New Zealand conservation strategies address fauna, flora, and fungi

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Abstract. The New Zealand Government's Department of Conservation facilitates assessment of the threat status of all species of New Zealand's fauna, flora, and fungi on a regular basis. Fungi have been included in these assessments since 2002, and this has stimulated renewed research and awareness of fungal conservation. Assessment has centred mainly on macrofungi and obligate species on threatened plants. Currently, 49 fungal species are listed in the highest threat category (Nationally Critical), 16 species in lower threat categories, and about 1440 species as Data Deficient. In a complementary initiative, the Department is prioritising long-term recovery plans of all species of New Zealand's threatened taxa that are in decline through evaluation of methodology, feasibility, and cost. This work includes the fungi. To support this work, recent studies have applied molecular techniques to seek new records of Data Deficient fungal species to more accurately define their threat status.

Key words: Australasia, data deficient, nationally critical, threatened fungi, prioritisation

New Zealand's geological history and impact on conservation of biodiversity

New Zealand is the most isolated temperate land mass in the world, and was the last large habitable land mass (270,000 km², comparable to Japan, UK) to be colonized by humans (Walrond 2009). New Zealand's biota is distinctive and shows high levels of endemism because of its geographic isolation from Gondwana for the past 80 million years, and successive turbulent geological events including fragmentation into small islands, volcanism, and tectonic plate movements (Johnston 2006). While its biota shows some remnants from Gondwana, much of the indigenous biota has apparently originated by trans-oceanic dispersal (Johnston 2010). Rapid changes and loss of indigenous biodiversity, especially in lowland ecosystems, followed human colonisation beginning with the arrival of Polynesians about 700 years ago, and Europeans about 200 years ago. Humans also introduced many animals, fungi and plants to New Zealand that have exacerbated change to native biota. Today, about 44 % of New Zealand is covered by native vegetation and 32 % of total land area is legally protected for conservation (Anonymous 2007).

The New Zealand Government's Biodiversity Strategy (http://www.biodiversity.govt.nz/picture/doing/nzbs/) aims to halt further decline in indigenous biodiversity, defined as "plants, animals, fungi, and microorganisms". To provide base data on declines to support this strategy, the Department of Conservation (DOC) administers a formal system to assess at

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regular intervals the threat status of all species in New Zealand's biota. Criteria used for threat assessments are similar to those used by IUCN but have been developed specifically for New Zealand to address the country's small size, the rapid impact on biodiversity from human colonisation, and the many taxa with small population size and restricted range (Molloy *et al.* 2002; since modified by Townsend *et al.* 2008). Earlier assessments using different criteria had focused on threatened birds, reptiles, larger invertebrates, and plants, but the Molloy *et al.* (2002) system was designed to include all taxonomic groups, including fungi. All biodiversity is protected within reserve land, such as that administered by DOC, but no species of fungi are specified in law for protection. New Zealand has yet to designate any protected areas specifically for fungi.

History of fungal conservation in New Zealand

The recent checklist of New Zealand's fungi records about 7,400 species (Pennycook & Galloway 2004), just over one-third of an expected total of 22,000 species of fungi (Buchanan *et al.* 2004). About two-thirds of recorded species are indigenous, and of these about half are assessed as endemic (Johnston 2006).

Threat status of New Zealand's non-lichenised fungi was first assessed in 2002 (Buchanan *et al.* 2002), concentrating on macrofungi and obligate species on threatened plants, with the first inclusion that year of fungi in assessments of threatened species (Hitchmough 2002). As detailed by Buchanan & May (2003), 49 species of fungi were formally listed in the highest threat category (Nationally Critical) and 16 species in other threatened categories. Assessments against defined criteria (Molloy *et al.* 2002) were based on field collecting experience by mycologist panel members and on literature and specimen records of each species – data from the national collections New Zealand Fungal and Plant Disease Herbarium (PDD) and Culture Collection ICMP (http://nzfungi.LandcareResearch.co.nz). The threat lists for all taxa undergo revisions of status every three to four years, and a review is currently in progress for non-lichenised fungi. A first assessment of threat status of New Zealand's lichenised fungi is in preparation for publication.

The years since the first assessment in 2002 have seen renewed awareness and attention to research and recording of threatened fungi, providing new knowledge and increasingly more accurate recognition of threat status. Especially at annual national fungal forays (www.funnz.org.nz) regions containing rarely recorded species have been re-surveyed, and particular attention paid to detection and care of infrequently collected species. As a result the next assessment will see some Nationally Critical species recognized as more common than earlier assessed and hence removed from this status level, while others will be added. Listing is therefore dynamic, reflecting an ever-developing understanding of New Zealand's fungi and a continuing refinement of priorities. New Zealand mycologists are also members of the Conservation Special Interest Group of the Australasian Mycological Society.

Among recent research initiatives, *Hypocreopsis amplectens* May & Johnston has been described as a new species, previously recognized as threatened in Australia (as *Hypocreopsis* sp. 'Nyora') and newly recorded for New Zealand (Johnston *et al.* 2007). Fungal conservation has been included in New Zealand's on-line encyclopedia (http://www.teara.govt.nz/en/fungi/2/2), in an education resource for schools (http://www.sciencelearn.org.nz/contexts/hidden_taonga/looking_closer/conserving_new_zealand_s_fungi), and in the introductory volume of Fungi of New Zealand (Buchanan *et al.* 2004). All Nationally Critical species have been annotated with supplementary information and illustrations for the New Zealand Plant Conservation Network website (http://www.nzpcn.org.nz/flora_details.asp?ID=6586).

Detection of Data Deficient species

Reflecting the scarcity of specimen and culture data for many species of New Zealand fungi, over 1440 rarely recorded fungal species were designated as Data Deficient (DD) (Hitchmough 2002). These poorly known species represent those with fewer than four collections in Herbarium PDD and with an inadequate knowledge of distribution; they also include about 200 species with New Zealand type specimens but with no specimens held in PDD. Those species first described from overseas and later recorded from New Zealand, but not supported by specimens in PDD, have not been assessed for threat status.

In work funded by the Department of Conservation, recent molecular studies have assisted reassessment of the status of some of the 213 ectomycorrhizal DD species. Ecological studies of the fungal partner(s) of mycorrhizal roots have been linked to data derived from specimens of DD species (Johnston *et al.* 2009). Matches were assessed between characteristic t-RFLP peaks from field-collected mycorrhizal roots and those generated from authenticated (mostly type) specimens of the DD mycorrhizal species. This study recommended that several DD species be removed to a not-threatened category because of frequent matches with ecological samples (Johnston *et al.* 2009).

Species prioritisation

Where are fungi positioned with regard to New Zealand's current expenditure on conservation? Priorities have traditionally been allocated to conservation of New Zealand's many threatened and iconic birds, to the exclusion of several other groups including fungi. DOC has recently embarked on a multi-year appraisal of long-term recovery strategies for prioritising all species in decline, modeled on methodologies discussed by Joseph *et al.* (2008, 2009). Prioritisation of resources is essential to maximise the conservation benefit of

allocated funds. Species are evaluated in a standard process using a suite of methods considered relevant to their recovery, including estimates of the difference management would make to the recovery of the species, and the likelihood of success and cost of management actions to achieve long-term persistence. The aim is to provide a cost/benefit ranking of recovery effort for all of New Zealand's threatened species of fauna, flora, and fungi which are in decline.

This exercise for fungi involved developing management actions to achieve long-term survival appropriate to each species' ecology, host relationships, and life cycle, such as: environmental management to protect host plants from herbivory, designation of appropriate areas of forest or other habitat, inoculating new sites or (for obligate pathogens of threatened plants) translocation of infected plants, assessing appropriate frequency of monitoring, and monitoring fungal populations by molecular probes in addition to visual surveys. Estimates of likelihood of success were also provided at each step. The resultant rankings for threatened fungi amongst species from other groups will be available at the end of 2010.

Conclusion

New Zealand mycologists take a pragmatic approach to fungal conservation, favouring integration of fungi in conservation initiatives spanning all taxonomic groups. We accept that designation of a species' threat status is dynamic and may change with advances in knowledge and technology. New molecular techniques offer advances in detection of cryptic taxa, and allow integration of conservation, taxonomic, and ecological studies. Awareness of the importance of fungal conservation strengthens values placed on relevant ecosystems, and will lead to meaningful strategies to achieve long-term survival of threatened fungi.

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