Does a toxic fungal endophyte of tall fescue affect reproduction of takahe on offshore islands?

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Does a toxic fungal endophyte of tall fescue affect reproduction of takahe on offshore islands?

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ABSTRACT

Tall fescue (*Schedonorus phoenix*) is a cultivated grass that in New Zealand is often infected with a fungal endophyte known to be toxic to livestock and other wildlife including birds. We determined whether tall fescue was present on two offshore islands (Maud and Tiritiri Matangi) where endangered takahe (*Porphyrio hochstetteri*) have been introduced and are known to suffer from high rates of egg infertility and poor hatching success. Despite extensive surveys, tall fescue was not observed on either island. Takahe on these islands fed almost exclusively on introduced grasses, particularly cocksfoot (*Dactylis glomerata*) and Yorkshire fog (*Holcus lanatus*), but none of these grasses are know to have toxic endophytes associated with them. Hence other factors must be responsible for the low reproductive success of takahe on islands. However, tall fescue is widespread throughout mainland New Zealand and establishment on offshore islands in the future means managers need to monitor its presence.

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1. Introduction

Takahe (*Porphyrio hochstetteri*) that have been translocated to highly modified island refuges are generally healthy and have higher survival rates than those from the only remaining natural population in Fiordland. Yet island pairs have higher egg failure and produce fewer chicks per egg than Fiordland pairs (Bunin *et al.* 1997; Jamieson & Ryan 2000). The majority of egg failures result from high egg infertility (64%); fertile eggs failing to hatch (24%) are the second most prominent cause of failure. This pattern of poor reproductive success has been evident since the initial founding birds first started breeding on islands in 1986 and, if anything, has become slightly worse in recent years (1995–97) (Jamieson & Ryan 1999). Therefore there is no evidence that island birds are adapting or overcoming this problem, at least not in the short term. Chemical residues left over from previous farm operations have been ruled out as a possible cause of the poor reproductive success (Jamieson & Ryan 1999), but naturally occurring toxins in introduced pasture grasses have not.

Toxins are often produced by fungal endophytes of many cultivated and wild grasses. The fungus obtains nutrients from the host plant, while the plant receives benefits that include protection from consumers, increased growth and survival, and increased competitive ability (Cheplick & Clay 1988). One grass species in the United States that is commonly infected with a fungal endophyte is tall fescue (*Schedonorus phoenix*). Infected tall fescue is known to decrease food intake and decrease weight gain in cattle (Hoveland *et al.* 1983) and decrease rates of development, growth and survival of insects (Cheplick & Clay 1988). In birds, infected fescue seeds have been shown to cause weight loss in several species of passerine, which also preferred non-infected seeds in choice trials (Madej & Clay 1991). Japanese quail (*Coturnix japonica*) fed a diet of 45% infected fescue showed a 10% reduction in male fertility (Zavos *et al.* 1993), although a second study on zebra finch (*Taeniopygia guttata*) showed no such effect (Conover & Messmer 1996). Some areas in the United States have had fields of tall fescue converted to native grasses to improve wildlife habitat, especially for birds (Washburn *et al.* 2000).

Tall fescue is a common component of pasture grasslands and grass-covered wasteland in New Zealand. This introduced grass species is often infected with an endophytic fungus *Neotyphodium coenophialum,* making the sward toxic to livestock (Christensen *et al.* 1998), with well-characterised ergopeptine alkaloids shown to be present in the foliage. Tall fescue infected with fungus is abundant in the takahe enclosures at Mount Bruce (S. Easton, pers. obs.), where egg infertility rates have historically been extremely high (D. Eason, pers. comm.). Because tall fescue is now widespread in New Zealand, it is possible that it and its fungal endophyte also occur on offshore islands where it could be consumed by takahe. Although tall fescue was not listed as one of the main food species for island takahe in two different studies (Trewick 1996; Jamieson & Ryan 1999), it was not specifically searched for. Our study aimed to survey Maud and Tiritiri Matangi Islands, sites where takahe are known to suffer from high rates of egg infertility (I. Jamieson, unpubl. data), to determine whether tall fescue is present, and if so, to which extent takahe feed on infected plants relative to other available food species.

2. Methods

Surveys were carried out on Maud Island located in the Marlborough Sounds and on Tiritiri Matangi Island in the Hauraki Gulf, with the co-operation of Department of Conservation staff. Surveys were conducted by traversing the islands using the system of well established tracks, which are frequented by takahe, and by visiting all takahe breeding territories on the islands and looking for feeding sign (which takes the form of a pile of cut grass stems). On occasion, we also observed takahe feeding directly. Samples of all food species were collected and brought back to AgResearch's Grassland Research Centre in Palmerston North, where they were identified.

3. Results and Discussion

The surveys were carried out on Maud Island on 23–24 November and on Tiritiri on 25–26 November 1999. No tall fescue was found on either island. Seven territories were checked on Maud Island. Cocksfoot (*Dactylis glomerata*) and Yorkshire fog (*Holcus lanatus*) were the grass species that had been predominantly eaten. These were the dominant species in the areas where takahe were observed), however sweet vernal (*Anthoxanthum odoratum*), sow thistle (puha, *Sonchus oleraceus*) and phalaris (*Phalaris aquatica*) were also taken less frequently (Table 1). There was some fine fescue (*Festuca rubra*) in the pastures on Maud, but no tall fescue was seen.

Four territories were checked on Tiritiri, on three of which takahe were directly observed feeding. The prominent grasses that were eaten were

TABLE 1. GRASSES FOUND IN FEEDING SIGN OR DIRECTLY SEEN BEING EATEN BY TAKAHE ON MAUD AND TIRITIRI MATANGI ISLANDS.

Site/Location (grid ref.)	Feeding sign	Observed feeding
Maud I.		
Woodlands (28–29)	cocksfoot (x4), Yorkshire fog (x2), sweet vernal (x1)	–
Te Pakeka Pt. (65)	cocksfoot (x7), Yorkshire fog (x3)	–
Southwood (68, 78, 83)	phalaris (x5), Yorkshire fog (x2), cocksfoot (x1)	–
Radio Tower (72)	Yorkshire fog (x6), cocksfoot (x1), phalaris (x1)	–
Top House (43)	cocksfoot (x4), Yorkshire fog (x4)	–
Fort Road (15)	cocksfoot (x3), Yorkshire fog (x1), sow thistle (x1)	–
Peninsula (91–92)	cocksfoot (x4), Yorkshire fog (x1)	–
Tiritiri Matangi I.		
Lighthouse (56)	cocksfoot (x3), Yorkshire fog (x3)	cocksfoot, Yorkshire fog, bromus seed Kentucky bluegrass seed
Ridge Track (38)	cocksfoot (x5), Yorkshire fog (x4)	–
Landing (54)	–	cocksfoot flower head, browntop
Toilet Cable Track (36)	–	cocksfoot, bromus seed, browntop

cocksfoot and Yorkshire fog, and birds were also seen stripping bromus (prairie grass, *Bromus willdenowii*) of their seeds (Table 1). Seeds from Kentucky bluegrass (*Poa pratensis*) were also seen being eaten along with flower heads of cocksfoot and browntop (*Agrostis capillaris*). Perennial ryegrass (*Lolium perenne*) was seen near the tracks. This species is commonly infected with an endophyte related to that of tall fescue, and may also be toxic. However, there was no sign of takahe feeding on it. Again, no tall fescue was seen.

We conclude that tall fescue is either absent or extremely rare on Maud and Tiritiri Matangi Island. Therefore the toxic fungal endophyte that is known to be associated with tall fescue is unlikely to be the cause of the high rates of egg infertility in island takahe. Deficiencies in essential dietary nutrients have also being investigated, but preliminary results do not indicate any abnormal levels (Jamieson & Ryan 1999; I. Jamieson, unpubl. data). However, the reproductive patterns we see in takahe are consistent with the hypothesis of environmentally dependent inbreeding depression. Low egg fertility and low hatching and fledging success observed in island takahe may indicate inbreeding depression, resulting from transferring inbred birds adapted to the alpine habitat of Fiordland to the highly modified environment of these lowland offshore islands (see Jamieson & Ryan 2000).

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5. References

Bunin, J.S.; Jamieson, I.G.; Eason, D. 1997: Low reproductive success of the endangered Takahe *Porphyrio mantelli* on offshore islands refuges in New Zealand. *Ibis 139*: 144–151.

Cheplick G.P.; Clay, K. 1988: Acquired chemical defences in grasses: the role of fungal endophytes. *Oikos 52*: 309–318.

Christensen, M.J.; Easton, H. S.; Simpson, W.R.; Tapper, B.A. 1998: Occurrence of the fungal endophyte *Neotyphodium coenophialium* in leaf blades of tall fescue and implications for stock health. *NZ Journal of Agricultural Research 41*: 595–602.

Conover, M.R.; Messmer, T.A. 1996: Consequences for captive Zebra Finches of consuming tall fescue seeds infected with the endophytic fungus *Acremonium coenophialum*. *Auk 113*: 492–495.

Hoveland, C.S.; Schmidt, S. P.; King Jr., C. C.; Odom, J. W.; Clark, E. M.; McGuire, J. A.; Smith, L. A.; Grimes, H. W.; Holliman, J. L. 1983: Steer performance and association of *Acremonium coenophialum* fungal endophyte on tall fescue pasture. *Agronomy Journal 75*: 821–824.

Jamieson, I.G.; Ryan, C.J. 2000: Increased egg infertility associated with translocating inbred takahe to island refuges in New Zealand. *Biological Conservation 94*: 107–114.

Jamieson, I.G.; Ryan, C.J. 1999: Causes of low reproductive success of translocated Takahe (*Porphyrio mantelli*) on predator-free islands. *Science for Conservation 125*. Department of Conservation, Wellington.

Madej, C.W.; Clay, K. 1991: Avian seed preference and weight loss experiments: the effect of fungal endophyte-infected tall fescue seeds. *Oecologia 88*: 296–302.

Trewick, S.A. 1996: The diet of Kakapo (*Strigops habroptilus*), Takahe *(Porphyrio mantelli)* and Pukeko (*P. porphyrio melanotus*) studied by faecal analysis. *Notornis 43*: 79–84.

Washburn, B.E.; Barnes, T.G.; Sole, J. D. 2000: Improving northern bobwhite habitat by converting tall fescue fields to native warm-season grasses. *Wildlife Society Bulletin 28*: 97–104.

Zavos, P.M.; Cantor, A. H.; Hemken, R. W.; Grove, R. J.; Varney, D. R.; Siegel, M. R. 1993: Reproductive performance of Japanese quail fed tall fescue seed infected with *Acremonium coenophialum*. *Theriogenology 39*: 1257–1266.