Conservation status and management of Wright's gardenia *Rothmannia annae*

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Abstract: The Seychelles endemic tree *Rothmannia annae* (Rubiaceae) was historically widespread in the granitic islands but since the early 1900s has been restricted to Aride island. On Aride it has been monitored since 1986, the population is currently believed to be stable at just under 1000 mature plants. The population is secure on the Special Reserve and conservation management aims to establish further wild populations on other islands.

Keywords: Aride, island, Seychelles, tree

Wright's gardenia, *Rothmannia annae* (Wright) Keay, is a small tree endemic to the granitic islands of Seychelles. Historically, it was widespread in the islands but has been restricted to Aride island since the early 20th century. It has also been recorded on Mahé (1871, 1874 and 1899; Summerhayes 1931), Silhouette (1905; Summerhayes 1931), Praslin (1871; Summerhayes 1931) and has also been cited without further details from Felicite (Friedmann 1994). The population in the Aride Island Special Reserve is largely associated with open glades and edge habitats and it may have been a relatively uncommon constituent of lowland and coastal forests on all the islands.

Its decline on most islands can be attributed to clearance of the lowland forests, with Mahé and Praslin being cleared in the 19th-20th centuries, Felicite and much of Silhouette shortly after 1905 (Gerlach 1997). The lowland forests on Aride were maintained, although extensively modifed, to encourage nesting of sooty terns (*Stena fuscata* Linnaeus, 1766). The hill woodland dominated by *Pisonia grandis, Ficus lutea, F. reflexa* and *Euphorbia pyrifolia* was coppiced while the plateau was converted to coconut plantation. *R. annae* appears to have survived in the coppiced hill woodland and may have benefited from the open aspect of such managed woodland. Although the woodland has regenerated to a semi-natural state since coppicing ceased in 1984-7 (Carty & Carty 1996) a notable proportion of the coppiced trees are still present (in 1987-8 37% of the *R. annae* showed signs of coppicing; Bullock 1989)

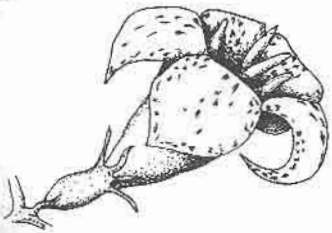

Fig 1. *Rothmannia annae*

Other historical threats have been suggested to include attack by alien mealy bugs (Coccoidea) which has been suggested to have caused the decline in the species, whilst a scarcity of such parasites has been suggested to have allowed its survival on Aride (Friedmann 1994). The significance of parasitism has been disputed (Gerlach 1997) and this is an unlikely cause of decline as mealy bugs and scale insects are also abundant on Aride. *R. annae* has not been observed to be exceptionally badly affected by mealy bugs. In addition mice (*Mus musculus* Linnaeus, 1758) have been recorded eating seedlings and seeds (Bullock 1989) but these were nursery specimens and field data suggest that few seeds are consumed by mice (9% of mice from hill woodland in 1999 may have consumed single *R. annae* seeds at a time when fruit was abundant, the figure for all habitats is 2%; Bowler & Hunter 2000).

As Aride retains the last wild *R. annae* the conservation of this population is of great importance and has been a high priority in monitoring and management work on the island. The current conservation status and ecological information on this species is summarised below.

Status on Aride

The population of *R. annae* on Aride has been monitored since 1985. The first survey used a Point Centre Quartered method for trees over 1.75m in height (Baum 1985), subsequent surveys have been whole-island surveys, aiming to count all individuals. Comparisons of the census data may not be reliable due to the different methods used and the highly clumped distribution of trees imposing difficulties on evaluating reliable error limits (Martin 1997), however, the data are compared in Table 1.

The large decrease between 1985 and 1987 can be ascribed to differences in survey methods (Martin 1997). Decreases since 1987 have been suggested to be significant and a cause for great concern (Carty & Carty 1996; Gerlach 1997). However, the reliability of the data have been questioned; the 18.3% decline recorded by Carty & Carty (1996) (corrected to 16.9% in Martin 1998) is not statistically significant (Martin 1995). The accuracy of the 1995 survey is further questioned by the apparent increase in 1997-9. Over the 12 years of whole-island surveys the population of adult trees has declined by 12.6% (1.05% per year) although since 1989 there has been a decline of only 3.8%. On this basis the population appears to be stable at approximately 1000 mature trees. All 987 trees over 1.5m in height now bear a uniquely inscribed aluminium tag attached by heavy-duty wire to allow identification of individual trees in subsequent surveys: a valuable monitoring and management tool.

R. annae was considered to be vulnerable in 1997 (Gerlach 1997; Oldfield *et al.* 1998; Walter & Gillett 1998) on the basis of its restricted range and the suggested population decline. As the revised data indicate a stable population of 1000 individuals and the species is widespread across Aride's 73ha, the species may appear to be under less threat that was

Table 1. *Rothmannia annae* census data

Year	Number of mature trees	Source
1985	2386 (1964-3283 95% confidence limits)	Baum 1985
1987	1129	Tyzack 1987
1989	1018	Bullock 1989
1995	938 (corrected to 979; Shaw & Upton 2000)	Carty & Carty 1996
1997/8	804 (corrected to 987; Shaw & Upton 2000)	Hill 1999
1998/9	987	Shaw & Upton 2000

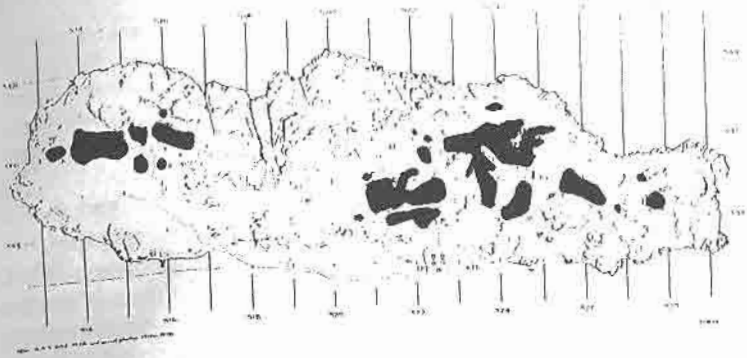

Fig. 2. Distribution of *R. annae* on Aride

believed earlier. However, application of the IUCN Red List Criteria (IUCN 1994) still classifies *R. annae* as vulnerable (Vu D1&2 - less than 1000 mature individuals and population restricted in area [<100km^2] and number of locations [<5]).

Ecology

The heavily scented flowers may be produced in all months, particularly after heavy rain. There is a peak of mass flowerings in October-January. This relates to flowers opening 6-13 days after rain (mean 9.8) (Bullock 1989). It has been suggested that the flowers may be self-fertile (Castle & Mileto 1991), however, the flowers are male or female by selective abortion by different individuals (Friedmann 1994); the female flowers are slightly more spotted. Studies of flower types have recorded that 17.7% were white, 41.9% sparsely spotted, 40.3% heavily spotted (N=62) (Bullock 1989). White and sparsely spotted flowers are assumed to be predominantly male, giving a suggested male biased sex ratio of 1.48:1.

Fruit is set in only 5% of flowers (Castle & Mileto 1991). The majority of trees fruit each year: in January-February 1996 76.4% of trees were fruiting. Relatively few fruits produce seedlings and of the trees recorded fruiting in 1996 52.8% had seedlings under the canopy, and of these only 9.7% had seedlings growing to over 25cm (Stoneman 1996). This appears to be principally due to smothering by weeds, in particular *Asystasia* sp. In favourable situations seedling survival is high and 14 month survival has been calculated at 39.2% (Bullock 1989).

The majority of trees continue to grow and height increases have been recorded since 1988 with mean annual growth of 0.2m (1988-96; data in Castle & Mileto 1991; Stoneman 1996). Mean height is currently 7.7m (in 1996; Stoneman 1996). These height measurements are estimated and subject to recorded error, however, directly measured diameters at breast hieght have also increased in the same time period. During 1988-92 diameter increased by a mean of 0.92cm (Castle & Mileto 1991), in 1992-6 98.4% increased their diameter, with an increment of 1.58cm (Stoneman 1996). These give an average annual increment of 0.31cm.

Conversely, a significant proportion of the population has decreased in canopy size

The extent of canopy decrease varies across the island: in 1992-6 declines were more frequent in closed woodland (66.6% of trees) than in edge/open habitats (34.6%) (Stoneman 1996). During the same time there was an increase in shading by *Pisonia grandis* and *Ficus reflexa*, this effect will be much more pronounced in closed woodland than in more open areas (Stoneman 1996). It should be noted that canopy decreases were much smaller than increases.

There are few direct observations of pollination or seed dispersal. Flowers are visited by the Seychelles sunbird (*Nectarinia dussumieri* (Hartlaub, 1860)), the carpenter bee *Mesotrichia inceria* (Perez) *seychellensis* and the leaf cutter bee *Megachile s. seychellensis* Cameron, 1907. Dispersal agents may be speculated to include fruit bats (*Pteropus seychellensis* Milne Edwards, 1888) and giant tortoises (*Dipsochelys* spp.). Small numbers of fruit bats are present on Aride but are not permanent residents, these appear to be attracted to the island by the large numbers of fig trees, consequently the bats may overlook the *R. annae* fruit; no bats have been seen feeding on *R. annae*. Dispersal by tortoises may have been significant in the past but native giant tortoises are extinct on Aride and the small number of introduced Aldabra giant tortoises (*D. dussumieri* (Gray, 1835)) were removed from the island in the 1970s. Currently dispersal appears to be very limited; seedlings are most abundant under parent trees and saplings and mature trees show a distinctly clumped distribution.

Management

Seedlings on Aride are extensively overshadowed, with clearance of ground cover seedling growth has been recorded as 5cm per month (Carty & Carty 1996). Overshadowing has been countered by selected removal of *Asystasia* sp. and *Pisonia grandis* from hill trees (Bowler & Hunter 1999) although this is not maintained as a permanent management technique but rather a means of providing temporary protection for selected trees. Planting on Aride has aimed at spreading the species into unoccupied areas on the plateau, although survival has been low (Bowler & Hunter 1999); there is currently no interventionist management for *R. annae* on Aride due to its apparent stability.

R. annae has been planted on other islands, initially as small numbers for ornamental purposes on Mahé. Significant introductions to other islands started in 1994 and subsequently on a semi-annual basis (Mahé 1995-99 - Carty & Carty 1996; Betts 1996; Bowler & Hunter 2000), Cousin (1994-5 - Carty & Herzig 1995; Carty & Carty 1996), Cousine (1994-6 - Carty & Herzig 1995; Betts 1996), Curieuse (1995 - Carty & Carty 1996), Praslin (1994-7 - Carty & Herzig 1995; Carty & Carty 1996; Betts 1997), Fregate (1996 - Betts 1996 & 1997) and Silhouette (2000). A variety of techniques have been used, from the export of seedlings, cleaned seeds and whole fruit. Cleaned seeds and fresh fruit have proved to be most effective (60% germination rate [N=500] - F. Dogley pers. comm.) and adaptable but germination rates from old fruits have been very poor (0-9%; Bowler & Hunter 2000).

The majority of seedlings transferred to Cousin, Cousine, Curieuse and Praslin died, those maintained at the Botanical Gardens on Mahé have been successfully established and trees planted in 1996 flowered in 1997 (Betts 1997), with fruiting in 1999 (Bowler & Hunter 2000).

Prospects

In order to determine whether special conservation measures were needed to maintain the genetic diversity of *R. annae* a genetic study was initiated (Fay *et al.* 2000). This found very restricted genetic variation (maximum of 6%) with no geographical pattern within the Aride population. 2 of the 20 individuals samples were categorised as genetic outliers and these are to be included in future distribution of seed to other islands to ensure that as much genetic diversity as possible is established in new populations.

The available data suggest that *R. annae* is stable on Aride and the population is expected to remain at just under 1000 individuals without active management. Accordingly there are no plans to increase the numbers or extend the distribution on Aride unless future monitoring data provide evidence of further decline. The most productive approach for improving the conservation prospects for *R. annae* will be to re-establish populations on other islands. A number of trees have been established on Mahé and 25 seedlings were planted by the Divison of Environment at Mare aux Cochons. Growth of these seedlings has been variable with significant die back during dry weather. Attempts to establish the species on other islands have had only limited success and need to be extended. At present, the best prospects lie with the extensive habitat restoration plans for Fregate and Silhouette. Seedlings have been established in a nursery on Fregate and the first seeds were sent to Silhouette in April 2000.

Due to the restricted land area of the grantic islands of Seychelles *R. annae* will always be categorised as vulnerable by nature of a restricted range (IUCN Red List Criterion Vu D2). Other threats to its survival can be reduced by increasing the number of mature individuals in the wild to over 1000 and establishing at least 4 more discrete populations. With maturity in 2-3 years there is a possibility that wild populations may be considered to be established on Fregate and Silhouette by 2003. It should also be possible to establish viable populations on Cousin, Cousine, Curieuse and North islands as part of existing or planned habitat management on those islands.

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