this study, supplemented by Argent et al. (1998), Cubey (2003) and McQuire & Robinson (2009). The propensity of

Rhododendron spp. to hybridise (Milne et al., 1999), subsequent discoveries, debate and reshuffling leave the taxonomy somewhat unresolved.

There are as-yet unnamed Vietnamese taxa (T. Hudson, Tregrehan Garden, pers. comm.). Others may await discovery in India (Dr A. Mao, Director, Botanical Survey of India, pers. comm.) and elsewhere, especially in regions that are difficult or dangerous to botanise (H. Lima, Member, Scottish Rhododendron Society, pers. comm.; Gibbs et al., 2011). In the light of ongoing debate, and without a full revision, it is not straightforward to delimit subsection Maddenia.

Distribution

Subsection Maddenia distribution extends from NE India, Nepal and Bhutan eastwards across the Himalaya into China



Fig. 2 The type species *Rhododendron maddenii* subsp. *maddenii* with the characteristically high number of stamens. Accession 19150028, pictured in Edinburgh, is also grown outdoors at Logan. It is one of the oldest examples of subsection Maddenia at RBGE and was collected in Bhutan by R.E. Cooper, who would later become RBGE's Curator. Its epithet honours Major Madden of the Bengal Civil Service (Hooker, 1849). Photo: A. Elliott.

and southwards into Myanmar, Thailand, Laos and Vietnam (Fig. 3). Most species are from China. Whilst many are from smaller, localised populations, the type species *Rhododendron maddenii* occurs across almost the full range. In its natural environment, the subsection grows in temperate montane regions (600–4,300 m) of high rainfall and humidity, and southwards where high elevation cools the otherwise warmer, subtropical climate.

General description

Subsection *Maddenia* species are typically 1–3 m in height. They have an open, at times lax habit and grow terrestrially, or sometimes

epiphytically. The leaves are evergreen, the flowers (Fig. 4) generally large, showy, often fragrant and coloured white, cream, yellow (Cubey (2003) notes these lack scent) or pale pink, sometimes with darker blotches. The calyx is usually conspicuous; the corolla funnel-form to campanulate; stamens 8–27 but usually about 10. Some species have attractive peeling bark.

Subsection *Maddenia* in cultivation

According to Argent et al. (1998), using the Royal Horticultural Society's (RHS) former hardiness ratings, most subsection *Maddenia* species are H1 (heated glass) – H2 (unheated

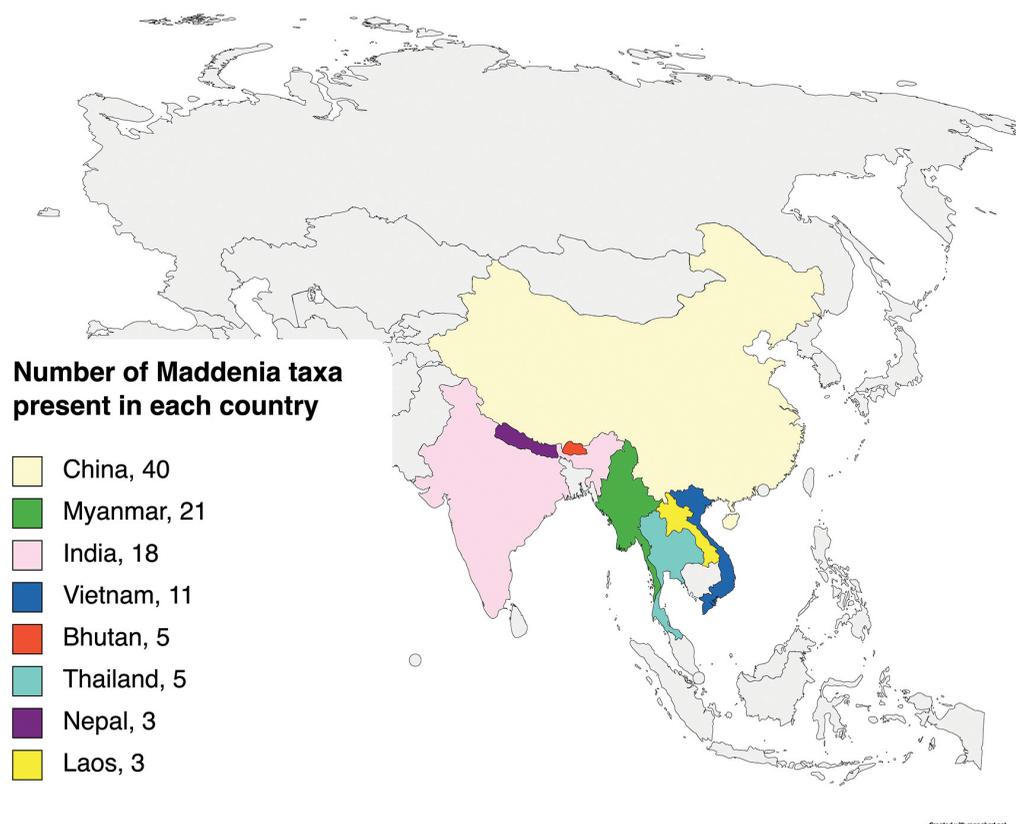


Fig. 3 Subsection *Maddenia* distribution by country: the number of species present in each country is based on geographical data from *The Red List of Rhododendrons* (Gibbs et al., 2011) and subsequent report to Botanic Gardens Conservation International (MacKay et al., 2018). Image created by H. McMeekin using mapchart.net CC-BY-4.0 (Mapchart, 2022).



Fig. 4 Typically shaped flowers, here with the distinguishing red markings of *Rhododendron dalhousiae* var. *rhabdotum*. Hooker named *R. dalhousiae* – ‘the noblest of the species’ – in honour of noted botanist Christian Ramsay, Countess Dalhousie. Usually epiphytic, it is Red Listed as Vulnerable in its native Bhutan, China and India. Photo: R. Baines.

glass), although *Rhododendron ciliatum* and *R. fletcherianum* are hardier to H4, meaning that they are generally hardy in the UK.

Using current RHS hardiness ratings, which are not directly equivalent (Gardiner, 2013), the species are between H1 (> 15 °C) and H4 (between –10 and –5 °C).

In the UK, they are often grown under glass. The general advice in the literature is that outdoors they require:

- mild winter temperatures, generally above 0 °C; shelter from drying winds but good airflow to limit diseases such as *Phytophthora* spp.
- humus-rich, acidic soils (pH 4.5–6); they grow well on sand and loam offering sharp drainage and moisture retention and a good mulch of leaf mould
- full sun or part-shade; any aspect except north. Full sun may be better considering

the UK’s lower light levels (P. Hayes, Head Gardener, NTS Brodick, pers. comm.).

In addition, some prefer being in raised beds or growing epiphytically, for example on tree stumps (Fig. 5). Established plants tolerate drought. If potted they can be left dry over winter and to become pot-bound (Glendoick, n.d.).

Subsection Maddenia in the context of RBGE’s living collection

RBGE’s database records 703 subsection *Maddenia* accessions (Table 1). The first arrived in 1912, and subsequent collections have come in every decade thereafter except 2010–2019. The material was largely wild collected through collaborative national and international expeditions, or sourced from other organisations including the National



Fig. 5 A sheltered bed in Logan’s central veranda contains several epiphytic rhododendrons, growing on tree and tree-fern stumps, including, at the rear left, the Near Threatened *Rhododendron valentinianum*, a low shrub with bright yellow flowers. Photo: H. McMeekin.

Table 1 The 703 accessions across RBGE's four Gardens.

RBGE Garden	Subsection Maddenia					
	No. of accessions including hybrids	No. of taxa	Total individuals	Extant individuals	No of individuals dead, removed or impossible to locate	% of individuals dead, removed or impossible to locate
Logan	359	31 (+1 hybrid; 4 cultivars; 5 aff.)	522	316	206	39
Edinburgh	254	34 (+5 aff.)	313	108	205	65
Benmore	89	10	93	42	51	55
Dawyck	1	1	1	0	1	100
Total	703	n/a	929	466	463	50

Logan records 51 per cent of the entire subsection collection and the lowest attrition rate at 39 per cent. Logan's collection is outdoors, whereas Edinburgh's is almost all under glass, therefore constrained by space. Edinburgh's ratio of plants to taxa is 3:1; Logan's is 8:1 and Benmore's is 4:1. Dawyck's climate is unsuitably cold.

Trust for Scotland's Brodick Castle on the island of Arran, which holds a Plant Heritage National Collection of the subsection (Plant Heritage, 2022a). Keith Rushforth is the single most prolific collector, having introduced 48 collections from 1994 to 2002.

Wild-origin material of thoroughly documented provenance is of greatest value to conservation and science (Cullen, 2004). Consequently, RBGE's Collection Policy is to increase wild-origin material from 53 per cent to 60 per cent (Rae et al., 2006). RBGE's living collection data show that Logan's percentage

of wild-collected accessions has increased from 12 per cent of all accessions to 42 per cent in the extant collection (Table 2), which is a significant step towards the Collection Policy target.

Cultivation at Logan Botanic Garden

Fully half of RBGE's living collection of subsection Maddenia has been grown outdoors at Logan Botanic Garden in the south-west of Scotland. The climate and conditions there are more favourable than

Table 2 The origin of plant material for Logan's collection of subsection Maddenia.

Origin	Subsection Maddenia accessions	
	% of all	% of extant
W – Wild	12	42
Z – Indirect wild	40	15
G – Garden	48	43

The collection is now closer to the RBGE target of 60 per cent wild origin. Material of indirect wild origin has greatly decreased. However, the decrease in less desirable garden-origin material is less pronounced.

those of RBGE's other Gardens: high rainfall, warmer temperatures, highest number of sunshine hours, fewest frost days and an increasing number of growing degree days (Met Office, 2020). Added to this are the shelter belt planting and walled garden wherein these tender rhododendrons flourish (Gibbs et al., 2011) (Fig. 6).

Logan Botanic Garden once formed part of the larger, private Logan estate. A century ago, the estate owner Kenneth McDouall, an avid collector and founding member of



Fig. 6 *Rhododendrum horlickianum*, from Myanmar, Red Listed as Data Deficient. It grows both terrestrially and epiphytically, up to 3 m. The white flowers are flushed pink with a yellow-orange plume. Six individuals grow outdoors at Logan and one, pictured here, in Edinburgh's temperate glasshouse. They are living type specimens of a 1932 accession (Elliott, 2014). Photo: F. Inches.

the Rhododendron Society (Postan, 1996), recognised Logan's suitability for subsection Maddenia. So began a tradition developed by head gardeners and curators that has lasted to the present day (R. Baines, Curator, pers. comm.), such that the subsection is now a representation theme of the Garden.

Rhododendron is a key genus of RBGE's living collection and must therefore 'display richness in species number and diversity' (Rae et al., 2006). Furthermore, recent plantings of the subsection accord with RBGE's Corporate Plan to rejuvenate displays and improve access to species (RBGE, 2015).

Subsection Maddenia has a historic connection to Logan. Its species grow well in, and are an attractive addition to, Logan's designed landscape. With Logan being a botanic garden, the plants are available for research and conservation. The Garden should rightly strive for a taxonomically and geographically diverse collection (Rae et al., 2006).

Conservation

Although *Rhododendron* is no longer a taxonomic focus of RBGE's science strategy, it remains valuable in terms of research, education, display, landscape and heritage (Rae et al., 2006) and, more recently, conservation. RBGE now leads Botanic Gardens Conservation International's (BGCI) Global Conservation Consortium for *Rhododendron*. The Consortium aims to develop collaborative conservation strategies for threatened species (BGCI, 2019).

Throughout its native distribution, *Rhododendron* provides significant ecosystem services; in the wild, however, one-third of its taxa are endangered to some extent and a quarter are yet to be fully assessed (Fig. 7). Threats include over-collection, deforestation, climate change and natural hazards (Gibbs

et al., 2011). The loss of Himalayan temperate forest, where rhododendrons are an understorey component, averaged 1.2 per cent from 2010 to 2014 (Brandt et al., 2017).

Recent plantings at Logan, and new to RBGE, have included subsection *Maddenia* species *Rhododendron carneum* and *R. chunienii* (RBGE, 2018a). The former, from Myanmar, Vietnam and S Central China (RBG, Kew, 2022), is known only in cultivation (Cullen et al., 2011). The latter, from Guangxi in Hunan, China, is considered taxonomically debatable (Gibbs et al., 2011). Their conservation statuses, Not Evaluated and Data Deficient respectively, render these species threatened until they can be assessed (Gibbs et al., 2011). Having these species in RBGE's living collection accords with the Collection Policy of prioritising genera in which the

Garden has a historic or scientific interest (Rae et al., 2006) and allows Logan to contribute to international conservation science.

Reviewing the collection

Completing the collection is neither a practicable nor a meaningful goal. However, Logan's subsection *Maddenia* collection is not maximally representative and already noted is the problematic lack of a recent taxonomic review and the subsequent discoveries.

Added to this are plant deaths which, although occurring as a matter of course (Rae et al., 2006), are an opportunity for learning, to better understand the plants' needs and therefore limit future losses, especially of the most important taxa. These combined factors create an ongoing need to review Logan's subsection *Maddenia*.



Fig. 7 Logan's climate, shelter belts and walls provide excellent conditions for tender plants. The *Maddenia* accessions are found nestled beside walls and as understorey. Photos: G. Ewan © RBGE.

Since RBGE is committed to adding 2,000 accessions per annum to its overall living collection (RBGE, 2015), this provides scope to augment the subsection *Maddenia* collection. New accessions would enhance this already important heritage collection and, importantly, would contribute to international conservation which could be communicated to Garden visitors and the wider public.

Aim and objectives

The aim of the project was to investigate how Logan's collection of subsection *Maddenia* could be made more comprehensively representative. To that end, four objectives were identified:

- research the subsection so as to create a list of current taxa
- ascertain which taxa exist in Logan's living collection and which are absent
- discover where target taxa are held in *ex situ* collections or in the wild
- establish an order of priority for new acquisitions

Materials and methods

For this observational descriptive study literature was researched to draft a list of subsection *Maddenia* taxa. This was cross-checked against Red List records (MacKay et al., 2018; Gibbs et al., 2011) and the *Plants of the World Online* (POWO) database (RBG, Kew, 2022). After discussion with Dr Alan Elliott, Biodiversity Conservation Network Manager at RBGE, a list was finalised.

Beginning with a query of the database of all RBGE's subsection *Maddenia* accessions, data were sorted by Garden then, for Logan, by bed. These bed lists were used to locate living specimens during a two-day visit to Logan in March 2020. Any specimens not

sighted by the author were confirmed by the Curator. Also noted were those plants not showing in the data query but sighted during the visit that were explicitly labelled as, or suspected of being, subsection *Maddenia*. All were then compared against the final list of taxa to create Logan's list and that of the 'missing *Maddenia*'.

To track the missing taxa, searches were made of online databases. Where relevant, those collection holders, along with specialists and botanic gardens uncovered in the literature, were contacted directly.

Lastly, a value system for prioritising acquisitions was created. This gave the taxa points according to the Red List conservation assessment of each one, with priority given to Chinese-origin rhododendrons for *ex situ* cultivation (MacKay et al., 2018) and to those taxa with the fewest occurrences in botanical collections as per BGCI *PlantSearch* (BGCI, 2022b).

Results

Logan's list and the 'missing Maddenia'

This study finds 62 taxa as potentially belonging to subsection *Maddenia*. Fifty are accepted by POWO (RBG, Kew, 2022). Of the twelve not accepted, five are affinis (i.e., closely related to a species already described but differing in some form); five are recorded in the Red Lists; one has been published but neither accepted nor rejected by POWO; and one is noted as being in cultivation or herbaria (Cubey, 2003). For the purposes of this study, all are included.

The survey confirmed at least one specimen of 38 taxa (Fig. 8), plus one unspecified, as growing at Logan (Appendix 1). Thirty-five were seen by the author and four were confirmed by the Curator. Thirty taxa were recorded on RBGE's database; nine were

not. Six are affinis or not specific. Thus, 61 per cent of subsection *Maddenia* taxa and 29 per cent of the subsection's threatened species grow at Logan. Verification status was not included in the database query. Few plant labels recorded this status.

Twenty-four taxa (Appendix 2) are considered absent from the collection, ten of which are of debatable taxonomy. For example, according to three sources (S. Hootman, Rhododendron Species Botanical Garden, Seattle, WA, USA; J. Ossaer, Arboretum Wespelaar, Belgium; and P.M. Jørgensen, University of Bergen, Norway – all pers. comm.), *Rhododendron mianningense* is possibly not a member of subsection *Maddenia*.

Tracking and prioritising the missing taxa

Of the 24 target taxa, 18 are found in cultivation (Fig. 9). Seventeen of them occur

in China; six each in India and Myanmar; two in Vietnam; one in Thailand; and one in Laos. Ten are in fewer than five *ex situ* botanical collections.

The BGCI PlantSearch database (BGCI, 2022b) anonymises collections but can facilitate enquiries to collection holders. From such enquiries and from direct contact with known private collections, 13 taxa were found to be held in UK collections. Eight species are held by the Rhododendron Species Botanical Garden in Seattle, WA, USA. The RHS Rhododendron, Camellia & Magnolia Group (RCMG) is compiling a list of the UK's extant rhododendrons (P. Hayward, Plant Committee Chair, RCMG, pers. comm.).

Rhododendron crassum var. *chapaense* is not listed on the PlantSearch database yet according to correspondence it grows in three collections; and although not showing on the database query, it may already be in



Fig. 8 The 38 taxa found growing at Logan included *Rhododendron burmanicum*. This forest-edge, yellow-flowered shrub has attractive cinnamon-coloured bark. Photo: R. Baines.



Fig. 9 One of the 24 target taxa, *Rhododendron taggianum*, in an early 20th-century photograph. It has limited distribution across its range in China, Burma and India but is held in at least nine botanical collections. ‘Deliciously fragrant’ was how George Forrest described this now vulnerable species. Stevenson (1930) added, ‘this will probably prove to be the gem of Mr. Forrest’s 1925 collection’. Photo: extracted from RBGE Herbarium specimen E00094967.

RBGE’s collection under the name *R. maddenii* subsp. *crassum*, collected in 1994 by Van On Tram at Sapa, Vietnam (D. Chamberlain, Research Associate, RBGE, pers. comm.). Citing a specialist, H. Lima (pers. comm.) suggests these may be one large hybrid group.

Rhododendron levinei, *R. coxianum*, *R. kiangsiense* and *R. taggianum* have been grown previously at Logan. *R. fletcherianum* and *R. pachypodum* are currently growing in Benmore and Edinburgh. *R. fletcherianum* and *R. fleuryi* have been propagated at Edinburgh (D. Chamberlain, pers. comm.). *R. wumingense* does not appear on RBGE’s database but is in the online Catalogue of the Living Collection (RBGE, 2018c) for Benmore. *R. ciliicalyx* grows at Logan, although as cultivar ‘Walter Maynard’, not as the species.

Of the ten debatable taxa, *Rhododendron iteophyllum* is noted as missing but RBGE may already hold it under *R. formosum* (D. Chamberlain, pers. comm.), the name recognised by POWO (RBG, Kew, 2022).

Prioritising the ‘missing Maddenia’

Using the points-based system (Appendix 2), the first five priority taxa are all Critically Endangered, with priority given to three Chinese species.

The first, *Rhododendron linearilobum*, is from a population of fewer than 50 individuals in a single cliffside location in S Yunnan; it is held in only one botanic garden collection (BGCI, 2022b), although this may be in doubt (S. Hootman, pers. comm.). The second, *R. rhombifolium*, occurs in only two,

fragmented populations (Gibbs et al., 2011) and in only two botanic gardens (BGCI, 2022b). The third, *R. mianningense*, from an unprotected area on a single mountain (Gibbs et al., 2011), occurs in four botanic gardens (BGCI, 2022b). The fourth, *R. fleuryi*, from NW Vietnam, is known only from a tiny population of six to ten mature shrubs (Gibbs et al., 2011) and is present in only one botanic garden (BGCI, 2022b).

Taxa six to ten are either Endangered, Vulnerable or Near Threatened, and are from small populations. The sixth and seventh may have some security by dint of their inaccessible or protected locations (Gibbs et al., 2011). Of taxa 11–24, seven are classed as Data Deficient (therefore assumed to be threatened); three are Not Listed and two are Not Evaluated. Two taxa, *Rhododendron pachypodum* and *R. pseudomaddenii*, are deemed of Least Concern.

Discussion

The aim of this study was to investigate how Logan's subsection *Maddenia* collection could be made more comprehensively representative. Following taxonomic research to create a species list, and a survey of Logan's collection, this study finds that of the 62 subsection *Maddenia* taxa, 24 are missing. Of these, 75 per cent could be obtained from *ex situ* botanical collections around the world.

It was expected that delimiting *Rhododendron* subsection *Maddenia* would be difficult, given the lack of a recent taxonomic review. The first person to do so, J. Hutchinson, warned of 'no easy path to the knowledge' (Stevenson, 1930). Ongoing debate is evident from this study's correspondence with specialists.

Whilst POWO provided a useful record of names, it does not indicate subsections, nor does it recognise the raising of taxa by

Mao et al. (2017). Therefore, until the 12 'not accepted' names and the debatable taxa are resolved, it seems prudent to include them. Consequently, the figure of 62 taxa in this study is an estimate, to be reviewed by others in the future.

The data show that the Edinburgh Garden has grown the widest range (39 taxa), which might be expected of RBGE's principal research site with its array of glasshouses. However, this study finds that Logan has grown a similar number, and outdoors, with a lower attrition rate than indoors in Edinburgh. This accords with the Collection Policy of 'the right plant in the right place' and removes the environmental impact of growing plants under glass. The entire Edinburgh collection could be transferred to Logan (or perhaps shared more widely, with other botanic gardens) but for the need for back-up material. Indeed, a severe winter would put Logan's outdoor collection at risk, possibly the cause of the increased plant deaths shown in the data as occurring there in 2000, 2008, 2009 and 2010.

That more than half of subsection *Maddenia* taxa grow at Logan was expected, since the subsection is a representation theme there. The Garden has 29 per cent of threatened taxa and therefore scope to increase this figure. Assessing the collection's genetic diversity and continuing to increase material of known wild origin (and perhaps deaccessioning garden-origin material) would add conservation value. That said, and although cultivars were not in the study's scope, one of several sighted, 'Lochinch Spinbur' (Fig. 10), is listed as 'critical' (RCMG, 2015), i.e. it is not currently known in collections nor available commercially (L. Pitman, Plant Conservation Officer, Plant Heritage, pers. comm.). Growing it accords with both Plant Heritage's work to conserve



Fig. 10 Maddenia cultivar *R. spinuliferum* × *burmanicum* 'Lochinch Spinbur' growing at Logan was raised and introduced in 1958 by Lord Stair of Castle Kennedy, also in Dumfries and Galloway (Leslie, 2004). The hybrid's status in cultivation is considered 'critical' (RCMG, 2015). Photo: R. Baines.

cultivars (Plant Heritage, 2022b) and RCMG's work to conserve rare *Rhododendron* species and hybrids (RCMG, 2022).

Accurate record-keeping is a key feature of botanical collections (PlantNetwork, 2006) and crucial to *ex situ* conservation collections (Badley et al., 2004). However, RBGE's data used herein have limitations. For example, some are at odds with what was surveyed or do not match RBGE's online Catalogue of the Living Collection (RBGE, 2018c) (Fig. 11). This could be explained by incomplete or inexact data, the expected lag in data input, an error in the query criteria or, most likely, the time lapse between generating the data query and carrying out the survey.

This study did not record whether plants had been verified, that is whether

the existing plant names are confirmed or require changing, or the identity of plants determined (Rae et al., 2006). Therefore, how near Logan's subsection Maddenia collection is to the Collection Policy target of 40 per cent verified is not known. While the process of verification is more difficult at RBGE's Regional Gardens (Cubey & Gardner, 2003), certain accessions could be prioritised because they meet target criteria. For example, those plants identified only to genus level, those of conservation importance and those flowering for the first time could be prioritised (Rae et al., 2006).

Targeting the 'missing Maddenia'

As noted, BGCI's PlantSearch database anonymises botanical collections. Therefore, it



Fig. 11 *Rhododendron ciliipes*, collected in Yunnan. Its Red List status is Data Deficient and it is considered to have a very narrow distribution in W Yunnan and N Myanmar. It did not appear on the data for Logan but is recorded in RBGE's Catalogue of the Living Collection (RBGE, 2018c) as growing in Edinburgh. It is one of 13 target taxa in UK collections. As such, pending a plant health assessment, it could be moved to or propagated for Logan. Photo: C. Tasker.

is unknown to what extent those collections overlap those of gardens uncovered in the literature and contacted directly. The response rate from both was very likely affected by COVID-19 restrictions.

More *ex situ* sources might have been discovered had the 16 institutions comprising BGCI's Global Conservation Consortium for Rhododendrons been contacted directly. Likewise, more might yet be discovered once RCMG publishes its list.

Thirteen taxa held in UK collections may be logistically the easiest to obtain, pending plant health assessments and permits, and if their accession predates the Nagoya Protocol (NP) regulations of 2014. The seven taxa listed as 'not in botanic gardens' would require wild collection from China (five are from China, so to have them would add to RBGE's already significant assemblage of Chinese plants

(RBGE, 2019)), India and Vietnam. Besides the greater physical logistics, wild collections necessitate other safeguards and contractual processes for which time and expectations must be factored in.

For example, to comply with NP regulations, RBGE is required to exercise due diligence to ascertain that any genetic material is lawfully collected. In practice, this involves obtaining prior informed consent from, and negotiating mutually agreed terms with, the relevant authorities in the countries of origin, for collecting and exporting, and material transfer agreements (P. Wilkie, Biodiversity Scientist, RBGE, pers. comm.).

However, RBGE has trusted relationships with many countries and already works collaboratively with a number of foreign institutions, including the Kunming Institute

of Botany in Yunnan, China and the Institute of Ecology and Biological Resources in Hanoi, Vietnam. It would be with the support of such organisations that RBGE would attempt both the contractual process and field trips (R. Baines; P. Brownless, Supervisor, RBGE; P. Wilkie, pers. comm.).

Otherwise, Logan's efforts could focus on collaborative *in situ* conservation, from which a virtual collection might be curated and exhibited in the Garden's Discovery Centre.

Only six of the twenty-four target taxa are considered secure in cultivation, that is in six or more botanic gardens. Using different acquisition criteria might rank the least secure species and/or those from the smallest, most precarious populations above BGCI's Chinese focus (MacKay et al., 2018). For example, *Rhododendron fleuryi*, here ranked 20th, is known only from one tiny population of six to ten plants in Vietnam and Red Listed as Critically Endangered.

In any case, a botanical collection should ideally contain genetically diverse material of assured wild origin. This and the need to comply with international conventions will guide any acquisitions.

The COVID-19 pandemic constrained this study. Access to the living collection in RBGE's Gardens was limited and staff in botanical institutions were unable to correspond at times. That said, and indicative of international collaboration towards the common goal of plant conservation, several correspondents were quick to assist and some to offer material from their collections.

It is hoped that this first work on Logan's subsection *Maddenia* contributes to RBGE's study of *Rhododendron* generally, and more specifically to the increasing need for the conservation value of any collection. To that end, the following recommendations are made:

- a taxonomic revision of subsection *Maddenia*
- a reassessment of Logan's subsection *Maddenia* collection against Collection Policy targets of 60 per cent wild origin and 40 per cent verified
- an assessment of the collection against Collection Policy information capture targets for Herbarium material (Fig. 12), images, DNA, phenological and horticultural data
- verification of data errors, with corrections made to the database where required
- a survey of the collection for plant health to ascertain if any accessions need to be replaced or propagated
- an assessment of the collection for genetic diversity to increase its conservation value
- obtaining target taxa from other RBGE Gardens and in collaboration with other botanic gardens and collectors, ensuring genetically diverse, wild-origin material
- collaboration on an international project to introduce the most threatened species into *ex situ* collections in China and Scotland
- discussion of opportunities for monitoring and interpreting the collection with RBGE Science, Horticulture and Visitor Services staff and volunteers
- consider applying for Plant Heritage National Plant Collection status
- consider climate modelling to ascertain the continued suitability of Logan for subsection *Maddenia*

Conclusion

This study recognises that subsection *Maddenia* will be revised in the future, but currently estimates that 24 such taxa



Fig. 12 This study recommends assessing Logan's subsection Maddenia collection against the information capture targets set out in the Collection Policy, including Herbarium specimens. Pictured is an early subsection Maddenia Herbarium specimen; the holotype of *Rhododendron supranubium*, collected by Forrest's team in June 1910 in Yunnan. Labelling shows it renamed by Cullen in 1974 as *R. pachypodum*. Scan of specimen E00010144. RBGE Herbarium (RBGE, 2018b).

are missing from Logan Botanic Garden's collection. In curating the collection, it is RBGE policy to audit it, identify gaps and work with others to acquire new material.

With further research, more collections of conservation value might be found in other institutions. From them and those already identified, and from the wild, genetically diverse material would augment Logan's collection and increase its conservation value. The latter is perhaps a more important goal than merely completing the collection.

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Appendix 1

Subsection *Maddenia* taxa growing at Logan

R. burmanicum

R. burmanicum aff.

R. carneum

R. changii

R. chunienii

R. ciliatum

R. crenulatum

R. dalhousiae var. *dalhousiae*

R. dalhousiae var. *rhabdotum*

R. dendricola

R. excellens

R. excellens aff.

R. formosum var. *formosum*

R. horlickianum

R. inaequale

R. johnstoneanum

R. leptoclodon

R. liliiflorum

R. lindleyi

R. lindleyi aff.

R. ludwigianum

R. lyi

R. maddenii subsp. *crassum*/*R. crassum*

R. maddenii/*R. maddenii* subsp. *maddenii*

R. megacalyx

R. nuttallii

R. nuttallii aff.

R. parryae

R. pseudociliipes

R. roseatum

R. rufosquamosum aff.

R. scopulorum

R. sinonuttallii

R. valentinianum var. *oblongilobatum*

R. valentinianum var. *valentinianum*

R. valentinioides

R. veitchianum

R. walongense

R. subsection *Maddenia* (unspecified)

Appendix 2

These 24 taxa are considered absent from Logan Botanic Garden. Points were awarded according to each Red List conservation assessment in Gibbs et al. (2011) and MacKay et al. (2018), whereby CR (Critical) = 6 points; EN (Endangered) = 5 points; VU (Vulnerable) = 4 points; NT (Near Threatened) = 3 points; DD (Data Deficient) = 3 points; NL/NE (Not Listed/ Not Evaluated) = 3 points; and LC (Least Concern) = 1 point.

* debatable taxonomy according to literature and/or correspondents

Maddenia taxon missing from Logan	Country of origin (MacKay et al., 2018; RBG, Kew, 2022)	Known elsewhere <i>ex situ</i>	Red List 2011 category	Red List Update 2018 category	Red List totals	BGCI China priority	Qualifier: instances on BGCI PS
<i>R. linearilobum</i>	China (S Yunnan)	Yes	CR	CR	12	Yes	1
<i>R. rhombifolium</i> *	China (S Central)	Yes	CR	CR	12	Yes	2
<i>R. mianningense</i> *	China (S Central Sichuan)	Yes	CR	CR	12	Yes	4
<i>R. fleuryi</i>	Vietnam (NW)	Yes	CR	CR	12	No	1
<i>R. coxianum</i>	India (Arunachal Pradesh)	Yes	CR	CR	12	No	3
<i>R. fletcherianum</i>	China (SE Tibet to NW Yunnan)	Yes	EN	EN	10	Yes	14
<i>R. wurmingense</i>	China (S Guangxi)	Yes	VU	VU	8	Yes	3
<i>R. taronense</i> *	China (NW Yunnan), Myanmar	Yes	VU	VU	8	Yes	5
<i>R. taggianum</i>	China (W Yunnan), Myanmar (NE), India (Arunachal Pradesh)	Yes	VU	VU	8	Yes	9
<i>R. kiangsiense</i>	China (Hunan, Fujian, W Jiangxi)	Yes	NT	NT	6	Yes	4
<i>R. amandum</i>	China (Xizang) Tibet	No	DD	DD	6	Yes	0
<i>R. eheinense</i> *	China (Sichuan)	No	NL	NE	6	Yes	0
<i>R. yaogangxianense</i> *	China (Hunan)	No	DD	DD	6	Yes	0
<i>R. yizhangense</i> *	China (Hunan)	No	DD	DD	6	Yes	0
<i>R. yungchangense</i>	China (W Yunnan)	No	DD	DD	6	Yes	0
<i>R. ciliipes</i>	China (W Yunnan), Myanmar (N)	Yes	DD	DD	6	Yes	6
<i>R. levinei</i>	China (SE to Guizhou)	Yes	DD	DD	6	Yes	8
<i>R. ciliicalyx</i>	China (Yunnan, Guizhou), India (Assam), Laos, Myanmar, Thailand, Vietnam	Yes	DD	DD	6	Yes	15
<i>R. crassum</i> subsp. <i>chapaense</i> *	Vietnam	Yes	NL	NL	6	No	0
<i>R. dalhousiae</i> var. <i>tashii</i> *	India (Sikkim, East Himalaya)	No	NL	NL	6	No	0
<i>R. iteophyllum</i> *	India (Khasia Hills, Assam)	Yes	NL	NL	6	No	2
<i>R. cuffeanum</i> *	Myanmar (N)	Yes	NL	NE	6	No	3
<i>R. pachypodium</i>	China (Yunnan), Myanmar (NE)	Yes	LC	LC	2	Yes	18
<i>R. pseudomaddenii</i>	India (Arunachal Pradesh)	Yes	NL	LC	1	No	1