

INTERIM RECOVERY PLAN NO. 123

PINGARING SPIDER ORCHID

(*CALADENIA HOFFMANII* SUBSP. *GRANITICOLA*)

INTERIM RECOVERY PLAN

2003-2008

Kim Kershaw, Bethea Loudon, Brett Beecham, Greg Durell and Andrew Brown



Photograph: A Brown

February 2003

Department of Conservation and Land Management
Western Australian Threatened Species and Communities Unit (WATSCU)
PO Box 51, Wanneroo, WA 6946



FOREWORD

Interim Recovery Plans (IRPs) are developed within the framework laid down in Department of Conservation and Land Management (the Department) 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.

The Department is committed to ensuring that Critically Endangered taxa are conserved through the preparation and implementation of Recovery Plans or Interim Recovery Plans and by ensuring that recovery action commences as soon as possible and always within one year of endorsement of that rank by the Minister.

This Interim Recovery Plan will operate from February 2003 to January 2008 but will remain in force until withdrawn or replaced.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 replaced by a full Recovery Plan after five years.

This IRP was approved by the Director of Nature Conservation 20 June, 2003. The provision of funds identified in this Interim Recovery Plan is dependent on budgetary and other constraints affecting the Department, as well as the need to address other priorities.

Information in this IRP was accurate at February 2003.

SUMMARY

Scientific Name:	<i>Caladenia hoffmanii</i> subsp. <i>graniticola</i>	Common Name:	Pingaring Spider orchid
Family:	Orchidaceae	Flowering Period:	September - October
Dept Region:	Wheatbelt	Dept. District:	Narrogin, Katanning
Shire:	Kulin, Kondinin, Lake Grace	Recovery Team:	Narrogin District Threatened Flora Recovery Team (NDFRT), Katanning District Threatened Flora Recovery Team (KDFRT)

Illustrations and/or further information: Brown, A.P., Thomson-Dans C. and Marchant N. (1998). *Western Australia's Threatened Flora*. Department of Conservation and Land Management; Durell, G. S. and Buehrig, R. M. (1997). *Declared Rare and Poorly Known Flora in the Narrogin District*; Department of Conservation and Land Management; Hoffman, N and. Brown, A. (1998). *Orchids of South-West Australia*, University of Western Australia Press. Hopper, S.D. and Brown A.P., (2001). Contributions to Western Australian orchidology: 2 New taxa and circumscriptions in *Caladenia*. *Nuytsia* 14 (1/2):27-308, Department of Conservation and Land Management.

Caladenia hoffmanii subsp. *graniticola* is a tuberous, perennial "spider orchid" 10 to 30 cm high with a single hairy leaf, 8-15 cm long and 5-10 mm wide. Each plant has 1-3 creamy or greenish-yellow, red marked flowers, 3-7 cm long and 3-5 cm wide. The shortened petals and sepals to 3cm long terminate in abbreviated glandular tips (Durell and Buehrig, 1997). The distinctive tapering labellum (lip) has a long, red fringe and dark red calli (glands) and a deep red tip that is curled under only at the apex (Hoffman and Brown, 1998).

Current status: *Caladenia hoffmanii* was declared as Rare Flora in 1987 as *Caladenia* sp. Moresby Range with the subspecies *graniticola* included and ranked as Critically Endangered (CR) in 1999. The subspecies currently meets IUCN 2000 Red List Criteria B2ab(ii,v); C2a(i) as the area of occupancy is less than 10 km², populations are severely fragmented, there is a continuing decline in the area of occupancy and the number of mature individuals, population size is estimated to be less than 250 individuals and there is a continuing decline in the number of mature individuals with no subpopulation containing more than 50 mature individuals.

Threats to populations include accidental destruction through recreational activities, inappropriate fire regimes, altered water run-off due to the damming of granite outcrops, grazing from native and feral animals, poor recruitment, lack of suitable habitat, drought and weed invasion.

Habitat requirements: The subspecies is geographically restricted and to date has been recorded from just five granite outcrops in the Pingaring – Newdegate area. Plants grow under tall tamar (*Allocasuarina campestris*) and Rock Sheoak (*Allocasuarina huegeliana*) near to and on granite outcrops.

Critical habitat: The critical habitat for *Caladenia hoffmanii* subsp. *graniticola* comprises the area of occupancy of the known populations; similar habitat within 200 metres of known populations; remnant vegetation that links populations and additional nearby occurrences of similar habitat that do not currently contain the subspecies but may have done so in the past and may be suitable for translocations.

Habitat critical to the survival of the species, and important populations: Given that this subspecies is listed as Critically Endangered it is considered that all known habitat for wild and future translocated populations is habitat critical.

Benefits to other species/ecological communities: There are no threatened ecological communities or other threatened species in the immediate vicinity of *Caladenia hoffmanii* subsp. *graniticola*. However, recovery actions implemented to improve the quality or security of the habitat of the subspecies, such as weed control and rehabilitation will benefit the remnant bushland habitat in which it occurs.

International Obligations: This plan is fully consistent with the aims and recommendations of the Convention on Biological Diversity, ratified by Australia in June 1993, and will assist in implementing Australia's responsibilities under that Convention. However, as *Caladenia hoffmanii* subsp. *graniticola* is not listed under any international agreement, the implementation of other international environmental responsibilities is not affected by this plan.

Role and interests of indigenous people: There are no known indigenous communities interested or involved in the management of areas affected by this plan. Therefore no role has been identified for indigenous communities in the recovery of this subspecies.

Social and economic impacts: The implementation of this recovery plan is unlikely to cause significant adverse social and economic impacts. The subspecies occurs on and around large granite outcrops that are in nature and Shire reserves.

Evaluation of the Plans Performance: The Department of Conservation and Land Management, in conjunction with the Recovery Team will evaluate the performance of this IRP. 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:

- Land managers have been notified of the threatened nature of this species and its location;
- Annual monitoring of the populations is being undertaken by staff from the Narrogin and Katanning Districts;
- Monitoring plots are established at Population 1;
- Joint Departmental and community surveys have been conducted within the species' known distribution range;
- Land managers have placed appropriate signage to protect population from accidental destruction (i.e. Pingaring Golf Club).

IRP Objective: The objective of this Interim Recovery Plan (IRP) is to abate identified threats and maintain or enhance the *in situ* population to ensure the long-term preservation of the taxon in the wild.

Recovery Criteria

Criterion for success: The number of individuals within populations and/or the number of populations have increased by 10% or more.

Criterion for failure: The number of individuals within populations and/or the number of populations have decreased by 10% or more.

Recovery actions

1. Coordinate recovery actions.	8. Develop and implement an appropriate fire management strategy.
2. Liaise with landowners and land managers.	9. Collect and preserve genetic material.
3. Undertake weed control.	10. Assess the need for translocations or restocking and if deemed necessary develop a translocation proposal.
4. Control rabbits.	11. Obtain biological and ecological information.
5. Monitor populations and establish monitoring plots.	12. Promote awareness.
6. Fence sections of Population 1.	13. Review the need for a full Recovery Plan
7. Conduct further surveys.	

1. BACKGROUND

History

Caladenia hoffmanii subsp. *graniticola* (Pingaring Spider Orchid) is a recently described subspecies of *C. hoffmanii* subsp. *hoffmanii* (Hoffman's Spider Orchid). When gazetted as Declared Rare Flora (DRF) in 1987 both subspecies were included under the single phrase name *C. sp.* (Moresby Range) G.J. Keighery 3328. In 1991 the name was changed to *C. hoffmanii* ms which in 1997 was informally split into two subspecies — *C.*

hoffmanii subsp. *hoffmanii* ms and *C. hoffmanii* subsp. *graniticola* ms. Both subspecies were formally described in September 2001.

Mrs K. White of Pingaring made the first collection of *C. hoffmanii* subsp. *graniticola* in 1984. Following this initial discovery Dr. S.D. Hopper and A.P. Brown found a small population of the subspecies on a granite outcrop south of Hyden in September 1985 and S. Van Leeuwen found a further 30 plants in the same area in late August 1986. Mr. John Tonkinson then found plants on a granite outcrop south-west of Karlgarin in 1987. More recently (in September 1991) Anne Coates and Diane McDonald found a new population in a Nature Reserve south of Hyden and an unconfirmed population was reported by the W.A. Orchid Study and Conservation Group in the same reserve in 1999. This site was surveyed by Conservation and Land Management staff in September 2001 with two shrivelled plants, suspected to be *Caladenia hoffmanii* subsp. *graniticola*, located. The subspecies is currently known from six populations in three areas.

Currently six herbarium collections are held in the W.A. Herbarium ([Florabase](#)).

Description

Caladenia hoffmanii subsp. *graniticola* differs from the typical subspecies in having slightly larger flowers, larger basal calli and a larger column. It also has a later flowering period (late September-October rather than August-September). Both subspecies are distantly related to members of the *Caladenia longiclavata* complex (Hoffman and Brown, 1998).

Caladenia hoffmanii subsp. *graniticola* is a tuberous, perennial “spider orchid” 10 to 30 cm high with a single hairy leaf 8-15 cm long and 5-10 mm wide. Each plant has 1-3 creamy or greenish-yellow, red marked flowers 3-7 cm long and 3-5 cm wide. The shortened petals and sepals to 3cm long terminate in abbreviated glandular tips (Durell and Buehrig, 1997). The distinctive tapering labellum (lip) has a long, red fringe, dark red central calli (glands) and a deep red tip that is curled under only at the apex (Hoffman and Brown, 1998).

Distribution and habitat

The typical subspecies is found on rocky hillsides between the Murchison River and Geraldton while the subspecies *graniticola* is found on and around granite outcrops much further to the south over a range of about 50 square kilometres between Pingaring, Dragon Rocks Nature Reserve and south of Karlgarin. Associated native plants include *Allocasuarina huegliana*, *A. campestris*, *Leptospermum erubescens*, *Verticordia chrysantha* and other *Caladenia* spp. (Durell and Buehrig, 1997).

Critical habitat

Critical habitat is identified as being habitat essential for the survival of a listed threatened species or community. Habitat means the biophysical medium or media: (a) occupied (continuously, periodically or occasionally) by an organism or group of organisms; or (b) once occupied (continuously, periodically or occasionally) by an organism or group of organisms, and into which organisms of that kind have the potential to be reintroduced. (*Environment Protection and Biodiversity Conservation Act 1999* EPBC Act).

The critical habitat for *C. hoffmanii* subsp. *graniticola* is:

- habitat in which the subspecies currently occurs;
- a buffer of native vegetation adjacent to the current habitat of the subspecies;
- corridors of intact native vegetation that link populations of the subspecies;
- habitat where it has been found in the past or is thought to have occurred.
- Adjacent areas of similar habitat.

Explanatory Note: Adjacent vegetation linked to the known habitat of the species provides opportunities for reintroduction or colonisation of the subspecies.

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

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

Benefits to other species/ecological communities

There are no threatened ecological communities or other threatened species in the immediate vicinity of *Caladenia hoffmanii* subsp. *graniticola*. However, recovery actions implemented to improve the quality or security of the habitat of the subspecies, such as weed control and rehabilitation will benefit the remnant bushland habitat in which it occurs.

International Obligations

This plan is fully consistent with the aims and recommendations of the Convention on Biological Diversity, ratified by Australia in June 1993, and will assist in implementing Australia's responsibilities under that Convention. However, as *Caladenia hoffmanii* subsp. *graniticola* is not listed under any international agreement, the implementation of other international environmental responsibilities is not affected by this plan.

Role and interests of indigenous people

There are no known indigenous communities interested or involved in the management of areas affected by this plan. Therefore no role has been identified for indigenous communities in the recovery of this subspecies.

Social and economic impacts

The implementation of this recovery plan is unlikely to cause significant adverse social and economic impacts. The subspecies occurs on and around large granite outcrops that are in nature and Shire reserves.

Evaluation of the Plans Performance

The Department of Conservation and Land Management, in conjunction with the Recovery Team will evaluate the performance of this IRP. 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.

Biology and ecology

C. hoffmanii subsp. *graniticola* produces a single hairy leaf in late May, June and flowers in late September and October (Hopper and Brown, 2001).

The biology of the subspecies is likely to be similar to other *Caladenia* species that are deciduous and survive the dry, hot conditions of summer as a dormant tuber. The tuberoid resprouts in autumn with the onset of cooler and moister conditions. The resprouting trigger is not clear, but may be in response to an increase in soil moisture following soaking autumn rains (Jones, 1988; Warcup, 1990), or a decrease in soil temperature (Pate and Dixon, 1982; Dixon, 1991). Once the sprouting leaf reaches the soil surface, many species stop further growth until sufficient moisture is available (Dixon, 1991). Growth to this stage progressively depletes resources stored in the parent tuber, which gradually shrivels. Completion of leaf growth, production of a replacement tuberoid, and the development of flowers and seeds through late winter and spring relies on photosynthetic gains by the new leaf (Pate and Dixon, 1982; Dixon, 1991). After flowering and seed production the above-ground parts of the orchid wither and the remaining nutrients are transported to the replacement tuber (Jones, 1988). In *Caladenia* the replacement tuber is usually produced deeper in the soil each season (Jones 1988; Bates and Weber, 1990) but this is dependent on factors such as soil depth and in shallow soils the new tuber is produced laterally or adjacent to the old one (Brown, pers. ob.). The replacement tuber then remains dormant until next season's growth cycle begins (Jones 1988).

In poor seasons some species of *Caladenia* are known to replace tubers without producing above ground leaves or flowers (Dixon, 1991). This may be the case with *C. hoffmanii* subsp. *graniticola*, as monitoring indicates

that about ten percent of plants appear to "miss" a season, for example remain dormant, and in that year do not produce any above ground growth. These plants have subsequently reappeared the following year.

Many south-western Australian *Caladenia* are pollinated by male thynnid wasps sexually attracted to the flowers (Stoutamire, 1983). The flowers of thynnid wasp pollinated *Caladenia* are usually dull yellow-green and maroon in colour, and have clubbed sepals and petals (Stoutamire, 1983). *C. hoffmanii* subsp. *graniticola* shares these same characteristic and is likely to be pollinated by a thynnid wasp. The wasps are only active in calm, sunny conditions when air temperatures exceed 20°C (Stoutamire, 1983; Carstairs and Coates, 1994). Studies of other thynnid wasp pollinated taxa suggest that most pollen is unlikely to be dispersed beyond several hundred metres (Peakall and Beattie, 1996; Peakall, 1990). Peakall and Beattie (1996) also showed that wasp behaviour meant that pollination of neighbouring flowers in a patch was unlikely. Based on these studies the transfer of pollen between populations of *C. hoffmanii* subsp. *graniticola* at Pingaring Rock, McGann Rock and Dragon Rocks NR is highly unlikely.

Pollination rates in populations of *Caladenia* appear to vary quite widely between species and seasons. Batty (2001b) reported pollination rates of 4% for *C. arenicola*; Carstairs and Coates (1994) observed rates of 60% in a population of *C. elegans* and 15% for a population of *C. caesarea* subsp. *maritima*; Beecham (unpublished data) recorded an average of 5% over four consecutive years for *C. calcicola* in south west Victoria; and Peakall and Beattie (1996) recorded pollination rates between 12% and 82% over two seasons and three populations of *C. tentaculata*.

Pollinated flowers take about six weeks to develop mature seed pods and dehisce. Again, whilst no specific information is available for *C. hoffmanii* subsp. *graniticola*, another Western Australian species, *C. arenicola*, produces up to 30 000 seeds per pod (Batty *et al.* 2001b). The seed of *Caladenia* species is minute and easily dispersed by the wind. Peakall and Beattie (1996) concluded that seed dispersal between populations of *C. tentaculata* up to 100 kilometres apart was sufficient to minimize genetic differentiation. Carstairs and Coates (1994) also estimated that gene flow over tens of kilometres between populations of *C. elegans* and *C. caesaria* ssp. *maritima* was high, although whether this was a result of pollen or seed dispersal is unknown. However they cautioned that this rate of flow probably reflected historic rather than contemporary circumstances, as much intervening habitat has now been cleared. Seed dispersal between populations of *C. hoffmanii* subsp. *graniticola* is theoretically possible.

Provided it lodges in a suitable area containing the correct mycorrhizal fungus, seed of the species germinates at the start of the winter wet season, and seedlings continue to develop until the onset of dry condition by which time they have produced a tuber. Any seeds that fail to germinate during this period die (Batty *et al.* 2001b). Even in favourable years less than 0.1% of the seed released at dehiscence produces seedlings that survive their first summer (Batty *et al.* 2001b)

The role of fire in the ecology of *C. hoffmanii* subsp. *graniticola* is unclear. Whilst many *Caladenia* species are stimulated to flower by hot summer fires that occur during their dormant period (Jones, 1988). Summer fire may also benefit seedling establishment and growth amongst *Caladenia*. A fire may reduce competition and providing a source of nutrients for the growth of associated mycorrhiza fungi (Carstairs and Coates, 1994). However, it is unlikely that *C. hoffmanii* subsp. *graniticola* is dependent on fire that rarely occurs in its habitat. Although fire during the plants dormant period does not harm the underground tubers, fire during periods of active growth will kill plants (Jones, 1988). Carstairs and Coates (1994) make reference to research that indicates adult plants are most susceptible when producing their replacement tuber (April-July).

It is likely that *C. hoffmanii* subsp. *graniticola* has an association with a symbiotic mycorrhizal fungus. Most terrestrial orchids have a complex relationship with mycorrhizal fungi that are important for seed germination and the growth of adult plants (Rasmussen, 1995), and all Western Australian orchids examined by Ramsay *et al.* (1986) had mycorrhizas. Mycorrhizal fungi are likely to be important in mediating the uptake of many substrates by orchids, including nutrients, water, carbohydrates and vitamins (Arditti, 1992). A study by Batty *et al.* (2000) into the soil seed bank dynamics of *C. arenicola* and *Pterostylis sanguinea* showed that orchid seed in the field remained dormant over the first summer, and only imbibe water when the testa was cracked by autumn rainfall. Germination of the seed did not proceed beyond this point in the absence of mycorrhizal fungal infection (Batty *et al.* 2000). They concluded that orchid seed germination and seedling establishment was restricted to autumn and early winter when the associated mycorrhizal fungi were likely to be most active (Batty *et al.* 2000).

Threats

Caladenia hoffmanii was declared as Rare Flora in 1987 as *Caladenia* sp. Moresby Range with the subspecies *graniticola* included and ranked as Critically Endangered (CR) in 1999. The subspecies currently meets IUCN 2000 Red List Criteria B2ab(ii,v); C2a(i) as the area of occupancy is less than 10 km², populations are severely fragmented, there is a continuing decline in the area of occupancy and the number of mature individuals, population size is estimated to be less than 250 individuals and there is a continuing decline in the number of mature individuals with no subpopulation containing more than 50 mature individuals.

Threats to populations include: accidental destruction through recreational activities, inappropriate fire regimes, altered water run-off due to the damming of granite outcrops, grazing from native and feral animals, poor recruitment, lack of suitable habitat, drought and weed invasion.

The main threats to *C. hoffmanii* subsp. *graniticola* are:

- **Small population size.** Can increase the risk of chance (stochastic) events leading to a decline or the rapid destruction of an entire population. Small populations may also be at greater risk of the Allee effect, and the loss of genetic diversity and inbreeding depression where these affect current adaptation and viability (Sherman and Moritz, 2000). All populations of *Caladenia hoffmanii* subsp. *graniticola* are small and the risk of demographic and environmental stochasticity causing decline and extinction is relatively large. The sequence of dry winters and springs during the past three growing seasons, and the impact of this on flowering and reproductive success is an example of environmental stochasticity.
- **Inappropriate fire regimes.** Is considered a moderate/high risk to all populations and may adversely affect the viability of populations. Fire should be excluded during April to August to prevent damage to actively growing plants. However occasional fire during the summer dormant season may benefit populations through increased flowering and recruitment. However, summer fires also have the potential to destroy seeds and dormant tubers of young plants not buried deep enough within the soil and may also cause an increase of introduced weedy species.

The survival and regenerational relationship of the species to fire is not known but there is little evidence of frequent fire in its habitat. It is however possible that periodic occasional fire may be beneficial in promoting the regeneration of orchids habitat.

- **Grazing.** Rabbits and/or kangaroos have the potential to impact on leaves, buds and flowers of *C. hoffmanii* subsp. *graniticola*, especially when grazing species are in moderate to high numbers. In addition, disturbance of soil by rabbit warren construction, digging and increase nutrient levels from their droppings may disturb plants and encourage weeds. Grazing of seedlings may limit natural recruitment, and grazing of adult plants during the growing season may disrupt the production of replacement tubers. Monitoring at Population 1b has shown that in September 1999, 29% of flowers were eaten by grazing animals, severely impacting on reproductive potential. In addition, disturbance of soil by rabbit warren construction and increased nutrient levels from their droppings may encourage weeds.
- **Weeds.** The species occupies habitat highly susceptible to weed invasion especially after a disturbance event such as a fire. Weed invasion following fire is a moderate/high threat at all known populations. Weed invasion is considered the highest at Populations 1 and 5. Weeds have the potential to compete with *C. hoffmanii* subsp. *graniticola* plants for space, nutrients, water and light, and may also reduce availability of sites suitable for seed germination. Weeds should be monitored at the other three populations due to the risk of rabbits introducing weeds and potentially causing further degradation to the habitat. Observations at Dragon Rock Nature Reserve show the spread of the Pimpernel weed (*Anagalis arvensis* var. *caerulea*) in rabbit droppings.
- **Lack of recruitment.** Recruitment to a population will ultimately lead to its extinction as plant's senesce and die. It is not clear whether poor recruitment into populations of *C. hoffmanii* subsp. *graniticola* is a threat at present, and indeed recruitment may be somewhat episodic. However monitoring has revealed several factors that may be having a detrimental effect on recruitment, including the grazing of buds and

flowers, low pollination rates, and the abortion of buds and flowers during periods of below average rainfall that has occurred in the last three years. Although no natural recruitment of *C. hoffmanii* subsp. *graniticola* has been observed, it would be easy to overlook seedlings during monitoring. The current timing and frequency of monitoring is unlike to detect new recruits until they reach a flowering stage, which may be several years after they are recruited into the population. The previous three growing seasons have coincided with below average rainfall and many adult plants failed to reach a reproductive state. Given the lack of specific information on limiting factors, initial actions should concentrate on ensuring a greater number of plants reach dehiscence each year.

- **Water stress.** Water stress may be adversely affecting all populations. The ongoing development of the orchid during the growth season is heavily reliant on adequate soil moisture. A late start to the wet season or an early onset of the dry summer season will result in premature senescence of many geophytes, including orchids (Pate and Dixon, 1982). Monitoring of *C. hoffmanii* subsp. *graniticola* at Pingaring Rock between 1999 and 2001, revealed that whilst 1999 appeared to be a favourable season, based on the numbers of flowering plants, both 2000 and 2001 had below average rainfall which resulted in the early senescence of many plants prior to, and during flowering. Very few flowering plants were found during monitoring in 2000 and 2001. Water interception walls on the granite outcrops where the subspecies occurs may alter patterns of run-off into the orchid's habitat. The long-term impact of this is unknown, however, in seasons of low winter and spring rainfall it could be significant.
- **Accidental destruction.** Deliberate or accidental destruction of individuals, populations or habitat may occur from human activities. This threat is greatest where populations occur near to recreation sites at Populations 1 and 2.
- **Lack of ecological opportunities to support viable populations.** Left unmanaged all identified threats may result in a reduction of pollination activity at a species level and population level. Small populations in the short term are more likely to be threatened by chance demographic or environmental threats, rather than by a lack of genetic diversity. Genetic diversity (or lack of it) may become a more important issue over the longer-term and is likely to require future research.

Summary of population information and threats

Numbers of plants for all populations except 1b and 1c are based on counts of flowering plants. Plant numbers for Populations 1b and 1c are based on more detailed monitoring, and include vegetative, flowering and known dormant plants. The 2000 and 2001 seasons had below average rainfall during the winter and spring growing season across the orchid's range. Monitoring at Populations 1b and 1c revealed that this was the most likely cause of the significant decline in the number of flowering plants.

Pop. No. and Location	Land Purpose	Year/No. of flowering plants	Condition	Threats
1a. E of Pingaring	Water reserve	1997 5 1999 8	Disturbed	Grazing, inappropriate fire, weed invasion.
1b. E of Pingaring	Shire reserve	1999 71 2000 29*(5**) 2001 20*	Disturbed	Grazing, inappropriate fire, weed invasion, recreational activities, destruction by humans.
1c. E of Pingaring	Water reserve	1994 1 1997 27 1999 21 2000 11*(1**) 2001 10*	Disturbed	Grazing, inappropriate fire, weed invasion.
1d. E of Pingaring	Shire reserve	1999 4	Disturbed	Grazing, inappropriate fire, weed invasion, recreational activities.
2. 11 km SW of Karlgarin	Water reserve	1994 4 1999 51	Disturbed	Grazing, inappropriate fire, weed invasion, recreational activities, destruction by humans.
3. Dragon Rocks Nature Reserve	Nature reserve	1986 30+ 1992 0 2000 0 2001 1	Disturbed	Grazing, inappropriate fire, weed invasion.
4. Dragon Rocks Nature Reserve	Nature reserve	1987 1 1988 0 1992 0 1999 30 2000 0 2001 2?	Disturbed	Grazing, inappropriate fire, weed invasion.
5. Dragon Rocks Nature Reserve	Nature reserve	1992 10 1999 1 2000 0 2001 4	Disturbed	Grazing, inappropriate fire, weed invasion.

* Numbers of plants within a 5 metre x 5 metre monitoring plot only.

** Additional "dormant" plants that re-emerged in 2001.

Guide for decision – makers

Section 1 provides details of current and possible future identified threats. Any potential threatening processes known or proposed in the immediate vicinity of any of the populations of *Caladenia hoffmanii* subsp. *graniticola* will require assessment. The impacts from human activities are considered to be a major threat and any activity that involves disturbance of the population or associated habitat requires approval.

2. RECOVERY OBJECTIVES AND CRITERIA

Objectives

The objective of this Interim Recovery Plan is to abate identified threats and maintain or enhance *in situ* populations to ensure the long-term preservation of the species in the wild.

Criteria for success: The number of individuals within populations and/or the number of populations have increased by 10% or more.

Criteria for failure: The number of individuals within populations and/or the number of populations have decreased by 10% or more.

3. RECOVERY ACTIONS

Existing recovery actions

- Appropriate land managers have been notified of the threatened nature of this species and its location.
- Regular surveys of the populations are undertaken.

- Monitoring plots established in 1999 are monitored annually at Populations 1b and 1c. Only a proportion of the plants within these 2 subpopulations are monitored, not the entire population.
- Surveys are continuing within the known distribution range of the subspecies by Department staff from Katanning and Narrogin, volunteer groups such as the Central South Naturalist Club, individuals and adjacent landowners.
- Land managers at population 1 maintain signs to protect the population from accidental destruction (Golf Club).
- The Narrogin and Katanning District Threatened Flora Recovery Teams (NDTFRT and KDTFRT) oversees the implementation of this IRP and includes details in its Annual Report to the Department's Corporate Executive and funding bodies.
- Seed has been collected during 2002 as part of the Millennium Seed Bank Project (A. Batty, pers. comm.).
- A double-sided A4 Poster was produced in 2002, and includes a description of the plant, its habitat, threats, recovery actions and photos. This will be distributed to community members, Wildflower groups, local libraries and Regional Herbaria.

Future recovery actions

Please note: The Department's Narrogin and Katanning Districts will frequently be listed as the responsible authority. This refers largely to implementing recovery actions as directed by the Recovery Team.

Where appropriate, the completion date for actions is given as year 1, 2, 3, 4 or 5, referring to the years for which this IRP operates.

Where recovery actions are implemented on lands other than those managed by the Department of Conservation and Land Management, permission will be sought from the appropriate land managers prior to actions being undertaken.

1. Coordinate recovery actions

The NDTFRT and KDTFRT will coordinate the implementation of recovery actions for *Caladenia hoffmanii* subsp. *graniticola* and will include progress information in their annual reports to the Department's Corporate Executive and relevant funding bodies.

Action: Coordinate recovery actions.
Responsibility: The NDTFRT and KDTFRT.
Cost: \$800 p.a.

2. Liase with landowners and land managers

Departmental staff will continue to liaise with landowners and land managers to ensure that populations are not damaged or destroyed accidentally. Approval and assistance of land owners/managers will also be sought to implement recovery actions.

Action: Liase with landowners and land managers.
Responsibility: The Department (Narrogin and Katanning District), Pingaring Golf Club, Water Corporation, Shire of Kondinin and adjacent landowners through the NDTFRT and KDTFRT.
Cost: \$800 p.a.

3. Undertake weed control

Weeds may be a threat to Population 1 and 2, and a potential threat to Populations 3, 4 and 5. The following actions will be implemented with the approval of land managers:

- Population's 1 and 2 have *Avena fatua* (wild oats), *Ursinia anthemoides*, *Hypochaeris glabra* and *Arctotheca calendula* (capeweed) growing amongst plants of *Caladenia hoffmanii* subsp. *graniticola*. Manual weeding will be done to maintain an area around existing plants free of weeds. This will be done with a minimum of soil disturbance in case damage to young seedlings results.

- A weed control program will be developed for the bushland containing plants of *C. hoffmanii* subsp. *graniticola* in order to prevent further decline in habitat quality.
- Populations 3, 4 and 5 will require annual monitoring to determine weed spread. Population 3 has a weed problem mainly dominated by *Anagallis arvensis* var. *caerulea* (Pimpernel) that is being spread by rabbits in the area.

Action: Undertake weed control.
Responsibility: The Department (Narrogin and Katanning District), Pingaring Golf Club, Shire of Kondinin through the NDTFRT and KDTFRT.
Cost: \$1,600 p.a.

4. Control rabbits

Action: Annual rabbit control should be conducted at all populations where permissible.
Responsibility: The Department (Narrogin and Katanning District), Pingaring Golf Club, Shire of Kondinin through the NDTFRT and KDTFRT.
Cost: \$1,250 p.a.

5. Monitor populations and establish monitoring plots

The current demographic monitoring program at Populations 1b and 1c will be expanded to better measure key population processes (numbers, structure, dynamics, and trends). This will help land-managers control and clarify the threatening processes described in section 1.

Monitoring will coincide with the major life-history stages of *C. hoffmanii* subsp. *graniticola*; leaf emergence flowering, seed production (fruit ripening) and likely periods of seedling recruitment and mortality. This may require up to 3 visits per year. A Rare Flora Report Form will be completed for each visit. All plants within the monitoring quadrats will either be individually marked or their location referenced from a known point to facilitate relocation on subsequent monitoring visits. All plants will be assigned a unique identification number to record data against.

The following data will be collected and recorded for all individuals plants recorded within the monitoring quadrats using absolute or relative/proportional measures:

- Health/vigour, such as wilting during dry periods.
- Life-history stage (vegetative, bud, flower and seed production).
- Damage to plant parts from grazing/browsing and the possible organism responsible.
- Observation on an opportunistic basis of any pollinator activity.

Collection of this information will add to existing information obtained at population 1 since 1999. The data will be used to develop a greater understanding of the orchid's ecology, identify threats to various life-stages, and measure population trends against any management actions undertaken.

The total number of flowering plants within each population should be recorded annually. By comparing this with the detailed monitoring data from the quadrats the total population size can be estimated.

More detailed monitoring should be considered at other populations. Initially this should include a count of plants that produce seed to determine whether seed production is potentially limiting population recruitment across other populations.

Action: Monitor populations and establish monitoring plots at all populations.
Responsibility: The Department (Narrogin and Katanning District), Pingaring Golf Club, Shire of Kondinin through the NDTFRT and KDTFRT.
Cost: \$1,800 p.a.

6. Fence sections of Population 1

Monitoring data collected by the Department's Narrogin District indicate approximately one third of possible flowering heads are being eaten by introduced and native animals at this site. Damage by human activity is also a threat and will be reduced considerably by a fence. Fencing of subpopulations 1b and 1c from grazing by kangaroos and rabbits will allow monitoring to determine the previous effect of grazing pressure.

Action: Fence sections of Population 1.
Responsibility: The Department (Narrogin District) and Pingaring Golf Club through the NDTFRT.
Cost: \$900.

7. Conduct further surveys

Further surveys by Department staff and members of the Central South Naturalists Club (CSNC), the Newdegate Rare Flora Group (NRFG), orchid groups and enthusiasts and other volunteers will be coordinated during the September flowering period of the species. Surveys will be focused over the next three years and will include areas of similar habitat close to where past collections have been made. There are a number of granite rock complexes located in Dragon Rocks Nature Reserve, and other reserves in close proximity to current known location that require surveying. Surveys will be conducted at the same time as monitoring to reduce costs.

It is possible that new populations may occur some distance from the known distribution of the species. The recovery teams will raise the awareness of the species, especially within orchid enthusiasts groups, Naturalist Clubs and Wildflower Society members. These groups will be encouraged to undertake opportunistic surveys.

Action: Conduct further surveys.
Responsibility: The Department (Narrogin and Katanning District) and NRFG through the NDTFRT and KDTFRT.
Cost: \$3,000 p.a.

8. Develop and implement an appropriate fire management strategy

Fire is likely to influence the persistence of all *C. hoffmanii* subsp. *graniticola* populations. Inappropriate fire regimes can impact on all aspects of the orchid's life-history, including flowering rates, seedling recruitment and mortality, and production of replacement tubers. An appropriate fire management strategy will be developed which will aim to prevent unplanned fires from occurring in the area of populations. The strategy will also investigate the use of smoke treatments and/or fire to increase flowering and, potentially, recruitment if required.

Action: Develop and implement a fire management strategy.
Responsibility: The Department (Narrogin and Katanning District) through the NDTFRT and KDTFRT.
Cost: \$1,400 in year 1, and \$900 in year 2 and 3.

9. Collect and preserve genetic material

Ex-situ collections of genetic material need to be maintained to minimise the risk of extinction. Storage of material is required as seed storage, living collections and cryostorage. Such collections would also require the isolation, identification and storage of any symbiotic mycorrhizal fungi associated with seed germination and the growth of plants. These collections should aim to sample and preserve the maximum range of genetic diversity possible. Such material may be used to propagate plants for future translocations if required (see 10). The "Germplasm Conservation Guidelines for Australia" produced by the Australian Network for Plant Conservation (Touchell *et al.*, 1997) and the work of Batty *et al.* (2001a) will be used to guide this process.

Actions: Collect and preserve genetic material.
Responsibility: The Department (Narrogin and Katanning District, Threatened Flora Seed Centre (TFSC)) and BGPA (Botanic Gardens and Parks Authority) through the NDTFRT and KDTFRT.
Cost: \$1,500 in first year, \$1,000 p.a. thereafter.

10. Assess the need for translocations or restocking and if deemed necessary develop a translocation proposal.

Translocation or restocking may be considered if:

- no new populations of *C. hoffmanii* subsp. *graniticola* are discovered during the period of this IRP;
- population recruitment either does not occur or is considered inadequate; and
- other methods to promote recruitment, including the use of smoke treatments and fire to promote flowering, and hand pollination to increase seed set, prove unsuccessful.

Translocations are generally undertaken under full Recovery Plans, but if it is deemed vital due to the critically threatened nature of the subspecies then this course of action will commence before a full Recovery Plan is written. All translocation proposals require endorsement by the Director of Nature Conservation and a source of funding. The translocation of propagated orchids into the wild has been problematic in the past (Todd, 2000), and suitable techniques will need to be available before restocking or translocations are viable.

The NDTFRT and the KDTFRT will coordinate translocations, if approved. Information on the translocation of threatened species in the wild is provided in the Department's Policy Statement No. 29 *Translocation of Threatened Flora and Fauna*.

Action:	Assess the need for translocations and if necessary, develop a translocation proposal.
Responsibility:	The Department (Science Division, Narrogin and Katanning District) and BGPA through the NDTFRT and KDTFRT.
Cost:	\$3, 000 in year 2.

11. Obtain biological and ecological information

Improved knowledge of the biology and ecology of *C. hoffmanii* subsp. *graniticola* will provide a scientific basis for the management of the species in the wild and will be used in the development of a full Recovery Plan should one be deemed necessary. Information includes:

1. Studying seed bank dynamics including its size, seed viability, germination stimulants (smoke, fire, physical disturbance, rainfall), rates of germination, seed predation, and the effects of competition, rainfall and predation on seedling development and survival.
2. Determining the effects of weed competition, rainfall fluctuations and grazing pressure on seedling survivorship and recruitment.
3. Developing techniques to successfully *ex situ* propagate the species symbiotically, including identifying the symbiotic mycorrhizal fungi.
4. Developing suitable methods and protocols for translocating propagated orchids into the wild.
5. Studying the species reproductive ecology including mating systems and pollination biology, including the habitat requirements of the pollinator.
6. Studying the populations' genetic structures and levels of genetic diversity.
7. Analysing population viability to assist in the development of future management and recovery actions, including translocations.

Commence 1, 2 and 3 as a high priority. Commence 4, 5, 6 and 7 as resources permit.

Actions:	Obtain biological and ecological information.
Responsibility:	The Department (Science Division, Narrogin and Katanning District, Threatened Flora Seed Centre (TFSC)) and the BGPA through the NDTFRT and KDTFRT.
Cost:	\$6,000 in year 1, \$6,800 in year 2 and \$3,900 in year 3.

12. Promote awareness

Raising public awareness of the importance of biodiversity conservation and the protection of *C. hoffmanii* subsp. *graniticola* will be promoted to the public and may result in the discovery of other populations. This will be done through an information campaign using the local print and electronic media. Posters will be produced and distributed. Poster displays featuring this plant will be encouraged at relevant community events and wildflower displays. Note: a poster has been produced and distributed for this subspecies.

- Action:** Promote awareness.
Responsibility: The Department (Narrogin and Katanning District, Corporate Relations, WATSCU (Western Australian Threatened Species and Communities Unit)) and the NRRF through the NDTFRT and KDTFRT.
Cost: \$750 in year 2.

13. Review the need for a full Recovery Plan

At the end of the fourth year of the five-year term of this Interim Recovery Plan, if the taxon is still ranked as Critically Endangered, the need for a full Recovery Plan or a review of this IRP will be assessed and a plan prepared if necessary.

- Action:** Review the need for further recovery actions and/or a full Recovery Plan
Responsibility: The Department (WATSCU, Narrogin and Katanning District) through the NDTFRT and KDTFRT.
Cost: \$19,000 in the fifth year (if full Recovery Plan is required)

4. TERM OF PLAN

This Interim Recovery Plan will operate from February 2003 to January 2008 but will remain in force until withdrawn or replaced. If the taxon is still ranked Critically Endangered after five years, the need to review this IRP or to replace it with a full Recovery Plan will be determined.

5. ACKNOWLEDGMENTS

We would like to thank the staff of the W.A. Herbarium for providing access to Herbarium databases and specimen information, and the Department's Wildlife Branch for their assistance.

6. REFERENCES

- Arditti J. (1992). *Fundamentals of Orchid Biology*. John Wiley and Sons, Canada.
- Bates R.J. and Weber, J.Z. (1990). Orchids of South Australia. The Flora and Fauna of South Australia Handbooks Committee, Government Printer, South Australia.
- Batty, A.L., Dixon, K.W. and Siavsithamparam, K. (2000). Soil seed bank dynamics of terrestrial orchids. *Lindleyana* 15(4):227-236.
- Batty, A.L., Dixon, K.W., Brundett, M. and Sivasithamparam, K. (2001a). Long-term storage of mycorrhizal fungi and seed as a tool for the conservation of endangered Western Australian terrestrial orchids. *Australian Journal of Botany* 49:619-628.
- Batty, A.L., Dixon, K.W., Brundett, M. and Sivasithamparam, K. (2001b). Constraints to symbiotic germination of terrestrial orchid seed in mediterranean bushland. *New Phytologist* 152:511-520.
- Brown, A., Thomson-Dans, C. and Marchant, N. (Eds). (1998). *Western Australia's Threatened Flora*. Department of Conservation and Land Management, Western Australia.
- CALM (1992). Policy Statement No. 44 *Wildlife Management Programs*. Department of Conservation and Land Management, Western Australia.
- CALM (1994). Policy Statement No. 50 *Setting Priorities for the Conservation of Western Australia's Threatened Flora and Fauna*. Department of Conservation and Land Management, Western Australia.
- CALM (1995). Policy Statement No. 29 *Translocation of Threatened Flora and Fauna*. Department of Conservation and Land Management, Western Australia.
- Carstairs, S and Coates, D. (1994). Conservation genetics and population ecology of five rare and threatened Western Australian orchids. Final report to the Endangered Species Unit, Australian Nature Conservation Agency. Department of Conservation and Land Management, Western Australia.
- Commonwealth *Environmental Protection and Biodiversity Conservation Act* (1999).
- Dixon, K.W. (1991). Seeder/clonal concepts in Western Australian orchids. pp. 111-123 in *Population ecology of terrestrial orchids*, T.C.E. Wells and J.H. Willems (eds), SPB Academic Publishing, The Hague, The Netherlands.
- Durell, G.S. and Buehrig, R.M. (1997). *Declared Rare and Poorly Known Flora in the Narrogin District*. Wildlife Management Plan Number 529. Department of Conservation and Land Management, Western Australia.
- Hoffman, N. and Brown, A. (1998). *Orchids of South-West Australia*, revised 2nd ed. with supplement. University of Western Australia Press, Perth.

- Hopper S.D. and Brown A.P. (2001). Contributions to Western Australian orchidology: 2. New taxa and circumscriptions in *Caladenia*. *Nuytsia* 14 (1/2):27-308.
- Hopper, S.D., S VanLeeuwen, A.P., Brown and Patrick S.J., (1990). *Western Australia's Endangered Flora*. Department of Conservation and Land Management, Western Australian Wildlife Research Centre, Wanneroo, Western Australia.
- IUCN. (1994). IUCN Red List Categories and Criteria: Version 2.3. IUCN Species Survival Commission. IUCN, Gland, Switzerland.
- Jones, D.L. (1988). *Native Orchids of Australia*. Reed Books, NSW.
- Pate, J.S. and Dixon, K.W. (1982). Tuberous, cormous and bulbous plants: Biology of an adaptive strategy in Western Australia. University of Western Australia Press, Nedlands, Western Australia.
- Peakall, R. and Beattie, A.J. (1996) Ecological and genetic consequences of pollination by sexual deception in the orchid *Caladenia tentaculata*. *Evolution* 50(6):2207-2220.
- Ramsay R.R., Sivasithamparam K. and Dixon K.W. (1986). Patterns of infection and endophytes associated with Western Australian orchids. *Lindleyana* 1:203-214.
- Rasmussen H.N. (1995). Terrestrial orchids from seed to mycotrophic plant. Cambridge University Press, Great Britain.
- Sherwin, W.B. and Moritz, C. (2000). Managing and monitoring genetic erosion. pp 9-34 In *Genetics, demography and viability of fragmented populations*, Andrew G. Young and Geoffrey M. Clarke (eds), Cambridge University Press, Cambridge, UK.
- Soutamire, W.P. (1983). Wasp-pollinated species of *Caladenia* (Orchidaceae) in South-western Australia. *Aust. J. Bot.* 31:383-394.
- Todd, J.A. (2000). Recovery plan for twelve threatened Spider-orchid *Caladenia* taxa (Orchidaceae: Caladeniinae) of Victoria and South Australia 2000-2004. Department of Natural Resources and Environment, Melbourne.
- Touchell, D.H., Richardson M. and Dixon K.W. (eds) (1997). *Germplasm Conservation Guidelines for Australia*. Australian Network for Plant Conservation, Canberra.
- World Conservation Union (1994). *IUCN Red List Categories* prepared by the IUCN Species Survival Commission, as approved by the 40th meeting of the IUCN Council. Gland, Switzerland.

7. TAXONOMIC DESCRIPTION

From *Hopper and Brown* (2001).

Caladenia hoffmanii Hopper and A.P. Brown, sp. nov.

Typus: Morseby Range, September 1984, *K. Miller sn.* (holo: PERTH!; iso: AD! CBG! MEL!).

Plant solitary. Leaf 8-15 cm x 5-10 mm, linear, erect, pale green, basal third usually irregularly blotched with red-purple. Scape 12-30 cm tall. Flowers one rarely two, ca. 3-5 cm across, predominantly cream to yellowish-green with variable suffusions, lines and spots of dull pinkish maroon; floral odour absent. Sepals and petals stiffly held, linear-lanceolate in basal third to half, then abruptly narrowing with slightly to strongly upturned/incurved margins on an acuminate apical osmophore, osmophores scarcely tumescent light brown to yellow, 2-10 mm long, consisting of minute dark brown densely packed globular to shortly barrel-shaped sessile glandular cells. Dorsal sepal 2-3.7 cm x 1.5-3.0 mm, erect and slightly incurved, osmophore 3-10 mm long. Lateral sepals 2-3.5 cm x 3-5 mm, spreading obliquely downward and laterally falcate with apices sometimes crossed in front, osmophore 3-10 mm long. Petals 1.7-3.0 cm x 2-3 mm, spreading horizontally too obliquely downward, osmophore 2-10 mm long. Labellum obscurely 3-lobed, prominently two-coloured, white in basal two thirds, sometimes with a greenish suffusion near fringe, lacking radiating stripes or with prominent to inconspicuous radiating stripes and maroon suffusions near the margins subtending the longer marginal calli, terminating in a uniformly dark maroon downcurved apex, stiffly articulated on a claw ca. 1.5-3 mm wide; lamina 12-20 mm x 6-9 mm, linear-cordate (rarely cordate) in outline when flattened with maroon apical midlobe one third the length, evenly curved in lateral view with basal half from erect to horizontal and apical half gradually downcurved to a vertical apex, transverse cross-section at widest point in front view scarcely curved upwards and terminated by obliquely to vertically ascending margins and calli; lateral lobes erect with entire margins within 3-4 mm of claw, then becoming fimbriate with slender acuminate linear dark maroon sometimes white-tipped calli to 5 mm long which are abruptly decrescent near midlobe; midlobe margins with short broad slightly forward-facing obtuse sometimes hooked incurved calli decrescent towards the apex. Lamina calli in four close rows extending at least four-fifths the length of the labellum, dark maroon, sometimes white at base, golf stick-shaped with enlarged tips densely and minutely papillate, the longest ca. 3 mm tall, decrescent towards apex and becoming sessile. Column 10-17 mm x 5-8 mm, broadly winged, creamy yellow to green with red-pink blotches. Anther ca. 1.5-3 mm x 1.5-2.5 mm, yellowish green and dark maroon. Pollinia ca. 2 mm long, flat, yellow. Stigma ca. 1.5-2.5 mm wide, green. Capsule not seen.

Distribution and habitat. WESTERN AUSTRALIA (Map 71): Occurs between the lower Murchison River and Geraldton, growing beneath dense heath in clay loams on hillslopes and near breakaways, and some 600 km to the south-east near Pingaring, growing beneath tall shrubs and sheoaks (*Allocasuarina huegeliana*) on and around granite outcrops.

Flowering period. August-October.

Etymology. Named after Mr Noel Hoffman (1931-), retired primary school headmaster and co-author of *Orchids of South-West Australia*, who made some of the earliest orchid collections from the Murchison River area where *Caladenia hoffmanii* grows, and who has contributed greatly to knowledge of and interest in the Western Australian orchids.

Notes. A rare species currently on the schedule of Declared Threatened Flora (Hopper *et al.* 1990, Brown *et al.* 1998) and remarkable in the wide disjunction of its two subspecies.

Caladenia hoffmanii is easily recognised and has no close relatives, the nearest appearing to be *C. corynephora*, a summer flowering south-coast endemic, from which *C. hoffmanii* differs in its less tumescent osmophores, its somewhat smaller labellum lacking a glandular golden brown apex, the basal half of the labellum lamina predominantly white, and its labellum with shorter marginal calli and smaller lamina calli.

Caladenia hoffmanii occasionally hybridises with *C. longicauda* subsp. *borealis*.

There are two subspecies distinguished in the following key.

Key to subspecies of *Caladenia hoffmanii*

1. Labellum lamina usually 12-14 mm long, linear-cordate to cordate in outline when flattened with maroon apical midlobe narrowly triangular and acute; lamina calli decrease in length evenly from base to near apex, the longest to 1.5 mm tall. Column 10-13 mm tall. *Caladenia hoffmanii* subsp. *hoffmanii*
- 1: Labellum lamina 15-20 mm long, linear-cordate (never cordate) in outline when flattened with maroon apical midlobe narrowly triangular to almost parallel sided with apex obtuse and mucronate, rarely acute; lamina calli decrease in length abruptly beyond the basal cluster towards apex, the longest to 3.0 mm tall. Column 14-17 mm tall *Caladenia hoffmanii* subsp. *graniticola*

Caladenia hoffmanii* Hopper and A.P. Brown subsp. *hoffmanii

Illustrations. N. Hoffman and A. Brown, *Orchids of South-West Australia*, 2nd ed., pg. 124, as *C. hoffmanii* (1992); N. Hoffman and A. Brown, *Orchids of South-West Australia*, rev. 2nd ed. with suppl., pg. 124 (1998); A. Brown, C. Thomson-Dans, and N. Marchant (eds), *Western Australia's Threatened Flora*, pg. 34 (1998).

Dorsal sepal 2-2.8 cm long. Lateral sepals 2-2.8 cm x 3-3.5 mm. Petals 1.7-2.5 cm x 2-2.5 mm. Labellum lamina 12-14 mm long, linear-cordate to cordate in outline when flattened with maroon apical midlobe narrowly triangular and acute. Lamina calli decrease in length evenly from base to near apex, the longest to 1.5 mm tall. Column 10-13 mm x 5-6 mm. Anther ca. 1.5-2 mm x 1.5-2 mm. (Fig. 89).

Other specimens examined. WESTERN AUSTRALIA: Moresby Range, 23 08 1985, *A. Brown s.n.* (PERTH 00905402); near Northampton, 25 08 1982, *A. Brown s.n.* (PERTH 00267538); near Geraldton, 23 08 1984, *A. Brown s.n.* (PERTH 00267554); Murchison River Gorge, 07 09 1966, *A.S. George s.n.* (PERTH 00267546); NE of Geraldton, 27 08 1980, *G.J. Keighery 3328* (PERTH 00330841); Murchison River, 09 1966, *J. Tonkinson s.n.* (PERTH 00267929).

Distribution and habitat. WESTERN AUSTRALIA (Map 71): Ranges from the lower Murchison River and Geraldton, growing beneath dense heath in clay loams on hillslopes and near breakaways.

Flowering period. August-September.

Notes. *Caladenia hoffmanii* subsp. *hoffmanii* differs from *C. hoffmanii* subsp. *graniticola* in its smaller flowers with shorter basal calli and column, its earlier flowering period, and its more northerly distribution in clay loams near lateritic sandstone breakaways.

Caladenia hoffmanii* subsp. *graniticola Hopper and A.P. Brown, subsp. nov.

A subspecie typica floribus majorioribus et labello callorum robustorum differt.

Typus: Pingaring Rock, 1985, *K. White sn.* (holo: PERTH!).

Illustrations. S. Hopper, S. van Leeuwin, A. Brown and S. Patrick, *Western Australia's Endangered Flora*, plate 56 (1990) as *Caladenia* sp. (Moresby Range) G.J. Keighery 3328, Hoffman's Spider Orchid; N. Hoffman and A. Brown, *Orchids of South-West Australia*, rev. 2nd ed. with suppl., pg. 419 (1998); A. Brown, C. Thomson-Dans, and N. Marchant (eds), *Western Australia's Threatened Flora*, pg. 157 (1998).

Dorsal sepal 2.5-3.5 cm long. Lateral sepals 2.2-3.2 cm x 3-5 mm. Petals 2.0-3.0 cm x 2.5-3.0 mm. Labellum lamina 15-20 mm long, linear-cordate (never cordate) in outline when flattened with maroon apical midlobe narrowly triangular to almost parallel sided with apex obtuse and mucronate, rarely acute. Lamina calli decrease in length abruptly beyond the basal cluster towards apex, the longest to 3.0 mm tall. Column 14-17 mm x 5-8 mm. Anther ca. 2.5-3.0 mm x 2.5-3.0 mm. (Fig. 90).

Other specimens examined. WESTERN AUSTRALIA: near Newdegate, 13 09 1985, *S.D. Hopper 4569* (PERTH 00909033).

Distribution and habitat. WESTERN AUSTRALIA (Map 71): In the Pingaring-Newdegate area of the south-central wheatbelt, growing beneath tall shrubs and sheoaks (*Allocasuarina huegeliana*) on and around granite outcrops

Flowering period. September-October.

Etymology. Named from the rock granite and Latin suffix *-cola* (dweller), alluding to the distinctive habitat occupied by the subspecies.

Notes. *Caladenia hoffmanii* subsp. *graniticola* was first brought to our attention by Mrs K. White in 1984. It remains a rare taxon, recorded from only five granite outcrops. The labellum is distinctive in shape when flattened, and basal calli and column are larger than in *C. hoffmanii* subsp. *hoffmanii*.

