The taskforce will also have the role of implementing a number of strategies with the following goals in mind:

- Preventing further spread.
- All relevant people being able to recognize it.
- All areas of serrated tussock to be covered by a community management strategy and subject to an appropriate management plan.
- Monitoring success of the strategy.

WeedPlan, Tasmania's Weed Management Strategy, promotes the fact that weeds are everyone's problem and aims to encourage the development of local and catchment/regional community based weed management programs. This approach has been adopted by Department of Primary Industries and Fisheries to manage serrated tussock and other significant weeds in Tasmania (WeedPlan 1996).

Conclusion

Serrated tussock has the potential to become a devastating weed in Tasmania. Action is often delayed until there is tangible evidence of a weed becoming a significant problem by which time the costs associated with eradication or management become exorbitant. Tasmania is in a fortunate position in having the ability to prevent serrated tussock from becoming a significant problem.

A co-operative and co-ordinated response involving land managers, community groups, local councils and state government agencies is the essence of Tasmania's approach to isolate and contain serrated tussock.

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Fungi in Victoria with biological control potential for *Nassella trichotoma* (serrated tussock)

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Abstract

Serrated tussock is a noxious pasture weed in Australia which is not well controlled. The aim of this study was to find fungal pathogens in Australia that cause death or reduction in seed set. Two fungi found on serrated tussock near Melbourne appear to have potential for biological control. *Zinzipegasa argentinensis* was observed causing black lesions on culms, reduction in flowering and apparently death of plants at Melbourne Airport and near the Organ Pipes National Park. *Fusarium* was associated with a crown rot in plants at Werribee and near the Organ Pipes National Park. These fungi should be investigated further for their potential to control serrated tussock, either as classical biocontrol agents or as mycoherbicides.

Introduction

Serrated tussock (*Nassella trichotoma* (Nees) Hack. ex Arechav.) originally from Argentina is one of the most serious agricultural and environmental weeds in south-eastern Australia (Campbell and Vere 1995). It currently occupies 1 million ha, mainly in New South Wales and Victoria, costs $55 million per year and, without effective control, could expand to 32 million ha (McLaren *et al.* 1998).

Various control methods have been proposed and implemented, ranging from burning and shading out to spray topping with herbicides such as flupropanate and glyphosate (Campbell 1998). None has been effective in stopping the spread of the weed and the cost of treatment on poor land is prohibitive (Campbell 1998).

The magnitude of the potential spread and cost of control has prompted calls for biological control (Briese and Evans 1998, McLaren *et al.* 1998). Wapshere (1990) discounted the feasibility of using fungi on the grounds that none had been recorded from *N. trichotoma* and that some rusts and smuts could infect species of both *Nassella* and *Stipa*, thus posing a threat to many Australian species of *Stipa*. However, a recent taxonomic revision suggests that Australian *Stipa* species are only distantly related to *Nassella* (Briese and Evans 1998). Furthermore, surveys of *N. trichotoma* in Argentina during 1995-6 found nine previously unrecorded species of fungi causing severe plant damage (Briese and Evans 1998). They therefore suggest that safe classical biological control agents may exist in Argentina and should be explored further. This would be costly, involving further surveys and pathogenicity testing against a wide range of grasses before satisfying quarantine regulations for importation to Australia.

The questions of safety and cost largely do not arise if fungal pathogens causing death of individual plants or reduction in seed set already exist on *N. trichotoma* in Australia. No previous survey in Australia has recorded any fungal pathogen, but a similar situation also existed for *N. trichotoma* in Argentina before the 1995-6 surveys (Briese and Evans 1998). The discovery of such pathogens in Australia could be valuable in obviating the time, expense and risk incurred to import exotic pathogens. Even if the pathogens do not spread naturally at a rate sufficient to control serrated tussock, mycoherbicide application might allow control or contribute to control by other methods.

The aim of this study was therefore to find fungal pathogens capable of causing death or reduction in seed set in serrated tussock in Australia.

Materials and methods

Collection of infected plants

Serrated tussock plants were surveyed within a 50 km radius of Melbourne during 1996–7.

***Zinzipegasa argentinensis* (Spegazzini) Nag Raj** Plants with black lesions on culms and reduction in flowering and seed set were collected on private property near the Organ Pipes National Park and at Melbourne Airport, 18–25 km N.W. of Melbourne, Victoria, during December 1997 and February 1998. Dead plants with the same symptoms were also collected from a fenced ungrazed area heavily infested with serrated tussock on private property near the Organ Pipes National Park. These areas had not been sprayed with herbicides for several years.

***Fusarium* sp. Link ex Fries.** Plants with a basal 1–5 cm of external white mycelium

on senescent culms in the middle of the tussock were collected in April and December 1996 from a damp area of a paddock on private property near Werribee, 35 km S.W. of Melbourne. Infected culms were easily pulled out. Similar symptoms were found on plants growing in the shade of a tree in dry soil in a paddock in private property near the Organ Pipes National Park in June 1996.

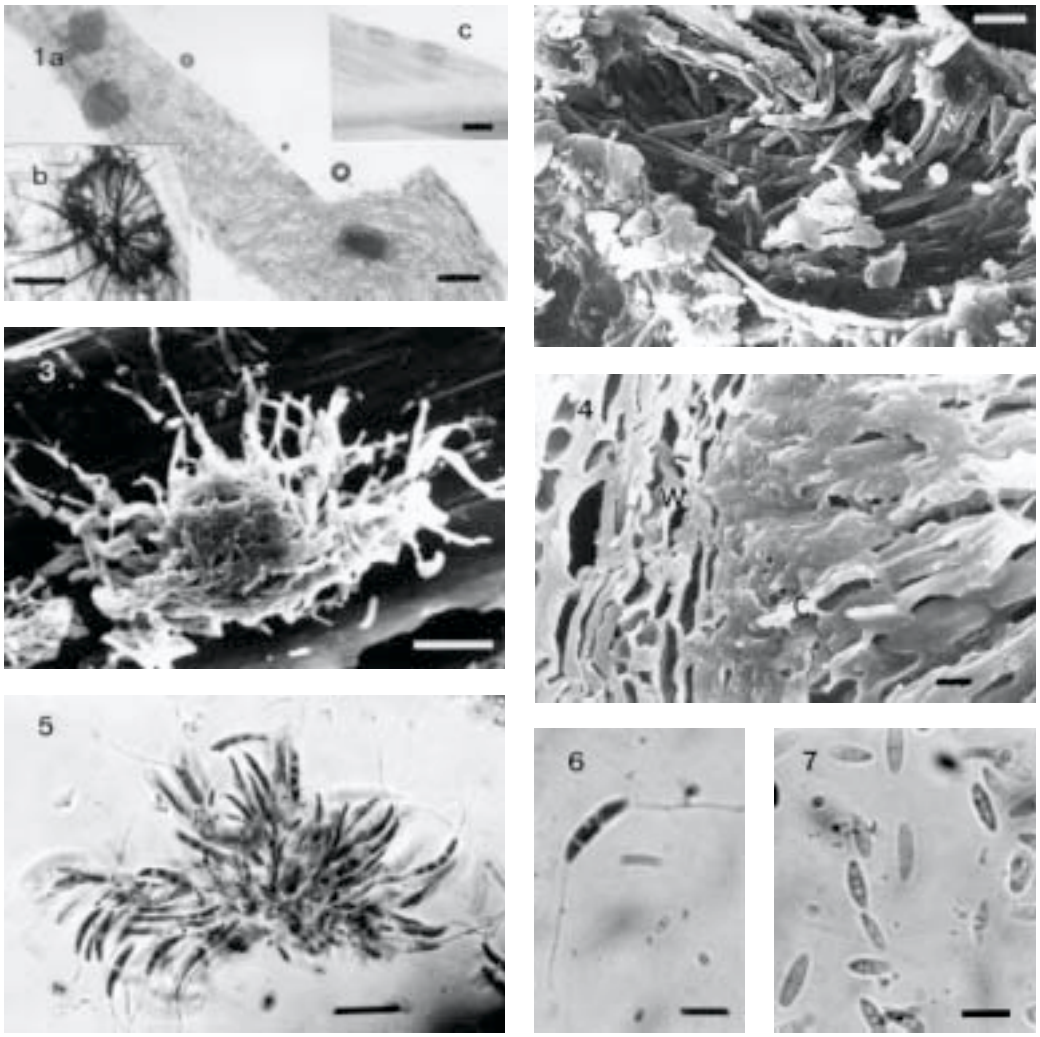
Isolation and identification

Infected parts from specimens of field-collected material were surface-sterilized with 1–2% NaOCl for five minutes, rinsed with sterile distilled water and plated out on half-strength potato dextrose agar (Oxoid) using standard procedures. Fungal growths were transferred as necessary to obtain pure cultures.

For light microscopy, materials were mounted in lactophenol-cotton blue. For scanning electron microscopy, air-dried material was sputter-coated with gold and examined with a Jeol JSM35CF.

Results

Zinzipegasa argentinensis Infected material or parts had grey-brown culms and foliage. Flowering stalks were infected inside the sheaths of older leaves. Those stalks which emerged had normal-looking seeds in the first whorl of spikelets in the panicle, but the distal spikelets were grey-white and lacked fully developed spikelets and seed. Plant culms contained immersed dark conidiomata (Figures 1a,c) with the opening to the surface surrounded by unbranched, often incurved dark setae (Figures 1b, 2). These conidiomata arose from dark septate hyphae which ramified inside the culms before aggregating to produce conidiomata (Figure 3) with simple conidiogenous cells on a basal pseudoparenchymatous



Figures 1–7. Fungi causing infections on serrated tussock (*Nassella trichotoma*) in Victoria.

Figures 1–6. *Zinzipegasa argentinensis*.
Figure 1. Hollow culm showing acervular, black, subepidermal, marginally setose appearance. a. Culm showing three conidiomata, bar=100 µm, b. superficial setae at entrance to conidioma, bar=50 µm, c. superficial appearance of conidomata on culm, bar=100 µm. Figure 2. Superficial appearance of incurved setae, bar=10 µm. Figure 3. Hyphae ramifying inside the culm and aggregating into a conidioma, bar=50 µm. Figure 4. Longitudinal section of conidioma, showing wall-like stroma (w) and conidia embedded in mucilage (c), bar=5 µm. Figure 5. Crushed hymenial region showing 1-, 2- and 4-celled conidia with appendages, bar=20 µm. Figure 6. Conidium showing 4 cells, basal and apical appendages, bar=10 µm.

Figure 7. *Fusarium* sp. Conidia, showing 1, 2 and 4 cells, bar=10 µm.

hymenium (Figures 4, 5). Conidia were 1–4-celled with single basal and apical unbranched appendages (Figures 5, 6). Isolates were initially white-pink and then developed dark-pigmented conidiomata with 1–4-celled conidia. The fungus was identified as *Z. argentinensis* (Nag Raj 1993). At the second site, this was on the same material as *Pleospora*-like ascomata containing bitunicate clavate asci with eight multicellular ascospores (Sivanesan 1984), but conidia and asci were not present simultaneously in the same fruiting body.

***Fusarium* sp.** The bases of infected culms had a white external layer of mycelium, microscopically like chains of chlamydospores. Surface-sterilized pieces of infected culm and well-washed pieces of the external white layer alone produced white velvety-fluffy fungal cultures with a pink-red-yellow reverse. These produced 1–4-celled conidia (Figure 7) on long slim phialides, characteristic of *Fusarium* sp.

Discussion

Despite no fungi being recorded on *N. trichotoma* in Australia before commencement of this study, the three Victorian fungi described here on serrated tussock have considerable potential for use in biocontrol of this weed. Ideally, fungi should kill individual tussocks, allow easy uprooting, destroy seeds and be sufficiently host-specific to avoid problems of attack on Australian *Stipa* species (now transferred to *Austrostipa* (Briese and Evans 1998)). *Z. argentinensis* attacks flowering culms and inflorescences, *Fusarium* sp. is associated with a crown rot which makes the culms easy to remove, and the 'smut' replaces the seed by spores. Thus together these fungi could potentially kill plants and control seed set, provided that they are sufficiently virulent and host-specific.

Zinzipegasa argentinensis has only been reported as causing small black spots on one other specimen, of '*Stipa caudata*' (*Achnatherum caudatum* (Trin.) S.W.J. Jacobs & J. Everett) from Bahia Blanca, Argentina (Nag Raj 1993). *A. caudatum* is one of the closest relatives of *N. trichotoma*, but since both species of *Achnatherum* in Australia are introduced and have the potential to become serious weeds (Briese and Evans 1998), their infection would not be considered a problem. *Z. argentinensis* has not been reported from any other species in Australia or Argentina, suggesting some degree of specificity and hence usefulness as a biological control agent. Its association with an ascomycetous fruiting body in the culms of dead tussocks suggests that both may be different stages of the same fungus, completing its life cycle in Australia.

Fusarium spp. cause crown rots in many grasses, with symptoms similar to those observed in serrated tussock. Such infections may kill plants, such as the blight found in California (Smith *et al.* 1989). Serrated tussock does not grow in wetter areas in Australia. This may be the result of such attacks, especially in areas where pasture grasses appear healthy. While many fusaria are not specific, there is evidence of some degree of specificity in this species which might allow its use as a biocontrol agent under conditions of prolonged high humidity where severe foliar blighting occurred only in suitable combinations of *Fusarium* genotype, plant genotype and air temperature (Smith *et al.* 1989).

None of these fungi was recorded on serrated tussock in Australia before this study; remarkably, there was no overlap in species with those found in Argentina. The question is – did they exist in Australia before serrated tussock, were they introduced with serrated tussock, or have they arrived recently? While the lack of previous reports might suggest their recent arrival, they may have been imported with the weed but not developed as serious, widespread pathogens because of lack of favourable conditions. *Z. argentinensis* was only found in areas which had not been sprayed with herbicides for some time, where plants had dead foliage with abundant fruiting bodies. It is possible that the regular use of burning and herbicides to control serrated tussock results in little inoculum being available to infect other plants, thus interrupting the disease cycle. Further work is needed to assess the specificity and virulence of these Australian fungi for use in biocontrol.

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