Selbyana 26(1,2): 189–195. 2005.

MAJOR THREATS TO ENDANGERED ORCHIDS OF VICTORIA, AUSTRALIA

MICHAEL DUNCAN*

Flora Ecology Research, Arthur Rylah Institute, Department of Sustainability and Environment, 123 Brown Street, Heidelberg, Victoria, Australia 3084.
Email: michael.duncan@dse.vic.gov.au

ANDREW PRITCHARD

Department of Sustainability and Environment, 78 Henna Street, Warrnambool, Victoria, Australia 3280.

FIONA COATES

Flora Ecology Research, Arthur Rylah Institute, Department of Sustainability and Environment, 123 Brown Street, Heidelberg, Victoria, Australia 3084.

ABSTRACT. Endangered terrestrial orchids in the public network of parks and reserves, on private land, along roadsides, and in small vegetation remnants in Victoria, Australia, face a range of threats. These include weed invasion, grazing by invertebrates and native and introduced herbivores, road maintenance, and small population size resulting from habitat fragmentation. In addition, these areas have been affected often and adversely by altered fire regimes or hydrology, introduced pathogens, mining and forestry activities, recreational activities, and site disturbance. Many species are under threat of illicit collection, and many suffer from inadequate public understanding of basic orchid biology, of conditions required for seedling recruitment, and of the need to maintain specific pollinators and mycorrhizal fungi.

Key words: Orchidaceae, threats, endangered, Victoria, conservation

INTRODUCTION

The state of Victoria, in the southeast corner of Australia, contains a diverse orchid flora with more than 370 taxa recognized. Orchids are among Victoria's natural treasures and must be counted among its most threatened assets (Backhouse & Jeanes 1995). Almost half (170) of Victorian terrestrial orchid taxa have a state conservation status of rare (R), vulnerable (V), endangered (E), or extinct (X), using criteria of the International Union for the Conservation of Nature and Natural Resources, also known as the World Conservation Union (IUCN 2001, TABLE 1). The perilous status of such a large proportion of our orchid flora reflects the serious and wide-ranging threats and threatening processes that adversely affect the quality and quantity of natural vegetation. Although the problems being faced by orchids are shared equally by other threatened plants and animals, orchids have the potential to act as flagship species, that is, to highlight broader nature conservation and biodiversity issues relating to a decline in the extent and quality of ecosystems.

The major threats and threatening processes facing terrestrial orchids in Victoria include land clearing, habitat fragmentation and small population size, weed invasion, grazing by invertebrates and native and introduced herbivores, site disturbance, mining, forestry, recreational activities, altered fire regimes or hydrology, and introduced pathogens. These threats are compounded by a general lack of understanding about the biology of native orchids, their mycorrhizal associations, and the requirements of their pollinators. Unfortunately, these threats rarely occur in isolation.

In the past 15 years, a number of people have undertaken assessments of the processes threatening the rarest orchids in Victoria (Beardsell & Muir 1992; Backhouse et al. 1999a, 1999b, 1999c; Berwick et al. 1999; Hill et al. 1999; Ingeme & Backhouse 1999; Todd 2000; Craig & Pritchard 2001a; Coates et al. 2002; Duncan et al. 2003). In this paper, we describe a range of threats and threatening processes present in Victoria, using examples of threatened terrestrial orchid populations. Based on DSE (2003), both the state and national threatened status of a taxon are bracketed following the first mention of each orchid taxon. Many orchid taxa, which are yet to be formally described, are also yet to receive a national threatened status. Nomenclature follows that of Ross and Walsh (2003).

* Corresponding author.

TABLE 1. Summary of the conservation status of Victorian orchids at the state and national level, Australia, 2003.

Conservation status	Victoria DSE (2003)	Victoria FFG (1988)	Australia EPBC (1999)
Presumed extinct (X)	11	8	3
Endangered (E)	73	50	27
Vulnerable (V)	41	13	24
Rare (R)	45	2	0
TOTAL	170	73	54

Source: DSE (2003).

Note: DSE = Victorian Department of Sustainability and Environment; conservation assessment of orchids by the DSE, using IUCN 2001 criteria.

FFG = Victorian Flora and Fauna Guarantee Act 1988; orchids listed under the FFG.

EPBC = Commonwealth Environment Protection and Biodiversity Conservation Act 1999; orchids listed under the EPBC.

DISCUSSION

In surveying the threats currently facing native orchids in Victoria, Australia, we found a variety of factors but list the following as most significant.

Land Clearing and Habitat Fragmentation

Habitat destruction is the single greatest threat to the Victorian orchid flora (Backhouse & Jeanes 1995). In little more than 150 years of European settlement, the natural vegetation in Victoria has been altered enormously. Land clearing of more than 60% of the state for agriculture and urban development has greatly reduced the extent of many habitats. For example, early settlers grazed their stock extensively on Victoria's native grasslands and grassy woodlands and forests. They cut down the trees for housing and mining during the gold rush of the 1850s, and then "improved" the pasture by introducing exotic grasses and applying fertilizers. Unfortunately some of these habitats were also the most orchid-rich, and today they contain the highest proportion of threatened species.

Western Basalt Plains Grassland

The Western Basalt Plains Grassland (WBPG) has a flora unique within Victoria. While members of the Myrtaceae, Mimosaceae, and Epacridaceae families dominate ecosystems across much of the state, the WBPG is dominated by Poaceae and Asteraceae families, with trees and shrubs restricted to water courses and rocky outcrops (Rouse 2002). As a result of clearing this fertile land for agriculture (principally grazing or cropping), less than 1% of the pre-European cover of WBPG remains (NRE 1997). Tiny remnants are restricted largely to roadsides, rail reserves, cemeteries, and unimproved paddocks that have so far escaped cultivation and heavy grazing (Scarlett & Parsons 1993). Although ca. 12% of Victoria is protected in national parks or reserves, these include very little WBPG habitat. Thus most of the remaining fraction continues to be degraded by stock grazing, weed invasion, and site disturbance. The WBPG has a high level of endemism, with ca. 50% of orchid species occurring nowhere else (Rouse 2002). As a result, 10 nationally threatened orchid species cling to survival in this region, while another two species are extinct.

For example, *Pterostylis basaltica* D.L. Jones and M.A. Clem. (E), *P.* sp. aff. *bicolor* (E), *P.* sp. aff. *cycnocephala* (E), and *P.* sp. aff. *mutica* (E) are all endemic to WBPG and were probably once widespread across the ecosystem. Today they occur together at the same single roadside site, associated with a small, stony rise surrounded by farmland (Ingeme & Backhouse 1999, Duncan et al. 2003). Two of these taxa (*P.* sp. aff. *cycnocephala* and *P.* sp. aff. *mutica*) occur nowhere else, while *P. basaltica* occurs on a second stony rise further along the same roadside, and *P.* sp. aff. *bicolor* also occurs in an unimproved paddock more than 100 km away. The roadside site is less than 0.5 ha in area, and within this site, all four species are restricted to the moss beds and shallow soils associated with the edges of exposed basalt rocks.

Protection of this site is critical. Until recently there was opportunistic grazing of the roadside by stock from surrounding farmland. Also a potential exists for fertilizer drift or run-off from these properties, as well as herbicide drift associated with weed spraying along the road. This roadside also forms part of a strategic firebreak in the district and as a result has been burnt annually by volunteers for the last 30 years. The timing of this management practice appears to have fortuitously favored native species over weeds.

Woolly Tea-Tree Scrub

Woolly Tea-Tree Scrub (WTTS), dominated by a dense overstory of *Leptospermum laniger-um* (Sol. ex Aiton) Sm., was once widespread in swamps and along watercourses on moist, black, peaty, alkaline soils in coastal areas of southern Victoria (Coates et al. 2002, Duncan et al. 2003). This habitat is well suited to agriculture. As a result, what must once have been continuous populations of the nationally threatened orchids—*Corybas* sp. aff. *diemenicus* (E), *Pterostylis* sp. aff. *furcata* (V), and *P. tenuissima*

Nicholls (V)—are now widely scattered, isolated populations. Only isolated pockets of WTTS remain, commonly as small stands in the wettest corners of active grazing paddocks. Draining and clearing have led to a highly fragmented distribution across ca. 600 km of Victoria's southern coastline. For example, *C.* sp. aff. *diemenicus* is only known from six populations, separated by a minimum of ca. 80 km. These populations are now almost certainly genetically isolated. In addition, because of the small size of these habitat fragments, these orchids are exposed to a range of other threats (particularly weed invasion, site disturbance, and altered hydrology). As a result, the thick *L. lanigerum* overstory is highly degraded at two sites.

Weed Invasion

Weed invasion, a critical threat to orchids across almost all Victorian habitats, is particularly threatening to the WBPG and WTTS habitats. Invasion of a habitat by weeds gradually changes the species composition of native vegetation through a process of competition and elimination. Weeds dominate by directly outcompeting native species (including orchids), changing the vegetation type and structure, and/or altering microhabitats, which can indirectly disfavor orchids. In addition, weed invasion can alter the fire regime by significantly increasing the biomass of dry vegetation over summer. Weeds also can promote soil erosion by forming a dense canopy that eliminates the natural groundcover (Cochrane 2001), and provide food and shelter for introduced herbivores that in turn may exert their own pressure on the native vegetation (Blood 2001).

Significant weed species that are adversely affecting orchid populations in Victoria include introduced grasses. For example, *Phalaris* spp., *Vulpia bromoides* (L.) Gray, *Briza maxima* L., and *Nasella trichotoma* (Nees) Hack. ex Arechav. invade from surrounding agricultural land, particularly on the WBPG. Species such as ragwort (*Senecio jacobaea* L.), Scotch thistle (*Cynara cardunculus* L.), and watsonia or *Watsonia meriana* (L.) Mill. var. *bulbullifera* (J.W. Marthews & L. Bolus) D.A. Cooke commonly invade a range of habitats. In coastal areas, common weeds include African boneseed or *Chysanthemoides monilifera* subsp. *monilifera* (L.) Norl., blackberries (*Rubus fruticosus* spp. aggregate), and flatweeds (*Hyposchaeris radicata* L.). Larger shrubs and trees, such as coast wattle or *Acacia longifolia* (Andrews) Willd. subsp. *sophorae* (Labill.) Court, mirror bush (*Coprosma repens* A. Rich., and Monterey pine (*Pinus radiata* D. Don), can cause significant changes to the vegetation structure and hydrology of sites.

Altered Fire Regimes

Fire is a major environmental factor in Australia, and major habitats for terrestrial orchids are burnt regularly (Jones 1988). A critical factor is the timing and frequency of fires (Backhouse & Jeanes 1995). Most Victorian orchids have evolved in a pattern of summer (December–February) fires, occurring when most orchid species are dormant. In many areas, however, this fire pattern has been altered or replaced with a no-fires regime, particularly close to urban areas (Lavarack 1998). The tendency has been to move to a slash/spray regime in urban areas, and such a regime requires careful management to avoid selection for weed species (particularly aggressive pasture grasses). As a result, maintaining a "natural" burning regime becomes very difficult when managing threatened orchid populations in urban areas. Poor urban planning with respect to conservation values has seen housing developments surround tiny patches of native vegetation; and in an increasing culture of litigation, gaining permission to burn sites can be near impossible.

Prasophyllum spicatum R.J. Bates and D.L. Jones (V) occurs in coastal heath and heathy woodland on sandy loams, among the outer southeast suburbs of Melbourne. Flowering is stimulated by hot summer fires (Jeanes & Backhouse 2000), which in the past would have burnt these sites every 5–10 years. With the urbanization of the surrounding land, however, fire has been replaced by biennial slashing of the vegetation. Slashing can stimulate *P. spicatum* flowering, but it also favors many weed species, particularly grasses such as *Briza maxima* and *Vulpia bromoides* and perennial herbs such as *Watsonia* spp., which can quickly come to dominate sites.

Altered Hydrology

Woolly tea-tree scrub (WTTS), a habitat that has suffered significantly from altered hydrology, naturally occurs in swampy areas and along creeklines. As the surrounding land has been cleared for agriculture and forestry, drainage patterns have been changed significantly at a landscape level, resulting in the environment disfavoring the persistence of WTTS. At the same time, the rise of agriculture in these areas has had the secondary effect of introducing weeds and farm stock to the WTTS habitat. Because some of these weed species use large amounts of water, the net result is that the site

dries out, and the existing WTTS habitat becomes degraded. Drier sites are further predisposed to invasion by more weed species and are placed in a spiral of decline. Similarly, grazing and trampling by stock can destroy vegetation and cause increased erosion, leading to a gradual decline in stand size and quality.

In far eastern Victoria, one nationally threatened orchid species is under threat from altered hydrology in its swampy habitat. *Cryptostylis hunteriana* Nicholls (VE) occurs in spear grass-tree (*Xanthorrhoea resinosa* Pers.) swamps in coastal areas of Victoria, New South Wales (Jeanes & Backhouse 2000), and Queensland in eastern Australia (Logan 1998). This orchid, however, is threatened in all three states. In Victoria, *C. hunteriana* occurs in swamps around a coastal holiday town. Unfortunately, as the popularity of this area as a holiday destination has increased, so too has the pressure on *C. hunteriana* populations. As the town expands, new roads are built, and land is cleared for new housing subdivisions. This has resulted in many swamps being either purposely drained for development, or inadvertently degraded by drainage pattern changes, resulting from the creation of the surrounding road network. *Cryptostylis hunteriana* appears well adapted to an environment that experiences seasonal inundation, and the removal of this event has seen the reduction and/or elimination of the species at some sites.

Competing Management Activities

In a landscape where huge areas have been cleared for urban or agricultural development, it is rare, outside of Victoria's system of parks and reserves, for remnant vegetation to survive, unless the site serves a dual purpose. For example, *Cryptostylis erecta* R. Br. (E) and *Cryptostylis hunteriana* occur in a swamp in eastern Victoria that has survived, because it is part of the land that forms the buffer around the end of the runway of a regional airport. Thus, for many years this area has been managed solely for the purpose of airport safety, but luckily this has not caused any significant change to the site hydrology, and the slashing regime has not disfavored these orchid species.

All but two plants of the 350 known *Caladenia xanthochila* D. and C. Beardsell (E) plants occur at a single site in rural western Victoria. This 100-ha site originally was owned by the local doctor, who never developed it for agriculture. Instead the doctor's passion was indulged, and a golf course was constructed on the site. Today, the *C. xanthochila* population survives in the rough along one of the fairways, and the ongoing cooperation of the golf club Committee of Management is needed to ensure protection of the native orchid.

A number of Victorian rare plants occur in small, rural cemeteries. One example is *Prasophyllum suaveolens* D.L. Jones and R.J. Bates (E), which occurs in a small cemetery in central Victoria. Three groups have a role in the management of this site. First, the Cemetery Trust is responsible for the running and general upkeep of the cemetery. The local shire council is responsible for mowing/slashing and site works, and the Department of Sustainability and Environment is responsible for managing areas with significant vegetation. The potentially competing interests of these groups must be accommodated when planning for the protection of this species.

In all cases, the security of these sites and of the threatened orchids can change dramatically as a result of something as simple as the current on-site manager leaving. It is critical that all parties are kept informed about the orchid population on their land, its progress, and its needs. In addition, everyone from the caretaker to the board and management need to be educated regarding the impact of the timing and methods of particular management practices to ensure the protection of each orchid.

Site Disturbance

Site disturbance covers a wide range of threats, which can act alone or in combination to adversely affect orchids or their habitat.

Remnant vegetation remains on the urban fringe of Melbourne and other regional towns, and often these urban fringe areas are most at risk from site disturbance. For example, a few small populations of *Prasophyllum spicatum* occur in heathy grassland around the town of Crib Point. These sites are under enormous pressure from the activities of the surrounding community. *Prasophyllum spicatum* sites are used for dumping rubbish and garden waste, which smothers plants and introduces weeds. They are slashed a few times a year to reduce their fire risk. They play host to the BMX bikes of the local children; and even worse, some local youths have taken to driving their cars in the mud on one site during the wet, winter months. This activity in particular has had a devastating affect on that site. In addition, *P. spicatum* sites are under threat of being developed for housing.

In the goldfields of central Victoria, *Pterostylis despectans* (Nicholls) M.A. Clem and D.L. Jones (E) is threatened by site disturbance caused by gold prospectors. During the gold rush of the 1850s, serious site disturbance occurred across this entire region, as miners "turned-over" the topsoil in their search for

gold and cut down most of the trees to sure-up mine shafts and build houses. In recent years, a new generation of gold miners has returned to this area, with powerful metal detectors, capable of recognizing metallic objects of a smaller size and at a greater depth in the soil. The relatively shallowly buried *P. despectans* tubers have been dug up extensively at one of its five known sites by gold prospectors eager to uncover the next big nugget.

Grazing

Grazing by native herbivores (principally kangaroos and wallabies) usually is not a problem in native vegetation; however, as the area of native vegetation shrinks because of land clearing, leaving a highly fragmented patchwork of bush, the grazing pressure on the remnant vegetation increases significantly. Too many animals and not enough vegetation is not a good scenario for highly palatable orchids. Add a drought to this scenario, and grazing pressure is further magnified. In unprotected vegetation (e.g., land not part of the public system of parks and reserves), grazing by introduced (e.g., sheep or cattle) or feral (e.g., rabbits or hares) herbivores can be devastating. In addition, the impact of sheep and cattle can be exacerbated by their trampling of any plants that escape grazing and their introduction of weed seed in their feces.

In the box-ironbark forests of Victoria, large flocks of 20–30 white-winged choughs are a common site. The size of small ravens or crows, they forage on the forest floor feeding on invertebrates and larvae, using their strong, sickle-shaped beaks to probe the ground, vigorously flipping sticks, stones, and leaf litter out of the way (Falkingham 1995). White-winged choughs also fancy orchid tubers. For example, upon discovery of a colony of *Pterostylis despectans* rosettes, the choughs carefully dig down and extract the plant with the tuber in tact. They then devour the tuber and carefully place the rosette and collar beside the hole, as if to tell you what they've done. A flock of choughs can devastate a population of *P. despectans* in just a few hours.

Introduced Pathogens

The introduction of the soil-borne fungal pathogen *Phytophthora cinnamomi* Rands has led directly to large-scale changes in the floristic composition of native vegetation in botanically significant areas of Victoria, such the Grampians National Park (NP), Brisbane Ranges NP, and Wilsons Promontory NP (Weste & Law 1973, Weste 1986, Kennedy & Weste 1986). This pathogen has been recorded infecting the roots of more than 400 native plant species, mostly in Victoria and southwest Western Australia (Weste 1972, Shearer & Smith 2000). It has been described as the most destructive plant pathogen ever recorded in native vegetation in this and possibly any region (Newhook & Podger 1972).

The direct impact of *Phytophthora cinnamomi* on orchid species is unclear, but in general they appear to be at least field resistant (M. Duncan unpubl. data). Its indirect effect on orchid species, however, can be devastating. In Victoria, *Paracaleana disjuncta* D.L. Jones (E) is known from a single colony of about 50 plants that occur in a 0.5 ha area adjoining the Grampians NP. The plants grow in moss beds in natural gaps in the heathy understory or around the trunk bases of *Eucalyptus baxteri* (Benth.) Maiden and Blakely ex J.M. Black. Death of some heath species (e.g., *Xanthorrhoea australis* R. Br.) caused by *P. cinnamomi* is occurring within 50 m of this population, and it is only a matter of time before it spreads into the site. *Eucalyptus baxteri* is susceptible to this pathogen. A common change in the floristic composition caused by *P. cinnamomi* is a reduction in the size and frequency of gaps in the ground layer. These gaps are often colonized by sedge species (e.g., *Lepidosperma laterale* R. Br. and *Gahnia sieberiana* Kunth.) following the removal of the susceptible heath understory species (Duncan & Keane 1996). The future of the *P. disjuncta* population is far from certain.

Natural Disasters

Natural disasters are perhaps the most frustrating of all threats because of their unpredictability and often large-scale impact. In Victoria, natural disasters generally are associated with environmental extremes such as floods, drought, or bushfires.

On 8 January 2003, lightning started 85 bushfires across northeast Victoria. Eight of these fires could not be contained and united to become the largest wildfire in Victoria in a 65-year period. Burning for 59 days, the fire burnt ca. 1.2 million ha of mostly native vegetation. One of the most severely effected areas was Omeo in the Victorian Alps, which includes the only population of *Pterostylis aenigma* D.L. Jones and M.A. Clem. (E). The population is located in a broad, flat seasonal creekline that flows out of the surrounding steep hills, which were severely burnt by the fire. In March 2003, however, less than a month after the fire, a localized storm event delivered 80 mm of rainfall to these hills in less than an hour. The result was a massive movement of sediment from the recently

denuded hilltops, which moved down the creek and came to a rest along the flats of the *P. aenigma* site.

In November 2003 at the upstream end of the site, the creek had cut a channel through the meter-deep silty layer of sediment from the surrounding hills. The creek continued to largely follow its original path. By the time it reached the *P. aenigma* population, the sediment depth was less than 20 cm, and slightly lower where the water was running. Surprisingly, *P. aenigma* rosettes and buds could be seen emerging through the sediment beneath the flowing water. Almost 50 flowering plants were recorded when official monitoring occurred in late November 2003 (J. Turner pers. comm.). Monitoring in previous years has recorded 23–59 flowering plants. Thus *P. aenigma* has survived the fire and the subsequent sediment movement; however, many tons of sediment still sit in the creekline less than 50 m upstream of the orchid population. The continuing movement of this sediment will be influencing the site for many years to come.

Conclusions

The prognosis for many of Victoria's 170 threatened orchid species is not rosy. The reality is that the threats and threatening processes at work in this state are formidable. Without intensive management intervention, many orchid species are facing extinction within the next 10 years. Thankfully, both the State and Commonwealth governments have recognized the urgency of the situation, and have facilitated the preparation of recovery plans for 59 nationally threatened species (including many of those discussed in this paper). In addition, an effective network has been established of officers working with threatened orchids, government scientists, universities, local orchid enthusiasts, and orchid societies. Cooperatively they are implementing strategies to combat each threat and create an environment where orchid numbers can grow into the future.

Literature Cited

Backhouse, G.N. and J.A. Jeanes. 1995. The Orchids of Victoria. The Miegunyah Press, Carlton, Victoria.

Backhouse, G.N., H. Bramwells, R. Musker, G. Walker, and K. Lester. 1999a. Draft Recovery Plan for the Frankston Spider-Orchid, *Caladenia robinsonii* G.W. Carr, 1999–2003. Victorian Department of Natural Resources and Environment, East Melbourne, Victoria.

Backhouse, G.N., C. Beardsell, D. Tonkinson, and G. French. 1999b. Draft Recovery Plan for the Charming Spider-Orchid, *Caladenia amoena* (Orchidaceae: Caladeniinae) 1998–2002. Victorian Department of Natural Resources and Environment, East Melbourne, Victoria.

Backhouse, G.N., A. Webster, and J. Arnott. 1999c. Recovery Plan for the Sunshine Diuris *Diuris fragrantissima* (Orchidaceae: Diuridinae) 1998–2002. Victorian Department of Natural Resources and Environment, East Melbourne, Victoria.

Beardsell, C.M. and A.M. Muir. 1992. A Recovery Plan for Rosella Spider-orchid (*Caladenia rosella* G.W. Carr). Report to the Australian National Parks and Wildlife Service, Canberra.

Berwick, S., A. Moorrees, and G. Backhouse. 1999. Draft Recovery Plan for Audas' Spider-Orchid *Caladenia audasii* (Orchidaceae: Caladeniinae) 1998–2002. Victorian Department of Natural Resources and Environment, Melbourne.

Blood, K. 2001. Environmental Weeds: A Field Guide for SE Australia. Cooperative Research Centre for Weed Management Systems, University of Adelaide, South Australia.

Coates, F., J. Jeanes, and A. Pritchard. 2002. Recovery Plan for Twenty-five Threatened Orchid Taxa in Victoria, South Australia, and New South Wales 2003–2007. Victorian Department of Natural Resources and Environment, Heidelberg, Victoria.

Cochrane, A. 2001. Alien Invaders: Identification, Control, and Monitoring of the Most Recognizable Environmental Weeds of Melbourne and Surrounds. Royal Botanic Gardens, Melbourne, Victoria.

Craig, A. and A. Pritchard. 2001. Recovery Plans for Three Species of Orchid in Southeast South Australia and Southwest Victoria: *Caladenia richardsiorum* (Little Dip Spider Orchid), *Caladenia calcicola* (Limestone Spider Orchid), and *Pterostylis tenuissima* (Swamp Greenhood) for 2001–2005. National Parks and Wildlife, South Australia and Victorian Department of Natural Resources and Environment, Warrnambool, Victoria.

DSE. 2003. Advisory List of Rare or Threatened Plants in Victoria—2003. Victorian Department of Sustainability and Environment, East Melbourne, Victoria.

Duncan, M.J. and P.J. Keane. 1996. Vegetation changes associated with *Phytophthora cinnamomi* and its decline under *Xanthorrhoea australis* in Kinglake National Park, Victoria. Aust. J. Bot. 44: 355–369.

Duncan, M., A. Pritchard, and F. Coates. 2003. Recovery Plan for Fifteen Threatened Orchids in Victoria and South Australia 2004–2008. Victorian Department of Natural Resources and Environment, Heidelberg, Victoria.

Falkingham, C. 1995. White-winged choughs *Corcorax melanorhamphos* and bird behaviour. Victorian Nat. 112(6): 258–260.

Hill, J., G. Carr, A. Pritchard, A. Govanstone and G. Backhouse. 1999. Draft Recovery Plan for Mellblom's Spider-orchid *Caladenia hastata* (Orchidaceae: Caladeniinae) 1998–2002. Portland Aluminum and the Victorian Department of Natural Resources and Environment, Melbourne, Victoria.

Ingeme, Y. and G. Backhouse. 1999. Recovery Plan for the Basalt Greenhood *Pterostylis basaltica.*

Victorian Department of Natural Resources and Environment, East Melbourne, Victoria.

IUCN. 2001. IUCN Red List Categories and Criteria: Version 3.1. IUCN Species Survival Commission. IUCN, Gland, Switzerland, and Cambridge, United Kingdom.

Jeanes, J. and G. Backhouse. 2000. Pictorial Guide to the Wild Orchids of Victoria, Australia. Zoonetics, Seaford, Victoria.

Jones, D.L. 1988. Native Orchids of Australia. Reed Books Pty Ltd, Frenchs Forest, New South Wales.

Kennedy, J. and G. Weste. 1986. Vegetation changes associated with invasion by *Phytophthora cinnamomi* on monitored sites in the Grampians, Western Victoria. Aust. J. Bot. 34: 251–279.

Lavarack, P.S. 1998. Conservation of orchids, the Queensland context. Orchadian 12(10): 468–475.

Logan, A.E. 1998. *Cryptostylis hunteriana* Nicholls in Queensland. Orchadian 12(10): 460.

Newhook, F.J. and F.D. Podger. 1972. The role of *Phytophthora cinnamomi* in Australian and New Zealand forests. Ann. Rev. Phytopath. 10: 299–326.

NRE. 1997. Victoria's Biodiversity: Directions in Management. Victorian Department of Natural Resources and Environment, East Melbourne, Victoria.

Ross, J.H. and N.G. Walsh. 2003. A Census of the Vascular Plants of Victoria. National Herbarium of Victoria, Royal Botanic Gardens, South Yarra, Victoria.

Rouse, D.T. 2002. Orchidaceae endemism on the basalt plains of western Victoria. Pp. 13–14 *in* F. Coates, ed. Proceedings of Mutual Gains: Co-operative Orchid Conservation in Southeastern Australia. Royal Botanic Gardens, Melbourne 16–18 October 2002. Victorian Department of Natural Resources and Environment, East Melbourne, Victoria.

Scarlett, N.H. and R.F. Parsons. 1993. Rare or threatened plants in Victoria. Pp. 227–255 *in* D.B. Foreman and N.G. Walsh, eds. Flora of Victoria Volume 1: Introduction. Inkata Press, Melbourne, Victoria.

Shearer, B.L. and I.W. Smith. 2000. Diseases of eucalypts caused by soilborne species of *Phytophthora* and *Pythium.* Pp. 259–291 *in* P.J. Keane, G.A. Kile, F.D. Podger and B.N. Brown, eds. Diseases and Pathogens of Eucalypts. CSIRO Press, Collingwood, Victoria.

Todd, J.A. 2000. Recovery Plan for Twelve Threatened Spider-Orchid *Caladenia* R. Br. Taxa of Victoria and South Australia 2000–2004. Victorian Department of Natural Resources and Environment, East Melbourne, Victoria.

Weste, G. 1972. A sinister invader. Victorian Resour. 14: 27–29.

———. 1986. Vegetation changes associated with invasion by *Phytophthora cinnamomi* of defined plots in the Brisbane Ranges, Victoria, 1975–1985. Aust. J. Bot. 34: 633–648.

Weste, G. and C. Law. 1973. The invasion of native forest by *Phytophthora cinnamomi.* 3. Threat to the National Park, Wilson's Promontory, Victoria. Aust. J. Bot. 21: 31–51.