Chapter 1. Thesis introduction and rationale

Interrelationships between mammals, mycorrhizal fungi and plants: the ecological importance of mycophagy

MYCORRHIZAS

Fungal interactions shape ecosystems. Most plants in natural ecosystems form mycorrhizal associations (mycorrhizas) with specialised soil fungi (Brundrett 1991; Smith and Read 1997). Mycorrhizas are highly-evolved mutualistic symbioses usually benefiting both plant and fungus (Brundrett 2004) and contributing to ecosystem function (Read 1991; Amaranthus and Perry 1994). Hyphae of mycorrhizal fungi are the primary interface between the soil and the roots of mycorrhizal plants, facilitating uptake of water and nutrients by the plant (Harley 1971; Smith and Read 1997). In return, the fungus acquires photosynthates (carbon) from the plant (Harley 1971; Smith and Read 1997). Mycorrhizal fungi play an important role in soil carbon fluxes (Treseder and Allen 2000; Hobbie 2006; Talbot *et al.* 2008; Wilson *et al.* 2009) and mediate interactions and transfer nutrients between individual plants, linking plant communities in extensive shared mycorrhizal networks (Simard and Durall 2004; Beiler *et al.* 2010).

The type and ecology of mycorrhizal associations is determined by host plant, fungus, and soil and other environmental factors (Brundrett 1991). Mycorrhizal fungal ecology is an emerging field; the ecological roles and functions of many mycorrhizal fungi are poorly known (Lilleskov and Bruns 2001; Lilleskov and Parrent 2007). Ectomycorrhizas (EM) and arbuscular mycorrhizas (AM) are the two most common mycorrhizal types. EM, formed by species of Basidiomycota, Ascomycota, and *Endogone* (Zygomycota), develop extensive hyphal systems outside of the host plant root, form sheaths around the root, and do not usually penetrate the host plant cells, while AM penetrate host cells and are formed by species in the

Glomeromycota (Brundrett 1991). More than 80% of vascular plants form mycorrhizas, but only 2% form EM (Brundrett 2009). However, EM plants, such as those in the Pinaceae, Fagaceae, Myrtaceae, and Betulaceae families, dominate forest ecosystems in mesic temperate and boreal landscapes (Read 1991; Allen *et al.* 1995). Globally, approximately 7750 species of EM fungi are known to science but conservative estimates put the potential global number of species around three times that amount (Rinaldi *et al.* 2008); most EM ecosystems remain under-sampled (Dickie and Moyersoen 2008). EM fungi, far more diverse than EM plants, tend to have widespread distributions and intermediate to broad host ranges (Molina *et al.* 1992; May and Simpson 1997; May 2002; Jumpponen *et al.* 2004). For example, EM fungi that form mycorrhizas with *Eucalpytus* associate with a variety of species within the genus as well as with other woody trees, shrubs and non-woody herbs (Chilvers 1973; Warcup 1980; Malajczuk *et al.* 1982).

TRUFFLE-LIKE FUNGI

Mycorrhizal macrofungi predominantly form EM associations and produce fleshy fruiting bodies (sporocarps), above (epigeous, mushroom-like) or below (hypogeous, sequestrate, truffle-like) the ground surface. Truffle-like fungi are particularly poorly known both taxonomically and ecologically, owing to their ephemeral, below-ground fruiting habit and the need to examine sporocarps for identification, although recent developments in the identification of fungi from vegetative material (mycelium or EM root tips) using molecular techniques are advancing the study of these and other sporocarpic EM fungi (Buscot *et al.* 2000; Horton and Bruns 2001; Anderson and Cairney 2007; Peay *et al.* 2008). In Australia, a centre for truffle-like fungi diversity and endemism (Lebel and Castellano 1999; Bougher and Lebel 2001), truffle-like fungi diversity is likely to be higher than epigeous macrofungal diversity (Bougher 1995) and is estimated at 1278-2450 species, of which only 12-23% have been described (Bougher and Lebel 2001). This thesis looks primarily at the truffle-like EM fungi on account of their importance in plant mycorrhizal networks, the prevalence of sporocarps of these fungi in the diet of many ground-dwelling mammals, and their reliance upon these mammals for spore dispersal. Truffle-like fungi are part of a complex, co-evolved, system of symbioses and interactions with plants, soils, and animals (Read 1997; Bougher and Lebel 2001; Brundrett 2002).

MAMMAL MYCOPHAGISTS: FUNGUS-FEEDERS AND SPORE DISPERSAL AGENTS

Macrofungal sporocarps are a food resource for many animals, including birds (Simpson 1998; Medway 2000; Simpson 2000), reptiles (Hailey *et al.* 1997; Vernes and Cooper in press), invertebrates, (Lilleskov and Bruns 2005; Houston and Bougher 2010) and mammals (Fogel and Trappe 1978; Claridge and May 1994). Mycophagy (fungus-feeding) is widespread among forest-dwelling mammals; sporocarps are recorded in the diet of marsupials, rodents, cervids, and primates in temperate, tropical, and boreal landscapes around the world (e.g. Fogel and Trappe 1978; Genard *et al.* 1988; Blaschke and Baeumler 1989; Cazares and Trappe 1994; Claridge and May 1994; Claridge *et al.* 1996; Mangan and Adler 2000; Porter 2001; Bertolino *et al.* 2004; Hanya 2004; Vernes 2007; Hilário and Ferrari 2010).

Mycophagous animals facilitate the dispersal of macrofungal spores because the spores of consumed sporocarps remain viable after gut-passage and are deposited in the faeces some distance from the point of consumption (Trappe and Maser 1977; Maser *et al.* 1978). This process is particularly important to truffle-like fungi because their below-ground fruiting habit and enclosed spore-bearing tissues limit abiotic dispersal mechanisms such as wind and water (Fogel and Trappe 1978; Maser *et al.* 1978; Claridge and May 1994; Johnson 1996; Trappe and Claridge 2005). In some cases, passage of spores through the mammalian gut is necessary for, and may even enhance, spore viability (e.g. Lamont *et al.* 1985; Caldwell *et al.* 2005). Mammal mycophagists are crucial to the maintenance of diverse EM fungi and EM plant communities and to the spread of these organisms in new or regenerating habitats (Maser *et al.* 1978; Cazares and Trappe 1994; Terwilliger and Pastor 1999; Ashkannejhad and Horton 2005). The relationship between truffle-like fungi, their host plants and mycophagous fauna is complex, and integral to biodiversity and ecosystem function (Malajczuk *et al.* 1987).

In Australia, most ground-dwelling mammals are mycophagous to some extent (Claridge and May 1994). While mycophagy is often considered most prevalent among Australian mammals with a body weight of less than 3kg, particularly among the Muridae (rodents) and Potoroidae (rat-kangaroos, bettongs and potoroos) families, many other mammals consume fungi (Claridge and May 1994; Claridge *et al.* 1996; Vernes 2010). Levels of mycophagy occur along a spectrum from primarily mycophagous mammals (fungal specialists) to mammals consuming sporocarps as part of a broader diet (non-specialists) and are seasonally variable (Claridge *et al.* 1996). Some potoroids are fungal specialists, and important dispersers of fungal spores (Bennett and Baxter 1989; Claridge and May 1994; Tory *et al.* 1997). Rodents, bandicoots, pademelons, wallabies, possums, and small dasyurids also consume sporocarps, to varying degrees (Claridge *et al.* 1991; Claridge and May 1994; Reddell *et al.* 1997; Tory *et al.* 1997; Claridge and Lindenmayer 1998; McIlwee and Johnson 1998; Claridge *et al.* 2001; Vernes and Trappe 2007; Vernes and McGrath 2009; Vernes 2010; Vernes and Lebel in prep.) although the interactions of these animals with macrofungal sporocarp communities have been less well studied. The importance of sporocarps in the diet of non-specialist mycophagists, and other potentially overlooked mycophagists, and the importance of these mammals as spore dispersal agents, remains relatively poorly known.

Research themes

The interrelationships outlined above (and in Figure 1.1) underpin the two research themes upon which this thesis is based:

1. Is there a relationship between truffle-like sporocarp diversity in the soil and diversity in the diet of a mycophagous mammal?
2. Are non-specialist mycophagous mammals effective spore dispersers for truffle-like fungi?

These themes are important from biodiversity conservation, natural resource management, and agricultural production perspectives. Macrofungal diversity is poorly known in many parts of the world, including Australia, and yet fungi are essential components of natural ecosystems and are involved in many aspects of ecosystem functioning. Animals that consume macrofungi sporocarps can be important in maintaining diverse fungal communities, and have other important roles in ecosystems such as contributing to nutrient cycling and water infiltration through digging activity or as prey for predators. Paddock trees and other remnant vegetation are valuable in agricultural landscapes because they contribute to both production and conservation values. They provide shade and shelter for livestock, mitigate erosion, store carbon, and provide habitat and corridors for native vertebrate and invertebrate wildlife. Ectomycorrhizal macrofungi are vital symbionts with trees and other woody plants. In modified or fragmented landscapes, transfer of ectomycorrhizal macrofungal propagules between established communities and new plantings or remnant trees surrounded by non-ectomycorrhizal communities could be vital to the functioning and resilience of these plants. Mycophagous mammals resilient in modified landscapes may play a key role in maintaining transfer of ectomycorrhizal macrofungal propagules between mycorrhizal plant communities.

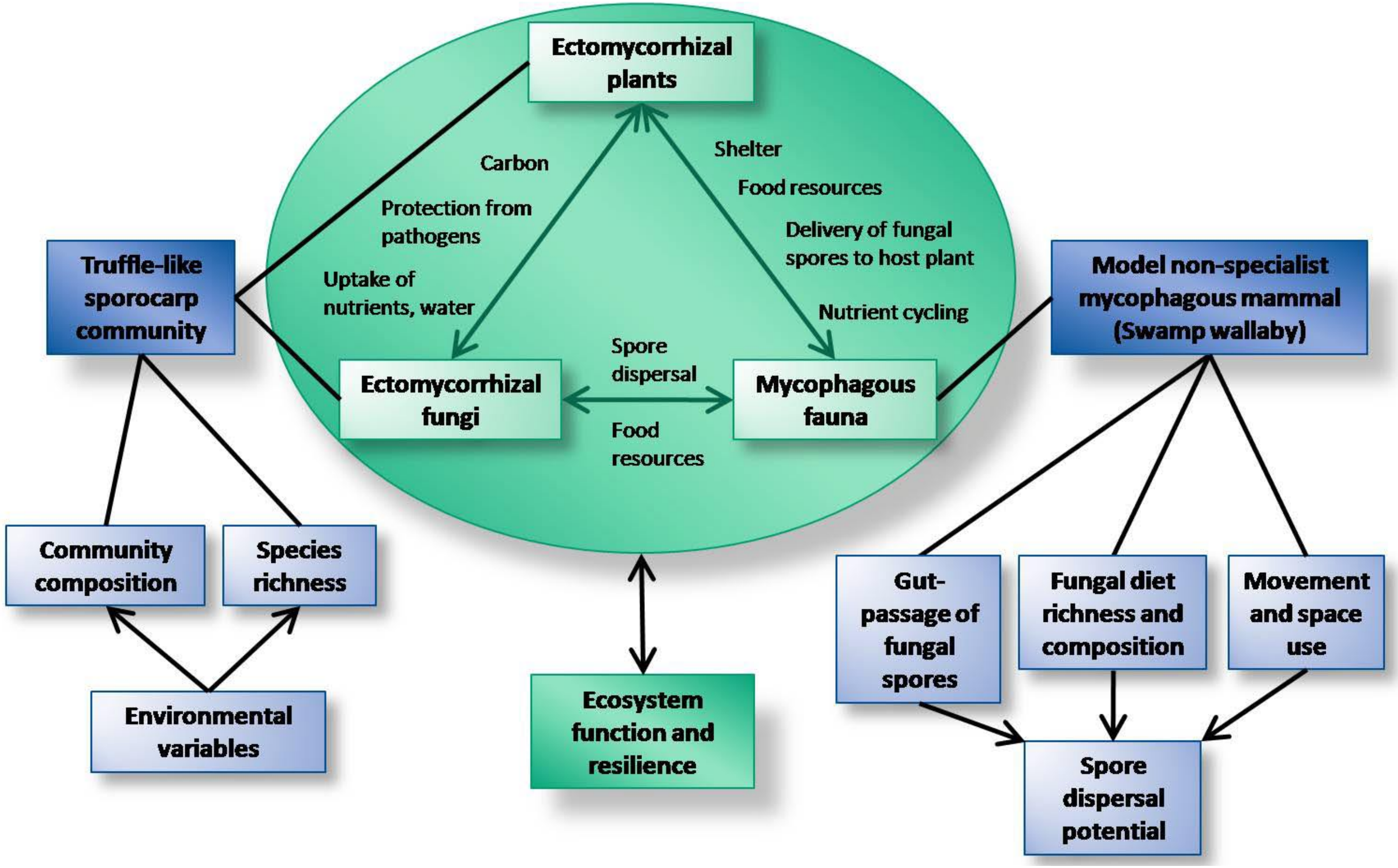


Figure 1.1 Simplified diagram of the interrelationships between mycophagous mammal, ectomycorrhizal fungi and plant communities (green boxes), with linkages to the research themes explored in this thesis (blue boxes).

Figure 2.2. Swamp wallaby, *Wallabia bicolor* (photo James Turner 2009).

The swamp wallaby: a generalist macropodid browser

The swamp wallaby *Wallabia bicolor* (Desmarest: Macropodidae; Figure 2.2) is a widespread, medium-sized (6 – 25 kg), macropod abundant in a range of habitats across eastern Australia, from Cape York to south-western Victoria (Pople 1989; Merchant 1995). While it is common within its range, surprisingly little is known of its ecology. The swamp wallaby was chosen as the model species for this study because it has recently been found to consume a variety of macrofungal sporocarps (Claridge *et al.* 2001; Vernes and McGrath 2009; Vernes 2010) and it remains common in some areas in which other mycophagists are in decline or have become extinct, and is therefore of interest as a disperser of macrofungal spores.

In the little more than 200 years since European occupation, Australian terrestrial mammals have suffered dramatic declines in number and range (Burbidge and McKenzie 1989; Johnson *et al.* 1989; Maxwell *et al.* 1996; Burbidge *et al.* 2009). More than 30% of species have become either locally or fully extinct (Burbidge *et al.* 2009). Mycophagous potoroos, bettongs, rat-kangaroos, bandicoots, and rodents are among the species experiencing the most severe declines (‘critical weight range’; 35 – 5 500 g (Burbidge and McKenzie 1989). The swamp wallaby, a non-specialist mycophagist, and one of the larger mycophagous Australian mammals, remains common across much of its range: it is estimated to have declined by less than 10% since European settlement and has a stable conservation status (Maxwell *et al.* 1996).

General objectives

The research reported in this thesis has two general objectives:

1. Quantify the diversity of truffle-like fungi (a) available in sporocarp communities, (b) as spores in swamp wallaby diet and (c) compare sporocarp communities and diet in terms of both swamp wallaby feeding strategy and methods of sampling truffle-like sporocarp communities;

2. Explore the potential importance of swamp wallabies as dispersers of truffle-like fungi spores in a modified landscape through examination of (a) spore gut-passage time and (b) home range and movement patterns.

Specific hypotheses are outlined below, for each chapter.

Thesis structure

This thesis has a ‘chapters as journal article manuscripts’ structure and study sites and methods are described within relevant chapters rather than in a separate preliminary chapter. Thus there is some overlap in introductory and methodological descriptions among chapters.

In Chapter 2 I quantify the diversity and composition of truffle-like fungi in three different eucalypt forest types at two geographically and climatically different locations over two seasons (Objective 1a) and assess differences between forest types, locations and seasons. This chapter also investigates relationships between truffle-like sporocarp community composition and environmental variables. Truffle-like communities are expected to differ between forests, locations, and seasons and soil chemistry, rainfall, temperature, and above-ground plant communities will influence the diversity and composition of truffle-like sporocarp communities.

In Chapter 3 I examine the diversity and composition of swamp wallaby macrofungal diet (Objective 1b) using microscopic analysis of faecal pellets collected from the same sites used in the preceding chapter. I assess differences between forest types, locations and seasons. This work supports previous research which found that swamp wallabies consume a great diversity of macrofungi, including truffle-like fungi. I also compare the taxon richness of swamp wallaby macrofungal diet to published accounts of the diet of other Australian mycophagous mammals.

Chapter 4 compares the diversity and composition of truffle-like sporocarp communities to swamp wallaby diet (Objective 1c). As swamp wallabies are considered to have a generalist feeding strategy, the diversity and composition of fungi consumed is expected to differ from, and reflect a subset of, the available sporocarp communities.

In Chapter 5 I quantify the time taken for truffle-like fungi spores to pass through the swamp wallaby gut (Objective 2), and compare this ‘gut-retention time’ to that of other mycophagous mammals, including specialist mycophagists. This is the first study to examine whole gut digesta passage in the swamp wallaby and one of the few studies to utilise a natural marker (truffle-like fungi spores). It is expected that gut-retention times in the swamp wallaby will be most similar to those found for smaller browsing wallabies as they are most similar to swamp wallabies in terms of diet. Gut-retention time information is essential as a baseline for determining the potential distances to which swamp wallabies could disperse spores of ingested sporocarps (Chapter 6).

In Chapter 6 I examine the home range and movement patterns of swamp wallabies within, and adjacent to, a large forested remnant in a patchily-forested landscape and assess use of isolated remnant woodland patches, shelterbelt plantings and paddock trees. I then estimate, with reference to Chapter 5, the potential distance from the point of consumption to which swamp wallabies could disperse spores and the likelihood of spore dispersal to isolated trees in this landscape (Objective 2).

Chapter 7 provides a synthesis of the main findings of this thesis, summarises themes for further research, and makes recommendations for natural resource management.

Journal-Article Format for PhD Theses at the University of New England

Chapter 2. Truffle-like (sequestrate) fungi sporocarps in a eucalypt-dominated landscape: patterns in diversity and community structure

STATEMENT OF ORIGINALITY

We, the PhD candidate and the candidate's Principal Supervisor, certify that the following text, figures and diagrams are the candidate's original work.

Type of work	Page number/s
Manuscript	11-46

[redacted]

PhD Candidate: Melissa Danks

[redacted]

Principal Supervisor: Dr Karl Vernes

25/2/2011

Date

Date

STATEMENT OF AUTHORS' CONTRIBUTION

We, the PhD candidate and the candidate's Principal Supervisor, certify that all co-authors have consented to their work being included in the thesis and they have accepted the candidate's contribution as indicated in the *Statement of Originality*.

	Author's Name	% of contribution
Candidate	Melissa Danks	90
Other Authors	Dr Karl Vernes	3.33
	Dr Teresa Lebel	3.33
	Dr Nigel Andrew	3.33

[redacted]

PhD Candidate: Melissa Danks

[redacted]

Principal Supervisor: Dr Karl Vernes

25/2/2011

Date

Date

Journal-Article Format for PhD Theses at the University of New England

Chapter 3. Landscape and local-scale patterns of mycophagy by a generalist browser macropod

STATEMENT OF ORIGINALITY

We, the PhD candidate and the candidate's Principal Supervisor, certify that the following text, figures and diagrams are the candidate's original work.

Type of work	Page number/s
Manuscript	48-77

[redacted]

PhD Candidate: Melissa Danks

[redacted]

Principal Supervisor: Dr Karl Vernes

25/2/2011

Date

Date

STATEMENT OF AUTHORS' CONTRIBUTION

We, the PhD candidate and the candidate's Principal Supervisor, certify that all co-authors have consented to their work being included in the thesis and they have accepted the candidate's contribution as indicated in the *Statement of Originality*.

	Author's Name	% of contribution
Candidate	Melissa Danks	90
Other Authors	Dr Karl Vernes	3.33
	Dr Teresa Lebel	3.33
	Dr Nigel Andrew	3.33

[redacted]

PhD Candidate: Melissa Danks

[redacted]

Principal Supervisor: Dr Karl Vernes

25/2/2011

Date

Date

Journal-Article Format for PhD Theses at the University of New England

Chapter 4. A comparison of truffle-like fungi sporocarp diversity and diet of a non-specialist mycophagist

STATEMENT OF ORIGINALITY

We, the PhD candidate and the candidate's Principal Supervisor, certify that the following text, figures and diagrams are the candidate's original work.

Type of work	Page number/s
Manuscript	79-99

[redacted]

PhD Candidate: Melissa Danks

[redacted]

Principal Supervisor: Dr Karl Vernes

25/2/2011

Date

Date

STATEMENT OF AUTHORS' CONTRIBUTION

We, the PhD candidate and the candidate's Principal Supervisor, certify that all co-authors have consented to their work being included in the thesis and they have accepted the candidate's contribution as indicated in the *Statement of Originality*.

	Author's Name	% of contribution
Candidate	Melissa Danks	90
Other Authors	Dr Karl Vernes	3.33
	Dr Teresa Lebel	3.33
	Dr Nigel Andrew	3.33

[redacted]

PhD Candidate: Melissa Danks

[redacted]

Principal Supervisor: Dr Karl Vernes

25/2/2011

Date

Date

Journal-Article Format for PhD Theses at the University of New England

Chapter 5. Retention time of truffle-like fungal spores in the swamp wallaby gut and comparison with other mycophagous mammals

STATEMENT OF ORIGINALITY

We, the PhD candidate and the candidate's Principal Supervisor, certify that the following text, figures and diagrams are the candidate's original work.

Type of work	Page number/s
Manuscript	101-123

[redacted]

PhD Candidate: Melissa Danks

[redacted]

Principal Supervisor: Dr Karl Vernes

25/2/2011
Date

Date

STATEMENT OF AUTHORS' CONTRIBUTION

We, the PhD candidate and the candidate's Principal Supervisor, certify that all co-authors have consented to their work being included in the thesis and they have accepted the candidate's contribution as indicated in the *Statement of Originality*.

	Author's Name	% of contribution
Candidate	Melissa Danks	90
Other Authors	Dr Karl Vernes	3.33
	Dr Teresa Lebel	3.33
	Dr Nigel Andrew	3.33

[redacted]

PhD Candidate: Melissa Danks

[redacted]

Principal Supervisor: Dr Karl Vernes

25/2/2011
Date

Date

Journal-Article Format for PhD Theses at the University of New England

Chapter 6. Short-term movement and potential dispersal of truffle-like fungi spores by a generalist mycophagous macropod in a variegated landscape

STATEMENT OF ORIGINALITY

We, the PhD candidate and the candidate's Principal Supervisor, certify that the following

Type of work	Page number/s
Manuscript	125-154

[redacted]

PhD Candidate: Melissa Danks

[redacted]

Principal Supervisor: Dr Karl Vernes

25/2/2011
Date

Date

STATEMENT OF AUTHORS' CONTRIBUTION

We, the PhD candidate and the candidate's Principal Supervisor, certify that all co-authors have consented to their work being included in the thesis and they have accepted the candidate's contribution as indicated in the *Statement of Originality*.

	Author's Name	% of contribution
Candidate	Melissa Danks	90
Other Authors	Dr Karl Vernes	3.33
	Dr Teresa Lebel	3.33
	Dr Nigel Andrew	3.33

[redacted]

PhD Candidate: Melissa Danks

[redacted]

Principal Supervisor: Dr Karl Vernes

25/2/2011
Date

Date

Chapter 7. Synthesis and perspectives

The aim of this thesis was to quantify the diversity of truffle-like fungi available as sporocarps and in swamp wallaby diet, and examine swamp wallaby feeding strategy by comparing available sporocarps and diet species richness and composition. Additionally, I aimed to explore the role of swamp wallabies as dispersers of truffle-like fungi spores in a modified landscape through examination of spore gut-passage time and home range and movement patterns. Here I present summaries of the main findings of my thesis and the significance of those findings for the management of the swamp wallaby, and other mycophagous mammals, in eucalypt forests. Potential future research directions are suggested. Additional research conducted during the course of the work presented in this thesis, and considered pertinent to future research directions, is outlined.

Summary of main findings

DIVERSITY AND DISTRIBUTION OF TRUFFLE-LIKE FUNGI

This study, the first systematic sampling of truffle-like fungi in the New England Tableland and Nandewar Bioregions, identified 118 species (35 genera) from 1126 sporocarps, with over half of these species undescribed at the time of collection. Eight new species in the genus *Cortinarius* have been described as a result of this work (Appendix 2, Danks *et al.* 2010) and taxonomic descriptions are ongoing. Sporocarp production was strongly seasonal: standing crop and species richness were greater in winter than in summer, similar to temperate and tropical regions of Australia despite different climatic patterns. As expected, variation in sporocarp community composition was high across spatial and temporal scales, indeed much variation was not explained by the effect of site, forest types, quadrat, or season. Variation in community composition among forest types was associated with habitat attributes that differed with site. At

Mount Kaputar, canopy cover, litter cover, litter depth, soil phosphorous and temperature were most important in differentiating the sporocarp communities of different forest types, while at New England, rainfall, aspect, soil texture, log (pH), and soil nitrogen distinguished communities.

MYCOPHAGY BY THE SWAMP WALLABY

Variation in truffle-like sporocarp production affects food resource availability for mycophagous mammals. The results of this work, the largest study of the macrofungal component of swamp wallaby diet, support the conclusions of previous research that found that swamp wallabies consume a great diversity of macrofungi in multiple seasons. Swamp wallabies consumed more truffle-like than epigeous sporocarps and the total number of spore types consumed was similar to other mycophagous marsupials in eucalypt-dominated landscapes, including specialist and non-specialist mycophagists. On the basis of their consistently diverse macrofungal diets, swamp wallabies are likely to be important spore dispersers, particularly for truffle-like fungi that rely upon mammalian spore dispersal. Variation in the composition of swamp wallaby diet was high at all spatial and temporal scales, and further investigation of the relationship between swamp wallaby diet composition and sporocarp community composition was warranted.

RELATIONSHIP BETWEEN SWAMP WALLABY MACROFUNGAL DIET AND SPOROCARP COMMUNITY

Overall, swamp wallabies did not consume sporocarps in relation to their availability. Wallabies showed preferences for a suite of taxa, some of which were frequently detected in sporocarp survey and some of which were rare. Only ~60% of the genera detected in sporocarp surveys were consumed but one quarter of the genera in their diet were not detected in surveys. At a more localised scale (the scale of the sampling quadrat), which is closer to the scale at which swamp wallabies would be foraging, swamp wallaby diet was similar in richness to the sporocarp community. Compositional differences between the diet and the community varied with forest type and season. Diet composition was highly variable at a fine spatial scale, as was the sporocarp community. Although spatial and temporal differences between the swamp wallaby diet and sporocarp community data limit inferences, swamp wallabies are clearly responding to sporocarp community diversity and composition at a fine-scale. In combination, dietary analysis and sporocarp survey might provide a more efficient and more comprehensive 'snapshot' of available sporocarp diversity in a forested landscape than either technique could alone.

GUT-PASSAGE OF TRUFFLE-LIKE FUNGI SPORES

Spores of a truffle-like fungus were retained in the swamp wallaby gut for a mean time of just over one day, and some spores for up to 3 days, before being deposited in faeces. This study is the first study of digesta gut-passage rate in the swamp wallaby, one of few studies to examine passage of macrofungal spores, and is also unusual in examining gut-passage in semi-free ranging animals consuming a predominantly natural, freely-chosen, diet. Gut- retention times in the swamp wallaby were most similar to gut-retention times in smaller mycophagous marsupials, including the specialist potoroids, but much longer than in the small wallabies with diets and gut morphologies most similar to the swamp wallaby. It is not clear why the swamp wallaby's spore gut-retention time is longer than would be expected for a medium-sized browsing macropodid. Gut-passage rates vary greatly with diet, activity patterns, and among individuals, and further studies of swamp wallaby gut morphology and digestive physiology will be required to answer this question. Nevertheless, I have provided an estimate of the time taken for truffle-like fungi spores to pass through the gut of the swamp wallaby, information that can be used to examine the swamp wallaby's role in spore dispersal. I also review published studies of gut-retention in mycophagous mammals, and both mycophagous and non-mycophagous macropodid marsupials.

SWAMP WALLABY MOVEMENT PATTERNS AND SPORE DISPERSAL POTENTIAL

Gut-passage time, together with movement patterns influence the distance to which a mycophagous mammal may carry the spores of ingested sporocarps. While GPS-telemetry indicated that most movement was restricted to the interior and edge of the large forest remnant in which swamp wallabies were captured, camera trapping revealed occasional use of isolated forest patches by swamp wallabies. The mean spore dispersal distance predicted by 'dispersal kernel' models based on GPS-telemetry movement records and spore gut-retention time (Chapter 5) was 187 m, with maximum distances of over one kilometre. Such distances represent long-distance spore dispersal for truffle-like fungi, further than an individual or a genet may spread via mycelial extension. Rare longer-distance movements, including to isolated trees and forest patches, could be extremely important in establishing new or refreshing existing EM associations in isolated host plants or communities. The approach used here represents a useful way to model spore dispersal that could be readily adapted for other mycophagous mammals and other landscapes.

The natural eucalypt-dominated landscapes of the study region are rich in truffle-like fungi, vital symbionts with forest trees and shrubs. The abundant sporocarps of these fungi, while highly variable both spatially and temporally, are an important food resource for mycophagous mammals, including the non-specialist browsing swamp wallaby. Swamp wallabies regularly consume a diversity of sporocarps, responding to fine-scale variation in sporocarp occurrence, and are key spore dispersal agents for truffle-like fungi, disseminating spores in their faeces across many hundreds of metres. This study emphasises the importance of non-specialist mycophagists, such as the swamp wallaby, and other potentially overlooked mammal mycophagists in dispersing the spores of truffle-like fungi in forest ecosystems. A diverse community of mammal mycophagists is likely important to the maintenance of these highly diverse sporocarp communities and thus to the functioning of these forests.

Implications and recommendations

The findings of this thesis have several implications for the management of the swamp wallaby. Regular consumption of a diversity of macrofungal sporocarps by this non-specialist mycophagist was highlighted. Small amounts of sporocarps are probably nutritionally important to the swamp wallaby year-round, supplementing the plant browse component of the diet. The requirements of the swamp wallaby for a diversity of macrofungi should be incorporated into management plans for landscapes in which this species occurs.

Australia has a rich ground-dwelling mammal fauna, many of which are mycophagous to some degree. Mycophagous mammals have important roles in maintaining diverse macrofungal communities through dissemination of spores, whether strongly mycophagous or not. Specialist mycophagous potoroids are known to be important consumers and dispersers of truffle-like fungi, while knowledge of the diets and spore dispersal roles of other mycophagous mammals is limited. This thesis has highlighted the role of the swamp wallaby, a common macropod and generalist mycophagist, in consuming and dispersing macrofungi spores. Further studies of diets and activity patterns across mycophagous mammal assemblages will improve our understanding of competition and niche partitioning, and the role of mammals in spore dispersal. Other non-specialist mycophagists are likely to be similarly important consumers in EM-forest dominated landscapes, and particularly in areas where specialist mycophagists do not occur. Multiple mammal mycophagists may be important in maintaining truffle-like fungi diversity in landscapes, such as the New England Tableland bioregion, which have a rich truffle-like sporocarp community and, historically, a rich mammal fauna. Conserving a diversity of mycophagists, macrofungi, and plant hosts is important to the functioning of remnant forests in these landscapes. In turn, a mosaic of forest types is likely to contribute to macrofungi diversity and to the sporocarp resource consumed by a wide range of mammals.

Mycophagous mammals tend to occupy areas of dense cover and adjacent areas for the food resources and protection from predators that they provide. These habitats also favour truffle-like sporocarp production, due to the presence of both host plants and mammalian spore dispersal agents. Many vertebrate species require mosaics of habitats (Law and Dickman 1998), and preference for ecotones or habitat mosaics at the scale of the home range that provide some dense cover are common among mycophagous mammals. For example, Vernes and Dunn (2009) report the bush rat *Rattus fuscipes* foraging for sporocarps across a eucalypt forest-rainforest ecotone, the northern bettong *Bettongia tropica* prefers ecotonal eucalypt woodland and *Allocasuarina* forest in the Australian Wet Tropics (Abell *et al.* 2006), the long-nosed potoroo *Potorous tridactylus* utilises contrasting microhabitats within its temperate eucalypt forest habitat (Bennett 1993), and the swamp wallaby *Wallabia bicolor* uses eucalypt forest-pasture interfaces (Edwards and Ealey 1975; Chapter 6) and mosaics of regenerating forest (Lunney and O'Connell 1988; Di Stefano *et al.* 2009).

Mycophagous mammals dispersing spores both within habitats and across habitat boundaries function as ‘mobile link organisms’ (sensu Lundberg and Moberg 2003), vital components in ecosystem development and resilience, influencing the development and survival of mycorrhizal plant and fungal communities (Lundberg and Moberg 2003). In early successional habitats, mycophagous mammals traversing the boundaries of adjacent habitats can be crucial to colonisation of ‘new’ habitat by a diversity of truffle-like fungi (Cazares and Trappe 1994; Terwilliger and Pastor 1999; Ashkannejhad and Horton 2005) because deposits of spore-containing faeces provide the seeds of EM host that germinate near the faeces with EM inoculum, facilitating the spread of EM plant species (Maser *et al.* 1978). Mammal mycophagists resilient in some human-modified landscapes, including the swamp wallaby, play a key role in the dispersal of fungal spores and the maintenance of ectomycorrhizal associations in these landscapes. This is particularly the case in fragmented or partially cleared landscapes, or areas with naturally sparse tree cover, where barriers to mycelial spread occur and in landscapes from which other mycophagous mammals have been extirpated. Establishment and maintenance of mycorrhizal symbioses may be crucial to the persistence of native vegetation remnants, shelterbelt plantings, and isolated paddock trees, and to the success of revegetation programs, in human-modified landscapes.

Australian EM forests and woodlands have co-evolved with a rich and highly endemic truffle-like fungi biota (Bougher and Lebel 2001). The taxonomy and ecology of these fungi, critical forest components, remain poorly known. More studies exploring the taxonomy, distribution, functional roles, and interactions with host plants and mycophagists are needed to elucidate the dynamics of EM fungi. An understanding of the drivers of diversity and sporocarp production at multiple spatial scales will inform sustainable forest management.

A major challenge in the conservation of macrofungi, and therefore in the conservation of mycophagous mammals, is incomplete knowledge of their taxonomy, distribution, and ecology (Buchanan and May 2003; Mueller *et al.* 2007; Molina *et al.*) and one of the impediments is the limited accumulation and sharing of expert knowledge (Molina *et al.* 2011). To help address this need, an online database for collation and communication of ecological and taxonomic information on macrofungi and mycophagous mammals is in development (Appendix 11).

Viability, dormancy, and longevity of truffle-like fungi spores in the soil, whether eaten and disseminated by mammals or other mycophagists, or deposited *in situ* as the sporocarp rots away, remain unknown (but see Bruns *et al.* 2009). Knowledge of potential distances to which mammals may disseminate spores, and the effect of digestion on spores, is necessary for investigation of disperser effectiveness. With some fundamental knowledge of macrofungal occurrence, habitat configuration, mycophagous mammal diets and movement patterns, spore viability, and host plant occurrence, more detailed models of mammal-mediated macrofungal spore dispersal in EM-dominated landscapes could be constructed. Such models could be used to examine further the functioning of mammal-fungal-plant relationships, and would be particularly useful tools for assessing functional diversity in mycophagous mammal communities.

Adaptive management of EM-dominated human-modified and ‘intact’ landscapes will require continued study of interactions between EM fungi, plants, and mycophagous mammals and their contributions to ecosystem function. The maintenance of genetic diversity, species diversity, and functional diversity is integral to ecosystem function, and understanding the drivers of soil biodiversity will aid our understanding of terrestrial ecosystems (Wardle 2006). Bougher & Tommerup (1996) note that association with a network of ectomycorrhizal fungi may have been advantageous for plants faced with climatic fluctuations in the geological past. Maintaining a taxonomically and functionally diverse ectomycorrhizal community, and their associated plant and animal assemblages, will be essential to the survival and resilience of EM forests and other EM ecosystems in a changing climate.

References

Abell S. E., Gadek P. A., Pearce C. A. & Congdon B. C. (2006) Seasonal resource availability and use by an endangered tropical mycophagous marsupial. *Biol. Conserv.* **132**, 533-40.

Addinsoft. (2010) XLSTAT 2010: data analysis and statistical software for Microsoft Excel. Addinsoft, Paris, France.

Alexander J. S. A., Scotts D. J. & Loyn R. H. (2002) Impacts of timber harvesting on mammals, reptiles and nocturnal birds in native hardwood forests of East Gippsland, Victoria: a retrospective approach. *Aust. For.* **65**, 182-210.

Allen E., Allen M., Helm D., Trappe J., Molina R. & Rincon E. (1995) Patterns and regulation of mycorrhizal plant and fungal diversity. *Plant Soil* **170**, 47-62.

Allen M. F. (2009) Bidirectional water flows through the soil–fungal–plant mycorrhizal continuum. *New Phytol.* **182**, 290-3.

Amaranthus M. P. & Perry D. A. (1994) The functioning of ectomycorrhizal fungi in the field: linkages in space and time. *Plant Soil* **159**, 133-40.

Amaranthus M. P., Trappe J. M., Bednar L. & Arthur D. (1994) Hypogeous fungal production in mature Douglas-fir forest fragments and surrounding plantations and its relation to coarse woody debris and animal mycophagy. *Can. J. For. Res.* **24**, 2157-65.

Anderson D. J. (1982) The home range: a new nonparametric estimation technique. *Ecology* **63**, 103-12.

Anderson I. C. & Cairney J. W. G. (2007) Ectomycorrhizal fungi: exploring the mycelial frontier. *FEMS Microbiol. Rev.* **31**, 388-406.

Anderson M. J., Gorley R. N. & Clarke K. R. (2008) PERMANOVA+ for PRIMER: guide to software and statistical methods. PRIMER-E Ltd., Plymouth, UK.

Anderson P., Brundrett M., Grierson P. & Robinson R. (2010) Impact of severe forest dieback caused by *Phytophthora cinnamomi* on macrofungal diversity in the northern jarrah forest of Western Australia. *For. Ecol. Manag.* **259**, 1033-40.

Ashkannejhad S. & Horton T. R. (2005) Ectomycorrhizal ecology under primary succession on coastal sand dunes: interactions involving *Pinus contorta*, suilloid fungi and deer. *New Phytol.* **169**, 345-54.

Australian Bureau of Meteorology. (2010) Climate Data Online. Commonwealth of Australia, Canberra. http://www.bom.gov.au/climate/data/index.shtml.

Baar J., Horton T. R., Kretzer A. M. & Bruns T. D. (1999) Mycorrhizal colonization of *Pinus muricata* from resistant propagules after a stand-replacing wildfire. *New Phytol.* **143**, 409-18.

Barrett G., Trappe J., Drew A., Stol J. & Freudenberger D. (2009) Fungus diversity in revegetated paddocks compared with remnant woodland in a south-eastern Australian agricultural landscape. *Ecol. Manag. Restor.* **10**, 200-9.

Baxter J. & Dighton J. (2005) Diversity-functioning relationships in ectomycorrhizal fungal communities. In: *The fungal community: its organization and role in the ecosystem* (eds J. Dighton, J. F. White and P. Oudeman) pp. 383-98. CRC Press, Boca Raton.

Beaton G., Pegler D. N. & Young T. W. K. (1985) Gasteroid basidiomycota of Victoria state, Australia: 8-9. *Kew Bull.* **40**, 827-42.

Beiler K. J., Durall D. M., Simard S. W., Maxwell S. A. & Kretzer A. M. (2010) Architecture of the wood-wide web: *Rhizopogon* spp. genets link multiple Douglas-fir cohorts. *New Phytol.* **185**, 543-53.

Bengtsson J. (1998) Which species? What kind of diversity? Which ecosystem function? Some problems in studies of relations between biodiversity and ecosystem function. *Appl. Soil Ecol.* **10**, 191-9.

Bennett A. (1993) Microhabitat use by the long-nosed potoroo, *Potorous tridactylus*, and other small mammals in remnant forest vegetation, south-western Victoria. *Wildl. Res.* **20**, 267-85.

Bennett A. & Baxter B. (1989) Diet of the long-nosed potoroo, *Potorous tridactylus* (Marsupialia, Potoroidae), in southwestern victoria. *Wildl. Res.* **16**, 263-71.

Bergemann S. E. & Miller S. L. (2002) Size, distribution, and persistence of genets in local populations of the late-stage ectomycorrhizal basidiomycete, *Russula brevipes*. *New Phytol.* **156**, 313-20.

Bertolino S., Vizzini A., Wauters L. A. & Tosi G. (2004) Consumption of hypogeous and epigeous fungi by the red squirrel (*Sciurus vulgaris*) in subalpine conifer forests. *For. Ecol. Manag.* **202**, 227-33.

Blaschke H. & Baeumler W. (1989) Mycophagy and spore dispersal by small mammals in Bavarian forests. *For. Ecol. Manag.* **26**, 237-45.

Blaxter K. L., McGraham N. M. & Wainman F. W. (1956) Some observations on the digestibility of food by sheep and on related problems. *Br. J. Nutr.* **10**, 69-91.

Bonello P., Bruns T. D. & Gardes M. (1998) Genetic structure of a natural population of the ectomycorrhizal fungus *Suillus pungens*. *New Phytol.* **138**, 533-42.

Börger L., Dalziel B. D. & Fryxell J. M. (2008) Are there general mechanisms of animal home range behaviour? A review and prospects for future research. *Ecol. Lett.* **11**, 1-14.

Börger L., Franconi N., Michele G. D., Gantz A., Meschi F., Manica A., Lovari S. & Coulson T. (2006) Effects of sampling regime on the mean and variance of home range size estimates. *J. Anim. Ecol.* **75**, 1393-405.

Bougher N. L. (1995) Diversity of ectomycorrhizal fungi associated with eucalypts in Australia. In: *Mycorrhizas for Plantation Forestry in Asia* (eds M. Brundrett, B. Dell, N. Malajczuk and G. Mingqin) pp. 8-14. ACIAR, Canberra.

Bougher N. L. & Friend J. A. (2009) Fungi consumed by translocated Gilbert's potoroos (*Potorous gilbertii*) at two sites with contrasting vegetation, south coastal Western Australia. *Aust. Mammal.* **31**, 97-105.

Bougher N. L. & Lebel T. (2001) Sequestrate (truffle-like) fungi of Australia and New Zealand. *Aust. Syst. Bot.* **14**, 439-84.

Bowie F. (2007) Fungal diversity in the diet of three small mammals from French Island, Victoria. Bachelor of Science (Honours) thesis. *Department of Zoology*, University of Melbourne, Melbourne.

Bozinovic F. & Muñoz-Pedreros A. (1995) Nutritional ecology and digestive responses of an omnivorous-insectivorous rodent (*Abrothrix longipilis*) feeding on fungus. *Physiol. Zool.* **68**, 474-89.

Bridie A., Hume I. & Hill D. (1994) Digestive-tract function and energy-requirements of the rufous hare-wallaby, *Lagorchestes hirsutus*. *Aust. J. Zool.* **42**, 761-74.

Brundrett M. (2009) Mycorrhizal associations and other means of nutrition of vascular plants: understanding the global diversity of host plants by resolving conflicting information and developing reliable means of diagnosis. *Plant Soil* **320**, 37-77.

Brundrett M. C. (1991) Mycorrhizas in natural ecosystems. *Adv. Ecol. Res.* **21**, 171-315.

Brundrett M. C. (2002) Coevolution of roots and mycorrhizas of land plants. *New Phytol.* **154**, 275-304.

Brundrett M. C. (2004) Diversity and classification of mycorrhizal associations. *Biol. Rev.* **79**, 473-95.

Brundrett M. C. (2005) Nursery inoculation of *Eucalyptus* seedlings in Western Australia and southern China using spores and mycelial inoculum of diverse ectomycorrhizal fungi from different climatic regions. *For. Ecol. Manag.* **209**, 193-205.

Bruns T. (1995) Thoughts on the processes that maintain local species diversity of ectomycorrhizal fungi. *Plant Soil* **170**, 63-73.

Bruns T. D., Bidartondo M. I. & Taylor D. L. (2002) Host specificity in ectomycorrhizal communities: What do the exceptions tell us? *Integr Comp Biol* **42**, 352–9.

Bruns T. D., Peay K. G., Boynton P. J., Grubisha L. C., Hynson N. A., Nguyen N. H. & Rosenstock N. P. (2009) Inoculum potential of *Rhizopogon* spores increases with time over the first 4 yr of a 99-yr spore burial experiment. *New Phytol.* **181**, 463-70.

Buchanan P. K. & May T. W. (2003) Conservation of New Zealand and Australian fungi. *N. Z. J. Bot.* **41**, 407 - 21.

Burbidge A. A. & McKenzie N. L. (1989) Patterns in the modern decline of Western Australia's vertebrate fauna: causes and conservation implications. *Biol. Conserv.* **50**, 143-98.

Burbidge A. A., McKenzie N. L., Brennan K. E. C., Woinarski J. C. Z., Dickman C. R., Baynes A., Gordon G., Menkhorst P. W. & Robinson A. C. (2009) Conservation status and biogeography of Australia's terrestrial mammals. *Aust. J. Zool.* **56**, 411-22.

Burt W. H. (1943) Territoriality and home range concepts as applied to mammals. *J. Mammal.* **24**, 346-52.

Buscot F., Munch J. C., Charcosset J. Y., Gardes M., Nehls U. & Hampp R. (2000) Recent advances in exploring physiology and biodiversity of ectomycorrhizas highlight the functioning of these symbioses in ecosystems. *FEMS Microbiol. Rev.* **24**, 601-14.

Cain J. W., III, Krausman P. R., Jansen B. D. & Morgart J. R. (2005) Influence of topography and GPS fix interval on GPS collar performance. *Wildl. Soc. Bull.* **33**, 926-34.

Calaby J. H. (1958) Studies on marsupial nutrition II. The rate of passage of food residues and digestibility of crude fibre and protein by the quokka, *Setonix brachyurus* (Quoy & Gaimard). *Aust. J. Biol. Sci.* **11**, 571-80.

Caldwell I. R., Vernes K. & Baerlocher F. (2005) The northern flying squirrel (*Glaucomys sabrinus*) as a vector for inoculation of red spruce (*Picea rubens*) seedlings with ectomycorrhizal fungi. *Sydowia* **57**, 166-78.

Carey A. B., Colgan W., III, Trappe J. M. & Molina R. (2002) Effects of forest management on truffle abundance and squirrel diets. *Northwest. Sci.* **76**, 148-57.

Castle E. J. (1956) The rate of passage of foodstuffs through the alimentary tract of the goat *Br. J. Nutr.* **10**, 15-23.

Cazares E., Luoma D. L., Amaranthus M. P., Chambers C. L. & Lehmkuhl J. F. (1999) Interaction of fungal sporocarp production with small mammal abundance and diet in Douglas-fir stands of the Southern Cascade Range. *Northwest. Sci.* **73**, 64-76.

Cazares E. & Trappe J. M. (1994) Spore dispersal of ectomycorrhizal fungi on a glacier forefront by mammal mycophagy. *Mycologia* **86**, 507-10.

Cázares E., Trappe J. M. & Jumpponen A. (2005) Mycorrhiza-plant colonization patterns on a subalpine glacier forefront as a model system of primary succession. *Mycorrhiza* **15**, 405-16.

Chase J. M. & Leibold M. A. (2002) Spatial scale dictates the productivity-biodiversity relationship. *Nature* **416**, 427.

Chen Y. L., Dell B. & Malajczuk N. (2006) Effect of *Scleroderma* spore density and age on mycorrhiza formation and growth of containerized *Eucalyptus globulus* and *E. urophylla* seedlings. *New For.* **31**, 453-67.

Chilvers G. (1973) Host range of some eucalypt mycorrhizal fungi. *Aust. J. Bot.* **21**, 103-11.

Christensen P. E. S. (1980) The biology of *Bettongia penicillata* Gray, 1837 and *Macropus eugenii* (Desmarest, 1817) in relation to fire. *For. Dept. WA Bull.* **91**, 1-90.

Claridge A. & Cork S. (1994) Nutritional value of hypogeal fungal sporocarps for the long-nosed potoroo (*Potorous tridactylus*), a forest-dwelling mycophagous marsupial. *Aust. J. Zool.* **42**, 701-10.

Claridge A., Tanton M. & Cunningham R. (1993a) Hypogeal fungi in the diet of the long-nosed potoroo (*Potorous tridactylus*) in mixed-species and regrowth eucalypt forest stands in south-eastern Australia. *Wildl. Res.* **20**, 321-38.

Claridge A. W., Barry S. C., Cork S. J. & Trappe J. M. (2000a) Diversity and habitat relationships of hypogeous fungi. II. Factors influencing the occurrence and number of taxa. *Biodivers. Conserv.* **9**, 175-99.

Claridge A. W., Castellano M. A. & Trappe J. M. (1996) Fungi as a food resource for mammals in Australia. In: *The Fungi of Australia* (eds K. Mallett and C. Grgurinovic) pp. 239-67. Australian Biological Resource Study, Canberra.

Claridge A. W., Cork S. J. & Trappe J. M. (2000b) Diversity and habitat relationships of hypogeous fungi. I. Study design, sampling techniques and general survey results. *Biodivers. Conserv.* **9**, 151-73.

Claridge A. W. & Lindenmayer D. B. (1998) Consumption of hypogeous fungi by the mountain brushtail possum (*Trichosurus caninus*) in eastern Australia. *Mycol. Res.* **102**, 269-72.

Claridge A. W. & May T. W. (1994) Mycophagy among Australian mammals. *Aust. J. Ecol.* **19**, 251-75.

Claridge A. W., McNee A., Tanton M. T. & Davey S. M. (1991) Ecology of bandicoots in undisturbed forest adjacent to recently felled logging coupes: a case study from the Eden Woodchip Agreement Area. In: *Conservation of Australia's Forest Fauna* (ed D. Lunney) pp. 331-45. Royal Zoological Society of NSW, Mosman.

Claridge A. W., Robinson A. P., Tanton M. T. & Cunningham R. B. (1993b) Seasonal production of hypogeal fungal sporocarps in a mixed-species eucalypt forest stand in south-eastern Australia. *Aust. J. Bot.* **41**, 145-67.

Claridge A. W., Tanton M. T., Seebeck J. H., Cork S. J. & Cunningham R. B. (1992) Establishment of ectomycorrhizae on the roots of two species of *Eucalyptus* from fungal spores contained in the faeces of the long-nosed potoroo (*Potorous tridactylus). Aust. J. Ecol.* **17**, 207-17.

Claridge A. W. & Trappe J. M. (2005) Sporocarp mycophagy: nutritional, behavioral, evolutionary, and physiological aspects. In: *The Fungal Community: Its Organization and Role in the Ecosystem* (eds J. Dighton, J. F. White and P. Oudemans) pp. 599-611. CRC Press, Boca Raton.

Claridge A. W., Trappe J. M. & Claridge D. L. (2001) Mycophagy by the swamp wallaby (*Wallabia bicolor*). *Wildl. Res.* **28**, 643-5.

Claridge A. W., Trappe J. M., Cork S. J. & Claridge D. L. (1999) Mycophagy by small mammals in the coniferous forests of North America: nutritional value of sporocarps of *Rhizopogon vinicolor*, a common hypogeous fungus. *J. Comp. Physiol. B Biochem. Syst. Environ. Physiol.* **169**, 172-8.

Claridge A. W., Trappe J. M., Mills D. J. & Claridge D. L. (2009) Diversity and habitat relationships of hypogeous fungi. III. Factors influencing the occurrence of fire-adapted species. *Mycol. Res.* **113**, 792-801.

Clark P. A. (1980) The distribution of forest and woodland associations on Newholme. B. Nat. Res. thesis. University of New England, Armidale.

Clarke K. R. & Gorley R. N. (2006) PRIMER v6 user manual/tutorial. PRIMER-E, Plymouth, UK.

Clarke P. J., Copeland L. M., Noble N. E., Bale C. L. & Williams J. B. (2000) The vegetation and plant species of New England National Park. p. 274. Botany, University of New England, Armidale.

Clauss M., Streich W. J., Schwarm A., Ortmann S. & Hummel J. (2007) The relationship of food intake and ingesta passage predicts feeding ecology in two different megaherbivore groups. *Oikos* **116**, 209-16.

Colgan W., III, Carey A. B., Trappe J. M., Molina R. & Thysell D. (1999) Diversity and productivity of hypogeous fungal sporocarps in a variably thinned Douglas-fir forest. *Can. J. For. Res.* **29**, 1259.

Colgan W., III & Claridge A. W. (2002) Mycorrhizal effectiveness of Rhizopogon spores recovered from faecal pellets of small forest-dwelling mammals. *Mycol. Res.* **106**, 314-20.

Colwell R. K. (2009) EstimateS: statistical estimation of species richness and shared species from samples. Version 8.2. User's Guide and application published at: http://purl.oclc.org/estimates.

Comport S. S. & Hume I. D. (1998) Gut morphology and rate of passage of fungal spores through the gut of a tropical rodent, the giant white-tailed rat (*Uromys caudimaculatus*). *Aust. J. Zool.* **46**, 461-71.

Cork S. J. & Foley W. J. (1990) Nutritional quality of hypogeous fungi for small mammals. *Proceedings Nutritional Society Australia* **15**, 168.

Cork S. J. & Kenagy G. J. (1989a) Nutritional value of hypogeous fungus for a forest-dwelling ground squirrel. *Ecology* **70**, 577-86.

Cork S. J. & Kenagy G. J. (1989b) Rates of gut passage and retention of hypogeous fungal spores in two forest-dwelling rodents. *J. Mammal.* **70**, 512-9.

Cousens R. D., Hill J., French K. & Bishop I. D. (2010) Towards better prediction of seed dispersal by animals. *Funct. Ecol.* **24**, 1163-70.

Cowan P. E. (1989) A vesicular-arbuscular fungus in the diet of the brushtail possums, *Trichosurus vulpecula*. *N. Z. J. Bot.* **27**, 129-31.

Curtis D. (1989) Eucalypt re-establishment on the Northern Tablelands of New South Wales. thesis. University of New England, Armidale, New South Wales.

D'Alva T., Lara C., Estrada-Torres A. & Castillo-Guevara C. (2007) Digestive responses of two omnivorous rodents (*Peromyscus maniculatus* and *P. alstoni*) feeding on epigeous fungus (*Russula occidentalis*). *J. Comp. Physiol. B Biochem. Syst. Environ. Physiol.* **177**, 707-12.

Dahlberg A. (2001) Community ecology of ectomycorrhizal fungi: an advancing interdisciplinary field. *New Phytol.* **150**, 555-62.

Dahlberg A., Jonsson L. & Nylund J. E. (1997) Species diversity and distribution of biomass above and below ground among ectomycorrhizal fungi in an old-growth Norway spruce forest in south Sweden. *Canadian Journal of Botany-Revue Canadienne De Botanique* **75**, 1323-35.

Dahlberg A. & Stenlid J. A. N. (1994) Size, distribution and biomass of genets in populations of *Suillus bovinus* (L.: Fr.) Roussel revealed by somatic incompatibility. *New Phytol.* **128**, 225-34.

Danks M., Lebel T. & Vernes K. (2010) 'Cort short on a mountaintop' - Eight new species of sequestrate *Cortinarius* from sub-alpine Australia and affiliations to sections within the genus. *Persoonia* **24**, 106-26.

Deacon J. W. & Fleming L. V. (1992) Interactions of ectomycorrhizal fungi. In: *Mycorrhizal Functioning: An Integrative Plant-Fungal Process* (ed M. F. Allen) pp. 249-95. Routledge, Chapman & Hall, New York.

Dell B., Malajczuk N., Grove T. S. & Thomson G. (1990) Ectomycorrhiza formation in *Eucalyptus*. IV. Ectomycorrhizas in the sporocarps of the hypogeous fungi *Mesophellia* and *Castoreum* in Eucalypt forests of Western Australia. *New Phytol.* **114**, 449-56.

Dellow D. (1979) Physiology of digestion in the macropodine marsupials. PhD thesis. *The Department of Biochemistry and Nutrition*, University of New England, Armidale.

Dellow D. (1982) Studies on the nutrition of macropodine marsupials. 3. The flow of digesta through the stomach and intestine of macropodines and sheep. *Aust. J. Zool.* **30**, 751-65.

Dellow D. & Hume I. (1982) Studies on the nutrition of macropodine marsupials. 4. Digestion in the stomach and the intestine of *Macropus giganteus*, *Thylogale thetis* and *Macropus eugenii*. *Aust. J. Zool.* **30**, 767–77.

Demment M. W. & Soest P. J. V. (1985) A nutritional explanation for body-size patterns of ruminant and nonruminant herbivores. *Am. Nat.* **125**, 641-72.

Di Stefano J. (2007) Home range size and resource selection by the swamp wallaby, *Wallabia bicolor*, in a landscape modified by timber harvesting. PhD thesis. *Zoology*, University of Melbourne, Melbourne.

Di Stefano J. (2010) Effect of habitat type, sex and time of day on space use by the swamp wallaby. In: *Macropods: The Biology of Kangaroos, Wallabies and Rat-kangaroos* (eds G. Coulson and M. Eldridge) pp. 187-96. CSIRO Publishing, Collingwood, Victoria, Australia.

Di Stefano J., Moyle R. & Coulson G. (2005) A soft-walled double-layered trap for capture of swamp wallabies *Wallabia bicolor*. *Aust. Mammal.* **27**, 235-8.

Di Stefano J. & Newell G. R. (2008) Diet selection by the swamp wallaby (*Wallabia bicolor*): feeding strategies under conditions of changed food availability. *J. Mammal.* **89**, 1540.

Di Stefano J., York A., Swan M., Greenfield A. & Coulson G. (2009) Habitat selection by the swamp wallaby (*Wallabia bicolor*) in relation to diel period, food and shelter. *Austral. Ecol.* **34**, 143-55.

Dickie I. A. & Moyersoen B. (2008) Towards a global view of ectomycorrhizal ecology. *New Phytol.* **180**, 263-5.

Dighton J., Morale Bonilla A. S., Jimînez-Nûñez R. A. & Martînez N. (2000) Determinants of leaf litter patchiness in mixed species New Jersey pine barrens forest and its possible influence on soil and soil biota. *Biol. Fertil. Soils* **31**, 288-93.

Donaldson R. & Stoddart M. (1994) Detection of hypogeous fungi by the Tasmanian bettong (*Bettongia gaimardi*: Marsupialia; Macropodoidea). *J. Chem. Ecol.* **20**, 1201-7.

Edwards G. P. & Ealey E. H. M. (1975) Aspects of the ecology of the Swamp Wallaby, *Wallabia bicolor* (Marsupialia: Macropodidae). *Aust. Mammal.* **1**, 307-17.

Egan J. & Doyle P. (1984) A comparison of particulate markers for the estimation of digesta flow from the abomasum of sheep offered chopped oaten hay. *Aust. J. Agric. Res.* **35**, 279-91.

Egerton-Warburton L. M., Querejeta J. I. & Allen M. F. (2007) Common mycorrhizal networks provide a potential pathway for the transfer of hydraulically lifted water between plants. *J. Exp. Bot.* **58**, 1473-83.

Fadlalla B., Kay R. N. B. & Goodall E. D. (1987) Effects of particle size on digestion of hay by sheep. *J. Agric. Sci.* **109**, 551-61.

Fahrig L. (2003) Effects of habitat fragmentation on biodiversity. *Annual Review of Ecology, Evolution and Systematics* **34**, 487-515.

Faichney G. J. (1975) The use of markers to partition digestion within the gastro-intestinal tract of ruminants. In: *Digestion and Metabolism in the Ruminant* (eds I. W. McDonald and A. C. I. Warner) pp. 277-91. University of New England Publishing Unit, Armidale.

Faichney G. J. & Griffiths D. A. (1978) Behaviour of solute and particle markers in the stomach of sheep given a concentrate diet. *Br. J. Nutr.* **40**, 71-82.

Ferry J. (1991) In the shadow of Duval: the Newholme Story. *Armidale Dist. Hist. Soc. J.* **34**, 47-66.

Fletcher D. J. & Underwood A. J. (2002) How to cope with negative estimates of components of variance in ecological field studies. *J. Exp. Mar. Biol. Ecol.* **273**, 89-95.

Floyd R. B. (1980) Density of *Wallabia bicolor* (Desmarest) (Marsupialia: Macropodidae) in eucalypt plantations of different ages. *Aust. Wildl. Res.* **7**, 333-7.

Fogel R. (1976) Ecological studies of hypogeous fungi. II. Sporocarp phenology in a western Oregon Douglas Fir stand. *Can. J. Bot.* **54**, 1152-62.

Fogel R. & Trappe J. M. (1978) Fungus consumption (mycophagy) by small animals. *Northwest. Sci.* **52**, 1-31.

Foley W. J. & Hume I. D. (1987) Passage of digesta markers in two species of arboreal folivorous marsupials: the greater glider (*Petauroides volans*) and the brushtail possum (*Trichosurus vulpecula*). *Physiol. Zool.* **60**, 103-13.

Foot J. & Romberg B. (1965) The utilization of roughage by sheep and the red kangaroo, *Macropus rufus* (Desmarest). *Aust. J. Agric. Res.* **16**, 429-35.

Forbes D. & Tribe D. (1970) The utilization of roughages by sheep and kangaroos. *Aust. J. Zool.* **18**, 247-56.

Frair J. L., Fieberg J., Hebblewhite M., Cagnacci F., DeCesare N. J. & Pedrotti L. (2010) Resolving issues of imprecise and habitat-biased locations in ecological analyses using GPS telemetry data. *Phil. Trans. R. Soc. B* **365**, 2187-200.

Francis A. A. & Bougher N. L. (2003) Historical and current perspectives in the systematics of Australian cortinarioid sequestrate (truffle-like) fungi. *Aust. Mycol.* **21**, 81-93.

Francis A. A. & Bougher N. L. (2004) Cortinaroid sequestrate (truffle-like) fungi of Western Australia. *Aust. Mycol.* **23**, 1-26.

Frank J. L., Barry S. & Southworth D. (2006) Mammal mycophagy and dispersal of mycorrhizal inoculum in Oregon white oak woodlands. *Northwest. Sci.* **80**, 264-73.

Freudenberger D. & Hume I. (1992) Ingestive and digestive responses to dietary fiber and nitrogen by 2 macropodid marsupials (*Macropus robustus robustus* and *M. r. erubescens*) and a ruminant (*Capra hircus*). *Aust. J. Zool.* **40**, 181-94.

Freudenberger D. O., Wallis I. R. & Hume I. D. (1989) Digestive adaptations of kangaroos, wallabies and rat-kangaroos. In: *Kangaroos, Wallabies and Rat-kangaroos* (eds G. Grigg, P. Jarman and I. D. Hume) pp. 179-87. Surrey Beatty & Sons, Chipping Norton, Australia.

Gannon W. L., Sikes R. S. & Animal Care and Use Committee of the American Society of Mammalogists. (2007) Guidelines of the American Society of Mammalogists for the use of wild mammals in research. *J. Mammal.* **88**, 809-23.

Gardes M. & Bruns T. D. (1996) Community structure of ectomycorrhizal fungi in a *Pinus muricata* forest: above- and below-ground views. *Can. J. Bot.* **74**, 1572-83.

Gaudinski J. B., Trumbore S. E., Davidson E. D., Cook A. C., Markewitz D. & Richter D. D. (2001) The age of fine-root carbon in three forests of the eastern United States measured by radiocarbon. *Oecologia* **129**, 420-9.

Gehring C. A., Theimer T. C., Whitham T. G. & Keim P. (1998) Ectomycorrhizal fungal community structure of pinyon pines growing in two environmental extremes. *Ecology* **79**, 1562-72.

Genard M., Lescourret F. & Durrieu G. (1988) Mycophagie chez le sanglier et hypotheses sur son role dans la dissemination des spores de champignons hypoges. *Canadian Journal of Zoology-Revue Canadienne De Zoologie* **66**, 2324-7.

Genney D. R., Anderson I. C. & Alexander I. J. (2006) Fine-scale distribution of pine ectomycorrhizas and their extramatrical mycelium. *New Phytol.* **170**, 381-90.

Gherbi H., Delaruelle C., Selosse M. A. & Martin F. (1999) High genetic diversity in a population of the ectomycorrhizal basidiomycete *Laccaria amethystina* in a 150-year-old beech forest. *Mol. Ecol.* **8**, 2003-13.

Gibbs L., Reid N. & Whalley R. D. B. (1999) Relationships between tree cover and grass dominance in a grazed temperate stringybark (*Eucalyptus laevopinea*) open-forest. *Aust. J. Bot.* **47**, 49-60.

Gibson L. A. & Hume I. D. (2000) Digestive performance and digesta passage in the omnivorous greater bilby, *Macrotis lagotis* (Marsupialia: Peramelidae). *J. Comp. Physiol. B Biochem. Syst. Environ. Physiol.* **170**, 457-67.

Gill R. A. & Jackson R. B. (2000) Global patterns of root turnover for terrestrial ecosystems. *New Phytol.* **147**, 13-31.

Gillman L. N. & Wright S. D. (2006) The influence of productivity on the species richness of plants: a critical assessment. *Ecology* **87**, 1234-43.

Glen M., Bougher N. L., Colquhoun I. J., Vlahos S., Loneragan W. A., O'Brien P. A. & Hardy G. E. S. J. (2008) Ectomycorrhizal fungal communities of rehabilitated bauxite mines and adjacent, natural jarrah forest in Western Australia. *For. Ecol. Manag.* **255**, 214-25.

Green K., Tory M. K., Mitchell A. T., Tennant P. & May T. W. (1999) The diet of the long-footed potoroo (*Potorous longipes*). *Aust. J. Ecol.* **24**, 151-6.

Grogan P., Baar J. & Bruns T. D. (2000) Below-ground ectomycorrhizal community structure in a recently burned bishop pine forest. *J. Ecol.* **88**, 1051-62.

Hailey A., Coulson I. M. & Chidavaenzi R. L. (1997) Fungus eating by the African tortoise *Kinixys spekii*. *J. Trop. Ecol.* **13**, 469-74.

Hanson A. M., Hodge K. T. & Porter L. M. (2003) Mycophagy among primates. *Mycologist* **17**, 6-10.

Hansteen T. L., Andreassen H. P. & Ims R. A. (1997) Effects of spatiotemporal scale on autocorrelation and home range estimators. *J. Wildl. Manag.* **61**, 280-90.

Hanya G. (2004) Diet of a Japanese macaque troop in the coniferous forest of Yakushima. *Int. J. Primatol.* **25**, 55.

Harestad A. S. & Bunnel F. L. (1979) Home range and body weight - A reevaluation. *Ecology* **60**, 389-402.

Harley J. L. (1971) Fungi in ecosystems. *J. Appl. Ecol.* **8**, 627-42.

Harrington G. N., Freeman A. N. D. & Crome F. H. J. (2001) The effects of fragmentation of an Australian tropical rain forest on populations and assemblages of small mammals. *J. Trop. Ecol.* **17**, 225-40.

Harrington J. R. (1976) The diet of the swamp wallaby, *Wallabia bicolor*, at Diamond Flat, N.S.W. Diploma of Natural Resources thesis. *School of Natural Resources*, University of New England, Armidale, New South Wales.

Harris S., Cresswell W. J., Forde P. G., Trewhella W. J., Woollard T. & Wray S. (1990) Home-range analysis using radio-tracking data: a review of problems and techniques particularly as applied to the study of mammals. *Mammal. Rev.* **20**, 97-123.

Hendrick R. L. & Pregitzer K. S. (1992) The demography of fine roots in a northern hardwood forest. *Ecology* **73**, 1094-104.

Hilário R. R. & Ferrari S. F. (2010) Feeding ecology of a group of buffy-headed marmosets (*Callithrix flaviceps*): fungi as a preferred resource. *Am. J. Primatol.* **72**, 515-21.

Hill F. A. R. & Triggs B. E. (1985) Ecology and distribution of the long-footed potoroo (*Potorous longipes*)—a second preliminary examination. Department of Conservation, Forests and Lands, Victoria.

Hobbie E. A. (2006) Carbon allocation to ectomycorrhizal fungi correlates with belowground allocation in culture studies. *Ecology* **87**, 563-9.

Hoeksema J. D., Chaudhary V. B., Gehring C. A., Johnson N. C., Karst J., Koide R. T., Pringle A., Zabinski C., Bever J. D., Moore J. C., Wilson G. W. T., Klironomos J. N. & Umbanhowar J. (2010) A meta-analysis of context-dependency in plant response to inoculation with mycorrhizal fungi. *Ecol. Lett.* **13**, 394-407.

Högberg P., Nordgren A., Buchmann N., Taylor A. F. S., Ekblad A., Högberg M. N., Nyberg G., Ottosson-Löfvenius M. & Read D. J. (2001) Large-scale forest girdling shows that current photosynthesis drives soil respiration. *Nature* **411**, 789.

Holland G. J. & Bennett A. F. (2007) Occurrence of small mammals in a fragmented landscape: the role of vegetation heterogeneity. *Wildl. Res.* **34**, 387-97.

Holland G. J. & Bennett A. F. (2010) Habitat fragmentation disrupts the demography of a widespread native mammal. *Ecography* **33**, 841-53.

Hollis C. J., Robertshaw J. D. & Harden R. H. (1986) Ecology of the swamp wallaby (*Wallabia bicolor)* in north-eastern New South Wales. I. Diet. *Aust. Wildl. Res.* **13**, 355-65.

Horton T. R. & Bruns T. D. (1998) Multiple-host fungi are the most frequent and abundant ectomycorrhizal types in a mixed stand of Douglas fir (*Pseudotsuga menziesii*) and Bishop pine (*Pinus muricata*). *New Phytol.* **139**, 331-9.

Horton T. R. & Bruns T. D. (2001) The molecular revolution in ectomycorrhizal ecology: peeking into the black-box. *Mol. Ecol.* **10**, 1855-71.

Horton T. R., Cázares E. & Bruns T. D. (1998) Ectomycorrhizal, vesicular-arbuscular and dark septate fungal colonization of bishop pine (*Pinus muricata*) seedlings in the first 5 months of growth after wildfire. *Mycorrhiza* **8**, 11-8.

Houlder D. J., Hutchinson M. F., Nix H. A. & McMahon J. P. (2000) ANUCLIM user guide, version 5.1. Centre for Resource and Environmental Studies, Australian National University, Canberra.

Houston T. F. & Bougher N. L. (2010) Records of hypogeous mycorrhizal fungi in the diet of some Western Australian bolboceratine beetles (*Coleoptera*: Geotrupidae, Bolboceratinae). *Aust. J. Entomol.* **49**, 49-55.

Howe H. F. & Smallwood J. (1982) Ecology of seed dispersal. *Annu. Rev. Ecol. Syst.* **13**, 201-28.

Hubbell S. P. (1979) Tree dispersion, abundance, and diversity in a tropical dry forest. *Science* **203**, 1299-309.

Hume I. & Carlisle C. (1985) Radiographic studies on the structure and function of the gastrointestinal tract of two species of potoroine marsupials. *Aust. J. Zool.* **33**, 641-54.

Hume I. D. (1982) *Digestive Physiology and Nutrition of Marsupials*. University Press, Cambridge.

Hume I. D. (1984) Microbial fermentation in herbivorous marsupials. *Bioscience* **34**, 435-40.

Hume I. D. (1989) Optimal digestive strategies in mammalian herbivores. *Physiol. Zool.* **62**, 1145-63.

Hume I. D., Morgan K. R. & Kenagy G. J. (1993) Digesta retention and digestive performance in sciurid and microtine rodents: effects of hindgut morphology and body size. *Physiol. Zool.* **666**, 396-411.

Hunt G. A. & Trappe J. M. (1987) Seasonal hypogeous sporocarp production in a western Oregon Douglas-fir stand. *Can. J. Bot.* **65**, 438-45.

Hutto R. L. (1990) Measuring the availability of food resources. *Stud. Avian Biol.* **13**, 20-8.

Izzo A. D., Meyer M., Trappe J. M., North M. & Bruns T. D. (2005) Hypogeous ectomycorrhizal fungal species on roots and in small mammal diet in a mixed-conifer forest. *For. Sci.* **51**, 243-54.

Janos D. P. (1980) Vesicular-arbuscular mycorrhizae affect lowland tropical rain forest plant growth. *Ecology* **61**, 151-62.

Janos D. P., Sahley C. T. & Emmons L. H. (1995) Rodent dispersal of vesicular-arbuscular mycorrhizal fungi in Amazonian Peru. *Ecology* **76**, 1852-8.

Jarman P. & Vernes K. (2006) Wildlife. In: *High Lean Country. Land, People and Memory in New England* (eds A. Atkinson, J. S. Ryan, I. Davidson and A. Piper) pp. 44-56. Allen & Unwin, Crows Nest, NSW.

Johnson C. (1994a) Fruiting of hypogeous fungi in dry sclerophyll forest in Tasmania, Australia: seasonal variation and annual production. *Mycol. Res.* **98**, 1173-82.

Johnson C. N. (1994b) Mycophagy and spore dispersal by a rat-kangaroo: consumption of ectomycorrhizal taxa in relation to their abundance. *Funct. Ecol.* **8**, 464-8.

Johnson C. N. (1994c) Nutritional ecology of a mycophagous marsupial in relation to production of hypogeous fungi. *Ecology* **75**, 2015-21.

Johnson C. N. (1995) Interactions between fire, mycophagous mammals, and dispersal of ectomycorrhizal fungi in *Eucalyptus* forest. *Oecologia* **104**, 467-75.

Johnson C. N. (1996) Interactions between mammals and ectomycorrhizal fungi. *Trends Ecol. Evol.* **11**, 503-7.

Johnson C. N., Jarman P. J. & Southwell C. J. (1987) Macropod studies at Wallaby Creek V. Patterns of defaecation by eastern grey kangaroos and red-necked wallabies. *Aust. Wildl. Res.* **14**, 133-8.

Johnson C. N. & McIlwee A. P. (1997) Ecology of the northern bettong, *Bettongia tropica*, a tropical mycophagist. *Wildl. Res.* **24**, 549-59.

Johnson K. A., Burbidge A. A. & McKenzie N. L. (1989) Australian Macropodoidea: status, causes of decline and future research and management. In: *Kangaroos, Wallabies and Rat-Kangaroos* (eds G. Grigg, P. Jarman and I. Hume) pp. 641-57. Surrey Beatty & Sons, Chipping Norton, New South Wales.

Jones F. A. & Muller-Landau H. C. (2008) Measuring long-distance seed dispersal in complex natural environments: an evaluation and integration of classical and genetic methods. *J. Ecol.* **96**, 642-52.

Jonsson L., Dahlberg A., Nilsson M.-C., Zackrisson O. & Kårén O. (1999a) Ectomycorrhizal fungal communities in late-successional Swedish boreal forests, and their composition following wildfire. *Mol. Ecol.* **8**, 205-15.

Jonsson L., Dahlberg A., Nilsson M. C., Kårén O. & Zackrisson O. (1999b) Continuity of ectomycorrhizal fungi in self-regenerating boreal *Pinus sylvestris* forests studied by comparing mycobiont diversity on seedlings and mature trees. *New Phytol.* **142**, 151-62.

Jonsson L. M., Nilsson M.-C., Wardle D. A. & Zackrisson O. (2001) Context dependent effects of ectomycorrhizal species richness on tree seedling productivity. *Oikos* **93**, 353-64.

Jumpponen A., Claridge A. W., Trappe J. M., Lebel T. & Claridge D. L. (2004) Ecological relationships among hypogeous fungi and trees: inferences from association analysis integrated with habitat modeling. *Mycologia* **96**, 510-25.

Kelt D. A. & van Vuren D. (1999) Energetic constraints and the relationship between body size and home range area in mammals. *Ecology* **80**, 337-40.

Kennedy P. G., Izzo A. D. & Bruns T. D. (2003) There is high potential for the formation of common mycorrhizal networks between understorey and canopy trees in a mixed evergreen forest. *J. Ecol.* **91**, 1071-80.

Kenward R. E. (2001) *A Manual for Wildlife Radio Tagging*. Academic Press, London.

Kenward R. E., South A. B. & Walls S. S. (2006) Ranges7eXtra: for the analysis of tracking and location data. Online Manual. Anatrack Ltd., Wareham, UK.

Kinnear J. E., Cockson A., Christensen P. & Main A. R. (1979) The nutritional biology of the ruminants and ruminant-like mammals - a new approach. *Comparative Biochemistry and Physiology Part A Comparative Physiology* **64**, 357-65.

Kjoeller R. & Bruns T. D. (2003) *Rhizopogon* spore bank communities within and among California pine forests. *Mycologia* **95**, 603-13.

Koide R. T., Shumway D. L., Xu B. & Sharda J. N. (2007) On temporal partitioning of a community of ectomycorrhizal fungi. *New Phytol.* **174**, 420-9.

Kotter M. M. & Farentinos R. C. (1984a) Formation of ponderosa pine ectomycorrhizae after inoculation with feces of tassel-eared Squirrels. *Mycologia* **76**, 758-60.

Kotter M. M. & Farentinos R. C. (1984b) Tassel-eared squirrels as spore dispersal agents of hypogeous mycorrhizal fungi. *J. Mammal.* **65**, 684-7.

Kranabetter J., Durall D. & MacKenzie W. (2009) Diversity and species distribution of ectomycorrhizal fungi along productivity gradients of a southern boreal forest. *Mycorrhiza* **19**, 99-111.

Krebs C. J. (1999) *Ecological Methodology*. Benjamin-Cummings.

Kretzer A. M., Dunham S., Molina R. & Spatafora J. W. (2004) Microsatellite markers reveal the below ground distribution of genets in two species of *Rhizopogon* forming tuberculate ectomycorrhizas on Douglas fir. *New Phytol.* **161**, 313-20.

Kretzer A. M., Dunham S., Molina R. & Spatafora J. W. (2005) Patterns of vegetative growth and gene flow in *Rhizopogon vinicolor* and *R. vesiculosus* (Boletales, Basidiomycota). *Mol. Ecol.* **14**, 2259-68.

Kuikka K., Härmä E., Markkola A., Rautio P., Roitto M., Saikkonen K., Ahonen-Jonnarth U., Finlay R. & Tuomi J. (2003) Severe defoliation of Scots pine reduces reproductive investment by ectomycorrhizal symbionts. *Ecology* **84**, 2051-61.

Kytöviita M.-M. (2000) Do symbiotic fungi refresh themselves by incorporating their own or closely related spores into existing mycelium? *Oikos* **90**, 606-8.

Lamont B. B., Ralph C. S. & Christensen P. E. S. (1985) Mycophagous marsupials as dispersal agents for ectomycorrhizal fungi on *Eucalyptus calophylla* and *Gastrolobium bilobum*. *New Phytol.* **101**, 651-6.

Langer P. (1980) Anatomy of the stomach in three species of Potoroinae (Marsupialia: Macropodidae). *Aust. J. Zool.* **28**, 19-31.

Langer P., Dellow D. & Hume I. (1980) Stomach structure and function in three species of macropodine marsupials. *Aust. J. Zool.* **28**, 1-18.

Laurance W. F., Laurance S. G. & Hilbert D. W. (2008) Long-term dynamics of a fragmented rainforest mammal assemblage. *Conserv. Biol.* **22**, 1154-64.

Law B. S. & Dickman C. R. (1998) The use of habitat mosaics by terrestrial vertebrate fauna: implications for conservation and management. *Biodivers. Conserv.* **7**, 323-33.

Lebel T. & Castellano M. A. (1999) Australasian truffle-like fungi. IX. History and current trends in the study of the taxonomy of sequestrate macrofungi from Australia and New Zealand. *Aust. Syst. Bot.* **12**, 803-17.

Lebel T. & Castellano M. A. (2002) Type studies of sequestrate Russulales II. Australian and New Zealand species related to *Russula*. *Mycologia* **94**, 327-54.

Lebel T. & Tonkin J. E. (2007) Australasian species of Macowanites are sequestrate species of Russula (Russulaceae, Basidiomycota). *Aust. Syst. Bot.* **20**, 355-81.

Lebel T. & Trappe J. M. (2000) Type studies of sequestrate Russulales. I. Generic type species. *Mycologia* **92**, 1188-205.

Lehmkuhl J. F., Gould L. E., Cazares E. & Hosford D. R. (2004) Truffle abundance and mycophagy by northern flying squirrels in eastern Washington forests. *For. Ecol. Manag.* **200**, 49-65.

Lehouck V., Spanhove T., Demeter S., Groot N. E. & Lens L. (2009) Complementary seed dispersal by three avian frugivores in a fragmented Afromontane forest. *J. Veg. Sci.* **20**, 1110-20.

Lentle R., Stafford K. & Hume I. (2004) A comparison of the gross gastrointestinal morphology of genetically similar tammar wallabies (*Macropus eugenii*) from different nutritional environments. *Aust. J. Zool.* **52**, 437-46.

Levey D. J., Tewksbury J. J. & Bolker B. M. (2008) Modelling long-distance seed dispersal in heterogeneous landscapes. *J. Ecol.* **96**, 599-608.

Lilleskov E. A. & Bruns T. D. (2001) Nitrogen and ectomycorrhizal fungal communities: what we know, what we need to know. *New Phytol.* **149**, 156-8.

Lilleskov E. A. & Bruns T. D. (2005) Spore dispersal of a resupinate ectomycorrhizal fungus, *Tomentella sublilacina*, via soil food webs. *Mycologia* **97**, 762-9.

Lilleskov E. A. & Parrent J. L. (2007) Can we develop general predictive models of mycorrhizal fungal community–environment relationships? *New Phytol.* **174**, 250-6.

Lindenmayer D. B., Cunningham R. B., Donnelly C. F., Triggs B. E. & Belvedere M. (1994) Factors influencing the occurrence of mammals in retained linear strips (wildlife corridors) and contiguous stands of montane ash forest in the Central Highlands of Victoria, southeastern Australia. *For. Ecol. Manag.* **67**, 113-33.

Lindenmayer D. B., McCarthy M. A., Parris K. M. & Pope M. L. (2000) Habitat fragmentation, landscape context, and mammalian assemblages in southeastern Australia. *J. Mammal.* **81**, 787-97.

Lu X., Malajczuk N. & Dell B. (1998) Mycorrhiza formation and growth of Eucalyptus globulus seedlings inoculated with spores of various ectomycorrhizal fungi. *Mycorrhiza* **8**, 81-6.

Lundberg J. & Moberg F. (2003) Mobile link organisms and ecosystem functioning: implications for ecosystem resilience and management. *Ecosystems* **6**, 0087-98.

Lunney D., Matthews A. & Triggs B. (2001) Long-term changes in the mammal fauna of logged, coastal forests near Bega, New South Wales, detected by analysis of dog and fox scats. *Aust. Mammal.* **23**, 101-14.

Lunney D. & O'Connell M. (1988) Habitat selection by the swamp wallaby, *Wallabia bicolor*, the red-necked wallaby, *Macropus rufogriseus*, and the common wombat, *Vombatus ursinus*, in logged burnt forest near Bega, New South Wales. *Aust. Wildl. Res.* **15**, 695-706.

Luoma D. L., Eberhart J. L., Molina R. & Amaranthus M. P. (2004) Response of ectomycorrhizal fungus sporocarp production to varying levels and patterns of green-tree retention. *For. Ecol. Manag.* **202**, 337-54.

Luoma D. L., Frenkel R. E. & Trappe J. M. (1991) Fruiting of hypogeous fungi in Oregon Douglas-fir forests: seasonal and habitat variation. *Mycologia* **83**, 335-53.

Luoma D. L., Trappe J. M., Claridge A. W., Jacobs K. M. & Cazares E. (2003) Relationships among fungi and small mammals in forested ecosystems. In: *Mammal Community Dynamics: Management and Conservation in the Coniferous Forests of Western North America* (eds C. J. Zabel and R. G. Anthony) pp. 343-73. Cambridge University Press, Cambridge.

Malajczuk N., Molina R. & Trappe J. M. (1982) Ectomycorrhiza formation in *Eucalyptus*. I. Pure culture synthesis, host specificity and mycorrhizal compatibility with *Pinus radiata*. *New Phytol.* **91**, 467-82.

Malajczuk N., Trappe J. M. & Molina R. (1987) Interrelationships among some ectomycorrhizal trees, hypogeous fungi and small mammals: Western Australian and northwestern American parallels. *Aust. J. Ecol.* **12**, 53-5.

Mangan S. A. & Adler G. H. (1999) Consumption of arbuscular mycorrhizal fungi by spiny rats (*Proechimys semispinosus*) in eight isolated populations. *J. Trop. Ecol.* **15**, 779-90.

Mangan S. A. & Adler G. H. (2000) Consumption of arbuscular mycorrhizal fungi by terrestrial and arboreal small mammals in a Panamanian cloud forest. *J. Mammal.* **81**, 563-70.

Manly B. F. J., McDonald L. L., Thomas D. L., McDonald T. L. & Erickson W. P. (2002) *Resource Selection by Animals: Statistical Design and Analysis for Field Studies*. Kluwer Academic Publishers, Dordrecht, Netherlands.

Maser C., Claridge A. W. & Trappe J. M. (2008) *Trees, Truffles, and Beasts: How Forests Function*. Rutgers University Press, New Brunswick.

Maser C., Trappe J. M. & Nussbaum R. A. (1978) Fungal-small mammal interrelationships with emphasis on Oregon coniferous forests. *Ecology* **59**, 799-809.

Maser Z., Maser C. & Trappe J. M. (1985) Food habits of the northern flying squirrel (*Glaucomys sabrinus*) in Oregon. *Can. J. Zool.* **63**, 1084-8.

Maxwell S., Burbidge A. A. & Morris K. (1996) The 1996 Action Plan for Australian Marsupials and Monotremes. Wildlife Australia.

May T. W. (2002) Where are the short-range endemics among Western Australian macrofungi? *Aust. Syst. Bot.* **15**, 501-11.

May T. W. & Simpson J. A. (1997) Fungal diversity and ecology in eucalypt ecosystems. In: *Eucalypt Ecology - Individuals to Ecosystems* (eds J. E. Williams and J. C. Z. Woinarski) pp. 246-77. Cambridge University Press, Cambridge.

Mayor J. R., Schuur E. A. G. & Terry W. Henkel. (2009) Elucidating the nutritional dynamics of fungi using stable isotopes. *Ecol. Lett.* **12**, 171-83.

McClelland K. L., Hume I. D. & Soran N. (1999) Responses of the digestive tract of the omnivorous northern brown bandicoot, *Isoodon macrourus* (Marsupialia: Peramelidae), to plant- and insect-containing diets. *J. Comp. Physiol. B Biochem. Syst. Environ. Physiol.* **169**, 411-8.

McDonald R. C., Isbell R. F., Speight J. G., Walker J. & Hopkins M. S. (1990) *Australian Soil and Land Survey Field Handbook*. Inkata Press, Melbourne.

McGee P. A. & Baczocha N. (1994) Sporocarpic Endogonales and Glomales in the scats of *Rattus* and *Perameles*. *Mycol. Res.* **98**, 246-9.

McIlwee A. P. & Johnson C. N. (1998) The contribution of fungus to the diets of three mycophagous marsupials in *Eucalyptus* forests, revealed by stable isotope analysis. *Funct. Ecol.* **12**, 223-31.

McIntire P. W. (1984) Fungus consumption by the Siskiyou chipmunk within a variously treated forest. *Ecology* **65**, 137-46.

McIntosh D. (1966) The digestibility of two roughages and the rates of passages of their residues by the Red Kangaroo, *Megaleia rufa* (Desmarest), and the merino sheep. *CSIRO Wildl. Res.* **11**, 125-35.

McIntyre S. & Barrett G. W. (1992) Habitat variegation, an alternative to fragmentation. *Conserv. Biol.* **6**, 146-7.

McIntyre S. & Hobbs R. (1999) A framework for conceptualizing human effects on landscapes and its relevance to management and research models. *Conserv. Biol.* **13**, 1282-92.

McIntyre S. & Lavorel S. (1994) Predicting richness of native, rare, and exotic plants in response to habitat and disturbance variables across a variegated landscape. *Conserv. Biol.* **8**, 521-31.

McKenzie D. C. (1976) The distribution and abundance of macropod species in rainforest, eucalypt forest and exotic pine plantation at clouds creek, NSW. B. Nat. Res. thesis. University of New England, Armidale.

McMullan-Fisher S. J. M., Kirkpatrick J. B., May T. W. & Pharo E. J. (2010) Surrogates for macrofungi and mosses in reservation planning. *Conserv. Biol.* **24**, 730-6.

Medway D. G. (2000) Mycophagy by North Island robin. *Aust. Mycol.* **19**, 102.

Merchant J. C. (1995) Swamp wallaby. In: *The Mammals of Australia* (ed R. Strahan) pp. 404-5. Reed Books, Chatswood.

Miller S. L., Torres P. & McClean T. M. (1994) Persistence of basidiospores and sclerotia of ectomycorrhizal fungi and *Morchella* in soil. *Mycologia* **86**, 89-95.

Millington S., Leach D. N., Wyllie S. G. & Claridge A. W. (1998) Aroma profile of the Australian truffle-like fungus *Mesophellia glauca*. In: *Flavor Analysis* pp. 331-42. American Chemical Society.

Mills K. J., Patterson B. R. & Murray D. L. (2006) Effects of variable sampling frequencies on GPS transmitter efficiency and estimated wolf home range size and movement distance. *Wildl. Soc. Bull.* **34**, 1463-9.

Mittelbach G. G., Steiner C. F., Scheiner S. M., Gross K. L., Reynolds H. L., Waide R. B., Willig M. R., Dodson S. I. & Gough L. (2001) What is the observed relationship between species richness and productivity? *Ecology* **82**, 2381-96.

Molina R., Horton T. R., Trappe J. M. & Marcot B. G. (2011) Addressing uncertainty: how to conserve and manage rare or little-known fungi. *Fungal Ecol.* **4**, 134-46.

Molina R., Massicotte H. & Trappe J. M. (1992) Specificity phenomena in mycorrhizal symbioses: community-ecological consequences and practical implications. In: *Mycorrhizal functioning: an integrative plant-fungal process* (ed M. J. Allen) pp. 357-423. Routledge, Chapman & Hall, New York.

Moore B. D. & Foley W. J. (2000) A review of feeding and diet selection in koalas (*Phascolarctos cinereus*). *Aust. J. Zool.* **48**, 317-33.

Moore P. D. (1996) Invertebrates and mycophagy. *Nature* **381**, 372-3.

Moyle D. I., Hume I. D. & Hill D. M. (1995) Digestive performance and selective digesta retention in the long-nosed bandicoot, *Perameles nasuta*, a small omnivorous marsupial. *J. Comp. Physiol. B Biochem. Syst. Environ. Physiol.* **164**, 552-60.

Mueller G., Schmit J., Leacock P., Buyck B., Cifuentes J., Desjardin D., Halling R., Hjortstam K., Iturriaga T., Larsson K.-H., Lodge D., May T., Minter D., Rajchenberg M., Redhead S., Ryvarden L., Trappe J., Watling R. & Wu Q. (2007) Global diversity and distribution of macrofungi. *Biodivers. Conserv.* **16**, 37-48.

Muller-Landau H. C., Wright S. J., Calderón O., Condit R. & Hubbell S. P. (2008) Interspecific variation in primary seed dispersal in a tropical forest. *J. Ecol.* **96**, 653-67.

Munn A. J. & Dawson T. J. (2006) Forage fibre digestion, rates of feed passage and gut fill in juvenile and adult red kangaroos *Macropus rufus* Desmarest: why body size matters. *J. Exp. Biol.* **209**, 1535-47.

Nathan R. (2006) Long-distance dispersal of plants. *Science* **313**, 786-8.

Nehls U., Göhringer F., Wittulsky S. & Dietz S. (2010) Fungal carbohydrate support in the ectomycorrhizal symbiosis: a review. *Plant Biology* **12**, 292-301.

Nguyen V., Needham A. & Friend J. (2005) A quantitative dietary study of the 'critically endangered' Gilbert's potoroo *Potorous gilbertii*. *Aust. Mammal.* **27**, 1-6.

Norbury G. L. & Sanson G. D. (1992) Problems with measuring diet selection of terrestrial, mammalian herbivores. *Aust. J. Ecol.* **17**, 1-7.

North M., Trappe J. M. & Franklin J. F. (1997) Standing crop and animal consumption of fungal sporocarps in Pacific Northwest forests. *Ecology* **78**, 1543-54.

Northcote K. H. (1979) *A Factual Key for the Recognition of Australian Soils*. Rellim Technical Publications, Glenside.

NSW Department of Environment Climate Change and Water. (2010) Mount Kaputar National Park: Climate. http://www.environment.nsw.gov.au/NationalParks/parkClimate.aspx?id=N0038.

NSW National Parks and Wildlife Service. (1991) New England National Park Plan of Management. Department of Environment and Conservation (NSW), Hurstville.

NSW National Parks and Wildlife Service. (2002) Cathedral Rock National Park Plan of Management. NSW National Parks and Wildlife Service, Hurstville.

NSW National Parks and Wildlife Service. (2003) Booroolong Nature Reserve plan of management. NSW National Parks and Wildlife Service, Hurstville.

NSW National Parks and Wildlife Service. (2004) Mount Kaputar National Park plan of management. Department of Environment and Conservation (NSW), Hurstville.

NSW National Parks and Wildlife Service. (2010) Atlas of New South Wales Wildlife. NSW Department of Environment Climate Change and Water. http://wildlifeatlas.nationalparks.nsw.gov.au/wildlifeatlas/watlas.jsp.

Orians G. H. (1997) Evolved consequences of rarity. In: *The Biology of Rarity* (eds W. E. Kunin and K. J. Gaston) pp. 190-205. Chapman & Hall, London.

Osawa R. (1990) Feeding strategies of the swamp wallaby, *Wallabia bicolor*, on North Stradbroke Island, Queensland. I: Composition of diets. *Aust. Wildl. Res.* **17**, 615-21.

Osawa R. & Woodall P. (1990) Feeding strategies of the swamp wallaby, *Wallabia bicolor*, on North Stradbroke Island, Queensland .2. Effects of seasonal changes in diet quality on intestinal morphology. *Aust. Wildl. Res.* **17**, 623-32.

Osawa R. & Woodall P. (1992) A comparative study of macroscopic and microscopic dimensions of the intestine in five macropods (Marsupialia, Macropodidae).2. Relationship with feeding habits and fiber content of the diet. *Aust. J. Zool.* **40**, 99-113.

Packham J. M., May T. W., Brown M. J., Wardlow T. J. & Mills A. K. (2002) Macrofungal diversity and community ecology in mature and regrowth wet eucalypt forest in Tasmania: A multivariate study. *Austral. Ecol.* **27**, 149-61.

Parrent J. L. & Vilgalys R. (2007) Biomass and compositional responses of ectomycorrhizal fungal hyphae to elevated CO_2 and nitrogen fertilization. *New Phytol.* **176**, 164-74.

Pärtel M., Laanisto L. & Zobel M. (2007) Contrasting plant productivity-diversity relationships across latitude: the role of evolutionary history. *Ecology* **88**, 1091-7.

Peay K. G., Bruns T. D., Kennedy P. G., Bergemann S. E. & Garbelotto M. (2007) A strong species-area relationship for eukaryotic soil microbes: island size matters for ectomycorrhizal fungi. *Ecol. Lett.* **10**, 470-80.

Peay K. G., Kennedy P. G. & Bruns T. D. (2008) Fungal community ecology: a hybrid beast with a molecular master. *Bioscience* **58**, 799-810.

Peay K. G., Kennedy P. G., Davies S. J., Tan S. & Bruns T. D. (2010) Potential link between plant and fungal distributions in a dipterocarp rainforest: community and phylogenetic structure of tropical ectomycorrhizal fungi across a plant and soil ecotone. *New Phytol.* **185**, 529-42.

Pei Y. X., Wang D. H. & Hume I. D. (2001) Selective digesta retention and coprophagy in Brandt's vole (*Microtus brandti*). *J. Comp. Physiol. B Biochem. Syst. Environ. Physiol.* **171**, 457-64.

Perry D. A., Amaranthus M. P., Borchers J. G., Borchers S. L. & Brainerd R. E. (1989) Bootstrapping in ecosystems. *Bioscience* **39**, 230-7.

Pople A. (1989) Habitat associations of Australian Macropodidae. In: *Kangaroos, Wallabies and Rat-Kangaroos* (eds G. Grigg, P. Jarman and I. Hume) pp. 755-66. Surrey Beatty & Sons, Chipping Norton.

Porteners M. F. (1998) Vegetation survey of Mt Kaputar National Park (southern portion). p. 61.

Porter L. (2001) Dietary Differences Among Sympatric Callitrichinae in Northern Bolivia: *Callimico goeldii*, *Saguinus fuscicollis* and *S. labiatus*. *Int. J. Primatol.* **22**, 961-92.

Preston F. W. (1948) The commonness, and rarity, of species. *Ecology* **29**, 254-83.

Pyare S. & Longland W. S. (2001a) Mechanisms of truffle detection by northern flying squirrels. *Can. J. Zool.* **79**, 1007-15.

Pyare S. & Longland W. S. (2001b) Patterns of ectomycorrhizal-fungi consumption by small mammals in remnant old-growth forests of the Sierra Nevada. *J. Mammal.* **82**, 681-9.

R Foundation for Statistical Computing. (2009) R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria. http://www.R-project.org.

Ramsey D. S. L. & Wilson J. C. (1997) The impact of grazing by macropods on coastal foredune vegetation in southeast Queensland. *Aust. J. Ecol.* **22**, 288-97.

Rayment G. E. & Higginson F. R. (1992) *Australian Laboratory Handbook of Soil and Water Chemical Methods*. Inkata Press, Melbourne.

Read D. (1997) Mycorrhizal fungi: the ties that bind. *Nature* **388**, 517-8.

Read D. J. (1991) Mycorrhizas in ecosystems. *Experientia* **47**, 376-91.

Reddell P. & Spain A. V. (1991) Earthworms as vectors of viable propagules of mycorrhizal fungi. *Soil Biology and Biochemistry* **23**, 767-74.

Reddell P., Spain A. V. & Hopkins M. (1997) Dispersal of spores of mycorrhizal fungi in scats of native mammals in tropical forests of northeastern Australia. *Biotropica* **29**, 184-92.

Redecker D., Szaro T. M., Bowman R. J. & Bruns T. D. (2001) Small genets of *Lactarius xanthogalactus*, *Russula cremoricolor* and *Amanita francheti* in late-stage ectomycorrhizal successions. *Mol. Ecol.* **10**, 1025-34.

Rempel R. S., Rodgers A. R. & Abraham K. F. (1995) Performance of a GPS animal location system under boreal forest canopy. *J. Wildl. Manag.* **59**, 543-51.

Richard F., Moreau P. A., Selosse M. A. & Gardes M. (2004) Diversity and fruiting patterns of ectomycorrhizal and saprobic fungi in an old-growth Mediterranean forest dominated by *Quercus ilex* L. *Can. J. Bot.* **82**, 1711.

Richardson K. C. (1989) Radiographic studies on the form and function of the gastrointestinal tract of the Woylie (*Bettongia penicillata*). In: *Kangaroos, Wallabies and Rat-kangaroos* (eds G. Grigg, P. Jarman and I. D. Hume) pp. 205-15. Surrey Beatty & Sons, Chipping Norton, Australia.

Rillig M. C. & Mummey D. L. (2006) Mycorrhizas and soil structure. *New Phytol.* **171**, 41-53.

Rinaldi A. C., Comandini O. & Kuyper T. W. (2008) Ectomycorrhizal fungal diversity: separating the wheat from the chaff. *Fungal Divers.* **33**, 1-45.

Robinson R. M., Mellican A. E. & Smith R. H. (2008) Epigeous macrofungal succession in the first five years following a wildfire in karri (*Eucalyptus diversicolor*) regrowth forest in Western Australia. *Austral. Ecol.* **33**, 807-20.

Royal Botanic Gardens Melbourne. (2011) Interactive Catalogue of Australian Fungi. Royal Botanic Gardens Melbourne. http://www.rbg.vic.gov.au/dbpages/cat/index.php/fungicatalogue.

Ruhinda G. C. (1984) The altitudinal distribution of vegetation on Mount Duval, Armidale. M. Nat. Res. thesis. University of New England, Armidale.

Sakaguchi E. & Hume I. D. (1990) Digesta retention and fibre digestion in brushtail possums, ringtail possums and rabbits. *Comparative Biochemistry and Physiology, Part A: Molecular & Integrative Physiology* **96A**, 351-4.

Schmidt B. (2010) Habitat partitioning among sympatric grey kangaroos and swamp wallabies in box-ironbark remnants. In: *Macropods: the Biology of Kangaroos, Wallabies and Rat-Kangaroos* (eds G. Coulson and M. Eldridge). CSIRO Publishing, Collingwood, Victoria, Australia.

Scotts D. J. & Seebeck J. H. (1989) Ecology of *Potorous longipes* (Marsupialia: Potoroidae); and preliminary recommendations for management of its habitat in Victoria. Arthur Rylah Institute for Environmental Research, Melbourne.

Senft R. L., Coughenour M. B., Bailey D. W., Rittenhouse L. R., Sala O. E. & Swift D. M. (1987) Large herbivore foraging and ecological hierarchies. *Bioscience* **37**, 789-99.

Simard S. W. & Durall D. M. (2004) Mycorrhizal networks: a review of their extent, function, and importance. *Can. J. Bot.* **82**, 1140-65.

Simpson J. A. (1998) Why don't more birds eat more fungi? *Aust. Mycol. Newsl.* **17**, 67-8.

Simpson J. A. (2000) More on mycophagous birds. *Aust. Mycol.* **19**, 49-51.

Sinclair E. A., Danks A. & Wayne A. F. (1995) Rediscovery of Gilbert's potoroo, *Potorous tridactylus*, in Western Australia. *Aust. Mammal.* **19**, 69-72.

Smith A. P., Rowe M. D. & Andrews S. P. (1987) Newholme, a progress report of the Newholme Field Laboratory. University of New England, Armidale.

Smith J. E., Molina R., Huso M. M. P., Luoma D. L., McKay D., Castellano M. A., Lebel T. & Valachovic Y. (2002) Species richness, abundance, and composition of hypogeous and epigeous ectomycorrhizal fungal sporocarps in young, rotation-age, and old-growth stands of Douglas-fir (*Pseudotsuga menziesii*) in the Cascade Range of Oregon, U.S.A. *Can. J. Bot.* **80**, 186-204.

Smith M. E., Douhan G. W., Fremier A. K. & Rizzo D. M. (2009) Are true multihost fungi the exception or the rule? Dominant ectomycorrhizal fungi on *Pinus sabiniana* differ from those on co-occurring *Quercus* species. *New Phytol.* **182**, 295-9.

Smith S. E. & Read D. J. (1997) *Mycorrhizal symbiosis*. Academic Press, San Diego.

Southwell C. (1989) Techniques for monitoring the abundance of kangaroo and wallaby populations. In: *Kangaroos, Wallabies and Rat-kangaroos* (eds G. Grigg, P. Jarman and I. Hume) pp. 659-93. Surrey Beatty & Sons Pty Ltd, Chipping Norton, New South Wales.

Speigel O. & Nathan R. (2007) Incorporating dispersal distance into the disperser effectiveness framework: frugivorous birds provide complementary dispersal to plants in a patchy environment. *Ecol. Lett.* **10**, 718-28.

Stein C., Auge H., Fischer M., Weisser W. W. & Prati D. (2008) Dispersal and seed limitation affect diversity and productivity of montane grasslands. *Oikos* **117**, 1469-78.

Stendell E. R., Horton T. R. & Bruns T. D. (1999) Early effects of prescribed fire on the structure of the ectomycorrhizal fungus community in a Sierra Nevada ponderosa pine forest. *Mycol. Res.* **103**, 1353-9.

Stern H., de Hoedt G. & Ernst J. (2000) Objective classification of Australian climates. *Australian Meteorological Magazine* **49**, 87-96.

Stevens C. E. & Hume I. D. (1995) *Comparative Physiology of the Vertebrate Digestive System* Cambridge University Press, Cambridge.

Swan M., Di Stefano J., Greenfield A. & Coulson G. (2009) Fine-scale habitat selection by adult female swamp wallabies (*Wallabia bicolor*). *Aust. J. Zool.* **56**, 305-9.

Talbot J. M., Allison S. D. & Treseder K. K. (2008) Decomposers in disguise: mycorrhizal fungi as regulators of soil C dynamics in ecosystems under global change. *Funct. Ecol.* **22**, 955-63.

Taylor A. F. S. (2002) Fungal diversity in ectomycorrhizal communities: sampling effort and species detection. *Plant Soil* **244**, 19-28.

Taylor R. J. (1983) The diet of the eastern grey kangaroo and wallaroo in areas of improved and native pasture in the New England Tablelands. *Aust. Wildl. Res.* **10**, 203-11.

Taylor R. J. (1984) Foraging in the Eastern grey kangaroo and the Wallaroo. *J. Anim. Ecol.* **53**, 65-74.

Taylor R. J. (1991) Plants, fungi and bettongs: A fire-dependent co-evolutionary relationship. *Aust. J. Ecol.* **16**, 409-11.

Taylor R. J. (1992a) Distribution and abundance of fungal sporocarps and diggings of the Tasmanian bettong, *Bettongia gaimardi*. *Austral. Ecol.* **17**, 155-60.

Taylor R. J. (1992b) Seasonal changes in the diet of the Tasmanian bettong (*Bettongia gaimardi*), a mycophagous marsupial. *J. Mammal.* **73**, 408-14.

Tedersoo L., Jairus T., Horton B. M., Abarenkov K., Suvi T., Saar I. & Kõljalg U. (2008) Strong host preference of ectomycorrhizal fungi in a Tasmanian wet sclerophyll forest as revealed by DNA barcoding and taxon-specific primers. *New Phytol.* **180**, 479-90.

Tedersoo L., May T. & Smith M. (2010) Ectomycorrhizal lifestyle in fungi: global diversity, distribution, and evolution of phylogenetic lineages. *Mycorrhiza* **20**, 217-63.

Terwilliger J. & Pastor J. (1999) Small mammals, ectomycorrhizae, and conifer succession in beaver meadows. *Oikos* **85**, 83-94.

Theodorou C. & Bowen G. D. (1973) Inoculation of seeds and soil with basidiospores of mycorrhizal fungi. *Soil Biology and Biochemistry* **5**, 765-71.

Thiers H. D. (1984) The secotioid syndrome. *Mycologia* **76**, 1-8.

Tierney G. L. & Fahey T. J. (2002) Fine root turnover in a northern hardwood forest: a direct comparison of the radiocarbon and minirhizotron methods. *Can. J. For. Res.* **32**, 1692-7.

Tilman D., Lehman C. L. & Thomson K. T. (1997) Plant diversity and ecosystem productivity: theoretical considerations. *Proc. Natl. Acad. Sci. U. S. A.* **94**, 1857-61.

Tobler M. W. (2009) New GPS technology improves fix success for large mammal collars in dense tropical forests. *J. Trop. Ecol.* **25**, 217-21.

Tommerup I. C. & Bougher N. L. (1999) The role of ectomycorrhizal fungi in nutrient cycling in temperate Australian woodlands. In: *Temperate Eucalypt Woodlands in Australia: Biology, Conservation, Management and Restoration* (eds R. J. Hobbs and C. J. Yates) pp. 190-224. Surrey Beatty & Sons, Chipping Norton, Australia.

Tory M. K., May T. W., Keane P. J. & Bennett A. F. (1997) Mycophagy in small mammals: A comparison of the occurrence and diversity of hypogeal fungi in the diet of the long-nosed potoroo *Potorous tridactylus* and the bush rat *Rattus fuscipes* from southwestern Victoria, Australia. *Aust. J. Ecol.* **22**, 460-70.

Tóth B. & Barta Z. (2010) Ecological studies of ectomycorrhizal fungi: an analysis of survey methods. *Fungal Divers.* **45**, 3-19.

Trappe J. M. (1988) Lessons from alpine fungi. *Mycologia* **80**, 1-10.

Trappe J. M. & Claridge A. W. (2005) Hypogeous fungi: evolution of reproductive and dispersal strategies through interactions with animals and mycorrhizal plants. In: *The Fungal Community: Its Organization and Role in the Ecosystem* (eds J. Dighton, J. F. White and P. Oudemans) pp. 613-23. CRC Press, Boca Raton.

Trappe J. M. & Maser C. (1976) Germination of spores of *Glomus macrocarpus* (Endogonaceae) after passage through a rodent digestive tract. *Mycologia* **68**, 433-6.

Trappe J. M. & Maser C. (1977) Ectomycorrhizal fungi: interactions of mushrooms and truffles with beasts and trees. In: *Mushrooms and Man, an interdisciplinary approach to mycology* (ed T. Walters) pp. 165-79. Forest Service, United States Department of Agriculture.

Trappe J. M., Nicholls A. O., Claridge A. W. & Cork S. J. (2006) Prescribed burning in a *Eucalyptus* woodland suppresses fruiting of hypogeous fungi, an important food source for mammals. *Mycol. Res.* **110**, 1333-9.

Treseder K. K. & Allen M. F. (2000) Research review: mycorrhizal fungi have a potential role in soil carbon storage under elevated CO_2 and nitrogen deposition. *New Phytol.* **147**, 189-200.

Trowbridge J. & Jumpponen A. (2004) Fungal colonization of shrub willow roots at the forefront of a receding glacier. *Mycorrhiza* **14**, 283-93.

Troy S. & Coulson G. (1993) Home range of the swamp wallaby, *Wallabia bicolor. Wildl. Res.* **20**, 571-7.

Troy S., Coulson G. & Middleton D. (1992) A comparison of radio-tracking and line transect techniques to determine habitat preferences in the swamp wallaby (*Wallabia bicolor*) in south-eastern Australia. In: *Wildlife Telemetry: Remote Monitoring and Tracking of Animals* (eds I. G. Priede and S. M. Swift) pp. 651-60. Ellis Horwood, New York.

Udén P., Colucci P. E. & Van Soest P. J. (1980) Investigation of chromium, cerium and cobalt as markers in digesta. Rate of passage studies. *J. Sci. Food Agric.* **31**, 625-32.

Underwood A. J. (1997) *Experiments in Ecology: Their Logical Design and Interpretation Using Analysis of Variance.* Cambridge University Press, Cambridge.

van der Heijden M. G. A., Klironomos J. N., Ursic M., Moutoglis P., Streiwolf-Engel R., Boller T., Weiemken A. & Sanders I. R. (1998) Mycorrhizal fungal diversity determines plant biodiversity, ecosystem variability and productivity. *Nature* **396**, 69-72.

Van der Pijl L. (1982) *Principles of Dispersal in Higher Plants* Springer-Verlag, Berlin.

Vernes K. (2007) Are diverse mammal communities important for maintaining plant-fungal associations and ecosystem health? *Aust. Plant Conserv.* **15**, 16-8.

Vernes K. (2010) Mycophagy in a community of macropod species. In: *Macropods: The Biology of Kangaroos, Wallabies and Rat-kangaroos* (eds G. Coulson and M. Eldridge) pp. 155-69. CSIRO Publishing, Collingwood, Victoria, Australia.

Vernes K., Blois S. & Baerlocher F. (2004a) Seasonal and yearly changes in consumption of hypogeous fungi by northern flying squirrels and red squirrels in old-growth forest, New Brunswick. *Can. J. Zool.* **82**, 110-7.

Vernes K., Castellano M. & Johnson C. N. (2001) Effects of season and fire on the diversity of hypogeous fungi consumed by a tropical mycophagous marsupial. *J. Anim. Ecol.* **70**, 945-54.

Vernes K. & Dunn L. (2009) Mammal mycophagy and fungal spore dispersal across a steep environmental gradient in eastern Australia. *Austral. Ecol.* **34**, 69-76.

Vernes K., Johnson C. N. & Castellano M. A. (2004b) Fire-related changes in biomass of hypogeous sporocarps at foraging points used by a tropical mycophagous marsupial. *Mycol. Res.* **108**, 1438-46.

Vernes K. & McGrath K. (2009) Are introduced black rats (*Rattus rattus*) a functional replacement for mycophagous native rodents in fragmented forests? *Fungal Ecol.* **2**, 145-9.

Vernes K. & Trappe J. M. (2007) Hypogeous fungi in the diet of the red-legged pademelon *Thylogale stigmatica* from a rainforest-open forest interface in northeastern Australia. *Aust. Zool.* **34**, 203-8.

Vernes K. A. (1999) Fire, fungi and a tropical mycophagist: ecology of the northern bettong (*Bettongia tropica*) in fire-prone sclerophyll forest. PhD thesis. *School of Biological Sciences*, James Cook University, Townsville.

Waide R. B., Willig M. R., Steiner C. F., Mittelbach G., Gough L., Dodson S. I., Juday G. P. & Parmenter R. (1999) The relationship between productivity and species richness. *Annu. Rev. Ecol. Syst.* **30**, 257-300.

Wallis I. R. (1994) The rate of passage of digesta through the gastrointestinal tracts of potoroine marsupials: more evidence about the role of the potoroine foregut. *Physiol. Zool.* **67**, 771-95.

Warcup J. H. (1980) Ectomycorrhizal associations of Australian indigenous plants. *New Phytol.* **85**, 531-5.

Wardle D. A. (2006) The influence of biotic interactions on soil biodiversity. *Ecol. Lett.* **9**, 870-86.

Warner A. (1981a) The mean retention times of digesta markers in the gut of the tammar, *Macropus eugenii*. *Aust. J. Zool.* **29**, 759-71.

Warner A. (1981b) Patterns of feeding, defaecation and digestion in the tammar, *Macropus eugenii*, under laboratory conditions. *Aust. J. Zool.* **29**, 751-7.

Warner A. C. I. (1981c) The rate of passage of digesta through the gut of mammals and birds. *Nutr. Abstr. Rev. Ser. B* **51**, 789-820.

Waters J. R. & Zabel C. J. (1995) Northern flying squirrel densities in fir forests of northeastern California. *J. Wildl. Manag.* **59**, 858-66.

Wellard G. & Hume I. (1981) Digestion and digesta passage in the brushtail possum, *Trichosurus vulpecula* (Kerr). *Aust. J. Zool.* **29**, 157-66.

Westoby M. (1974) An analysis of diet selection by large generalist herbivores. *Am. Nat.* **108**, 290-304.

Will H. & Tackenberg O. (2008) A mechanistic simulation model of seed dispersal by animals. *J. Ecol.* **96**, 1011-22.

Williams S. E., Marsh H. & Winter J. (2002) Spatial scale, species diversity, and habitat structure: small mammals in Australian tropical rain forest. *Ecology* **83**, 1317-29.

Willig M. R. & Lacher T. E., Jr. (1991) Food selection of a tropical mammalian folivore in relation to leaf-nutrient content. *J. Mammal.* **72**, 314-21.

Willis K. J. & Whittaker R. J. (2002) Species diversity: scale matters. *Science* **295**, 1245-8.

Willson M. F., Rice B. L. & Westoby M. (1990) Seed dispersal spectra: a comparison of temperate plant communities. *J. Veg. Sci.* **1**, 547-62.

Wilson G. W. T., Rice C. W., Rillig M. C., Springer A. & Hartnett D. C. (2009) Soil aggregation and carbon sequestration are tightly correlated with the abundance of arbuscular mycorrhizal fungi: results from long-term field experiments. *Ecol. Lett.* **12**, 452-61.

Worton B. J. (1987) A review of models of home range for animal movement. *Ecol. Model.* **38**, 277-98.

Worton B. J. (1989) Kernel methods for estimating the utilization distribution in home-range studies. *Ecology* **70**, 164-8.

Xiao S., Zobel M., Szava-Kovats R. & Pärtel M. (2010) The effects of species pool, dispersal and competition on the diversity–productivity relationship. *Glob. Ecol. Biogeogr.* **19**, 343-51.

Young Owl M. & Batzli G. O. (1998) The integrated processing response of voles to fibre content of natural diets. *Funct. Ecol.* **12**, 4-13.

Zobel M., Öpik M., Moora M. & Pärtel M. (2006) Biodiversity and ecosystem functioning: it is time for dispersal experiments. *J. Veg. Sci.* **17**, 543-7.

Appendices

Appendix 1. Attributes of site x forest type combinations (mean ± SE of three replicate quadrats). Values of categorical attributes are presented as ranges. MK = Mt Kaputar site, NE = New England site, GW = grassy woodland, WS = wet forest, DS = dry forest.

	MK			NE		
Attribute	GW	WS	DS	GW	WS	DS
Climate [a]						
Annual mean temperature (°C)	10.9 ± 0.1	11.6 ± 0.1	13.5 ± 0.1	9.6 ± 0	10.7 ± 0	11.2 ± 0.1
Mean diurnal temperature range (°C)	12.5 ± 0	12.9 ± 0.1	13.8 ± 0.1	9.8 ± 0	10.6 ± 0	11.2 ± 0.1
Annual temperature range (°C)	27.4 ± 0	28 ± 0.1	29.2 ± 0.1	21 ± 0	22 ± 0	22.8 ± 0.1
Mean temperature wettest quarter (°C)	17.7 ± 0.1	18.5 ± 0.1	20.5 ± 0.1	14.2 ± 0	15.3 ± 0	16.4 ± 0.1
Mean temperature driest quarter (°C)	7.5 ± 0.1	7.3 ± 0.4	8.4 ± 0.1	6.1 ± 0	7.1 ± 0	7.1 ± 0.1
Mean temperature warmest quarter (°C)	17.8 ± 0.1	18.5 ± 0.1	20.5 ± 0.1	14.6 ± 0	15.7 ± 0	16.4 ± 0.1
Mean temperature coldest quarter (°C)	4 ± 0.1	4.6 ± 0.1	6.3 ± 0.1	4.4 ± 0	5.3 ± 0	5.8 ± 0.1
Annual mean precipitation (mm)	1222 ± 5.7	1160.7 ± 10.3	1022.7 ± 10.1	2093 ± 9.3	1651 ± 10.6	1218.3 ± 8
Mean precipitation wettest quarter (mm)	374 ± 1.5	359 ± 2.6	328 ± 2.3	871 ± 4.6	641.7 ± 5.6	453.3 ± 1.2
Mean precipitation driest quarter (mm)	260.3 ± 1.2	247.7 ± 2.3	217 ± 2.3	266.3 ± 0.9	226.7 ± 0.9	186 ± 2.3
Mean precipitation warmest quarter (mm)	372 ± 1.5	357.7 ± 2.3	328 ± 2.3	772 ± 3.6	604.3 ± 3.8	452.7 ± 1.5
Mean precipitation coldest quarter (mm)	294 ± 1.5	276.7 ± 2.9	237 ± 2.9	365 ± 1.2	308.7 ± 1.5	238.7 ± 4.1
Annual mean radiation (Mj/m^2)	17.1 ± 0	17.3 ± 0	17.6 ± 0	15.9 ± 0	16.4 ± 0	17 ± 0
Mean radiation wettest quarter (Mj/m^2)	21.7 ± 0.1	22 ± 0	22.3 ± 0	17.9 ± 0	18.4 ± 0	20.9 ± 0
Mean radiation driest quarter (Mj/m^2)	16.7 ± 0	15.8 ± 0.5	15.3 ± 0.2	15.1 ± 0	15.4 ± 0	15.1 ± 0
Mean radiation warmest quarter (Mj/m^2)	22.2 ± 0	22.3 ± 0	22.7 ± 0	19.6 ± 0	20.2 ± 0	21.2 ± 0
Mean radiation coldest quarter (Mj/m^2)	11 ± 0	11.1 ± 0	11.3 ± 0	11 ± 0	11.2 ± 0	11.5 ± 0
Annual mean moisture index (0–1)	0.8 ± 0	0.8 ± 0	0.7 ± 0	1 ± 0	1 ± 0	0.9 ± 0
Mean moisture index highest moisture quarter (0–1)	1 ± 0	1 ± 0	1 ± 0	1 ± 0	1 ± 0	1 ± 0

Attribute	MK			NE		
	GW	WS	DS	GW	WS	DS
Mean moisture index lowest moisture quarter (0–1)	0.6 ± 0	0.6 ± 0	0.5 ± 0	1 ± 0	1 ± 0	0.9 ± 0
Mean moisture index warmest quarter (0–1)	0.6 ± 0	0.6 ± 0	0.5 ± 0	1 ± 0	1 ± 0	0.9 ± 0
Mean moisture index coldest quarter (0–1)	1 ± 0	1 ± 0	0.9 ± 0	1 ± 0	1 ± 0	1 ± 0
Landscape						
Elevation (m asl)	1429.7 ± 10.7	1311 ± 20.4	998.3 ± 23.4	1522 ± 4	1323.7 ± 1.9	1226.7 ± 24.3
Latitude (degrees S)	30.3 ± 0.0	30.3 ± 0.0	30.3 ± 0.0	30.5 ± 0.0	30.5 ± 0.0	30.5 ± 0.0
Longitude (degrees E)	150.2 ± 0.0	150.2 ± 0.0	150.1 ± 0.0	152.4 ± 0.0	152.4 ± 0.0	152.3 ± 0.0
Position in slope (ridge; up-slope; mid-slope; low-slope; flat)[b]	1-2	2-3	3	1-2	2	1-2
Aspect (degrees from north)[c]	89.7 ± 11.3	46 ± 112.1	-46 ± 19.7	64.7 ± 74.9	12.7 ± 24.5	-8.3 ± 60.6
Slope (degrees from horizontal)	12.3 ± 0.7	18.3 ± 4.3	15.7 ± 1.8	8.7 ± 1.9	17 ± 7.2	6.3 ± 1.5
Floristic						
Eucalyptus species [f]	1.5 ± 0.3	3 ± 0	3 ± 0	3.5 ± 0.3	2 ± 0	2.5 ± 0.3
Acacia species [f]	1.5 ± 0.3	1 ± 0.6	1 ± 0	1 ± 0	1 ± 0	1 ± 0
Other woody plant species [f]	6 ± 0.6	4 ± 0.6	11 ± 0	4 ± 0.6	8.5 ± 1.4	18 ± 1.7
Total ectomycorrhizal plant species [f]	13 ± 1.2	16.5 ± 2	24 ± 0.6	22 ± 3.5	26 ± 0	31.5 ± 0.9
Structure of 'live' vegetation						
Total upper canopy cover (%)	93.6 ± 2.6	97 ± 0.3	94.9 ± 1.9	89 ± 3.6	96.4 ± 1.9	92.2 ± 4
Tree fern cover (%)	0	13.7 ± 13.2	0	0	18 ± 16	0
Shrub cover (%)	10.3 ± 4.7	38.3 ± 6	70 ± 2.9	20 ± 7.6	63.3 ± 21.9	23.3 ± 8.8
Total understorey cover (%)	10.3 ± 4.7	52 ± 9.9	70 ± 2.9	20 ± 7.6	81.3 ± 6.4	23.3 ± 8.8
Ground fern cover (%)	0	13.8 ± 6.9	0	2.5 ± 1.9	19.6 ± 4.2	0
Graminoid cover (%)	68.3 ± 4	43.7 ± 6.1	10.8 ± 1.2	82.4 ± 13.2	37.6 ± 10.2	37.9 ± 6.7

	MK			NE		
Attribute	GW	WS	DS	GW	WS	DS
Total live ground cover (%)	68.3 ± 4	57.4 ± 2.2	10.8 ± 1.2	84.9 ± 11.4	57.2 ± 14.2	37.9 ± 6.7
Structure of 'dead' vegetation						
Rock cover (%)	0	13.9 ± 10.1	5.6 ± 4.2	1.7 ± 1.7	0.8 ± 0.8	0.4 ± 0.4
Coarse woody debris cover (%)	6.8 ± 4.3	5 ± 0	6.7 ± 1.7	7.7 ± 3.7	10 ± 2.9	5.7 ± 2.3
Litter cover (%)[d]	31.7 ± 4	27.6 ± 8.4	68.1 ± 1	12.6 ± 10.1	42.4 ± 13.3	59.6 ± 7.1
Litter depth (cm)[d]	55.8 ± 8	49.9 ± 0.8	28.8 ± 1.9	50.6 ± 4	60 ± 17	37.1 ± 5.5
Edaphic						
Total P concentration (ppm)[d]	0.11 ± 0.04	0.16 ± 0.04	0.17 ± 0.05	0.32 ± 0.04	0.161 ± 0.021	0.005 ± 0.001
Total C concentration (ppm)[d]	5.02 ± 0.82	7.56 ± 2.51	3.81 ± 0.36	13.02 ± 1.60	13.314 ± 2.895	1.66 ± 0.43
Total N concentration (ppm)[d]	0.29 ± 0.00	0.39 ± 0.14	0.29 ± 0.02	0.83 ± 0.10	0.674 ± 0.135	0.08 ± 0.02
pH [c]	5.4 ± 0.3	5.9 ± 0.1	7 ± 0.1	5.4 ± 0.1	5.4 ± 0	5 ± 0.2
Electrical conductivity (µS)[d]	50.5 ± 2.6	74.6 ± 7.5	65.4 ± 2.4	67.8 ± 11.2	69.4 ± 14	31.5 ± 2
Soil texture (sand; loam; clay-loam; clay)[de]	3 - 4	3 - 4	4	3	2 - 4	2 - 3
Soil moisture content [d]	2.6 ± 0.4	3.4 ± 0.9	2.9 ± 0.5	15.3 ± 5.1	12.2 ± 2.6	0.6 ± 0.1

a Values of climatic parameters estimated for each quadrat using ANUCLIM 5.1.

b Where 1=ridge, 2=up-slope, 3=mid-slope, 4=low-slope, 5=flat.

c Distance from 0 (north). Westerly values negative, easterly values positive, maximum value 180 (south).

d Average measured at central points of four 1m^2 sub-plots.

e Where 1=sand, 2=loam, 3=clay-loam, 4=clay.

f Species contributing >10% cover

Appendix 2.

Danks, M., T. Lebel and K. Vernes (2010). "'Cort short on a mountaintop' - Eight new species of sequestrate *Cortinarius* from sub-alpine Australia and affiliations to sections within the genus." Persoonia 24: 106-126.

Appendix 3. Percent occurrence of sporocarps, proportion of total sporocarp abundance and proportion of total sporocarp biomass (dry weight) of truffle-like fungi species sampled in 18 quadrats at New England NP and Mt Kaputar NP over two seasons (summer and winter). EM = ectomycorrhizal, NM = non-mycorrhizal.

Species	Nutritional mode	No. of quadrat samples	Percent occurrence (%)	Proportional abundance (%)	Proportional biomass (%)
Amylascus herbertianus	EM	1	2.78	0.09	0.38
Arcangeliella sp[a]	EM	1	2.78	0.18	0.04
Aroramyces sp 1[a]	EM	3	8.33	0.36	0.28
Austrogautieria '7-ridges'[a]	EM	1	2.78	0.98	2.50
Austrogautieria 'aff costata'[a]	EM	1	2.78	0.09	0.09
Austrogautieria clelandii	EM	3	8.33	1.24	0.49
Austrogautieria manjimupana	EM	1	2.78	0.44	1.27
Castoreum radicatum	EM	3	8.33	0.44	1.72
Chamonixia mucosa	EM	4	11.11	0.62	0.70
Chamonixia vittatispora	EM	3	8.33	2.66	2.19
Chondrogaster sp 1[a]	EM	1	2.78	0.09	0.11
Chondrogaster sp 2[a]	EM	3	8.33	1.07	2.61
Chondrogaster sp 3 'winged'[a]	EM	1	2.78	0.27	0.40
Cortinarius basorapulus	EM	1	2.78	0.44	0.93
Cortinarius caesibulga	EM	2	5.56	0.62	4.01
Cortinarius cinereoroseolus	EM	2	5.56	0.80	0.55
Cortinarius kaputarensis	EM	1	2.78	0.36	0.72
Cortinarius maculobulga	EM	2	5.56	0.98	1.33
Cortinarius 'mustard green gleba'[a]	EM	1	2.78	0.09	0.01
Cortinarius nebulobrunneus	EM	1	2.78	0.62	2.28
Cortinarius sinapivelus	EM	1	2.78	0.27	0.51
Cortinarius sp 1[a]	EM	3	8.33	1.24	1.80
Cortinarius sp 2[a]	EM	1	2.78	1.15	2.28
Cortinarius sp 3[a]	EM	1	2.78	0.09	0.30
Cortinarius sp 5[a]	EM	1	2.78	1.69	0.34
Cystangium 'aff sessile'[a]	EM	1	2.78	0.98	0.18
Cystangium balpineum	EM	2	5.56	0.27	0.44
Cystangium luteobrunneum	EM	1	2.78	0.09	0.16
Cystangium phymatodisporum	EM	2	5.56	0.18	0.04
Cystangium seminudum	EM	4	11.11	1.87	0.67
Cystangium sessile	EM	3	8.33	0.53	0.11
Cystangium sparsum	EM	1	2.78	0.27	0.11
Cystangium trappei	EM	2	5.56	0.62	0.54
Dermocybe globuliformis	EM	8	22.22	18.03	7.78
Dermocybe sp 1[a]	EM	1	2.78	0.18	0.07
Descomyces albellus	EM	4	11.11	1.60	0.26
Descomyces albus	EM	6	16.67	1.95	0.26

Species	Nutritional mode	No. of quadrat samples	Percent occurrence (%)	Proportional abundance (%)	Proportional biomass (%)
Descomyces 'dougmillsii' [a]	EM	3	8.33	0.62	0.08
Descomyces 'jumpponenii' [a]	EM	1	2.78	0.18	0.04
Descomyces 'lebelii' [a]	EM	9	25.00	2.93	0.93
Descomyces 'miresii' [a]	EM	1	2.78	0.62	0.18
Descomyces 'parviretifer' [a]	EM	1	2.78	0.44	0.03
Dingleya 'cf geometrica'[a]	EM	1	2.78	0.18	0.04
Dingleya verrucosa	EM	1	2.78	0.09	0.21
Endogone sp[a]	EM/NM	1	2.78	0.09	0.00
Gallacea sp 1[a]	EM	1	2.78	0.09	0.19
Gallacea sp 2[a]	EM	1	2.78	0.09	0.08
Gymnohydnotrya ellipsospora	EM	1	2.78	0.09	0.13
Gymnomyces 'aff eburneus'[a]	EM	1	2.78	0.09	0.10
Gymnomyces 'aff glarea'[a]	EM	2	5.56	0.44	0.26
Gymnomyces 'aff pallidus'[a]	EM	1	2.78	0.09	0.05
Gymnomyces 'aff westresii'[a]	EM	1	2.78	0.09	0.07
Gymnomyces eburneus	EM	4	11.11	4.80	3.66
Gymnomyces eildonensis	EM	3	8.33	1.51	2.27
Gymnomyces glarea	EM	2	5.56	0.27	0.09
Gymnomyces pallidus	EM	1	2.78	0.09	0.12
Gymnomyces 'rosy pink'[a]	EM	1	2.78	1.42	1.72
Gymnomyces sp[a]	EM	1	2.78	0.09	0.03
Hydnangium carneum	EM	5	13.89	1.87	1.57
Hydnangium 'parvisporum' [a]	EM	4	11.11	1.24	0.64
Hydnoplicata convoluta	EM	6	16.67	1.51	1.80
Hysterangium 'aff gardneri'[a]	EM	1	2.78	0.18	0.12
Hysterangium 'aff inflatum'[a]	EM	2	5.56	0.80	2.01
Hysterangium 'agglutinatum' [a]	EM	8	22.22	5.95	11.24
Hysterangium aggregatum	EM	1	2.78	0.09	0.39
Hysterangium 'bubble weed'[a]	EM	1	2.78	0.09	0.10
Hysterangium 'golden inflated'[a]	EM	5	13.89	2.84	6.22
Hysterangium 'green inflated'[a]	EM	1	2.78	0.09	0.02
Hysterangium inflatum	EM	1	2.78	0.09	0.12
Hysterangium 'multi layer rosy'[a]	EM	2	5.56	0.27	0.11
Hysterangium 'non-gel'[a]	EM	1	2.78	0.27	0.74
Hysterangium 'olive not rosy'[a]	EM	2	5.56	0.98	0.79
Hysterangium 'rosy'[a]	EM	5	13.89	2.31	1.72
Hysterangium 'smooth'[a]	EM	1	2.78	0.36	0.28
Hysterogaster 'apricot on drying'[a]	EM	1	2.78	0.62	0.09
Hysterogaster 'descogasteroides' [a]	EM	4	11.11	2.04	0.35
Hysterogaster rodwayii	EM	1	2.78	2.58	0.63
Hysterogaster sp[a]	EM	1	2.78	0.36	0.14
Hysterogaster tasmanicus	EM	1	2.78	0.09	0.03

Species	Nutritional mode	No. of quadrat samples	Percent occurrence (%)	Proportional abundance (%)	Proportional biomass (%)
Leucogaster rubescens	EM	1	2.78	0.80	0.43
Malajczukia fusispora	EM	1	2.78	0.18	0.44
Mesophellia angustispora	EM	2	5.56	0.27	0.57
Mesophellia elelandii	EM	1	2.78	1.69	6.80
Nothocastoreum sp 1[a]	EM	1	2.78	0.44	0.47
Octaviania sp 1[a]	EM	1	2.78	0.09	0.05
Octaviania sp 2[a]	EM	1	2.78	0.36	0.87
Pisolithus hypogaeus	EM	1	2.78	0.09	0.11
Protoglossum sp 1[a]	EM	1	2.78	0.27	0.17
Quadrispora oblongispora	EM	2	5.56	0.27	0.20
Quadrispora sp 1 'aff tubercularis'[a]	EM	1	2.78	0.27	0.41
Russula 'aff pilosella'[a]	EM	6	16.67	0.71	1.28
Russula 'aff pumicoidea'[a]	EM	1	2.78	0.62	0.37
Russula albobrunnea	EM	2	5.56	0.18	0.09
Russula brunneonigra	EM	1	2.78	0.27	1.34
Russula sinuata	EM	1	2.78	0.53	0.87
Scleroderma densum	EM	4	11.11	0.71	1.46
Scleroderma paradoxum	EM	1	2.78	0.27	0.24
Setchelliogaster sp 1[a]	EM	1	2.78	0.18	0.02
Setchelliogaster sp 2[a]	EM	1	2.78	0.27	0.09
Timgrovea reticulata	EM	1	2.78	0.18	0.03
Unknown 1[a]	unknown	2	5.56	0.44	0.54
Zelleromyces aff 'mattrappei'[a]	EM	7	19.44	0.89	0.48
Zelleromyces 'aff rosy 2'[a]	EM	1	2.78	0.09	0.06
Zelleromyces 'aff subamyloideus'[a]	EM	1	2.78	0.27	0.46
Zelleromyces 'brown gleba 1'[a]	EM	1	2.78	0.27	0.28
Zelleromyces 'brown gleba 2'[a]	EM	1	2.78	0.53	0.55
Zelleromyces claridgei	EM	3	8.33	0.53	0.31
Zelleromyces daucinus	EM	2	5.56	1.24	0.29
Zelleromyces 'golden turf'[a]	EM	1	2.78	0.09	0.21
Zelleromyces 'lebelii' [a]	EM	1	2.78	0.27	0.12
Zelleromyces majus	EM	1	2.78	0.09	0.20
Zelleromyces microsporus	EM	2	5.56	0.18	0.13
Zelleromyces 'orange & white'[a]	EM	4	11.11	0.98	0.51
Zelleromyces 'rosy'[a]	EM	1	2.78	1.07	0.75
Zelleromyces sp [a]	EM	3	8.33	0.36	0.11
Zelleromyces 'spiny spore'[a]	EM	1	2.78	0.09	0.13
Zelleromyces striatus	EM	2	5.56	0.62	0.20
Zelleromyces 'vittatus' [a]	EM	6	16.67	1.07	0.49

a Undescribed species.

b Dry weight not recorded for one of these two collections.

Appendix 4. Spore morphotype image gallery: guide to identification of macrofungal spores in swamp wallaby faecal pellets.

Spore morphotype gallery

-

to aid identification of spores in mycophagous mammal dietary samples

-

M. Danks & T. Lebel 2010

-

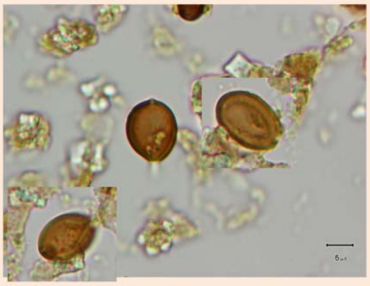
Micrographs of spores in swamp wallaby *Wallabia bicolor* faecal pellet samples collected at Newholme Field Station, Booroolong NR, Mt Kaputar NP, New England NP, & Cathedral Rock NP in northern New South Wales, 2007 – 2009.

Identifications made with reference to sporocarp collections of known taxa from the same sites, and various published and unpublished keys.

Background colour of slide indicates classification of fungal habit:

Green = epigeous	Brown = sequestrate	Pink = unclassifiable

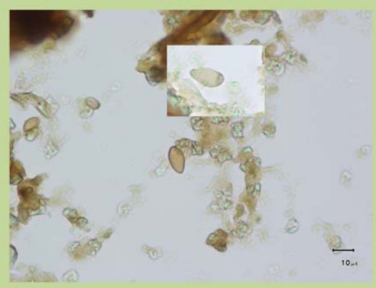
- Samples stained with Melzer's Reagent and mounted in CytoSeal™60 permanent mountant
- Micrographs taken at 1000 x or 400 x magnification. Bars indicate scale.
- Measurements ex ornamentation and apiculus



Agariceae 1

Rusty brown; subglobose; smooth; thick walled; germ pore visible at apex; blunt or cup-like point of attachment; 8 -10 x 11 -12 um

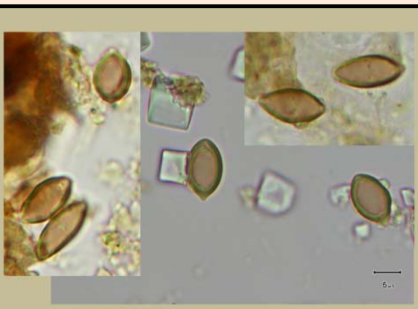
---



Agariceae 2

Pale brown, oblong – obovoid with one blunt end, asymmetrical, smooth, 6 -11 x 3 -7 um

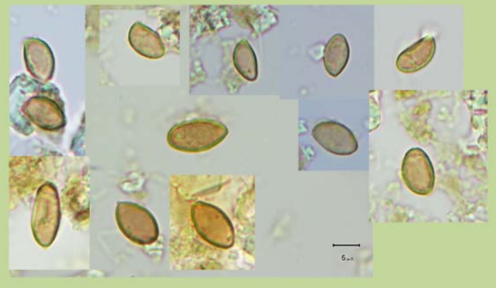
---



Agariceae 3

Sub-hyaline, brown-tinted; smooth; teardrop shaped to fusiform; rounded apex with clear 'lens'; small conical apiculus; 11 - 15 x 5 -6 um

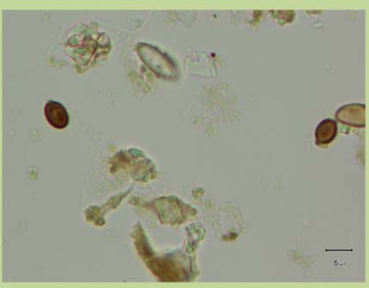
---



Agariceae 4

Pale brown or yellow brown, some pinkish; asymmetrical; ellipsoid; ovoid in face view; smooth; 6.5 -10 x 3 -5 um

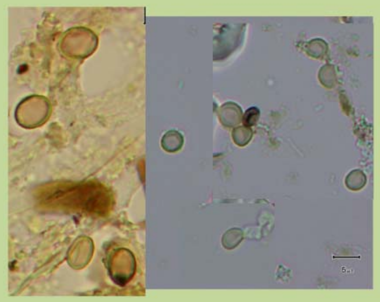
---



Agariceae 5

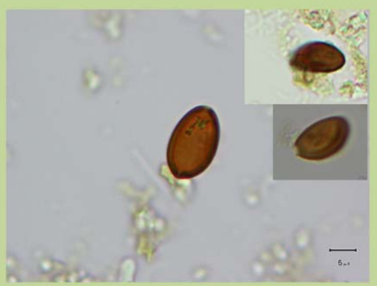
Globose to subglobose; brown; smooth; obvious apiculus; 4 -5 x 3 -4 um

---



Agariceae 6

Globose to subglobose; smooth; hyaline or pale brown-tinted; 4 -7 x 3 -5 um

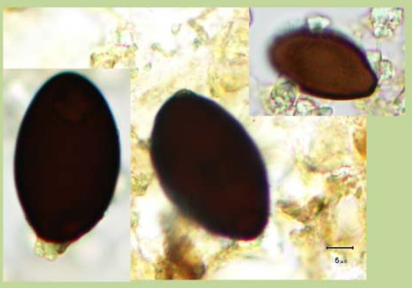


Agaricus / Panaeolus

Bronze-brown; broadly ellipsoid / asymmetric 'gumnut'; smooth; cup-like point of attachment; mucronate apex (germ pore visible); narrow lighter band around apex; fairly thick-walled (0.5 um); 10 -14 x 5 -8 um.

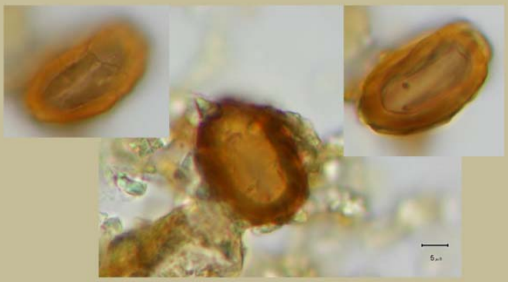
Aroramyces 3

Ellipsoid; asymmetrical; minutely punctate; utricle inflated to 1um at base; 8 -10 x 6 -7 um; differs from *A. sp nov 1* & *A. sp nov 2* (found in sporocarp survey)



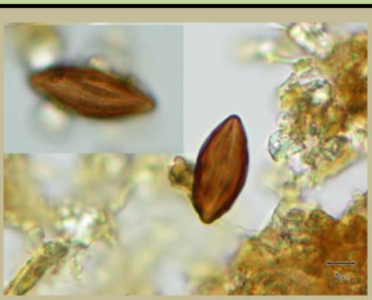
Ascomycete

Large, dark brown, broadly fusiform, asymmetric, smooth (or minutely textured); (16) 20 -30 x 10 –18 um



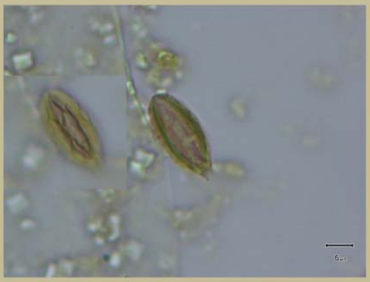
Austrogautieria 1

Golden brown; ovoid to citriniform; rounded indistinct 'broken' ridges to 4 um tall; ornamented with sparse pegs under ridges; prominent blunt hyaline apiculus 5 um long; 23 -25 x 11 -12 um. Similar to A. clelandii, but is larger.



Austrogautieria 2

Broadly fusiform, many branching longitudinal ridges, red-brown, 20 -25 x 8 um.

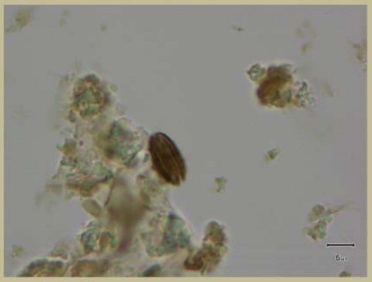


Austrogautieria 3

Pale pinkish-golden brown; narrowly citriniform; sharp ridges 1 -2 um tall, branched; prominent apiculus 2 um tall; 11 -16 x 5 -6 um.

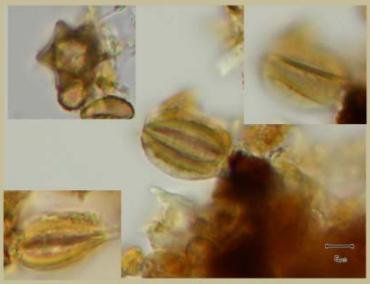
Doesn't have prominent 'beak'.

Narrower and paler than A. manjimupana.



Austrogautieria 5

Brown; narrow citriniform; ~5 sharp ridges (1 um tall) extending beyond spore ends; 10 x 3 um



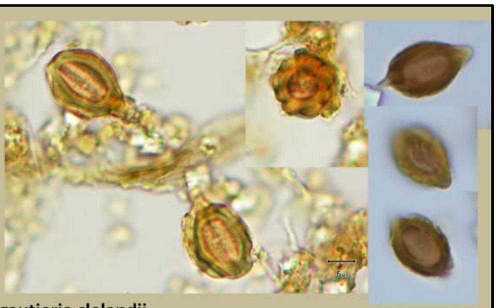
Austrogautieria 7

Pale golden brown or grey-brown; ovoid; 6 -7 sharp ridges to 3 um tall, sometimes branching; smooth under ridges; apiculus unobtrusive; 17 -18 x 7 -9 um

Austrogautieria aff manjimupana

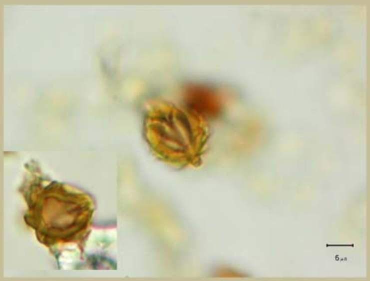
Pale golden brown to greyish brown; citriniform; sharp ridges to 2 um tall, branched; prominent apiculus 2 um tall; 13 -15 x 5 -6 um

Doesn't have prominent 'beak'.



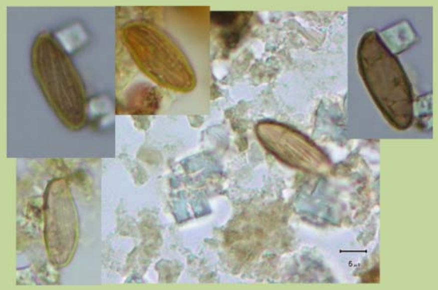
Austrogautieria clelandii

Golden brown; ovoid to citriniform; 8-9 rounded indistinct 'broken' ridges to 3 um tall; ornamented with minute pegs under ridges; prominent blunt hyaline apiculus; 15 -17 x 6 -7 um (young spores 10 -15 um long).



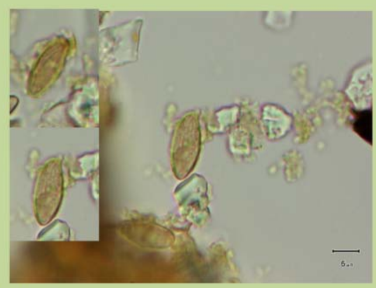
Austrogautieria costata

Golden brown; sub-globose; ~10 sharp ridges (2 um); 10 -12 x 7 -8 um



Boletellus 1

Fusiform; brown-tinted; slightly asymmetrical; many fine longitudinal low ridges/striations; 16 -20 x 5 -8 um.

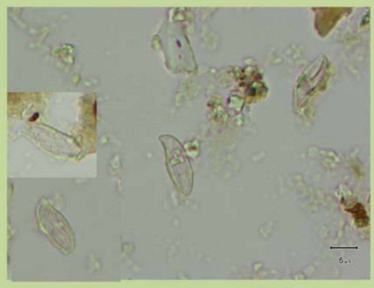


Boletellus 2

Fusiform; brown-tinted; asymmetrical; many fine longitudinal low ridges/striations; 13 x 3 um.

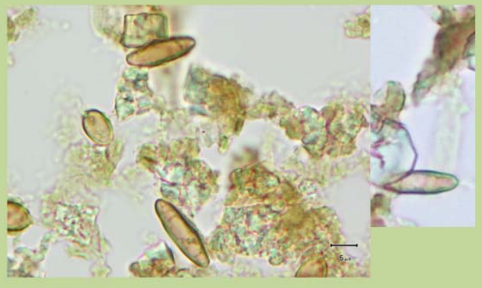
Smaller than Boletellus 1.

Larger than Boletellus 3 and brown rather than hyaline.



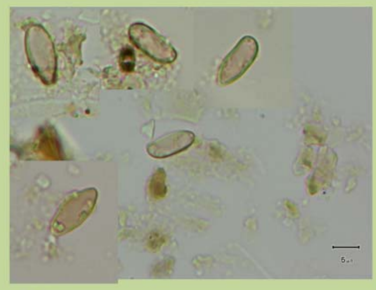
Boletellus 3

Fusiform; hyaline; asymmetrical; many fine longitudinal low ridges/striations; 11 -12 x 4 -5 um.



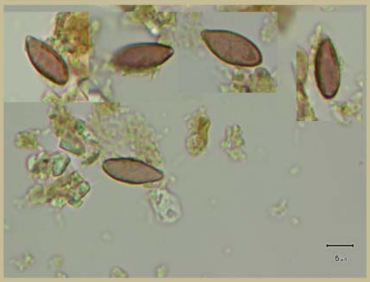
Boletoid 1

Fusiform; pale brown; smooth; asymmetrical; 12 -15 x 3 -4 um.



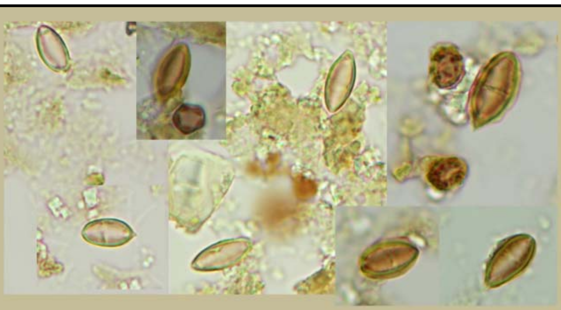
Boletoid 2

Hyaline to pinkish; fusiform-oblong; asymmetric; smooth; 10 -11 x 3 -4 um



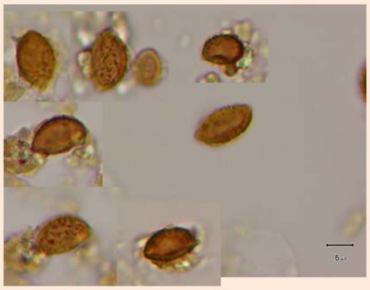
Boletoid 3

Purple-tinted; fusiform; smooth, but slightly 'undulating' surface; 12 -14 x 3 -4 um



Chamonixia

Pink-brown tinted to golden bronze-brown, broadly fusiform, low broad smooth longitudinal ridge, 8 - 11 (13) x 3.5 -5 um. Episporium not always obvious. Darker spores = more mature.

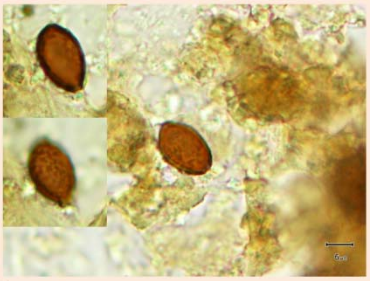


Cortinariaceae 1

Rusty brown; amygdal; asymmetrical; finely nodulose; 9 x 5 um

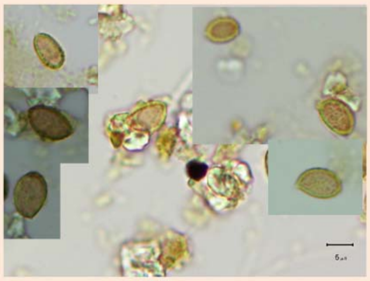
Cortinariaceae 2

Pale rusty brown; amygdal; asymmetrical; finely nodulose / verrucose; 12 x 7 um



Cortinariaceae 3

Light golden brown; broadly ovoid; verrucose, 'wrinkled'; 10 -12 x 6 um



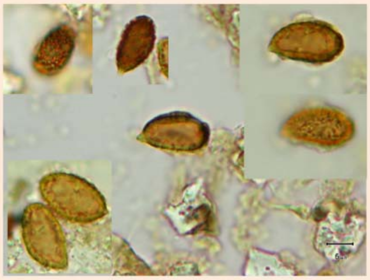
Cortinariaceae 4

Pale rusty brown; ovoid-ellipsoid; asymmetrical; minutely warty/punctate ; apiculus hyaline; 5 -9 x 3 -5 um

Cortinarius 1

Pale brown; narrowly ovoid; symmetrical; short conical hyaline apiculus; apex somewhat square; fine low rounded warts, distinctive utricle to 1 um; 9 -11 x 5 um

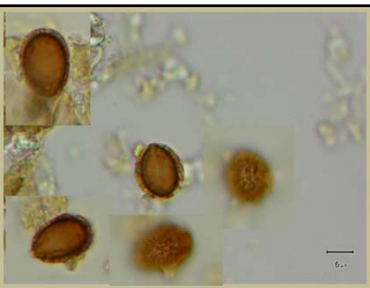
Similar to 'Cortinarius 4' but pale and narrower. Similar to 'Cortinariaceae 4' but much larger.



Cortinarius 2

Rusty brown or dark brown; ovoid or almost amygdal; slightly asymmetrical; irregular low fine warts and lines to partial reticulum; hyaline apiculus; 7 -13 x 4 -6

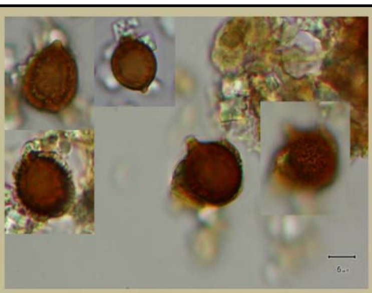
Sequestrate Cortinarius/Thaxterogaster



Cortinarius 4

Rusty brown; broadly ovoid; symmetrical; short conical hyaline apiculus; apex somewhat square; crowded low rounded warts, short lines or partial reticulum, distinctive utricle to 1 um; 9 -12 x 6 -8 um

Similar to C. 6 & C. 2 but has obvious utricle and is broader



Cortinarius 5

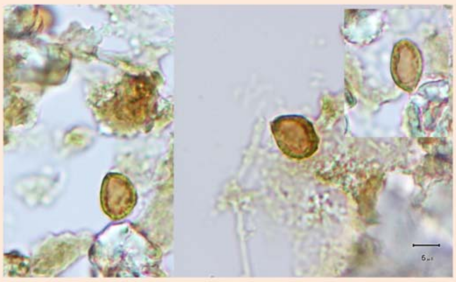
Dark rusty brown; broadly ovoid; symmetrical; broad conical hyaline apiculus; regular, crowded, small warts and short lines, utricle to 1 um; 8 -9 x 9 -12 um.

Similar to C. 6 & C. 2 but has obvious utricle. Darker and broader than C. 4.

Cortinarius 6

Ovoid; asymmetrical; rusty brown; fine warts, partial reticulum <1 um; hyaline apiculus curved, 1 um tall; 10 x 7 um

Similar to C. 10 but slightly larger. Shorter and broader than Quadrispora and sometimes has short lines. Shorter and broader than C. 2.

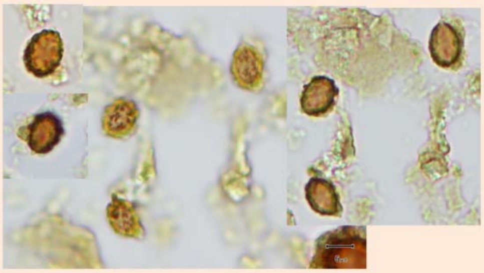


Cortinarius 7

Rusty brown, broadly ovoid –amygdal, asymmetrical, low fine warts/verrucose , thick-walled?; 6 -8 x 4 -6.5 um

Sequestrate Cortinarius/Thaxterogaster

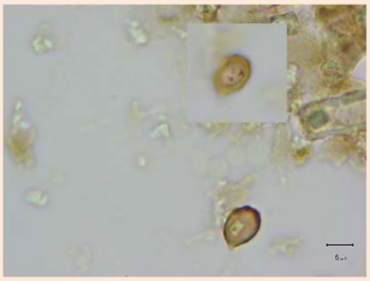
Smaller than C. 15.



Cortinarius 8

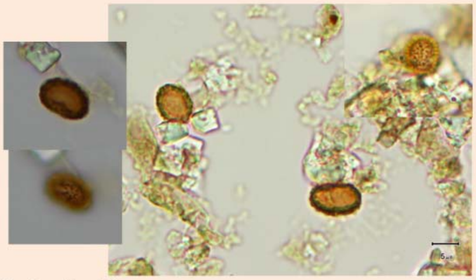
Rusty brown - pale yellow brown, broadly ovoid to sub-globose, robustly warty (angular or rounded irregular warts), 5 -8 x 4.5 -6 um

Compared to C. 14 is symmetrical; slightly smaller; warts sparser and more angular



Cortinarius 9

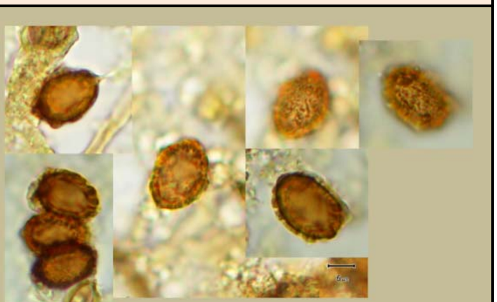
Pale yellow brown; broadly ovoid to sub-globose; asymmetrical; sparse, irregular low warts; hyaline, asymmetrical apiculus 1.5 um tall; 7 -8 x 4 -5 um



Cortinarius 10

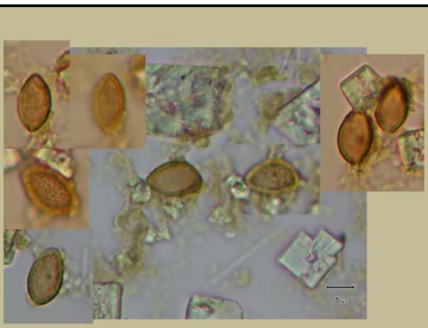
Sub-globose to broadly ovoid or oblong; asymmetrical in side view; rusty brown or pale rusty brown; crowded, minute pegs <1 um tall, irregular;

5 -8 x 4.5 -6 um



Cortinarius 11

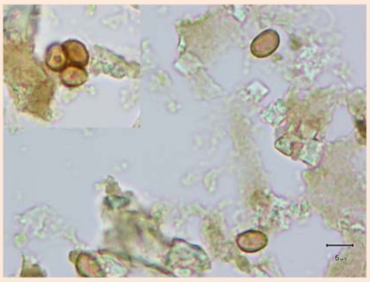
Rusty brown, broadly ovoid, low irregular warts to 1um tall, 11 -14 x 7 -9 um.



Cortinarius 12

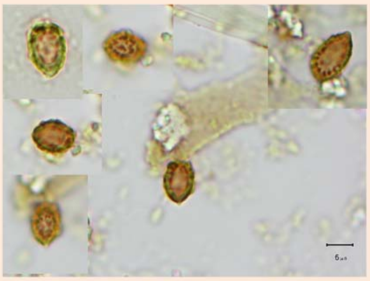
Pale yellow-brown; almond-shaped; asymmetrical; finely verrucose (only visible at high magn.); 5 -6 x 10 -11 um.

Similar to C. 15 but paler & ornamentation less robust.



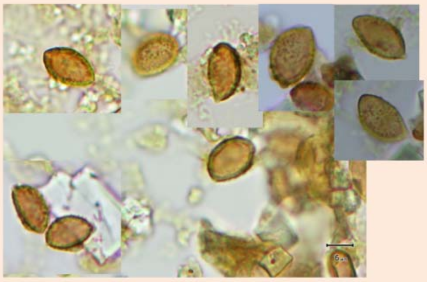
Cortinarius 13

Pale rusty brown, sub-globose to broadly ovoid, slightly asymmetrical, verrucose , 4.5 -6 x 3 -4 um



Cortinarius 14

Rusty brown; broadly ovoid; large robust irregular warts; asymmetrical; apex rounded; apiculus small conical; 7 -10 x 4 -6 um.



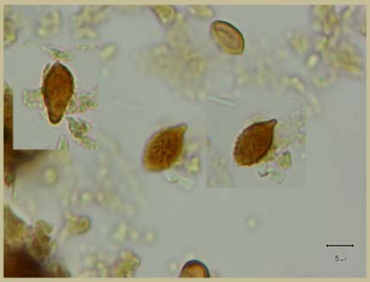
Cortinarius 15

Rusty brown or yellow brown; broadly ovoid; low fine warts; asymmetrical; mucronate base; apex rounded; warts more robust to apex; 8 -13 x 5 -8 um

Larger than C. 7

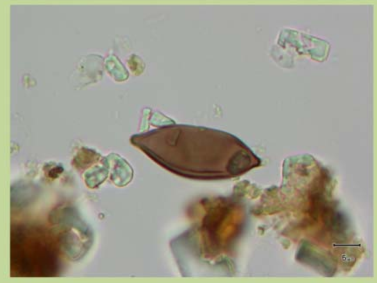
Descolea

Rusty brown; broadly ovoid - citriniform; appearing almost smooth; apex rounded; apiculus small conical; 9 -10 x 6 um.



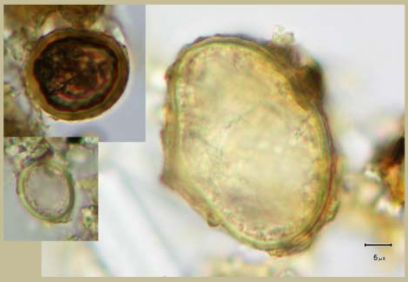
Descomyces aff lebelii

Rusty brown; citriniform; low fine irregular warts; naked rostrum; hyaline apiculus; 11 x 6 um



Entolomataceae

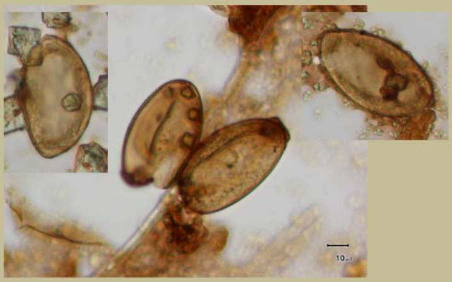
Pinkish-brown; fusiform, slightly angular; smooth; thick-walled; both ends pointed; 22 x 9 um



Glomus

Yellow- or brown-tinted or hyaline; smooth, verrucose or nodulose; thick walled; sub-globose; attachment point visible; 20 -50 x 14 -45 um (11 x 9 um immature).

(NB: 1 point of attachment = Glomus. None or 2 = Endogone)

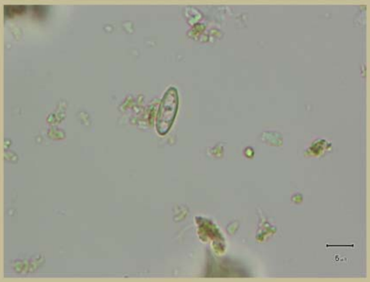


Glomus 2

Pale brown; ellipsoid; asymmetrical; smooth; thick walled; 30 -35 x 60 -65 um

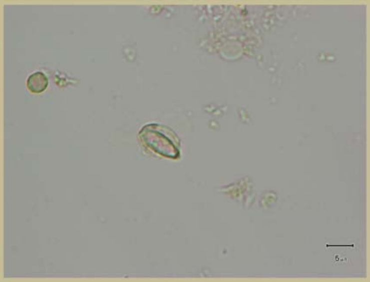
Hydnoplicata convoluta

Sub-globose; sub-hyaline; low warts or wrinkles; 8 x 5 um. Likely H. convoluta, although spores typically hyaline.



Hysterangium 1

Hyaline; fusiform; smooth; blunt/cup-like point of attachment; 10 x 3 um

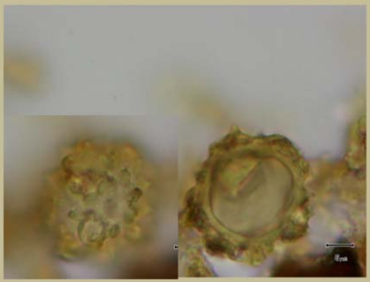


Hysterangium 2

Hyaline; fusiform; utricle inflated to 2 um; 8 x 3 um

Hysterangium 3

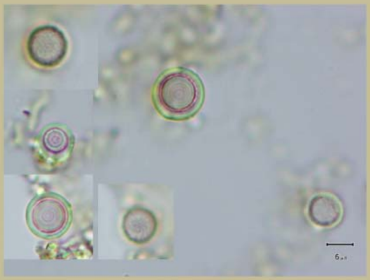
Hyaline; broadly fusiform; smooth; some small bubbles/wrinkles in utricle; apiculus cup-like; 8 -12 x 3 - 3.5 um.



Labyrinthomyces

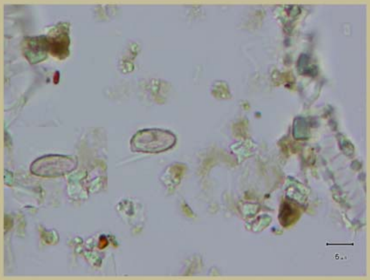
Globose; sub-hyaline / yellow-tinted; ornamentation rough, crowded, angular warts to 3 um tall; thick-walled; 15 -18 x 15 -20 um

Labyrinthomyces / Dingleya / Reddellomyces



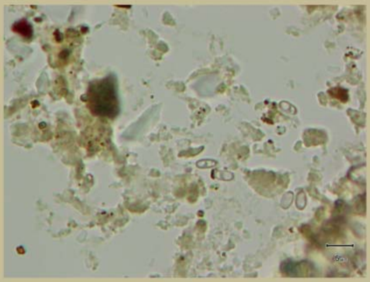
Leucogaster

Hyaline; globose; pitted reticulum (pits very small); thick-walled; covered by thick gelatinous utricle; inamyloid; non-dextrinoid; variable size, 5 – 11 um diam



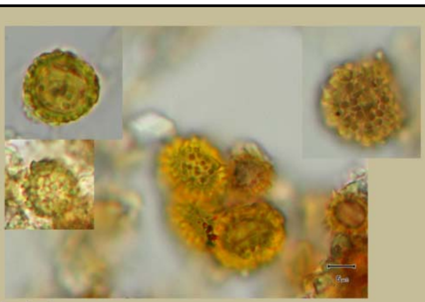
Mesophelliaceae

Hyaline; ellipsoid; asymmetric; verrucose; 9 x 4 um



Protubera

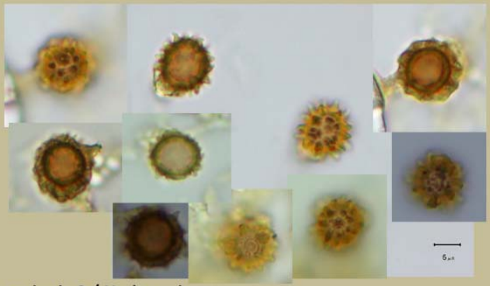
Hyaline; oblong; smooth; 3 -4 x 1.5 -2 um



Octaviania 1

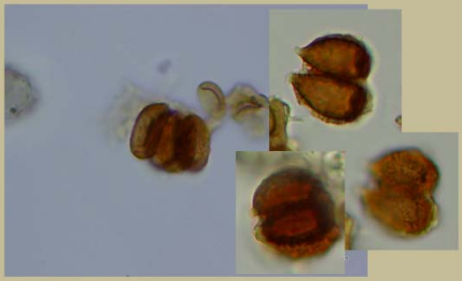
Sub-globose; bright yellow-tinted, rarely dull yellow; pegs irregular, angular, blunt-ended, isolated, 2 -3 um tall; 7 -10 x 8 -11 um.

Brighter, slightly larger, and appearing 'cleaner' than Octaviania 2 / Hydnangium.



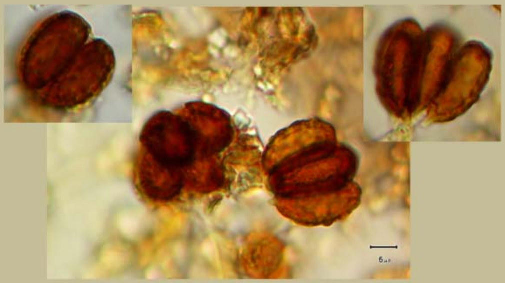
Octaviania 2 / Hydnangium

Sub-globose – globose; yellow-tinted to yellow-brown; spines messy, angular, crowded, curved or straight, can be hard to distinguish or encased in debris, made of multiple spines to 3 um tall; thick-walled; 6 -8 x 7 -9 um.
Unlike Scleroderma 1 and Russuloid 7 has cones rather than pegs.
NB: morphotype includes Hydnangium parvisporum MS Trappe.



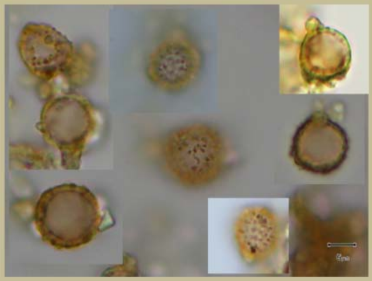
Quadrispora musispora

Rusty brown; ellipsoid; in a tetrad; irregular warts; hyaline, curved apiculus 1 um.tall; 11 -13 x 6 um



Quadrispora oblongispora

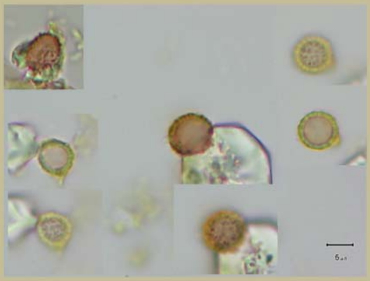
Rusty brown; ellipsoid; asymmetrical; in a tetrad; irregular warts and short lines; hyaline, curved apiculus 2 um.tall; 15 -17 x 7 um



Russula aff brunneonigra

Pale yellow tinted; sub-globose; fine reddish brown verrucae or lines to 1 um tall, sparse, irregular; thick-walled; apiculus conical, hyaline, broad 1.5 x 2 um; 8 -11 x 9 -12 um

Paler, not robustly ornamented, has reddish ornamentation as compared to Scleroderma spp. Larger than Russuloid 1.



Russuloid 1

Globose; sub-hyaline or pale reddish-brown; thick-wallled; crowded, low pegs to 1um, pale or dark reddish-brown; hyaline, conical apiculus 1.5 -2 um; 5 -8 x 5 -7 um.

Similar to Russuloid aff brunneonigra, but is smaller and apiculus slender. Similar to Russuloid 6, but is not reticulate.

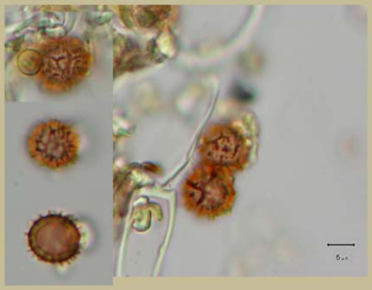
Russuloid 2

Globose; pale yellowish brown; hyaline, conical spines to 1.5 um; 6 x 7 um.

Differs from Russuloid 1 in having tall, conical spines

Russuloid 3

Reddish-brown; sub-globose; thick-walled; isolated, broad or fine, 1.5 um tall spines; 8 -9 x 8 -10 um.



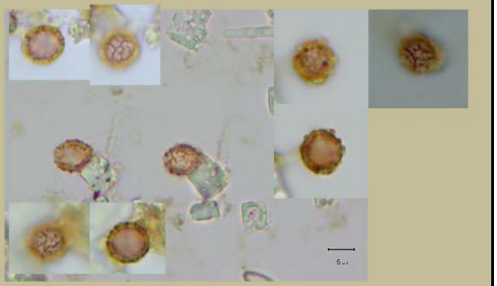
Russuloid 4

Reddish-brown; globose; sparse, fairly robust, partial reticulum and short lines to 1um tall; 8 -9 x 8 -11 um

Russuloid 5

Globose; reddish-brown tinted; fine sparse reddish-brown reticulum to 1um tall, connection points darker than lines; 8 -10 x 8 -10 um.

Larger than Russuloid 6. Lines finer than R. 4 and Scleroderma reticulate.



Russuloid 6

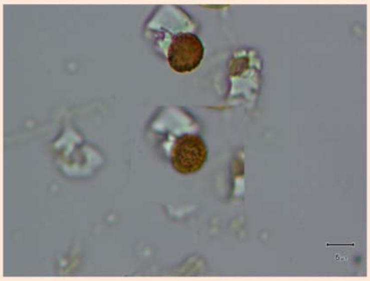
Pale reddish-brown tinted; sub-globose or globose; fine reddish-brown partial or complete reticulum <1 um tall; 6 - 8 x 5 -7 um

Similar to Russuloid 3, but has at least a partial reticulum and usually smaller and finer.

Russuloid 7

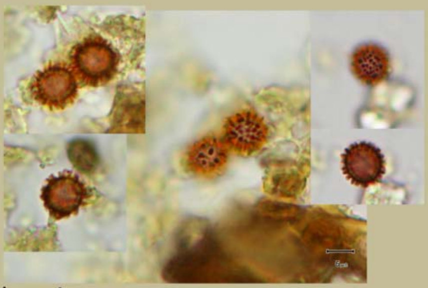
Pale brown to reddish brown; short isolated pegs/spines; sometimes encrusted with debris; sub-globose; apiculus conical, hyaline, 1 -2.5 um tall, rarely seen; 7 -9 x 5 -9 um.

Appears messier, is larger, has shorter spines than Scleroderma 1. Similar to Octaviania but has pegs not cones.



Scleroderma / Pisolithus

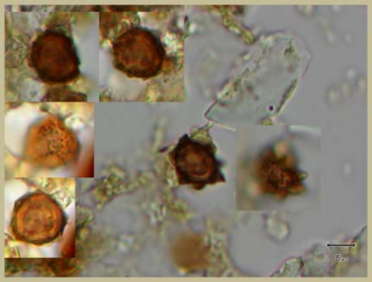
Subglobose; brown; low crowded fine warts; 7 -8 x 6 -7 um



Scleroderma 1

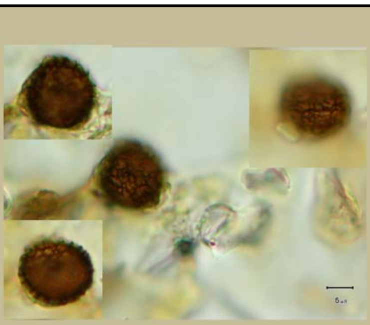
Globose – sub-globose; reddish brown; large hyaline conical apiculus; crowded isolated pegs to 1.5 um tall; 5 -7 x 5 -7 um

Compared to other Scleroderma spp - is smaller; spines are more slender, longer, peg-like; is reddish brown. Spore wall is darker, browner than Russuloids.



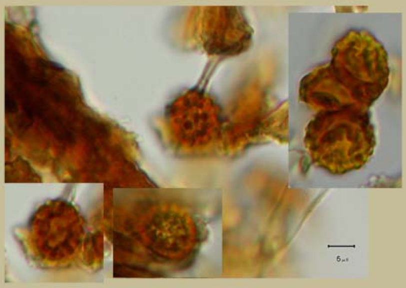
Scleroderma 2

Dark brown; sub-globose to globose; broad irregular cones 2 um tall, and short fine irregular pegs to 1 um tall; 7 -9 x 8 -9 um



Scleroderma 3

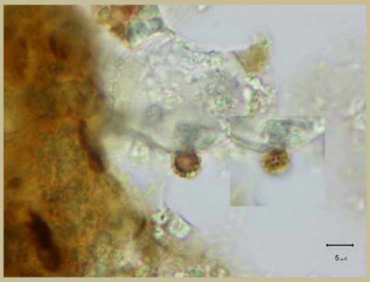
Brown; sub-globose; reticulum of low narrow ridges and sometimes curved pegs; 9 -12 x 8 -12 um



Scleroderma 4

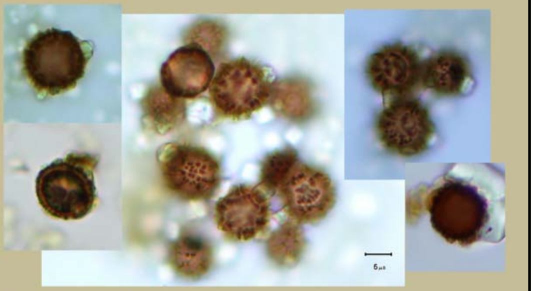
Dark brown; subglobose; crowded 'gravelly' warts to 2 um tall; 6 -8 x 7 -8 um

Similar to Octaviania 1, but is brown and ornaments are larger.



Scleroderma 5

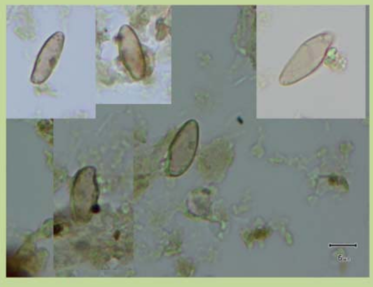
Brown; globose; robustly (1.5 um tall) nodulose; 4 um diam.



Scleroderma aff paradoxum

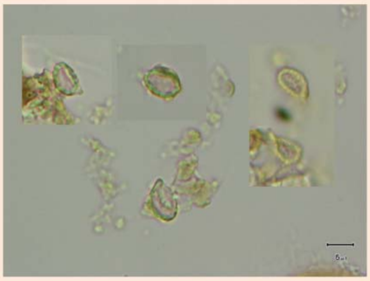
Brown; irregular, isolated, crowded cones to 2 um, sometimes curved, irregularly distributed; large, hyaline apiculus 3 x 3 um; sub-globose; 8 -10 x 8 -10 um

Compared to Scleroderma 1 and 2, has cones not pegs.



Tylopilus

Fusiform; sub-hyaline/pink-brown tinted; asymmetrical; smooth; 10 -14 x 4 -5 um.



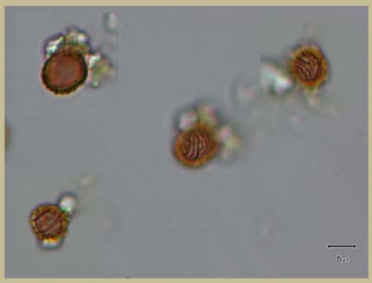
Unknown 1

Hyaline; ellipsoid; asymmetrical; regular warts; prominent broad apiculus; 6 -7 x 3 -4 um.

Zelleromyces microsporus

Globose; reddish brown; thick-walled; ridges/partial reticulum, short lines or long 'swirls' 1 -2 um tall; 9 -12 x 9 -12 um

This morphotype includes Z. daucinus, Z. microsporus & Z. cremus.



Zelleromyces striatus

Globose; reddish-brown; distinct 'zebra' pattern, isolated and branched ridges to 1 um tall; 6 x 6 um

Appendix 5. Occurrence of macrofungal taxa detected in swamp wallaby faecal pellet samples (N = 196) in eucalypt-dominated forest over two seasons (summer and winter). Taxa occurring in more than 20% of samples indicated in bold type.

Taxon	No. of samples	Total frequency of occurrence (%)
Epigeous (mushroom-like) taxa	*92*	*54.8*
Agariceae 4	**54**	**32.1**
Agariceae 5	8	4.8
Agariceae 6	10	6.0
Agaricus / Panaeolus	5	3.0
Ascomycete	8	4.8
Boletellus 1	13	7.7
Boletellus 2	5	3.0
Boletellus 3	4	2.4
Boletoid 1	7	4.2
Boletoid 2	13	7.7
Cortinarius 14	1	0.6
Cortinarius 6	2	1.2
Descolea	3	1.8
Entolomataceae	1	0.6
Tylopilus	11	6.5
Sequestrate (truffle-like) taxa	*164*	*97.6*
Agariceae 3	6	3.6
Aroramyces 3	1	0.6
Austrogautieria 1	1	0.6
Austrogautieria 3	4	2.4
Austrogautieria 5	1	0.6
Austrogautieria 7	7	4.2
Austrogautieria aff manjimupana	1	0.6
Austrogautieria clelandii	6	3.6
Boletoid 3	4	2.4
Chamonixia	**68**	**40.5**
Cortinarius 1	3	1.8
Cortinarius 11	23	13.7
Cortinarius 4	1	0.6
Descomyces aff lebelii	3	1.8
Glomus	14	8.3
Hydnoplicata convoluta	2	1.2
Hysterangium 1	1	0.6
Hysterangium 2	2	1.2
Hysterangium 3	20	11.9
Labyrinthomyces group	6	3.6
Mesophelliaceae	6	3.6
Octaviania 1	3	1.8
Octaviania 2 / Hydnangium	**95**	**56.5**

Taxon	No. of samples	Total frequency of occurrence (%)
Quadrispora musispora	2	1.2
Russula aff brunneonigra	22	13.1
Russuloid 1	**37**	**22.0**
Russuloid 3	14	8.3
Russuloid 4	1	0.6
Russuloid 5	6	3.6
Russuloid 6	**57**	**33.9**
Russuloid 7	24	14.3
Scleroderma 1	6	3.6
Scleroderma 3	3	1.8
Scleroderma aff paradoxum	2	1.2
Zelleromyces microsporus	2	1.2
Zelleromyces striatus	3	1.8
Unclassifiable taxa	*104*	*61.9*
Cortinariaceae 1	6	3.6
Cortinariaceae 2	7	4.2
Cortinariaceae 4	**40**	**23.8**
Cortinarius 10	**42**	**25.0**
Cortinarius 13	4	2.4
Cortinarius 15	33	19.6
Cortinarius 2	22	13.1
Cortinarius 7	12	7.1
Cortinarius 8	5	3.0
Cortinarius 9	1	0.6
Scleroderma / Pisolithus	3	1.8
Unknown 1	2	1.2

Appendix 6. Sequestrate macrofungal species and spore types included in genera or higher taxonomic groups for comparative analysis of swamp wallaby diet and sporocarp community.

Genus or higher taxon group	Species or spore type	Record Source
Agariceae	Agariceae 3	Diet
Amylascus	*Amylascus herbertianus*	Survey
Arcangeliella	*Arcangeliella* sp	Survey
Aroramyces	*Aroramyces* 3	Diet
	Aroramyces sp 1	Survey
	Aroramyces sp 2	Survey
Austrogautieria	*Austrogautieria* 1	Diet
	Austrogautieria 2	Diet
	Austrogautieria 3	Diet
	Austrogautieria 5	Diet
	Austrogautieria 6	Survey
	Austrogautieria 7	Survey
	Austrogautieria 'aff costata'	Survey
	Austrogautieria 'aff manjimupana'	Diet
	Austrogautieria clelandii	Survey & Diet
	Austrogautieria costata	Survey & Diet
	Austrogautieria manjimupana	Survey
Boletoid	Boletaceae	Survey
	Boletoid 3	Diet
Castoreum	*Castoreum radicatum*	Survey
Chamonixia	*Chamonixia*	Diet
	Chamonixia mucosa	Survey
	Chamonixia vittatispora	Survey
Chondrogaster	*Chondrogaster* sp 1	Survey
	Chondrogaster sp 2	Survey
	Chondrogaster sp 3	Survey
Cordyceps	*Cordyceps rodwayi*	Survey
Cortinarius	*Cortinarius* 1	Diet
	Cortinarius 11	Diet
	Cortinarius 12	Diet
	Cortinarius 4	Diet
	Cortinarius 5	Diet
	Cortinarius 'aff walpolensis'	Survey
	Cortinarius argyrionus	Survey
	Cortinarius basorapulus	Survey
	Cortinarius caesibulga	Survey
	Cortinarius cinereoroseolus	Survey
	Cortinarius kaputarensis	Survey
	Cortinarius maculobulga	Survey
	Cortinarius nebulobrunneus	Survey
	Cortinarius sinapivelus	Survey
	Cortinarius sp 16	Survey

Genus or higher taxon group	Species or spore type	Record Source
	Cortinarius sp 18	Survey
	Cortinarius sp 19	Survey
	Cortinarius sp 20	Survey
	Cortinarius sp 21	Survey
	Cortinarius sp 22	Survey
	Cortinarius sp 25	Survey
Dermocybe	*Dermocybe globuliformis*	Survey
	Dermocybe sp 1	Survey
Descomyces	*Descomyces* (aff lebelii)	Diet
	Descomyces albellus	Survey
	Descomyces albus	Survey
	Descomyces 'dougmillsii'	Survey
	Descomyces 'jumpponenii'	Survey
	Descomyces 'latisporus'	Survey
	Descomyces 'lebelii'	Survey
	Descomyces 'miresii'	Survey
	Descomyces 'parviretifer'	Survey
	Descomyces 'psilosporus'	Survey
	Descomyces sp 2	Survey
	Descomyces sp 3	Survey
Dingleya	*Dingleya* 'cf geometrica'	Survey
	Dingleya verrucosa	Survey
Endogone	*Endogone* sp	Survey
Gallacea	*Gallacea* sp 1	Survey
	Gallacea sp 2	Survey
Glomeraceae	*Glomus* sp	Diet
	Glomus ellipsoid	Diet
Gymnohydnotrya	*Gymnohydnotrya ellipsospora*	Survey
Hydnangium	*Hydnangium carneum*	Survey
	Hydnangium 'parvisporum'	Survey
	Hydnangium sp 1	Survey
Hydnoplicata	*Hydnoplicata convoluta*	Survey & Diet
	Hydnoplicata sp 1	Survey
Hysterangium	*Hysterangium* 'aff gardneri'	Survey
	Hysterangium 'aff inflatum'	Survey
	Hysterangium 'agglutinatum'	Survey
	Hysterangium aggregatum	Survey
	Hysterangium sp 1	Diet
	Hysterangium sp 10	Survey
	Hysterangium sp 11	Survey
	Hysterangium sp 12	Survey
	Hysterangium sp 2	Diet
	Hysterangium sp 3	Diet
	Hysterangium sp 4	Survey
	Hysterangium sp 5	Survey

Genus or higher taxon group	Species or spore type	Record Source
	Hysterangium sp 6	Survey
	Hysterangium sp 7	Survey
	Hysterangium sp 8	Survey
	Hysterangium sp 9	Survey
Hysterogaster	*Hysterangium* sp 13	Survey
	Hysterogaster 'descogasteroides'	Survey
	Hysterogaster H1307	Survey
	Hysterogaster pogiesperma	Survey
	Hysterogaster rodwayii	Survey
	Hysterogaster sp	Survey
	Hysterogaster tasmanicus	Survey
Labyrinthomyces	*Labyrinthomyces* sp	Diet
	Labyrinthomyces varius	Survey
Leucogaster	*Leucogaster*	Diet
	Leucogaster rubescens	Survey
Mesophellioid	*Malajczukia fusispora*	Survey
	Mesophellia angustispora	Survey
	Mesophellia elelandii	Survey
	Mesophellia rava	Survey
	Mesophelliaceae	Diet
	Nothocastoreum sp 1	Survey
Octaviania / Hydnangium	*Octaviania* 1	Survey & Diet
	Octaviania 2	Survey
	Octaviania 2 */ Hydnangium*	Diet
Pisolithus	*Pisolithus hypogaeus*	Survey
Protoglossum	*Protoglossum* sp 1	Survey
Protubera	*Protubera* 'aff parvispora'	Survey
Quadrispora	*Quadrispora* 'aff tubercularis'	Survey
	Quadrispora sp 1 (musispora)	Diet
	Quadrispora oblongispora	Survey & Diet
Royoungia	*Royoungia boletoides*	Survey
Russuloid	*Cystangium* 'aff sessile'	Survey
	Cystangium 'aff xanthocarpum'	Survey
	Cystangium balpineum	Survey
	Cystangium clavatum	Survey
	Cystangium luteobrunneum	Survey
	Cystangium phymatodisporum	Survey
	Cystangium seminudum	Survey
	Cystangium sessile	Survey
	Cystangium sp	Survey
	Cystangium sparsum	Survey
	Cystangium trappei	Survey
	Gymnomyces 'aff boranupensis'	Survey
	Gymnomyces 'aff eburneus'	Survey
	Gymnomyces 'aff glarea'	Survey

Genus or higher taxon group	Species or spore type	Record Source
	Gymnomyces 'aff pallidus'	Survey
	Gymnomyces 'aff westresii'	Survey
	Gymnomyces aff wirrabarensis	Survey
	Gymnomyces eburneus	Survey
	Gymnomyces eildonensis	Survey
	Gymnomyces glarea	Survey
	Gymnomyces pallidus	Survey
	Gymnomyces sp 1	Survey
	Gymnomyces sp 2	Survey
	Gymnomyces sp 3	Survey
	Gymnomyces wirrabarensis	Survey
	Russula 'aff brunneonigra'	Diet
	Russula 'aff pilosella'	Survey
	Russula 'aff pumicoidea'	Survey
	Russula albobrunnea	Survey
	Russula brunneonigra	Survey
	Russula sinuata	Survey
	Russuloid 1	Diet
	Russuloid 2	Diet
	Russuloid 3	Diet
	Russuloid 4	Diet
	Russuloid 5	Diet
	Russuloid 6	Diet
	Russuloid 7	Diet
	Zelleromyces 'aff maculatus'	Survey
	Zelleromyces 'aff mattrappei'	Survey
	Zelleromyces 'aff subamyloideus'	Survey
	Zelleromyces claridgei	Survey
	Zelleromyces daucinus	Survey
	Zelleromyces 'lebelii'	Survey
	Zelleromyces majus	Survey
	Zelleromyces microsporus	Survey & Diet
	Zelleromyces sp 1	Survey
	Zelleromyces sp 2	Survey
	Zelleromyces sp 3	Survey
	Zelleromyces sp 4	Survey
	Zelleromyces sp 5	Survey
	Zelleromyces sp 6	Survey
	Zelleromyces sp 7	Survey
	Zelleromyces sp 8	Survey
	Zelleromyces sp 9	Survey
	Zelleromyces striatus	Survey & Diet
	Zelleromyces 'vittatus'	Survey
Scleroderma	*Scleroderma* 1	Diet
	Scleroderma 2	Diet

Genus or higher taxon group	Species or spore type	Record Source
	Scleroderma 3	Diet
	Scleroderma 4	Diet
	Scleroderma 5	Diet
	Scleroderma ‘aff paradoxum’	Survey & Diet
	Scleroderma densum	Survey
	Scleroderma paradoxum	Survey
	Scleroderma sheltonii	Survey
Setchelliogaster	*Setchelliogaster* sp 1	Survey
	Setchelliogaster sp 2	Survey
	Setchelliogaster sp 3	Survey
Timgrovea	*Timgrovea ferruginea*	Survey
	Timgrovea reticulata	Survey
Unknown	Unknown 1	Survey

Appendix 7. One-way analysis of similarity percentages (SIMPER) based on Bray Curtis similarity. Species contributions cumulating up to 90% of similarity are shown.

Group Survey
Average similarity: 33.57

Species	*Av.Abund*	*Av.Sim*	*Sim/SD*	*Contrib%*	*Cum.%*
Russuloid	0.80	14.57	1.11	43.40	43.40
Hysterangium	0.57	7.46	0.60	22.23	65.63
Descomyces	0.54	5.13	0.61	15.28	80.91
Cortinarius	0.31	1.45	0.31	4.33	85.24
Hydnangium	0.23	0.77	0.22	2.29	87.53
Dermocybe	0.23	0.73	0.22	2.16	89.70
Hysterogaster	0.20	0.66	0.19	1.96	91.66

Group Diet
Average similarity: 56.26

Species	*Av.Abund*	*Av.Sim*	*Sim/SD*	*Contrib%*	*Cum.%*
Russuloid	1.00	22.23	4.48	39.51	39.51
Octaviania / Hydnangium	0.80	13.55	1.25	24.08	63.59
Chamonixia	0.71	10.12	0.97	17.98	81.57
Hysterangium	0.37	2.70	0.38	4.80	86.37
Cortinarius	0.37	2.41	0.38	4.29	90.66

Groups Survey & Diet
Average dissimilarity = 69.47

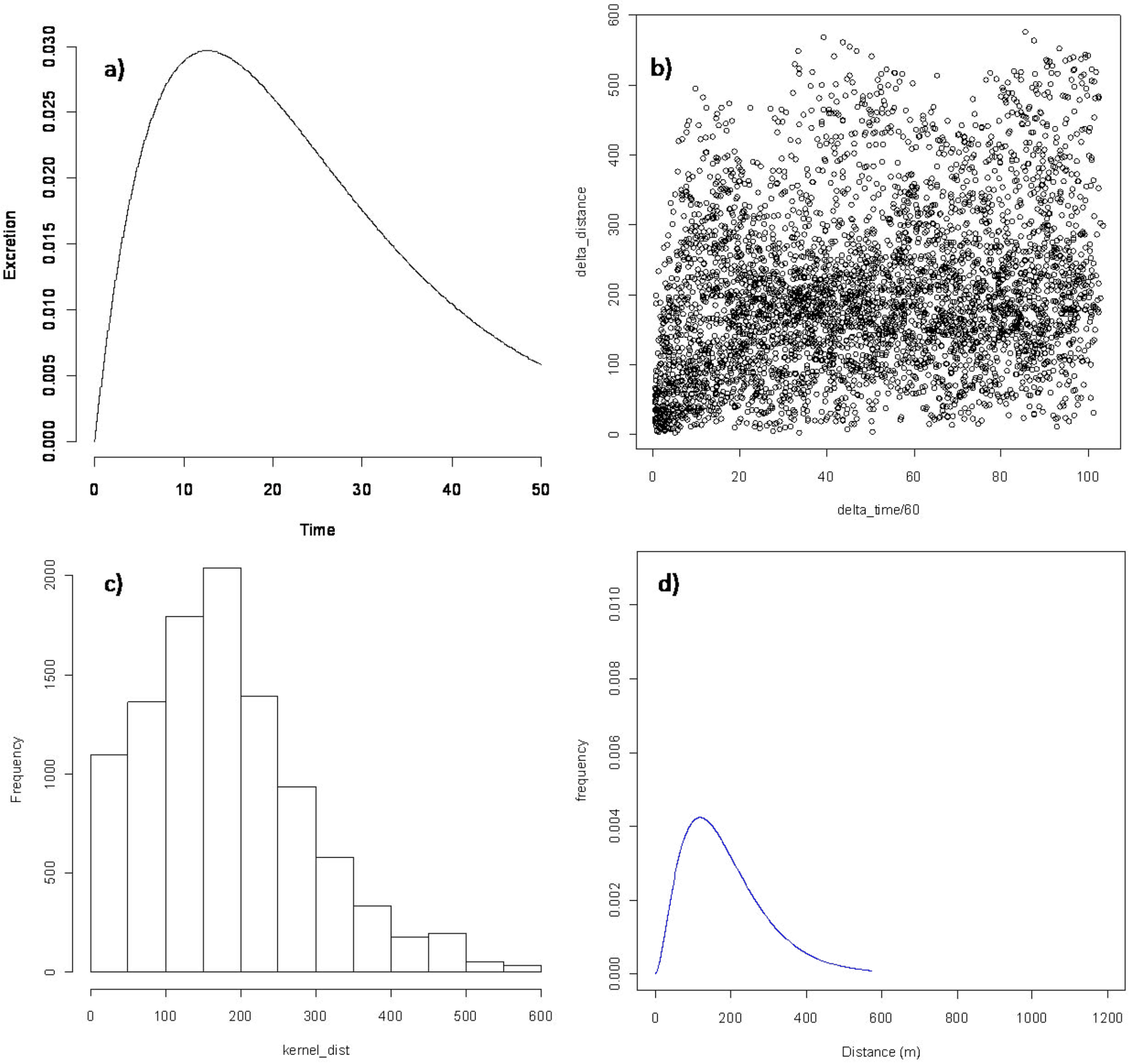
	Group Survey	*Group Diet*				
Species	*Av.Abund*	*Av.Abund*	*Av.Diss*	*Diss/SD*	*Contrib%*	*Cum.%*
Octaviania / Hydnangium	0.06	0.80	8.99	1.51	12.94	12.94
Chamonixia	0.20	0.71	7.34	1.18	10.57	23.51
Hysterangium	0.57	0.37	6.11	0.94	8.79	32.30
Descomyces	0.54	0.03	5.42	1.02	7.80	40.10
Cortinarius	0.31	0.37	4.88	0.86	7.02	47.12
Glomus	0.00	0.34	3.70	0.68	5.32	52.45
Scleroderma	0.14	0.26	3.61	0.64	5.20	57.65
Mesophellioid	0.17	0.17	3.27	0.59	4.70	62.35
	Group Survey	*Group Diet*				
Species	*Av.Abund*	*Av.Abund*	*Av.Diss*	*Diss/SD*	*Contrib%*	*Cum.%*
Austrogautieria	0.17	0.23	3.18	0.65	4.58	66.93
Russuloid	0.80	1.00	2.86	0.47	4.12	71.05
Hydnangium	0.23	0.00	2.15	0.53	3.10	74.15
Dermocybe	0.23	0.00	2.10	0.52	3.02	77.17
Hydnoplicata	0.17	0.06	2.06	0.49	2.96	80.14
Hysterogaster	0.20	0.00	2.04	0.48	2.93	83.07
Agariceae	0.00	0.14	1.68	0.39	2.41	85.48
Chondrogaster	0.14	0.00	1.51	0.38	2.18	87.66
Labyrinthomyces	0.00	0.11	1.33	0.34	1.92	89.58
Quadrispora	0.09	0.06	1.20	0.38	1.73	91.31

Appendix 8. R code used to calculate swamp wallaby generated dispersal curves of macrofungal spores (spore 'dispersal kernels') combining observed spore gut-retention times and distribution of displacement distances. Programmed by D. Haydon, D. Kerlin, and K. Vernes, with modifications by M. Tighe and M. Danks, in R (version 2.10.1, R Foundation for Statistical Computing 2009, downloaded from http://www.R-project.org on 14 Dec 2009).

```
#Plot gut-passage rate
data <- read.table("etWB.csv", header = TRUE, sep = ",")
attach(data)
t1<- c(First[1], X50.[1], X90.[1], X99.[1])
t2<- c(First[2], X50.[2], X90.[2], X99.[2])
t3 <- c(t1, t2)
CE1 <-c(.01, .5, .9, .99)
CE2 <-c(.01, .5, .9, .99)
CE3 <- c(CE1, CE2)
plot(t1, CE1, ylab="Proportion excreted", xlab = "time")
line(t2, CE2)
#Function to compare observed pattern with prediction from a gamma distribution
criterion <- function(param){
cdf <- pgamma(t3, param[1], param[2])
 p <- diff(cdf)
sum((diff(CE3)-p)^2/p)
}
# Optimization to find best gamma parameters
v1 <- optim(c(14, 0.5), criterion)
x <- seq(0, 50, 0.001)
plot(x, dgamma(x, v1$par[1], v1$par[2]), type = "l", ylab = "Excretion", xlab = "Time", main = " ", frame.plot = FALSE)
### Distance matrix
x11()  # Creates a new figure window
### BELOW CODE REPEATED FOR EACH TRACKING PERIOD###
travel <- read.table("WB4Feb08.csv", header = TRUE, sep = ",")
attach(travel)
timename<-time
noRecords <- dim(travel)[1]
delta_distance<-0
delta_time<-0
zz<-0
k<-0;
for (lagahead in 1:100) { #select values randomly and lag ahead between 1 and 300 steps - must be set according to number of points, and time between fixes - use as default 100 for 30 min fixes
for (i in 1:50) #performs each selection of lagged pairs 50 times {
	z1<-runif(1,1,(noRecords-lagahead));
	z2<-trunc(z1);
	k<-k+1;
delta_distance[k] = sqrt((Easting[z2+lagahead]-Easting[z2])^2 + (Northing[z2+lagahead]-Northing[z2])^2)
	delta_time[k] =(timename[z2+lagahead]-timename[z2])
	}
	}
plot(delta_time/60, delta_distance)
### Kernel Distribution
kernel_dist<-0
k<-0  #sets k to zero
for (i in 1:10000){
```

```
	k<-k+1;
	xt<-rgamma(1, v1$par[1], v1$par[2])*60
	it<-which(abs(delta_time-xt)==min(abs(delta_time-xt)))
	kernel_dist[k]<-delta_distance[it]
	}
### Create a Spore Dispersal Kernel as a Histogram
hist(kernel_dist)
### Model Spore Dispersal as a Gamma Probability Distribution
bestkfit <-fitdistr(kernel_dist, "gamma")
x <- seq(0, max(kernel_dist), 0.01)
xlim=c(0,1200)
ylim=c(0,0.011)
first<-plot(x, dgamma(x, bestkfit$estimate[1], bestkfit$estimate[2]), type = "l", xlim=xlim, ylim=ylim,ylab = "frequency", xlab = "Distance (m)", main = "spore dispersal",col=4)
### Generate a summary (mean, min, max, etc.) of the Kernel Distribution
summary(kernel_dist)
```

Appendix 9. Spore gut-retention time, swamp wallaby movement pattern, and spore dispersal kernel generated by a swamp wallaby for macrofungal spores. (a) Mean proportion of spores deposited in swamp wallaby faeces as a function of time since ingestion. (b) Distribution of GPS-tracked swamp wallaby displacement distances (lags of 100 fixes from origin, a randomly selected point) as a function of time since origin. Example shown is swamp wallaby #1, tracked in February 2008 at Newholme Field Station, northern New South Wales, Australia. (c) Dispersal kernel combining the spore gut-retention time distribution and the displacement distance distribution. (d) Dispersal curve fitted to a gamma distribution.



Appendix 10. Summary - Inoculum potential of ectomycorrhizal fungal spores deposited in swamp wallaby faecal pellets

Effective spore dispersal relies upon the viability of spores deposited in faecal pellets. How passage through the swamp wallaby gut affects spore viability is unknown, so I established experiments to test the hypotheses (1) spores of truffle-like ECM fungi remain viable after passage through the swamp wallaby digestive tract and (2) digestion by the swamp wallaby enhances the mycorrhizal potential of EM fungal spores. The mycorrhizal effectiveness of spores of *Hysterangium gardneri* in swamp wallaby faecal pellets (captive swamp wallabies which had not consumed other EM sporocarps), and from uneaten basidiomes, on *Eucalyptus nobilis* seedlings was examined in a glasshouse experiment. *Hysterangium* species are commonly found in native and planted eucalypt forests (Beaton *et al.* 1985; Johnson 1994; Nouhra *et al.* 2008), form ectomycorrhizas with eucalypts (Malajczuk *et al.* 1987; Burgess *et al.* 1993; Lu *et al.* 1999; Reddell *et al.* 1999; Nouhra *et al.* 2008), and produce truffle-like sporocarps which are found as spores in the diet of swamp wallabies (Vernes 2010). The results of the seedling inoculation experiment were inconclusive as all treatments (eaten spores, uneaten spores, and control) had similar, low, levels of root colonisation by *Hysterangium*, *Coenococcum*, and other, unidentified, EM fungi. Contamination among treatments in the glasshouse was considered to have obscured any treatment effects. Lab experiments to synthesize mycorrhizas of *Hysterangium* and *Pisolithus* and eucalypt germinants on agar media, and to variously test the metabolic activity or viability of eaten and uneaten *Hysterangium* spores using Tetrazolium and Flouricene-diacetate stains were also unsuccessful.

The inoculum potential of EM spores deposited in swamp wallaby faecal pellets therefore remains unknown, but some predictions can be made based upon the results of previous studies of mycophagous mammals. Studies on potoroids (Lamont *et al.* 1985; Claridge *et al.*

1992; Reddell *et al.* 1997), peramelids (Reddell *et al.* 1997), and rodents (Reddell *et al.* 1997; Colgan and Claridge 2002; Caldwell *et al.* 2005) have demonstrated that EM spores remain viable, and for some EM fungi taxa mycorrhizal effectiveness is enhanced (Lamont *et al.* 1985) by passage through the mammalian gut and subsequent deposition in faeces. I therefore consider it likely that EM spores remain able to form associations with host plant roots after passage through the swamp wallaby gut. Nevertheless, clarification of the effect on EM spores of gut-passage in the swamp wallaby, and other mycophagous mammals is needed.

References

Beaton G., Pegler D. N. & Young T. W. K. (1985) Gasteroid Basidiomycota of Victoria State, Australia: 4. Hysterangium. *Kew Bulletin* **40**, 435-44.

Burgess T. I., Malajczuk N. & Grove T. S. (1993) The ability of 16 ectomycorrhizal fungi to increase growth and phosphorus uptake of *Eucalyptus globulus* Labill. and *E. diversicolor* F. Muell. *Plant and Soil* **153**, 155-64.

Caldwell I. R., Vernes K. & Baerlocher F. (2005) The northern flying squirrel (*Glaucomys sabrinus*) as a vector for inoculation of red spruce (*Picea rubens*) seedlings with ectomycorrhizal fungi. *Sydowia* **57**, 166-78.

Claridge A. W., Tanton M. T., Seebeck J. H., Cork S. J. & Cunningham R. B. (1992) Establishment of ectomycorrhizae on the roots of two species of *Eucalyptus* from fungal spores contained in the faeces of the long-nosed potoroo (*Potorous tridactylus). Australian Journal of Ecology* **17**, 207-17.

Colgan W., III & Claridge A. W. (2002) Mycorrhizal effectiveness of Rhizopogon spores recovered from faecal pellets of small forest-dwelling mammals. *Mycological Research* **106**, 314-20.

Johnson C. (1994) Fruiting of hypogeous fungi in dry sclerophyll forest in Tasmania, Australia: seasonal variation and annual production. *Mycological Research* **98**, 1173-82.

Lamont B. B., Ralph C. S. & Christensen P. E. S. (1985) Mycophagous marsupials as dispersal agents for ectomycorrhizal fungi on *Eucalyptus calophylla* and *Gastrolobium bilobum*. *New Phytologist* **101**, 651-6.

Lu X., Malajczuk N., Brundrett M. & Dell B. (1999) Fruiting of putative ectomycorrhizal fungi under blue gum (*Eucalyptus globulus*) plantations of different ages in Western Australia. *Mycorrhiza* **8**, 255-61.

Malajczuk N., Dell B. & Bougher N. L. (1987) Ectomycorrhiza formation in *Eucalyptus*. III. Superficial ectomycorrhizas initiated by *Hysterangium* and *Cortinarius* species. *New Phytologist* **105**, 421-8.

Nouhra E. R., Dominguez L. S., Daniele G. G., Longo S., Trappe J. M. & Claridge A. W. (2008) Occurrence of ectomycorrhizal, hypogeous fungi in plantations of exotic tree species in central Argentina. *Mycologia* **100**, 752-9.

Reddell P., Gordon V. & Hopkins M. S. (1999) Ectomycorrhizas in *Eucalyptus tetrodonta* and *E. miniata* forest communities in tropical northern Australia and their role in the rehabilitation of these forests following mining. *Aust. J. Bot.* **47**, 881-907.

Reddell P., Spain A. V. & Hopkins M. (1997) Dispersal of spores of mycorrhizal fungi in scats of native mammals in tropical forests of northeastern Australia. *Biotropica* **29**, 184-92.

Vernes K. (2010) Mycophagy in a community of macropod species. In: *Macropods: The Biology of Kangaroos, Wallabies and Rat-kangaroos* (eds G. Coulson and M. Eldridge). CSIRO Publishing, Collingwood, Victoria, Australia.

Appendix 11. Summary - Online database for truffle-like fungi and mycophagous mammal information (TRUFFMO)

Difficulties with accurate identification of macrofungal spores in mammal diets has hampered studies of mammal mycophagy, and limited accumulation and sharing of knowledge. This is certainly the case in Australia, where macrofungi and, particularly, truffle-like fungi, are poorly known. A major impediment is the lack of an accessible, additive, central database (data is currently scattered in disparate researcher and organisational datasets, collections and student theses) to advance information sharing and collaborative research across disciplines. To address this need, an online database, dubbed 'TruffMO', is in development, in collaboration with ArmidaleIT (Armidale, Australia), Dr Teresa Lebel (Royal Botanic Gardens Melbourne, Australia), and Dr Karl Vernes (Ecosystem Management, University of New England, Armidale, Australia). New and existing data will form the basis of this database to facilitate accurate identification of fungal spores and taxa, standardisation of methods, and provision of study site information. Ecological and taxonomic information, such as fungal sporocarp and faecal material collection data, images, descriptive information, spore types and identifications, and site information will also be included. This will increase potential for comparisons between studies and encourage collaboration and information sharing. The database is currently in the development and testing phases. In the final stage the database will be further developed for the web for worldwide access, including data uploads from other research teams. The information database will be a significant tool for communication of results, disseminating information, and facilitating collaboration between researchers, land managers, and community groups with benefits beyond the life of this project.