Natural enemies of the South American pampas grasses *Cortaderia* spp. in New Zealand

Stanley E. Bellgard[1], Christopher J. Winks[1], Daniel J. Than[1] and Clémence C. Aliaga[2]
[1] Landcare Research, Private Bag 92170, Auckland 1142, New Zealand
[2] Montpellier SupAgro, 2 Place Pierra Viala, 34060, Montpellier Cedex 1, France
Corresponding author: bellgards@landcareresearch.co.nz

Summary The South American pampas grasses *Cortaderia selloana* and *C. jubata* (Poaceae) are serious weeds in New Zealand, particularly in pine plantations and in indigenous plant communities, where it successfully invades bare ground (including cliffs). A national survey of pampas grasses in New Zealand was initiated in 2008 to identify any herbivores (and their associated predators and parasitoids) and fungal pathogens present. The survey revealed a wide range of native and introduced invertebrates associated with pampas in New Zealand but no specialised pampas-feeding invertebrates were found. The most obvious foliage damage was caused by the larvae of the native flax notcher moth, *Tmetolophota steropastis*. Plant pathogens found included a range of previously recorded, generalist grass pathogens. Assessment will be made of the biological control potential for the insects and pathogens recovered from pampas.

Keywords Pampas grass, *Cortaderia selloana*, *Cortaderia jubata*, pathogen, herbivore, parasitoid, predator.

INTRODUCTION

Pampas grasses, *Cortaderia selloana* (Schult. & Schult.f.) Asch. & Graebn. and *C. jubata* (Lemoine) Stapf, are native to South America. *C. selloana* is native to Brazil, Argentina, Uruguay and Chile, while *C. jubata* is native to Argentina, Bolivia, Ecuador and Peru (McGregor 2000). Both have become serious invasive weeds in New Zealand. Both pampas grass species are large perennial tussock-forming grasses (Figure 1) – displacing our native toetoe species in coastal cliff, dune, wetland and turfland communities.

Much of the invasive potential of pampas grass arises from its ability to produce thousands to millions of wind-borne seeds per year over 10–15 years. Flowering can occur within the first year of growth but it usually takes around 2–3 years for the first flower heads to emerge. Pampas grass seeds are small and light and have long fine hairs that assist with long distance dispersal. Seed germination is fairly rapid, with no dormancy, and most seeds germinate within 3 weeks provided water and light are available (McGlone 2003).

The potential for biological control of pampas grass was reviewed by McGregor (2000). A variety of methods has been used around the world but many are labour-intensive, require ongoing surveillance to prevent reinvasion or are suitable only for specific situations. Biological control could offer some advantages over current control methods. Use of host-specific biological control agents would reduce chemical herbicide impacts on desirable flora. Biological control also offers continuous action and self-dispersal that current control methods do not offer. There have been no previous biological control programmes for pampas grass elsewhere in the world, but other countries may be interested in collaborating with New Zealand on such a programme.

As part of a proposed classical biological control programme, a survey of the invertebrate fauna and plant pathogens associated with pampas in New Zealand was undertaken. The main aims of the survey were to determine whether any specialist pampas invertebrate herbivores or fungi are already present in New Zealand, whether any generalist invertebrate herbivores or fungal pathogens are exerting significant adverse impact on pampas, and to record the invertebrate parasitoids and predators associated with the herbivorous invertebrates on pampas.

Figure 1. Large clump of pampas *C. selloana* in Waikanae township, North Island, New Zealand.

MATERIALS AND METHODS

Invertebrate fauna of pampas grass were surveyed at 66 sites between September 2008 and February 2010 (Figures 2 and 3). In total, 41 *C. selloana* sites and 25 *C. jubata* sites were surveyed. Site visitation was staggered across the sites, to ensure that visitation frequency covered both seasonal and spatial variation. To achieve this, all sites were visited at least once, with three locations surveyed on three separate occasions at different times of the year (see Bellgard *et al.* 2010 for sampling details).

At each site, 10 collection locations were selected. A collecting tray, 80 × 80 cm, was placed under suitable parts of selected plants, and the foliage above the tray was hit five times with a solid stick. Most invertebrates that fell onto the tray were collected with an aspirator and preserved in 95% alcohol. Caterpillars (Lepidoptera) and immature stages of other groups (e.g. Heteroptera) were collected live and placed, along with pampas grass foliage, in ventilated containers to rear through to adult for identification. Parasitoids emerging from the larvae were identified.

A rapid visual inspection (generally less than 1 min for each of the 10 collection locations at each site) was made of the foliage for signs of invertebrates such as gall-formers, leaf miners and scale insects. Invertebrates found during the visual inspections were collected live, along with the plant material they were on, for identification. At each site, a visual estimate was made of the amount of herbivore-related damage, and the likely cause of the damage was noted (e.g. adult beetles, leafroller caterpillars).

Micro-organisms associated with pampas grass were surveyed across 62 sites (Figures 2 and 3). At each site, 10 collection points were inspected closely for signs of pathogen damage (see Bellgard *et al.* 2010 for sampling details). Diseased plant parts were placed in paper bags kept cool in transit and then held in a 4°C coolstore until processing.

In the laboratory, disease symptoms were recorded and photographed. A dissecting microscope was used to search necrotic areas for fungal reproductive structures. Small pieces of tissue (*c.* 3 × 3 mm) were cut from the edge of diseased areas and surface-sterilised. Sterilisation was by immersion in 95% ethanol for 30 s followed by rinsing in two beakers of sterile water. The tissue fragments were blotted dry with sterile filter paper and placed on potato dextrose agar (Difco Labs, Detroit, MI, USA) with 0.02% streptomycin (Sigma, St Louis, MI, USA), contained in 9 cm Petri dishes. Plates were incubated under near-ultraviolet and white light (12 h photoperiod) at temperatures of 22 ± 2°C (day) and 18 ± 2°C (night).

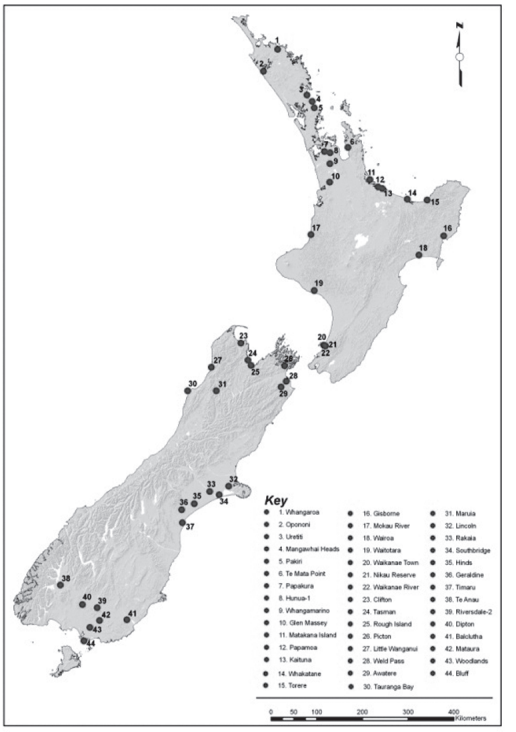

Figure 2. Survey sites for *C. selloana*.

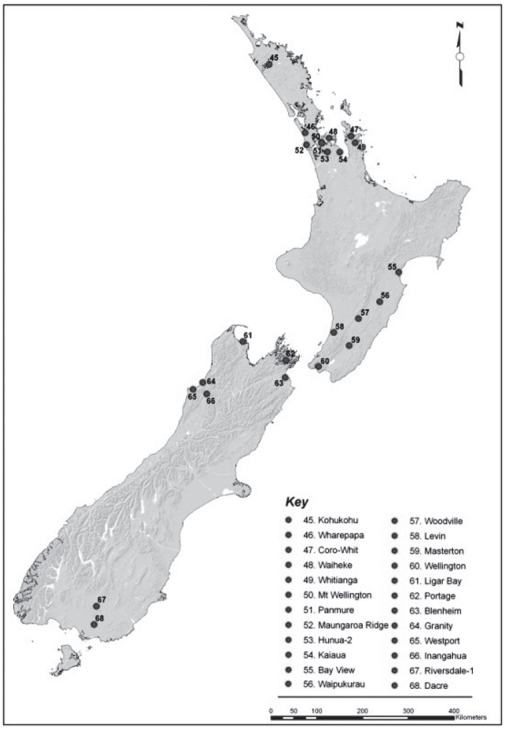

Figure 3. Survey sites for *C. jubata.*

ITS ribosomal gene sequences were generated for fungi, using a standard PCR protocol with the fungal-specific primers ITS1F and ITS4 (Gardes and Bruns 1993). Sequences obtained were subjected to a GenBank BLASTn search to determine the closest sequence-based match. Species identifications were confirmed using spore or cultural morphology where possible.

RESULTS AND DISCUSSION

Invertebrate herbivores A total of 79 herbivorous invertebrate species was recorded from the two pampas species during this survey and a further six groups of taxonomically related herbivorous species were recorded. A wide range of native and introduced invertebrates are associated with pampas grass, but no specialised pampas-feeding invertebrates were found during this survey and foliage damage caused by invertebrate herbivory was considered to be minimal. It was rare to find a leaf that was more than 10% consumed and the overall amount of foliage that appeared to have been consumed or damaged by herbivores was estimated to be less than 1%.

The native flax notcher (*Tmetolophota steropastis* Meyrick), appears to be the most damaging invertebrate. The most obvious damage found was long notches chewed into the edges of the leaf blades, which are characteristic of flax notcher damage.

Slaters (Order Isopoda) were common at some sites, and may have caused some damage to living tissue, but are likely to have been feeding mostly on dead and decaying material. The sap-feeding passionvine hopper, *Solypopa australis* Walker, was also common at some sites, but the damage caused by transient sap-feeders is difficult to quantify.

The combined effect of generalist predators found to be associated with pampas grass, such as spiders, earwigs, ants and praying mantids, could inhibit the effectiveness of some potential invertebrate biocontrol agents for pampas. A number of moth larvae, collected to rear through to adult for identification, died during rearing, and parasitoids emerged from some of them. These parasitoids could particularly affect some potential lepidopteran biocontrol agents.

Fungal species A range of disease levels, from minimal to mild necroses, was observed on plants sampled across all sites. In the main, foliar necroses were the principal symptoms – associated with spotting or longitudinal-linear lesions occurring variously on the leaf surface. Laminar, mid-vein and marginal lesions were all observed (Figures 4a and 4b).

In total, 62 fungal species were identified, based upon cultural morphology and diagnostic spore characters and confirmed by ITS sequencing. Of these, 33 are considered primary plant pathogens. The pathogens are a mix of grass- and crop-pathogens (Table 1). Some have been known to cause a range of serious stem cankers and foliar blights on their target-host(s) – many of which are not grasses.

The most frequently isolated grass-pathogen was *Nigrospora oryzae* – a seed-borne fungus causing minute leaf and grain spot in rice (Mew and Gonzales 2002). *Leptosphaerulina chartarum,* a common pathogen from grassland vegetation (Caretta *et al*. 1999), was also recovered. A new species of *Pyricularia* sp. *nov*. was collected from the Pakiri site associated with a leaf blight. Other significant non-grass pathogens include *Neofusicoccum australe* – recently identified as the cause of grapevine dieback in New Zealand (Amponash *et al*. 2009).

Of the secondary pathogens *Epicoccum nigrum* and *Microdochium phragmitis* were by far the most ubiquitous in distribution. The most commonly recovered endophyte belonged to the mitosporic, *Dothideomycete* species group. These endophytes have been found to produce important secondary plant metabolites (Chomcheon *et al*. 2009), potentially associated with plant defence mechanisms.

Future research will involve host-testing to confirm pathogenicity, as well as a comparative analysis of the suite of endophytes that occur here in NZ pampas specimens to that of pampas specimens from the host's native range, e.g. Brazil.

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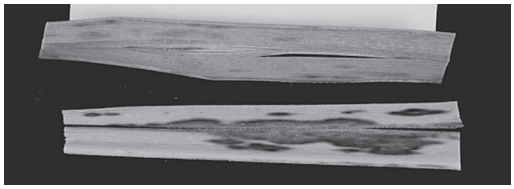

Figure 4a. Longitudinal, mid-vein lesions.

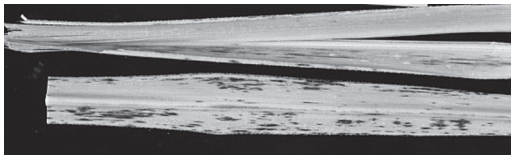

Figure 4b. Discrete spots and linear lesions.

Table 1. Fungi associated with damage to pampas in New Zealand during 2008/09.

Fungi	No. of sites	Plant part affected/disorder
Plant pathogen		
Alternaria alternata (Fr.) Keissl.	5	Laminar, head blight
Arthrinium sacchari (Speg.)	1	Head blight
Ascochyta pinodes L.K.Jones	1	Leaf spot
Atradidymella muscivora gen. *et* sp. *nov.*	1	Laminar
Aureobasidium Viola and Boyer (2 spp.)	7	Laminar
Claviceps sp. Frederickson, Mantle & de Milliano	1	Floret, ergot
Leptosphaeria coniothyrium (Fuckel) Sacc.	1	Leaf margin
Epicoccum nigrum Link.	25	Laminar
Fusarium Link. (3 spp.)	6	Laminar, head blight
Leptosphaerulina chartarum Cec. Roux	3	Leaf scold / blight
Magnoporthe grisea (T.T.Hebert) M.E.Barr	2	Laminar, seed rot
Neofusicoccum australe Slippers, Crous, & M.J.Wingf.	1	Laminar
Nigrospora Zimm. (2 spp.)	24	Laminar
Paraphaeosphaeria michotii Shoemaker (5 spp.)	7	Laminar
Phoma Desm. (6 spp.)	12	Laminar, endophyte
Pyrenophora semeniperda (Brittleb. & D.B.Adam) Shoemaker	3	Laminar
Stemphylium Wallr. (5 spp.)	5	Laminar
Stagonospora Sacc. sp.	10	Leaf base
Secondary pathogen / saprobe / necrotroph		
Bipolaris Schoemaker sp.	1	Laminar, head mould
Cladosporium Link. (3 spp.)	3	Laminar, head mould
Davidiella macropsora (Kleb.) Crous & U.Braun	4	Laminar
Dothideomycete spp.	35	Endophyte
Epicoccum nigrum Link.	25	Laminar, head blight
Lewia infectoria (Fuckel) M.E.Barr & E.G.Simmons	5	On dead tissue
Microdochium phragmitis Syd.	33	Saprobe
Pestalotiopsis de Not. (5 spp.)	7	Saprobe, endophyte

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REFERENCES

Amponash, N.T., Jones, E.E., Ridgway, H.J. and Jaspers, M.V. (2009). First report of *Neofusicoccum austral*, a cause of grapevine dieback in New Zealand. *Australasian Plant Disease Notes* 4, 6-8.

Bellgard, S.E., Winks, C.J., Than, D.J., Smith, L.A. and Toft, R.J. (2010). Invertebrates and pathogenic micro-organisms associated with pampas grass *Cortaderia selloana* and *C. jubata* (Poaceae), in New Zealand. Landcare Research Contract Report for the National Biocontrol Collective, July 2010. Landcare Research, Auckland, New Zealand.

Caretta, G., Piontelli, E., Picco, A.M. and Del Frate, G. (1999). Some filamentous fungi on grassland vegetation from Kenya. *Mycopathologia* 145, 155-69.

Chomcheon, P., Wiyakrutta, S., Sriubolmas, N., Ngamrojanavanich, N., Mahidol, C., Ruchirawat, S. and Kittakoop, P. (2009). Metabolites from the endophytic mitosporic Dothideomycete sp. LRUB20. *Phytochemistry* 70, 121-7.

Gardes, M. and Bruns, T.D. (1993). ITS primers with advanced specificity for basidiomycetes. *Molecular Ecology Notes* 2, 113-8.

McGlone, H.M. (2003). Quantifying the threat that pampas (*C. selloana* and *C. jubata*) poses to the Waikato Region. Master's thesis, University of Waikato, Hamilton, New Zealand.

McGregor, P.G. (2000). Prospects for biological control of pampas grass (*Cortaderia* spp.) (Poaceae). Landcare Research Contract Report LC9900/138. Landcare Research, Auckland, New Zealand.

Mew, T.W. and Gonzales, P. (2002). 'A handbook of rice seed-borne fungi.' (International Rice Research Institute Science Publishers).