

INTERIM RECOVERY PLAN NO. 224

CORRIGIN GREVILLEA **(*GREVILLEA SCAPIGERA*)**

INTERIM RECOVERY PLAN

2006-2011



May 2006

Department of Conservation and Land Management
Species and Communities Branch (SCB)
Kensington



FOREWORD

Interim Recovery Plans (IRPs) are developed within the framework laid down in Department of Conservation and Land Management (CALM) Policy Statements Nos. 44 and 50.

IRPs outline the recovery actions that are required to urgently address those threatening processes most affecting the ongoing survival of threatened taxa or ecological communities, and begin the recovery process.

CALM is committed to ensuring that Threatened taxa are conserved through the preparation and implementation of Recovery Plans (RPs) or IRPs, and by ensuring that conservation action commences as soon as possible and, in the case of Critically Endangered (CR) taxa, always within one year of endorsement of that rank by the Minister.

This Interim Recovery Plan results from a review of, and replaces Wildlife Management Program No 24, Corrigin Grevillea Recovery Plan, Rossetto *et al* (2000). This Interim Recovery Plan will operate from June 2004 to May 2009 but will remain in force until withdrawn or replaced. It is intended that, if the taxon is still ranked Critically Endangered, this IRP will be reviewed after five years and the need for a full Recovery Plan will be assessed.

This IRP was given CALM regional approval on 13 February, 2006 and was approved by the Director of Nature Conservation on 22 February, 2006. The allocation of staff time and provision of funds identified in this Interim Recovery Plan is dependent on budgetary and other constraints affecting CALM, as well as the need to address other priorities.

Information in this IRP was accurate at May 2006.

IRP PREPARATION

This IRP was prepared by Julie Patten¹, Kim Kershaw², Greg Durell³, Bob Dixon⁴ and Andrew Brown⁵.

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ACKNOWLEDGMENTS

The following people have provided assistance and advice in the preparation of this Interim Recovery Plan:

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Amanda Shade	Horticulturalist, Botanic Garden and Parks Authority
Bryan Shearer	Principal Research Scientist, CALM's Science Division

Thanks also to the staff of the W.A. Herbarium for providing access to Herbarium databases and specimen information, and CALM's Species and Communities Branch for assistance.

Cover photograph by Andrew Brown.

CITATION

This Interim Recovery Plan should be cited as:

Department of Conservation and Land Management (2006). Corrigin grevillea (*Grevillea scapigera*) Interim Recovery Plan 2006-2011. Interim Recovery Plan No. 224. Department of Conservation and Land Management, Western Australia.

SUMMARY

Scientific name:	<i>Grevillea scapigera</i>	Common name:	Corrigin Grevillea
Family:	Proteaceae	Flowering period:	September to December (Peak October to November) and opportunistically after summer rains (March)
CALM region:	Wheatbelt	CALM district:	Narrogin
Shires:	Corrigin and Brookton	Recovery teams:	Narrogin District Threatened Flora Recovery Team (NDTFRT)

Illustrations and/or further information: Brown, A., Thomson-Dans, C. and Marchant, N. (Eds). (1998) *Western Australia's Threatened Flora*. Department of Conservation and Land Management, Perth, Western Australia; CALM (1998) Western Australian Herbarium FloraBase – Information on the Western Australian Flora. Perth, Western Australia. <http://www.calm.wa.gov.au/science/>; McGillivray, D.J. (1993). *Grevillea (Proteaceae) - a taxonomic revision*. Melbourne University Press. Carlton, Victoria.

Current status: *Grevillea scapigera* was Declared as Rare Flora under the Western Australian *Wildlife Conservation Act* 1950 in September 1987 and ranked as Critically Endangered (CR) in 1995. It currently meets World Conservation Union (IUCN 2000) Red List Category 'CR' under criteria B1ab(i-v)+2ab(i-v); C2a(i) and D as it is has a highly restricted geographic range and area of occupancy, there is severe fragmentation of populations, all population contain less than 50 mature individuals and there is a continuing decline in quality of habitat, the number of populations and mature individuals. The species is also listed as Endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act). The main threats are habitat fragmentation, lack of critical habitat, lack of natural disturbance regimes, seed predation, road maintenance activities, accidental destruction, rabbits, weeds, low genetic diversity, fertilizer and herbicide drift and salinity.

Description: *Grevillea scapigera* is a prostrate, spreading shrub, 5-10 cm high by up to 2m across with slightly hairy stems. The leaves, which are erect and on long slender stalks, are 3–9 cm long, hairy at first and become glabrous with age. Each leaf has flat, sharply pointed, deeply cut lobes that in some cases, are cut almost to the base of the midrib. Mature leaves are hairless, slightly leathery, and slightly prickly. Creamy white, sweetly-scented flowers are borne in unusual globular heads to 4 cm in diameter on scapes to 30cm. Fruits are 1 to 1.5 cm long, sticky, slightly oblique and compressed, and contain two curved to oblique-navicular seeds (McGillivray 1993). The seeds are light brown to grey and mottled. This colouring may aid in avoidance of seed predation.

Habitat requirements: *Grevillea scapigera* is found in flat country on sandy, or gravelly, lateritic soils. The remaining three wild adult plants and two seedlings occur in the Corrigin region on narrow, degraded road verges. All known populations are found over a range of 40 kilometers.

Habitat critical to the survival of the species, and important populations: Habitat critical to the survival of the species includes the area of occupancy of important populations; areas of similar habitat surrounding important populations (i.e. flat country on sandy or gravelly, lateritic soils associated with low heath amongst tall shrubland) provide potential habitat for natural range extension and are necessary to provide habitat for pollinators; the local catchment of the surface and possibly ground waters that maintain the habitat of the species; and additional occurrences of similar habitat that may contain the species or be suitable sites for future translocations.

Given that this species is listed as Critically Endangered it is considered that all known habitat for wild and translocated populations is habitat critical.

Benefits to other species/ecological communities: Recovery actions implemented to improve the quality or security of the habitat of *Grevillea scapigera* will also improve the health of another Declared Rare Flora species *G. dryandroides* subsp. *hirsuta* that occurs in the habitat of Population 2. Research carried out into the protection of *G. scapigera* which has included translocation, cyrostorage and seed dormancy will benefit the conservation of other rare grevillea species.

International obligations: This plan is fully consistent with the aims and recommendations of the Convention on Biological Diversity that was ratified by Australia in June 1993, and will assist in implementing Australia's responsibilities under that Convention. The species is not listed under the United Nations Environment Program World Conservation Monitoring Centre (UNEP-WCMC) Convention on International Trade in Endangered Species (CITES). In addition, it is not listed under any other specific international treaty and this Interim Recovery Plan (IRP) does not affect Australia's obligations under these international agreements.

Role and interests of indigenous people: Indigenous communities interested or involved in the region affected by this plan have not yet been identified. The Aboriginal Sites Register maintained by the Department of Indigenous Affairs does not list any significant sites in the vicinity of these populations. However, not all significant sites are listed on the Register. Implementation of recovery actions under this plan will include consideration of the role and interests of indigenous

communities in the region.

Social and economic impacts: The implementation of this recovery plan is unlikely to cause adverse social and economic impacts as most populations are located on road reserves or in nature reserves. *Grevillea scapigera* is a flagship species and the floral emblem of Corrigin Shire and there is a great deal of community support for its protection.

Affected interests: Stakeholders potentially affected by the implementation of this plan include the Shire of Corrigin, as managers of the areas containing Populations (1a, 3a, 3b, 4, 5, 6, 7, 8, 10, 11 and 12), the Shire of Brookton (Populations 2 and 13), and Main Roads WA (Population 1b).

Evaluation of the plans performance: CALM will evaluate the performance of this IRP in conjunction with the Narrogin District Threatened Flora Recovery Team. In addition to annual reporting on progress with listed actions and comparison against the criteria for success and failure, the plan is to be reviewed within five years of its implementation.

Existing Recovery Actions: The following recovery actions have been or are currently being implemented:

1. Appropriate land managers have been made aware of the location and threatened status of the species.
2. Declared Rare Flora (DRF) markers have been installed at all roadside populations.
3. Dashboard stickers and posters describing the significance of DRF markers have been produced and distributed. Stubby holders illustrating DRF markers have also been produced and distributed amongst Shire workers.
4. Research has been carried out on propagation techniques using macro cuttings, tissue culture and grafting.
5. Phytosanitary guidelines have been developed for the translocation of *Grevillea scapigera*.
6. A total of approximately 3,300 seeds from 21 plants are stored in CALM's Threatened Flora Seed Centre (TFSC) and an additional 2,000 seeds are stored at The Botanic Gardens and Park's Authority (BGPA).
7. Translocations were begun in 1996 and are ongoing.
8. Watering systems have been set up at the three translocation sites to improved survivorship and increase seed production for long term soil seedbank storage.
9. A number of weed control experiments have taken place including pre-planting spraying, strip spraying and post planting spraying (*Grevillea* plants covered with containers) using non-selective herbicides.
10. Broad scale weed control was undertaken at Population 1t in 2001 to control perennial veldt grass
11. Material from most of the original 10 clones is stored in liquid nitrogen (cryostorage – liquid phase) at -196°C for future use.
12. BGPA currently have 15 potted plants of *Grevillea scapigera* from 5 clones.
13. A number of pre-seed treatments have been trialed including heat, smoke (aerosol and water) gibberelic acid, standard scarification, specific scarification and a mixture of treatments to improve germination rates.
14. Trials treating seed with salicylic acid, which helps with drought resistance and salt resistance, were inconclusive.
15. On site smoke trials using tents to concentrate chemicals were tested to stimulate germination of the *Grevillea* soil seed store.
16. Populations 1a, 1t and 8t have been surrounded with rabbit proof fencing to protect plants from rabbit grazing.
17. Initial testing of dieback susceptibility on three plants indicate resistance to *Phytophthora*.
18. There are 9 clones in tissue culture at BGPA which may be used in supplementary planting.
19. Research into the genetics of *Grevillea scapigera* was undertaken to asses the genetic fidelity of the 9 clones.
20. Opportunistic surveys in areas of suitable habitat following disturbance are ongoing.
21. Translocated populations are regularly monitored.
22. Staff from CALM's Narrogin District monitor naturally occurring populations annually.
23. The Narrogin District Threatened Flora Recovery Team is overseeing the implementation of this IRP.

IRP objective: The objective of this Interim Recovery Plan is to abate identified threats and maintain and/or enhance the habitat of natural and translocated populations, gain an understanding of the recruitment dynamics of the species, obtain *in situ* recruitment (through artificial or naturally occurring disturbance), maintain the soil seed bank and ensure the long-term preservation of the species.

Criteria for success: Identified threats are abated, recruitment dynamics are understood, seedlings are produced *in situ* and the soil seed bank is maintained over the period of the plan's adoption under the EPBC Act.

Criteria for failure: Threats are not abated, recruitment dynamics are not understood, no recruitment occurs and the soil seed bank is depleted over the period of the plan's adoption under the EPBC Act.

Recovery actions

- | | |
|--|---|
| 1. Coordinate recovery actions | 11. Protect plants from bird damage at translocation sites |
| 2. Map total habitat | 12. Conduct a seed viability trial |
| 3. Formally notify land managers | 13. Conduct additional tests for <i>Phytophthora</i> resistance |
| 4. Reposition and replace DRF markers where required | 14. Continue liaison |
| 5. Stimulate germination of soil-stored seed | 15. Continue monitoring populations |

6. Collect seed and cuttings
7. Continue to propagate and translocate plants
8. Implement insect control at translocation sites
9. Implement rabbit control
10. Implement weed control as necessary
16. Conduct further surveys
17. Increase community awareness
18. Implement habitat protection.
19. Review the IRP and assess the need for further recovery actions

1. BACKGROUND

History

Grevillea scapigera was first collected from the Corrigin area by N.H. Brittan in 1954 and was described as a new species by A.S. George in 1974 (George 1974). It appears to be extremely rare and is restricted to a 40 km range in the Corrigin area. There is an unconfirmed record from the Hyden area. In 1986 the species was thought to have become extinct when the last known naturally occurring plant died near Corrigin. Subsequently, a grafted plant was located at the Royal Botanic Gardens, Sydney. Material of that plant was brought back to Perth and tissue cultured at the Botanic Garden and Parks Authority (BGPA). Since then some 50 plants have been located in the wild. However, most of these have now died and currently just three adults remain.

Description

Grevillea scapigera is a prostrate woody perennial 5-10 cm high by 1-3.5 m wide with slightly hairy stems. The leaves are hairy when young, 3-9 cm long and erect on long slender stalks. They have flat, sharply pointed, deeply cut lobes that, in some cases, are cut almost to the base of the midrib. Mature leaves are hairless, slightly leathery, and slightly prickly. Strongly scented flowers are borne in unusual globular heads to 4 cm in diameter which are produced on a glabrous 16-33cm long peduncle. Fruits are 1 to 1.5 cm long, sticky, slightly oblique and compressed, and contain two curved to oblique-navicular seeds (McGillivray 1993, Brown *et. al.* 1998). The seeds are light brown to grey, mottled and blend in with the soil surface. This colouring may aid in avoidance of seed predation.

The species is allied to *Grevillea eryngioides*, but differs in its sprawling habit, smaller bipinnate leaves, simple inflorescence in a shorter peduncle, up to 30cm in height. It is also glabrous with large style, narrower fruits and seeds.

Distribution and habitat

Grevillea scapigera is found in flat country on sandy or gravelly soils over a 40 km range between Corrigin, Bullaring, Bulyee and Quairading, where greater than 95% of its original habitat has been cleared for agriculture. The largest natural area containing remnants of *G. scapigera* are in two reserves. The Corrigin area has moist winters and dry summers where the average rainfall between May and August is 223 mm (Bureau of Meteorology data). A single unconfirmed record of *G. scapigera* was from Hyden in 1970, and, if confirmed, would extend the range of the species to 150 km.

Natural populations are found in a shrubland of *Acacia acuminata*, *Allocasuarina campestris*, *Allocasuarina microstachya*, *Astroloma serratifolium*, *Austrostipa elegantissima*, *Baeckea crispiflora*, *Banksia sphaerocarpa*, *Calothamnus quadrifidus*, *Comesperma scoparia*, *Gastrolobium spinosum*, *Grevillea cagiana*, *Grevillea hookeriana*, *Grevillea pilulifera*, *Grevillea dryandroides* subsp. *hirsuta*, *Hakea incrassata*, *Hakea scoparia*, *Lepidobolus chaetocephalus*, *Leptospermum roei*, *Leptospermum erubescens*, *Leucopogon* sp. Brookton, *Persoonia helix* and *Waitzia acuminata*.

Summary of population land vesting, purpose and tenure

Pop. No. & Location	CALM District	Shire	Vesting	Purpose	Tenure
1a SW Corrigin	Narrogin	Corrigin	Non vested	Airport	Non-CALM Act
1b SW Corrigin	Narrogin	Corrigin	Main Roads WA	Road Reserve	Non-CALM Act
1t SW Corrigin	Narrogin	Corrigin	Non vested	Airport	Non-CALM Act
2 NE of Aldersyde	Narrogin	Brookton	Shire of Brookton	Road Reserve	Non-CALM Act
3a NNE of Jubuk	Narrogin	Corrigin	Shire of Corrigin	Road Reserve	Non-CALM Act
3b NNE of Jubuk	Narrogin	Corrigin	Shire of Corrigin	Road Reserve	Non-CALM Act
4 NW of Corrigin	Narrogin	Corrigin	Shire of Corrigin	Road Reserve	Non-CALM Act

5 NW of Bullaring	Narrogin	Corrigin	Shire of Corrigin	Road Reserve	Non-CALM Act
5t NW of Bullaring	Narrogin	Corrigin	Shire of Corrigin	Road Reserve	Non-CALM Act
6 NW of Kunjin	Narrogin	Corrigin	Shire of Corrigin	Road Reserve	Non-CALM Act
7 SSW of Jubuk	Narrogin	Corrigin	Shire of Corrigin	Road Reserve	Non-CALM Act
8 WSW of Corrigin	Narrogin	Corrigin	Non vested	Airport	Non-CALM Act
8t WSW of Corrigin	Narrogin	Corrigin	Shire of Corrigin	Road Reserve	Non-CALM Act
9 NW of Lomos	Narrogin	Brookton	Conservation Commission	Conservation of Flora and Fauna	Nature Reserve
10 N of Kweda	Narrogin	Corrigin	Shire of Corrigin	Road Reserve	Non-CALM Act
11 N of Kunjin	Narrogin	Corrigin	Shire of Corrigin	Road Reserve	Non-CALM Act
12 N of Kunjin	Narrogin	Corrigin	Shire of Corrigin	Road Reserve	Non-CALM Act
13 NE of Aldersyde	Narrogin	Brookton	Shire of Brookton	Road Reserve	Non-CALM Act

t = translocated population

Biology and ecology

For his PhD Dr Maurizio Rossetto studied the biology of *Grevillea scapigera* which included an assessment of genetic diversity and propagation methods.

Grevillea scapigera flowers mainly between September and December with a peak between October and November. At other times of the year single, rare, scattered flowering events have been recorded following good rainfall events. Inflorescences are produced on new growth and over 1000 inflorescences can be observed at one time on an average 1.5m diameter plant. Flowers are strongly scented and produce abundant nectar, usually for a short period in the early morning. The flowers are protandrous (flowers assume a functional male condition during development before reversal to a functional female state) and approximately six flowers per day open for each inflorescence. These remain receptive for pollination for up to 4 -5 days. Pollen is shed quickly and electron-microscopy shows that the stigma reaches its peak receptivity around the fourth day after anthesis (the splitting of pollen sacs to release pollen).

On average, three to five fruits (up to ten) per inflorescence are produced naturally, each fruit containing two seeds. Seeds have high viability (usually > 90 % germination *in vitro*) and remain viable for at least four years, probably longer. However seeds are prone to very high levels of predation (as indicated by damage to seed coats) by insects and birds. Plants either do not flower or, if they do, produce very little seed in drought years (B. Dixon personal communication¹). Seeds generally require soil disturbance to germinate as juvenile plants have been mainly recorded following road grading or other disturbance such as digging by rabbits. However, some inter-disturbance recruitment appears to occur following heavy summer rain and in the Bullaring population there is some evidence of this having occurred more than once. The influence of ants as dispersal agents is not well understood but ants could be an important factor for the survival, germination and dispersal of seeds. Germinants that appear early in the season appear to have a longer lifespan (B. Dixon personal communication).

Research into the genetics of *Grevillea scapigera* using the DNA fingerprinting technique of amplified fragment length polymorphism (AFLP) was undertaken to assess the genetic fidelity of the 9 clones held at the BGPA (Brennan 1995). Material was taken from 46 plants that had been propagated from the 9 clones. Contrast genetic variation and average genetic similarities of F1s to their parents was examined to gather information on genetic decline and assign paternity to reintroduced plants to assess the reproductive success of each clone.

Flowers are pollinated by a range of insects, especially Hymenoptera and Lepidoptera, with the greatest activity occurring on warm days between 9 am and midday. Ants frequently visit flowers to

¹ Dr Bob Dixon – Manager Biodiversity and Extensions, BGPA

feed on nectar, however because of their small size and shape are unlikely pollinators. Due to the characteristics of current pollinating agents and the distances involved it is unlikely that any inter-population pollination occurs.

Pollen from nine different *Grevillea* species, including *G. scapigera*, has been successfully placed in cryostorage at the BGPA. This has resulted in no significant decline in viability (Touchell personal communication²). This process is important for future crossing and breeding studies as under normal conditions *Grevillea* pollen loses viability within ten days.

Natural levels of selfing in *Grevillea scapigera* are very low. In experimental field trials, no seed set was obtained after self-pollination compared to 26% seed set for out-crossed plants. Furthermore, a slightly higher level of seed abortion occurred following crosses between closely related (i.e. from the same population) rather than distantly related (i.e. from different populations) plants.

The life span of individuals of the species is relatively short. Germinants usually appears after disturbance such as fire or grading and live between 7 and 9 years. Adult plants are killed by fire. Flowering has been noted on cutting grown plants in less than one year. Seedlings in the natural environment usually take at least 1 year to flower, and often longer in drought conditions. However, when raised in cultivation they often flower in 8 months. Seed is dehisced soon after maturity, as is typical of most *Grevillea* species. High levels of seed predation by insects has been observed, mainly by weevils and looper caterpillars. Parrots have also been known to attack seed heads.

Three seedlings of *Grevillea scapigera* have been tested and appear resistant to the plant pathogen *Phytophthora cinnamomi* (unpublished data, A. Cochrane³). Further testing is required to confirm these results.

Several *Grevillea* species that are difficult to germinate using normal methods are known to be smoke responsive (Roche *et al.* 1997, Dixon *et al.* 1995, Morris 2000, Morris *et al.* 2000). However, experiments on *G. scapigera* have shown this to be unnecessary. At times, controls have provided germination rates as good as smoke treated seed (Dixon 2002). Treatments trialed to determine which result in the best germination rates include heat treatment, smoke (aerosol and water) gibberelic acid, standard and specific scarification and a mixture of treatments. A precise method of scarification has been shown to be the most effective, and produces average germination rates of over 50%.

Threats

Grevillea scapigera was Declared as Rare Flora under the Western Australian *Wildlife Conservation Act 1950* in September 1987 and ranked as Critically Endangered (CR) in 1995. It currently meets World Conservation Union (IUCN 2000) Red List Category 'CR' under criteria B1ab(i-v)+2ab(i-v); C2a(i) and D as it is has a highly restricted geographic range and area of occupancy, there is severe fragmentation of populations, all population contain less than 50 mature individuals and there is a continuing decline in quality of habitat, the number of populations and mature individuals. The species is also listed as Endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The main threats are habitat fragmentation, lack of habitat, lack of natural disturbance regimes, seed predation, road maintenance activities, accidental destruction, rabbits, weeds, low genetic diversity, fertilizer and herbicide drift, and salinity (at Population 2).

- **Restricted and fragmented habitat** is a major threat to the species in the wild. It has a very narrow distribution and, as a result of clearing for agriculture, little habitat remains. In the Corrigin

² Dr Darren Touchell – Former Researcher (Cryostorage) BGPA

³ Anne Cochrane – Manager CALM's Threatened Flora Seed Centre

area greater than 95% of the landscape has been cleared for agriculture. The absence of large or contiguous reserves in the current distribution range of the species (other than the aerodrome and water reserves in Corrigin) is a major limiting factor for the long term survival of *Grevillea scapigera*, with most of the remaining natural populations of the species being confined to road verges with cleared land beyond. The lack of associated native vegetation also increases the likelihood that pollinators and disturbance mechanisms (such as fire) will be infrequent or absent. In addition, the lack of available habitat for recruitment is of concern.

- **Lack of disturbance.** The plants are relatively short-lived and natural recruitment from soil-stored seed appears to be rare. Prior to European settlement, the species would have recruited following soil disturbance (e.g. marsupial activity) or fire. However, these natural phenomena are either no longer present or are highly restricted. Habitat fragmentation has prevented natural processes occurring and human intervention is now required to ensure the long-term preservation of the species in the wild.
- **Road maintenance** threatens all naturally occurring populations of *Grevillea scapigera*. Associated threats include grading, chemical spraying, construction of drainage channels and the mowing of roadside vegetation. Several of these actions also encourage weed invasion.
- **Seed and fruit predation** by insects is a major threat to populations. Preliminary research indicates that an extremely high rate of seed predation by insects (mainly looper caterpillars and weevils) occurs while seed is still on the plant but also continues once the seeds are shed onto the ground (72.7 % of seed bank) (unpublished data, M. Rossetto⁴). Parrots have also been observed chewing on the fruits of *Grevillea scapigera*.
- **Accidental damage** Many natural populations are precariously close to roads and could be accidentally damaged by vehicles parking or driving in the road reserve, or by large agricultural machinery.
- **Weed invasion and competition** is a threat to both natural and translocated populations. Weeds suppress early plant growth by competing for soil moisture, nutrients and light. They also exacerbate grazing pressure and increase the fire hazard due to the high fuel loads that are produced annually by many grass weed species. Narrow linear populations such as are found on road reserves have little buffering and are severely affected by weed invasion, particularly grass species. Veldt grass (*Ehrharta calycina*), wild oats (*Avena fatua*), african lovegrass (*Eragrostis curvula*), guildford grass (*Romulea rosea*) and wild radish (*Raphanus raphanistrum*) are present in many of the populations.
- **Grazing** by rabbits and occasionally insects such as locusts (notably in spring 1990) has been observed in some populations and is likely to have a significant impact on plant survival. In addition to direct grazing of foliage and digging and eating of the root system, rabbits also encourage invasion of weeds through soil digging and the addition of nutrients. The high level of palatable weeds in the habitat of populations and in adjacent farming properties attracts herbivorous animals that are often unselective in their grazing.
- **Low genetic diversity** is a threat for all populations as plants with low genetic diversity are generally less resilient to environmental change. Studies by Rossetto *et. al* (1998). showed that 85% of the seeds used in the translocations before 1995, were the product of only four clones. More clones have since been added and this has lessened the problem, however the genetic diversity is still low.

⁴ M. Rossetto – Former Research Scientist, BGPA

- **Fertilizer and herbicide drift** from adjacent farmlands pose a potential threat to several *Grevillea scapigera* populations.
- **Salinity** is a threat to the long term survival of Population 2. The ground water in the area is rising due to widespread agricultural clearing and the increased recharge to the groundwater. The effect of salinity on *Grevillea scapigera* is unknown but it is likely to be detrimental.

Summary of population information and threats

Pop. No. & Location	Land Status	Year/No. plants	Condition	Threats
1a SW Corrigin	Airport	1989 6* 2004 0	No extant plants	Road maintenance, weeds, accidental destruction, lack of habitat, inappropriate fire regimes, chemical drift, poor recruitment.
1b SW Corrigin	MRWA Road Reserve	1989 6* 2004 2	Poor	Road maintenance, weeds, accidental destruction, lack of habitat, inappropriate fire regimes, chemical drift, poor recruitment.
1t SW Corrigin	Airport	1996 [207] 1997 [259] 1998 8 (161) [282] 1999 169 (166) [258] 2002 299 [276] 2003 213 (138) [1607]*	Healthy	Poor recruitment, inappropriate human activities.
2 NE of Aldersyde	Shire Road Reserve	1989 7 2004 (1)	Poor	Road maintenance, weeds, accidental destruction, lack of habitat, inappropriate fire regimes, chemical drift, gravel dumping, burning, salinity / rising groundwater, poor recruitment.
3a NNE of Jubuk	Shire Road Reserve	1990 3 2004 0	No extant plants	Road maintenance, weeds, accidental destruction, lack of habitat, inappropriate fire regimes, chemical drift, poor recruitment.
3b NNE of Jubuk	Shire Road Reserve	1990 1 2004 (1)	One seedling	Road maintenance, weeds, accidental destruction, lack of habitat, inappropriate fire regimes, chemical drift, poor recruitment.
4 NW of Corrigin	Shire Road Reserve	1992 6 2004 0	No extant plants	Road maintenance, weeds, accidental destruction, lack of habitat, inappropriate fire regimes, chemical drift, poor recruitment.
5 NW of Bullaring	Shire Road Reserve	1994 31 2004 0	No extant plants	Road maintenance, weeds, accidental destruction, lack of habitat, inappropriate fire regimes, chemical drift, rabbits, poor recruitment.
5t NW of Bullaring	Shire Reserve	2000 [533] 2003 410[1607]*	Healthy	Poor recruitment
6 NW of Kunjin	Shire Road Reserve	1992 1 2004 0	No extant plants	Road maintenance, weeds, accidental destruction, lack of habitat, inappropriate fire regimes, chemical drift, poor recruitment.
7 SSW of Jubuk	Shire Road Reserve	1993 1 2004 0	No extant plants	Grazing, disease, road maintenance, weeds, accidental destruction, lack of habitat, inappropriate fire regimes, chemical drift, poor recruitment.
8 WSW of Corrigin	Airport	1992 2 2004 0	No extant plants	Road maintenance, weeds, accidental destruction, lack of habitat, inappropriate fire regimes, chemical drift, poor recruitment.
8t WSW of Corrigin	Shire Road Reserve	1996 (40) [120] 1997 40 (40) [116] 1998 80	Healthy	Poor recruitment.

		2002 23 2003 11 [1130]		
9 NW of Lomos	Nature Reserve	1994 2 2002 0	No extant plants	Road maintenance, weeds, accidental destruction, lack of habitat, inappropriate fire regimes, chemical drift, rabbits, poor recruitment
10 N of Kweda	Shire Road Reserve	1995 3 2002 0	No extant plants	Road maintenance activities, weeds, accidental destruction, lack of habitat, inappropriate fire regimes, chemical drift, poor recruitment.
11 N of Kunjin	Shire Road Reserve	1998 1 2002 0	No extant plants	Road maintenance activities, weeds, accidental destruction, lack of habitat, inappropriate fire regimes, chemical drift, poor recruitment.
12 N of Kunjin	Shire Road Reserve	2000 1 2002 0	No extant plants	Road maintenance activities, some weeds, accidental destruction, lack of habitat, inappropriate fire regimes, chemical drift, poor recruitment.
13 NE of Aldersyde	Shire Road Reserve	2003 1	Poor condition	Road maintenance activities, weeds, accidental destruction, lack of habitat, inappropriate fire regimes, chemical drift, poor recruitment.

() = number of juveniles (<2yrs including planted), Pop. t = translocated population, [] = additional plantings, * = total from more than one site.

Populations in **bold text** are considered to be Important Populations

Guide for decision-makers

Section 1 provides details of current and possible future threats. Proposed developments and on-ground works (clearing, firebreaks etc) in the immediate vicinity of habitat critical to the survival of *Grevillea scapigera* will require assessment. Works should not be approved unless the proponents can demonstrate that they will have no significant impact on the species, its habitat or potential habitat, or the local surface or ground water hydrology.

Habitat critical to the survival of the species, and important populations

Habitat critical to the survival of the species includes the area of occupancy of important populations; areas of similar habitat surrounding important populations (i.e. flat country on sandy or gravelly, lateritic soils associated with low heath amongst tall shrubland) provide potential habitat for natural range extension and are necessary to provide habitat for pollinators; the local catchment of the surface and possibly ground waters that maintain the habitat of the species; and additional occurrences of similar habitat that may contain the species or be suitable sites for future translocations.

Given that this species is listed as Critically Endangered it is considered that all known habitat for wild and translocated populations is habitat critical.

Benefits to other species/ecological communities

Recovery actions implemented to improve the quality or security of the habitat of *Grevillea scapigera* will also improve the health of the Declared Rare Flora species *G. dryandroides* subsp. *hirsuta* (ranked as Vulnerable under the Western Australian *Wildlife Conservation Act 1950* and Endangered under the EPBC Act) which occurs in the habitat of *Grevillea scapigera* at Population 2. Research carried out into the protection of *G. scapigera* which has included translocation, cryostorage and seed dormancy will benefit the conservation of other grevillea species.

International Obligations

This plan is fully consistent with the aims and recommendations of the Convention on Biological Diversity that was ratified by Australia in June 1993, and will assist in implementing Australia's responsibilities under that Convention. The species is not listed under the United Nations Environment Program World Conservation Monitoring Centre (UNEP-WCMC) Convention on International Trade in Endangered Species (CITES). In addition, the species is not listed under any other specific international treaty and this Interim Recovery Plan (IRP) does not affect Australia's obligations under these international agreements.

Role and interests of indigenous people

No indigenous communities interested or involved in the land affected by this plan have been identified. The Aboriginal Sites Register maintained by the Department of Indigenous Affairs does not list any significant sites in the vicinity of populations. However, not all significant sites are listed on the Register. Implementation of recovery actions under this plan will include consideration of the role and interests of indigenous communities in the region.

Social and economic impacts

The implementation of this recovery plan is unlikely to cause adverse social and economic impacts as most populations are located on road reserves or in Nature Reserves. *Grevillea scapigera* is a flagship species and the floral emblem of Corrigin Shire and there is a great deal of community support for its protection.

Affected interests

Stakeholders potentially affected by the implementation of this plan include the Shire of Corrigin, as managers of the areas containing Populations (1a, 3a, 3b, 4, 5, 6, 7, 8, 10, 11 and 12), the Shire of Brookton (Populations 2 and 13), and Main Roads WA (Population 1b).

Evaluation of the Plan's Performance

CALM will evaluate the performance of this IRP in conjunction with the Narrogin District Threatened Flora Recovery Team. In addition to annual reporting on progress with listed actions and comparison against the criteria for success and failure, the plan is to be reviewed within five years of its implementation.

2. RECOVERY OBJECTIVE AND CRITERIA

Objectives

IRP objective: The objective of this Interim Recovery Plan is to abate identified threats and maintain and/or enhance the habitat of natural and translocated populations; gain an understanding of the recruitment dynamics of the species; obtain *in situ* recruitment (through artificial or naturally occurring disturbance), maintain the soil seed bank and ensure the long-term preservation of the species.

Criteria for success: Identified threats are abated, recruitment dynamics are understood, seedlings are produced *in situ* and the soil seed bank is maintained over the period of the plan's adoption under the EPBC Act.

Criteria for failure: Threats are not abated, recruitment dynamics are not understood, no recruitment occurs and the soil seed bank is depleted over the period of the plan's adoption under the EPBC Act.

3. RECOVERY ACTIONS

Existing recovery actions

Appropriate land managers have been made aware of the location and threatened status of the species.

Declared Rare Flora (DRF) markers have been installed at all roadside populations.

Dashboard stickers and posters that describe the significance of DRF markers have been produced and distributed. Stubby holders that illustrate DRF markers have also been produced and distributed amongst Shire workers.

Research on propagation techniques was carried out by staff from the BGPA using macro cuttings, tissue culture and grafting (Bunn and Dixon 1992, Dixon 2002 unpl.). However, due to expense and difficulty involved in producing plants by tissue culture, research into seedling production was then carried out. When the genetic mix is correct; this is the preferred method of producing plants for translocations.

Staff from the BGPA have developed Phytosanitary guidelines for the translocation of *Grevillea scapigera* (Dixon unpl.).

A total of approximately 3,300 seeds from 21 plants are stored in CALM's Threatened Flora Seed Centre (TFSC) and an additional 2,000 seeds are stored at the BGPA for propagation and research purposes.

Four research translocation sites have been established, with 800 seedlings planted out. These include areas where natural populations had been found (Populations 1 and 2) and introduction areas (Populations 1t and 2t). The Population 2 site has not been used since trial plantings; however the other three sites are well established ongoing translocation sites.

Detailed research has been carried out on different aspects of the species biology, genetics, *ex situ* conservation and reintroduction potential in joint projects between BGPA and the University of Western Australia. BGPA holds 17 different clones *in vitro*, and container collections, and has successfully cryostored the species.

The first large scale plantings were carried out in 1996. Re-introduction on some naturally occurring sites has occurred at Populations 1 and 2. Translocations are ongoing at Airstrip, Bullaring and more recently at Hartleys reserves with site enlargement and major replanting.

Cost effective, battery operated, drip irrigation watering systems have been set up at the three translocation sites to improved survival and increase seed production for long term soil seedbank storage.

A number of weed control experiments have taken place including pre-planting spraying, strip spraying and post planting spraying (*Grevillea* plants covered with containers) using non-selective herbicides. The use of low rates of the non selective herbicide Lontrel™ as a pre and post emergent herbicide both in the laboratory and *in situ* have been very effective for the control of Cape weed.

Broad scale weed control was undertaken at Population 1t in 2001 to control perennial veldt grass.

Material from most of the original 10 clones is stored in liquid nitrogen (cryostorage – liquid phase) at -196°C for future use. BGPA has a minimum of 8 of the original 10 clones in storage but there may be more than this as not all of the material has been re-tested for genetic purity.

BGPA currently have 15 potted plants of *Grevillea scapigera* from 5 clones.

A number of pre-seed treatments were trialed including heat, smoke (aerosol and water) gibberelic acid, standard scarification, specific scarification and a mixture of treatments. This has resulted in the development of a method of scarification that produces average germination rates of over 50%.

Trials treating seed with salicylic acid, which helps with drought resistance and salt resistance, were inconclusive

On site smoke trials using tents to concentrate chemicals were tested to stimulate germination of the *Grevillea* soil seed store. No germination occurred in either *Grevillea scapigera* or other natives, due to drought.

Populations 1a, 1t and 8t have been surrounded with rabbit proof fencing to protect plants from rabbit grazing.

Staff from CALM's Science Division undertook Dieback susceptibility testing on three plants and results indicate that this species is resistant to *Phytophthora* (CALM 1992a). However, further testing will be required to confirm these initial results.

There are 9 clones in tissue culture at BGPA which may be used in supplementary planting. Genetic material will be taken from new plants found in the wild and, if deemed appropriate, held in cryostorage.

Research into the genetics of *Grevillea scapigera* using the DNA fingerprinting technique of amplified fragment length polymorphism (AFLP) was undertaken to assess the genetic fidelity of the 10 clones. Material was taken from 46 plants used in translocations. Contrast genetic variation and average genetic similarities of F1s to their parents was examined to gather information on genetic decline and assign paternity to reintroduced plants to assess the reproductive success of each clone.

Opportunistic surveys in areas of suitable habitat following disturbance is ongoing.

Staff of BGPA monitor translocated populations at least twice yearly. Between 1996 and 1999 this was done on a monthly basis.

Staff from CALM's Narrogin District Monitor naturally occurring populations on an annual basis.

The Narrogin District Threatened Flora Recovery Team is overseeing the implementation of this IRP and will include information on progress in an annual report to CALM's Corporate Executive and funding bodies.

Future recovery actions

Where populations occur on lands other than those managed by CALM, permission has been or will be sought from appropriate land managers prior to recovery actions being undertaken. The following recovery actions are roughly in order of descending priority; however this should not constrain addressing any of the priorities if funding is available for 'lower' priorities and other opportunities arise.

1. Coordinate recovery actions

The Narrogin District Threatened Flora Recovery Team (NDTFRT) coordinate recovery actions for *Grevillea scapigera* and will include information on progress in their annual report to the CALM's Corporate Executive and funding bodies.

Action: Coordinate recovery actions
Responsibility: CALM (Narrogin District) through the NDTFRT
Cost: \$1,000 per year

2. Map total habitat

It is a requirement of the EPBC Act that spatial data relating to total habitat of the species be determined. Although habitat critical to the species' survival is described in Section 1, the areas as described have not yet been mapped and that will be redressed under this action. If any additional populations are located, then total habitat will also be determined and mapped for these locations.

Action: Map total habitat
Responsibility: CALM (Narrogin District, SCB) through the NDTFRT
Cost: \$4,000 in the first year

3. Formally notify land managers

Two new seedlings were located in 2004. The Shires will be notified of the presence of these plants.

Action: Formally notify land managers
Responsibility: CALM (SCB)
Cost: \$100 in first year

4. Reposition and replace DRF markers where required

DRF markers need to be replaced or repositioned at Populations 2, 3b and 12.

Action: Reposition and replace DRF markers where required
Responsibility: CALM (Narrogin District) through the NDTFRT
Cost: \$700 in first year

5. Stimulate germination of soil-stored seed

Soil disturbance and fire has been shown to be effective in stimulating the germination of soil-stored seed for many *Grevillea* species. However, as experimental disturbance and smoke trails conducted on *Grevillea scapigera* have had varying results, research into the soil seed bed dynamics and the role of various disturbances, competition, rainfall and grazing in germination and recruitment will be examined. Disturbance trials will form the basis of future research and recovery for this species. Once an understanding of the role of disturbance in recruitment is understood trails will also be carried out in the habitat of extinct (above ground) natural populations, and in translocated populations to encourage germination of any soil-stored seed that is present. If germination is successful research such as checking the genetic mix after a major germination event, will also be carried out.

Action: Stimulate germination of soil-stored seed
Responsibility: BGPA, CALM (Narrogin District) through the NDTFRT
Cost: \$5,000 per year

6. Collect seed and cuttings

A fairly large bank of *Grevillea scapigera* seed and other genetic material has already been collected by BGPA and TFSC and some of this is in cryostorage. However further genetic material needs to be collected from the two new seedlings discovered in 2004 and also any additional seedlings that

germinate in the habitat of wild populations of *Grevillea scapigera*. Material can then be grown up and planted into translocation sites to increase the genetic diversity.

Action: Collect seed and cuttings
Responsibility: BGPA, CALM (TFSC and Narrogin District) through the NDTFRT
Cost: \$1,000 per year

7. Continue to propagate and translocate plants

A translocation proposal has been prepared and is being coordinated and implemented by the NDTFRT. Translocation work planned in the future includes the propagation and planting of new clones found in natural populations at Hartley's and Airstrip reserves. Information on the translocation of threatened animals and plants in the wild is provided in CALM's Policy Statement No. 29 *Translocation of Threatened Flora and Fauna*.

Action: Continue to propagate and translocate plants
Responsibility: CALM (Narrogin District) and BGPA through the NDTFRT
Cost: \$3,000 per year

8. Implement insect control at translocation sites

Predation of seed is a serious problem. Predation is also more likely on sites with large numbers of plants as the insect pests quickly build up their numbers. Control of insects with insecticide or other means will be required at least periodically throughout the life of this IRP. Care will be required to ensure that any methods used do not result in damage to plants, possible pollinators, or habitat.

Action: Implement insect control at translocation sites
Responsibility: BGPA and CALM (Narrogin District) through the NDTFRT
Cost: \$300 per year

9. Implement rabbit control

Previous rabbit control has reduced the level of threat to moderate. Translocated populations have been surrounded by rabbit proof fences to protect them from grazing. However, as rabbits are still having some impact on other populations through grazing and digging they will be controlled using a variety of methods as appropriate in consultation with relevant landholders.

Action: Implement rabbit control
Responsibility: CALM (Narrogin District) through the NDTFRT
Cost: \$300 per year

10. Implement weed control as necessary

Although many naturally occurring populations are highly weed infested no weed control is currently planned as mature plants survive in degraded weedy habitat and the proximity of population sites to adjacent farmland and their small size probably means that they will never be weed free. Weed control may however be required following fire when seedlings may be out-competed. Weed control will be carried out after an assessment of the level of weeds and the type of weed present in the area, in consultation with the land managers.

Action: Implement weed control as necessary
Responsibility: BGPA and CALM (Narrogin District) through the NDTFRT
Cost: \$300 per year

11. Protect plants from bird damage at translocation sites

Parrots and galahs have been seen chewing on the fruits of *Grevillea scapigera* and have the potential to severely effect seed numbers if predation rates are high. Parrot and galah numbers will be monitored and control may be needed at seeding time. Methods used could involve protective caging, trapping or shooting.

Action: Implement Monitor and implement measures to protect plants from bird damage
Responsibility: BGPA and CALM (Narrogin District) through the NDTFRT
Cost: \$200 per year

12. Conduct a seed viability trial

A viability trial will be set up, with seed buried in the third year of the IRP and some then excavated every two years over a 50 year period to check long term viability. These trials are intended to provide information about how long seed can remain viable and to establish how much predation takes place. Some seed will be left on top of the soil and open to insect/rodent predation while other seeds will be covered in fine stainless steel mesh to prevent predation. To prevent rodent predation the trial will be contained in a fixed wire mesh vandal-proof cage cemented into the ground.

Action: Conduct a seed viability trial
Responsibility: BGPA and CALM (Narrogin District) through the NDTFRT
Cost: \$500 in first year, \$300 in third and fifth years

13. Conduct additional tests for *Phytophthora* resistance

Three plants of *Grevillea scapigera* have been tested by CALM's Science Division and initial results have indicated that the species is resistant to *Phytophthora cinnamomi*. Further testing is required to confirm these results.

Action: Conduct additional tests for *Phytophthora* resistance
Responsibility: CALM (Science Division) through the NDTFRT
Cost: \$200 in second year.

14. Continue liaison

Staff from CALM's Narrogin District will continue to liaise with relevant land managers to ensure that populations of *Grevillea scapigera* are not accidentally damaged or destroyed. Input and involvement will also be sought from any Aboriginal groups that may have an active interest in areas that contain the habitat of *Grevillea scapigera*.

Action: Continue liaison
Responsibility: CALM (Narrogin District) through the NDTFRT
Cost: \$500 per year

15. Continue monitoring populations

Annual monitoring of factors such as habitat degradation (including weed invasion and salinity), population stability (expansion or decline), pollination activity, seed production, recruitment, longevity and predation is essential. Competition from associated native species will also be monitored at Population 1b.

Action: Continue monitoring populations
Responsibility: CALM (Narrogin District) (Natural populations) BGPA (Translocated populations) through the NDTFRT

Cost: \$2,000 per year

16. Conduct further surveys

Although the area in which *Grevillea scapigera* occurs has been extensively surveyed over the last decade it is possible that additional populations of this species may be discovered on private land or near extant populations following disturbance. Opportunistic surveys will continue to be carried out by CALM staff and community volunteers during the flowering period of the species (October - November). This may lead to the expansion of the known gene pool.

Action: Conduct further surveys
Responsibility: CALM (Narrogin District) through the NDTFRT
Cost: \$500 per year

17. Increase community awareness

The recovery team has implemented a significant public education, community support and promotion program, and this will be continued.

Action: Increase community awareness
Responsibility: CALM (Narrogin District) through the NDTFRT
Cost: \$500 per year

18. Implement habitat protection

Most populations are found on narrow road verges where protection from threats is proving difficult. Negotiations will be carried out with the Shire of Brookton regarding land use options and gravel extraction at the Lake Mears population. For all sites containing populations of *Grevillea scapigera*, road maintenance, construction activities and herbicide applications (other than for the control of weeds around DRF) will ideally be minimized and land managers will be requested to contact CALM prior to any works being carried out. Similarly, chemical drift from farming areas and road side burning needs to be minimized in these areas.

Action: Implement habitat protection
Responsibility: CALM (Narrogin District) through the NDTFRT
Cost: \$500 per year

19. Review the IRP and assess the need for further recovery actions

If *Grevillea scapigera* is still ranked Critically Endangered at the end of the fourth year of the five-year term of this IRP, the plan will be reviewed and the need for further recovery actions assessed.

Action: Review the IRP and assess the need for further recovery actions
Responsibility: CALM (SCB, Narrogin District) through the NDTFRT
Cost: \$20,300 in the fifth year (if full Recovery Plan is required)

4. TERM OF PLAN

This Interim Recovery Plan will operate from May 2006 to April 2011 but will remain in force until withdrawn or replaced. If the taxon is still ranked as Critically Endangered after five years, the need for further recovery actions, or a review of this IRP will be assessed and a plan prepared if necessary.

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6. TAXONOMIC DESCRIPTION

McGillivray, D.J. (1993) *Grevillea (Proteaceae) - A taxonomic revision*. Melbourne University Press. Carlton, Victoria.

Prostrate to weakly ascending scrub 0.15-0.4m in height, up to 1.8 m across, with emergent inflorescences; branches slightly angular to rounded, subsericeous to glabrous.

Leaves petiole, pinnatifid, pinnatisect or occasionally partly pinnate, (2-)3-7.5(-9) cm long with the primary lobes usually sessile, occasionally petioluate, pinnatifid to trifid and becoming entire towards the leaf apex; base narrowly attenuate, petioles (0.4-)1.5-3cm long; basal lobes (0.5-) 1.0-2.2 cm long, their bases cuneate or narrowly attenuate; apex and apices of lobes acuminate, weakly pungent; margin slightly thickened, flat or occasionally shortly recurved; young leaves with appressed leaves and lobes, hairs sometimes persisting, otherwise mature leaves glabrous and sometimes glaucous; venation obscure except for midveins of leaves and lobes; texture chartaceous to weakly coriaceous.

Inflorescences curved at the base to an upright position on the living plant, terminal or occasionally axillary, simple, very conspicuous, 16-33cm long, on prominent, usually unibracteate, glabrous peduncles (7-) 14-31 cm long; flower bunches subglobose, centripetal, c. 3-4 cm across; rachis narrowly conical, narrower than the peduncle, 5-8 mm long, glabrous; bracts very narrowly triangular, or narrowly ovate, 3.2-4.5 mm long; 0.4-1.0 mm wide, apex caudate, margin conspicuously ciliate, bracts deciduous soon after anthesis; floral orientation parallel with the sutures adaxial; **pedicels** 3-3.5 mm long, glabrous, torus transverse to slightly oblique (to 10°), 1.1-1.3 (-1.5) mm across; perianth

slender, *c.* 1-1.3 mm across, glabrous outside, sparsely pilose inside from the base for 1.5-2 mm; limb oblique, broadly to depressed ovoid, 1-1.2 mm long, *c.* 1.5 mm across; tepals slightly keeled; dorsal tepals almost parallel-sided, curved from near the base, 7-9 mm long, 0.7-0.9 mm wide; nectary inconspicuous, broadly U-shaped to lunate, 0.2-0.3 mm wide, protruding 0.1 mm above the level of the rim, surface almost flat, and smooth; pistil 15-19 mm long; stipe 2.8-4.0 mm long, glabrous; ovary obliquely obovoid-ellipsoid, glabrous, becoming verrucate after anthesis, ovules attached at the medial position; style very finely papillose-aculeolose from above the ovary and smooth towards the apex; pollen presenter oblique at *c.* 70°, obovate or sometimes almost round, 1.5-1.6 mm long, 1.1-1.4 mm wide, slightly concave except for the distally off-centre, stigmatic cone.

Fruits sometimes persistent, erect or very slightly oblique, slightly compressed, 10-13 mm long, 6-7 mm wide, 3-3.5 mm thick; styles persistent; surface prominently verrucose, sticky; pericarp variable in thickness because of verrucae, 0.6-1.3 mm across at the suture, 0.2-1.5 mm thick at the centre-face, (0.3-) 0.6-1.0 mm thick at the dorsal side, texture crustaceous.

Seeds curved to oblique-navicular, 7.9-10.8 mm long, 2.3-3.4 mm wide, 1.8-2.4 mm thick, including an apical pulvinus 2-2.5 mm long beyond a sub apical constriction; edge marginate with a narrow membranous border up to 0.2 mm wide; outer face convex, somewhat lineolate, the lines often traverse and most conspicuous near the margin; inner face slightly concave and with a low broad central ridge.

