A Thousand Days in the Forest

An Ethnography of the Culture of Fungi

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Statement of Originality

I declare that this thesis is my own work, and that, to the best of my knowledge and belief, it contains no material previously published or written by any other person, nor material that has been accepted for the award of any other degree of a university or other institute of higher learning, except where due acknowledgement is made in the text.

Alison Pouliot

Note on Methodology

Short footnotes have been used throughout, with a full bibliography at the end, so as to be accessible to readers from the many disciplines (with various methodologies) that have contributed to my thinking. Raw data and discussions of these appear in appendices for those interested in how the material used in the text was developed.

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People didn't just assist with this thesis, they *are* the thesis. Their contributions inspired and shaped it. I have simply collected and interpreted their perceptions and impressions, stories and anecdotes, as a means to understand fungi. All have in some way challenged me to reconsider and reimagine these organisms in new ways.

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special mention in the acknowledgements. This thesis could not have been written anywhere but in these places. Over the course of this research, billions (that is not a typo) of trees have been razed, wetlands drained and other habitats demolished. These are lost fungal places too. Each day I woke up to the realities of pervasive ecocide and human injustices. Each day I woke up and recognised the privilege of spending my days researching and writing what I care about. It often felt like an indulgence to be writing about fungi rather than actively resisting these perverse acts of environmental destruction. I hope this research might be a lever for reimagining fungi and other ways of being in the world, to improve possibilities not just for fungi to flourish, but all life.

Abstract

Without fungi, life is radically diminished. Fungi regulate the biosphere and support the earth's ecological functioning. Yet the exceptionally few mushrooms with the capacity to dismantle human livers and kidneys have received disproportionate attention. This thesis presents an account of human-fungus relationships and how fungi are perceived and understood. It uses fungi as a lens to reconfigure ways of thinking, not just about fungi, but all nature, including *Homo sapiens*. It expands on the dominant mycological narratives through which fungi are represented, to create space for other forms of knowledge that allow these marginalised organisms to emerge through the cracks of human awareness and concern.

The research had a threefold aim: first, to understand why fungi are regarded differently to other organisms. Second, to present a more inclusive concept of fungi by proposing a shift in thinking – from thinking of sporebodies as discrete entities, to considering fungi as sophisticated relational systems relevant to human lives. Third, I examined what is required to enable their inclusion within what is valued; including within concepts of nature, biodiversity and conservation. This means finding ways to insert fungi into the ecological imagination and consciousness.

Through interactions with all sorts of 'fungal folk,' I elucidated the differences between definitive and expansive perceptions of nature and how the manifest indeterminacy of fungal development highlights the need for broader perceptions and an enhanced language. Fungus reproductive structures such as mushrooms provide a tangible link to humanity. However, I argued that mycelia provide a more imaginative and insightful way to consider the bigger fungal picture. Mycelia provide a matrix of interconnectivity with organisms and environments across multiple temporal and spatial scales, underpinning ideas of interactions and circulations explored throughout this thesis. I examined how the plastic essentiality of mycelia – versatility, complexity, heterogeneity, changeability, resilience, indeterminacy and biological utility – offers a compelling and constructive framework to contemplate the living world. The mycelial tangle also provides metaphors for human societies; for connectivity, spontaneity, unpredictability and ways to attune to the dynamism of natural systems that move beyond ideas of balance and control.

The thesis is brought together through a collection of voices in stories and anecdotes, histories and science, gleaned across hemispheres and cultures. It comes alive particularly through direct engagement with people and fungi in their habitats. It is embedded in the sensorial as much as the philosophical; through sensing fungi and their places during my thousand days in the forest. Through a combination of text and visual essays working in counterpoint, I reflected on how aesthetic, sensate experience deepened by scientific knowledge offers a rich understanding of fungi, the forest and human interactions.

At a time when Australia is shifting from a traditionally mycophobic position towards greater interest in fungi, new questions arise about their place in the living world. This thesis presents fungi as a catalyst to rethink environmental concepts and issues during a time of rapid change.

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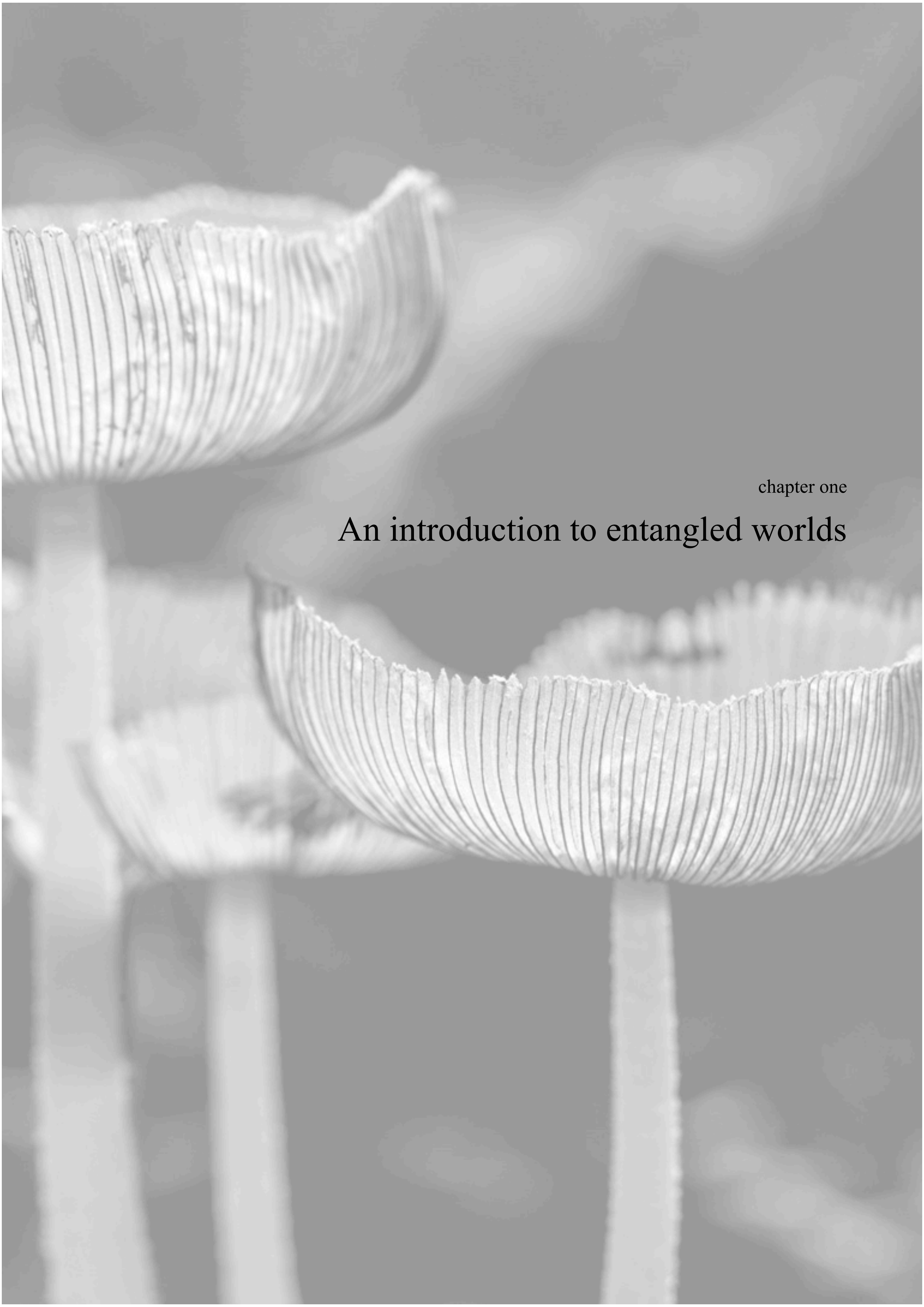

chapter one

An introduction to entangled worlds

Low mists spanned the hills of Victoria's Great Dividing Range. The crops were harvested and surpluses pickled and bottled. A handful of remaining wildflowers flashed their last blooms of colour. Slipping through the slanting light of the Wombat Forest our senses awakened to the change of seasons. Autumn. All was subtly muted, softened. Dampness subdued the usual crack of sticks and leaf litter underfoot. Birdcall and the buzz of insects diminished with the cooling air. And it smelt different. Distinctively different. At first it seemed the forest was winding down for the winter. But something stirred beneath the leaf litter, beneath the soil. With extraordinary reproductive zeal, fungi revealed their whereabouts as their sporebodies pushed through the forest floor. We had come to meet with mushrooms.[1]

'Look!' exclaimed Angelica, my five-year-old companion. We squatted down beside a *Russula*. Vermillion red, its cap mapped tiny peregrinations – slid, rasped and bitten through by unknown wayfarers. Each trail traced a tiny journey in search of shelter or food. Angelica flipped onto her stomach and peered under its cap. 'Look!' she exclaimed again, pinching off a slug with her fingers, its stalked eyes rapidly contracting. I opened my field guide. There were at least two dozen reddish russulas. Angelica examined the images, sliding a slug-slimed finger across each. 'Nup, it's none of 'em,' she asserted dismissively and continued prodding the slug. My field guide was European not Australian and she might therefore have been right, but I asked her anyway how she could be so sure. She shot me a pitying look then explained how none had a slug or the same pattern of holes. She was right. The field guide meticulously illustrated idealised specimens, depicting morphological features for identification. But each was also an isolated entity, concealing larger stories of interactions with a congregation of unseen creatures, of connecting ecosystems, underpinning the forest's existence, our existence, life.[2]

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[1] The word *fungus* (pl. fungi) is used in this thesis to refer to the entire organism, including its mycelium and reproductive structure. The mycelium is the matrix of threadlike branching fungal cells called hyphae that constitute the fungus body or what is often referred to as the vegetative body. I use the word *sporebody* to refer to the reproductive structures of a fungus, for example, a mushroom or puffball (I use *sporebody* rather than the more commonly used term, *fruitbody*, to avoid using a botanical reference to a fungus. I also prefer *sporebody* to the more technical term, *sporophore*). The term *mushroom* is used in a broad generic sense to refer to reproductive structures that have a cap-and-stipe style sporebody. The word *toadstool*, which was once commonly used to refer to poisonous mushrooms, is seldom used today, hence *mushroom* implies no information about edibility or toxicity. *Mycota* is the fungal equivalent of fauna and flora. This thesis follows the scientific convention of italicising scientific names (with the initial letter of the genus capitalised). The initial letters of vernacular names are capitalised to distinguish them more easily from surrounding text. Foreign language vernacular names and words are also italicised. All species mentioned in this thesis are listed in Appendix 1.

[2] Angelica Elliot, informal conversation with the author, Wombat Forest, Victoria, 7 April 2014.

This is an inquiry into fungi. Into people. Fungi and people. Kingdoms, ecosystems, landscapes, underworlds. It focuses less on individual species or places and more on relationships. Between fungi and fungi. Fungi and plants. Fungi and animals including *Homo sapiens*. Fungi and soil. Fungi and life. Complex entanglements, interconnections, circulations. In particular, it explores the histories that shape the ways fungi are perceived and valued.

I interacted with people who interacted with fungi, including mycologists and mycophagists, farmers and field naturalists, aesthetes and conservationists, rangers and biodiversity managers and those who sought fungi for reasons beyond food or science. I gleaned their perceptions through the natural, cultural and imaginative histories of fungi to understand why these organisms are regarded so differently to other forms of life. Mycologists Rolfe and Rolfe recognised the paradoxic and symbolic potency of fungi in 1925:

> Nurtured in death and decay, often bizarre of form and lurid of colour, some bloated and leering, others dainty and graceful, all appearing and often disappearing in such uncanny fashion, these pariahs of the plant world have been for ages at once a source of wonder and of loathing to the uninitiated.[3]

I questioned what makes sporebodies – often the same species growing in different places or at different times in history – simultaneously objects of abhorrence and delight.

I present this research as a stimulus for including fungi in concepts of nature, biodiversity and conservation. This means finding ways to insert fungi into the ecological imagination and consciousness. It requires an understanding of how mycology, taxonomy and the way science has been practiced intersect with other cultural perceptions of fungi. I examined binaries that affect how fungi are perceived: those of nature and culture, epistemology and ethics, facts and values, foragers and forayers, amateurs and professionals, those who write lists and those who do not. Using various social-cultural theories and other knowledge-making processes, I reassessed scientific frameworks for understanding nature, bringing them into conversation with one another.

The story is told through a collection of voices in anecdotes, histories and science gleaned across hemispheres and cultures. It comes alive particularly through direct engagement with people and fungi in their habitats – in the bush, forests, woodlands, grasslands, deserts, backyards and unregarded places. It is embedded in the

[3] Rolfe and Rolfe, *Romance of The Fungus World*, 1.

sensorial as much as the philosophical; through sensing fungi and their places, through tracks and traces, through all weather and changes of seasons. I have tried to reflect fungi in their various guises, not so much to classify them, but in the hope I might touch the essence or lyric of these organisms. I hope to not just inform, but inspire care, so that to exclude fungi from concepts of nature or conservation might seem as ludicrous to the reader as it did in motivating me to write this account.

Myco-blindness

Without fungi, life is radically diminished. Fungi regulate the biosphere and support the earth's ecological functioning. Yet the exceptionally few mushrooms with the capacity to dismantle human livers or kidneys are the ones deemed worthy of most attention by a spectacle-obsessed press. Mycologist and scientific historian Geoffrey Ainsworth contended that humans have 'always been impressed by calamities, and the earliest written records of fungi are not of the fungi themselves, but of their depredations'.[4] Such calamity-causing species remain the focus of contemporary reporting of fungi, particularly in the English-speaking world. Shark attacks sell newspapers splendidly, but once the swimming season ends, any notion of gently easing into autumn is quickly expunged by lethal fungus substitutes: 'Killer mushrooms invade picnic spots'; 'Potential killers stalk Victoria's fields'; 'Wild fungi death trap'; 'Beware the killer mushrooms', caution the Australian newspapers.[5] Fungi are seldom considered to have agency within spheres of human moral consideration, except it seems, when intentionally stalking their human victims.

English language speakers' common aversion to fungi has long been recognised. British cryptogamist Miles Joseph Berkeley noted negative attitudes toward fungi in 1857: 'From the poisonous qualities, the evanescent nature, and the loathsome mass of putrescence presented in decay by many species, [fungi] have become a byword among the vulgar, and are frequently regarded as fit only to be trodden under foot'.[6] Negative portrayals of fungi arise not only through public ignorance and misunderstanding, but also through the scientific focus on the destructive capacities of fungi.[7] This is unsurprising given fungal potential to wreak havoc on crops and bodies, albeit usually

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4 Ainsworth and Sussman, *The Fungi*, 4.

5 "Killer mushrooms invade picnic spots," *Herald Sun*, 04 April 2012; Geoff Strong, "Potential killers stalk Victoria's fields," *Age* 21 April 2011; "Wild fungi death trap," *Geelong Advertiser*, 29 April 2001; "Beware the killer mushrooms," *Stonnington Leader*, 30 April 2001.

6 Berkeley, *Introduction to Cryptogamic Botany*, 241.

7 e.g. Fisher et al., "Emerging Fungal Threats," 186.

in direct response to poor human management. To what extent might such perceptions of fungi inhibit appreciation of their many values or human dependence on their existence? Strongly contrasting feelings triggered by fungi are well documented. In 1957 the controversial ethnomycologist Robert Wasson coined the terms ‘mycophilia’ and ‘mycophobia,’ referring to the love and fear of fungi. Wasson, an American, and his Russian wife, Valentina Pavlovna Wasson, discovered their conflicting feelings toward fungi while on honeymoon, or so the story goes, sparking a lifelong quest to understand cultural relationships between humans and fungi.[8] Australia’s sparse mycological history and negative press portrayals of fungi typify mycophobic English-speaking nations. However, attitudes to fungi today might not be as polarised as the Wassons supposed. My findings suggest Australia is shifting from a traditionally mycophobic position towards a greater spectrum of attitudes. But just for a moment, imagine how things could have been very different for fungi, as well as for *Homo sapiens*.

Had biology taken another path to understanding nature – a path that focussed on interactions as much as individual identities – the living world might have been perceived in an entirely other way. Darwin’s oft-quoted and uncharacteristically poetic description of foliage on his ‘tangled bank’ in the concluding paragraph of *On the Origin of Species* (1859) acknowledged the inherent interdependency of species. Whether metaphorical or real, his tangled bank could perhaps be considered as an early precursor to the concept of ‘ecosystems’ coined by British botanist Arthur Roy Clapham in the early 1930s and first used in print by biologist Arthur Tansley in 1935.[9] Unnamed and less formulated concepts of interdependencies between organisms go back more than two millennia to Theophrastus.[10] Anthropologist, Tim Ingold, considers how current concepts of nature might be very different if fungi had been taught as being representational of biology, with ‘mycelium as the prototypical exemplar of the living organism’.[11] Ingold reflects the ideas of mycologist Alan Rayner who describes how fungal mycelia mirror organisational and behavioural principles in human societies. A mycologist himself, Rayner recognises the enormous value of the sciences but also how they can inhibit thinking by mathematising the world.[12] He demonstrated how many biological processes are generic to life on earth by applying ideas such as symbioses in different scales and contexts including as a means to understand human culture. Says

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[8] Letcher, *Shroom*, 81; Yamin-Pasternak, “How The Devils Went Deaf,” 51-52.
[9] Willis, “The Ecosystem,” 268.
[10] Ibid.
[11] Ingold, *Being Alive*, 85-86. Tim Ingold’s father was the world-renowned mycologist, Cecil Ingold.
[12] “Fungal mycelia” is a tautology but is useful in reinforcing a poorly appreciated concept.

Rayner: 'In many natural environments fungi provide the hidden energy-distributing infrastructure – like the communicating pipelines and cables beneath a city – that connects the lives of plants and animals in countless and often surprising ways'.[13] In a twenty-first century twist, mycelial interconnectivity is sometimes referred to as Nature's Internet.[14]

Rayner's concept of Natural Inclusionality rejects reductionist notions of Cartesian dualism and understanding the world through competition and opposition. Rather, he advocates natural complementation as an alternative to natural selection. Rayner considers there to be no such thing as absolute independent singleness, with entities being distinct but not isolated and dynamically interactive:

> the ecological and evolutionary sustainability of natural life forms, from the cells and tissues in a human body to the trees in a forest depend upon close *mutual attunement with* (as distinct from unilateral adaptation to) the diversity, complementary nature and changeability of all within their neighbourhood, to which they themselves contribute.[15]

His argument in favour of a more fluid approach of 'understanding each in the otherness' is useful in shifting from narrow conceptions of fungi as isolated sporebodies to the sophisticated biological collective of mycelia.

Rayner's idea of space as being continuous through boundaries allowing for reciprocal flows speaks to physicist Karen Barad's concept of Agential Realism. Barad's theory reconceptualises the processes by which knowledge is produced in scientific pursuits and questions assumptions of Western epistemology including subject/object dichotomies. Informed by physicist Niels Bohr's quantum physics, Agential Realism combines epistemology, ontology and ethics in reformulating agency, realism, causality and the 'ontological inseparability of intra-acting agencies'.[16] Like Rayner's Natural Inclusionality, Agential Realism dissolves the metaphysics of individualism and underscores how fungi are diminished by boundary-making processes that produce 'objects' and 'subjects'. Barad's concept advances invertebrate biologist, Jakob von Uexküll's notion of *Umwelt* by allowing inclusionality and

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[13] Rayner, *Degrees of Freedom*, vii.

[14] e.g. Stamets, *Mycelium Running*, 2.

[15] Rayner, "Space Cannot Be Cut," 166. Italics original.

[16] Barad differentiates the neologism "intra-action" from "interaction," to emphasise the "mutual constitution of entangled agencies" that "do not precede but rather emerge through, their intra-action" and are "only distinct in a relation to their mutual engagement". Barad, *Meeting the Universe Halfway*, 33. The distinction is important as intra-action enables different ways of thinking about relationships, knowledge frameworks, ways of thinking and being.

reciprocity.[17] *Umwelt* encapsulates the idea of an organism's 'place and being' from its perspective, rather than just human perspectives. Said von Uexküll: 'This island of the senses, that wraps every man like a garment, we call this Umwelt'.[18] Historian of science Libby Robin suggests that while an organism's *Umwelt* might be difficult or even impossible to accommodate in conservation, it is useful in implying a precautionary principle 'that even unlikely areas have the potential to be valuable to some species'.[19]

Barad considers 'thingification – the turning of relations into "things", "entities", "relata",' as a fundamentally problematic way to regard the world.[20] Her idea of intra-actions enables another way of thinking about fungal interconnectivities and recognises how divisive knowledge frameworks reduce some things (e.g. fungi) to invisibility. Neither Rayner's nor Barad's concepts deny individuality or differentiation, but rather they assert that differences are relational. Considering differences relationally offers richer ways to contemplate them. To define something *only* by its identity risks underestimating its interrelations. Returning to the forest floor, I am not suggesting we throw away our field guides. Recognising something as different and being able to name it, imbues it with meaning and significance. How else can one refer to what a fungus *is* without identifying it, categorising it in some way, to acknowledge what differentiates it from being another fungus, or a numbat for instance.

I aim to prompt a reconsidering of why identity has historically overshadowed relationships and how this perpetuates limited concepts of nature. To consider a fungus in the context of its mycelium rather than *only* by its taxonomic identity enables a more inclusive way of considering nature including human entanglements. Fungal mycelia pervade soils. Fungus spores are omnipresent in air, water and human bodies, shaping environments as much as environments shape fungi. Rethinking fungi involves a switch from regarding a sporebody as a thing, subject to naming, plucking or representation, to in Barad's words, 'a substance of intra-active becoming – not a thing, but a doing'.[21]

Ideas about the continuity and fluidity of nature have been extensively critiqued from the perspectives of Aboriginal Australians. Kombu-merri Indigenous elder, Mary Graham, describes Aboriginal logic as very different to Western logic, in that

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[17] *Umwelt* incorporates all the factors that affect something in a place where the world is constituted within an organism's circuit of perception and action. Ingold, *Being Alive,* 80.
[18] von Uexküll, "An Introduction to Umwelt," 107.
[19] Robin, *How a Continent*, 174.
[20] Barad, "Posthumanist Performativity," 812.
[21] Barad, *Meeting the Universe Halfway*, 151.

Aboriginal logic maintains that there is no division between the observing mind and anything else: there is no "external world" to inhabit. There are distinctions between the physical and the spiritual, but these aspects of existence continually interpenetrate each other.[22]

From her extensive interaction with Aboriginal people, anthropologist Deborah Rose discusses how the concept of 'Country' dissolves the division of nature and culture.[23] Country is multidimensional, representing more than species, land and water. It has future and past, exists in and through time. It is life. Country is an all-embracing notion of belonging, being owned by place and connection.[24] Aboriginal ideas of animals as part of kin, rather than species, upend European approaches to biodiversity conservation that rely on defining individual species. People are also part of Country. Says Rose:

Australian Aboriginal people have one of the most complex kinship systems on earth . . . Their system of kinship confounds Western expectations along many parameters, one of which is that it does not set up a hierarchically separated dualism between human culture and the rest of the natural world. Rather, most living things are included within the kinship system, and because kinship is a domain of ethics, most living things are included within an ethical system.[25]

Reflecting Barad's ideas of intra-action, Rose explores how Aboriginal thinking goes beyond mere connections to include reciprocity, differentiation and obligation.

A more inclusive approach to considering fungi inspires greater focus on relationships and contexts and the fluid character of the life process, rather than one based only on separating and cataloguing it. Mycology has revealed the staggering diversity and complexities of the fungus kingdom, but Rayner questions whether a century of British mycology might also have hindered recognition of mycelial fungi as living systems. In an offbeat yet appropriate metaphor he notes:

Rather like a cinema audience that focuses on the film stars whilst forgetting the production team, mycologists have tended to be distracted by sporophores – giving them names and dressing them in fancy language – whilst taking the mycelial infrastructure for granted . . . What should have been the current providing the vital spark igniting an awareness of the fundamental nature of mycelial systems has always been undercurrent – a dark suspicion of unseemly activities not quite within grasp.[26]

I don't read this as an attack on mycology. Rather, it is a call toward its depth and mystery.

Sporebodies provide an obvious tangible link to humanity. However, I argue

[22] Graham, "Aboriginal Worldviews," 113.
[23] Rose, "Indigenous and Western Understandings of Nature."
[24] Lay, "Juris Materiarum," 131.
[25] Rose, "Rainbirds," 186.
[26] Rayner, "Interconnectedness and Individualism," 195.

that the bigger fungal picture of the plastic essentiality of their mycelia – versatility, complexity, heterogeneity, changeability, resilience, interconnectivity, indeterminacy, biological utility – offers a compelling and constructive framework to contemplate the full potential of fungi and the living world. The mycelial tangle also provides opportunities to explore fungal metaphors for human social systems. Ingold reminds us that the tangle is the texture of the world.[27] This tangle of relationships is central to life and evolution, not an alternative or secondary strategy. Although symbioses were long considered an anomaly, they are now regarded as foundational and a general mechanism of evolutionary innovation.[28] Given the scientific acceptance of symbioses, I investigate why these remarkable unions have been overlooked in ways of understanding the world.

Thinking, un-thinking, re-thinking fungi

I do not recall eating mushrooms in my Australian childhood. I am not sure why they never appeared on my dinner plate, but suspect they were too 'foreign' or 'undefinable' for my mother to contemplate buying them. They were not meat, and they were not quite vegetable and she was certainly not about to go digging for them in the dirt.

It never occurred to me to eat them. I had seen the benign and insipid mushrooms (*Agaricus bisporus*) in the supermarket but somehow never linked them with the incredible representations of fungal life in the bush. I knew neither was animal or vegetable, but the similarity between the supermarket mushrooms and those in the bush ended there. Those in the bush were lifeforms of sheer beauty and bizarreness. Soon enough, their aesthetics intensified my curiosity. I wanted to know why they looked like they did and what they were doing.

Of most immediate concern was that I had no idea how to walk in the bush. I was acutely aware of treading on things. Every footstep crushed stuff; tiny lichens and mushrooms, mosses and sundews, spiders sleeping inside curled leaves. There was no space to tread. How heavy did I need to be before the fungal webs of mycelia beneath the leaf litter would be destroyed? What was blatantly apparent even to a child's mind – or perhaps because of having a child's mind – was that everything in the bush was connected. Connectivities were more obvious than the distinctiveness of things. Why does this glaring truth dissipate as we retreat into adulthood? Perhaps Antoine de Saint-Exupéry was right: 'Les enfants seuls savent ce qu'ils cherchent'.[29] Clambering about in

[27] Ingold, *Being Alive*, 71.
[28] Sapp, "The Dynamics of Symbiosis," 1046.
[29] de Saint-Exupéry, *Le Petit Prince*, xxii, trans., Only children know what they are looking for.

the bush triggered a life-long urge to document these unseen microcosms in the hope they might not get trodden on and their connections severed. The inspiration for this thesis therefore began long ago.

This research extends a lifelong quest with a threefold aim. First, to understand why fungi are regarded differently to other organisms. Second, to present a more inclusive concept of fungi by proposing a shift in thinking – from thinking of sporebodies as discrete entities, to considering fungi as sophisticated entangled systems. And third, to propose a challenge for their inclusion within what is valued. Conserving fungi requires reinvigorating the moral imagination; merging facts and values to articulate the missing ethical aspirations to foster obligation and action.[30] I see it as a transition from thinking about fungi (inserting them in human consciousness) to unthinking fungi (in the limited ways they have been perceived historically) to rethinking fungi (within broader dimensions). It then goes a step further to inspire passion that arouses compassion that might lead to caring and conserving. The conservation dimension has driven this research and begins with examining human-fungus relationships.

Australian philosopher Val Plumwood wrote extensively about the need for knowledge frameworks that focus on interactions, including human relationships with nature. Her ideas echo across those of Rayner, Ingold and Barad, in identifying human hyper-separation from nature and its reduction to something to be dominated and 'managed,' as being central to its exclusion from ethical significance within prevailing Western culture.[31] She recognised the dualisms and exaggerated oppositions, the reductionism at the centre of Western thought that limits conceptions of nature, and like Barad, drew on feminist theory to articulate a philosophical background for a new paradigm or way to be in the world.[32] I am interested in how fungi can be included in such a paradigm. This first requires unthinking current narrow concepts of fungi and then rethinking them in more expansive ways, but more critically, asks *how* to rethink them. What forms of knowledge and knowledge-creating processes could foster a more inclusive and imaginative understanding of fungi? Plumwood did not write specifically about fungi. However, like Rayner and Barad, her questioning of the dualistic and hierarchical frameworks imposed on nature comes to the heart of their invisibility.

[30] Dean Moore and Nelson, "Introduction: Toward a Global Consensus for Ethical Action," xviii.
[31] Plumwood, *Feminism and the Mastery of Nature*, 6.
[32] Staples, "Philosophy and the Natural World".

Plumwood's 'reconceiving of nature' is a precursor to including fungi in any sort of 'environmental consciousness'. In *Defending the Little Desert*, Robin explores the rise of ecological consciousness in Australia, addressing the 'political dimensions of concerns about the natural world and the place of people in nature'.[33] Today, fungi remain largely absent from an ecological consciousness that incorporates other life-forms and places inhabited by fungi. Plumwood considered that a true ecological consciousness must go beyond a sense of place to an ethics of place.[34] Given the ubiquity and ecological significance of fungi, almost all environmental issues also involve fungi. Only by firmly embedding fungi in an ecological consciousness are they ever likely to be considered within environmental issues. Media representations of environmental issues rarely acknowledge their significance. As supposed 'newsworthiness' requires topics to be 'event focused, time bound, and body bound,' fungi usually only gain media attention when they *cause* destruction (e.g. human poisonings or crop losses) rather than themselves being casualties of environmental calamity.[35] Consequently they are rarely considered part of environmental issues such as climate change, species extinction or catastrophic fire, all of which affect fungi. As fungi operate on slow time scales in invisible realms, they are especially prone to what Rob Nixon refers to as the 'hushed havoc and injurious invisibility that trails slow violence'.[36] If a fungus species or a thousand fungus species succumb to extinction in the subterrains of the soil, would anybody notice? I suspect only a few, and only then if the fungi were known in the first place. Nixon chronicles the challenges of portraying the attritional yet exponentially lethal slow violence of environmental decline.[37] How do we develop the fine-tuning to detect and represent issues beyond the human range of perception? How do we re-focus media attention from the spectacular, to also consider the speck?[38] This thesis is in part an attempt to give fungi a voice through stories and images and interrogate their media-marginalisation.

The lack of acknowledgement of fungi in Australian environmental management and biodiversity conservation makes for a challenging starting point. To be endowed with chlorophyll or a backbone is to be deemed charismatic. Such organisms have historically been the focus of biodiversity conservation. In recent decades conservation

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[33] Robin, *Defending the Little Desert*, 4.
[34] Plumwood, "Philosophy and the Natural World".
[35] Nixon, *Slow Violence,* 3.
[36] Ibid., 6.
[37] Ibid., 5.
[38] Ronell, "Walking as a Philosophical Act".

shifted from species to ecosystem and landscape scales, giving greater consideration to functions, processes and interactions. However, the ambiguity of concepts such as ‘biodiversity’ mean that all groups of organisms still require representative flagships and dedicated advocates. Red Lists have helped prioritise conservation efforts and Red-listing of fungi has been crucial to their inclusion in European conservation. The absence of fungi on Australian Red List equivalents could partly explain their near exclusion from Australian biodiversity conservation.[39] However, the conservation dimension of this thesis is not a plea to squeeze another group onto lists of species to conserve. It is not a manual on how to save the fungus kingdom. There are no dot-point lists of recommendations or policy guidelines. Before this, we need to question what saving fungi means as well as the implications of not saving them. This requires an examination of their history of exclusion from what is valued, and a reimagining and reconceptualising of more plural and inclusive concepts of nature, biodiversity and conservation. It means questioning the frames of reference that shape thinking and considering fungi in larger contexts as the connective tissue of terrestrial life. It means re-envisaging the hierarchical and polarising histories that have led to the radically degraded environment in which we now find ourselves. My approach is simply a return to the dirt, to the senses, to fungus-human interactions, as a means of confronting these challenges in the hope we might remember we are part of the one ecology.

‘Can I eat it?’ ask foragers with predictable regularity. ‘What do fungi do for the community?’ asked a skeptical Canberra politician, as if admonishing them for their absence from the community sausage sizzle. ‘How can fungi increase my yields?’ asked a Queensland farmer. This research also explores the tensions in considering how fungi might be considered within human contexts, without reducing them only to their usefulness to humans. ‘Mushrooms there are, such as the clathrus cancellatus, so strange of line and hue that he who for the first time sees them is struck incredulous: can such things really be?’ asked Valentina Pavlovna Wasson in 1957.[40] Can such things really be? Can we not just let them be and value them for just be-ing? Can we just ‘let be’ in the Heideggerian sense of *Seinlassen*, as ecologist and philosopher Mick Smith explains:

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[39] Examination of 40 National Park Management Plans (Plans) across 28 countries showed how Red Listing of fungi influences their inclusion in Plans. Fungi were included in all of the Plans examined from countries with fungi on Red Lists. In countries where fungi were not Red Listed, they were less likely to appear in Plans (appearing only in 18%). I refer to Red List “equivalents” as there is no national Red List in Australia although protective legislation for listing species exists at state and national levels. See appendix 2.

[40] Wasson and Wasson, *Mushrooms, Russia and History*, 4. Binomial original.

> To let something be is to hold open the possibilities of beings appearing in ways that are significant while not conforming to our expectations, desires, or definitions. It is to recognize that a being has such potential significance precisely because it transcends (goes beyond) what we would otherwise make of it.[41]

Might we just for a moment contemplate possibilities to be more often 'struck incredulous,' to rediscover a sense of wonder in the extraordinariness of fungal lives?

From Downunder to Hochgebirge – researching across hemispheres[42]

Histories have traditionally been tightly tied to place. However, the fungal places in this history are not bounded, but ubiquitous domains as well as in-between-places, subterranean spaces, edges and interfaces. As fungi comprise part of the very fabric of the earth including its watery and gaseous components, conventional political or cartographic boundaries are largely irrelevant, as ecological phenomena predate and transcend such human-imposed borders.[43] Hence, bounding fungal spatial 'places' geographically is not especially useful in itself without a contextual temporal dimension. This thesis was largely written in the bush, the outback and at the end of the world. The bush and the outback are in Australia. While neither appear on maps, the outback usually lies beyond the bush, both being comparatively remote from urban areas. To constrain it geographically, my research took place mostly in the southeastern half of the Australian continent; in Tasmania, Victoria, New South Wales, the Australian Capital Territory and southern Queensland. Victoria is where I mostly pitched my tent and its fungus habitats are those with which I am most familiar. As the home of Australia's largest and oldest field naturalist club, the Field Naturalists' Club of Victoria (established 1880) and the 'citizen science' organisation, Fungimap (established 1996), Victoria also offers a hub of fungus enthusiasts with whom I engaged.

Australia is a fungal utopia. Tens of millions of years of isolation from other landmasses has fashioned a distinctive mycota. The size of the continent along with its variable climate, variety of fungal habitats and hosts all contribute to its megadiversity. This dichotomy between the wealth of fungal diversity and their invisibility adds a paradoxical dimension to the research. While my research is situated largely in Australia, forays into the rich and extensive cultural histories of European fungal worlds greatly informed my understanding of Australian perspectives on fungi. This

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41 Smith, *Against Ecological Sovereignty*, 108.
42 Hochgebirge means "high mountains".
43 Wakild, "The Challenge of Scale," 22.

comparative dimension not only provided new insights but also unsettled my ideas and assumptions about Australian fungi and their followers. So off I went to the 'end of the world', which is in the middle of Europe, although I imagine there are other ends elsewhere. It is only about twenty-five minutes away according to the yellow sign on the track marked *End der Welt* in the Swiss Jura. However, in reality, getting to the end of the world took me much longer. The twenty-five minute timing is determined with Swiss temporal precision, based on a formula of walking at exactly four kilometres per hour and calibrated accordingly for gradient changes. This timing, of course, reckons the prompt arrival at the destination *End der Welt*. It is not about pausing to marvel at the expanding ring of Giant Cloud Funnels (*Clitocybe nebularis)* or be amused by the gang of Gray Shags (*Coprinus cinereus*) rolling up their inky caps and exposing their spore-laden lamellae to the world. It does not allow for an idle conversation with foragers scouting in the undergrowth for *Eierschwämmli* (*Cantharellus cibarius*) or *Steinpilze* (*Boletus edulis*), let alone building a fire and sampling the bounty. In the fast-forward fury of the Anthropocene, serendipitous encounters while slowly ambling to the end of the world forged the richest discoveries of my research. Ambling was the operating speed that allowed for sensorial connection and meaningful interaction. Andante. I then meandered beyond the end of the world to engage with fungi and fungal folk across the Swiss Alps, dropping down into the Northern Italian Larch and Chestnut forests; across to the ancient Oaks of the French Jura; along the Turkish Turquoise Coast, over to England's Yorkshire Moors and Scotland's windswept Hebridean islands; and among the lichen-splattered boulders of the Swedish High Coast.

Mycogeography – the study of the distribution of fungi – lags behind the biogeographic study of many other groups of organisms. Australia is yet to be comprehensively surveyed for fungi, with fungus distribution maps still reflecting fungus surveyor distributions as much as those of fungi, although this is changing as maps get dottier. Geographical concepts usually refer to the surfaces of places and most Australian fungus survey is based on the surface distributions of fungus sporebodies. Survey techniques are changing as molecular analyses of mycelia become more accessible and affordable. However, such maps currently represent distribution of fungus sporebodies, not fungi, as the true geography of fungi occurs below the soil surface. In occupying an underground geography, fungi therefore inhabit even less known and less mapped geographies than many other organisms. This is further exaggerated in a country shaped by age and isolation, nutrient-poor soils, drought and fire, where in response to such extremes, many fungi have adopted an ingenious fruiting response – their truffle-like sporebodies remain underground, in the safe comfort of the soil, away from desiccating winds and climatic extremes. When not just their mycelium, but also their sporebodies remain hidden underground, the potential vastness of this kingdom becomes acutely apparent, along with the challenges of mapping the margins. I explore how fungi – by inhabiting edges and unseen terrains – are not just elusive, but also at times, illusory. As historian, Jane Curruthers notes in discussing the edges of environmental history, 'the edge, whether cultural, political, ideological, geographical, or natural, is not a hard line but is permeable and, indeed, sometimes illusory'.[44] Underground (hypogeous) truffle-like fungi evolved in many different evolutionary lineages and are considered to be among the most advanced fungi, activating a whole other time scale from an evolutionary perspective. Australia is, in fact, thought to be the evolutionary centre of the world for truffle-like fungi, although trying to convince a Frenchman of this is probably futile.

Thesis structure, scale and scope

This thesis explores fungi and fungal folk through a matrix of relationships – between fungi, people, ecosystems and ideas – a rather more mycelial approach than a chronological event-oriented history, although some of the stories take the form of historical narratives. I think of this matrix, to borrow Ingold's term, as a 'meshwork' rather than a 'network,' implying entangled lines of life, growth and movement as opposed to simply a network of interacting entities.[45] Human-fungus interrelations are deeply intertwined making them difficult to disentangle and order. However, I have wrangled them into nine themed chapters that follow the activity of recurring human and fungus characters, who emerge and re-emerge in various thematic contexts. I adopted a largely narrative style because, as historian William Cronon argues, it offers greater opportunity to contextualise the relative significance of events, places and people than a pure chronicle.[46]

Although I delve into geological and human history time scales, the main narrative focusses on comparatively recent history, particularly the last few decades during which fungi slowly infiltrated public awareness in Australia. The research moves through various spatial scales from the intimate to the infinite, but operates mostly over areas that I can traverse in a day, stopping of course, to meet fungi and fungal folk along

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[44] Carruthers, "Environmental History with an African Edge," 9.
[45] Ingold, *Being Alive*, 63.
[46] Cronon, "A Place for Stories," 1351.

the way. Fungal biological processes operate at multiple spatial and temporal scales. Comprehending geological scales of fungal origins (possibly 500 mya) is giddying.[47] Even contemplating individual fungi whose lifetimes are twenty or thirty times longer than ours, requires a decent dose of imagination. Fungal time scales are imprecise but fungi sit even less comfortably in concepts of spatial scale. For example, an unearthed plant clearly reveals its entirety; its leaves, flowers, stem and roots. Likewise, animals are spatially bounded. However, such physical boundaries are less apparent with fungi. Moreover, unlike many plants and animals, they are not neatly bounded by defined 'home ranges' or 'territories' or other discernable 'confines': 'A mycelium, or fungus colony, has no characteristic scale above that of an individual hypha (the basic unit of the mycelium) and can potentially persist indefinitely, reproducing when environmental circumstances are favourable'.[48] This scalar ambiguity of fungi complicates choices of scale with which to understand them. We can hold most sporebodies in our hands, but the mycelium is almost always microscopic, unseen without magnification. Added to this are the varying scales for human interactions with fungi. The intricacies of taxonomy require mycologists to work at the microscopic, often single-cell scale, some zooming in more closely to the genetic scale of molecular sequences. Foragers in Australia roam at a Pine plantation-sized scale. Fungus conservationists operate on various habitat scales. Those working with global fungus Red Lists assess species extinction risk at a global scale. Each scale is a trade-off between detail and context. Switching between scales offers different insights and perspectives or as historian Emily Wakild notes, 'the ability to shift from the microscope to the telescope, and, perhaps most revealingly, to the kaleidoscope,' allows us to 'think about ratios as a way of seeing and understanding patterns'.[49] Transferring fungus knowledge across scales and in contexts accessible to diverse human audiences is the hard part.

Size provides a practical way to differentiate fungi. Macrofungi are those that produce sporebodies visible to the human eye.[50] Microfungi are microscopic. While the destructive capacity of microfungi such as smuts and rusts has been a focus of mycological research as well as media attention, this study targets macrofungi. I chose macrofungi because my research hinges on perceptions of fungi. I limited this study to

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[47] Conventions for distinguishing dates from durations when discussing the deep past have aroused debate among geologists, but I use "mya" to mean "million years ago".
[48] Ruth Falconer et al., "Biomass Recycling," 1727.
[49] Wakild, *Crossing Mountains*, 29.
[50] These include sporebodies such as mushrooms and puffballs, sometimes referred to as "larger" or "fleshy" fungi.

those fungi that might be perceived on a forest stroll through a range of senses, unencumbered by a microscope. As this research considers the broader implications of fungi as the connective fibre of ecosystems, I do not address the commercial production of edible mushrooms that are increasingly grown by computers in the confines of commercial factories under artificially sterile conditions, connected only to supply chains.

A gap in the mycelial meshwork

Human perceptions of fungi are unexplored in Australia. This interdisciplinary cross-cutting venture melds history, science and art in exploring fungi and human-fungus relationships in detail and in general. It provides an opportunity to understand human-fungus histories and enhance possibilities for their inclusion in Australian conservation. Australia's reputation for having a progressive approach to conservation is highly questionable if an entire kingdom is overlooked. While the focus is on fungi and fungal folk, more pertinently, this research uses fungi as a prism or lens through which to rethink larger environmental concepts. I hope this research fills a gap in Australian knowledge of fungi and stimulates interest in mycology.

Most of the academic literature on fungi could be broadly categorised as scientific. However, fungal connections to human cultures are thousands of years old and a colourful folkloric literature of mushrooms also exists, mainly in Europe. Fungi adorn children's books and have appeared in prose, poetry and drama, often in metaphoric form, since classical Greek and Roman times, as well as being the subject of early herbals.[51]

Australian mycological literature has been produced sporadically mostly by mycologists and botanists since the late nineteenth century. Before monographs and field guides were published on Australian fungi, various fungus lists were compiled for different Australian regions. In 1885 Ferdinand von Mueller noted in the first issue of the *Victorian Naturalist* that the first

> list of fungaceous species . . . arose for Eastern Continental Australia in 1873, giving the specific names of 235; but Berkeley had enumerated already in 1845 for Western Australia 120 species, and the great Elias Fries in 1846 recorded from the same region 42.[52]

In 1892 British mycologist Mordecai Cooke produced the first *Handbook of Australian Fungi*. This was followed in 1895 by an annotated list of Australian fungi, the

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[51] Ainsworth, *History of Mycology*, 2.

[52] Ferdinand von Mueller, "Notes on Victorian Fungs," 77. (The use of 'Fungs' is peculiar to von Mueller).

Systematic Arrangement of the Australian Fungi compiled by Scottish agricultural scientist Daniel McAlpine. Professor of Pathology at the University of Adelaide and amateur mycologist John Cleland published *Toadstools and Mushrooms and other Larger Fungi of South Australia* as a two part monograph in 1934 and 1935 representing the first monograph on Australian fungi since Cooke's work almost half a century earlier.[53] In 1944 mycologist Gordon Cunningham published *The Gasteromycetes of Australia and New Zealand*. However, most of this literature was relatively specialist and not accessible to the casual forayer interested in identifying mushrooms they might encounter in the field.

The journal of the Field Naturalists Club of Victoria, *The Victorian Naturalist*, published lists of fungus species, fungal finds from field trips and reports of fungus exhibitions since its first edition in 1884. Prior to this, fungi appeared in 1880 among the first pages of its predecessor, the *Southern Science Record*. It was not until 1934 that botanist Jim Willis produced the first field guide to Victorian fungi that was accessible to the general public.[54] Most of the books on fungi in English language can be categorised as either technical mycological texts and taxonomic monographs or field guides. However, in the last two decades several books chart a more interdisciplinary approach to fungi, reflecting a growing interest in their wider cultural significances, although none are Australian.[55]

This research differs from existing Australian publications on fungi, firstly by not being a field guide, and secondly by considering human-fungus interactions. It differs from the international literature on human-fungus relationships by having an Australian (and comparative European) focus. I present a biological-cultural interface from the multiple perspectives of various fungal folk, as a stepping-stone from purely scientific texts to a more interdisciplinary narrative account.

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[53] Lepp, "The Study of Australian Fungi,".

[54] Ross MacDonald and John Westerman published the first field guide with colour photos, *A Field Guide to Fungi of South-Eastern Australia* in 1979. About a dozen further field guides focussing on Southern Australia fungi appeared over the next three decades. In 1996 the Australian Biological Resources Study launched the *Fungi of Australia* book series. However, despite the promising start of two introductory volumes (with excellent summaries of taxonomy, history, biology, poisoning and Aboriginal use) and two checklist volumes on macrofungi, only three taxonomic treatments have appeared in the subsequent two decades, one of which is on macrofungi (Hygrophoraceae). Cheryl Grgurinovic revised Cleland's taxonomic work and produced a monograph on the genus *Mycena*. Tony Young produced the *Fungi of Australia* treatment of Hygrophoraceae and several other books on fungi. Across the Tasman Gordon Cunningham produced monographs on Polyporaceae and Thelephoraceae and Ian Hood produced various books on wood decay fungi in New Zealand. Other notable works include Mien Achmad Rifai's regional monographs on the Australasian Pezizales and Maas Geesteranus on *Hydnaceous Fungi of the Eastern Old World*.

[55] Recent books charting a more interdisciplinary approach to fungi are listed in appendix 3.

The cast of fungi

The human 'characters' of this research are accompanied by an eclectic cast of 'fungus characters'. They are protagonists as much as their human counterparts, holding significance for people for different reasons, having recurred in written records throughout history. Species such as the Anemone Stinkhorn (*Aseroë rubra*), Ghost Fungus (*Omphalotus nidiformis*), Death Cap (*Amanita phalloides*), Saffron Milk Cap (*Lactarius deliciosus*) and the Vegetable Caterpillar (*Cordyceps gunnii*) recur in newspapers because of conspicuous characteristics or cultural resonances. Each possesses particular qualities such as toxicity, luminosity, palatability, strange habits, or other physiological or morphological peculiarities that have repeatedly separated them from the fungal crowd. Such species are key to elucidating human perceptions of fungi.

Early reports of sporebodies often describe their morphological or physiological features as many were either yet to be named, or their names were unknown. Given the rarity of traits such as luminosity, much can be surmised about a species' identity from such descriptions. Over time, previously unmentioned species gradually began to appear in the press. These 'new' species might indicate the arrival of exotic species in Australia (such as the Death Cap, *Amanita phalloides*) or newfound cultural significances (such as the edibility of the Saffron Milk Cap, *Lactarius deliciosus*) or increased awareness of fungus diversity. Rather than condense all the known information about these fungus species in one place as one would find in a typical field guide, fragments of information about particular species are successively revealed. My aim is not to just impart information about a species, but to situate them within different frameworks of significance as they arise within a particular theme. In doing so, I hope these fungal characters move beyond being merely taxonomic or 'biological specimens'.

The human cast

Humans are also a part of a forest's biodiversity. Humans rely on fungi to create soils, purify water and recycle nutrients. Then there are those who have a particular interest in fungi. People seek fungi for various reasons, some by tradition but rarely by training. There are those who forage and those who foray. Mycologists study the ecological and evolutionary significance of fungi to situate them within larger schemes of life. Naturalists make lists of species to understand fungal ecology and geography, or to test identification skills. 'Blockies' inventory biota, sometimes including fungi, on their ‘blocks’ as a way of understanding and connecting with their place.[56] Farmers tend to care less about names or lists and want to know what fungi do in soils.[57] For fungal aesthetes, form and colour are the focus. A growing band of foragers seek edible species. Biological and cultural motivations often intertwine. Birding shares much with fungus foraying and historian Tom Dunlap describes how identifying and listing species intricately mixes nature and culture and discusses how although biology made listing plausible, culture defined the list.[58] Then there are those who target mushrooms for extermination, should these organisms have the gall to spring forth on their neatly manicured lawns or putting greens.

Fungi vary between Australia and Europe, but what they do in ecosystems is very much the same. Bigger differences exist in the ways they are perceived. Examining both differences and commonalities in perceptions helps trace the roots of the alienation of fungi.

A thousand days in the forest

I am not a trained mycologist but a background in scientific research has allowed me to frame an ecological understanding of fungi. My experience as an environmental photographer has perhaps enabled me to relate to fungi in ways that I might not have, had I not spent a good deal of time crawling around forests. Hence, I have tried to synthesise a naturalist-scientist’s perspective with a more aesthetic appreciation of fungi.

The role of art in promoting and problematising environmental issues is well critiqued. Artistic practice influences perceptions of fungi, revealing the ways in which they are endowed with meaning as well as exposing limitations in thinking and consciousness. Those who create objects or perform with affective potential make fungi accessible, allowing for emotional connections not usually considered or applied within mycology. In this research I examine the sensory as a precursor to artistic expression of fungi. In particular, I move beyond sight as the dominant sense to a more multisensory aesthesis. Perceiving fungi with all the senses augments visual appreciation and helps

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[56] “Blockie” is a colloquial Australian term for someone who lives on a “block” of land (usually a few acres) for rural or agricultural reasons.

[57] For many farmers, pathogenic fungi that damage crops are the target of their attention. As macrofungi are the focus of this thesis, I refer to farmers who recognise the beneficial role of macrofungi in soils.

[58] Dunlap, “Thinking with Birds,” 26.

dissolve subject/object binaries, offering opportunity to broaden our conceptualisation and appreciation of them.[59]

Most of these words were conceived on foot while wandering through the bush; observing, touching, smelling, listening, tasting, hearing and simply being present, wondering and noticing change. It felt less like a method, a peripatetic method, than an intrinsic condition of the research. Movement itself was a catalyst, not just in traversing space, but as a means of sensing, knowing and being.[60] Psychologist James Gibson suggests that humans see better when moving than stationary, perceiving along a path of observation through an 'ambulatory vision,' in what Ingold refers to as a form of 'circumambulatory knowing'.[61] Ingold considers that locomotion, rather than cognition, is the starting point for the study of perceptual activity, with places delineated by movement in what he terms 'wayfaring'.[62] It is in the bush where the perpetual din of life's distractions diminish, where the world makes most sense to me, and so I headed there daily seeking fungi and ideas. Swathes have been written about the synergies of walking and writing and Robert Macfarlane remarks that 'a walk is only a step away from a story, and every path *tells*'.[63] Every path tells and they are rarely singular or distinct. Going off-track and straying into unfamiliar terrain tells even more. Stepping into the forest is both stepping into a domain of intimacy, and stepping into the void. It is a physically felt sensation in the reassurance of familiar terrain counterpoised by the thrill of the unexpected.

My daily interactions with the forest, fungi and folk were epitomised by the notion of emergence. Emergence of fungi and thoughts. This resonates with Margaret Somerville's concept of Postmodern Emergence as 'an important and under-acknowledged quality in all research that proposes to generate new knowledge'.[64] Somerville describes it as a 'process of wondering and generating . . . that cannot begin with logic but comes from a place of not knowing, informed by intuition and responsiveness'.[65] Emergence as a method mirrors the liminal nature of fungi as organisms that occupy the margins of space and time. Somerville refers to Japanese researcher, Tamah Nakamura's idea of 'waiting in the chaotic place of unknowing'.[66]

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[59] Ryan, "Towards Intimate Relations," 30.
[60] Macfarlane, *The Old Ways*, 24, 27.
[61] Gibson, *The Ecological Approach to Visual Perception*, 197; Ingold, *Being Alive*, 46.
[62] Ingold, *Being Alive*, 46, 149.
[63] Macfarlane, *The Old Ways*, 18. Italics original.
[64] Somerville, "Postmodern Emergence," 225.
[65] Somerville, " 'Waiting in the Chaotic Place of Unknowing'," 210.
[66] Ibid.

Knowing fungi and fungal folk is also about sensorial immersion in their worlds. This challenged the more scientific approach of my past projects where I devised a methodology around a hypothesis followed by rigorous analysis. However, this research was not just about collecting data to prove a process or seek an empirically verifiable truth. It also invited uncertainty in engaging deeply with fungi and folk in their environments, allowing the unexpected to emerge: 'curiosity explores what it does not yet know and what seems interesting and worth knowing, often for reasons it cannot name'.[67] It explores how fungi are perceived within and beyond mycology, enabling new impressions and conceptualisations to emerge, the unforeseen being intrinsic to the essence of the work. As writer David Malouf comments, writing mostly grows out of puzzlement.[68]

My desk disappeared long ago beneath newspaper archives and species lists, hand-scrawled notes in rain-splattered field books, transcribed interviews and spreadsheets of survey data, dried fungus specimens and spore-printing mushrooms. The richest material surfaced in the serendipitous opportunities in situ, from unsystematic observations, fortuitous conversations and unexpected encounters, in the 'incidents between official events that add up to a life'.[69] Working across hemispheres, Internet tools were a boon. However, it was not within the censoring and adulterations of Internet search engines that I expected to find the unexpected. Such things are less often recorded and were more commonly experienced first hand, and every moment spent with the computer was a lost opportunity to be in the more bountiful realms of the bush.

In speaking of Australians' relationship with the landscape in 1961, Australian poet and environmentalist Judith Wright famously commented:

> Australia is still, for us, not a country but a state of mind. We do not speak from within, but from outside. From a state of mind that describes rather than expresses its surroundings or from a state of mind that imposes itself upon rather than lives through landscape and event.[70]

Understanding fungi involves getting into the dirt, 'living through' rather than 'imposing upon' the landscape, going into it deeply, tuning to its subtleties and nuances, experiencing it intensely. I have come to my understanding of fungi only through embodied engagement, rather than detached speculation where I could at best only hope

[67] Nowotny, *Insatiable Curiosity*, 3.
[68] Malouf, "David Malouf on Australian Culture and Writing."
[69] Solnit, *Wanderlust*, 10.
[70] Wright, "The Upside-Down Hut," 301.

to skim the surface of fungal worlds, missing out on their quirks and riches and opportunities for astonishment.[71]

The research dips into various disciplines from mycology, ecology, natural and cultural history, philosophy, anthropology and sociology to visual representation and other ways of knowing that are not labelled as disciplines. I adopt methodologies from each, combining direct observation, semi-structured interviews, surveys, conversations, oral histories, archive searches and insights gleaned from interactions during forays, workshops and conferences. It approaches the optical metaphor of diffraction, as referred to by Barad and Haraway, for a methodology that combines insights from multiple disciplines. Such a methodology acknowledges entanglements by reading insights through one another diffractively, allowing for changes in meaning in different contexts and opening up new meanings, enabling a more subtle vision.[72] As well as examining the nature of difference, most critically, Barad suggests a refractive methodology is also inherently linked to values and responsibility. She considers ethical concerns as integral to the nature of knowing and being, focussing not just on differences, but on those which matter, thus enhancing the possibility of making a difference in the world.[73] Examining fungi through multiple disciplines helps define the processes that shape perceptions. To borrow ecologist and activist, Barry Commoner's term, this research moves from the bounds of interdisciplinarity to a more free form 'adisciplinarity'.[74] Questioning human perceptions and the narrative templates and metaphors used to think about nature helps reframe existing knowledge of fungi within more dynamic and inclusive contexts. I have endeavoured to retain rigour and robustness, but not at the expense of a more nuanced approach of distilling and synthesising facts, stories and perspectives, seeking to understand their resonances and dissonances.

The most illuminating interactions with fungal folk took place in the field. The workshops and forays that I have led have enabled me to directly observe interactions between people and fungi.[75] The field is where conversations were most animated and exuberant, open and alive to the forest, enabling surprise, curiosity and contemplation, rather than the distant objectivity favoured by science. These were conversations held

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[71] I think of "embodied engagement" in the sense that Barad refers to it as "a matter not of being specifically situated in the world, but rather of being of the world in its dynamic specificity".
[72] Barad, *Meeting the Universe Halfway*, 37.
[73] Ibid.
[74] Howard, "Science of Survival," 45-55.
[75] The workshops, forays and seminars conducted during this research are listed in appendix 4.

while slowly ambling and interacting with fungi. Conversations rich with perception, nuance, energy and humour, shaped by the textures and scents and moods of the forest, not clipped or blunted as were those held indoors or via email. Artist and writer, John Berger captures the potency of the spoken relative to the written word in his comment: ‘A spoken language is a body, a living creature, whose physiognomy is verbal and whose visceral functions are linguistic’.[76] In exploring ways of communicating meaning Somerville notes ‘writing fixes things in ways that oral language does not’.[77] People expressed their attitudes to fungi in diverse ways. Some were demonstrative and some were secretive. Some became childlike in expressing the discovery of a newfound passion. Others enjoyed the power of holding knowledge of fungi. There were those who were simply glad to meet someone interested in their obscure corner of mycological research. Perceptions of fungi were often relatively benign, with fungi regarded as largely irrelevant to people’s lives. Others displayed obvious repulsion, relaying powerful images of disgust. Some found it odd or amusing that I should ask about these organisms. Many struggled to find any context for fungi beyond food or disease. The very occasional (usually European) person expressed what could only be described as a visceral attachment to fungi. Sociologist Gary Fine considers, ‘to understand nature is to be able to talk about it’.[78] And they sure did. Some wouldn’t stop! Foraging stories were often held as dear as the forage itself. As with fishing stories, it was in the telling that fungi took on another level of significance and meaning, when the sharing of personal accounts were validated or venerated or challenged. In a data-choked world, stories are what people remember and hold. Fungi make good stories because of their bizarreness, elusiveness and the plots humans embed in their being. Fungi thrive on storytelling and people inhabit the stories. My workshops not only provided the opportunity to hear stories, observe reactions and share knowledge, but also allowed for the oral expression of my research. Each workshop was in a sense a performance; a means to test different ways of imparting ideas across diverse knowledge frameworks, allowing for reflection, translation and adaptation.

Most stories within this narrative were told to me directly by living people. Historical stories have emerged from archival and manuscript sources. I found them in the National Libraries of Australia, Switzerland and Sweden, in the Royal Botanic

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[76] Berger, John. “Writing is an Offshoot of Something Deeper.” *Guardian*. 12 December 2014. Accessed 12 October 2015. http://www.theguardian.com/books/2014/dec/12/john-berger-writing-is-an-off-shoot-of-something-deeper.
[77] Somerville, “Water in a Dry Land,” 70.
[78] Fine, *Morel Tales*, 134.

Gardens in Melbourne and London, and odd snippets in the historical societies of one-horse towns. But the richest archives were the forest archives. The histories and stories are all there; in and on trees, etched in rockfaces, within the leaf litter, among communities of fungi. Human perceptions of fungi were also apparent. Stomped-on Death Caps or disturbance to forest leaf litter all reflect human attitudes.[79] Historian Donald Worster considers: 'Before one can write environmental history one must first understand nature itself – specifically, nature as it was organized and functioning in past times'.[80]

Not all people chose words to relay their perceptions of fungi. Many preferred visuals, jamming my inbox with image files. Images reveal a lot about species of interest, perspectives and how fungi are regarded. More and more people have the means to visually record the world including fungi. However, I wondered whether this reinforces sight as the dominant sense in perceiving fungi. Might people have once reached down to touch a fungus, or smell it, or explore it in other more multisensory ways and not only visually? Would they have stayed with it longer, perhaps pondered its existence, rather than rushing off to snap the next one? I was interested to understand not just what people think and feel about fungi, but literally how they perceive them with the senses, and with which particular senses.

The most telling information about perceptions of fungi was unspoken: it was in the physical gestures, facial expressions, pauses and hesitations, the way someone moved through the bush, whether they handled fungi, and if so whether with care, caution or disdain. I observed whether they took a closer look with a hand lens and the nature of their expression on seeing a fungus close up; what they did with a fungus after they had examined it; the ways in which scientific collectors wielded specimens; how fastidiously they washed their hands afterwards, or if they just nonchalantly wiped them on their jeans. All speak volumes about how fungi and the forest are regarded. It was also a poignant reminder that words and actions don't always align. Such details about people's fungal interactions are often written out of scientific accounts committed to objectivity. This thesis restores the stories and their telling to the fungus-human moments.

Written chapters are interspersed with visual essays or vignettes. Images can unite the aesthetic and scientific with the historical, both human and environmental. The

[79] Destructive attitudes to fungi are often more apparent than positive attitudes. For example, traces such as destroyed sporebodies (often species that are toxic to humans but also those that are thought to be toxic) or disturbance to leaf litter by raking as a technique to find truffles.
[80] Worster, *The Wealth of Nature*, 48.

slow and contemplative process of creating the images enabled me to dwell and be deeply attentive to fungi in both their minutiae and enormity. As an environmental photographer, I represent nature both literally and metaphorically. When photographing a fungus for a field guide, for example, I emphasise its diagnostic features to aid identification. However, this is not a field guide and my aim was to portray something of the essence of individual fungi, their idiosyncrasies and individuality, as opposed to being representations of species. I intended to evoke a mood or texture, to surprise or disquiet, inspire rather than necessarily inform. The idea is that the viewer experiences the visual aspects, rather than deferring to a written caption. However, for those interested in the species names, full captions are provided in appendix 10. Visuals are counterpoint to words. This thesis adopts a contrapuntal structure, sequencing images not as illustrations of the words, but 'in conversation' with them and the spaces between. While the text describes human perceptions of fungi, the images mostly portray the fungi themselves.

What's inside?

Having given a general introduction to fungi, fungal folk and the purpose and path of this thesis, the second chapter delves deeper into the extraordinary manifestations of fungus sporebodies. As the research aims to understand perceptions of fungi, it makes sense to begin with an overview of fungus diversity, form and function. It begins in Southern Tasmania in 1792 with French naturalist Jacques Labillardière who made the first scientific description of an Australian fungus species, the striking Anemone Stinkhorn, *Aseroë rubra*. This perplexing fungus provides a rich starting point to unravel the great array of perceptions and attitudes that fungi evoke. From here we dart among the multitude of fungus forms, exploring their complexities and plasticity. The ingenuity of the 'biological umbrella' that characterises the mushroom form is introduced through the iconic Fly Agaric, *Amanita muscaria*, the world's most depicted and mythologised species. Other less familiar fungus forms from goblets to lattice balls are examined through the inventiveness of their spore-dispersal mechanisms. Such forms broaden popular concepts of what constitutes a fungus sporebody. To understand fungi within their habitats means understanding, to borrow from polymath George Seddon, how they make a living. What exactly are fungi doing there on and under the forest floor? In providing clues to the secrets of their success I trawl back through geological time scales to contemplate the first symbioses – the lichens. However, the idea of organisms in mutual existence did not sit well within nineteenth century scientific circles and I revisit the embittered historic battles in advancing a theory that contradicted Linnaean biological autonomy. From arguing that alliances are the norm, I then challenge the reader to rethink parasites as sustainers and not just destroyers.

Chapter three explores some of the places where fungi grow, beginning in the blistering sands of the Australian desert. I focus particularly on the subterranean and hidden nature of fungal places and how this confounds ideas about ‘place’. I also consider dis-placed fungi and how concepts of ‘native and exotic’ translate across cultures. Organisms that occupy the margins of the subterrain, taxonomic categories and human consciousness can perhaps only be understood in context of the processes within the places they exist and create. I explore fungi through Jakob von Uekûll’s concept of *Umwelt*, Tim Ingold’s idea of Meshworks and Alan Rayner’s Natural Inclusionality, tracing their connectivities and ‘intra-actions,’ to use Karen Barad’s term. I then turn to the more objectionable fungal places – dirt, litter and dung – as literal and allegorical barriers to connecting with fungi. I delve deep into the faecal depths of a solitary cow pat high in the Swiss Alps to stir the volatile politics of coprophilous cohabitation, cooperation and competition.

Every discipline has its own specialist lexicon as well as its jargon. Fungi escaped neither. I have tried, wherever possible to avoid mycological terminology while being careful to maintain scientific resolution and meaning. Where necessary for clarity, specialist terms and concepts are introduced throughout the thesis in the context of the themes in which they arise, rather than confronting the reader with a barrage of contextless terms from the start. Chapter four examines the development of language around fungi and how this profoundly affects the way they are perceived. From Linnaeus’ perception of fungi as thievish and voracious beggars to the use of ‘mushrooming’ as a verb of condescension, I consider how the degradation of mushrooms by derogatory monikers contributes to their disregard. I ask how new metaphors and semiotics could furnish a more appropriate sensorium for fungi.

Chapter five finds us at the kitchen table of potato farmer, Dorothy Hunter, where Saffron Milk Caps (*Lactarius deliciosus*) threaten to discolour the laminex. Dorothy has spent more time digging in the dirt than most and has very particular thoughts about which mushrooms are worthy of consideration and which find themselves kicked across the paddock at the end of her ancient gumboot. What are the origins of fungal ambivalence and fear? I search for answers in the foreign-ness, obscurity and otherness of fungi, in their toxicity and other associations embedded in the myths and witchcraft that mar impressions. Revisiting Plumwood’s critique of the radical exclusion of organisms cast to the bottom of the hierarchy and inferiorised as 'other,' I explore how current dualistic frameworks of thinking have marginalised fungi, entrenching their invisibility.[81]

Mycology in Australia is inherently taxonomic. Without the taxonomic revelations of the last 150 years, science would be largely ignorant of the fungal riches of the Australian continent. Part of knowing is the act of naming.[82] How would scientists communicate without the universal currency of Linnaean binomial nomenclature that theoretically transcends language and culture? Chapter six revolves around the question of how best to order life. It investigates the nomenclature and measures used by mycologists and other scientists to identify and categorise organisms. I examine how naming is inherently cultural, not biological, and how identity provides meaning. DNA sequencing has revolutionalised taxonomic mycology and accelerated access to a previously only imaginable wealth of fungal life. The zeal to classify has driven mycology but how is this need for names and order apprehended by those beyond the scientific community? How are the ways that fungi are perceived via the senses affected by their reduction to numbers? This leads us to an exploration of the many ways of 'knowing' fungi, which is the theme of the next chapter.

Returning to the dirt, chapter seven questions how objectivity and meaning-making might come together. What does it mean to 'know nature,' to 'know fungi'? It expands on traditional epistemologies and the ways in which knowledge is produced. Could knowledge of fungi be enriched by giving greater focus to their relationships and processes? Drawing on Barad's refractive approach, I argue that knowledge creation is not just about unearthing facts, but about contextualising by reading insights from different disciplines against each other.[83] What other fungal knowledge-making processes could allow for a more inclusive and empathic understanding of fungi and fungus-human worlds? We take a trip to the dusty plains of Northern Victoria and meet with Judy Crocker, Howard Hepburn and a bunch of flannelette-shirted farmers to get their take on fungi. We also fossick among the scant ethnomycological records in Australia to discover that little is known about Australian Aboriginal knowledge of fungi. This takes us to the Mandurama scrub with Wiradjuri custodians to search further for Aboriginal traces of fungal knowledge. In particular, this chapter returns to the

[81] Plumwood, *Feminism and the Mastery of Nature*, 123.
[82] Arthur, *The Default Country*, 78.
[83] Barad, *Meeting the Universe Halfway*, 91.

underlying methodology of this thesis in understanding fungi through multisensory discovery.

Extending ideas about knowledge from the previous chapter, the eighth chapter is in the field with foragers and forayers. What motivates some people to forage and others to foray and do they perceive and regard fungi differently? While the divide between forayer and forager is strongly demarcated in Australia today, this is not always the case in some European countries such as Sweden, where forager-forayers wander through the forest with a specimen collection box under one arm and a basket brimming with Chanterelles under the other. Among the moss and mushrooms we delve into the cultural divides and ideologies, the intersections and tensions, the different reasons for collecting fungi and how relationships with fungi develop in different places over time. Sociologist Gary Fine's concept of 'Naturework' provides a useful framework for understanding the cultural and social significances of fungi for foragers. What do language, narrative, semiotics, risk and fear and numerous social codes reveal about the intersections of fungi and humanity? From the Kooyoora State Park in Northern Victoria to the Italian Piedmont, I investigate how foragers negotiate their contested terrains.

The final chapter asks about the ways in which fungi are valued and why it might be worth conserving them. I begin by examining current approaches to fungal conservation in a rapidly changing world, questioning whether existing paradigms such as biodiversity and Red Lists still hold traction. I consider how old questions might be newly inflected to reconcile reductionist science and holistic culture. This entails looking at how knowledge can be transfigured and differently scaled to find the place where epistemology and ethics meet. The dearth of taxonomic knowledge of fungi needs remedying, but how can fungi be included in ecological consciousness? Drawing on progressive conservation initiatives in Fennoscandian countries I ask how we might 'augment the motivational energy needed to move selves from the endorsement of ethical principles to the actual practice of ethical behaviours'.[84] How might we rediscover the 'attentiveness to things' (like fungal 'things') that Thoreau but also more recently writers including Val Plumwood, David Malouf and Robert Macfarlane urge us to rekindle? In a time of rapid environmental change we might want to reconsider how nature is evaluated, to move beyond the economic sense of a price placed on nature in

[84] Bennett, *Vibrant Matter*, xi.

service of a profit imperative. I ask whether ethical solutions to environmental issues can be included within concepts such as biodiversity.

Second, I examine which lenses, frameworks or paradigms could be most helpful in imagining fungi in more inclusive concepts of life. I revisit notions of Natural Inclusionality (Rayner), Meshwork (Ingold), Intra-action (Barad) and Ecological Community (Smith) to ask what fungi can contribute, both ecologically and allegorically. The Anthropocene discourse addresses urgent environmental issues for a more sustainable future. I explore whether fungi can make a difference to the Anthropocene narrative and whether it can make a difference for fungi.

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I pen these words in the sunny garden of a friend's house in Vesancy, France. Formerly a chateau, it was reputedly frequented by Antoine de Saint-Exupéry, whose open-minded inquisitiveness resonates with ways to contemplate fungi. Before retiring to the attic the previous evening, we feasted on a grand selection of Camembert, Gruyère and Roquefort cheeses accompanied by crusty baguettes, and local wine from dusty bottles. This immensely pleasurable experience would not have been possible without the work of fungi, whose actions contributed to our feast and spared me the *escargot* (snails). Fungi can also spoil the fun and flair of the feast along with the forgotten food in the fridge. The nectarines that rolled to the back corner sprouted whiskers. Had we been here a few centuries earlier, the effects of ergot contamination of our baguettes might have had us uncontrollably convulsing in psychosis. Fortunately we survived these fungal perils to sing the praises of their more agreeable actions and to embrace another day wandering the forests in search of fungi.

The mycelial matrix

In their literal and metaphorical manifestations, mycelia eclipse even their remarkable reproductive structures.

Scaffolds of mycelia connect species, ecosystems, landscapes, life. Coursing through soils, radiating unseen, vast mycelial wefts support the warps of terrestrial ecosystems and the very ground on which humans tread oblivious.

Of fungi, Rachel Carson writes, 'we know too little of the threads that bind the soil organisms to each other and the world'. Yet, fungal mycelia mirror the organisation and behaviour of human societies.

chapter two

Meeting mushrooms

First fungal acquaintances

The first fungus to be named by European colonisers in Australia was never going to be an ordinary one. The little brown mushrooms that are the bane of forays because they are so indistinguishable, did not stand a chance. The ostentatious Anemone Stinkhorn, *Aseroë rubra* on the other hand, caught the eye – or possibly the nose – of French naturalist, Jacques Labillardière on 1 May 1792. This fungus belongs to a group known as phalloids or stinkhorns. It deviates from the more usual phallic form by resembling an anemone or starfish, while simultaneously reeking like a decomposing wombat. Across the globe in his hometown of Alençon, Labillardière's kinsfolk may have been enjoying more pleasant olfactory encounters in the exchange of sweetly scented Lily of the Valley, a May Day tradition initiated by King Charles IX on 1 May 1561.

Labillardière was not intentionally seeking a malodorous mushroom, but rather the lost ships of La Pérouse that disappeared during the Oceania expedition three years earlier. Joseph Bruny D'Entrecasteaux was entrusted with overseeing the rescue expedition, commanding the frigate, *La Recherche*. A second vessel, *L'Espérance* was commanded by Jean-Michel Huon de Kermadec. The names of these men and their ships soon appeared in early floras and on maps of Van Diemens Land, and it was among the mosses of Rechereche Bay that *A. rubra* revealed itself. While the expedition was primarily a search and rescue mission, scientific objectives and the charting of unknown regions were also on the agenda. As expedition naturalist, Labillardière collected over five thousand plant and animal specimens. What is less often mentioned in accounts of Labillardière's explorations is that *A. rubra* was the first Australian fungus to be scientifically described. This pioneering contribution to documenting organisms that later became their own kingdom, went unnoticed.

Aseroë rubra was the earliest representation of a kingdom whose curious forms, taxonomic ambiguities and dubious connotations challenge many Australians' perceptions of them today. Labillardière was 'agreeably surprised by the singular form of a new species of fungus'.[85] He named it 'aseroe, on account of the disposition of its radii,' recording it in his *Relation du voyage à la recherche de La Pérouse*.[86] While Labillardière's brief anatomical description and rudimentary sketches tell us something about the fungus, virtually nothing is known of his emotional response to it. Labillardière's biographers have uncovered little in his writing that reveal his character, other than his austerity and emotional restraint. Given his reserve and the necessity of

[85] Labillardière, *Voyage in Search of La Pérouse*, 187.
[86] Ibid.

scientific objectivity, it is perhaps unsurprising that Labillardière's only noted emotional reaction to the discovery of *A. rubra* was 'agreeable surprise'.

Today almost eight thousand species of macrofungi have been named in Australia among a total of about fifteen thousand known species across the Kingdom Fungi. This total might yet increase by an order of magnitude. While they represent an astonishing variety of morphologies, human reactions to *A. rubra* suggest it is one of the more potent forms. Mycologist Bryce Kendrick describes the genus *Aseroë* as being one of the 'most flamboyant members of a spectacular order'.[87] Indeed Labillardière's 'agreeable surprise' appears less agreeable to those who discover it unfurling its tentacle-like appendages in their suburban Australian gardens. Explicit emotional reactions to these unexpected discoveries populate platforms for popular opinion such as social media. The Australian Fungi blog, for example, represents a spectrum of responses from curiosity to repulsion, with more perturbed contributors relaying extraordinary claims of this species' supposedly dastardly deeds. Others issue warnings or request advice on its extermination.[88] Some find it wondrous. *Aseroë rubra* alerts not just the senses but also ignites the imagination. Other portrayals of *A. rubra* are less reactive even hinting at a nationalistic pride of such fungal peculiarities. While charismatic fauna and flora more typically feature in the popular press, a 1957 issue of the *Australian Women's Weekly* magazine pictured *A. rubra* among other fungi under the unequivocal headline 'Fungi, These are Australian'.[89] Nevertheless, it might still be a while before a stinkhorn emerges among the emu, kangaroo and wattle blossom on the Australian coat of arms, or adorns the walls of Parliament House. Fungi do not feature in a national consciousness that fervently embraces iconic and enigmatic flora and fauna. No fungi appear among the flora and fauna that are state and national emblems nor is there a National Fungus Day. Impressions of Australian fungi did, however, manage to disperse themselves around the world courtesy of an Australia Post stamp issue in 1981.

Labillardière's germane choice of the name *Aseroë rubra* describes both its anatomical characteristics and emotional responses to this species. The generic name,

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[87] Kendrick, *The Fifth Kingdom*, 98.

[88] "*Aseroe rubra*," Australian Fungi blog. http://australianfungi.blogspot.ch/2007/05/12-aseroe-rubra.html. Between 15 May 2007 and 17 December 2012 contributors reported discovering this "horrible smelly plant" and "ugly mushroom" and their efforts to destroy it included pouring bleach on it and hitting it with a whipper snipper. Contributors expressed concerns for their children, dogs and trees and reported becoming ill simply by being in its proximity. Others were less fearful calling them "funky fungi," "beautiful," "wonderful" and "mysterious life forms," expressing interest and the desire to let them thrive.

[89] "Fungi, These are Australian," 27.

Aseroë, originates from the ancient Greek, *aseros*, meaning 'disgusting' (Asē) and 'juice' (roë), while its specific epithet, *rubra*, refers to its red colouration.[90] The extraordinary appearance and habits of *A. rubra* epitomise unease with organisms that defy categorisation. Such ambiguity plagued early taxonomists and similarly challenges perceptions of enigmatic organisms today. Mycologist Tom May begins his introductory lectures on fungi with the truism, 'fungi are really different'. Such differences extend deep into life histories and reproductive and trophic modes, but their compelling morphologies sensorily exemplify such differences. *Aseroë rubra* looks like an animal and a marine rather than terrestrial one at that. Moreover, while it might smell like an animal long dead, its strong sensory expressions suggest vitality and vigour. It also superficially resembles a plant owing to its sessile nature, subterranean 'root' system and defined sporebody. Its peculiarities not only transgress attempts at classificatory order, but are also emotionally perplexing. 'The thing is at once beautiful and repulsive,' wrote J.M. Stevens of *A. rubra* in the *Brisbane Sunday Mail* in 1930.[91] Such ontological ambiguity and physical alterity have shaped perceptions of fungi since Labillardière's important discovery.[92]

Fungi inhabit not only the interfaces of physical environments, but also confound the compartmentalisation of life. In his *Text-book of British Fungi* published in 1887, William Hay notes 'there are forms, as in the greater divisions of the Vegetable Kingdom, which come so close to the border of their class that they may easily be taken as belonging to another'.[93] Over two centuries earlier the Italian botanist, Pier Antonio Micheli – often considered the founder of scientific mycology – was just one of many in his time who thought fungi were plants. Naturalist and polymath Robert Hooke lumped them in with animals. Hooke's 'hairy mould,' the microfungus *Mucor* described in 1665 in *Micrographia* was the first illustration of a microfungus, which he assigned to the animal section of sponges.[94] Fungal taxonomy remains in a state of flux as new technologies reveal unexpected relationships and names and categories are redefined. As microscopic and molecular techniques advance taxonomic mycology, many of the higher fungal taxa, founded on morphological appearance, have been dismembered and rearranged.

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[90] Rea, *British Basidomycetae*, 22; Williams, *A Dictionary of Scientific Words*, s.vv. "asero, rubrica." There is some uncertainty about the derivation of the genus with some authors suggesting *Aseroë* could be a mis-spelling of *Asteroe*, from *aster*, meaning star.
[91] J. M. Stevens, "The Bush Track in Winter," *Sunday Mail* (Brisbane), 24 August 1930, 19.
[92] Ryan, "Which to Become?," 132.
[93] Hay, *Text-book of British Fungi*, 5.
[94] Money, *Mushroom,* 6.

Such 'in-between-ness' of indeterminate life forms exemplified by the extreme morphological plasticity of fungi is evidently unsettling. Linnaeus' two-kingdom framework imposed an 'either-or' limitation on the categorisation of life and fungi had to somehow be squashed into one or other box, despite controverting the rules of both. About the same time that Labillardière discovered *A. rubra*, George Shaw, Keeper of the Department of Natural History at the British Museum, was confounded by a zoological specimen he received from Australia. The enchanting story of the supposed hoax of what became known as the platypus is deeply embedded in Australian history. The combination of the platypus' unusual anatomical characters rendered it unlike any other vertebrate previously encountered by Shaw. Well aware of the centuries-old game of hoodwinking naive naturalists by refashioning the body parts of various creatures into new composite organisms, Shaw meticulously examined the specimen for signs of deliberate reconfiguration. However, the platypus was free from tampering and indeed the genuine article, being just one example of the extraordinary forms that millions of years of evolution on an isolated continent can furnish.[95] Had *A. rubra* been less perishable and able to withstand the punishing voyage to Europe, it too might have been a suspect of such chicanery.

Although the world's first mycological society, the *Société Mycologique de France* was not founded until 1884, by the time Labillardière discovered *A. rubra* the French had already been cultivating the Champignon (*Agaricus bisporus*) in the dank Parisian subterrains for almost a century. While *A. rubra* bore little semblance to this comparatively unspectacular mushroom, fungi were probably not unfamiliar to Labillardière. Although he knew *A. rubra* was a fungus, he did not mention its characteristic smell. Either the fungus was insufficiently mature to be emitting a smell, he failed to notice or record it, or its stinking spore mass had been washed away by rain. Yet his choice of a name meaning 'disgusting' most likely refers to its smell rather than its appearance. Labillardière allocated just 129 words in describing the first Australian fungus in his journal of almost 500 pages. However, this defining characteristic of stinkhorns not only stimulates one's nose but also the mind in contemplating the major driver behind the great diversity of fungal forms – to produce and disperse spores.

Spore production and dispersal underpins the evolutionary success of fungi as some of the oldest, most ubiquitous and diverse organisms on earth. Fecundity and effective distribution of spores is the blueprint to their evolutionary success. The effluvium that typifies *A. rubra* and other stinkhorns arises not from the sporebody but

[95] Robin, "Paradox on the Queensland Frontier".

specifically from the spore mass. Stinkhorns have evolved this ingenious strategy of attracting airborne vectors – flies and other carrion-loving creatures – to which they effectively 'outsource' spore distribution. Indeed *A. rubra* parodies the aforementioned human tricksters by mimicking the apparently irresistible stench of decay, thereby fooling its hapless spineless visitors into dispersing its spores.

Describing the undefinable

Fungi can be described in as many ways as they are perceived. Attempts to define them by what they are not – as British mycologist Paul Cannon does entertainingly – suggest both a lack of language and an unwillingness to become familiar with them.[96] Many scientific descriptions focus on fungus anatomy, physiology and function. Others describe and group them by their trophic or reproductive modes, or evolutionary histories. Some early books such as David Badham's *Treatise on the Esculent Funguses of England* (1863) present fungi in the utilitarian context of their nutritional value to humanity. Others document human-fungal relationships that exploit medicinal species or those whose psychoactive qualities lend them spiritual significance. Some of the first references to fungi appeared in early herbals in the late fifteenth century. Herbalist John Gerard published *Gerard's Herball* in 1597 adding to earlier accounts by renaissance botanists including Mathias de l'Obel (1581). Collectively this knowledge provides an understanding of fungi as well as human-fungus relationships over time. Following a brief biological description of fungi in this chapter, I explore them primarily in the context of their connectivities; with environments and other organisms including *Homo sapiens*.

Fungi entered human consciousness throughout history mostly via the sexual expressions of their being, that is, their reproductive structures or sporebodies. These commonly manifest in the familiar forms of mushrooms. Others are shaped like corals, brains, lattice balls, goblets, icicles and even more eccentric morphologies. However, the growing and feeding part of a fungus exists as a matrix of interconnecting mycelium within soils, leaf litter, wood and other substrates. Anatomically, mycelia consist of finely branched, threadlike hyphae. These are essentially thin tubes filled with organelle-containing cytoplasm. Hyphae first came into focus through the microscope of Italian biologist, Marcello Malpighi who published illustrations of his findings in *Anatome Plantarum* in the 1670s. While the classic depictions in biology textbooks represent plant or animal cells, fungus cells, despite their unique structures such as the

[96] Cannon, "The Fungarium." 2 min.

Spitzenkörper (a mass of vesicles at the hyphal tip involved in growth) are seldom portrayed.

Although fungi are commonly thought to be plants, they are not, differing in a number of key features, including how they obtain nutrition. Fungi are eukaryotic heterotrophs.[97] Put simply, fungi gain carbon nutrition by sitting directly in their food source, not via photosynthesis like plants. By secreting extracellular enzymes they break down complex organic compounds then absorb them as simple sugars, aptly described by Tom May as 'slobbering and absorbing'. In his seminal 1969 paper, 'New Concepts of Kingdoms of Organisms,' ecologist Robert Whittaker advanced Linnaeus' two kingdom system that implied two principal types of nutrition, proposing three modes: photosynthetic, absorptive and ingestive. These 'correspond to the three major functional groupings in natural communities, the producers (plants), reducers (saprobes, that is, bacteria and fungi), and consumers (animals) . . . The three modes of nutrition imply different logics on which the evolution of structure in higher organisms was based'.[98]

A second major feature that differentiates fungi from plants is chitin – a tough compound (a long carbohydrate polymer) also found in arthropod exoskeletons (the rigid external body covering of crustaceans, insects and their kin). It forms the main component of fungus cell walls providing rigidity and structural support. These traits of heterotrophy and the presence of chitin rather than cellulose not only distinguish fungi from plants, but also indicate their closer relatedness to animals, with both groups thought to have a common flagellated protistan ancestor.[99] While fungi have historically been classified as 'lower plants,' evolutionary biologist Thomas Cavalier-Smith threw a spanner in the works of evolutionary history by proposing a new group, Opisthokonta, in 1987. The name refers to the possession of a rear (opistho-) flagellum (-kont), a trait shared by some of its animal and fungal members.[100] Cavalier-Smith's proposal was not without contention in the scientific community but it is well accepted today that fungi and animals are closer multicellular relatives than fungi and plants.

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[97] Eukaryotes are organisms of the domain Eukarya whose cells contain a nucleus and other organelles enclosed within membranes, such as animals, fungi, plants and protists. The presence of a nucleus encased within membranes is what differentiates eukaryotes from prokaryotes.

[98] Whittaker, "New Concepts of Kingdoms and Organisms," 152.

[99] Moore, *Fungal Morphogenesis*, 13.

[100] Not all fungi and animals have flagellae, but when they do, they are single and whiplash (as opposed to the heterokont, dual flagellae of the fungoid protista such as Oomycota, which have one whiplash and one tinsel flagellum).

The mechanisms and manoeuvres that shape fungal sporebodies in all their diverse morphologies inspire both science and mythology. However when one descends from their sexual expression into the subterrain, fungi become even more astonishingly arcane. Mycelia in all their vast literal and metaphorical manifestations arguably eclipse their albeit remarkable reproductive structures. Mycelia provide a tapestry of interconnectivity with organisms and environments across multiple temporal and spatial scales, underpinning ideas of interactions and circulations explored in this thesis.

Fungal mycelia perform vital roles in the substrates they inhabit. These are commonly soils, leaf litter and all parts of living and dead trees, but also more obscure habitats such as arthropod body cavities, jars of jam and less frequently, prosthetic heart valves. That soils are commonly treated like dirt suggests poor understanding of the role of fungi in maintaining soils. Expansive scaffolds of mycelia bind soils; aerate them by creating spaces between particles; and filter water. Fungi dismantle large organic molecules into simpler forms, building soils through the process of pedogenesis. Consequently fungi cycle and govern nutrient and energy flows through ecosystems, regulating resources for subterranean and above-ground organisms.

Mycelia operate on multiple scales from the microcosm of a moth larva body cavity to vast forested landscapes, yet their presence is little realised. Fungi elude human scales of vision firstly because fungal hyphae are incredibly fine and secondly because they are mostly hidden within substrates. The signs and traces of their activities other than in destructive contexts are rarely recognised. Few people associate a healthy forest or a rotting log with the actions of fungi. Whether sensed of not, fungi are all-pervasive. If you poke your hand into an old log and it gives way, fungi are likely to be present. Walk into an old forest after rain and the smell is unmistakably fungal. However, if not convinced by your nose, then roll over a handful of leaf litter and look closely for the fine cobwebby tapestry holding it together. That is fungal mycelium.

As the reproductive structures, it is the sporebodies of fungi that have alerted us to the otherwise largely inconspicuous existence of underground mycelia. These forms are briefly examined in the context of their major ‘morphogroups,’ essentially arbitrary groupings based on their gross appearance. Each group has developed its own curious morphologies and specialist strategies for reproduction, perfectly fine-tuning their spore-dispersal mechanisms and often benefiting from vectors including *Homo sapiens*.

Biological umbrellas

Among the most familiar fungi are those that resemble umbrellas commonly known as mushrooms. Most mushrooms are 'agarics'. These produce a sporebody with radially arranged lamellae (gills) on the underside of the pileus (cap). Zooming in to a microscopic scale, each gill is equipped with club-like spore-bearing structures known as basidia. Hence, an agaric's underside is referred to as the 'fertile surface' or hymenium.[101] The typical agaric comprises a pileus and vertical stipe (stalk). Some agarics are protected in their earlier development by one or two membranous veils. The Death Cap, *Amanita phalloides*, has a membranous universal veil that encloses the entire young sporebody, the remnants of which leave a volva (sheath) around the base of the stipe as it matures. Others have a protective partial veil connecting pileus and stipe that breaks away as the cap expands, leaving an annulus (skirt or ring) on the stipe. Veil remnants also sometimes remain on the cap as scales, warts or patches.

Agaric mushrooms are what people notice on their first fungus forays before other more unusual forms challenge their notions of what a fungus looks like. Australian fungus field guides also introduce readers to agarics before other forms. If you ask someone to draw a fungus, most will draw an agaric. If you give them some coloured pencils, they will usually colour the cap red except for some white spots. The iconic Fly Agaric, *Amanita muscaria* is the world's most commonly depicted and mythologised fungus. It is regarded as the 'popular culture representative' of all mushrooms, even in countries like Australia where it is not native.[102] Children in urban Zimbabwe where Fly Agarics are also introduced, favour this mushroom in their illustrations too.[103] The Fly Agaric has infiltrated the global fungal imagination as captured in the myths of Viking Bezerker warriors, Siberian Chukchi, Finnish Sami and an elderly Dutch man whom I met cramming sporebodies into plastic buckets in a Central Victorian Pine plantation. All were seeking (and some still seek) its famed psychoactive qualities, while others succumb to its more destructive toxins.

The multiple appearances of umbrella-shaped sporebodies in evolutionary history suggest the great advantages of this form. Its success lies in the protection of the hymenia, which if exposed to rain, cannot effectively release spores. The umbrella form transpires in various configurations of shape, size, colour and texture. Some *Coprinus*

[101] Confusingly, the taxonomic order Agaricales also contains sporebody forms with hymenia equipped with tubes, spines, ripples or folds. I refer to agarics as sporebodies with lamellae only, addressing those with differently architectured hymenia by other names.
[102] Money, *Mushroom*, 52.
[103] Sharp, "Status of Fungal Conservation in Zimbabwe," 37.

form deeply cylindrical umbrellas. Others resemble parachutes. There are *Marasmiellus* that fit on a pinhead and *Amanita* that grow to the size of dinner plates. Some agarics look felted, others resemble elegant French parasols. *Hygrocybe* have extra-waterproof waxy caps while the Emperor Cortinar, *Cortinarius archeri* is covered in glutinous slime. Some are striated and some are spotted. Some glow in the dark. Others have a raised central boss on the pileus called an umbo, or gently frosted margins. Some wear a skirt, the remains of the partial veil. All manage to protect their precious spores courtesy of this ingenious umbrella form and each has evolved its own game plan to maximise spore dispersal.

Mushrooms that share the umbrella shape but have undersides with pores (not paws, as one dispirited child discovered on a foray) instead of lamellae are commonly called 'boletes'. The origin of the word is uncertain, but some authors believe it is derived from the Latin term *bōlētus* (from the ancient Greek word βωλίτης that transliterates as *bolites*).[104] Language specialist August Imholtz advances the suggestion of classical philologist, Max Niedermann that it could refer to the Spanish town of Boletum, where these fungi might first have been found.[105] Each pore of a bolete is the opening of a tube that is lined with spore-bearing basidia. The pores are often tightly packed, resembling a sponge, as suggested by *Schwamm*, one of several German names for mushrooms. While agarics vary greatly in form, boletes are typically 'well-upholstered'. Their stipes are often short and thick and their caps well-rounded, affording them a portly stature. Others defy the trend, furnishing long slender stipes like the charismatic Australian native species, the Rhubarb Bolete, *Boletellus obscurecoccineus*. The bolete known as the Old Man of the Woods, *Strobilomyces strobilaceus* has a tousled fibrous cap and looks as if it has just got out of bed. While the toxic Fly Agaric epitomises agarics, the equivalently famous bolete is the highly favoured and flavoured edible species, *Boletus edulis* – or *Porcino* (little pig) to the Italians, *Steinpilz* (stone mushroom) to German speakers, *Cep* to the French and Penny Bun to the British. Each vernacular name reflects similar cultural interpretations of its chubby form. While *B. edulis* was recently recorded as introduced in Australia, many Australians are more familiar with the Slippery Jack – a vernacular homonym shared by two species, *Suillus luteus* and *S. granulatus*. The Slippery Jack, despite being mucousy and often maggot-infested, is a prized edible species. Like the famous Penny Bun and Fly Agaric, Slippery Jacks also come from elsewhere. This paradox of Australians'

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[104] Lepp, "Snippets of Mycological History," 16.
[105] Imholtz, "Fungi and Place-Names," 71.

familiarity with exotic rather than native species is explored in chapter five. Unlike Australian fungus field guides, European guides characteristically begin with boletes. Their convenient location among the first pages reflects their cultural significance as the great majority of European boletes are edible.

In the first fifty years following colonisation in Australia, fungi largely failed to capture the attention of the new settlers. A great bounty of flora and fauna specimens were collected and sent back to Europe for identification, but only cursory references to fungi are found in the narratives of the early expeditioners.[106] The aforementioned Stinkhorn, *Aseroë rubra*, remained the only described (non-lichenised) species for almost half a century. Very occasional unpublished references to fungi appear in early journals and letters such as those of English botanists George Caley and Allan Cunningham, as well as Austrian botanist Franz Sieber.[107] Fungi were named and used by Aboriginal Australians but this knowledge is only fleetingly referred to by the early settlers, most notably James Backhouse, as explored in chapters seven and eight. Whether fungi went completely unnoticed by the early settlers or simply proved too difficult to collect is hard to determine. Fungi are elusive in their sporadic and seasonal appearance and fruit less commonly in drier habitats, where most early exploration occurred.[108] Only the more opportunistic explorers might therefore have encountered fungi. In order to give a fungus a name, many things need to fall into place. Detailed descriptions and fresh specimens that retain characteristic features are vital. Being evanescent and difficult to preserve, any fungus specimens discovered during early expeditions stood little chance of surviving the prolonged journey to the other side of the world for identification, hence the slow progress of early Australian taxonomy.

Things changed in 1836 when British cryptogamist Miles Berkeley kick-started the study of Australian mushrooms.[109] Collecting became more systematic and intermediaries catalysed correspondence between collectors in Australia and taxonomists in Europe. The English botanist William Hooker recruited Australian collectors who supplied most of the specimens during the following two decades and numerous species were named as from 1839 onwards.[110] Berkeley described and

[106] May, "History of the Australian Agaricales," 265.
[107] May and Pascoe, "History of the Taxonomic Study of Australian Fungi," 171.
[108] May, "History of Australian Agaricales," 265.
[109] In 1839 and 1840 the second and third species of Agaricales were named. *Favolus pusillus* Fr. var. *pallidus* Berk., and *Lentinus fasciatus* also originated from Tasmania and were supplied by collectors Ronald Gunn and Robert Lawrence. *Favolus pusillus* Fr. var. *pallidus* Berk. = *Dictyopanus pusillus* and *Lentinus fasciatus* = *Panus fasciatus*. May, "History of Australian Agaricales," 266.
[110] May and Pascoe, "History of the Taxonomic Study of Australian Fungi," 175.

published many of the 130 fungal specimens sent by Hooker in Hooker's 1845 *Journal of Botany*.[111] In the second half of the nineteenth century specimen collection was mainly driven by Ferdinand Müller and F. M. Bailey. In addition to Berkeley their specimens were mostly named by British taxonomists Mordecai Cooke, Christopher Broome and George Massee as well as the Hungarian taxonomist Károly Kalchbrenner. However, the lack of sufficient field descriptions and poor state of the specimens made identification difficult.[112]

It was the appointment of agricultural scientist Daniel McAlpine in 1890 to the Victorian Department of Agriculture that saw Australian fungal taxonomy start to shift from Europe to Australia. While McAlpine focussed mainly on microscopic pathogenic fungi rather than Agricales, he set the systematic mycological scene for the likes of John Cleland who described many larger fungi in the 1930s, making over 16,000 collections in all.[113] McAlpine also established Australia's first mycological herbarium between 1890 and 1911 and published a comprehensive list of Australian fungi in 1895, followed by volumes on rusts in 1906 and smuts in 1910.[114] He collaborated with Tasmanian Government botanist, Leonard Rodway who made many collections from the 1890s. Between 1910 and 1940 Cleland along with Edwin Cheel made the major contributions to naming Agaricales.[115] Unlike the European taxonomists who worked with preserved Australian specimens, Cleland and Cheel had the enormous advantage of observing fungi in the field. As techniques for identifying fungi have advanced today based on the identification of fresh specimens, earlier European collections lodged in European fungaria are being re-examined. Mycologists David Pegler, Egon Horak and Rolf Singer have made great inroads into this process.[116] Each year hundreds of Australian fungi are described, albeit often by overseas mycologists in collaboration with local mycologists.[117] However, a dearth of Australian mycologists continues to hamper understanding of Australian fungi.

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[111] Parbery and Sheather, "Aspects of Australian Mycology," 254.
[112] The first monograph of Australian fungi, Cooke's *Handbook of Australian Fungi* (1892) was criticised for its inaccuracies. In Cooke's defense, naming something that could "shrink out of all recognition, change colour, and are liable not only to decay, but also to quick demolition by insects," would have been no easy feat. Cooke, Handbook of Australian Fungi, xxxi-xxxii.
[113] May, "History of Australian Agaricales," 270.
[114] Ainsworth, *History of Mycology*, 230.
[115] May, "History of Australian Agaricales," 270.
[116] Ibid.
[117] Tom May pers. comm., 29 September 2015.

From goblets to lattice balls

A mushroom umbrella, whether with an underbelly of lamellae, pores or spines, is among the most familiar fungus forms. Other sporebodies materialise in curious configurations that are often less recognisably fungal. These more abstruse forms sometimes push fungi even further into obscurity, challenging taxonomic systems based on appearance. Along with agarics and boletes, the following morphogroups described belong to the phylum Basidiomycota, as they produce their spores on club-like basidia. Another group of fungi, the Ascomycota, produce their spores within sac-like structures known as asci. This division is of convenience to mycologists in understanding evolutionary and reproductive histories. However, given the division is not apparent by looking at sporebodies without a microscope, it is often of less relevance to those who simply enjoy discovering fungi in the field. Nevertheless, field guides such as *Fungi Down Under* adopt this taxonomic framework to organise morphogroups and I follow suit for consistency.

Fungus morphogroup names reflect the nature of their members. For example, coral fungi are coralline, jellies have a gelatinous texture and stinkhorns stink. Sporebodies vary greatly in size, shape, colour, texture, smell and habits within and between groups. Puffballs are perhaps the next best-known form after umbrella-shaped mushrooms. Their sudden appearance spurred an extensive and negative mythology with many meeting their demise at the end of a ruthless kick. The puffball strategy to success is a numbers game. They produce a gleba (mass) of millions, sometimes trillions of spores inside papery balls. Some rely on a raindrop or insect to depress the peridium (outer covering) of the gleba, generating a 'puff' of spores through a small apical opening. Other puffballs such as *Calostoma* and *Battarrea* thrive in drier inland areas. They are a tough and woody bunch, producing their glebae on top of long stipes that provide a height advantage for spore release.

Earthstars are closely related to puffballs but form star-shaped sporebodies. As they mature, the outer layer of the peridium radially splits into 'rays'. This results in the characteristic star shape and also often elevates the spore sac for optimal spore dispersal. The Arched Earthstar, *Geastrum fornicatum* excels at this trick, its peridium splitting into downward-pointing rays that stand acrobatically poised on mirrored upward-pointing rays. Growing in Australia's arid inlands, the Daisy Earthstar, *Geastrum floriforme* conserves water by curling its 'rays' around the spore sac to protect its precious cargo.

The Anemone Stinkhorn, *Aseroë rubra* that featured at the beginning of this chapter is just one of many quirky forms within the phalloid or stinkhorn group. Arising from a gelatinous matrix within a membranous casing known colloquially as an 'egg,' stinkhorns manifest as phalluses, lattice balls, or project octopus-like 'arms'. Most produce a spore-filled slurry of foul-smelling slime to entice flying vectors that engorge themselves before zooming off and distributing the spores. The phallic form of the Common Stinkhorn, *Phallus impudicus*, has inspired a great range of names, myths and beliefs and while few entertain its culinary potential, biologist Elio Schaechter describes it as having a 'a subtle, radish-like flavour'.[118]

Hypogeous fungi (those that produce underground sporebodies) include true truffles, truffle-like fungi and false-truffle fungi. The terminology for truffles is confused, with the term 'truffle' sometimes applied only to members of the genus *Tuber*, and other times to all ascomycete truffles. 'True truffles' generally refers to the famous European gourmet fungi of the ascomycete genus *Tuber*. False-truffles look similar with irregularly spherical and variously textured sporebodies, but belong in several unrelated groups of Ascomycota and Basidiomycota. False-truffles are sometimes referred to as sequestrate fungi, because they sequest their spores and do not release them via an opening. Being underground and unable to rely on wind to disperse their spores, most hypogeous fungi produce powerful scents to attract animals (mostly mammals) to do the job for them. While dozens of native Australian mammal species benefit from their nutritional value, the palatability of native Australia truffles to *Homo sapiens* is largely untested.

While gasteroid or "stomach-like" fungi (puffballs, earthstars, stinkhorns and truffle-like fungi) can arouse uneasy reactions, clavaroid (coral) fungi usually delight the lucky forayer who chances upon their often large and brightly coloured sporebodies. Clavarioids include both coral and club fungi. Some grow in complex coralline clusters, others appear like cauliflowers or misplaced antlers, and some arise as simple blunt clubs. While most grow in soil, a few inhabit wood like the Icicle Fungus, *Mucronella pendula* that dangles from the undersides of old logs like miniature stalagmites. While the clavarioids share similar forms, the category is something of a catchall for various unrelated groups that like most fungi, originally landed in the same basket based solely on shared appearance.

Jelly fungi, sometimes appear like coral fungi, but are characteristically gelatinous or rubbery. *Calocera* produce little jelly spikes on logs and those of the

[118] Schaechter*, In the Company of Mushrooms*, 172.

genus *Auricularia* look like rubbery ears. Form can vary greatly within a species. The White Brain, *Tremella fucifomis*, for example, appears in multiple manifestations like its convoluted seaweed namesake, *Fucus* (wrack). Some arise as blobs or globs, others are lobed, and some form gelatinous masses as if deposited by a sneezing giant. The underside of the Tooth Jelly, *Pseudohydnum gelatinosum*, has perfect short white 'teeth' and sometimes finds itself in Asian soups. While conspicuous in wet weather, jellies can shrivel back to a fraction of their size in dry spells, reconstituting in the next shower.

Some of the most endearing fungi of all are the 'birdsnests' fungi. Those with keen eyes will spot their tiny inconspicuous forms on twigs, leaves or dung. Their spores are packaged in tiny egg-like 'seeds' (peridioles) encapsulated within a 'nest'. Indeed, several pioneering mycologists thought the peridioles were seeds, following Flemish botanist Carolus Clusius' first description of birdsnest fungi in 1601. Like puffballs, birdsnest fungi harness the kinetic energy of falling raindrops to assist in spore dispersal. The 'nest' is often deeply funnelled and known as a splash-cup. As water droplets bounce out and fragment, the peridioles are flung out and spores dispersed.

Like boletes, polypores produce their spores in tubes and hence their undersides appear sponge-like. Unlike boletes, they tend be tough and leathery to touch. While almost all boletes grow in soil, most polypores grow on wood. They are often called bracket or shelf fungi as almost all lack a stipe and attach laterally to their substrate. Some appear in overlapping clusters of sporebodies like pikelets served on the side of a tree. While many fungi produce ephemeral sporebodies, polypores are often perennial and can last decades, producing a fresh fertile layer of tubes each year. If the polypore's host tree should fall, the fungus slowly reorientates its pores to face downwards, ensuring the uninhibited escape of its spores.

Chanterelles are recognisable by their funnel or trumpet-shaped sporebodies. Their undersides are either smooth, folded, bluntly ridged or wrinkled. Golden Chanterelles, *Cantharellus cibarius*, often grow in dense troops on the forest floor where they are eagerly sought by Scandanavians and many continental Europeans. The Black Chanterelle, *Craterellus cornucopioides*, is also a highly regarded edible species. Closely related to chanterelles are the hydnoids, otherwise known as tooth or spine fungi. Their undersides are bristled with tapering 'teeth' that feel like velvet. Most of the few species of European hydnoids are rare, appearing on Red Lists in many countries.

The diverse assortment of corticioid (or resupinate) fungi form crust-like sporebodies, mostly on decaying wood. The fungal crust can be so thin as to appear like a stripe of paint. Others are convoluted, wrinkled or adorned with short blunt projections and grow in a great variety of colours. As they often lack obvious anatomical features they can be tricky to identify in the field. Some leather fungi form distinct sporebodies such as the Pagoda Fungus, *Podoserpula pusio*, which sprouts chamois-textured tiers from soft pink stipes.

Microfungi with names likes rusts, smuts, bunts, blights and blasts have a lovely alliterative ring that belies their destructive power. This capacity for destruction have made them the most ‘economically significant’ of all fungi. While not always of great interest to the casual forayer as they do not produce large sporebodies, they are of great torment to farmers and gardeners who often unintentionally create situations in which they flourish and leave their mark on human history. Rusts are so-called as some have a reddish-brown spore stage, resembling metal corrosion. Others appear as blister-like pustules, often causing distortions in the host plant. Smuts appear as a sooty mass of spores and commonly infect grasses including cereal crops. Crop monocultures, particularly of cereals and other grains have resulted in these fungi reaching epidemic proportions with the subsequent loss of people’s livelihoods. As well as wreaking havoc in the field these fungi also spoil food in storage, transport and refrigeration. They might perhaps be trying to tell us that monocultures are not a great idea. Unsurprisingly, they have been the focus of mycological research, with McAlpine appointed to the Department of Agriculture in Victoria to specifically research fungal rusts and other plant pathogens.[119]

Moving on to the Ascomycota, this phylum contains a disparate assemblage of fungal groups including microfungi and macrofungi, and like the Basidiomycota, are linked only by their shared mode of spore production. Popular in science fiction and among zombie afficionadi, the parasitic genus *Cordyceps* is one of the more freakish fungal groups. Appearing in strange configurations shaped like clubs, spindles, fingers, antennae, maces and tridents, the sporebodies arise from an infected host invertebrate, or sometimes another fungus. Beyond zombie fetishes, the Caterpillar Fungus, *Ophiocordyceps sinensis,* which parasitises moth larvae (especially *Hepialus/Thitarodes*) is probably the most valued as well as the most contentious. Harvested in vast quantities in the Himalayas for use in traditional Chinese and Tibetan

[119] May and Pascoe, “History of the Taxonomic Study of Australian Fungi,” 183.

medicine, increased harvesting in recent years has led to serious social and conservation issues.[120]

Morels are recognisable by the convolutions of their conical honeycomb-like caps and hollow stipes. Their polymorphic appearance has systematists in dispute over their taxonomy. Some suggest there are only a few species with great phenotypic variation while others claim there are many distinct species. The range of English (mostly American) folk names for morels – Merkels, Roons, Miracles, Molly Moochers, Hickory Chickens and Sponge Mushrooms – suggests their great cultural resonance.[121] Those who value them for their edibility are less likely to argue over their taxonomy and instead contest harvesting territory.

Beech Oranges resemble golf balls. The Beech Orange, *Cyttaria gunnii*, forms clusters of pitted sporebodies that grow from gnarly gall-like cankers on Myrtle Beech (*Nothofagus cunninghamii*). Once a traditional food of Aboriginal Australians, other *Cyttaria* are still eaten in South America.[122] *Cyttaria* all grow in association with *Nothofagus* and are hence only found in the Southern Hemisphere. The most famous is perhaps Darwin's fungus, *Cyttaria darwinii*, which he collected from Tierra del Fuego during the voyage of the Beagle in 1832.[123]

Cup and disc fungi can be disc, saucer or bowl-like, sometimes on stalks, sometimes not, sometimes irregularly shaped and mostly unimaginably perfect. They can be microscopic or grow to the size of one's palm. Most emerge from wood, soil or herbivore dung and some seem fond of shower recesses. The chosen habitat of the reclusive *Lanzia echinophila* is the inner sanctums of spikey chestnut husks. The delightful Eyelash Cup, *Scutellinia scutellata* is a cosmopolitan species first described by Linnaeus in 1753 and easily recognisable from its 'eyelash-fringed' cup.

Lichenised life on the edge

One of the most successful ancient alliances manifested as lichens. The combined attributes of a fungus (mycobiont) with an alga or cyanobacterium (photobiont) allow lichens to withstand acute temperatures, desiccation, irradiation, salinity and extreme fluctuations that are intolerable to most other life, earning them the moniker of

[120] Cannon et al., "Steps Toward Sustainable Harvest," 2270-2272.
[121] Fine, *Morel Tales*, 87. These perhaps reflect the German, Swedish and other non-British influences in the USA.
[122] Stephenson, *The Kingdom Fungi*, 73.
[123] Darwin, *Journal of Researches*, 236.

'extremophiles'. Lichens are pioneers, occupying the edges of biological limits, 'invading places where there is nothing more than rock and mist to live on'.[124]

How does this partnership work exactly? Put simply, what one partner lacks, the other provides. Through photosynthesis the alga/cyanobacterium produces carbohydrates. Cyanobacterial partners also fix atmospheric nitrogen. The fungus reciprocates by supporting and protecting the alga/cyanobacterium by providing a dwelling. This intimate relationship materialises in a structure called a thallus, with the algal cells securely wrapped up by the fungal hyphae. Additionally, the fungus supplies the alga with mineral nutrients extracted from the substrate through enzyme secretion. Lichens exist as communes of multiple organisms of mutual benefit, albeit with the occasional freeloading fungal parasite.

Given lichens comprise two or three organisms representing as many kingdoms and arise from different ancestral lineages, one might question why they are classified as 'species' and why they are placed in the kingdom Fungi. Although each lichen is a composite of species, the entire organism, sometimes called a 'lichenised fungus,' is referred to by a single species name simply for convenience and convention. Lichens are categorised in the kingdom Fungi because the fungal partner is unique to each lichen. That is, every lichen has a different fungus that unites with one of a small range of photobionts.[125] The fungal partner also constitutes most of the biomass.

The study of lichens got off to a literal and allegorical rocky start. Some regarded them as 'vegetable monstrosities' and Linneaus referred to them as 'beggarly among plants'. However, lichens generally arouse less ire than other fungal morphogroups, often being admired for their aesthetics and delicate beauty.[126] Their greater acceptance might also be a case of mistaken identity. With their green hues and firm texture, lichens are commonly confused as plants. This confusion distances them from the more contentious terrains of the fungal kingdom. Their enduring presence also lends them a level of predictability. Relative to the seemingly spontaneous appearance and ephemeral existence of other fungus sporebodies, the tangible presence of lichens is perhaps less unsettling to those who find fungi inexplicable or unappealing.

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[124] Moore, *Fungal Biology*, 12.
[125] May and Catcheside, "Introducing Five New Lichen Target Species," 1, 3.
[126] This is based on observations of participants in over 150 fungus workshops held in Australia over the last decade. During these workshops, different fungal morphogroup specimens were displayed on separate tables. While almost every morphogroup incited a spectrum of responses from disgust to delight, the lichen table only elicited neutral or positive responses. Whether participants were responding to the aesthetics of the display is unknown, but as a general observation, lichens seem to be regarded with less aversion than other morphogroups. One indication is perhaps people's greater willingness to handle lichen specimens and engage with them sensorily, relative to other morphogroups.

Awareness, if not understanding, of the interdependencies of life extends back centuries. Early Greek and Roman accounts by Herodotus, Aristotle and Cicero acknowledged animal symbioses.[127] German biologist Albert Bernhard Frank first used the term symbiosis (symbiotismus) in a biological context in 1877 to specifically describe the mutualisms of lichens, although this is often credited to German botanist Anton de Bary who published the term in his monograph *Die Erscheinung der Symbiose* two years later.[128] It was almost a decade earlier that Swiss botanist Simon Schwender determined that the green blobs inside lichens were algal cells and not gonads.[129] He consequently proposed his 'dual hypothesis' of lichens as being a mutualism between an alga and a fungus. As revolutionary as it was, Schwender's theory was derided by systematists of the time as it contradicted Linnaean concepts of the singularity of species and biological autonomy. Some questioned whether symbioses existed at all. Others challenged their scope and significance. The cultural connotations of Frank's master-slave description of the alliance – with the fungus wearing the proverbial pants forcing its algal slaves into submission – was also highly controversial. British lichenologist James Crombie ridiculed Schwender's proposition as an 'unnatural union between a captive Algal damsel and a tyrant Fungal master'.[130] Across the Swiss-German border it was de Bary who developed the scope of Schwender's concept, recognising symbiosis as a driving factor of evolution.[131] However, even when the existence of symbioses gradually gained acceptance, scientists disagreed on the nature of the relationship between lichen partners. Whether it is truly mutualistic or parasitic remains in debate today. Despite the scientific commotion, Schwender and de Bary persisted with their research establishing experimental botanical institutes in Switzerland and Germany respectively. Today lichens are one of the best-known groups of all the fungi.

Returning to the Southern Hemisphere, the lace-like Coral Lichen, *Cladia retipora* (Labill.) Nyland was the first lichen to be described in Australia. Labillardière collected it during the same expedition during which he recorded *Aseroë rubra* in 1792.[132] Further European explorers documented lichens including Frenchman Charles

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[127] Whether the famous Egyptian plover's relationship with the Nile crocodile was a true symbiosis or merely an opportunistic plover is questionable, coloured perhaps by Herodotus' lively imagination. More important than scientific exactitude was the message in promoting inter-species relationships.
[128] trans. *The phenomenon of symbiosis*.
[129] Louwhoff, "An Introduction to the Lichens," 4.
[130] Sapp, *Evolution by Association*, 4.
[131] Ibid., 5-10.
[132] *Cladia retipora* was originally classified as an alga and named *Baeomyces reteporus*.

Gaudichaud-Beaupré and the British botanist Allan Cunningham. In the nineteenth century Austrians Franz Sieber and Karl von Hügel also collected lichen specimens from Australia. The botanist Robert Brown's contributions to the appendix of Matthew Flinder's *A Voyage to Terra australis* (1814) included a list of 58 lichens relative to just 10 species of other non-lichen fungi.[133] As with other fungi, the dearth of Australian lichenological expertise meant most specimens made the journey to the Northern Hemisphere for identification. Early collections were examined by mycologist Christiaan Persoon and lichenologist August von Krempelhuber. On the western side of the continent collections were made by J.A. Ludwig Preiss between 1838-1942, which were examined by Swedish mycologist Elias Fries. Tasmanian collectors, Robert Lawrence and Ronald Gunn sent specimens to English botanist William Hooker and his son Joseph Hooker, successive directors of the Royal Botanic Gardens at Kew from 1841–1885. The second half of the nineteenth century saw lichenology progress markedly with the work of German-born Australian botanist Ferdinand von Mueller who sent further specimens to Europe. Consequently, mycogeographical relationships between Australian lichens and those in other parts of the world started to emerge.[134] Taxonomy of lichens in Australia preceded other fungal groups, beginning in the 1880s with the work of the Australian clergyman Francis Wilson and New Zealand surgeon Charles Knight. Lichenology developed as a separate discipline largely because of the characteristic structure and physiology of lichens.[135] Australian lichen distribution is better known than for other fungal groups owing to the ongoing presence of a productive community of lichenologists. At the time of writing 3709 species have been described with about 36 percent thought to be endemic.[136]

Extremist specialists

Lichens occupy extreme and often very specialist niches. These include natural and human-made substrates. While foraying in the Swiss Centovalli I came upon an unexpected case of lichens eating trucks. Each and every material of the long-abandoned vehicles in a disused quarry – metal, rubber, glass, plastic, wood, upholstery – was being slowly dismantled by their actions. There seemed to be no apparent preference for vehicles of French or Italian origin both being suitable to colonisation. This ability of lichens to decompose such seemingly indigestible material results from

[133] Parbery and Sheather, "Aspects of Australian Mycology," 254.
[134] Lepp, "Episodes in Australian Lichenology".
[135] May, "Documenting the Fungal Biodiversity of Australasia," 336.
[136] McCarthy, "Checklist of the Lichens".

their possession of an enormous arsenal of enzymes, enabling them to exploit niches unavailable to other organisms.

While some lichens colonise seemingly toxic substrates, others are highly sensitive to pollutants. Wandering through the forests of Skule National Park on the High Coast of Sweden, one could be forgiven for thinking a giant spider had been at work, weaving webs between trees in the hope of ensnaring human-sized prey. On the north facing slopes, the rare Beard Lichen, *Usnea longissima*, spans old Spruce trees. While some lichens require a magnifier to detect, this one extends metres in length, draping every available branch, gently swaying in micro-currents of air. Highly sensitive to sulphur dioxide pollution, they grow only in areas of high quality air in late-successional forests. Lichens pattern and upholster every surface of these forests, challenging one to find a vacant space to tread on the forest floor.

Lichens are old organisms, but the landscapes of the Swedish High Coast are among the world's youngest. Forming since the last ice age as a result of post-glacial rebound, the land is pushing upwards as it is relieved by the weight of glacial melt. However, it would not have taken long for lichens to claim new territory, breaking down rock and creating new landscapes as they have done for hundreds of millions of years. A little further south from the remarkable lichen-scapes of Skule is the town of Skàve, where the 'Father of Lichenology,' botanist Erik Acharius was born in 1757. Furthering the work of Linneaus who in 1753 recognised about eighty species of the genus *Lichen* that he classified as algae, Acharius developed the first coherent classification system for lichens. During a lifetime dedicated to lichens, Acharius classified hundreds of species the first of which were published in *Lichenographiae Suecia Prodomus* in 1798.[137]

A month later and over 15,000 kilometres south east I began a sunrise ascent up Mount William in the Grampians National Park in Western Victoria, known as *Gariwerd* to the Djab Wurrung and Jardwadjali traditional people of the region. In contrast to the freshly minted Swedish High Coast, this terrain represents some of the world's oldest geology. In the pushing and shoving of tectonic turmoil over the last five hundred million years, ancient seabed was thrown up to 1,167 metres above sea level to form what is today known as Mount William. Embedded in the summit rock are the curious creatures of ancient seabed fossils deposited during the Palaeozoic – the likes of tree-sized algae, brittle stars and spiny fish. But even these ancient fossils are not

[137] Kärnefelt and Frödén, "Erik Acharius," 117.

immune to the erosive actions of various *Xanthoparmelia* and other lichen colonisers furnishing the summit rocks.

However, the richest lichen diversity is found in the cool and shady gullies of rainforest environments. Some of the most dramatic are in Tasmania. While a great range of plant species compete for space in the wet forests of the Central Plateau, like Skule in Sweden, one has a sense that these landscapes belong to lichens. No surface remains uncolonised. Leafy (foliose) lichens dominate the shady understorey where they cycle nitrogen.[138] Others mottle tree trunks among tapestries of mosses and liverworts. Honeycombed overlapping lobes of the Kidney Lichen, *Nephroma australe*, nestle into tree boles. The richness of detail is best observed from the forest floor, once one's eyes adjust to the low light and another operating scale, fine-tuning to ecosystems in miniature. Like a giant who stumbled into a diminutive landscape, I became absorbed by carpeted dingles, encrusted rocks, festoons of thalli. Tiny pastel balls on filigree pedicels. Collective existences. Meanwhile, other lichen communities endure the salt and spray-swept margins of the intertidal zone. The familiar orange boulders captured on postcards of Wineglass Bay on Tasmania's east coast are dominated by hardy *Caloplaca* and *Xanthoria.* Here they contend with the hostilities of the splash zone, grazing snails, seabird guano and abrasion by sand-laden winds.

Further south on Australia's southernmost landmass, the treeless Macquarie Island, lichens endure even greater extremes. Remarkably, this remote island has been more comprehensively surveyed for lichens than the Australian mainland.[139] However, it is not just the edges of the Australian continent and its islands that are colonised by lichens. In the arid interior rangelands lichens form crusts that aggregate fragile soils, binding and securing them from erosion by wind and rain and disturbance by animals. Crust-forming or 'crustose' lichens tightly adhere to these friable substrates providing enough stability for other life-forms to take a root-hold. In contrast, the 'vagrant lichens' often adopt a mobile existence, blowing about Australia's dry and sandy deserts, curling up their thalli to protect photosynthesising cells from abrasive winds. Some of the newest lichen real estate, however, transpires with the melting of glaciers.

Clambering off the elemental terrain of Europe's longest glacier, the Aletschgletscher, the Map Lichen (*Rhizocarpon geographicum*) was the first biological entity I enountered. Unfazed by life on the edge, Map Lichens 'map' every boulder

[138] Kantvilas, "Lichen Alert for Fungimappers," 6.
[139] J. H. Scott visited Macquarie Island in 1880 and recorded seven species and A. Hamilton made further collections in 1894. More recently in 1960 and 1970, surveys and collections were made by R. B. Filson, K. Simpson and S. Thrower. Seppelt, "Lichens of Macquarie Island," 15-16.

luminously yellow, etching the fungal record on a fabric of stone. Among the austerity of rock and ice, lichens slowly and imperceptibly obliterate the iconic Swiss mountains. A chain of 4000 metre peaks wrapped in scarves of cloud, wait in line. In a world stuck on fast forward, lichens inspire patience. As the retreating glacier creaked and groaned below, it felt like time itself was caught in the lichens' unhurried encroachment of freshly exposed terrain.

What fungi do

Two blue eyes stared at me from the underside of a log that lay across the Erskine River in Victoria's Otway Ranges. I was seven years old and scrambling across the river when I spied the 'eyes'. They were in fact two fruit bodies of the Pixie's Parasol, *Mycena interrupta*. The experience remains deeply embedded in my memory and this captivating fungus still thrills me four decades later. It seems I am not the only one. Almost half of the respondents to a survey in the newsletter of the Victorian conservation organisation, *Wombat Forestcare* voted the Pixie's Parasol as the 'most alluring fungus' among a dozen candidates.[140] My attention was captured by the aesthetics of this fungus. But its appearance soon gave way to a burning curiosity to know what it was doing. What do fungi do? Today, fungal function is well understood, but rarely inspires general interest. When not regarded as pathogenic organisms, fungi are sometimes seen as unimportant 'accessories' in the landscape, their underground workings and beneficial acts largely unacknowledged. To understand what fungi 'do' and how their lives are intimately entangled with other organisms, it is necessary to understand how they survive, that is, how they gain nutrition.

Fungi have evolved essentially two modes of existence or ways of nourishing themselves – they either decompose matter or muster the help of others. Lichens epitomise the latter, but other fungi are also symbiotic. I address these relationships before moving on to the second nutritional mode of decomposing organic matter, known as saprobism. While nutritional modes provide yet another convenient way of

[140] The 28th newsletter of Wombat Forestcare published in June 2014 was a special issue on fungi guest-edited by Alison Pouliot and Valérie Chételat. In the previous newsletter, readers were asked to nominate the most alluring fungus from a set of 12 images that included *Armillaria luteobubalina, Russula clelandii* group, *Flavoparmelia* sp., *Tremella fuciformis, Morchella elata/conica, Ramaria capitata* var. *capitata, Amanita muscaria, Hypocreopsis amplectens, Agaricus xanthodermus, Mycena interrupta, Omphalotus nidiformis* and *Psilocybe subaeruginosa*. This was not intended to be a scientifically rigorous study but simply aimed to engage people's interest in the kingdom Fungi and to provide opportunities to express their thoughts about fungi. Thirty readers responded to the survey with 14 (47%) nominating *Mycena interrupta* as "the most alluring". This and other papers, articles and images published during this research are listed in appendix 5.

categorising fungi, not all fungi adhere to the boxes to which they have been assigned, with some adopting both parasitic and saprobic lifestyles.

Alliance as norm

Alliances, Symbioses. Mutualisms. A fungus uses every trick in the book to cooperate with other organisms. Finding many different allies shores up a fungus genome against environmental hostilities. Along with strategies for dispersing vast numbers of spores and using their mycelia every which way, fungi are successful because they team up with others that survive in different ways. Such alliances in nature are the norm not the exception, with most organisms existing in relationships.

One 'fungal co-operation that shaped the Earth's biosphere' is the ancient alliance of the mycorrhiza – a mutualistic association between a fungus and plant roots.[141] Arising very early in terrestrial colonisation (450+ mya), mycorrhizal symbioses precipitated remarkable changes to life on earth, facilitating the transition from aquatic to terrestrial existence and consequently shaping ecosystems. These relationships are largely unchanged today. Albert Frank was an innovative scientist unafraid of challenging conventional scientific thought. He not only recognised the true nature of lichen symbioses but also presented the idea of mycorrhizal symbioses in 1885. This mutualistic relationship of nutritional interdependence exists between fungi and the great majority of plants. Although the early terrestrial plants could photosynthesise, they had not evolved effective root systems to enable them to extract enough water and nutrients from the depauperate primeval soils. Mycorrhizal fungi form the interface between plant roots and soil. By greatly extending plant root systems, mycorrhizal fungi facilitate water and selective nutrient uptake. These relationships are especially important in Australia's old and weathered, phosphorus-poor soils. Plants in return provide fungi with sugars produced through photosynthesis. Mycorrhizal fungi also improve the resilience and health of plants by increasing their resistance to soil-borne disease and other stresses associated with extremes of soil temperature and chemistry. Moreover their work goes beyond the individual. Fungi extend relationships through the soil to other plants, facilitating nutrient transfer between them, uniting plant communities via a tapestry of connectivity. Mycorrhizal networks are increasingly recognised as the orchestrators of plant interactions mediating their growth and

[141] Moore, *Fungal Biology,* 193.

survival.[142] Plants on all continents (including those in the fossil record of Antarctica) have evolved these relationships.

Frank was not the first to discover mycorrhizas but he was the first to correctly acknowledge their function and significance.[143] He also distinguished different types of mycorrhizas, recognising ectomycorrhizas as those that form an external mycelial sheath around a plant root, while endomycorrhizas directly penetrate plant root cells. Mycorrhizas were first described over four decades earlier by German forestry scientist, Theodor Hartig (1840), but he wrongly assumed they were a part of plant roots and not a separate fungal organism. Other early researchers did recognise the fungal component of mycorrhizas, but although they documented and described them, often with remarkable detail and accuracy, their function remained elusive. Given the lowly status of fungi most researchers assumed that any relationships they formed must be parasitic. The idea that fungi could form beneficial and not just destructive relationships had not been previously conceived. Frank, however, was unconvinced about theories of parasitism and he was right. The sheer pervasiveness of mycorrhizas he observed on multiple tree species and across diverse habitats provided another clue to their function, debunking ideas of parasitism. Given the forests Frank surveyed did not appear to be suffering from the effects of such extensive parasitism, he concluded the relationship was more likely to be cooperative.

Despite the significance of Frank's findings they met with resistance as they challenged well-accepted concepts of Darwinian evolution as 'proceeding by competitive struggle'.[144] Conflict and competition rather than cooperation very much drove the development of evolutionary ideas. Physician Frank Ryan notes 'as Darwinism, with its emphasis on competitive struggle, thrived, symbiosis, its cooperative alter ego, languished in the shadows, derided or dismissed as a novelty'.[145] Concepts of symbiosis also presented logistical problems as they straddled the neat disciplines that characterised the development of the natural sciences at this time. The organisms that comprised these associations crossed over kingdoms threatening the autonomy of these specialised fields of study.

Frank had the foresight and imagination to think outside the limitations of contemporary scientific thought that assumed fungi were agents of disease and of no beneficial value. But old ideas die hard. The infectious belief that all fungi are agents of

[142] Beiler et al., "Architecture of the Wood-Wide Web," 543.
[143] Trappe, "A.B. Frank and Mycorrhizae," 278.
[144] Ibid., 280.
[145] Ryan, *Darwin's Blind Spot*, 24.

disease persists today, not just among the general public, but also among those writing conservation policy as explored further in chapter four. Despite the slow uptake, Frank's monumental discoveries revealed that these relationships are the norm; they are beneficial; and they are pervasive. Life is more cooperative than is often realised.

Rethinking parasites

Life might be cooperative but not all relationships are equal. Parasites take from their host, but do not give back. They do however, inadvertently give to other organisms, for example, by providing new habitats or food from things they have dismantled. The activities of fungal parasites and saprobes are much maligned by those who value what they are deconstructing. These fungi are therefore a focus of the forestry, agriculture, horticulture and construction industries. The effects of their actions are often highly visible and can cause great economic losses. The activities of beneficial fungi on the other hand, such as creating soils and regulating ecosystems are less obviously apparent, overshadowed by the actions of parasites and saprobes.

'I've made the most terrible discovery in my garden,' wrote Bernie Ryan. 'We've been invaded by the honey fungus'. I've raked all the leaf litter, burnt it and drenched the ground with Roundup. My wife removed all the mushrooms (with gloves on) and the nearby bark but can we be sure they won't come back and will the trees die?'[146] The email message, marked 'URGENT,' was followed by a series of out-of-focus images, taken perhaps in haste to swiftly address the issue. The species of concern appeared not to be the Australian Honey Fungus, *Armillaria luteobubalina*, but the Spectacular Rustgill, *Gymnopilus junonius*. The two are often confused. Paradoxically, the necessary nutrient cycling provided by the Spectacular Rustgill and other fungi in the Ryans' garden might have been disrupted by their interventions. Consequently, they could have inadvertently increased the trees' susceptibility to aggressive fungal parasites such as the Australian Honey Fungus that are normally kept in check by a diverse mycota. This reaction reflects the common erroneous assumption that fungi are more likely to be detrimental than beneficial.

Not all parasites kill their hosts. Many are only 'weakly parasitic,' extracting what they need, but not destroying their life-support system. These are known as biotrophic parasites. They tend to be rather choosy with most opting for a specific host. Necrotrophic parasites on the other hand, kill host tissues or the whole host in the process of obtaining nutrition and often adopt a wider range of hosts. Some

[146] Bernie Ryan (pseudonym), pers. comm., 18 June 2013.

necrotrophic parasites such as the Australian Honey Fungus are highly adaptive. Having destroyed its life-support system, it is then thought to become saprobic, decomposing the tree it has felled. While much maligned as a parasite, at least it tidies up after itself. Other necrotrophs invade and kill invertebrates, while some cause diseases such as foot rot and leaf blotch. Although many parasites are agents of disease, they are also a natural and essential part of healthy ecosystems. Ecosystems without parasites are unsustainable. Parasites affect species' interactions, regulate populations and influence nutrient cycling. Recent work in the Amazonian basin showed that parasitic fungi regulate tree diversity in tropical forests.[147] In what is known as negative density dependence, these host-specific fungi along with plant-eating insects, prevent single plant species from dominating forests because they inflict more damage where their hosts are more abundant.

Fungal symbioses have evolved in many guises. Parasitic ones mostly involve microfungi. These have been the focus of most mycological research and their stigmatisation has tainted perceptions of all fungi. The significance of beneficial mutualisms in supporting forest ecology has also been largely overlooked. I therefore chose to make the more visible and mutually beneficial fungi the focus of this research.

Fungal rotters

The weather bureau had forecast a wet weekend and got it right. I was soaked through by a penetrating drizzle while photographing fungi in the foothills of the Victorian Alps. Mountain ash towered overhead, their canopies lost in mist. Bracing myself on a steep slope, I propped the lower leg of my tripod against a log for greater support. As I framed the shot, things took another turn. As the log disintegrated, tripod, camera, log remnants and I tumbled rapidly downslope narrowly avoiding an unplanned dip in the Toorongo River. Somehow I have repeatedly underestimated the capacity of fungi to rot. Each misadventure has increased my appreciation of this remarkable ability to dismantle nature's constructions. If only I had a longer memory.

Along with bacteria and invertebrates, fungi are major decomposers or recyclers of organic matter. They are known as saprobes. Most fungi are thought to adopt a saprobic lifestyle and have done so for a good half billion years.[148] That is, most fungi recycle organic matter, not cause disease as commonly believed. Through the external digestion of primeval landscapes fungi provided the first soils for colonisation by other

[147] Peay, Baraloto and Fine, "Fungal Community Structure," 1852.
[148] Taylor et al., "Fungi from the Rhynie Chert," 457.

organisms. If you consider the amount of organic debris produced by a tree, let alone a forest, you start to get a sense of the staggering profusion of fungi that permeate ecosystems. Fungi also break down animal matter. The Ghoul Fungus, *Hebeloma aminophilum* and other *Hebeloma* are described as sarcophilous as they emanate among the remains of dead animals. Ghoul Fungus has a taste for urea, springing up in truck stops and campgrounds. Some fungi decompose keratin, a fibrous protein that gives structure to skin, hair, nails, hooves, teeth and feathers. One feather-fancying fungus, *Arthroderma curreyi*, has a penchant for old tennis balls.[149]

While fungi can degrade pretty much any organic material containing carbon, among the two most significant are cellulose and lignin. Together they form the major structural and strengthening components of wood. Bacteria and invertebrates also contribute to decomposition processes, but only fungi degrade lignin. Each leaf and branch that falls to the forest floor is likely to be recycled by saprobic fungi that release locked up energy and perpetuate cycles of life. Different saprobes degrade different compounds. Some are generalists deconstructing a variety of compounds while others are specialists. Some set to work on an individual leaves while others tackle entire logs. White-rot fungi metabolise both cellulose and lignin, brown-rot fungi break down cellulose and hemicellulose, while soft-rot fungi seem to have a shot at rotting them all.

If a tree falls to the forest floor on its own accord and not courtesy of a chainsaw, it might lie there for decades if not hundreds of years. Over the course of its horizontal life it will be colonised by a succession of fungi and other organisms. The primary decomposers such as the Oyster Mushroom, *Pleurotus ostreatus*, move in first and like early plant colonisers, grow fast and quickly colonise their newfound substrate. Once their work is done secondary decomposers, such as *Coprinus* further the efforts of the primary decomposers. Processes of primary and secondary decomposition can take decades, depending on the type of wood and the nature of environmental conditions. Tertiary decomposers such as members of the species-rich genus *Mycena* move in toward the end of the decomposition process. Maintaining age structure of trees including fallen logs is crucial to the survival of a range of fungi.

Whether forming symbioses with other organisms or recycling organic matter as saprobes, fungi occupy almost every habitat imaginable. The next chapter ventures into the many habitats and places where fungi are found and how these affect perceptions of fungi.

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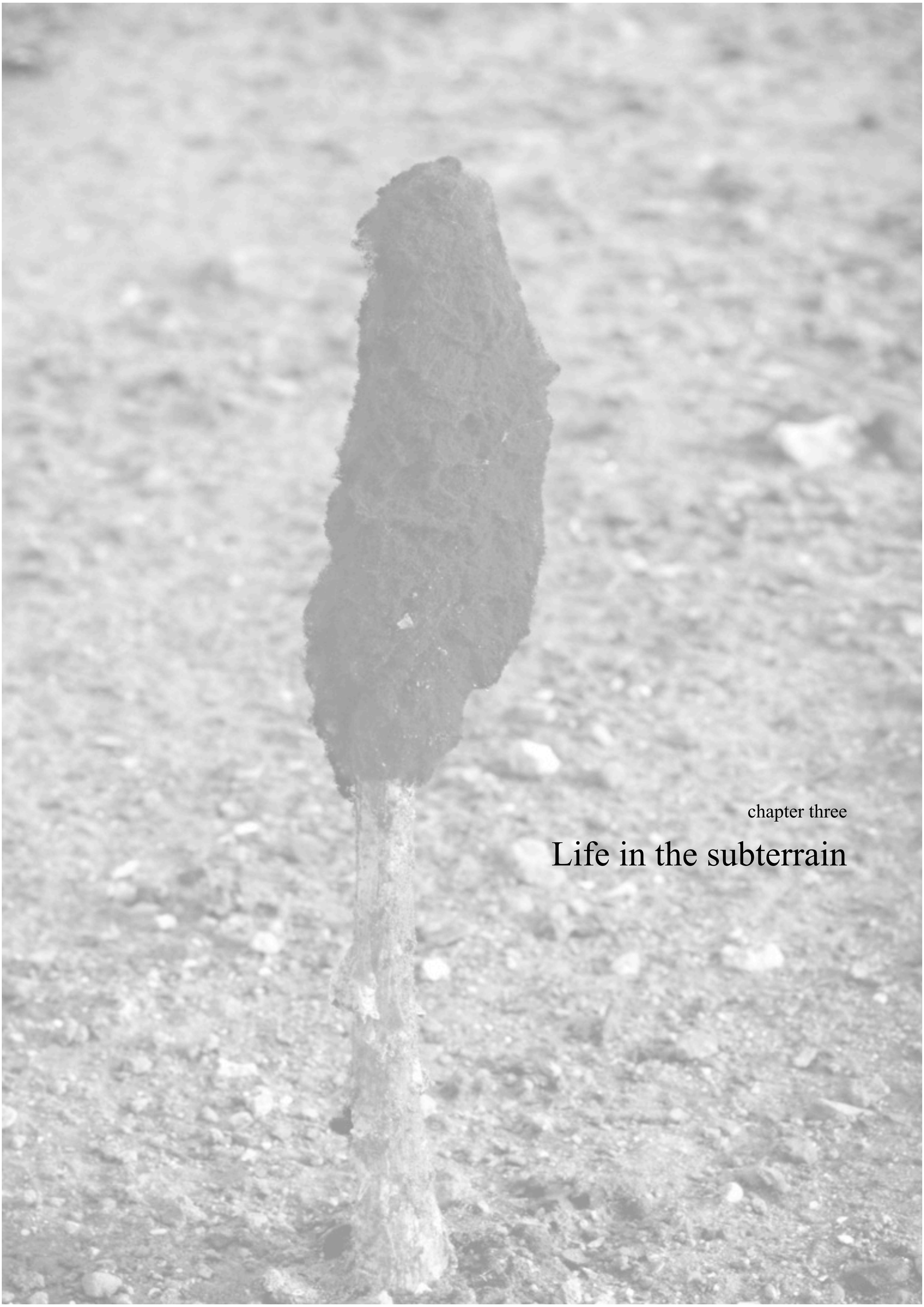
[149] Henrici, "Notes and Records," 29.

Endless forms most bizarre

Dispersing spores requires ingenuity. Solving the problem of distributing spores creates the beautiful architecture of the sporebody, argued mycologist Cecil Ingold in 1953.

The evolutionary improvisations of the last hundred million years are reflected in the bizarre bevy of endless fungal forms.

At times, these eccentric, subterranean intrusions seem both surreal and inexplicable. The mycologically-odd oozed and infused their way into folktales and the cult classics of science fiction; fantasy rendered fungal worlds amenable to narrative.



chapter three

Life in the subterrain

The desert horizon blurred into forty-four degree heat. Like desert fungi, the handful of inhabitants of the Australian outback town of White Cliffs largely occupy the subterrain. The Barkindjii Aboriginal people are the traditional owners of the region, with *barka* meaning river, but at that moment, any sign of water was just a mirage.[150] Those who gravitate to White Cliffs do so to try their luck at unearthing opals. Some get lucky, others do not, but all retreat to their burrows to escape the extremes and unpredictability of an arid inland existence.

Outside the pub, a Blue Heeler momentarily relinquished its patch of shade and ambled over to chew the crumpled bodies of locusts jammed in the radiator grill of my car. I wandered across to the town's decommissioned experimental solar station, lowering my eyes from the blinding glint of thousands of mirrors embedded in its parabolic dishes. Then something else caught my eye. There in the copper-red sand, the stalked puffball known as the Black Powderpuff, *Podaxis pistillaris*, stood a good 20 cm tall and unlike me, showed no sign of wilting. This fungus grows in the deserts of Australia, Asia, Africa and America and is superbly adapted to xeric environments.[151] Its cultural properties are also well known. In Australia, its spores are used to darken the white whiskers of Aboriginal men and repel flies.[152] In Yemen, its antibacterial properties are exploited in the treatment of skin disease, while in South Africa it soothes sunburn. It is eaten as food in the Rajasthan Desert of Northern India as well as the deserts of Afghanistan and Saudi Arabia.[153] Although well known by desert people and mycologists, the blisteringly hot desert is not the place where most people would expect to find fungi.

The place of fungi can be explored through the intersections of the many layers of their geographies, and natural and cultural histories. Place has long been a consuming theme of historians, anthropologists, geographers, sociologists and others in the humanities and is gradually becoming more inclusive of species beyond *Homo sapiens*. The sciences on the other hand tend to focus on multiple species, with *Homo sapiens* usually conspicuously absent. Both approaches have contributed to nature (including fungi) being relegated to 'out there,' to 'another place,' reinforcing nature-culture binaries, a theme exhaustively critiqued over the last few decades. The fields of conservation biology, environmental ethics and philosophy, along with the emerging

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[150] Barkindjii is also referred to with the names Barkindji, Paakantji and Paaka.
[151] In 2013 *Podaxis pistillaris* was recorded for the first time in Europe on the Aeolian Islands, north of Sicily. Friebes and Wendekin, "Erstnachweis von *Podaxis pistillaris* in Europa," 81.
[152] Lepp, "Aboriginal Use of Fungi".
[153] Ibid.; Batra, "Edible Discomycetes," 293; Al-Fatimi et al., "Bioactive Components," 87.

multidisciplinary amalgam of the environmental humanities help reframe the artificial division of 'human worlds' and 'natural ecosystems'. As environmental humanists go beyond *Homo sapiens* as their raison d'etre and scientists become more broadly inclusive of this pervasive hominid, possibilities for thinking about fungi within more inclusive perspectives emerge.

A great swathe of terms has evolved to define the places inhabited by organisms including *Homo sapiens*. Concepts of place, biome, niche, habitat, ecosystem, environment, landscape, territory, Country, *Umwelt*, *Lebensraum*, *terroir*, biosphere and others span intertwining aspects of literal and allegorical place. Some define geographical or cartographical space or dynamic systems of interactions, while others focus on human contexts and themes including identity, belonging and heritage. Probing the depths of these different concepts of 'place' is beyond the context of this research. Rather, I begin by describing where fungi grow and then focus on two aspects of fungal places – first, the subterranean and hidden nature of fungi; and second, how the undesirability of their places of inhabitation (such as dirt, litter and dung) contribute to disregard for fungi. Both add a compelling dimension to understanding fungi within the frameworks used to comprehend the places of other organisms.

Fungi exist in staggeringly diverse environments. While some fungi colonise a wide range of habitats and conditions, many are especially selective about where and what they colonise. I discovered one of the more arcane while photographing in the tropics among the mangroves of the Northern Territory's Cobourg Peninsula. Although little known, mangroves harbour a great variety of fungi that contribute to the functioning of marine systems.[154] However, the fungi I refer to were not in the mangroves, which appeared with a soft-focus effect through my viewfinder, but inside my lens. It is hard to imagine what nutrition a fungus might extract from the chemical coating on lens elements or glues used to assemble them, but an impressive network of mycelia was gradually obscuring my view like an encroaching cataract. Fungi grow in even more extreme and obscure places, among them the inner sanctums of the Chernobyl nuclear reactor, the frozen extremes of Antarctica and the toxic depths of aircraft fuel. Other fungi are considered 'cosmopolitan,' that is, occurring worldwide or at least having a geographically wide distribution. Fungi are often portrayed by their omnipresence of spores, 'waiting' to colonise any available substrate.[155] Theories of fungal distribution in evolutionary contexts have themselves rapidly evolved with the

[154] Hyde, "Intertidal Fungi," 711.
[155] Kendrick, *The Fifth Kingdom*, 48.

growth of DNA sequencing techniques and advances in the fields of phylogeography and mycogeography.[156] These new approaches challenge early twentieth century ideas about microbial populations posited by Dutch microbiologists, Lourens Baas Becking and Martinus Beijerinck who maintained that 'everything is everywhere, but the environment selects'.[157] The basic premise of their theory is that the presence of a given microbial species can be explained by habitat properties alone, with historical factors being irrelevant. This contrasts sharply with theories on the distribution of macroscopic plants and animals. These ideas arose in response to the high dispersal ability, large population sizes and resistance of spores to extremes of temperature and radiation, suggesting that geography is less relevant for microbes than for larger animals and plants. Many spores (such as those of *Ganoderma*) have melanised, hardened, thickened or doubled walls to counter the extreme conditions of high altitude dispersal.[158] It seems reasonable that if you are a spore, it is easier to get airborne and end up in the high winds that circulate the earth, than for example, if you are a wombat. However, recent findings suggest that fungi are not as ubiquitous as once believed, with very few fungi having a global distribution.[159]

The place of fungi also has meaning beyond their geographical distribution or habitat. For some, the place of fungi is a tangible concrete entity. For others, they occupy the liminal spaces of the mind and imagination, straddling the bounds of myth and science. Fungal habitats become fungal places once they are overlaid with a mental layer of human significance, contextualised or named and imbued with meaning.[160] These processes make them cultural by conjuring a sense of place or spirit, genius loci, that eventually become absorbed in the knowledge and stories of how people know and imagine fungi.[161] Place will arguably revert to habitat, once *Homo sapiens* permanently departs the planet, taking our fungal stories and significances with us.

Forests form the most familiar fungus habitats. In Europe, the forest was once considered a dark place, an unknown beyond, where dubious characters lurked. Forests were off-limits, brimming with literal and metaphorical shadows. They were places of enchantment but also fear, from where fairy tales and legends sprung, especially in

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[156] Lumbach et al., "Phylogeography and Biogeography of Fungi," 423.
[157] Salgado-Salazar, Rossman and Chaverri, "Not as Ubiquitous as We Thought," e76737.
[158] Moncalvo and Buchanan, "Molecular Evidence for Long Distance Dispersal," 434.
[159] Salgado-Salazar, Rossman and Chaverri, "Not as Ubiquitous as We Thought," 1; Heilmann-Clausen et al., "A Fungal Perspective on Conservation Biology," 1; Fisher et al., "Emerging Fungal Threats," 189.
[160] Vanclay "Place Matters," 4.
[161] Relph, "A Pragmatic Sense of Place," section: Spirit and Sense of Place.

Germany.[162] They were places beyond the realms of normal human experience, where the unexpected and often sinister occurred, but also places of magical refuge. As the place of fungi, they are implicated within perceptions of forests. In *Gossip from the Forest* Sara Maitland waxes lyrical about the joys of unexpected encounters on a forest wander:

> the lovely clearing, the little waterfall, the pied flycatcher skipping black and white on an oak branch, a cloud of butterflies feeding or equally, of course, you stumble on the dead fox, the rubbish dump, the ancient wrecked car or the wicked grinning fungus.[163]

Maitland epitomises the reverence with which some forms of life are held (colourful and charismatic birds and butterflies that inoffensively flitter about), while this fungal casualty of an active imagination is lumped in with the dead and discarded (fungi wickedly grin and rot things). The ways in which forests have been conceived in the cultural imagination of the West is explored in great depth in Robert Harrison's pioneering work *Forests, The Shadow of Civilisation*. Harrison explores the history of forests but also of the human psyche and how forests represent 'an outlying realm of opacity which has allowed that civilization to estrange itself, enchant itself, terrify itself, ironize itself, in short to project into the forest's shadows its secret and innermost anxieties'.[164]

Like European forests, the Australian bush with its interior of unknowns was similarly intimidating to early settlers.[165] Australian poets and writers such as Henry Lawson and later Eleanor Dark, Judith Wright, Patrick White and David Malouf captured settlers' uneasy relationship with the bush. In *Ecological Pioneers*, social ecologists Martin Mulligan and Stuart Hill explore the contradictions of a land perceived as both appealing and appalling. They argue that although from the 1860s onwards a new ecological attentiveness and sensibility emerged, a 'fascination for the melancholy that could be triggered by contact with the Australian bush was at the same time an acknowledgement of fear of the unknown'.[166] They note that as late as the 1890s, 'most Australians were living on the coast looking out towards the sea, casting

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[162] Maitland, *Gossip from the Forest*, 8.
[163] Ibid.,128.
[164] Harrison, *Forests, The Shadow of Civilization*, xi.
[165] The bush can incorporate what are known as woods or forests as well as woodlands, scrub, grasslands, agricultural areas and typically refers to an area outside urban regions and fairly sparsely inhabited by *Homo sapiens*, rather than being a reference to a particular vegetation type. Australian folklore, myths and legends are rich with impressions of the bush and it is deeply embedded within Australian identity. The term is also used in other countries including New Zealand, Alaska and South Africa and has similar but not exactly the same connotations.
[166] Mulligan and Hill, *Ecological Pioneers*, 33.

nervous glances over their shoulders at landscapes behind them'.[167] Such contradictory feelings persist today. While the bush has since been mapped and penetrated it still remains seemingly impervious to many. Those who have made the so-called tree change from urban to rural life are often content to be in proximity of the bush, perhaps occasionally looking in, but rarely engaging with it in any intimate way. The bush, after all, offers not only the opportunity to be bitten by a deadly snake, get lost or die of thirst, but also harbours a new breed of dubious characters to add to the once feared bushrangers and Aboriginals – those seeking psychotrophic mushrooms. Efforts to convert the bush to a place of discovery and enchantment rather than of dangerous unknowns are not yet won.

As well as being pervasive, the places of mushrooms and their seekers are also marginal places, interstitial spaces, interfaces of subterranean and aboveground worlds. Or perhaps it is at the margins where the presence of mushrooms becomes most apparent – in the dampness of road verges and forest edges, compost heaps and untended corners, as well as suburban Australian nature strips where great crops of Yellow Stainers (*Agaricus xanthodermus*) compete for space with dog excrement until Saturday morning when both are unceremoniously mown down in a parodic stripping of nature from the nature strip. Interfaces of different environments are usually productive zones. Think of the liveliness of the intertidal zone, or the buzz of activity along the shallow margins of a lake. It is at the,

> boundaries that all life's action occurs – the places where nature (genetic influences) and nurture (outside influences) inextricably intertwine to generate the rich complexity of the living world. These boundaries can never be completely fixed, but instead define the ever-changing contexts, the local environments within and between which life processes are transacted across scales of organisation ranging from microscopic to global.[168]

Fungi also occupy allegorical margins of certainty and uncertainty, risk and fear. For consumers of psychotrophic fungi, they are sacred places; places of enlightenment, otherworldliness, pushing the extremes of sensory thresholds. For over-protective parents, the place of fungi represents danger zones. The indeterminacy of fungi confounds taxonomists who need to assign them a precisely defined place, as explored in chapter six.

[167] Ibid., 77.

[168] Rayner, *Degrees of Freedom*, 4.

Different hemispheres, different fungi

Different hemispheres produce not only different fungi but also different ways of perceiving fungi. Just over two centuries after Labillardière discovered *Aseroë rubra,* I too sailed down the D'Entrecasteaux Channel in Southern Tasmania. My mind, however, was not on Labillardière or *A. rubra*, but on the big southerly that was pushing in fast. Only hours earlier we had prised oysters off the rocks and sat in the sun to eat them. Now we anxiously watched the barometer and the dimming beam of the Cape Bruny lighthouse – the most southern on the Australian landmass – as we headed further south, waiting for the wind to swing and deliver us further up the west coast to Port Davey. After hours of riding enormous swells we straggled into the shelter of Bathurst Harbour and it began to snow. It was Christmas eve. A white Christmas in the Australian summer at sea level seemed perverse, but it was not the first time. Tasmania's South West Cape is exposed to weather extremes, with cold, wet, southerly winds prevailing and rain every other day, even in summer. Extreme weather warnings are the norm. It is exactly this changeability of Australia's weather along with the diversity of habitats and geographical isolation that has shaped Australia's mycota into one of the most diverse in the world. The relatively high rainfall, old forest remnants and diversity of habitats make Tasmania a fungal hotspot.

Extreme variability of climate and its implications is what perhaps most differentiates Australia from much of Europe. Extreme weather also occurs in Europe, especially in the high Alps, but less often. Like Australian flora and fauna, fungi are adapted to a different set of pressures and influences compared to those in Europe, including desiccation, fire and nutrient-poor soils. Historian of science, Libby Robin and archaeologist Mike Smith, consider the irregularity of rain in Australia as being 'at the core of creative ecological pulse' with animals (and plants and fungi alike) developing 'impressive adaptations to cope with scarcity and plenty'.[169] Uncertainty, variability and aseasonality drive the peculiar habits and forms that epitomise Australia's biota as idiosyncratic. They also shape a particularly Australian way of perceiving and regarding these organisms. Robin and Smith add that Northern Hemisphere perspectives have "sometimes made it difficult to observe the strategies of animals that live in landscapes ruled by variability and aseasonality'.[170]

The places of this research span the Spinifex grasslands of the Australian deserts to the high meadows of the European Alps, but most were bush and forests. Swiss

[169] Robin and Smith "Introduction: Boom and Bust," 2.
[170] Ibid., 4.

forests contrast starkly with the Australian bush. I became aware of these differences with my first footsteps into a Swiss forest. They smelt and sounded different. Deciduous trees create a deeper and wetter litter layer that sounds different beneath one's feet. They also felt different. Even in boots, one feels the give of the forest floor. On first impression Swiss forests seemed silent, dark and tidy, with few bird and insect sounds, until one's senses attune to their subtleties. They are characterised by Beech, Oak, Birch, Sycamore, Maple, Larch, Fir and Pine and do not grab and spike like the Australian bush. With an open understorey I moved through the Swiss forest with relative ease.

In contrast, the bush of Southeastern Australia typically has an overstorey of eucalypts with smaller trees (often dominated by acacias), shrubs and grasses below. Adapted for extremes, these hard-leaved sclerophyllous trees dominate Australia's vegetation and characterise the bush. The highly recalcitrant litter they produce, combined with low rainfall and nutrient-poor soils means decomposition happens slowly. It crunches and crackles underfoot. The bush also occupies a place deeply entwined in Australian identity accompanied by a vast literature exploring its shaping of imaginative and aesthetic sensibilities. Synergies of topography, climate, histories of disturbance, human perceptions and more all define fungal places across hemispheres, but *process* is a more useful concept than place to think about where fungi grow.

Place as a process – more a verb than a noun

The place of a fungus is intrinsically linked with what it does; its functional relationships, actions and interactions in both time and space. Fungi occupy a transitional continuum between life and death, as architects of both, constantly transforming and configuring their environments, creating new life – indeed new places – by forming connections, recycling and building soil architecture. In moving beyond the inertia of a physical place, thinking of fungi as processes that contribute to (and result from) a matrix of interactions more acutely reflects their dynamism. As geographer Hayden Lorimer says, it is about trying to 'make sense of the ecologies of place created by actions and processes, rather than the place portrayed as the end product'.[171] Place then shifts from a static 'location' to an interplay of environmental and cultural factors in constant change and exchange.

Jakob von Uexküll's concept of *Umwelt* extends ideas of 'habitat' or 'place,' allowing fungi to be subjects rather than objects and thus providing a radically different

[171] Lorimer, "Cultural Geography," 85.

way to think about place.[172] Von Uexküll focussed on how living beings perceive their environments and how this affects behaviour, claiming that 'no one, who has the least experience of the *Umwelten* of animals will ever harbour the idea that objects have an autonomous existence that makes them independent of the subjects'. Fungi do not 'behave' or 'perceive' in the same way as animals, but his notion of the inseparability of object and subject is pertinent to fungi.[173] *Umwelt* switches the standpoint of the meaning of place from humans, to the perspectives of other species, so that 'meaning is bestowed by the organism on its environment'.[174] Each organism inhabits its own 'lifeworld' – a world of perception, sensation and orientation, with *Umwelt* denoting an organism's subjective world.[175] However, how do humans perceive organisms whose lifeworlds revolve around places deemed undesirable?

Undesirable dwellings – dirt, litter and dung

Fungi often inhabit places considered unworthy of concern. Aesthetic landscapes and their charismatic inhabitants attract more attention – places where iconic koalas doze in Gum trees or kangaroos bound across grassy plains. Such places and their creatures are deeply embedded in the Australian sense of landscape and identity. Extending this appreciation to something that lives in dirt or excrement presents greater challenges.

Dirt is rarely considered kindly. After all, it is dirty. It is where faeces and radioactive waste, dead pets and relatives, and objects no longer desired are disposed. Dirt harbours germs and worms and makes stains that must be vehemently scrubbed from sight. It is the place called 'away' when something is discarded. With its menacing legion of bacteria, dirt is feared and expunged and prised from children's fingernails. Hostile beliefs toward dirt are reflected in language, culture and the ever-expanding artillery of cleaning products. If it were viewed more positively, it could not be defiled, fouled, have blood spilt on it, or the bits of interest blasted out.

English language has evolved a miscellany of words to describe this 'stuff' – dirt, soil, earth, humus, ground and mud being among the more literal descriptors. While often used synonymously, they are not only differently physically constituted, but also differently regarded and symbolised. Differentiating them requires more than

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[172] Ibid., 77.

[173] As the pioneer of the semiotic approach to biology in the twentieth century, von Uexküll was known for bringing together biology and aesthetics in playful experimentation and was subsequently denounced by the scientific community for his anthropocentrism. Kull, "Jakob von Uexküll," 11.

[174] Ingold, *Being Alive,* 64.

[175] Kull, "Jakob von Uexküll," 7.

assessing their constitutive elements, but also the processes, movements and vitality of each. Definitions of soil and dirt are plastic, but essentially soil is alive and dirt is dead. Dirt contains the inorganic material of rock particles, minerals and water. A soil scientist might describe dirt as the basic mineral component of soil, consisting of sand, silt and clay. Soil contains these plus living components and their processes. Dirt can convert to soil if organisms find a way to inhabit it. Likewise, soil reverts to dirt if its living inhabitants and processes are destroyed.

Soil is the foundation of life and the place of the dynamic nourishing and flourishing of the teeming unseen, in which life also ends. It is the most biologically diverse and intensely productive part of almost every terrestrial ecosystem as the 'interface between geology and biology, the bridge between the dead world of rock and the bustling realm of life'.[176] The darker organic layer that forms near the soil's surface known as humus 'lives and breathes through a complex mix of interacting organisms'.[177] Soil shelters the intimate interconnectivities of these organisms, largely bacteria, fungi and invertebrates that support producers and hence the biosphere. Soil maintains hydrological and nutrient cycles, sequesters carbon and stabilises climate. It filters, absorbs, buffers and stores, making life possible on earth. Its inhabitants add to the organic layer and collectively underpin the overall health, fertility and productivity of the soil. Soil is also not just a solid. Healthy soil resembles a giant sponge filled with pockets of air that often make up more than half its volume.[178] Within this matrix of air pockets, supported by scaffolds of mycelium and the roots of plants, water percolates to deeper soil horizons. As soil is the foundation of every forest, disruption compromises its inhabitants and hence their capacity to support the forest.

The complexity and continuity of the processes in this thin lamina of life are impossible to untangle and exist 'in cycles that have no beginning and no end'.[179] Rachel Carson was one of the few writers within the early environmental movement who recognised the importance of fungi in soils and noted: 'we know too little of the threads that bind the soil organisms to each other and the world'. Her threads might be assumed to be more allegorical than literal references to mycelia, however, she adds 'perhaps the most essential organisms in the soils are the smallest – the invisible hosts of bacteria and of threadlike fungi'.[180] Carson recognised the soil community as an

[176] Montgomery, *Dirt: The Erosion of Civilisations*, x.
[177] Maser, Claridge and Trappe, *Trees, Truffles and Beasts*, 38.
[178] Ibid., 8.
[179] Carson, *Silent Spring*, 61.
[180] Ibid., 62.

inseparable web of interwoven lives, with soil only being viable so long as its inhabitants flourished.

In not on

Soil is not just a surface. Thinking of it in this way limits perceptions of how it, and how fungi, are perceived. Rather, thinking of soil as depths of interactive complexity expands perceptions of its dynamism. Indiscreet use of language perpetuates misunderstandings of fungi as separate entities, rather than as a matrix of relationships. A quick flick through any Australian fungus field guide, for example, reveals how they might contribute to inaccurate conceptualising of fungal habitats as surfaces. Fungi do not exist *on* the surface of soil, but within it. The sporebody might well appear on the surface, or at the above-ground and below-ground interface, but to say a fungus 'grows on soil,' is to misrepresent the entire organism and the extent of its occupation. A field guide is, of course, designed to assist the reader in identifying a particular species by its sporebody. Most guides simply aim to differentiate with which type of substrate – for example, soil, wood, dung or leaf litter – a particular species is likely to be found. More comprehensive descriptions of fungal function are found in mycological texts. Nevertheless, describing fungi as growing *on* surfaces reinforces misunderstandings that sporebodies represent the entire organism. As a simple comparison, the root systems of trees are also mostly invisible, yet trees are not said to grow *on* soil. Relative to the above-ground sporebody, the below-ground mycelia is often far greater in size, compared to the above and below-ground portions of a tree, reinforcing the inappropriateness of referring to fungi as growing *on* soil. The distinction matters because fungi do a great deal more *in* than *on* soil in contributing to the functioning of ecosystems. Ingold explores the limitations of 'surfaces' in the context of beings not occupying the world, but inhabiting it and contributing to its 'ever-evolving weave'. He notes that the 'inhabited world, as such, has no surface'.[181] In describing how young children interact with place, writer Robert Macfarlane, says 'What we bloodlessly call "place" is to young children a wild compound of dream, spell and substance: a place is somewhere they are always *in*, never *on'*.[182] Inhabiting rather than occupying implies active involvement. Recognising the fungal habitat of soil as alive and having agency acknowledges fungi as *in*-habitants.

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[181] Ingold, *Being Alive*, 71.

[182] Macfarlane, *Landmarks*, 315.

Further to the material definitions of soil and dirt, they are also richly symbolic, associated with all that is undesirable, unclean, unknown and uncontrollable. In her influential book *Purity and Danger*, anthropologist Mary Douglas explores the symbolic systems of societal understandings of purity and dirt, famously defining dirt as 'matter out of place'.[183] Such impurities are anomalies that defy the boundaries of social systems that strive for order. Symbolic of impurity, darkness and inertia, dirt is undesirable as are its inhabitants. Montgomery also describes the topsoil that gets blown, washed or otherwise removed from agricultural landscapes as soil out of place, as dirt. Dirt is displaced, anonymous and devoid of history – as mud on the carpet, spots on my camera sensor and the vast quantities of dirt displaced by agriculture and mining. Dirt is what we call the stuff that exists in places we would rather it did not. The very act of displacement is why soils are so often regarded as dirt, as inert, rather than as vibrant living systems.

Children know that dirt is animate, that it has vital materiality, to use the term of political theorist, Jane Bennett. Perhaps being in closer proximity to the ground and with less distracted minds, they notice the myriad lives scurrying and scuttling in intimate association with soil. The vitality of matter needs human concern, because, says Bennett 'the image of dead or thoroughly instrumentalized matter feeds human hubris and our earth-destroying fantasies of conquest and consumption'.[184] This way of thinking hinders the detecting and sensing of environments that fungi create and sustain. Only when soil is not considered as an inert substratum, devoid of life, might fungi be regarded. It is impossible to over-exaggerate human reliance on soil. Humans have grasped their dependence on air and water, but soil still proves more challenging. Hopefully we might soon catch on because on a global scale, it is running out.[185]

In June 2013 I bounced along in a Landcruiser through the forested foothills of the Victorian Alps with a couple of fire officers from the then Department of Primary Industry. We passed what was once a familiar damp and ferny dell that previously flourished with fungi. Now bulldozed to make a fire track, it was reduced to mounds of dirt and broken tree roots. However, within days of the disturbance, dozens of pure white cylindrical *Coprinus comatus* sporebodies pushed through the dislodged soil, trying to stabilise it, put it back in place, like a fungal version of the State Emergency

[183] Douglas, *Purity and Danger*, 2, 36.
[184] Bennett, *Vibrant Matter*, ix.
[185] Montgomery, *Dirt: The Erosion of Civilisations*, 3.

Service. *Coprinus comatus* is commonly known as a Lawyer's Wig – a bush court for environmental justice perhaps?

Litter and literacy

Fungi live in soils and also in litter. Litter is the organic layer of dead plant material and the tiny bodies of invertebrates that accumulate on and in soil and through decomposition, become soil. It is the living dynamic interface between the soil depths and the atmosphere. In early autumn 2012, as the mist peeled off the back of the semi-circular spur of Mount Stapylton in Victoria's Grampian Ranges, Swiss photographer Valérie Chételat and I headed for the summit. In the pre-dawn we heard the dull percussive thump of kangaroos as they moved through the bush and the morning swell of birdsong. With the first light, I glanced into the undergrowth of what is usually the drier end of the range and was surprised to see an accumulating layer of leaf litter and hence, the promise of fungi. Casually commenting on this unexpected observation, I noticed Valérie's eyes following mine, peering into the bush, a perplexed expression on her face. 'But why is it good?' she asked, prompting me into a long explanation of the decompositional processes of fungi. 'But what's any of that got to do with litter?' she insisted. I then realised that she was looking for 'litter,' thinking that I was literally referring to rubbish, to human refuse. English was her fifth language, but a native English speaker might well have asked the same question. After explaining that litter also referred to the accumulation of organic matter, the negative connotation of the word, 'litter,' occurred to me – yet another unfortunate dysphemism that diminishes its value as one of the most diverse habitats on the planet. Although the Oxford English Dictionary states that it originates from old French *litiere*, or from Latin *lectus*, meaning *bed,* its use today is commonly associated with unwanted refuse. More recently, litter has also become known as 'fuel' in the anxious context of the Australian fire landscape. One might argue that it is just a matter of semantics. However, in the doublespeak of politics, it is easier to justify the removal or burning of something referred to as litter or fuel, than to acknowledge the destruction of vital habitat and killing of its inhabitants. Litter teems with a phenomenal diversity of creatures. Largely unknown and cryptic, they inhabit the cracks and crevices and caverns, hidden from view. Faunal diversity in litter is believed to be orders of magnitude greater than the more familiar aboveground habitats. In tropical forests, it rivals the biodiversity of coral reefs. Yet like soil, litter has been misappropriated by those who regard it of marginal interest, or worse, as a blight on tidiness.

Conceiving the complexity and diversity of litter requires studying it closely. Castlemaine illustrator Rachel Legge made detailed and long-term observations of a single Yellow Gum (*Eucalyptus leucoxylon*) and the menagerie that inhabited its small patch of leaf litter. She documented the intricate and complex relationships between organisms, including a great suite of fungi. Drawn in cross-section, her illustrations capture the above and belowground activities of organisms throughout their life cycles.[186] Rachel published her impressions in an award-winning book entitled *Leaf Litter* in 2010. In describing her experience and fascination with fungi, Rachel commented:

> Illustrating fungi can be quite tricky. Some live only a day; some shrivel and others double in size while I am attempting to paint them. Bird's nest fungi are my favourites. It's amazing how the tiny spore sacks jump out when the raindrops hit them. I sat in front of the same gum tree in all kinds of weather, sometimes sheltering under a piece of plastic, watching them change colour and form before my eyes.[187]

Retaining litter on the forest or garden floor keeps in moisture, protects tree roots, shelters fungi and supports life. Yet the standard rhetoric presents the stuff as a threat: a fire threat, a slipping-over threat and a threat to clogging the swimming pool filter. Like soil, trees disregard human efforts to contain them. Anyone who lives near a eucalypt knows that if you burn its protective litter layer, it simply drops more to compensate. 'Never underestimate the intelligence of a Gum Tree,' were the last words Western Victorian farmer Bill Alderman said to me just months before he died.

Disco in a cowpat

Sliding further down the scale of unappreciated habitats, excrement is even more maligned than soil and litter. Yet without the industry of fungi, bacteria and invertebrates, the world would be overrun in dung. Extracting my sodden notebook from my coat pocket, I tried to decipher a scrawl of notes, written with frozen fingers while descending Obersteinberg in the Swiss Bernese Alps. 'Disco in a cowpat' read like an error in translation, but it was in fact, an accurate interpretation. My notebook recorded an observation of tiny fungus sporebodies perched in the middle of a cowpat. Most dung-living or dung-loving (coprophilic) fungi belong to the phylum Ascomycota, affectionately known among fungal folk as ascos. My specimens belonged to the subclass Discomycetes, colloquially known as discos. Discos are among the more

[186] Rachel created the cross-sections by filling an old fish tank with soil and topping it with litter and its inhabitants and observing their behaviours.
[187] Rachel Legge, pers. comm., 31 Aug 2015.

conspicuous ascos often being brightly coloured and shaped like cups or saucers. Many live in cowpats and other herbivore dung, sometimes collectively resembling an ornately decorated birthday cake, or as mycologist Cecil Ingold noted, 'a forest of tiny fruit-bodies'.[188] Except for dung emanating from cows subjected to antibiotics and antifungals, it usually arrives ready-primed with bacteria and fungi. Added to this is the continual supply of countless spores drifting on currents that quickly colonise the newly created habitat, along with those creatures that fly in to assist in the dung deconstruction mission.[189] Fungi flourish in fertile habitats and dung offers one of the most nutritional of all. Along with the masticated remains of ingested herbage, dung contains an enriched elixir of bile pigments, red blood cell fragments and remnants of other waste products.[190] Invisible armies of microbes provide a supply of nitrogen many times higher than that found in wood and other fungal substrates. This combined with the acidity of dung make it highly attractive habitat for fungi. However, for many coprophilous fungi, not just any old dung will do. Some coprophilous fungi choose their dung carefully. Most coprophilous fungi opt for the dung of herbivores or omnivores because they prefer cellulose-containing substrates (as opposed to carnivore dung that is more often degraded by protein-preferring bacteria). Some fungi like their dung freshly supplied while others favour a more mature vintage. There are those that prefer horse to cow. Others opt only for that deposited by the natives, while others still are less specialist and live in soils and other matter as well as dung.[191] Because of Australia's unique native herbivore fauna – all of which must defecate – specialist and diverse habitat exists for coprophilous fungi that might occur nowhere else in the world.[192]

The dungscape is never constant, thronging with the steady arrival and departure of different fungi. Fungal succession in dung as in other habitats involves complex inter-relationships and interactions between living and non-living components.[193] The short life span of a cowpat allows one to witness a miniature ecosystem in succession on 'fast-forward' as different fungi exchange territory. Cowpats also accommodate

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[188] Ingold, *Dispersal in Fungi*, 138. Mycologist Nicholas Money, describes Cecil Ingold as one of the most influential mycologists of the twentieth century. Ingold's mycological research spanned more than 70 years. He died in 2010 at the age of 104. Money, "Obituary, Cecil Terence Ingold," 1025.

[189] Paine, "Fungi: The Rotten World About Us".

[190] Webster, "Presidential Address: Coprophilous Fungi," 168.

[191] Ascomycete genera such as *Ascobolus* and *Sporormiella* grow pretty much exclusively in dung. The basidiomycete genus *Coprinus* is probably the most familiar genus found inhabiting dung as suggested by its name, which means "living on dung," although other *Coprinus* also grow in wood or leaf litter. The genera *Psilocybe* and *Panaeolus* also have many species partial to dung. Bell, *Dung Fungi*, 12.

[192] Orchard, "Dung Hunters Wanted," 11.

[193] Bell, "Dung Fungi", 17.

armies of nematodes, swarms of slime moulds, uncountable bacteria and numerous spineless airborne creatures that flutter or clamber into the corroboree. Cowpat politics are highly volatile. Competition and cooperation occur on multiple levels, each species adopting its own strategies to gain control of the excremental enclave. And there appear to be few rules. Deep within cowpat labyrinths underhand activities transpire. Luckless nematodes fall prey to fungal strangulation, hopelessly ensnared in sticky nets, constrictive rings and glue traps.[194] In what is termed 'hyphal interference' some fungi attack the mycelium of fungal rivals, physically deactivating or dissolving it with powerful chemicals. *Coprinus* species are known to be especially antagonistic to other fungi that push in on their territory, ensuring their swift elimination. At the end of the cowpat fungal succession, *Coprinus* usually reigns supreme. The appearance of sporebodies on the dung surface however, does not necessarily represent the fungal succession occurring within. While *Coprinus* sporebodies usually appear late within the process, their spores are often present before the cowpat was deposited. Hidden within the dung, the spores germinate, produce mycelia, which meet with other vegetatively compatible mycelia, anastomose and permeate the entire cowpat as a single mycelium.[195] Hence, the succession of visible sporebodies on the surface of the cowpat is unlikely to represent the full range of fungal succession going on in its decompositional depths.[196]

In his presidential address to the British Mycological Society in 1970, mycologist John Webster advocated the merits of dung as a study medium, recommending that for beginners 'wishing to make a serious study of fungi, there is no better instruction than to follow the sequence of fungi, which appear when fresh dung is incubated in a glass dish placed near a window'.[197] Despite Webster's enthusiasm, few people who attend my fungal ecology workshops are drawn to coprophilous fungi, even when given the opportunity to handle specimens and examine their intricacies with a magnifier. Mallee farmer, Ethel Anderson, was an exception. In her eighth decade, Ethel was keen to make unexpected new discoveries commenting: 'Well I never imagined such an exquisitely beautiful thing could exist on a wallaby dropping!'[198] Gary Fine suggests that 'the repulsiveness of dung gives pungency to the encomiums to

[194] These are mycelial adaptations of "nematocidal" fungi used to hunt their prey.
[195] Kendrick, *The Fifth Kingdom*, 182.
[196] Lepp, "Dung Fungi".
[197] Webster, "Presidential Address: Coprophilous Fungi," 161.
[198] Ethel Anderson, comment in workshop, Swan Hill, Victoria 1 May 2013.

these [coprophilic] mushrooms'.[199] However, the dearth of mycologists let alone coprophilic fungal experts in Australia suggests Webster's commendable recommendations might still take time to catch on.

Dirt, litter and dung are not popular habitats. In her concept of *Dirt Theory*, ecocritic Heather Sullivan contends that interconnectedness with dirt is usually despised rather than desired. She posits that 'efforts to conceal "dirt" in its many forms have encouraged urban residents to believe that dirty nature is something far away and disconnected from themselves and their bodies'.[200] Moreover, those fungi that opt for human bodies as their substrate of choice commonly flourish in armpits, toenails and genitals, personalising human discomfort with their habitats.

A cargo of the uncanny – habitat specificity

One unseasonally balmy evening in October 2014, Silvia Feusi of the *Verein für Pilzkunde Biel and Umgebung* (Mycological Society of Biel and Surrounds, Switzerland) burst through the meeting room door. Like a covert drug dealer, she then extracted something wrapped in foil from her coat pocket. 'I've got a surprise for you,' she beamed, unfolding the foil to reveal a chestnut husk.[201] Pricking my fingers on its spines and trying not to swear or drop it, I examined it with my lupe. On the inner lining of the husk a tiny colony of *Lanzia echinophila* discs huddled together under a protective mantle of spines, each sporting a tiny stipe. They stood a mere three millimetres tall. I wondered about their interesting choice of habitat, chestnut husks being the only place they grow. What are the implications for a fungus with such a restricted habitat? How did this fungus come to grow only in this one very specialist place? Contemplating this modest habitat emphasises the striking richness of fungi. If almost every plant hosts a different fungus, or several different fungi, the great diversity of fungi becomes apparent. However, when the different parts of every plant host different fungi, then the enormity of fungal diversity magnifies exponentially.

Earlier in the day, while crawling beneath a Scots Pine (*Pinus silvestris*) in the Swiss Jura, I noticed that many of the pinecones strewn around me bore a kidney-shaped fungal periscope. Inspecting the tiny fungi more closely I felt their bristly stipes and saw that they attached laterally rather than centrally to their caps. Beneath each cap hung long spines. *Auriscalpium vulgare*, also unattractively known as the Earpick

[199] Fine, *Morel Tales*, 74.
[200] Sullivan, "Dirt Theory," 15.
[201] Silvia Feusi, informal conversation with the author, Bienne, Switzerland, 15 September 2014.

Fungus, was first described by Linnaeus in 1753 as *Hydnum auriscalpium*, before being reclassified by British botanist Samuel Gray as *A. vulgare* in 1821. Once one develops a search image to detect these inconspicuous sporebodies, its relative abundance and choice of pinecone habitat become apparent. The story of *Auriscalpium* in Australia is very different. On an overcast winter's day in early July 2005 near the Central Victorian town of Blackwood, members of the Field Naturalists Club of Victoria spied a strange fungus growing on the side of a Narrow-Leaf Peppermint Gum (*Eucalyptus radiata*). Given the presence of other more distinct and colourful species, the tiny rather drab-coloured specimens almost went unnoticed.[202] In many years combing Victoria's forests and woodlands for fungi, the naturalists had encountered a great range of curious forms, but this was one of the more perplexing. What they had discovered was possibly Australia's most rare fungus. However, as field naturalist Jurrie Hubregste recalled,

> the rarity of this fungus was recognised only after a few years of investigation. There was no Eureka event. If it had been a small unidentified agaric on the side of the tree most likely it would have gone unrecorded, since we come across a lot of fungi we cannot identify.[203]

The consensus was that it might be an *Auriscalpium* owing to its similarity to the aforementioned Northern Hemisphere species *A. vulgare*.[204]

Specimens were sent to mycologist Tom May at the Melbourne herbarium who confirmed it was an *Auriscalpium* by DNA analysis. It had never before been recorded in Australia. The field naturalists return to the tree each year to discover it has survived the threats posed by fire, logging and mining. But despite intensive searching, it has only ever been found on this one tree.[205] Why does it grow on this tree and does it only grow on this tree? How many other unnamed species exist on a single tree or marginal habitat – or cease to exist – without anyone ever knowing?

Other *Auriscalpium* grow in Australia. *Auriscalpium barbatum* was found in the Fitzgerald River National Park in Southwestern Australia in 1977 and more recently from the Paganoni Swamp by mycologist Roger Hilton.[206] In 1978 Dutch mycologist Rudolph Maas Geesteranus described Hilton's specimen as a new species, noting its close relatedness to *A. vulgare* owing to the similar hyphal structure of its spines.[207] Another species with the field name of *Auriscalpium* sp. 'Warrensis,' was found by

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[202] Pat Grey, pers. comm., 11 October 2014; Grey and Grey, "*Auriscalpium* sp. 'Blackwood'".
[203] Jurrie Hubregste, pers. comm., 15 Oct 2014.
[204] Ibid. This important find was recorded as: "*Auriscalpium* sp. 'Blackwood'. On *Eucalyptus radiata*; cap 7 mm, brown, spiky white hairs near stem; spines seem long 1-2 mm, longest towards stem attachment, pointed, white, run back down very short stem; stipe 3 mm, lateral, dark brown".
[205] Grey, "Have You Seen an *Auriscalpium* Species Like This?," 4.
[206] Maas, "Notes on Hydnums," 493.
[207] Mycobank, "Fungal Databases."

mycologists David Ratkowsky and Genevieve Gates near Warra in Tasmania in 2007 and an undescribed species was found in Bunyip State Park, Victoria.[208] However, each of these differ from *Auriscalpium* sp. 'Blackwood' in that they grow on the ground in decaying litter and have central stipes. The Australian *Auriscalpium* species await naming and describing, joining the long queue of fungi waiting to be assigned an 'official' identity.

The distribution of species is linked to endless interactions between geological, ecological, climatic and cultural influences. Within a continent, Tom May found that most larger fungi appear to be widespread with little evidence of short-range endemic species in Australia.[209] However, those species that are symbionts or parasites are affected by the distribution of their hosts.[210] As knowledge of fungus distribution grows along with that of their hosts, better predictions can be made about occurrences. The Beech Orange, *Cyttaria gunnii* has a limited distribution within Australia and New Zealand, restricted by the whereabouts of its host, the tree genus, *Nothofagus*.[211] Similarly, the genus *Banksiamyces* is restricted to *Banksia* cones in Australia. The Vegetable Caterpillar, *Cordyceps gunnii* parasitises the larvae of moths of the genus *Oxycanus* in Australia and New Zealand.[212] Such species are key in elucidating the past and present mycogeography of Australasian fungi. As the number of collections increases, species distributions are mapped and herbarium collections re-examined, the bigger picture of Australia's hidden mycota begins to emerge.

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While some fungi grow in obscure habitats, fungi are more commonly encountered in the bush, forests and woodlands. Such environments offer a great variety of hosts and partners, substrates and habitats, conditions and microclimates, in which fungi thrive. One of the most important and rapidly vanishing fungal habitats is that of old wood.

A tree that is dead is commonly called 'dead wood'. However, dead wood is a pleonasm as wood (the dead cells of secondary xylem) is by its nature, dead. People who are unproductive in the work place are also referred to as dead wood. Inappropriate

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[208] David Ratkowsky, pers. comm., 19 October 2014.
[209] May, "Short Range Endemics," 501, 506. Very few short range species were recorded in West Australia.
[210] Horak, "Mycogeography," 1.
[211] Korf, "*Cyttaria* (Cyttariales)," 77.
[212] Lepp, "Mycogeography within Australia;" Lepp, "Mycogeography: Australia and Nearby".

use of the idiom reflects poor understanding of 'dead wood' or simply, old wood, as highly productive in ecosystems. To be dead, in the case of wood in a forest or woodland, is not to be redundant. 'Dead wood' forms the major core of a large living tree and a forest's excess energy is stored within its dead components.[213] Whether a dead tree remains standing as a stag or falls to the ground, it will be slowly dismantled by fungi and other organisms through a series of mechanical, biological, chemical and often cultural processes. Gradually it becomes soil, releasing nutrients for living trees and perpetuating forest regeneration.[214]

While searching for fungi in the *End der Welt* forest, fungus enthusiasts Christian Merz, Barbara Thüler and I watched a woodpecker at work on a conifer stag. Darting among the bracket fungi and lichens, between holes drilled by beetles, glistening trails of slugs and processions of ants, it tapped its way up the tree. This kinetic sculpture of burls and contortions, stubbled with moss setae and draped in liverworts, was constantly transformed by the actions of unseen armies of organisms. The tree also bore a fluorescent pink cross, the forester's death knell. I watched Christian as he etched away at the bark in attempt to remove the cross, but his efforts were in vain. A week later the stag was gone. Felled. Riddled with the tunnels of creatures and structurally weakened by fungi, its wood was economically worthless. Its unacknowledged value was in the unimaginable biodiversity it supported. This 'dead tree' was a functioning ecosystem of interactivity, vital to forest processes, yet 'tidy forests,' Christian assured me, are more highly valued. Although such wood rarely figures in economic assessments of forests, maintaining wood of all ages is vital to the functioning of all woody ecosystems. Humans obsessed with tidying up forests and gardens remove not just 'dead wood,' 'fuel' or 'litter,' but also the habitats of specialist fungi and their kin.

Dis-places

Fungi can be 'out of place,' as can the substrates they colonise. The ubiquitous woodchip has highly effective vectors such as the hardware chain, Bunnings Warehouse. The Australian obsession with spreading woodchips in gardens and beneath playground equipment has also created new environments for some fungi, having destroyed the original environment of a greater range of other fungi that prefer their habitats not minced into evenly-sized pieces. Few people have probably heard of (or can

[213] Maser, Claridge and Trappe, *Trees, Truffles and Beasts*, 4.
[214] Ibid., 8.

pronounce) the tiny Central Victorian settlement of Korweinguboora. While it is usually the surrounding forests that offer interesting fungi, it was among the woodchips of the children's playground at the local recreation reserve that fungi feasted on newfound fare. Hundreds of sporebodies of *Psilocybe subaeruginosa* had sprung up beneath the play equipment, their spores presumably having blown in from nearby native bush. Known colloquially as Golden Tops or Blue Meanies, these fungi contain the mind-altering psychotrophic compounds, psilocybin and psilocin. They are highly sought after by local folk but usually those of an age who have moved on from playgrounds to higher adventures.

The place of fungi can be dichotomised as native or exotic. Generally, native biota are those that are considered as belonging to a local place, while exotic biota originate from elsewhere. An island nation attunes more acutely to the native-exotic binary relative to a continent of countries demarcated by political boundaries, where ideas about species' origins do not exist in quite the same way. Unlike displaced flora and fauna that are referred to as ferals, pests, weeds, exotics, noxious organisms and invasives, equivalent references to displaced macrofungi, to fungal *weeds*, are only slowly emerging. While pathogenic microfungi are described with negative terms like *blight* or *pestilence*, such terms do not differentiate their origins. Given the knowledge of Australian fungus distribution is relatively recent, it is unsurprising that awareness of fungal origins is less developed than that of flora and fauna. Different cultural histories also shape perceptions of the same fungus species in different places. Australia's Pine plantations draw foragers of European background who value familiar edible Northern Hemisphere fungi that arrived with the trees via their symbiotic associations. These *dis-placed* mushrooms offer foragers an opportunity to re-territorialise place by realigning cultural traditions from elsewhere. The small band of Australians who forage for fungi rarely do so in native bush, but also collect 'foreign fungi' from Pine plantations, as greater knowledge exists about the edibility of European fungi than Australian species. Yet the places they grow, exotic Pine forests, are often poorly regarded. Pine plantations are not *real bush*. They are production forests existing for the sole purpose of providing wood. They are also seen as 'fire weeds'. The Pine plantations to the north-west of the Victorian town of Macedon have become an uninviting sump of refuse and disregard. Commercial mushroom pickers from Melbourne, local residents and migrant mushroomers ride a volatile merry-go-round of accusations of blame for the polluted plantations. The forest is obviously valued for more than its harvested wood. Environmental and forestry managers juggle the divergent significances of different interest groups. Such novel environments confound ideas about the 'place of fungi' as well as the native-exotic binary and this is explored further in chapter five. These ideological debates around place and conservation made me wonder how Europeans historically regarded Australia's native fungus cargo, especially those that go underground.

Retreating underground

Because of its ancientness, Australia was regarded by early European taxonomists as 'a place of refuge for mediaeval types' with 'missing links,' primitive creatures and 'curiosities,' where the 'development of the natural creatures had stalled'.[215] This 'vast museum of relics and fossils' was considered impoverished and degenerative, stranded in time.[216] Historians Tom Griffiths and Libby Robin describe how some Eurocentric taxonomic thinking of the early 1900s was fixated with the notion of 'primitive' species. Australia's ark of primitive curiosities was in turn used to justify its civilising with more 'advanced' creatures from elsewhere, by 'subverting the natural order, making it anew, acclimatizing imported species, destroying indigenous nature, sponsoring aggressive biological imperialism'.[217] To unearth a truffle (or perhaps to chance upon one kicked up by a lyrebird) and take it in your hand, to inhale its dank muskiness and ponder its amorphous form, ideas of being 'progressive' or 'advanced' might not immediately spring to mind. But looks are deceiving. As are odours. Despite the appearance of the smelly dirty lump in your hand, Australia is home to some thoroughly modern mushrooms.

'Are there mushrooms in Australia?' asked a young French woman during a field foray at Mt Mussy in the French Franche-Comté.[218] It was a genuine question. It reminded me how mushrooms are so intrinsically linked with Europe and European cultures – especially those of the French. What was the place of her imagined Australia that failed to harbour mushrooms? Fungi are commonly connected with wetness; with the dampness of forests, mossy dells and misty fields. Australia is perhaps perceived by some as only hot and dry and sandy, somewhere devoid of fungi. Yet it is these extreme conditions that catalyse their speciation and enable the Black Powderpuff to stand unflaggingly in the blistering midday sun. Among the world's most 'advanced' fungi are the hypogeous fungi that produce underground frutibodies. Truffle expert, Jim

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[215] Robin "Emu," 252.
[216] Griffiths, *Hunters and Collectors*, 12.
[217] Ibid., 12; Robin "Emu," 252.
[218] Foray participant in informal discussion with the author, Mont Mussy, France, 14 September 2014.

Trappe estimates between two and three thousand truffle species exist in Australia, compared to about three hundred in Europe.[219] High levels of endemism at both generic and species levels suggest Australia is an evolutionary centre for these subterranean fungi.[220] Australian fungi have been adapting to extreme habitats and unpredictable climate for a long time. The idea of 'progressive intermediacy,' rather than of primitiveness, is perhaps best exemplified by hypogeous fungi. Many straddle an evolutionary transition between above-ground and below-ground existences. A cross-section through, for example, a *Hydnangium* reveals a curious form, mid-way between a cap-and-stipe style agaric and a truffle-like fungus. These fungi abandoned the agaric form, opting instead for a subterranean existence. Because its cap will never expand, this odd organism's vestigial lamellae appear crumpled and anastomosed. Tucked in among them is a stub of a stipe, or at least a remnant column of tissue that resembles one, that will never push above the soil surface and support the umbrella-form of an agaric. Why did these fungi go underground? It is thought most agaric families across the globe arrive at the same evolutionary solution to environmental extremes by retreating to the safety of the subterrain. They are also thought to be the more recent forms in fungal evolutionary history.

An underground existence, removed from the spore-dispersal power of wind and the loss of functional lamellae presented another evolutionary hurdle – how to reproduce. The solution was to entice something – usually a mammal with a good sense of smell – to locate, unearth, ingest and unwittingly disperse their spores. Problem solved. That is, until another mammal, *Homo sapiens*, also discovered it had a penchant for these funky fungi. Truffles have been used by humans for several millennia as seen in the writings of Theophrastus, Pliny the Elder and Dioscorides and even appeared in the first known European cookbook, *Apicus* in AD 400.[221] Unwritten records of human use of truffles by Aboriginal Australians probably extend back even further. However, Aboriginal use of fungi is virtually undocumented with only scant references to truffles and the species sought. Lepp notes that the truffles *Elderia arenivaga* and *Mycoclelandia bulundari* were (and still are) both widely consumed.[222] Arpad Kalotas documents seven species of fungi used by Aboriginal Australians as food including the

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[219] Trappe, "Why Earth Needs Truffles".
[220] Lepp, "Truffle-like Fungi in Australia".
[221] China Truffles, "Truffle Timeline".
[222] *Elderia arenivaga* was the first Australian desert truffle recorded in 1891 as part of the Elder Scientific Exploration Expedition. Lepp, "Desert Truffles".

two mentioned above.[223] Trappe and colleagues' ethnomycological research of the use of desert truffles by central desert Aboriginal Australians includes a painting, *Tjintipanta* (which means 'bush truffles') by Aboriginal artist Betsy Napangardi, depicting women collecting truffles.[224] Despite their hidden existence, truffles are among the better-known fungi in Australia. Coupled with the high diversity of Australian truffles, their consumption by endangered mammals such as bettongs and potoroos has stimulated taxonomic research on the fungi.

While little is known of possible changes to Australian truffle distribution and abundance, in Europe, truffle numbers are declining due to social and climate changes.[225] Mycologist Simon Egli linked a continuous decline of the Périgord truffle (*Tuber melanosporum)* with long-term Mediterranean summer drying.[226] European Australians have in recent decades also caught on to the obsession for European truffles, as the commercial truffle growing industry burgeons in the Southern Hemisphere. What happens when the place of truffle fungi disappears in Europe, and is re-created in Australia? While Australian *Homo sapiens* might revere European truffles, the native truffles that thrive with Australian eucalypts might be less willing to share territory with foreign truffles. In discussing the complexities and ambiguities inherent in ideas about native and exotic, environmental historian Harriet Ritvo notes how the reciprocal resonance of these categories has intensified.[227] Ideas about place and their native and exotic fungal inhabitants become ever more convoluted and expose the diminishing meaning of these terms in novel ecosystems. To talk about fungi requires an adequate language and that is the focus of the next chapter.

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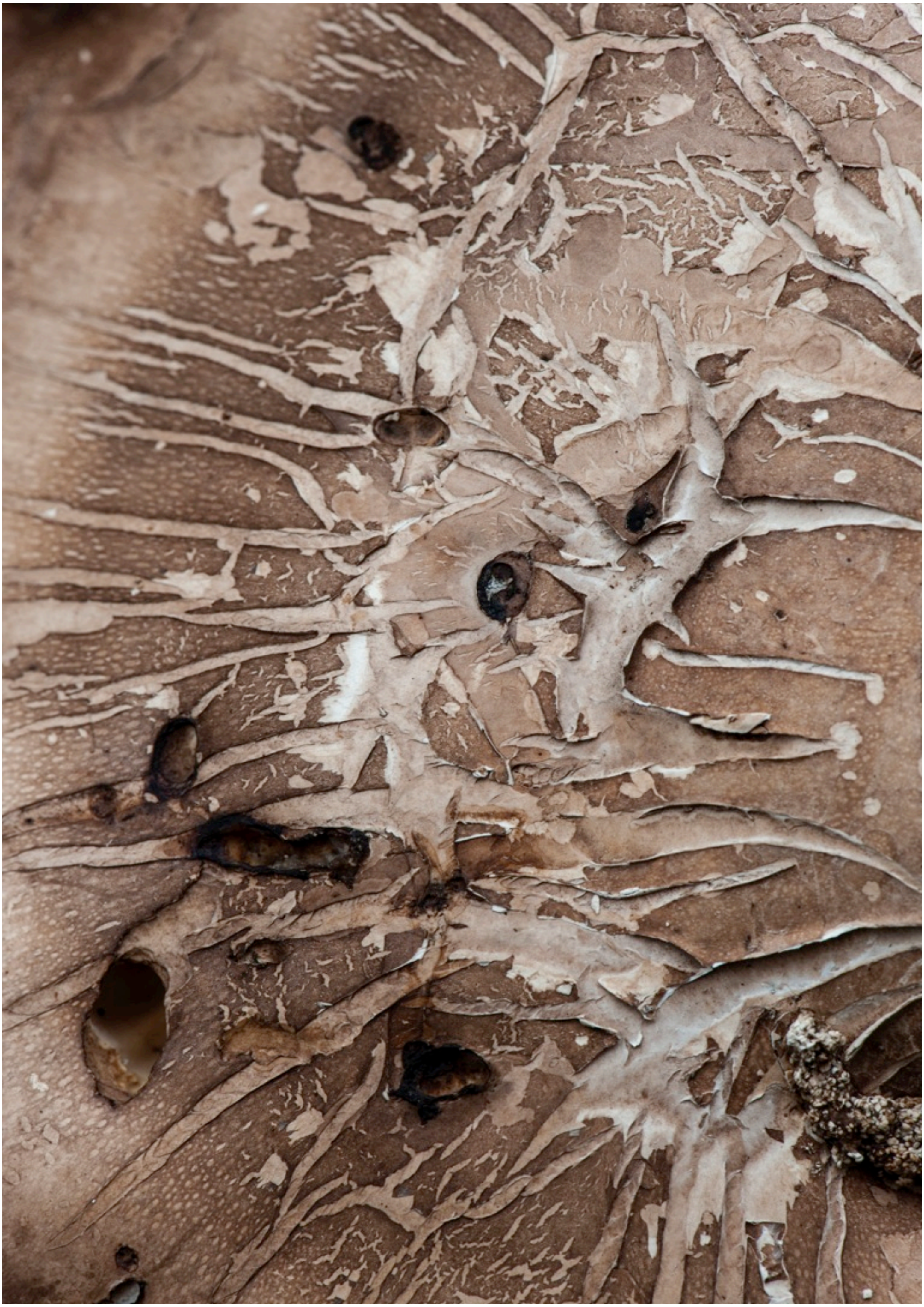
[223] Kalotas, "Aboriginal Knowledge and Use of Fungi," 272.
[224] Trappe et al., "Desert Truffles of the Australian Outback," 497.
[225] Stephenson, *The Kingdom Fungi*, 91.
[226] Büntgen et al., "Drought-Induced Decline," 827.
[227] Ritvo, "Lunchtime Colloquium".

Fungal grub and fungal havens

Fungi provide food and shelter for a host of largely unseen inhabitants. Mostly, we detect just their vestiges – carved, burrowed and slid through these acquiescent life-forms.

Mycophagous molluscs feast on fungal fare and like humans, carefully select for ripeness. Springtails tuck themselves in between lamellae. Flies deposit eggs in fungal nurseries. Bandicoots, wallabies, bettongs and woylies burrow for tasty truffles when no-one is watching.



chapter four

Speaking for fungi

A stubbly bun skirmish

'*Semmelstoppelpilze*!' exclaimed Barbara dropping to her knees and gently parting the beech leaves on the forest floor.

'Ah *Hydnum repandum*,' I responded, spying the buff-coloured caps.

'Yeah maybe, but that doesn't mean much to me,' Barbara shrugged, expertly slicing them away with her knife. As the mushrooms tumbled into her cloth bag, I wondered how we might each relate to this species in the contexts of different cultures, languages and names with which we recognised it.

Swiss fungus enthusiast Barbara Thüler knows her fungi. Together we have roamed the mixed deciduous-conifer forests of the Jura mountain range since wet met a decade ago at the Lake District Mycological Society. Barbara names the fungi we find by their German or Swiss-German vernacular names. My knowledge is limited mostly to their scientific names. Barbara perplexes me as to how she keeps all the vernacular names in her head, given they seem to lack the systematic logic that for me, makes scientific names easier to remember. However, over the years we have nutted out the identity of the fungi we have encountered, as much for the cultural-linguistic curiosities of their names, as for their taxonomy.

Stepping over snaking tree roots we emerged from the chill of forest shadows into a clearing. Surreal forms of moss-covered karst loomed luminously green in the late afternoon light. Barbara told me she liked the vernacular names because of their cultural connections and imaginative nature. She finds *Semmelstoppelpilz* descriptive and endearing because it translates to 'little bread bun with a stubble'. The pale colouration and spines beneath the cap poignantly capture that description. The British know it as a Hedgehog or Wood Hedgehog and the latter appears in the Australian field guide, *Fungi Down Under*. While the modern approach of this guide maintains consistent naming within Anglophone realms, the British origins of this common name seem inappropriate in Australia given few Australians refer to the bush as a wood, nor are there hedgehogs. It is also a little misleading as some might interpret 'wood' to mean the substrate in which it grows, whereas in fact, it grows in soil. The fungus does not really resemble a hedgehog, and even less so an echidna, other than the fact that it has pointy projections beneath its cap, a feature also shared by several other genera. Known as *Pied de Mouton* in French, I am also yet to meet a sheep, even a French one, with feet that look like this fungus, further reflecting different cultural perceptions. Whether the hedgehog metaphor is apt or not, the association dates back to at least 1697 from an illustration by the Sicilian naturalist, Paulo Sylvius Boccone. The fungus depicted is captioned *Fungus erinaceus* and appears to be a species of the modern tooth fungus genus *Hericium*.[228] As Estonian-Australian mycologist Heino Lepp commented, pithy names become entrenched in people's minds and are hence retained in language.[229]

As usual, Barbara and I bantered over the value of scientific versus vernacular names. I explained how *Hydnum* is derived from the Greek noun *hudnon*, meaning truffle or spongy plant or fungus, while the species epithet means 'turned up,' referring to its irregular margin. But as the words came out of my mouth, I realised how they could also have described several other species encountered that day, and anyway, Barbara has already moved on to investigate a riot of sporebodies clustered around an old oak stump that was evidently more compelling than my explanation.[230]

German botanist Johann Dillenius first referred to the genus *Hydnum* as *Erinaceus* in 1719. A decade later, Micheli used it to include both *Hydnum* and *Phellodon*.[231] Since Linneaus first described *Hydnum repandum* in *Species Plantarum* in 1753, it has been shuffled between various genera before its current name was finally accepted in 1977.[232] Moreover, recent molecular work reveals an unstable taxonomy and the likely presence of cryptic species and hence the name might well change again. My arguments in favour of scientific names based on evolutionary relationships, a scientific nomenclatural standard and therefore consistency of naming, started to crumble. Early German field guides reveal the use of the vernacular name *Semmelstoppelpilz* at least since 1896 and prior to that it was known as *Stoppelpilz* at least since 1831.[233] Its vernacular name has therefore been more consistent than the names of its scientific counterparts within Germanic cultures. Whether we choose vernacular or scientific names, what matters most is that the species referred to is clear. After all, as sociologist Gary Fine contends, scientific names are also vernacular names,

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[228] Heino Lepp, pers. comm., 15 July 2015. *Ericius* is Latin for "hedgehog". Boccone's drawings in his 1767 publication "Museo Di Fisica Ed Esperienze" were apparently so accurate that species were identified from them by Fries and others. Institute for Environmental Protection and Research, "History of Italian Mycology," 51. There is a modern species called *Hericium erinaceus* and *Erinaceus* is also the generic name for hedgehog.
[229] Ibid.
[230] Barbara Thüler, informal conversation with the author, *End der Welt*, Switzerland, 7 September 2014.
[231] Heino Lepp, pers. comm., 15 July 2015.
[232] Petersen, "The Typification of *Hydnum*," 144-6.
[233] Heino Lepp, pers. comm., 1 June 2015. Information from Krombolz, "Naturgetreue Abbildungen und Beschreibungen," 351-352. Other fungi we found that day with vernacular names in longer consistent use than scientific names were the *Grüner Knollenblätterpilz* (*Amanita phalloides*), the *Gemeine Strubbelkopfröhrling* (*Strobilomyces strobilaceus*) and *Hallimasch* (*Armillaria mellea*).

created by a scientific community.[234] These shared experiences with Barbara during our circumambulatory ramblings of the forest revealed the significance of language in creating context and meaning and being able to communicate across the divides of culture, language and different forms of knowledge. The vernacular names I have learnt for fungi that I previously knew only by scientific names, provide a revelatory glimpse into another culture's perceptions of these organisms. They also allow richer ways to contemplate a familiar species through new perspectives and contexts. Differences among names are often subtle, as metaphors for fungi with conspicuous features commonly bridge languages.[235] Scientific and vernacular names are explored further in the context of their historical development and use by different people in chapter six.

Language greatly colours the way life is perceived. This chapter explores how the use of language influences perceptions and conceptual and social knowledge of fungi.[236] Where do fungi sit in the English language? How are fungal words used, confused, misused and abused? I examine how the choice of words and expressions affect the way fungi are perceived, understood and valued in different contexts over time.

Mushrooming from shady obscurity

'In the English language the very word *fungi* is an ugly, half-assimilated alien, detached and cold in its emotional personality,' said Valentina Pavlovna Wasson doggedly conveying her disdain.[237] In reference to toadstools she says, 'with this single word *toadstool*, soaked in condescension and repugnance, the English-speaking world lumps together and dismisses without a second glance some of the richest and most varied embroidery doing honor to wild nature's glorious vesture'.[238] Not all people respond to these words as viscerally as Wasson, but a look at the synonyms for fungi in the English language reveals why many indeed might.

Fungi have been corrupted by centuries of negative associations, both literally and symbolically in the English language. The first listing for the keyword 'mushroom' in the National Library of Australia catalogue is *Mushroom: The Story of the A-bomb*

[234] Fine, *Morel Tales*, 62.
[235] Hladký, *The Czech and the English Names of Mushrooms*, 65.
[236] I refer to Steven Pinker's definition of conceptual knowledge as that which provides the meaning of words and their relationships, and social knowledge as how language is used and interpreted in social contexts. Pinker, "An Adaptation to the Cognitive Niche," 21.
[237] Wasson and Wasson, *Mushrooms, Russia and History*, 17. Italics original.
[238] Ibid., 18.

Kid.[239] The menacing image of the pyrocumulus mushroom-shaped cloud emanating from volcanic eruptions and most impressionably, nuclear explosions, instills fear and dread. The resultant deadly mushroom cloud from the American atomic bombing of Nagasaki and Hiroshima in 1945 is burnished in the memories and genes of its survivors. In Australia, those affected by the nuclear bombing of Maralinga by the British in 1956 still await radiation compensation. The mushroom cloud has become powerfully symbolic of these catastrophes and their injustices, and the allegorical use of 'mushroom' as a verb is often highly stigmatised. While good ideas, the economy and love relationships are described with positive botanical references being said to bud, blossom and bloom, what are perceived as the societal scourges of crime, communism, spies, scandals, shanty towns, pornography, brothels, adult video stores, bigotry, xenophobia, racism, gambling, munitions, foreigners, street clashes and even potholes, are all said to 'mushroom'.[240] 'Mushroom' is also used in a more general sense to depict rapid, sudden or unexpected growth. However, the following newspaper headlines and quotes reflect more troublesome notions of mushrooming:

> 'He hired gunmen . . . to intimidate any reform organisation which might protest about the mushroom growth of brothels' *Mirror* (Perth), 1956.[241]
>
> 'Bigotry, xenophobia, racism and ugly Muslim baiting are mushrooming,' *Conversation*, 2015.[242]
>
> 'Shanty towns are mushrooming on the fringes,' *Canberra Times*, 1994.[243]
>
> 'One of the biggest scandals in American history . . . centres around the wartime activities of the mysterious Garsson brothers, who mushroomed from shady obscurity into munition millionaires,' *World News*, 1946.[244]
>
> 'A disturbance at a Los Angeles high school mushroomed into street clashes between Negro crowds and police,' *Canberra Times,* 1967.[245]

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239 National Library of Australia Catalogue.
240 I was first alerted to this observation by Gould. Gould *Dinosaur in a Haystack*, 335.
241 "Greasy Thumbs Guzik," *Mirror* (Perth), Saturday 24 March 1956, 7.
242 Keane, John. "The European Madhouse." *Conversation*, Monday 29 June 2015. https://theconversation.com/the-european-madhouse-44033.
243 Mark Train, "Urban Renewal Banishes the Sleaze from Times Square, "*Canberra Times,* Thursday 13 January 1994, 8.
244 Herbert Gladstone, "Generals, Politicians in Big Munitions Scandal," *World News* (Sydney) Saturday 5 October 1946, 7.
245 "Negroes, Police Clash at School," *Canberra Times,* Saturday 21 October 1967, 5.

> 'Gambling – for decades the long-shot hope of countless poor Italians has in this postwar period mushroomed to proportions described recently by the Council of Ministers as preoccupying and grave,'[246] *Morning Bulletin*, 1946.

> 'A newly-created Bolshevik Party has mushroomed into existence in Burma, and has issued an unsigned manifesto,' *The Mercury*, 1949.[247]

Such negative associations of 'mushroom' as a verb do not appear in European languages such as German, French, Italian, Dutch, Swedish or Finnish. For example, French-American-Swiss Alison Bouvard, says of the French use of the equivalent word *champignon*: 'Champignon does have the same meaning as mushroom in the expression, *ville-champignon*, describing the fast-growing cities and suburbs, but it isn't as negative as the English use. It is associated more with shape and speedy growth than with poisonous fungi lurking in the shadows'.[248] Ecocritic Arnaud Barras concurs, adding '*pousser comme des champignons* (sprouting like mushrooms) generally means rapid growth . . . and usually entails feeling genuinely surprised at the development of something rather than a criticism of it'.[249] Interestingly, Barras adds that any negative use in French is probably an English corruption: 'In the twentieth-century, with the development of residential areas based on the American model of suburban homes, the negative connotations of the term *champignonner* or the phrase *pousser comme des champignons* have been transferred from English to French'.[250] Swedish mushroom enthusiast Gunilla Kärrfelt, says that in the Swedish language, '*växa upp som svampar ur marken* (to spring up like mushrooms out of the ground) does not carry a negative connotation and simply describes an abundance'.[251] Kärrfelt adds that to be a s*vampplockare* (mushroom picker) is perceived positively and politicians and personalities regularly claim to partake in this reputable pastime. In Finnish language the equivalent expression also means abundance with no negative connotations, says environmental social researcher, Minna Santaoja: '*kasvaa kuin sieniä sateella* means *to grow like mushrooms in the rain*. There is no negative tone in it, it just means that there is plenty of something'.[252] Landscape researcher Maunu Häyrynen, agrees although

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246 "Gambling 'Boom' in Italy," *Morning Bulletin* (Rockhampton), Saturday 25 May 1946, 5.
247 "Bolshevik Party in Burma," *Mercury,* Wednesday 2 March 1949, 2.
248 Alison Bouvard, pers. comm., 2 July 2015.
249 Arnaud Barras, pers. comm., 3 July 2015.
250 Ibid.
251 Gunilla Kärrfelt, pers. comm., 4 July 2015.
252 Minna Santaoja, pers. comm., 5 July 2015.

adds that there are derogatory synonyms for inedible mushrooms in areas in Finland where they are not eaten.[253]

How do negative fungal synonyms affect people's perceptions of fungi when they are presented with real fungi? During an environmental history workshop at the Australian National University in May 2014, I passed around a basket brimming with a variety of freshly picked sporebodies to a group of fifteen doctoral students. I then read out a group of synonyms for fungi that I had gathered from various freely available online thesauri. Some such as the 'Power Thesaurus' provided a rather non-sensical list of jumbled lifeforms including: alfalfa, moth, worm, ivy, kelp, pimple, viper and yam, making it difficult to draw any connection to fungi.[254] Others such as www.thesaurus.com lists synonyms for fungi including: affliction, bane, blot on the landscape, canker, contamination, corruption, curse, decay, dump, evil, eyesore, infestation, glop, goo, gunk, mildew, mud, muck, mire, mucus, ooze, pestilence, pollution, rot, scourge, scum, sludge, waste, withering and woe. Roget's Thesaurus gives the option to search synonyms for 'fungus' under the subheadings, 'plant,' 'dirt' or 'blight'.

I then simply asked the students if they considered there to be any discrepancy between their perceptions of the sporebodies in the basket and their synonyms. They responded with laughter, rolling of eyes and shaking of heads, conveying the general impression that the synonyms were incongruous. These synonyms have probably evolved from the combination of the effects of a relatively small selection of pathogenic microfungi supplemented by fertile imaginations. Yet all fungi within this vast and diverse kingdom are tarred with the same brush. Historical uses and associations of fungal words provided a good starting point to examine the evolution of fungal language.

From moushrimpes to mucerons

Words to describe fungi have long histories dating back almost two millennia although their precise etymologies are difficult to verify. British mycologist and scientific historian Geoffrey Ainsworth notes that English is unusual in using the international term 'fungi' for all fungi in general, compared with other languages (such as German and French) where a word that was originally used for some fungi, now refers to the

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[253] Maunu Häyrynen, pers. comm., 7 July 2015.

[254] Power Thesaurus, "Fungus Synonyms", accessed 13 May 2014, https://www.powerthesaurus.org/fungus/synonyms.

whole group.[255] During the nineteenth century the German word *Pilz* gradually replaced the word *Schwamm* for fungus. While *Pilz* is now the accepted form, German language linguist, Bruce Donaldson says variations of *Schwamm* are still widely used in Central West German and Upper German regions including Swabia, Alsace, Switzerland and Austria.[256]

Lepp documents the appearance of fungal words during the Mediaeval period noting that spellings and meanings change over time, place and between authors. Although many old accounts are too ambiguous to accurately determine which species were being described, over fifty authors documented fungi during this period.[257] Lepp considers that while various Mediaeval scholars mentioned fungi, they contributed little to their understanding, as the microscope had not yet been invented. While mycological understanding might have not progressed in this time, other forms of fungal knowledge were growing. However, even less is known about the accumulation of folk knowledge as most was probably oral (or occasionally depicted artistically). Moreover, the knowledge of fungi held by women was largely disregarded. Pier Antonio Micheli and Flemish botanist Carolus Clusius were exceptional in their incorporation of folk knowledge into mycological documentation. According to Lepp, their contribution resulted from the uncommon combination of mycological curiosity and residence in areas where fungi had long been used by knowledgeable local people who had a vernacular language for fungi.[258]

The development of medieval medicine, particularly during the eleventh century, saw fungi included in written texts. While the efficacy of the remedies and antidotes in surviving manuscripts is dubious, they satisfied consumers and practitioners for half a millennium in the absence of alternatives.[259] The Benedictine abbess and herbalist Hildegard von Bingen documented her observations of fungi in her encyclopaedic work on natural history *Liber Simplicis Medicinae* (the first of the nine-book *Physica*) written around 1155. Translator Bruce W. Hozaski suggests that her work documents actual observations rather than repetition of earlier writings based on

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[255] Ainsworth, *History of Mycology*, 2.
[256] Bruce Donaldson, pers. comm., 6 July 2015. The word *svamp* is used in Swedish.
[257] Lepp, "Snippets of Mycological History," 38. Note that some authors repeated the work of earlier authors. Determining the first true appearance of certain words is also difficult, as copyists could have inserted them at a later date.
[258] Heino Lepp, pers. comm, 15 July 2015.
[259] Black, "Forget Folk Remedies".

the likelihood of the species being local or growing within the convent grounds.[260] Von Bingen also used several words for fungi and differentiated those that grew in soil from those on trees, the former considered harmful and poisonous. Some of Bingen's writing on fungi still remains a mystery especially that on entheogenic fungi as she wrote about them in a code that has never been fully deciphered.[261] Other Medieval writers who documented fungi include the German Catholic Bishop and philosopher Albertus Magnus in his book, *De vegetabilus et plantis libri septem* published in 1250.[262] In translating from Latin, Lepp says that although Magnus held fungi in low regard (referring to them as 'excrescences of the earth') he did use the words *fungi* along with *Tuberes* and *boleti*. The German scholar Konrad von Megenberg (c. 1309-1374) also mentioned fungi in his compendium of various natural history themes called, *Buch der Natur*. He referred to fungi as *swammen* (later spelt *Schwammen*) with some advice on which to avoid.[263]

The word 'mushroom' also dates back centuries. Mycologist William Hay noted in 1887 that the word 'mushroom' is used generically for any of the larger fungi, 'in contradistinction only to those small though numerous forms that might similarly be broadly styled Moulds. Taken in this sense, the word "mushroom" is an equivalent for the French *Champignon*, or for the German *Pilze* and *Schwämme*'.[264] The exact origin of the word 'mushroom' is uncertain but probably has either Welsh or British origins evolving from *mushrumps* through various spellings to 'mushroom,' or, is a corruption of the French word *mousseron*.[265] Rolfe and Rolfe cite various early references to fungi from between 1440 and 1732 with spellings including *muscheron*, *moushrimpes*, *mushrumpes* and *mucerons*.[266] Mycologist Geoffrey Ainsworth also refers to the derivation from the old French word *moisseron*.[267] Various commentators over the centuries have drawn connections between *mousseron* and moss (*mousse* meaning moss

[260] von Bingen, *Hildegard's Healing Plants*," xi. Hozeski's statement is in reference to plants but is likely to also include fungi.
[261] Keizer, "Hildegard of Bingen," 95. Eight hundred years later, women's knowledge of fungi is still poorly acknowledged. Amateur mycologist Beatrix Potter also wrote in code.
[262] Suzuki and Grady, *Tree: A Life Story*, 42.
[263] Lepp, "Snippets of Mycological History," 46. Interestingly, *Pfifferlinge* is the German word for some chanterelles that are not only edible but highly sought after, but perhaps the name or the identification was confused, or as Lepp notes, had a broader meaning in earlier times including such species as the peppery *Lactarius* known to make some people ill.
[264] Hay, *Text-book of British Fungi*, 2-3. Hay cites the German plural forms although technically, the German equivalent of mushroom and champignon should read *Pilz* and *Schwamm*.
[265] Ibid., 6.
[266] Rolfe and Rolfe, *Romance of The Fungus World*, 295.
[267] Ainsworth, *History of Mycology*, 2.

in French and a habitat where fungi commonly grow). Ecologist Tony Baker proposed the less explored idea that its origins could be associated with the alternative meaning of *mousse* as sea-foam or spume, in concert with archaic ideas of fungi developing from glutinous froth or foam. He also links this association of fungi and sponges (*Schwamm* in German) noting that 'fungus' and 'sponge' share a common root, both of which were believed to be compacted forms of foam or froth.[268] In Australia, the word 'mushroom' often translates only to the Field Mushroom (*Agaricus campestris*) and its cultivated variety (*A. bisporus)*, which are the main species consumed. Botanist George Atkinson made the same observation of the narrow meaning of *mushroom* in English-speaking America in the nineteenth century.[269] As the edibility of 'the rest' was unknown, they were collectively known as toadstools.

Fungi, mushrooms, mushrumps and more. But what about toadstools?

Of toads and toadstools

'It is a striking instance of the confused popular notions of fungi in England that hardly any species have or ever had colloquial English names. They are all 'toadstools,' and therefore are thought unworthy of individual baptism,' said William Hay in 1887.[270] One hundred and thirty years later, Hay might be pleased to know of the progress of vernacular fungus names in the Anglophone world including Australia. However, 'toadstools' still remains an arbitrary category. During a foray among the giant Mannas and Messmates of Mt Macedon in autumn 2013, a forayer commented 'You mean there are mushrooms other than the white ones in Australia? I thought other mushrooms only grew in Europe and the rest of ours were all bad, just toadstools'. This comment might be a reflection that Australian field guides (unlike European ones) rarely denote edibility or toxicity, the feature that differentiates mushrooms and toadstools for many people. It also suggests unawareness of their significance beyond their food value to humans. The word 'toadstool' was first recorded in 1398 to mean any fungus, before narrowing in 1607 to refer specifically to poisonous fungi.[271] The words 'toad' and 'stool' existed independently before this, but where does the word 'toadstool' come from?

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[268] Baker, "Origins of the Word 'Mushroom'," 89.
[269] Atkinson, *Mushrooms: Edible, Poisonous*, iii.
[270] Hay, *Text-book of British Fungi*, 12.
[271] Hladký, *The Czech and the English Names of Mushrooms*, 104.

Disappointingly, none among the thousands of 'toadstool' images I have created sports a toad, as often portrayed in children's book illustrations. The amphibian subjects atop toadstools in the magical wonderland of the Internet appear to be suspiciously coerced or superimposed into position. The connection between toads and sporebodies is unlikely to reflect direct observations or ecological associations but rather, has probably spawned from imaginative folk histories of symbolic associations. Hay blamed Spenser, or 'some other poet' before him.[272] Mycologist John Ramsbottom suggested the connection simply derives from the shared quality of poisonousness.[273] Natural history writer Peter Marren, reinforces this idea noting that the toxin found in the skin glands of some toads has also been isolated from some fungi.[274] Baker proposes that the association between amphibians and fungi could have transpired from ancient beliefs going back to Pliny that both emanated from slime and mucoid matter.[275] In their efforts to unravel the origins of the word 'toadstool,' the Wassons discovered that the 'sinister mark of the toad' exists not just in English but in multiple languages. Not all languages refer to a 'toad*stool*,' but many include 'toad' in associations such as toad's skin, toad's hat and toad's cheese and all, purport the Wassons, 'exhale a bad odor'.[276] The association of toads and fungi also crosses continents to Africa, Asia and Central America.[277] Whatever the exact origin, all collectively resonate aversion towards both fungi and toads.

'Toad' is also a term of abuse in many languages, among the more famous insults being Shakespeare's, 'thou art like a toad; ugly and venomous' and Edgar's condemnation of Edmund in King Lear as a 'most Toad-spotted traitor'. It seems that frogs are less maligned, having been granted some reprieve in recent decades. This might stem from their value as environmental indicators, or concern over their demise resulting from chytridiomycosis.[278] Interestingly, early English references to toadstools referred to *Paddocstol* or *Padddockstole*, with *padok* or *paddok* being old Scottish

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[272] Hay, *Text-book of British Fungi*, 2-3, 6.
[273] Ramsbottom, "Mushrooms and Toadstools," 42.
[274] Marren, *Mushrooms*, 47.
[275] Baker, "Origins of the Word 'Mushroom'," 89.
[276] Wasson and Wasson, *Mushrooms, Russia and History*, 67.
[277] Morgan, "Who Put the Toad in the Toadstool?," 44.
[278] Chytridiomycosis is an infectious fungal disease of amphibians first discovered in Australia in 1993, caused by the aquatic fungal pathogen chytrid, *Batrachochytrium dendrobatidis*. It is known to affect over 300 amphibian species and has led to the dramatic population decline or extinction of 200 frog species worldwide. Laurance, McDonald and Speare, "Epidemic Disease," 406.

words for frogs, not toads, however, this taxonomic distinction is probably recent.[279] Although technically, toads are frogs, toads often evoke visceral reactions. The warty skin and stumpy bodies (being among the features that differentiate 'true frogs' from 'true toads') seem not to inspire human empathy.

Both toads and toadstools are frequently subjected to exaggerated hostility in Australia. The introduction of the cane toad (*Rhinella marina,* formerly *Bufo marinus*) to Northern Queensland in 1935 by sugarcane industry scientists as a biological control for the cane beetle, not only failed as a scientific experiment but subsequently exposed a darker undercurrent in Australian society. The toad's extreme toxicity to wildlife that consume it as prey (e.g. freshwater crocodiles, tiger snakes, goannas, quolls) coupled with its high dispersal success, prompted its listing as a key threatening process under the Environment Protection and Biodiversity Conservation Act, 1999. Animosity toward this displaced amphibian has manifested in cane toad 'busts' and 'musters' described as 'family activities,' melodramatised as 'the story of the brave Australian people battling a ruthless invader'.[280] 'Killing Toads is Great Fun for the Whole Family, Expert Says,' reads the headline of the *Whitsunday Coast Guardian*.[281] While fully acknowledging the severity of the toad's ecological impact, describing the killing of anything as a fun family activity might require a questioning of so-called expertise. The celebrated cane toad muster, in the words of historian of science, Libby Robin, 'confuses machismo with good outcomes for the natural world' through the convenient, if subconscious justification of cane toads providing 'something to hate together'.[282] This is perhaps not so far from the sport of kicking over toadstools. Toadstool stomping rarely attracts media attention, but the mentality appears to be similar. To my dismay, students studying Conservation and Land Management at a Western Victorian university revelled in this impromptu activity on a fungal ecology foray. The reckless destruction of sporebodies in a heritage Oak forest planted by pioneer forester John La Gerche over a century ago, suggests carnal responses eclipse environmental understanding. But this is evidently an old sport. Margaret Plues in her book *Rambles in Search of Flowerless Plants* published in 1865 noted,

> Men will acknowledge beauty in the tiniest moss, the most formless lichen, or even in coarse sea-wreck, and then peep into your basket of Fungi, varied in form, and of every brilliant hue,

[279] Rolfe and Rolfe, *Romance of The Fungus World*, 298. "Pad" is also found in the Dutch, Norwegian and Danish words for toadstool/mushroom.

[280] Lyons, "Cows with Guns".

[281] "Killing Toads is Great Fun for the Whole Family, Expert Says," *Whitsunday Coast Guardian*, 13 November 2012, http://www.whitsundaytimes.com.au/search/?tag=Toads&all-sites=on.

[282] Robin, "Domestication in a Post-Industrial World".

> and merely exclaim with disgust, "What a lot of toadstools!" Fungi are only accounted fit to be kicked over, hands are considered too good for them.[283]

Such activities are encouraged not just in the English-speaking world. Australian-Bosnian anthropologist Lejla Voloder described how in Bosnian language children are taught to step on wild mushrooms.[284] Hay says, 'By precept and example children are taught from earliest infancy to despise, loathe, and avoid all kinds of toadstools'.[285] Fortunately some children resist such indoctrination. Five year-old Angelica Elliot from chapter one inspires in her navigation of the tenuous relationship between awe and fear as she explores the forest and its fungi with daring and imagination.

Articulating fungi

Armillaria luteobubalina. Say it slowly. Twelve syllables. I remember the shape and feel of this name in my mouth as a child. It was more than a name, but a rhyme with a lyrical and entrancing rhythm. An inherent poetry. It was probably the longest name that had ever left my lips. It was also brand new, only being scientifically described in 1978 and depicted by botanical artist Celia Rosser on the fifty-five cent postage stamp in 1981. Names enchant a fungus. Acquiring a name, identity and a place, both in reality and in my imagination, increased its spell. As David Attenborough said on his eighty-ninth birthday in a conversation with Barack Obama 'I've never met a five year old who's *not* interested in natural history . . . so the question is, how did you lose it, how did anyone lose the interest in nature?'[286]

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'What did you say?' asked Georges Meyer, the president of the Lake District Mycological Society, Switzerland.

'*Psilocybe,*' I repeated.

'What?' asked Georges.

'*Psilocybe,*' I replied, as slowly and as articulately as I could.

'What?' asked Georges, impatiently screwing up his face.

'*Psilocybe,*' I said for the fourth time, realising that our *Misverstandnis* was a matter of my pronunciation.

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[283] Plues, *Rambles*, 240.
[284] Lejla Voloder, pers. comm., 2 July 2015.
[285] Hay, *Text-book of British Fungi*, 6.
[286] ABC News, "Barack Obama and David Attenborough".

I flipped open my field guide and pointed to an illustration of the fungus. Georges looked at me exasperatedly and replied, ‘Well, that’s *Psilocybe*!’[287]

The ways in which the language of fungi is spoken and pronounced influences perceptions of these organisms. Given fungal knowledge and lore are largely oral, accessibility depends on how their names are heard. Variations in English pronunciation of the genus *Psilocybe* cause great confusion as I experienced with Georges. *Psilocybe* originates from Greek and has two distinct components: ‘psilo’ meaning ‘bare, smooth or uncovered’ and ‘cybe’ meaning ‘head,’ referring to the nature of the sporebody pileus.[288] Australians pronounce *Psilocybe* in multiple ways (for example, sill-oss-o-bee, silo-cy-bee, silo-sibe and sill-o-cybe), all varying from the single pronunciation, p-sill-o-see-be, spoken by Georges and heard throughout Germanic Europe. While spoken German language is often referred to unkindly, its phonetic alphabet (like Latin) is a blessing when trying to hear, learn and spell scientific names. All languages evolve their own character and distinctive pronunciation. However, the more variation in pronunciation, the more unrecognisable and inaccessible names become, particularly to those who do not speak English as a first language or are more attuned to phonetic pronunciation. Whether people choose to speak in everyday English or biological Latin is, of course, a matter of choice. But would it not make more sense if the aim of pronunciation was to maximise understanding and preserve some of the meaning of the Latin or Greek components by not splitting them in half (as in the pronunciation sil-oss-o-bee)? As well as causing confusion, inconsistent and arbitrary pronunciations in English perpetuate the obscurity of scientific nomenclature and mycology, removing fungi even further from wider audiences. Field guides such as *Fungi Down Under* have attempted to standardise pronunciation in Australia with pronunciation suggestions.

Idiomatic mushrooms

As illustrated with the newspaper articles earlier in the chapter, the figurative use of ‘mushroom’ as a verb depicts sudden, often uncontrollable growth, most commonly in the context of things or events undesirable. Other than this association, fungal representations rarely find their way into the idioms of English language compared with European languages. A customary Australian expression is to ‘go bush’. It can be literally or figuratively interpreted and commonly connotes departing the city and reverting to a ‘less civilised’ state, ‘roughing it’ in the bush, or cutting off

[287] Georges Meyer, informal conversation with the author, Biel, Switzerland, 13 October 2014.
[288] Williams, *Scientific Words*, 169, 60.

communication. It can also mean to be lost or to elude authorities. To be 'bushed' is to be disoriented or lose one's bearings, perhaps reflecting early colonist impressions of the vast and unnavigable nature of the bush.[289] In German language, an interesting comparison that incorporates fungi is *in die Schwämme gehen*, or *in die Pilze gehen*. Literally, both mean 'to go into the mushrooms'. It first appeared in a written literary context in 1663.[290] Like 'going bush,' the idiom can be interpreted literally or metaphorically, to depict gathering mushrooms, to get lost in the forest, or to evade debt. It can also mean to 'go off with a girl,' or more sinisterly, to kidnap her.[291] Linguist Martina Šiffalovičová explored the multiple meanings of this expression noting that it generally means to be lost in an unmanageable situation or overgrown area.[292] 'Going bush' or 'going mushrooms' share similar interpretations but the latter has not embedded in Australian culture and language as it has in continental Europe, further reflecting the near absence of fungi in English language and consciousness.

'Why do you say hunt mushrooms rather than gather mushrooms?' asked a Swiss forager as we wandered through the alpine meadows of the Bernese Highlands. 'Do your Australian mushrooms have a habit of running away from the hunter?' I paused, not having made this connection before and wondered if it were peculiar to English. Certainly 'to hunt mushrooms' (as opposed to gathering or searching for them) is a common expression among foragers but the word 'hunt' more usually refers to moving targets, i.e. animals. Hunting is not used in reference to gathering plants; one does not hunt for blackberries or watercress for instance. Perhaps the risk of confusing poisonous and edible species adds an element of bravado more commonly associated with hunting for animals, although this also represents an exaggerated or mythologised sense of risk given many more people are poisoned in Australia by plants and animals than mushrooms.[293] Then again, treasure, like fungi, is generally immobile and also hunted. Perhaps the hunting association is not so remote if Russian philologist Vladimir Toporov was correct about the mythological connections between fairy rings and buried treasure.[294] Lepp offers a more plausible explanation in that relative to plants, the unpredictability of fungus fruiting aligns more closely with the elusiveness of animals.

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[289] Arthur, The Default Country, 64.

[290] *Das Wörterbuch der Idiome*, accessed 9 June 2015 http://idiome.deacademic.com/2187/Pilz.

[291] Heinsius, *Volksthümliches Wörterbuch der Deutschen Sprache*, 885.

[292] Šiffalovičová, "Karpatendeutsche Phraseologie," 76-77.

[293] For example, in 2014, the Victorian Poisons Information Centre received more than twice as many calls regarding potential poisoning from plants and three times as many from animals. Austin Health, *Annual Report*, 24, 27. Also see, chapter 5, section: Fairy Cakes and Trompettes de la mort.

[294] Toporov, "Conceptions About Mushrooms," 304.

Plants in comparison are not only stationary, but typically fruit more predictably. He considers the hunting analogy is apt and reflects the greater effort required to obtain animals or fungi relative to plants, and is not peculiar to English.[295] In discussing the mushroom-picking experiences of Russian nature writer Vladimir Soloukin, Sveta Yamin-Pasternak notes,

> harvesting mushrooms is fundamentally different from that of berries. Compared to other wild crops, he says, mushrooms are more spatially scattered and must be sought out individually – the features that are more characteristic of a hunt, than a gathering activity.[296]

In his exploration of European colonists' hunting in Australia, historian Tom Griffiths describes hunting as a form of collecting where naturalists and antiquarians were inspired by the 'gathering of objects for study and display . . . as a refined and educated form of hunting'.[297]

As one would expect, the stronger the cultural connections to fungi, the greater the fungal vocabulary in a culture's language. In Eastern European and Russian mythologies, fungi abound and individual species are often personified in children's stories and rhymes. The Wassons note: 'These stanzas with their shrewd comments on the diverse species are the didactic and mnemonic device by which a people's rich mushroom lore is passed on to the next generation'.[298] Mushrooms are so deeply embedded in Russian culture that they have been commonly adopted as family names. Mycologist Tatyana Svetasheva confirms the Russian love of mushrooms describing surnames associated with fungi including: Gribov, Gribunin, Borovikov, Gruzdjov, Ryzhikov, Opjonkin, Syroezhkovskij and Lisichkin among many others. She says: 'Our governor of the Tula region is called Gruzdev (Gruzd meaning *Lactarius*) and the well-known Russian actor was Gribov (Grib means fungus). Almost every well-known mushroom is connected with some surname'.[299] Imagine a time when Ms Stinkhorn or Mr Pinkgills joins Miss Finch, Fox or Birch. Fungi might first need to nestle more comfortably within the English language before being adopted as family names.

Ergonomic fungi

Examining language and thought processes reveals much about how fungi are perceived, experienced and understood. These include the linguistic structures and semiotic frames through which they are given meaning. Biologist Carol Kaesuk Yoon

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[295] Heino Lepp, pers. comm., 15 July 2015.
[296] Yamin-Pasternak, "How the Devils Went Deaf," 260-261.
[297] Griffiths, *Hunters and Collectors*, 19.
[298] Wasson and Wasson, *Mushrooms, Russia and History*, 14.
[299] Tatyana Svetasheva, pers. comm., 7 November 2014.

considers that it is an inherently human trait to order and name the world, but psychologist Richard Nisbett argues there is no universal human cognition, but rather that perception is strongly cultural. In *The Geography of Thought* he explores the socio-psychological gaps between Easterners and Westerners and how modes of language acquisition affect different perceptions of objects.[300] Nisbett purports that Eastern children are more likely to grow up in a world of relationships and connections between objects as signified by verbs, compared to American children who typically have the world categorised (and decontexualised) for them by nouns. He describes English as a 'subject-prominent' language preoccupied with focal objects as opposed to context. In drawing on the linguistic theories of anthropologists Edward Sapir and Benjamin Whorf, Nisbett maintains that these linguistic differences reflect habitual thinking processes.[301] Nisbett and biologist Denis Noble note these seemingly small differences in word choice in accounting for a greater sensitivity to connections and contexts. In reflecting on East Asian languages Noble says: 'what these languages do is to emphasise the "doing-ness" of things, the processes that occur, that is, the verb, rather than the subject who is the possessor of the being-ness or doing-ness'.[302] Cultural anthropologist Richard Nelson explored how syntactic differences between languages affect the agency and autonomy of organisms. During his interactions with the Alaskan Koyukon Indians, Nelson observed that in the Koyukon language the names of animals often derive from verbs rather than nouns, with each name reflecting a characteristic activity or behaviour of the species. Tim Ingold similarly depicts how for the Inuit of the Canadian Arctic, animals are 'distinguished by characteristic patterns of activity or movement signatures, and to perceive an animal is to witness this activity going on, or to hear it'.[303] Australian Aboriginal languages are similarly ergonomic in that they 'name by action' rather than simply by nouns. Such referencing to actions by verbs, rather than more 'static features' by nouns and adjectives, underlies perceptions of an organism's dynamism and interactivity.

In the Australian field guide *Fungi Down Under* only six percent of fungus vernacular names describe an action.[304] Some morphogroups such as Stinkhorns and

[300] Nisbett acknowledges the limitations of the generalisations in his study of "Easterners" representing mainly Chinese, Japanese and Korean and "Westerners" being predominantly American.
[301] Nisbett, *The Geography of Thought*, 158-159.
[302] Noble, *The Music of Life,* 140.
[303] Ingold, *Being Alive*, 72.
[304] Species describing actions are: Yellow Stainer, Death Cap, Mauve Splitting Waxcap, Austral Dripping Bonnet, Rooting Shank and the Red-Staining Stalked Polypore. Grey and Grey, *Fungi Down Under*. This is one of only two Australian guides with vernacular names. The concept is recognised in some

Puffballs portray actions. European field guides reveal that naming fungi by nouns is not peculiar to English. However, imagine fungus names that took greater account of their processes so that they were more contextualised within their actions, interactions and environments. Revising fungal names to a verb-based naming system is of course fanciful, especially given the actions of fungi are less apparent or diverse than those of animals. I simply reiterate the limitations of an object-focussed approach in contemplating organisms. Recognising how syntactic differences affect perceptions of the interconnectedness of organisms and their environments helps diminish binaries that isolate them as disconnected entities. How such relationships are conceived influences how nature is perceived. Drawing on linguist and semiotician Gregory Bateson, environmental philosopher Freya Matthews, says: ‘the unit of survival, under natural selection, is not, as Darwin thought, the breeding individual, or the family group, or the species. The unit of survival is an-organism-in-its-environment. If the environment fails to survive, so does the individual’.[305]

A meander of mycelia

Fungus enthusiast Langdon Cook considers ‘It is a mark of fungi’s otherness that we don’t have a proper lexicon with which to discuss them’.[306] The lack of vocabulary used to describe fungi is also reflected in the deference to botanical references. For example, *sporophore* is a mycological term for the fungal reproductive structure, but more commonly used is the botanical reference *fruit*body. Similarly, mycelium is commonly referred to as the *vegetative* part of the fungus. Mycologists use specific mycological language to describe sporophore parts, for example, pileus, lamellae, stipe and annulus. However, such terms are not within the common vernacular compared with equivalent terms for plants and animals and hence the need to translate to cap, gill stem and ring (even though these commoner terms often have specific meanings when applied to other biota, such as the gills of fish). The reduction of fungi to the ‘lowest group of plants’ also affects the way they are regarded and treated, with lowly things rarely receiving attention or funding.[307] Moreover, how does one refer to a group of fungi? Collective names for animals and plants abound. Even Linneaus’ lowly worms are collectively

vernacular names that indicate relationships, e.g. Birch Bolete (*Leccinum scabrum*) and Dung Button (*Poronia erici*).

[305] Matthews, *The Ecological Self*, 106.

[306] Cook, *The Mushroom Hunters*, 5.

[307] Fungi are commonly defined as “lower plants,” for example, Sandra Anderson et al. eds., *The Chambers Dictionary*, 647.

known as a clew. Many organisms have specific collective nouns, often reflecting cultural perceptions and emotional responses, for example, a parliament of owls, a caravan of camels and a murder of crows. Unearthing collective nouns for fungi is more difficult. Sometimes the words ‘troop,’ ‘clump,’ ‘cluster’ or ‘ring’ are used in reference to sporebodies more generally. Precise adjectives are certainly used, for example, in field guides, to describe the ways in which fungi grow such as caespitose, gregarious or solitary, but there appear to be no English collective nouns specific to fungi. Herein lies an opportunity to collectively describe fungi with the same approach to flora and fauna, to further enrich the fungal lexicon. Here are a few suggestions incorporating both scientific and vernacular names to make a start:

An Accident of Ink Caps

An Unveiling of *Cortinarius*

A Glow of *Omphalotus*

A Curiosity of *Cordyceps*

An Army of *Armillaria*

A Hiding of *Hypocreopsis*

A Trip of *Psilocybe*

A Trembling of *Tremella*

A Stench of Stinkhorns

A Question of *Tricholomas*

A Hunger of *Hebelomas*

A Lactation of *Lactarius*

A Chunk of Curry Punk

A Crumbling of *Russulas*

A Pile of *Gymnopilus*

A Pagoda of *Podoserpula*

A Field of *Agaricus*

A Melting of *Coprinus*

A Marcescence of *Marsmiellus*

A Creeping of Slime Moulds

A Weeping of *Lacrymaria*

A Powderpuff of *Podaxis*

A Galaxy of Earthstars

Words to conserve

The above list represents something of a lexical game, but the implications of this fungal language deficit reverberate much further. How is it possible to understand fungi if they cannot be adequately conceived or contextualised within their relationships and actions? If the necessary words for fungi do not exist, then neither do they have a presence in concepts such as conservation. This makes it extremely difficult to explain or justify, for example, a fungus conservation imperative without it appearing either radical or absurd. Australian environmental policy and biodiversity conservation management documentation show that fungi (in the exceptional cases of their inclusion) are referred to only very generally and usually only at the blunt taxonomic level of kingdom.[308] In contrast, fauna and flora are frequently discussed at species level. The only fungi mentioned at species level are usually pathogenic fungi considered as threats, usually as the cause of threats. They are rarely addressed as symptoms of more complex environmental processes, especially the influence of human actions, scapegoating the fungus as the cause of the problem.

The conservation goals of many of these documents are well intentioned. Most specifically identify the importance of conserving biodiversity.[309] However, such visions are likely to fail if the concept of biodiversity is narrowly or wrongly conceived. Many National Park Management Plans define biodiversity as: 'the variety of life forms: the different plants, animals and microorganisms, the genes they contain, and the ecosystems they form,' or by definitions such as 'the natural diversity of all life: the sum of all our native species of flora and fauna'.[310] Fungi are rarely explicitly included in definitions of biodiversity although one might assume the word 'microorganisms' is meant to include fungi (despite being some of the largest organisms on earth), or that fungi are plants (despite having been designated their own kingdom for over fifty years). While some fungi are indeed microorganisms, this arbitrary categorising by size is inappropriate because it mixes biota from several kingdoms (prokaryote and eukaryote) and excludes many fungi that have readily visible sporebodies.[311] Given that animals and plants are categorised by taxonomic kingdom, rather than by ambiguous

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[308] For example, Natural Resource Management Ministerial Council, *Australia's Biodiversity Conservation Strategy*; Department of Primary Industries, Parks, Water and Environment, *Natural Heritage Strategy for Tasmania*.

[309] In these documents biodiversity is more commonly described as "wildlife", "wilderness", "nature", "flora and fauna", "animals or plants" or "the natural environment".

[310] For example, Great Otway National Park and Otway Forest Park Management Plan; Freycinet National Park Wye River State Reserve Management Plan.

[311] Minter, "Fungal Conservation Needs Help from Botanists," 946.

size categories, it follows that other organisms including fungi should be considered in the same way.

To examine how language for fungi is used in Australian biodiversity conservation and to compare the relative representation of fauna, flora and fungi, I reviewed forty National Park Management Plans from across the country using a simple word analysis.[312] As with the policy and conservation documents, almost all showed misunderstanding of fungi, gross under-representation and insufficient terminology to describe them. On average, flora and fauna were mentioned sixty times more frequently than fungi.[313] Recalling the list of fungal synonyms earlier in this chapter, it is perhaps unsurprising that all fungi are often regarded as problematic. As with the biodiversity management documentation, the pathogenicity of fungi overshadows their benefits.[314] Only an eighth of Plans mention fungi in other contexts, usually simply acknowledging their existence.[315] Australia has an international reputation for its progressive approach to biodiversity conservation, a strong scientific basis as a driver of National Park formation and advocacy for ecological survey.[316] Yet none of the Plans has a developed notion of what fungi are, why they are significant, why they require explicit attention or why they might be worth conserving.

When Australian biodiversity and conservation 'authorities' struggle to comprehend and convey the significance of fungi, public misunderstanding is to be expected. In the final chapter I consider how limited conceptions of biodiversity could inadvertently threaten the actual diversity of organisms that exists in nature. Of the

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312 Following Minter (2013) in his assessment of the national biodiversity strategies of the signatories of the Convention on Biological Diversity 1992, the representation of fungi in National Park Management Plans was determined based on the number of times they were referred to in Plans using selected keywords. Equivalent terms were also used for flora and fauna. Results are tabulated in appendix 6.

313 The average number of references per Plan is similar for fauna (177) and flora (186) but strikingly less for fungi (3).

314 Eighty-six percent of references were to pathogenic fungi. The exotic organism *Phytophthora cinnamomi* (cinnamon fungus) was most frequently mentioned (67%) with further references to other *Phytophthora*. *Phytophthora* is not technically a fungus but a fungus-like organism (as it has flagellated spores) but commonly gets lumped in with fungi, perhaps because of its pathogenicity or indeterminacy. Other pathogenic species (mostly indigenous) included *Chalara australis* (Myrtle Wilt), *Armillaria luteobubalina* (Honey Fungus), *Botryosphaeria ribis*, *Phellinus noxius* and the Chytrid fungi found in association with amphibians.

315 For example, Grampians National Park Management Plan; Stirling Ranges & Porongurup National Parks Management Plan; Shannon Park and D'Entrecasteaux National Park Management Plan.

316 Robin, "Being First," 326. Moreover, the under-representation of fungi is likely to be significantly greater than revealed by analysis of the key terms alone, as many more terms for fauna and flora than those defined in the search method appear in the Plans. For example, a search of the Bago Bluff Plan for all terms relating to fauna, flora and fungi revealed an additional 56 words relating to plants (increasing the total by 75%) and an additional 106 words related to fauna (increasing the total by 141%). This Plan contains no references to fungi under any terms. See appendix 7 for details.

hundreds of people who participated in this research, all could easily differentiate a dog from its genitalia or a gumtree from a gumnut. Yet few knew the difference between the equivalent of a fungus and a mushroom. This lack of language and understanding pointed me toward an investigation of how fungal metaphors are used to help interpret fungi.

Metaphorical mushrooms

The staccato rap of rain on the corrugated iron roof persisted through the night. Rising before dawn, I peered out into the wet darkness, listening to the crash and caterwaul of the sea slamming the cliffs below. It was perfect weather for fungi and for photographing them at their best, but harder to hold the attention of the dozen forayers due to arrive in a couple of hours time.

Following the Barham River to a spot in the Otways Forest in Southern Victoria suitably known as Paradise, I checked the track was still passable. Mingled scents of damp leaf litter filled my nostrils. Currawongs alerted inhabitants to my presence in the waking forest with their ringing rolling calls. An azure kingfisher jackknifed across the water surface in an iridescent flash of azure and bronze. The forayers soon appeared, wrapped in colourful raincoats and with a hopeful shine in their eyes. Only a few footsteps along the track and fungi fruited in full force. Lobed nests of the Ghost Fungus, *Omphalotus nidiformis*, hugged eucalypt trunks. Dozens of tiny *Marasmius crinisequi* adorned parallel twigs like notes on staves. Tiered pagoda-like sporebodies of *Podoserpula pusio* decorated logs. Then came cries of dismay as what appeared to be a spectacularly large Jelly Fungus, *Tremella fuciformis*, metamorphosed into a sodden wad of discarded toilet paper. Within minutes a drenching downpour sent us scrambling under the sheltering fronds of giant tree ferns. Determined not to lose a fungus-spotting opportunity the forayers congregated around a fallen log in which all the scents of the wet forest seemed to circumfuse. While everyone's sense of smell was heightened, I asked whether anyone was familiar with truffles and if they could describe the smell.[317] I watched curiously as eyes rolled upwards as they tried to conjure the memory of the smell and find words to describe it. Others instantaneously screwed up their noses: 'earthy,' 'nutty,' 'like a wet dog,' 'like rotting cabbage,' 'musky,' 'like a damp tea-towel,' 'like honey,' 'like my teenage son's bedroom,' 'like old strawberries,' 'sweaty,'

[317] In this instance I was referring to European truffles likely to be served as culinary species (e.g. White Truffle, *Tuber magnatum*, Périgord truffle, *T. melanosporum*, Summer Truffle *T. aestivum*, Burgundy Truffle *T. uncinatum*), rather than native Australian truffles, with which people are typically less familiar.

‘like old runners,’ they replied. Then a piercing scream killed the conversation as a forayer discovered the bloody advance of a leech in his pants, prompting the others into a frantic flurry of bodily inspections. However, before the disruption, I noticed that each forayer relied on similes or metaphors to describe truffle smells.

Metaphors are ubiquitous and engaging for their simplicity and intuitive appeal, particularly when communicating across different forms of knowledge and disciplines. What metaphors are used to interpret fungi? How do the ways in which fungi are valued become apparent through metaphor? Metaphors serve as powerful tools for shaping perceptions of the unfamiliar or abstract and in shifting unintelligible concepts or phenomena into semiotic frames. The forayers’ use of definitive smells to describe truffles transformed familiar experiences to unfamiliar contexts and into the nostrils of those who had not smelt truffles, prompting a sensory imagining. Such metaphors provide not just a means of transmitting information but also ‘common ground’ for communicating ideas.[318]

Said Henry David Thoreau in the late 1900s in a mushrooming of fungal metaphors:

> The most interesting domes I behold are not those of oriental temples and palaces, but of the toadstools. On this knoll in the swamp they are little pyramids of Cheops or Cholula, which also stand on the plain, very delicately shaded off. They have burst their brown tunics as they expanded, leaving only a clear brown apex, and on every side these swelling roofs or domes are patched and shingled with the fragments, delicately shaded off thus into every tint of brown to the edge, as if this creation of a night would thus emulate the weather-stains of centuries; toads’ temples, so charming is gradation.[319]

Environmental writer Jay Griffiths regards metaphor as the greatest human gift. She considers humanity to be gripped by an ‘intellectual paralysis of a deadly literalism, where only what is measured, costed, counted and accounted is considered valuable’.[320] Metaphor is not just pervasive in language, but is fundamental to thought and action. In their seminal book, *Metaphors We Live By*, George Lakoff and Mark Johnson assert that metaphor does not simply embellish thought, but rather is the very process by which thought itself is understood:

> Metaphor pervades our normal conceptual system. Because so many of the concepts that are important to us are either abstract or not clearly delineated in our experience . . . we need to get

[318] Väliverronen, “Biodiversity and the Power of Metaphor,” 20.
[319] Channing, *Thoreau The Poet-Naturalist*, 39.
[320] Griffiths, “Kith”.

> a grasp on them by means of other concepts that we understand in clearer terms . . . This leads to a metaphorical definition in our conceptual system.[321]

In his book *Morel Tales*, sociologist Gary Fine provides an ethnographic narrative of human-fungal interactions based on three years in the field with foragers and mycologists. In exploring the intersections of fungi and humanity, Fine describes the complex cultural constructions among foragers and the role of metaphor and semiotics, noting that 'metaphors on top of metaphors build the meaning of mushrooms'.[322] Likewise, Biologist Denis Noble considers that metaphor lies deep in language and that little can be said of significance without metaphor, in both literary and scientific language.[323]

Metaphors also have their limitations and inevitably represent a tradeoff, highlighting some aspects while obscuring others. No metaphor can perfectly depict the object or situation it describes. It is, of course, impossible to be fully attuned to the complexities of the linguistic/cultural conceptual frameworks within which ideas and metaphors develop. When used beyond the shared interpretative contexts for which they are intended, metaphors are prone to misinterpretation or misappropriation. Scientific metaphors are especially predisposed to misappropriation because they compete with aesthetic and other criteria and the authority of science can get in the way of empirical veracity. Metaphors have been extensively critiqued for their oversimplification of scientific knowledge. For example, ecologists Christoph Kueffer and Brendon Larson argue how competition for funding, citations and attention can push scientists toward metaphor-prominent marketing strategies. As a result, they can undermine objectivity and misrepresent scientific knowledge, tunnelling their scientific narrative into dominant news frames of narratives.[324] Matthew Chew and Manfred Laublichler note how metaphors can hamper rather than ease understanding because of the instability of contexts from which metaphors are borrowed and changing interpretations over time.[325] They caution that metaphorical abstractions can evolve into concrete objects that overshadow description, for example, 'biological "productivity" and "diversity" become not only measurable, but virtuous'.[326] Karen Barad extends their concern adding that reasoning by analogy can be misleading by positing separate categories of items, analysing one in the context of the other and 'thereby necessarily excludes by its own

[321] Lakoff and Johnson, *Metaphors We Live By*, 115.
[322] Fine, *Morel Tales*, 65.
[323] Noble, *The Music of Life,* 141.
[324] Kueffer and Larson, "Responsible Use of Language," 2.
[325] Chew and Laubichler, "Perceptions of Science," 52-53.
[326] Ibid.

procedures an exploration of the nature of the relationship between them'.[327] However, metaphors can also evoke details and impressions that are not recorded within the necessary objectivity of scientific documentation. Such analogies can also augment and sharpen perceptions rather than increase ambiguity. Despite their limitations, wise and rigorous metaphorical thought provides one sensorium through which to perceive what is often imperceptible, uncovering relationships, new meanings and significances. Metaphors help bridge notions of time, space and scale. Finding ways to represent the intangibility of fungi makes them knowable and consequential. Given their invisibility, fungal spores are an abstract entity for many people. As a visual metaphor, a spore print – created when a mushroom releases spores that then accumulate on a surface such as piece of paper placed beneath it – not only make fungi tangible, but aesthetic.

Many participants in this research were initially unaware that a fungus consists of more than its reproductive structure. Explanations of the network of mycelia interlacing soils and the mycorrhizal relationships they form with tree roots prompted a spectrum of responses, from astonishment to confusion to disbelief. The processes of this subterranean tapestry seem unbelievable, as do the mechanisms for fungal-plant relationships. Mycelia can be perplexingly abstract and difficult to visualise. A simple visual metaphor to demonstrate mycorrhizal relationships using a piece of polypipe to represent a plant root sheathed by an entanglement of pantyhose to represent fungi, has been remarkably effective in conveying challenging concepts. Fungus workshop participants often comment, 'Why don't we all know about this?' or 'There's so much more to fungi than I ever realised,' or 'I will think very differently about fungi from now on'.[328] During a foray near Trentham, Victoria, in April 2015, farmer Jill Riley, on realising the underground presence of mycelia commented: 'I will never view the forest in the same way again'.[329] Following a fungal ecology workshop in Bowning, NSW in April 2015, environmental geographer Lesley Instone commented: 'I was particularly fascinated by the way fungus makes complex relations with trees, algae as well as humans and other animals . . . the importance of fungi for biodiversity made me think about the hidden worlds just below the surface, and the importance of small things'.[330] This simple visual metaphor shifts perceptions of fungi as discrete disconnected sporebodies, to fungi as vast and interconnected organisms. Fungi transform from

[327] Barad, *Meeting the Universe Halfway*, 23-24.
[328] These comments were taken directly from workshop assessment surveys where over 500 participants anonymously responded. Many others expressed similar sentiments.
[329] Jill Riley, informal conversation with the author, Trentham, Victoria, 24 April 2015.
[330] Lesley Instone, informal conversation with the author, Bowning, NSW, 11 April 2015.

individual 'surface objects' to organisms providing the processes and functions that underpin ecosystems. During a foray near Maldon, Victoria in April 2015, Rosa Bianchi commented: 'I came along hoping to learn a few edible mushrooms, but what I now know about the bigger fungi picture leaves me speechless'.[331]

Re-chanting the fungal lexicon

There are fungi I have encountered, concealed in minuscule crevices, pushing through desert sands, or hiding in plain view that confound with their alterity. I watch as the mouths of other forayers open and attempt to shape words, and then wordlessly close again. As Robert Macfarlane maintains, language is always late for its subject.[332] In echoing John Berger's comment 'life outstrips our vocabulary,' anthropologist Michael Jackson adds: 'Life cannot be pressed into the service of language'.[333] Berger and Jackson refer to events and experiences in places, but their comments equally apply to the fungal inhabitants and processes within those places. While fully embracing the thrill of discovering something that leaves one dumbstruck, there is good reason to foster a fungal language. This takes time. Language evolves slowly and connections usually precede and catalyse language.

Inadequate or inappropriate fungal language risks robbing fungi of not just their poetry and cultural significances, but also the precision necessary to convey their science beyond scientists. To discuss any subject with a level of coherence and resolution requires a particular vocabulary and meaningful forms of expression. Words are not mere labels for cataloguing, but also become infused within the organisms themselves. The more articulately fungi are described and discussed, the less likely they are to remain marginalised as obscure and unimportant. An exacting and lyrical lexicon opens possibilities for sharpened perception of subtleties, clearer and richer thinking, and more powerful and nuanced expression.

In 1925 Rolfe and Rolfe discussed the 'unpalatability' of literature on fungi as a barrier to public interest and the need for a *lingua franca* to enchant fungi as counterpoint to the analytical categorising of life:

> The ordinary reader is appalled when he turns over the leaves of many of the very excellent text-books of fungi which have been published. Yet, we can assure him, the subject is not necessarily so precise, inhuman, not to say *desiccated*, as some well-intentioned laboratory mycologists would make it appear. On the contrary, it is a *human* subject. Many are the

331 Rosa Bianchi, informal conversation with the author, Maldon, Victoria, 28 April 2015.
332 Macfarlane, "Landspeak," 7-8.
333 Jackson, *At Home in the World*, 5.

> quaint fantasies which have been interwoven by man into its lore, and thus, *its* history is almost *his* history.[334]

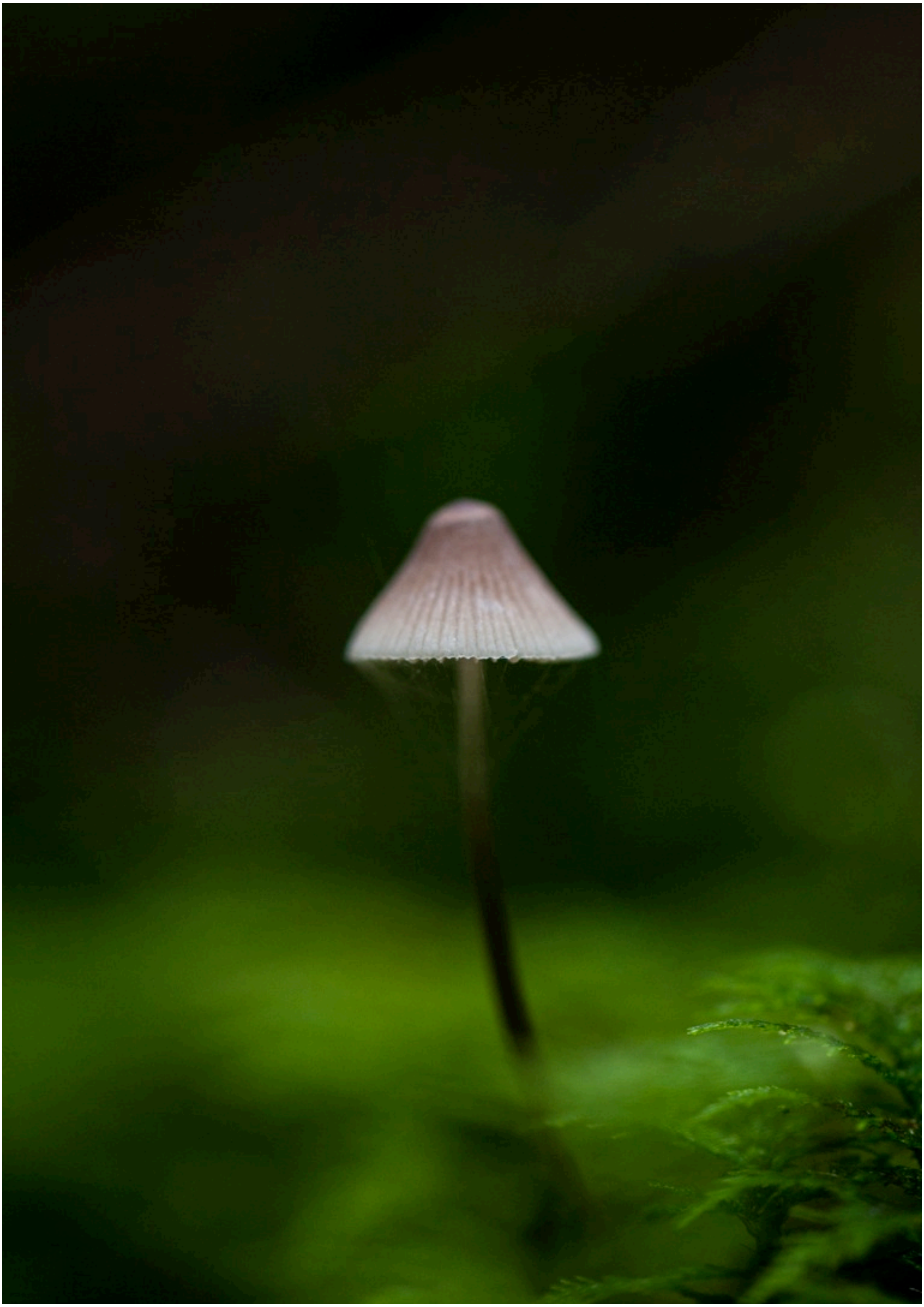
An accessible fungal lexicon that supplements mycological language could release the facts of their ballast of objectivity, allowing them to take metaphoric and imaginative flight. In turn, an enriched fungal language and imagination sensitises and deepens perception, augmenting the science. A precise, poetic and powerful fungal language rich with fungal narratives, metaphors, images, semiotic references and other imaginative structures also ignites wonder. As environmental philosopher Steven Fesmire contends, 'Only through imagination do we see actual conditions in light of what is possible to our best scientific, aesthetic, and moral thinking'.[335]

[334] Rolfe and Rolfe, *Romance of The Fungus World*, ix. Or arguably, *her* history . . . .
[335] Fesmire, "Ecological Imagination," 187.

Biological Umbrellas

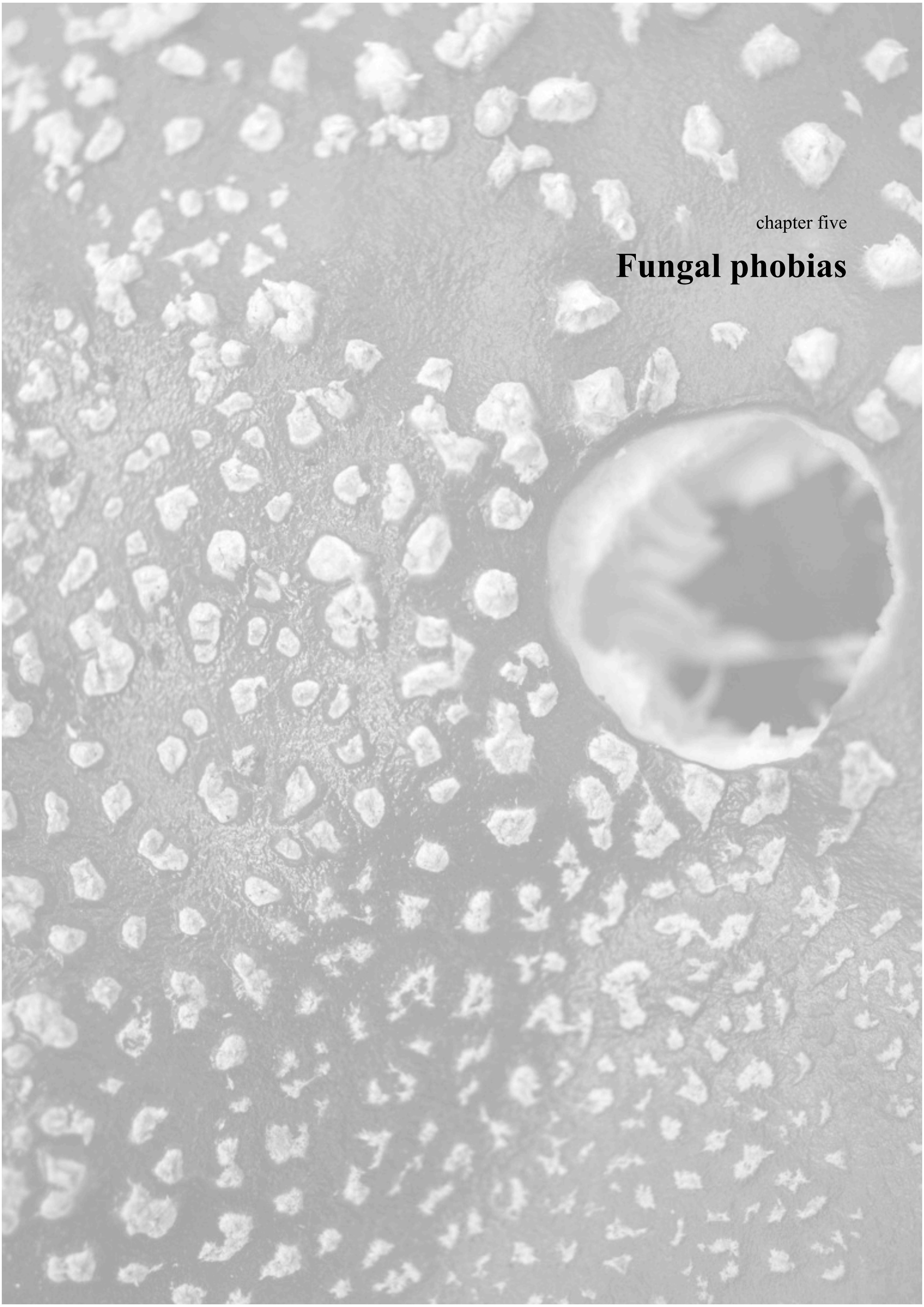
A symbol of shelter, the ingenious umbrella fungus form evolved many times in history. Its success lies in the protection of its fertile undersides, which if exposed to rain, cannot release spores effectively.

Fungal umbrellas transpire in a medley of configurations – ornate variations on a theme – suddenly appearing, then disappearing again once the spore dispersal job is done.



chapter five

Fungal phobias



Wicked wild mushrooms – a morality tale

Dorothy Hunter had hands like tree roots. For nigh on seventy years they had plunged the deep volcanic soils of Victoria's Central Highlands grubbing for spuds. They now passed me a cup of tea. Nothing much had changed in Dorothy's kitchen since husband Harold came home one day with a refrigerator, securely wedged between hay bales on the back of the Holden ute. That was 1956. The refrigerator was the only *modern* appliance in the room and it was still going. I had come to talk to Dorothy (not her real name) about mushrooms. In fact, I had brought her a basketful freshly picked from under the old Pines that skirted the local cemetery. They were still wet and glistening as the odd slug left the safety of its fungal sanctuary and slid over the rim. Dorothy peered into the basket, then reeled back in alarm, her face distorted by a grimace of disgust.

I knew it wasn't the slugs. Such benign creatures were unlikely to upset this spirited and seasoned farmer, but her reaction took me by surprise. I had erroneously assumed something picked from 'the wild' would please someone whose family had for generations lived from the fruits of the land. I had got to know Dorothy through Harold. He had been a forester for over half a century and was also the local woodman. While hurling firewood off the back of his truck, I would coerce him in to telling me where the biggest trees grew in the Central Highlands' forests. I wanted to know what sort of fungi might grow on trees – standing or fallen – that were many hundreds of years old.

Dorothy stared warily at the basket. 'Oooh Alison they're like the ones the Polish lass down the road brang me,' she said, backing away as if at any moment one might leap out and throttle her. 'She just plonked 'em down on the table and oooh and they were so poisonous they stained me laminex orange,' exclaimed Dorothy, her eyes scanning the tabletop for traces of evidence. The contentious species of our conversation was *Lactarius deliciosus*. It is also known as the Pine Mushroom, Milk Cap or Saffron Milk Cap. It falls within the *Lactarius* sect. *Deliciosi*, which grow mostly in the Northern Hemisphere.[336] In Europe, its range extends from Northern Sweden through to Southern Spain and eastwards as far as Turkey.[337] It also grows in the British Isles. Like Dorothy's relatives 150 years previously, *L. deliciosus* found its way to Australia by unknown means. No-one seems to know exactly when or how it arrived in Australia, but it was probably through early horticulture or forestry. Botanist, Jim Willis, first mentioned its presence in Australia in 1934.[338] *Lactarius deliciosus* is

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[336] Nuytinck, *"Lactarius* Section *Deliciosi*," 3.
[337] Hall, *Saffron Milk Cap*, 7.
[338] Willis, "The Agaricaceae," 284.

ectomycorrhizal, forming relationships mainly with conifers such as *Pinus radiata*. Native to California, *P. radiata* was introduced to Australia in 1857 as a seed batch for the Melbourne and Sydney Botanic Gardens and *L. deliciosus* was a likely hitchhiker.[339] Others suggest the Pine arrived with gold miners who came to the Australian goldfields from California in the 1850s.[340]

Originally known as the remarkable Pine or *Pinus insignis,* its success as a softwood timber product worldwide stems from its adaptability to a range of growing conditions, growth speed and large yields. It was first grown commercially in 1914 near the NSW town of Tuncurry and about 770,000 hectares of Radiata Pine plantations exist in Australia today.[341] In Australia and New Zealand, *L. deliciosus* grows in great abundance in many Radiata Pine plantations with sporebodies appearing en masse like giant orange goblets scattered across the forest floor. Mycologist Ian Hall estimated the seasonal crop of *L. deliciosus* in a Pine forest near Castlemaine, Victoria to be between 100-200 kilograms per hectare.[342] While in recent decades Pine trees are increasingly regarded with ambivalence or disdain, their fungal partners are becoming revered. Pine forests are a favourite haunt for fungus foragers where *L. deliciosus* is unlikely to be confused with toxic lookalike species.

I am fairly sure Dorothy neither knew or cared about the ‘imported’ status of *L. deliciosus* as she was focussed on its prompt expulsion from her kitchen before more than her laminex fell foul of its influence. However, the fact that it was picked by a foreigner aroused her suspicions. ‘The Polish lass picks lots of strange things,’ Dorothy confided, ‘and they all got funny names, but those orange toadstools, I reckon they don’t do you no good now do they Alison? I nearly threw ’em to the chooks but was worried I’d kill ’em, so I threw ’em in the fire instead’. Dorothy’s reaction mirrored that of Charles Darwin’s daughter, Henrietta, well over a century earlier, who gathered Stinkhorns and discretely disposed of them in the drawing-room fire. Except it was not the chooks Henrietta was worried about, but the delicate sensibilities of the maids whom she did not want exposed to the phallus-shaped sporebodies.[343] In describing Darwin’s daughter’s reaction to Stinkhorns, ethnomycologists Valentina Pavlovna Wasson and Robert Wasson regarded English speakers’ mycophobia as an ‘affliction, a

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339 Mead, *Sustainable Management of* Pinus radiata, 3.
340 Tyrrell, *True Gardens of the Gods*, 88.
341 New South Wales, Department of Primary Industries, “Radiata Pine,” 3.
342 Hall, *Saffron Milk Cap*, 8.
343 Raverat, *Period Piece*, 135.

recessive trait. Sometimes this racial infirmity erupts with terrifying ferocity'.[344] Almost two centuries earlier, John Gerard printed Clusius' illustration of *Phallus impudicus* upside down in his *Herball*, perhaps in a similar (although questionably ineffective) effort to disguise any human anatomical resemblance.

Dorothy hurled another log onto the fire and filled my teacup from her battered teapot. She slid a tin of freshly-baked Anzac biscuits toward me, casting a distrusting backwards glance toward the basket of mushrooms on the sink. 'Oh but Alison I get myself a good feed of mushies from the back paddock. Size of dinner plates they are. They're the only ones you oughta trust now Alison. You can't mix 'em up with nothin' you know'. Ironically, the Field Mushrooms (*Agaricus campestris/A. arvensis*) that Dorothy never mixes up are the most commonly mixed up mushroom by Australian foragers who confuse them with the toxic Yellow Stainer (*A. xanthodermus)*.[345] Most mushroom poisonings in Victoria result from *A. xanthodermus*.[346] Fortunately, unlike the Death Cap (*Amanita phalloides*), it contains only gastro-intestinal irritants sparing the ingester from organ damage or death.

During our afternoon together, Dorothy and I talked about her cows and chooks, the 'wretched wombats' that broke her fences, the roos that 'needed shootin'' and the Polish woman and her supposedly toxic toadstools. Our discussion was a revelatory insight into how Dorothy perceived and valued different species and it was not straightforward. Dorothy's chooks and cows, both exotic, had high utilitarian value relative to the pesky local native fauna. Yet despite their utilitarian value, the Polish woman's exotic mushrooms (and possibly the Polish woman) got lumped in with the troublesome kangaroos and wombats. Meanwhile, her 'back paddock mushies' (also possibly exotic) were revered. It was a reminder that different logics and experiences, combined with preconceived ideas about less familiar species, shapes attitudes in very different ways. As the kitchen slowly darkened in the fading autumn light, I bade Dorothy goodbye as she plied me with armfuls of spuds, a jar of green tomato relish and some Anzac biscuits wrapped in brown paper, and headed out into the drizzle. Before I

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[344] Wasson and Wasson, *Mushrooms, Russia and History*, 25.

[345] In Australia, it is not known whether people more commonly eat *Agaricus campestris* or *A. arvensis*. *A. arvensis* is commonly called the Horse Mushroom, although the species epithet, *arvensis*, like *campestris*, also means "of the field". Tom May pers. comm., 29 September 2015. It is likely that both are consumed without the consumer necessarily being aware that they are different species.

[346] Pers. comm., Tom May, who is an Honorary Consultant to the Victorian Poisons Information Centre, 30 June 2015; Hender, May and Beulke, "Poisoning Due to Eating Fungi," 1000.

reached the front gate, I heard the flywire door slam and a shriek as Dorothy rushed toward me with the basket: 'You forgot ya darned toadstools!'[347]

At the end of the road low clouds buffeted the forest. A wallaby eyed me cautiously from the bracken as I approached. Pulling my hat over my ears, I slid through the undergrowth and the forest drew me in like a magnet. Inhaling its dampness, I ducked beneath contorted Blackwood limbs and squeezed the last thirty minutes of light out of the day, searching for fungi and Harold's big trees.

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Morning broke with a great crack of thunder. Fists of wind punched the sides of my tent as I peered out into the rain that sheeted and sluiced across the valley. It seemed like a good day to contemplate my experience with Dorothy and tuck into the Anzacs. Why did the basket of orange mushrooms provoke such abhorrence? Was it simply a fearful reaction to the unknown or the foreign? Or are humans hardwired for fear, as entomologist-turned-psychologist Jeffrey Lockwood suggests?[348] Anthropologist Sveta Yamin-Pasternak distinguished between fearful and adverse reactions in her ethnomycological research into the beliefs and practices connected with mushrooms in the Russian Arctic: 'While fear was a predominant sentiment in some reactions, others placed more emphasis on aversion, shrugging with disgust when I brought up the idea of cooking and eating wild mushrooms'.[349] My desire to understand the origins and persistence of fungal fears and aversions has motivated dozens of conversations in Australia and Europe. These conversations reinforced that fungi possess a multitude of unnerving characteristics: dirtiness, toxicity, obscurity, unpredictability, invasiveness, foreignness, bizarreness, ephemerality, indeterminacy, rotting capacity, as well as all the symbolic associations such qualities evoke. As fungus enthusiast Andy Letcher contends, mushrooms are 'living repositories of all that is weird, enchanted, other-worldly and uncanny'.[350] Fungi also share much in common with invertebrates in terms of being cryptic, overlooked and feared. In exploring the nature of human phobic reactions to insects Lockwood maintains that fear and anxiety are the 'twin pillars of

[347] Dorothy Hunter, informal conversation with the author, 9 April 2014, Victoria.
[348] Lockwood, *Infested Mind*, 23.
[349] Yamin-Pasternak, "How The Devils Went Deaf," 12.
[350] Letcher, *Shroom*, 8.

aversive emotion'.[351] This chapter of phobias explores the many intertwining factors that evoke fungal fears and aversions.

Thievish and voracious beggars – origin myths

Despite scientists' efforts to dissociate the empiricism of mycology from folkloric interpretations, fungi did not get off to a good scientific start. Linneaus relegated them to the lowest order of plants – the Cryptogamia – referring to them as 'thievish and voracious beggars'.[352] Long before Linneaus' time, Greek doctor and poet Nikandros of Kolophon (c. 185 BC) attempted to differentiate edible and poisonous fungi in his *Alexipharmaca* but derided them all as 'the evil ferment of the earth'.[353] There are many reasons for adverse reactions to fungi. Fears and anxieties were translocated to Australia from the traditionally fungus-fearing British Isles. Unlike many continental Europeans, few from the British Isles celebrated cultural connections with fungi until recent decades. In 1887, mycologist William Hay said, 'no eye can see their beauties; their office is unknown: their varieties are not regarded; they are hardly allowed a place among nature's lawful children, but are considered something abnormal, worthless and inexplicable'.[354] While a small band of British field naturalists have sought fungi since the reign of Queen Victoria, wider public interest only developed in the United Kingdom in the 1980s.[355] Public interest in fungi grew in Australia about the same time although not to the same extent. I headed to Fungimap, the Australian hub for fungus enthusiasts in Melbourne, to sift the best archives of newspaper clippings about fungi, and to forage for stories of changing perceptions in Australia over time.

Mycologist, Tom May greeted me at the door of National Herbarium at the Royal Botanic Gardens in Melbourne, which hosts Fungimap. Founded by May in 1996, Fungimap was also the first fungus-mapping scheme in the Southern Hemisphere. Almost a thousand participants have contributed over a hundred thousand fungus distribution records making it one of the largest citizen science organisations in Australia. May is respected among the mycological community for his depth and breadth of knowledge and feisty determination in issues of fungal conservation. In 2014

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[351] Lockwood, *Infested Mind*, 2.
[352] Buller, "The Fungus Lore of the Greeks and Romans," 64.
[353] Ainsworth, *History of Mycology*, 13.
[354] Hay, *Text-book of British Fungi*, 6.
[355] Martyn Ainsworth, pers. comm., 4 August 2015. Ainsworth, a mycologist, considers that public interest was catalysed by the publication of Roger Phillips' illustrated fungus guidebook, Michael Jordan's "Mushroom Magic" TV series, and the growth of the British Mycological Society's network of fungus groups. According to writer, Peter Marren this accelerated in the 1990s with the rise of television cooking programs of Italian chef Antonio Carluccio. Peter Marren, pers. comm., 2 August 2015.

he became the second mycologist to receive the Australian Natural History Medallion for his mycological research and Fungimap work.[356] In the darkened interior of the herbarium, May's desk nestled among rows of archived specimens and written records. Chemical smells hovered above the distinctive tang of timeworn documents. May has amassed hundreds of newspaper articles about fungi from around the country over the years. He produced a series of fading manila folders crammed with clippings and cleared a space among the microscopes and specimens on the desk for me. I later supplemented Fungimap's clippings with several hundred more digitised newspaper records accessible by keywords through Trove, the online digital archive of the National Library of Australia. Slowly I began to get an impression of how newspapers reveal public ideas about fungi.

The microfungal smuts, bunts and rusts that ravaged the crop monocultures of the early Australian colonists were the focus of newspaper articles about fungi in the first decades of the nineteenth century when agriculture was the main enterprise of the nation.[357] While the destructive actions of microfungi influence perceptions of all fungi, I searched the newspapers for portrayals of macrofungi. Few early articles were specifically about macrofungi but incorporated the words 'mushroom' or 'fungus' in limited contexts such as to describe shape, often reported as 'miscellanea'.[358] Fungi abounded in metaphors, usually negative. In political contexts, they appeared in extraordinarily savage insults. For example, 'they petitioned the abolition of that legislative fungus, that bastard aristocracy, the Legislative Council'.[359] There are frequent references to 'mushrooms speculators,' 'upstarts and mushrooms,' 'political fungus' and even more caustically, 'such mushrooms, those abortions of Englishmen'.[360]

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[356] The Australian Natural History Medallion has been awarded by the Field Naturalists Club of Victoria since 1940 for outstanding contributions to the understanding of Australian natural history. Joan Cribb was awarded the Medallion in 1994 for her mycological work and various others such as Jim Willis received the award for their contributions to botany that also incorporated mycological research.
[357] For example, "Miscellany, Original and Select," *Hobart Town Gazette,* 27 Jan 1827, http://nla.gov.au/nla.news-article8791700; "The Vine," *Australian* (Sydney), 4 February 1845, http://nla.gov.au/nla.news-article37158546; "Smut in Wheat," *Geelong Advertiser and Squatters' Advocate*, 11 Jun 1845, http://nla.gov.au/nla.news-article91122788; "Disease in Potatoes," *South Australian Register,* 28 January 1846, http://nla.gov.au/nla.news-article27451869.
[358] "Expedition to the Northward," *Perth Gazette and Western Australian Journal*, 8 February 1840, http://nla.gov.au/nla.news-article638800.
[359] "From the Tasmanian," *Cornwall Chronicle* (Launceston) 9 September 1837, http://nla.gov.au/nla.news-article65951118.
[360] "To The Editor of The Sydney Monitor," *Sydney Monitor*, 28 September 1831, http://nla.gov.au/nla.news-article32076098; "From the Tasmanian," *Cornwall Chronicle* (Launceston), 9 September 1837, http://nla.gov.au/nla.news-article65951118; "The People's Journal," *Hobart Town*

The earliest Australian article that made reference to actual fungi came from 1808, reporting the deprivations of a family for whom, 'mushrooms and Indian Corn had been . . . their only food'.[361] Although seemingly trivial, this reference to fungi as food, along with advertisements for mushroom chutney that appeared in the early 1800s, confirm that mushrooms were eaten by early European Australians. These mushrooms might have been wild-picked but were more likely imported.[362] Early newspaper articles also refer to other utilitarian uses of fungi, often as a light source, tinder, or for smoking and stupefying bees.[363] For example: 'in most of the stock huts that we have visited we have generally found in the evenings a large piece of the fungus which grows on the gum trees set in a vessel of melted fat, emitting a light very injurious to the eyes'.[364] Several early articles reported Aboriginal use of fungi, using mostly only English vernacular names or generalised descriptive phrases. The exact identifications are uncertain, but the following names have been extrapolated from later recording of names and use: Native Bread (*Laccocephalum mylittae*), Beech Orange (*Cyttaria gunnii*), Puffballs (e.g. *Phellorinia herculeana, Podaxis pistillaris* and *Pisolithus*), Punks (*Laetiporus portentosus*), crimson Boletes 'growing out of trees' (*Fistulina hepatica)* and Truffles (e.g. *Elderia arenivaga* and *Mycoclelandia bulundari*).[365] Aboriginal words were used, but very rarely and usually not with enough

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Courier and Van Diemen's Land, 29 May 1840, http://nla.gov.au/nla.news-article8748357; "The Candidate," *Geelong Advertiser*, 6 June 1850, http://nla.gov.au/nla.news-article93135225; "Advance Australia Sydney Gazette, and New South Wales Advertiser," *Sydney Gazette and New South Wales,* 24 January 1842, http://nla.gov.au/nla.news-article2555448; "Sinking In Trade," *Australian* (Sydney), 17 February 1829, http://nla.gov.au/nla.news-article36865112; "The Colonies of Swan River and King George's Sound," *Perth Gazette and Western Australian Journal*, 2 May 1835, http://nla.gov.au/nla.news-article640965; "No. 5, of a Series. The Tyrant's Levee Continued," *Australian* (Sydney), 4 February 1831, http://nla.gov.au/nla.news-article36867490.

[361] This is the earliest newspaper article within the Trove archive, but there could be earlier articles mentioning macrofungi. "Court of Criminal Jurisdiction," *Sydney Gazette and New South Wales Advertiser*, 2 October 1808, http://nla.gov.au/nla.news-article627596.

[362] For example, "Classified Advertising," *Sydney Gazette and New South Wales Advertiser*, 25 December 1808, http://nla.gov.au/nla.news-article627654; "The Hobart-Town Courier," *Hobart Town Courier,* 5 April 1828, http://nla.gov.au/nla.news-article4223347. Commercial mushroom production in Australia did not begin until over a century later. The imported mushrooms were most likely pickled.

[363] "Which is Best," *The Hobart Town Courier,* 23 August 1828, http://nla.gov.au/nla.news-article4221545; "Lectures on Chemistry," Australian (Sydney), 14 October 1831, http://nla.gov.au/nla.news-article36864677; "No title," *Launceston Advertiser,* 6 May 1841, http://nla.gov.au/nla.news-article84754084; "The Productions, Industry, and Resources of New South Wales," *Sydney Morning Herald,* 13 September 1851, http://nla.gov.au/nla.news-article12930282.

[364] "Shipping and Commercial Intelligence," *Hobart Town Gazette*, 1 September 1827, http://nla.gov.au/nla.news-article8791861.

[365] For example, "The Country Post," *Hobart Town Courier*, 7 February 1829, http://nla.gov.au/nla.news-article4218235; "Some Remarks," *Hobart Town Courier*, 25 April 1834, http://nla.gov.au/nla.news-article4185434; "Local," *Courier,* 18 October 1848, http://nla.gov.au/nla.news-article2967845;

information to identify the species. For example, in 1884, an article entitled 'Anecdotes and Remarks Relative to the Aborigines at King George's Sound,' (now in Western Australia) commented on two edible species eaten by Aboriginal people:

> They are species of boletus; the one growing out of trees, of a beautiful crimson colour above. Its native name is numar. The other grows out of the ground, of a greyish colour, and globular form: it is named mord. They are both eaten raw, are very juicy, and have a slight flavour of the chestnut.[366]

The existence of Aboriginal words for fungi suggests their cultural value, as discussed in chapter seven.

In the 1830s articles about the edibility of fungi appeared including advice on edible and poisonous species, mushroom cultivation and reports of poisoning.[367] Little was known (and still is) about the edibility of Australian fungi. Early advice was often questionable and usually translocated from the United Kingdom. In 1830 one of the first articles on fungus edibility (between an article on an elopement scandal and methods for stopping haemorrhage!) was republished from the *London Medical and Surgical Journal* (1828).[368] Bizarre fungi were particularly newsworthy, especially luminous fungi (most likely *Omphalotus nidiformis*), Vegetable Caterpillars (*Cordyceps*) and Stinkhorns. Although mostly unnamed, their peculiar characteristics coupled with sufficient descriptive detail enable a pretty good guess at the species discussed. These unusual fungi were often regarded as curiosities. Sometimes reports were sympathetic, for example (from Hobart in 1829): 'We do not recollect that any of our botanical visitors has remarked the beautiful phosphoric fungus which is at this season to be found in full luxuriance on our hills'.[369] Another article, from Melbourne in 1861, described 'the delicate tracings of its fibres' and the 'aspect of a brilliant shell,' inviting readers to come and view it.[370] Various articles about *Cordyceps* recognised symbioses, even if not always correctly conceived.[371] Large fungal sporebodies and hallucinogenic

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"Anecdotes and Remarks Relative to the Aborigines at King George's Sound," *Perth Gazette and Western Australian Journal;* 16 August 1834, http://nla.gov.au/nla.news-article641366.

366 "The Colonies of Swan River and King George's Sound," *Perth Gazette and Western Australian Journal*, 2 May 1835, http://nla.gov.au/nla.news-article640965. *Numar* is probably *Fistulina hepatica*.

367 For example, "Gardening in South Australia," *South Australian Register*, 14 December 1839, http://nla.gov.au/nla.news-article27441040.

368 "Miscellanea," *Sydney Gazette and New South Wales Advertiser*, 19 August 1830, http://nla.gov.au/nla.news-article2195822.

369 "The Hobart-Town Courier," *Hobart Town Courier*, 14 February 1829, http://nla.gov.au/nla.news-article4218156.

370 "Shipping Intelligence," *Argus* (Melbourne), 16 May 1861, http://nla.gov.au/nla.news-article5700239.

371 "Literature and Science," *Colonist* (Sydney), 28 September 1837, http://nla.gov.au/nla.news-article31719867; "A Week at Cowes Review," *Cornwall Chronicle* (Launceston), 16 April 1845: *Sydney Morning Herald,* 1 August 1849, http://nla.gov.au/nla.news-article66270666article12911556; "Review,"

fungi also attracted attention from the early 1800s.[372] From the 1830s more detailed articles enquiring about the natural history of fungi and their utilitarian uses began to appear.[373] Anecdotal records for some fungus species appeared in newspapers before being reported in scientific literature. For example, the first records from Victoria of Stinkhorns were reported in the *Ballarat Star* in 1863.[374] A richly metaphorical and poetic extract from David Badham's 1847 book, *Treatise on the Esculent Fungi of England* entitled 'Curious Funguses' was reprinted in the Sydney Morning Herald in 1948:

> some are shell shaped; many bell-shaped; and some hang upon their stalks like a lawyer's wig; some assume the form of the horse's hoof; others of a goat's beard: the *Phallus impudicia* is the very thing he calls himself; in the *Clathrus cancellatus* you look into the fungus through a thick red trellis which surrounds it . . . One exactly like an ear, and given for some good reason to Judas, (*Auricula Judae*) clings to several trees, and trembles when you touch it; the other, which lolls out from the bark of chestnut trees, (*Lingua de Castogna*,) is so like a tongue in shape and general appearance . . . The above are amongst the most remarkable of the many Protean forms assumed by funguses; as to their colours, we find in one genus only species which correspond to every hue! The bonnets of some shine as if they were sprinkled with mica; these have a rich velvety, those a smooth and kid-like covering stretched over them.[375]

Rarely are fungi described with such poetic curiosity today. While newspaper articles on macrofungi in recent decades cover a wider range of themes, the descriptions of curious fungi from the 1900s have been overshadowed by increasingly dramatised reporting of toxic fungi: 'Deadly Toadstool May Come Here,' 'Warning on Fatal Fungi Harvest,' 'Deadly Deceivers,' 'Fears Over Killer Fungi,' 'Beware the Common-or-

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Sydney Morning Herald, 30 August 1851, http://nla.gov.au/nla.news-article12929906; "Local Intelligence," Launceston Examiner, 6 January 1847, http://nla.gov.au/nla.news-article36251029.

[372] "Farming and Horticulture," *Adelaide Observer*, 10 February 1844, http://nla.gov.au/nla.news-article158918228; "Opium, Opium-Eaters, The Opium-Trade with China," *Courier,* 1 December 1840, http://nla.gov.au/nla.news-article2957620; "Monster Mushroom Stuns Gardeners," *Cairns Post*, 25 November 2009; "English and Foreign Intelligence," *Colonial Times* (Hobart), 17 December 1850, http://nla.gov.au/nla.news-article8768400.

[373] For example, "The Courier," *Hobart Town Courier*, 15 April 1836, http://nla.gov.au/nla.news-article4177040; "Literature," *Sydney Gazette and New South Wales Advertiser*, 18 August 1836, http://nla.gov.au/nla.news-article2206094.

[374] May, "Articles About Fungi in Old Australian Newspapers," 7-9. Although identified by von Mueller as *Aseroë* Tom May suggests it might have been *Anthurus archeri*. He notes that the first Victorian scientific record of *Aseroë rubra* was in 1872 and *Anthurus archeri* was not recorded until the twentieth century.

[375] "Domestic Intelligence," *Sydney Morning Herald*, 12 September 1848, http://nla.gov.au/nla.news-article12910921.

Garden Killers,' 'Mushroom Victim Awaits Liver'.[376] While fungi appear in newspapers in various contexts, their ecological significance is seldom cited. Recycling of organic matter is essential to healthy ecosystem function, but this process – more often conceived as rotting – was rarely regarded as a favourable fungus trait.

Rotting and disgusting - unsettling traits

Fungi sank more ships in the four hundred years from the sixteenth century than warring humans. Fungi were rotting wood for many millions of years prior to the invention of ships, but their mastery at dismantling wood became a curse for sailors. Sixty-six of the British navy's ships failed to leave harbour during the American Revolution (1765–1783) when the ships succumbed to fungal deconstruction. A combination of unseasoned timber, cycles of alternate wetting and drying and inadequate ventilation provided favourable conditions for the proliferation of wood rotting fungi, such as the Dry Rot fungus (*Serpula lacrimans*) and the Sulphur Polypore (*Laetiporus sulphureus*). Scientific understanding of fungal decay of wood was firmly established by 1878 when German mycologist, Robert Hartig, published *Die Zersetzungserscheinungen des Holzes*, although the process was recognised as early as 1803.[377] It was this ability of fungi to deconstruct structural timber that spurred early mycology.[378] The mycological career of British mycologist, Lynne Boddy, was also sparked when she discovered wood decay fungi dismantling her basement apartment.[379] Rotting, however, less commonly inspired curiosity and was more often associated with disease, death and destruction, rather than being a vital ecological process. Only a handful of newspaper articles among more than five hundred I examined mentioned the ecological importance and benefits of this process, while many more denounced fungi for their capacity to rot human constructions, food or toenails. To be infected with something that rots, something invisible, pervasive and unstoppable, is to be out of control, fuelling fear and anxiety. As well as rot and decay, fungi were commonly associated with things unclean, infectious and contaminous. I observed the extreme reactions of a hyper-vigilant parent at a workshop in Beaufort, Victoria who severely

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[376] "Deadly Toadstool May Come Here," *Courier Ballarat*, 15 May 1993; Adrian Rollins "Warning on Fatal Fungi Harvest," *Age*, 11 May 1997; Necia Hall, "Deadly Deceivers," *Age Epicure*, 15 May 2001; Wendy Busfeld, "Fears Over Killer Fungi," *Herald Sun*, 6 September 1999; Darren Gray, "Beware The Common-or-Garden Killers," *Sunday Age*, 21 April 1996; Jessica Wright and Stephen Gardener, "Mushroom Victim Awaits Liver," *Sydney Morning Herald*, 5 January 2012.

[377] trans. *The Occurence of Decomposition in Wood.*

[378] Ainsworth, *History of Mycology*, 90.

[379] Boddy, "Fungi: The Unsung Heroes of the Planet," 112.

reprimanded her son for touching mushrooms despite my reassurance that they did not present a health risk. Yamin-Pasternak describes a fungus known in Alaskan Inupiaq language as *argaignaq*, meaning 'something that makes your hand come off'.[380] She recounts her experiences with the Siberian Yupik for whom 'mushrooms drew the emotions of repugnance and fear of contamination. Touching mushrooms with bare fingers was prohibited . . . grounded in the belief that mushrooms are capable of causing skin to become rancid and subsequently infecting the rest of the body'.[381]

From Beaufort to Alaska, beliefs about fungal contamination cross continents and cultures and commonly manifest in extreme revulsion. Lockwood says that fear and disgust are deeply entangled: 'Disgust is a universal emotion that functions to protect the physical and psychological "self". We are disgusted by stimuli associated with contamination or infection'.[382] He considers disgust to be more intimately linked to sensory experience, particularly olfactory experiences and touch, than any other emotion.[383] People attending my fungus workshops are often reluctant to handle slimy-textured fungi, supporting Lockwood's theory. While some people are repelled by a general sense that fungi are dirty, fungi with mucilaginous textures have drawn particular revulsion over the centuries. The nineteenth century nature writer Margaret Plues referred her readers back to naturalist, Pliny the Elder, who declared that mushrooms "grow in showers of rain; they come from the slime of trees".[384] Lockwood contends that we are highly sensitive to tactile properties perceived as contaminating.[385] Perhaps because slimy textures are commonly associated with faeces, mucus, lesions and innards, fungus workshop participants are reticent about handling mucilaginous fungi such as some species of *Suillus, Cortinarius* or *Hygrophorus* compared with less mucousy-textured fungi.[386] Many participants are interested in learning how to identify edible species and among the easiest are the introduced species *Lactarius deliciosus* (Saffron Milk Cap) and *Suillus luteus/S. granulatus* (Slippery Jack). Handling fungi is necessary to become familiar with important identification features. However, fewer folk opt to handle the mucilaginous Slippery Jack than the drier-textured Saffron Milk Cap, because they say they find them slimy.

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[380] Yamin-Pasternak, "From Disgust to Desire," 215.
[381] Yamin-Pasternak, "How The Devils Went Deaf," 69.
[382] Lockwood, *Infested Mind,* 48, 54.
[383] Ibid., 56-58.
[384] Plues, *Rambles*, 259.
[385] Lockwood, *Infested Mind,* 54, 58.
[386] Over 1500 people participated in workshops, seminars and forays during this research – see appendix 4 for workshop list.

Historically, slime is associated with poison. A gardening article published in the *South Australian Register* in 1839 noted: 'there is one species only, which so nearly resembles the common mushroom that it may be mistaken for it . . . it may be easily known by its being slimy to the touch, and possessing a disagreeable and unmushroomy smell'.[387] Associations between sliminess and toxicity did not, according to the Wassons, extend to Russia, where slime was a positive trait: 'The mushrooms with a moist and sticky surface, which the English-born person is quick to scorn as "slimy", the Russians by a reverse semantic twist praised as the "buttery ones" – "the fat of the earth"'. [388]

For something to be slimy it must first be damp. Dampness is commonly associated with sweat, ill health and disease as in Arthur Conan Doyle's miasmic description of fungal landscapes in *Sir Nigel*:

> The rain had ceased at last, and a sickly autumn sun shone upon a land which was soaked and sodden with water. Wet and rotten leaves reeked and festered under the foul haze which rose from the woods. The fields were spotted with monstrous fungi of a size and colour never matched before – scarlet and mauve and liver and black. It was as though the sick earth had burst into foul pustules; mildew and lichen mottled the walls, and with that filthy crop, Death sprang also from the water-soaked earth.[389]

Sliminess, dampness and darkness are unusually embraced by author Raymond Briggs in his unconventional and erudite character *Fungus the Bogeyman*. *Fungus* represents a startling affront to conventional mores of hygienic and polite society, occupying the literal and allegorical terrains of his namesake: 'Bogeydom is dark, dim, unclear, indefinite, indistinct, abstruse, difficult to understand, unexplained, doubtful, hidden, secluded, remote from public observation, unknown, lowly, humble, dull, dingy, gloomy, murky'.[390] Through *Fungus*, Briggs unravels entrenched societal taboos of impurity, filthiness and malodour. Writer Suzanne Rahn suggests that Fungus' unconventionality represents Brigg's plea for tolerance of creatures different from ourselves.[391] *Fungus* occupies taxonomic margins; not quite human, not fungus, and anatomically adapted for an amphibious subterranean existence. Briggs' remote and dispassionate view of humanity epitomises its 'dryness' literally and figuratively, as judgmental and violent. The idiosyncratic cartoon-style format of the book, interspersed

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[387] "Gardening in South Australia," *South Australian Register*, 14 Dec 1839, http://nla.gov.au/nla.news-article27441040.
[388] Wasson and Wasson, *Mushrooms, Russia and History*, 6-7.
[389] Doyle, *Sir Nigel*, 2.
[390] Briggs, *Fungus the Bogeyman*, 1.
[391] Rahn, "Beneath the Surface with Fungus the Bogeyman," 11.

with detailed illustrations, explanations and diagrams of life in *Bogeydom*, encourages the reader to slowly amble, to pay attention to detail and reflect on difference – qualities also necessary to understand fungi in their habitats. While slime has been wrongly associated with toxicity, more disturbing for many people are the toxic fungi that appear benign.

Fairy Cakes and Trompettes de la mort

While descending a steep slope to the Northern Italian village of Pizzanco in September 2015, I stumbled upon a perfect fairy ring of *Hebeloma crustuliniforme* in a stand of birches. The fairies that made the ring are honoured in its vernacular name, Fairy Cakes. It sounds like something delicious to be enjoyed at a children's party, but confusingly, an alternative vernacular name, Poison Pie, more fittingly describes its toxic nature. More perplexing, *trompette de la mort* (trumpet of death) is the French vernacular name for the Black Chanterelle, the highly regarded edible *Craterellus cornucopioides*.[392] While these vernacular names are misleading, there is no uncertainty about the toxicity of some fungi. The earliest recorded claim of fungal poisoning was in 1018 by Thietmar of Merseburg in Germany: 'seven servants in my bishopric died quickly (and with sharp, burning pains) after eating a poisonous FUNGUS'.[393] Whether fungi were responsible for such swift and numerous deaths will never be known. Today, mycologists working in association with hospitals and Poisons Information Centres identify fungal toxins in cases of suspected poisoning. Such incidences, however, are relatively infrequent relative to those from plants and animals and, more treacherously, regular household products. A close look at the calls received by the Poisons Information Centres around the country reveal the bathroom cabinet to be a more dangerous place to forage than the forest. For example, in 2014, the combination of cosmetics, analgesics and cleaning products triggered more than fifty times as many calls to the Victorian Poisons Information Centre than the fungal kingdom of tens, possibly hundreds of thousands of species.[394] In furthering my own understanding of incidences of fungal poisoning, I asked over five hundred workshop participants if they ever became ill after eating wild-picked mushrooms. It seems it was only a rare exception. Most wild mushroom foragers do not ingest any they are uncertain about.[395]

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[392] The name could possibly refer to the shape of the funereal trumpet rather than a reference to death.
[393] Lepp, "Snippets of Mycological History," 38.
[394]Austin Health Victorian Poisons Information Centre, *Annual Report*, 19-35.
[395] Most calls to the Poisons Information Centres about fungi are from adults concerned with "accidental exposures" by young children (around two years old). Mycologist, Tom May says that it is very rare for

According to the superstitions of Pliny, foragers seeking edible mushrooms should steer clear of serpents' dens as the breath of serpents renders mushrooms toxic.[396] Dioscorides warned poisonous *mushrums* 'groweth where old rusty iron lieth, or cotton clouts, or neere to serpent's dens, or roots of trees that bring forth venomous fruit'.[397] Today, foragers might want to steer clear of mushrooms growing in the verges of busy roads where petrochemicals and other toxins accumulate, or Pine plantations that have been sprayed with herbicides to suppress regenerating native forest. Sporebodies can accumulate heavy metals such as lead and mercury hence poisoning can result not from toxins inherent in the fungi, but from those assimilated from the environment. In her gripping account of Chernobyl's radioactive 'zone of alienation,' Mary Mycio examines fungi in what has become Europe's largest 'nature sanctuary'. Mycio explains how mushrooms are highly contaminated with caesium-137 because of the intimate relationships between fungal mycelia and the caesium-rich organic layers of the forest floor. Contamination levels vary between species depending on the depth of mycelial penetration.[398] This capacity of fungi to both accumulate and deconstruct environmental toxins has inspired their use in decontaminating toxic waste sites in the process known as mycoremediation. Powerful fungal enzymes can degrade toxic components such as petroleum hydrocarbons as well as chlorinated compounds and anthracenes found in pesticides. Vocal mycoremediation advocate, Paul Stamets has demonstrated the effectiveness of the Oyster Mushroom, *Pleurotus ostreatus*, in breaking down diesel and has assessed the efficacy of a suite of fungal species for mycoremediation.

Poisoning from eating fungi can occur from inherent or absorbed toxins, but the actual risk is commonly over-stated. The number of fungus species that are toxic to humans is unknown, but estimates of deadly poisonous fungi are thought to be less than one percent.[399] Fear of toxic mushrooms is disproportionate to the real risk, but one toxic fungus worth being able to discern is the Death Cap, *Amanita phalloides*.

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these "exposures" to be conclusively connected to any adverse symptoms as it is often unclear whether the mushrooms are ingested. Tom May, pers. comm., 20 June 2015.

[396] Ainsworth, *History of Mycology*, 38.

[397] Woodward, *Leaves from Gerard's Herball*, 247-248.

[398] Mycio, *Wormwood Forest*, 64.

[399] Mycologist David Moore and colleagues suggest "fewer than 50 of the more than 2000 species of mushrooms that occur commonly in most countries can be considered poisonous, and only about six are deadly," Moore, Robson and Trinci, *21st Century Guidebook to Fungi*, 433.

The Death Cap arrives in Australia

In autumn 2014, I headed out early intending to photograph Death Caps in Haig Park in the inner north Canberra suburb of Turner. This fungus is a Fungimap target species and I was planning to contribute some distribution records to the Atlas of Living Australia data repository.[400] Among the Pine needles, purple-capped russulas bore the spoils of the nocturnal sorties of slugs. Grey ghosts (*Tricholoma terreum*) huddled in clumps, water droplets suspended on their felty caps. Then just off the path, a pale green pileus protruded through the leaf litter beneath an Oak. A Death Cap. *Amanita phalloides*. A nosey magpie watched as I positioned my tripod, then threw back its head and warbled. There was nothing to suggest any imminent danger or that anything was awry. Through my viewfinder I observed a tiny globular-bodied spider circumnavigate the Death Cap's pileus, oblivious to its potency to *Homo sapiens*, before abseiling into the leaf litter on a silken thread. Despite the nag of early morning traffic on nearby Northbourne Avenue, I was ensconced in this 'urban nature experience' until a suited passerby snapped an imperious caution, 'Don't you read the newspapers!' It was clearly a reprimand more than a question, as he did not wait around for my reply. This was the first of five warnings I was to receive within an hour. Except for the woman who thought I was dead and attempted to shake me, none were interested queries, but rather, bumptious cautions. Such responses were probably exacerbated by media coverage of recent Death Cap poisonings in a nearby suburb, along with the suggestive presence of my collection basket.[401] The poisoning report took a bizarre twist with the dubious claim that the mushrooms had been purchased from Woolworths supermarket. As no fresh wild-picked mushrooms are sold in Australian supermarkets, the public remained perplexed while police investigated the situation. No evidence of a link between Woolworths and the Death Caps was found, however, the complainant, Rajvir Kaur, is suing Woolworths for allegedly selling her toxic fungi. The source of the Death Caps remains unresolved. Was the complainant confused about their origins? Or could it be a 'supply chain problem' or worse, a psychopath planting deadly mushrooms on supermarket shelves? Was the already heightened fear of this toxic fungus magnified by the sinister possibility of its intentional use to poison unsuspecting grocery shoppers? I headed back

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[400] The two hundred "target species" of the Fungimap mapping program were selected for their ease of identification in the field. They include species of particular interest such as those that might be rare, or introduced species such as *A. phalloides* that have the potential to naturalise and are also highly toxic.

[401] "Three People Treated for Possible Death Cap Mushroom Poisoning in Canberra," ABC News, accessed 27 April 2014, http://www.abc.net.au/news/2014-04-26/three-treated-possible-death-cap-mushroom-poisoning/5413556.

to the newspaper archives to find some history of relations between this species and humans.

Death Caps first appeared in an Australian newspaper in 1895 in reference to it growing in England.[402] In 1909 an article in the 'Oddities' section of a Queensland newspaper described how to differentiate it from Field Mushrooms.[403] Things took a more sinister turn in 1923 with the report of a murder in Paris, supposedly using this species.[404] In the 1930s a couple more extensive articles addressed the edibility and toxicity of Australian and European fungi including the Death Cap.[405] Both articles are significant in that the authors report on first hand experience in Australia rather than republishing reports from Europe. The first article documenting the Death Cap's presence in Australia was in 1964 and simply noted 'found quite recently in Canberra,' and another, twenty years later, reported it being 'rediscovered' in Canberra.[406] The earliest Australian records of it in the Living Atlas of Australia repository were in 1974 in Kew, Melbourne then in 1978 near Morwell in Southeastern Victoria.[407] In recent decades, important health warnings regarding Death Caps are often accompanied by alarmist propaganda. An article published in 1987 with the stern pronouncement, 'Toadstool Warning Issued' featured a mugshot of the fungal culprit like a criminal on a 'wanted' poster, while the text supposedly assuaged alarmed readers with the reassurance 'field staff from the department are removing the fungus as it is found'.[408] One incensed Canberran, Ann Didcott, admonished the 'panic-stricken eradication program by over-zealous council employees,' questioning the authority of their

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[402] "Mushrooms," *Australian Town and Country Journal* (Sydney), 19 Jan 1895, http://nla.gov.au/nla.news-article71224720.

[403] Reprinted from the British *Gardeners' Chronicle* of 1907. "Oddities," *Maryborough Chronicle, Wide Bay and Burnett Advertiser*, 9 Feb 1909, http://nla.gov.au/nla.news-article150570018.

[404] "Terrible Borgia," *Register* (Adelaide), 16 April 1923, http://nla.gov.au/nla.news-article64176063.

[405] Ethel McLennan, "Mushrooms, Poisonous and Edible," *Argus* (Melbourne) 7 April 1934, http://nla.gov.au/nla.news-article10925514."Mushrumps," *Kalgoorlie Miner*, 31 January 1931, http://nla.gov.au/nla.news-article95214836.

[406] "The Neglected Toadstool," *Canberra Times*, 28 October 1964, http://nla.gov.au/nla.news-article131757382; "Most-Dangerous Fungus Found in Canberra," *Canberra Times*, 30 June 1984, http://nla.gov.au/nla.news-article127006238.

[407] Atlas of Living Australia, *Amanita phalloides*, accessed 30 September 2015, http://biocache.ala.org.au/occurrences/4da8e180-236a-4b18-b5a0-2714b4cd2550; Atlas of Living Australia, *Amanita phalloides*, accessed 30 July 2015, http://biocache.ala.org.au/occurrences/fdb43004-3414-4dd5-a337-10c8ea5a5c6e; The first specimen of *A. phalloides*, collected near Canberra, was submitted to the National Herbarium of Victoria in 1986, Atlas of Living Australia, *Amanita phalloides*, accessed 30 September 2015, http://biocache.ala.org.au/occurrences/ee3ada3c-f1c4-4007-8f70-3045f716a871.

[408] The "department" being the then ACT Parks and Conservation Service. "Toadstool Warning Issued," *Canberra Times,* 20 June 1987, http://nla.gov.au/nla.news-article118299110.

actions.[409] A year later the first poisonings were reported with misleading headlines like 'Deadly Mushroom Flourishing in the ACT' and more sensibly, 'Be Careful When Picking Wild Mushrooms'.[410] The first death from Death Cap poisoning was reported in 1995 with the title 'Mushroom "Health Freak" Dies'.[411] This prompted a letter to the editor of the *Canberra Times* from a friend of the deceased for irresponsible and sensationalist reporting.[412] A more objective article outlining the challenges of fungus identification appeared in May that year titled 'Expert Warns of Fungal Dangers'.[413]

The removal of Death Caps from frequently visited places such as the Melbourne Botanic Gardens is a sensible precaution, given the likelihood of Asian migrant visitors who are more prone to mistaking them for Paddy Straw Mushrooms (*Volvariella volvacea*), a similar-looking species picked for consumption in their homelands.[414] The Gardens' staff take the risk of poisoning seriously, providing public information on Death Cap identification and poisoning advice. Improving public knowledge of the dangers of Death Caps makes good sense given their potentially increasing distribution coupled with the growing Asian population.[415] However, the extreme toxicity of Death Caps exacerbates phobias that can extend toward all fungi. Fear often overpowers reason in triggering alarmist reactions. It is well known that perceptions of risk and the probability of rare events actually occurring are magnified by fear and anxiety.[416] Some councils and schools, for example, decided to remove all fungus sporebodies on their properties following the 2012 Death Cap poisonings in Canberra. Detailed explanations of the implausibility of Death Caps being present (because of the absence of mycorrhizal partners) failed to convince some council employees and school headmasters with a misguided sense of risk.[417] In reality, most

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[409] Ann Didcott, letter to the editor," Plea for a Toadstool," *Canberra Times*, 28 June 1987, http://nla.gov.au/nla.news-article118300650.

[410] "Angel of Death Fungus Poisons Three in ACT," *Canberra Times*, 4 May 1988, http://nla.gov.au/nla.news-article111970661; "Deadly Mushroom Flourishing in ACT," *Canberra Times*, 7 April 1989, http://nla.gov.au/nla.news-article122252364; "Be Careful When Picking Wild Mushrooms," *Canberra Times,* 1 March 1992, http://nla.gov.au/nla.news-article122401201.

[411] Bill Norman, "Mushroom 'Health Freak' Dies," *Canberra Times*, 14 February 1995, http://nla.gov.au/nla.news-article133335283.

[412] Brian Bolan, "Implied Blame Misapplied," *Canberra Times,* 26 February 1995, http://nla.gov.au/nla.news-article133338475.

[413] "Expert Warns of Fungal Dangers," *Canberra Times*, 20 May 1995, http://nla.gov.au/nla.news-article130551954.

[414] Most deaths due to Death Caps in Australia were of Chinese nationals.

[415] Trim et al., "Poisoning by *Amanita phalloides*, 247-249.

[416] "Why Tragedies Alter Risk Perception," Science Research News NPR Radio, accessed 15 July 2015, http://www.npr.org/2012/12/17/167427990/why-tragedies-alter-risk-perception.

[417] Pers. comm., with two Victorian Shire Council health officers and two primary school headmasters.

fungal poisonings in Australia are non-fatal and result not from Death Caps, but from Yellow Stainers (*Agaricus xanthodermus*).[418]

Sniffing out safety – toying with toxic mushrooms

Plump white mushrooms sprouted in their hundreds on the nature strips of the former Victorian gold-mining town of Creswick. I grabbed a basket from the back of the ute and had it filled in minutes. Two consecutive days of drizzle earlier in the week had stimulated their fruiting and the scowling sky hinted there would be more mushrooms to come. The mushrooms were exactly what I needed for an introductory workshop on edible and toxic fungi the following day.

John Elder (not his real name) held the mushroom to his nose and sniffed. Broken pink lamellae wedged in the bristly black hairs sprouting from his knuckles and nostrils. He then sniffed again, paused, grinned and assuredly announced, 'I know what I'm having for dinner!' His wife glared at him distrustingly and declared 'And I'll be having fish n' chips'. The group of twenty-five workshop participants laughed tentatively at their banter as the mushrooms were passed around, sniffed, prodded, examined and dismantled. With an uneasy mix of daring and prudence, they ardently debated the edibility of the mushrooms. The basket, in fact, contained only one species, the toxic Yellow Stainer, *Agaricus xanthodermus*. When I announced that each participant was holding a poisonous mushroom, some responded with shock and disappointment, others with spirited rivalry and some with disbelief.

More than half of the workshop participants were unable to detect the characteristic yellow discolouration, phenolic smell, or squarish shape of young mushrooms that usually differentiate *A. xanthodermus* from the edible Field Mushroom, *A. campestris*.[419] As the mushrooms were collected the previous day, the distinguishing features had become less conspicuous as they aged and dried, but this can also happen in situ. While toxic to most people, some ingest Yellow Stainers with no ill effect. French pharmacist and botanist Léon Gaston Genevier recognised this in 1876.[420] It is often anecdotally cited that ten percent of the population are unaffected by Yellow Stainer toxins although I unearthed no concrete evidence to support this claim. However, what is certain is that only a small minority of people can tolerate the toxins

[418] Eighty-five percent of reported fungal poisonings in Victoria between May 1997 and April 1999 were likely to be due to the single species, *Agaricus xanthodermus*, which contains non-lethal gastrointestinal toxins. Hender, May and Beulke, "Poisoning Due to Eating Fungi in Victoria," 38.
[419] Fourteen participants could not detect the smell or colouration, six could, and five were ambivalent.
[420] Genevier, "Étude sur les Champignons Consommés," 28-35.

and they are not odds you want to test through personal experience. Gastrointestinal toxins are down the less severe end of the mycotoxin scale but depending on the quantity eaten, can still produce unpleasant effects (nausea, abdominal cramping, vomiting, sweating and diarrhoea). The benign appearance of the Yellow Stainer and similarity to Field Mushrooms belie its toxicity. More commonly, the more bizarre a mushroom's form, the more suspicion it arouses.

Indeterminate and morphologically bizarre

In the 1890s Henry Lawson famously wrote: 'And the sun sank again on the grand Australian bush – the nurse and tutor of eccentric minds, the home of the weird, and of much that is different from things in other lands'.[421] Lawson's closing words to *The Bush Undertaker* reflect his refusal to glorify the unrelenting physical and mental challenges of life in the Australian bush. Perhaps his words have not before been interpreted in the context of Australia's 'fungal weird' but it is exactly these extreme physical conditions that have shaped them into some of the most bizarre morphologies. This quality of bizarreness has both fascinated and repelled those trying to make sense of fungi. Australian geographer and educator Charles Fenner noted in his book *Mostly Australian* published in 1944: 'Even among the extraordinary forms taken by many of the fungus family, there are some so outstanding as to be almost beyond belief'.[422] Idiosyncratic sporebodies such as those with odd shapes, smells or habits do, at times, appear 'unbelievable,' amplifying their ambiguity and potency. Beauty rather than bizarreness drives the aesthetics of nature. Bizarreness equates with undesirability. Farmer-historian Eric Rolls seemed well-acquainted with fungi especially in his concern for the effects of agriculture on mycelia. In *A Million Wild Acres* he names nine different types of fungi but says 'most of the other local fungi look too bizarre to be palatable'.[423] Bizarreness, it seems, also reduces palatability. Val Plumwood described human challenges in accepting difference in the context of animals: 'Different or Other, animals are treated after the fashion of Descartes, in ways involving radical exclusion, and constructed as alien. In both treatments they emerge as inferiorised, because dualism cannot allow a non-hierarchical or unassimilated concept of otherness'.[424]

[421] Lawson, "The Bush Undertaker".
[422] Fenner, *Mostly Australian*, 174. The two-page section on fungi entitled "Strange Fungus Forms" appears in the last section of the book, "Odds and Ends," between sections entitled, "Showers of Frogs and Fishes" and "Some Monuments in Egypt".
[423] Rolls, *A Million Wild Acres*, 266.
[424] Plumwood, *Feminism and the Mastery of Nature*, 123.

Plumwood's sentiments are particularly apt for fungi. Otherness and uncanniness threaten the predictability of the familiar and definable, as do the indeterminate.

Indeterminate organisms subvert ideas about species, taxonomic categorisation and scientific objectivity. Occupying enclaves of uncertainty within accepted knowledge frameworks, fungi unravel problematic binaries with which other organisms are rationalised: male-female, sexual-asexual, individual-communal, primitive-advanced, dangerous-benign. It is often said that the more an organism diverges from the human form, the less empathy it receives and the more it is feared.[425] Literary theorist, Anthony Camara describes human fear of the 'primitive':

> The fungus joins the ranks of literary monstrosities in the late-nineteenth century because the extreme morphological plasticity characteristic of this phylum graphically figures the essential formlessness of life in the wake of Darwinism, which stressed that organisms were continually changing in response to selective pressures in the environment. Far from holding the promise of a radically open-ended and continuous human evolution, the dysmorphic fungal body instead poses the threat of human devolution and a degrading return to a less organized primordial state of being.[426]

Indeed, fungi and fauna share closer evolutionary origins than flora and fauna. For those ill at ease in imagining an arboreal primate ancestry, contemplating fungi as 'phylogenetic older siblings' could further heighten the challenge.[427]

Commenting on the human tendency for superstition rather than rationality in explaining the appearance of mushrooms, mycologist Nicholas Money notes, 'there is something peculiarly strange about the fungal kingdom, something alien to our sense of how the rest of life is arranged'.[428] Linneaus, after all, in his twelfth (1767) edition of *Systema naturae* relegated some fungi to the disorienting category called *Chaos*.[429] Fungi have been confused as stones, plants, corals, excrement, stars, warts, human body parts and various indefinable objects apparently emanating from supernatural events. *Clathrus ruber*, the first stinkhorn to be illustrated in a printed publication was mistakenly thought to be a marine organism, referred to as '*Fungus marinus*'.[430] In exploring the portrayal of fungi in Australian poetry, ecocritic John Ryan describes fungi as representing non-human alterity and interstitiality, 'beautiful yet evanescent'.[431] He suggests their ability to appear like something else, something undefinable or

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[425] For example, Jeffrey Lockwood, 23.
[426] Camara, "Abominable Transformations," 10.
[427] Jehne, "The Role of Fungi in Soil Health".
[428] Money, *Mushroom*, 25.
[429] Ainsworth, *History of Mycology*, 23.
[430] Lepp, "Snippets of Mycological History," 64.
[431] Ryan, "Which to Become?," 132.

resembling another organism, or an edible species resembling a poisionous one, 'unlike other biological hazards, defy mere striking out'.[432] Their invisible spores and pervasive mycelial networks are not easy targets for extermination. These qualities of evanescence and liminality spark radical responses. Not being able to anticipate or control these seemingly unpredictable organisms unsettles the anxious. In exploring notions of fungal unpredictability Ryan examines the etymology of 'spore' alongside modern connotations of 'sporadic,' used in English since the 1650s. Says Ryan,

> fungi's primordial generative apparatus, the spore, lends itself to metaphors of elusivity and unpredictability–on the one hand, qualities that upend scientific precision and ontological cohesion–and resolute attachment to place–on the other hand, that which goes against the juggernaut of social and environmental "progress", especially in worlds where fungi live out their sporadic lives.[433]

However, as sociologist Gary Fine notes, the unpredictable nature of fungi is also thrilling, adding piquancy to the stories people recite about finding mushrooms.[434] Deeply entwined with concerns about the fungal unknown and indeterminate, is the fear that they might be from elsewhere.

Trouble from elsewhere – conservation and invaders

Ideas about a species' 'origin status' – its nativeness or exoticness – profoundly echo in biodiversity conservation and environmental management in Australia.[435] Multiple definitions exist for the swag of terms that describe species' origin status, but a common definition considers a native species to be one that existed in Australia before the First Fleet arrived (whose dispersal occurred independent of deliberate human translocation). Those that arrived after are considered to be exotic or introduced.[436] More broadly, the International Union for the Conservation of Nature defines non-native, non-indigenous, introduced, alien or exotic as those species that do not occur 'naturally' in an area or whose dispersal to an area has been mediated by human agency. Those that thrive and represent a potential threat to native species are deemed invasive in the language of invasion biologists and environmental managers.[437] The Management Plans of

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[432] Ibid.
[433] Ibid.
[434] Gary Fine, *Morel Tales*, 150.
[435] The term "Origin status" is adopted from Pyšek et al., who used it to differentiate native and alien plant taxa. Pyšek et al., "Alien Plants in Checklists and Floras," 131.
[436] Such terms are strongly spatial and temporal and in Europe native species are considered to be those that occurred in an area since before the Neolithic (c. 6000BC). Manchester and Bullock, "The Impacts of Non-Native Species on UK Biodiversity," 845.
[437] Head, "Decentering 1788: Beyond Biotic Nativeness," 167, 174.

Australian National Parks prioritise the eradication or stringent control of species from elsewhere, those usually deemed as feral, pest, weed, alien or invasive. Anyone arriving in Australia who deliberately or accidentally imports 'biological matter' can land a hefty fine or ten year prison sentence. Movement of organisms is also tightly controlled within the country. If crossing Bass Strait to the southern state of Tasmania, a zealous beagle in an orange smock awaits to give incomers a thorough sniff-over for contraband items. Despite the comic appearance of canine border control, protecting Australia's native biota from potentially invasive species is taken extremely seriously. Invasive species can severely affect crop monocultures but also biodiversity as in the case of Dieback (*Phytophthora cinnamomi*) and Myrtle Rust (*Puccinia psidii*). However, before the postwar era of rigorous regulation, all sorts of organisms were brought to Australia, intentionally and accidentally. Given the degree of alliances between fungi and other organisms, fungi often arrived as co-passengers. Other fungus species have been deliberately introduced as beneficial plant partners for improving the establishment, growth and resilience of plantation trees.[438]

The damage wrought by invasive pathogenic fungi on agricultural and forest ecosystems as well as human bodies is well documented. Fungal infections kill a couple of million people annually.[439] The opportunistic fungus *Pneumocystis carini* devastates the lungs of immuno-compromised people such as those with HIV/AIDS or undergoing chemotherapy, the elderly and the malnourished. The infamous 'late blight,' caused by *Phytophthora infestans* led to the Irish Potato Famine during which over a million people starved and more than three million emigrated between 1845 and 1852.[440] The accidental introduction of Chestnut Blight (*Cryphonectria parasitica*) to North America in the summer of 1904 killed tens of billions of chestnut trees within four decades. A few years after Chestnut Blight was recorded in America, Dutch Elm Disease (caused by *Ophiostoma*) appeared in Europe. While the first strain of the disease had limited effect, later outbreaks of more virulent strains had by the 1990s destroyed most mature Elms in the United Kingdom and Western Europe.[441] Dieback has led to severe tree declines worldwide including in Australia. The fungal plant pathogen, Myrtle Rust, has rapidly spread in Australia with severe effects on the plant family Myrtaceae. The

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[438] For example, Richardson et al., "Plant Invasions," 65.

[439] In sub-Saharan Africa, the fungus *Cryptococcus* causes over half a million deaths annually, more than tuberculosis. Centre for Disease Control and Prevention, "*C. neoformans* Infection Statistics".

[440] Cooke, *Fungi, Man and His Environment*, 25.

[441] Money, *The Triumph of the Fungi*, 26. Money notes that the fungus itself was not the problem, but the combination of the less acknowledged ideal fungal conditions provided by human-created forest disturbance and a chestnut monoculture that enabled it to thrive.

potentially fatal amphibian disease, Chytridiomycosis caused by the Chytrid fungus, *Batrachochytrium dendrobatidis*, is a global epidemic that has led to the radical decline of Australian rainforest frogs. The list goes on. These are all pathogenic microfungi or microscopic fungus-like organisms (*Phytopthora*) and hence only mentioned briefly as they are beyond the scope of this research.

Relative to microfungi, introduced macrofungi have attracted far less attention in Australia as they posed little economic threat. However, changing climate, environments and increased human mobility open new possibilities for introduced macrofungi to expand their range. While introduced macrofungi have been documented since the late nineteenth century, most of these were contained within human environments such as hothouses and apartments, where conditions approximated those of their origins.[442] Mycologist Else Vellinga and colleagues contend that most introduced ectomycorrhizal macrofungi keep company with their associated hosts and are constrained from spreading to novel habitats. They describe how an introduced species can potentially reach any of the following four stages: transport, establishment, spread and impact.[443] Few introduced macrofungi reach the fourth stage and adopt native hosts but the Fly Agaric, *Amanita muscaria* is an exception, having developed a new relationship with native Myrtle Beech (*Nothofagus cunninghamii*) in Victoria and Tasmania.[444] Researchers are trying to ascertain whether this fungus displaced the beech's other ectomycorrhizal partners in the process. The dynamics are not yet properly understood but a loss of diversity of ectomycorrhizal partners could potentially reduce the overall resilience of the forest. It is also not known whether *A. muscaria* and other associated exotic species such as the Peppery Bolete, *Chalciporus piperatus*, will venture into new terrains together.[445] Although little documented, many mycologists and ecologists would probably agree that the potential displacement of native fungi as they compete with introduced species for resources (e.g. plant hosts, carbon sources, mineral nutrients) is likely to reduce ecosystem rigour. Moreover, virtually nothing is known of the potential effects on carbon and nutrient cycles and overall ecosystem dynamics. *Amanita muscaria* produces conspicuous sporebodies, but could there be other less conspicuous introduced ectomycorrhizal fungi also switching to native hosts that have gone unnoticed? *Amanita muscaria* has also formed relationships with *Nothofagus* (and *Leptospermum*) in New Zealand where it has been classified as a

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[442] Wojewoda and Karasinski, "Invasive Macrofungi," 8.
[443] Vellinga, Wolfe and Pringle, "Ectomycorrhizal Introductions," 960.
[444] Dunk, Lebel and Keane, "Characterisation of Ectomycorrhizal Formation," 135.
[445] Tedersoo, May and Smith, "Ectomycorrhizal Lifestyle in Fungi," 241.

regulated pest since 2001.[446] Little is known of the mechanisms controlling its spread and whether non-native ectomycorrhizal fungi could promote exotic tree invasion into intact *Nothofagus* forest.[447] Furthermore, the effects of introduced fungi on native Australian fungivorous animals are unresearched and mostly only anecdotal, such as bird observer Jill Dark's observation in 2002 of Red Wattlebirds (*Anthochaera carunculata*) dying after eating *Amanita muscaria*.[448] On the other hand, the effects of toxic exotic fungi on scavengers such as domestic dogs are better known and probably do not endear fungi to pet lovers.[449]

The taxonomy and biogeography of *A. muscaria* are unresolved and it is thought to be a species complex rather than a single species. The molecular studies conducted by mycologist József Geml and his colleagues showed the existence of several phylogenetic species within *A. muscaria* with some lineages occupying very narrow niches.[450] This is the case for many fungi and uncertainty around which fungi are exotic and which are native starts to undermine the utility of the binary. No fungus distribution records prior to European arrival exist and little is known of the geographic origins and dispersal capacity of individual species. When a new 'species' is found at a particular location where it was previously unrecorded, it is difficult to determine whether it has been introduced or is the first record of a native species. Apart from *Aseroë rubra*, the first named fungi from Australia were reported as from the 1840s.[451] Moreover, as botanist Anthony Bean contends, human-mediated transfer of plants would likely have occurred for at least the past three thousand years by maritime explorers and traders in the Indo-Pacific. Some of these plants (along with their fungal symbionts) undoubtedly arrived in Australia prior to Cook's 1770 arrival, particularly in Northern Australia, where Aboriginal people had for at least hundreds of years traded with the Macassans.[452] The hulls of the fifty-four other European ships that beat Cook to Australian waters brought hardy travellers.[453] 'Gappy maps' characterise the

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446 Vellinga, Wolfe and Pringle, "Ectomycorrhizal Introductions," 967; Stevenson, "The Agaricales of New Zealand: II," 66; Horak, "Revision of the Agaricales," 403.

447 Dickie and Johnson, *Invasive Fungi Research Priorities*, 5.

448 Dark, "Red Wattlebirds and Toadstools," 10.

449 For example, Cope, "Mushroom Poisoning in Dogs," 95; Cole, "A Puppy Death," 271.

450 Geml et al., "Phylogeographic Structure in *Amanita muscaria*," 694.

451 Tom May pers. comm., 31 July 2015. These were the first records accompanied by voucher specimens that enabled identifications to be verified.

452 Macknight, *The Voyage to Marege'*.

453 Bean says that although there are no written records of the transportation of plants to Australia prior to 1770, he considers it "beyond doubt" that they occurred, given the level of activity to the north of Australia in the thousands of years prior. For example, the Macassan trepang-fishers who established

mycogeography of Australian fungi and the biogeographies of most ectomycorrhizal fungi are poorly known. Sometimes even their continent of origin is unknown.[454] Because of the sporadic and ephemeral nature of fruiting, a lag time typically occurs between species introduction and detection. The native-exotic binary is further complicated by ruderal fungi such as some *Coprinus*. Ruderal fungi colonise disturbed environments across the world and are characterised by short life spans, rapid growth and high reproductive potential.[455] The native distribution of ruderal fungi and the types of habitats they occupied prior to human disturbance is largely unknown. Concepts of nativeness are blurred further by shifting species concepts coinciding with molecular advancements. This is explored in the following chapter.[456]

The ecological and cultural complexities of the native-exotic binary have been re-examined over the last decade in the context of animals and plants. Much of this discourse is also relevant to fungi. Ecologist Mark Davis and colleagues outline inherent problems with what they consider to be the outdated native-alien dichotomy and the extent of public misunderstanding of exotic species, urging a more dynamic and pragmatic approach to conservation in keeping with a fast-changing planet.[457] Cultural geographer Lesley Head argues that nativeness as an axiom of environmental management is problematic in entrenching boundaries between humans and the rest of nature, as well as those before and after European colonisation in Australia.[458] In reviewing recent critiques she summarises problems stemming from an ‘olio of ideas from pre-Darwinian botany and pre-Victorian English common law [that] still underpins even the most recent, expert conceptions of biotic nativeness’. Drawing on Head’s research, historian Libby Robin describes the irony of how exotic plants with a commodity value are not only not ‘exotic,’ they are off the vegetation map altogether: ‘wheat is no longer a plant’.[459] The botanists who are challenged with determining the origin status of plants have thought long and hard about how to define the various categories and work from fixed and quantifiable definitions.[460] However, as Robin’s example shows, the mapmakers and those who view the maps, perceive such plants

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seasonal settlements and trade with North Australian Aboriginal people were a likely source of introduced plants. Bean, “A New System,” 8.

454 Vellinga, Wolfe and Pringle, “Global Patterns of Ectomycorrhizal Introductions,” 969.

455 Mueller, Bills and Foster, *Biodiversity of Fungi*, 220.

456 Pringle and Vellinga, “Last Chance to Know?,” 2.

457 Davis et al., “Don’t Judge Species on Their Origins,” 153-4.

458 Head, “Decentering 1788,” 170.

459 Robin, “Destroying Vermin and Noxious Weeds”.

460 For example, wheat would be classified as a “naturalised plant,” as comprehensively defined in VicFlora, which draws largely on Pysek et al., 2004. Royal Botanic Gardens Victoria, “VicFlora”.

differently. How does the status of a species change over time in different places from different perspectives? A kingdom of organisms that slips through definitions of biodiversity could easily disappear as a corporate product. Is the benign, perfectly formed and unblemished Button Mushroom (*Agaricus bisporus*), grown in computer-controlled sterile sheds and delivered to supermarket shelves with its shrunken spore count and reproductive bits tidily tucked up out of sight, considered to be a fungus? Or simply an innocuous Button Mushroom; a tasteless clone, far removed from the obscurities of its kingdom by the promises of commercial production and coercive marketing that speciously reinvents it as a 'Baby Bella'?

In exploring the dual status of the Wattle, *Acacia baileyana*, as native weed and national symbol in Australia, Robin describes how it 'leapt the garden fence and now complicates the idea of the 'alien' in invasive species. It is an alien to the ecosystem in the minds of the invasion biologist, but a native to the nation. When your national symbols go weedy you have an ecological conundrum'.[461] Botanists in Victoria have a category, 'Naturalised in part(s) of the state' to 'account' for these species, but the larger cultural picture of how they are perceived and regarded is another story. These sorts of issues have not yet arisen with macrofungi in Australia but the naturalisation of *A. muscaria* opens up compelling questions about how this widely mythologised species might be regarded in Australian contexts in the future, as well as exposing the limitations of the native-exotic binary. Although *A. muscaria* is exotic, it is also an archetypal and 'popular representative' of the kingdom.[462] Its reverence spans the globe and human associations date back to 8000BC from engravings in Siberian archeological remains.[463] What are the cultural implications if this fungus topples from favour as an iconic species to scorned competitor of the natives? Its enigmatic nature extends even further in that iconic fungus status is usually reserved for desirable edible species rather than toxic ones. However, as Marren notes, poisonous mushrooms also have glamour.[464] Danger is attractive. Many charismatic megafauna are carnivores after all. *Amanita muscaria* is not only toxic but also handsome and hallucinogenic. Mycologist David Arora quaintly summed up its wide appeal: 'Through the ages is has been compared to bull testicles and male genitalia and worshipped as the earthly incarnation of infinity, divinity, and virility . . . esteemed by both maggots and mystics'.[465]

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[461] Robin, "Destroying Vermin and Noxious Weeds".
[462] The wider public is probably less aware of its exotic status than its charismatic appearance.
[463] Institute for Environmental Protection and Research, "History of Italian Mycology," 16.
[464] Marren, *Mushrooms*, 205.
[465] Arora, *Mushrooms Demystified*, 265, 283.

Indeterminate, exotic, unpredictable, toxic . . . these fungal qualities that fuel fears and anxieties epitomise religious and supernatural beliefs about fungi. 'The beauty of a mushroom can mask a beast within,' so begins the commentary of the compelling 1980 fungus documentary film *The Rotten World Around Us*. 'A distrust of these earthy excrescences has evolved over the centuries . . . to the superstitious medieval mind, the phenomenon of fungus seemed supernatural'.[466] The powerful hallucinogens of many species further amplified beliefs in their supernatural powers. Are most fears about fungi still embedded in superstitious beliefs that arose in a time before science demystified their idiosyncrasies? Natural historians Rolfe and Rolfe considered that scientific revelations only partially alleviated misunderstanding of fungi:

> That these foul fungi spring up from the ruin of all that is fair and beautiful is perhaps, a not unnatural belief; but whether or not, it is one which has gradually erected against them a barrier of prejudice, through which only a few useful members have been allowed to creep . . . although education has more recently swept away many misconceptions, this distaste still lingers on, and finds outlet even nowadays in the insensate wrath with which these outcasts are often shattered by a militant walking stick, or ground to pulp 'neath a hostile heel.[467]

Europeans translocated their fungal mythologies to Australia but Aboriginal Australians also have their superstitions. Although few Aboriginal ethnomycological records exist, some Aboriginal groups associated particular fungi with evil spirits and supernatural activities of Dreamtime ancestors.[468] Early colonists recorded Aboriginal responses to what was almost certainly the luminous Ghost Fungus, *Omphalotus nidiformis*. The Koombumerri people of southeastern Queensland, for example, believed its luminosity to be the campfires of departed evil spirits.[469] Scottish naturalist and early settler James Drummond recorded the fearful reactions of West Australian Aboriginal people who referred to it as *Chinga*, meaning spirit.[470] Irish colonist George Fletcher Moore reported another Aboriginal name for this fungus, *Mettagong*, which also means spirit.[471] Yet fear of luminous fungi was not shared by all Aboriginal people. An article in the Sydney Mail in 1912 from an author noted only as A.V., reports:

> One dark night . . . while passing through a scrub at the mount of the Burdekin River (N.Q.), I observed some aboriginals amusing themselves with some luminous object,

[466] Paine, "Fungi: The Rotten World Around Us".
[467] Rolfe and Rolfe, *Romance of The Fungus World*, 4.
[468] Kalotas, "Aboriginal Knowledge and Use of Fungi," 270.
[469] Maguire, "Luminous Ghost Fungus;" "Australia," *World's News* (Sydney) 14 August 1935: 12, http://nla.gov.au/nla.news-article136321684; "Will-O'-the Wisps," *Daily Mercury* (Mackay) 1 Aug 1942, http://nla.gov.au/nla.news-article172128445; "Australiana," *World's News* (Sydney) 8 May 1948, http://nla.gov.au/nla.news-article137127085.
[470] Cleland, *Toadstools and Mushrooms*, 27.
[471] Kalotas, "Aboriginal Knowledge and Use of Fungi," 270.

> which I at first supposed to be a kind of large, firefly; but on making enquiry I found it to be a beautiful phosphorescent fungus.[472]

Fears and aversions to fungi in the Anglophone world have bubbled along in a roiling cauldron of myths and misunderstandings, intensified by the arcane and unpredictable nature of fungi. The fungal traits that arouse phobias are not new, but have simply been relocated. Australia imported myths from the dark forests of Europe and planted them in the dry and dusty Australian bush. The new wave of foragers actively attempts to reanimate the mystique, perhaps to elevate their implied rarity and economic value. Some fungal myths enchant fungi and some fuel their disregard. All have contributed to the many and varied ways in which they are perceived and regarded.

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The days grew shorter as the Australian autumn drew to a close. It was time to switch hemispheres and go north where the spring fungi would be emerging through the warming earth. I reckoned I could squeeze in a final hour in the bush before submitting to twenty more cramped in an airborne titanium capsule. Veering off the highway I slid down a familiar bush track. A swarm of black clouds loomed ominously in the rearview mirror. I parked, pulled on my coat and headed up the hill, cutting into the wind. A gnarly old Rhubarb Bolete (*Boletellus obscurecoccineus*) like the ruddy nose of a seasoned drinker just managed to stand upright on its wilting stipe. Dozens of flattened caps of *Laccaria* lay like scattered copper coins among a tangle of rusting barbed wire. I wondered how I could contemplate leaving while there were still so many fungi to meet. However, the temperature was dropping daily and soon they would turn inward for the winter. A sharp crack of splitting wood lifted my eyes from the ground and I spotted a lone figure ahead, dragging branches into a wheelbarrow. I recognised the strong but stooped and gumbooted profile instantly. My eyes smarted in the wind and I called out, but my voice was whipped away and Dorothy didn't hear me. I headed toward her, resisting a closer look at a bedraggled *Amanita*, its frilled petticoat of an annulus in tatters. 'Alison!' Dorothy cried with outstretched arms as she saw me approaching. In her wheelbarrow lay a pile of branches scalloped with the blue and grey striped arcs of the Rainbow Fungus, *Trametes versicolor*. 'You're not campin' out here I hope Alison? There's gonna be a big blow tonight. I'm just gettin' a bit of kindlin' in before it hits. I can't bear to see all this good wood lyin' around goin' to rot out here in the forest'. I

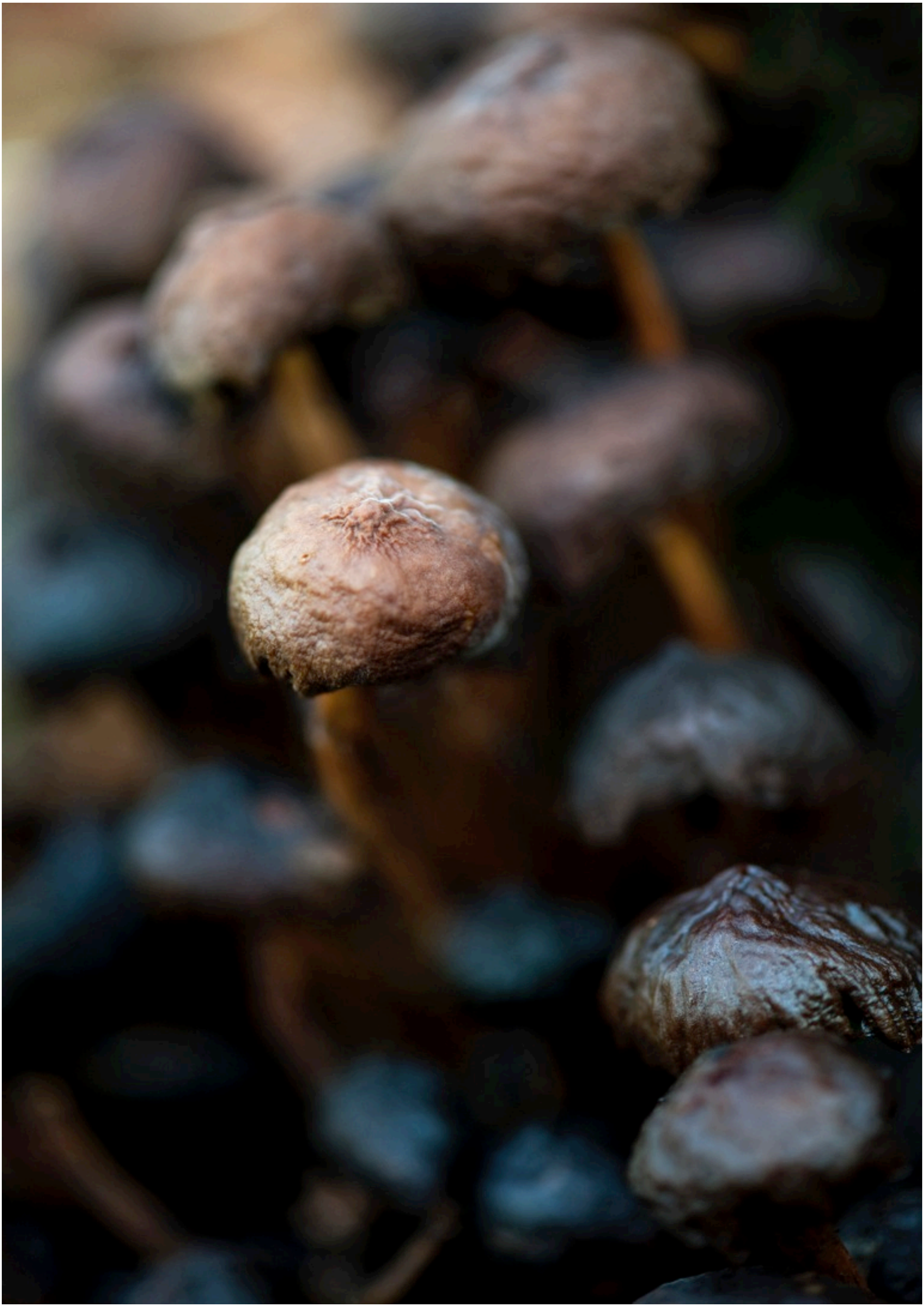
[472] L. Bate, "The Oriole," *Sydney Mail*, 12 Jun 1912, http://nla.gov.au/nla.news-article160341537.

longingly admired the fungal ecosystem in her wheelbarrow. I wished I could surreptitiously toss some of this fungus food back into the forest and wheel the rest into my next workshop, but Dorothy needed to keep warm. Dorothy updated me on recent happenings at the farm as we watched a raven ride a gust over the ridge. As the first raindrops fell we ambled back to her old truck and hurled the wood in the back. I hugged Dorothy goodbye then gunned it down the highway to the airport, imagining the crackle of *Trametes versicolor* in her fire and the sizzle of ‘back paddock mushies’ in her pan.

Recycling Worlds

'Wherever there is life there is twist and mess,' writes Annie Dillard. From death comes the twist and mess of life: this is the paradox of fungal realms.

Fungal rotting captures the literary imagination, inspiring revolt and disdain. The characteristic metamorphoses of fungi upend ideas of nature hinged on stability and fixity. Out of decay, disease and death, fungi come to life.



chapter six

Organising fungi

The last of the natural historians

It was a bitter winter evening in 2013 when I found myself at a meeting for the 'deliberation of dung-loving Ascomycetes'.[473] An hour train journey spat me into the depths of the conservative Swiss canton of Appenzell. I huddled in my coat as I waited for the mycological society members to arrive. With predictable punctuality, a small procession of senior participants appeared, each carrying a wooden box. After exchanging greetings and finally making it clear I was not lost, I was ushered inside out of the cold. Jackets flapped madly to remove snow, releasing a waft of sickly-sweet naphthalene. I then followed the clash of geometric-patterned jumpers up the narrow stairs to the attic meeting room.

After another round of greetings, microscopes were carefully extracted from the wooden boxes and set up. The old tables filled with desk lamps, hand microtomes and magnifying glasses, flasks of distilled water and petri dishes, forceps and scalpels, compartmentalised specimen boxes and wooden racks full of vials with staining agents. The smell of well-oiled machines and the sharpness of chemicals mingled with fusty fungus specimens. Then the door flew open again. A large plastic-moulded box rolled in with a small man attached at the rear. He then unclipped a sequence of safety catches and wrestled a digital Leica microscope complete with fibre-optic tentacles out of its tomb. A chaos of cables and wires, known in Switzerland as a Kabelsalat (cable salad) made contact. Microscope, camera and computer sprang to life in a series of beeps and flashes. The imposing contraption momentarily took centre stage. However, it was the meticulously maintained and calibrated old microscopes, their metal corners worn smooth from decades of use that captured my imagination.

The doyen of the group, Hans-Peter, soon spotted the stranger in the room and took me under his ancient wing. Although seemingly perplexed as to my presence, he fully embraced the responsibility of my dung-loving fungus education. I hung on every word, despite understanding only every third, listening out for a slight inflection in his thick Swiss-German that might indicate I was being asked a question. Hans-Peter prepared samples with an unfaltering steady hand, sectioning and staining them before ejecting cover slips from his custom-made holder. Spores and structures loomed into focus as we ventured into microscopic fungal wonderlands, elucidated by Hans-Peter's intricate diagrams and careful explanations. Hours slipped by as the mycological society

[473] Fungi of the phylum Ascomycota are characterised by sexual spores in asci (sac-like structures) as described in chapter two. Dung is a rich substrate, often colonised by small disc-like Ascomycetes with very interesting spores and other microscopic features.

members worked in the soft spill of lamplight, each absorbed in their own private microscopic world. In the corner three bearded octogenarians stooped beneath the thatched ceiling, solemnly uttering a monotone mantra in Latin as they negotiated identifications. It was as though I had stumbled upon a secret ritual, an ancient call to prayer. Like the overlooked subjects of our meeting, extraordinary happenings transpire in unexpected places. I recollected the various research laboratories of my past with their shining stainless steel benches, glaring overhead lights and the ever-lingering tang of ethanol. Places where all subjectivities and any enchantment with natural history were dissolved and scrubbed away along with other undesirable residues.

The appearance of the schnapps bottle suggested the evening was drawing to a close. Just after midnight I bade everyone goodbye and headed into the snowy darkness toward the train station. My head swam with impressions and a sentimental sense that such experiences grow rarer by the day. As the wind whipped the snow along the abandoned street, I wondered if indeed they were among the last of the natural historians. The obituary section of the mycological society newsletter tracks their demise. On the deserted platform, I could just make out the outline of two distant figures in the murky glow of a solitary lamp. The train slid through the gloom and I climbed aboard. It was empty except for the two distant figures who metamorphosed into mohawked punks at the other end of the carriage. I nestled back into my seat as the night veered down an unexpected trajectory. In a thrilling finale to an evening of dissection, I watched transfixed as one punk carved a giant 'A' into the other's head with a knife, smudging the blood away with a leather sleeve. I decided 'A' was probably not for 'Ascomycetes'. As the train wended its way through the night, I reminded myself to check whether my Swiss army knife had a specialised head-carving tool.

The desire to divide

Scrambling around in the dirt searching for fungi is messy business. Unscrambling the nomenclatural tangle of taxonomy is even messier. In this chapter I brush the dirt from my pants and delve into the inexorable human imperative to divide and conquer. Psychologist, Richard Nisbett suggests the individualistic and independent nature of Western thought draws Westerners toward classification. He considers how Westerners tend to focus on particular objects (e.g. species) in isolation from their context more so than East Asians, who negotiate the world through less classificatory thought systems.[474] I explore this tendency, dipping into taxonomy and the ways fungi have been categorised. I examine the importance of naming as well as issues of individuality and plurality. I ask how and why taxonomic fungal knowledge is collected and produced. Once the domain of enthusiasts like those at the dung-loving fungus meeting, notions of 'expertise' change throughout history and I examine how such folk might relate to the modern molecular techniques in producing mycological knowledge.

Much of mycology is taxonomic. The main priority is to find out what fungi exist, where they exist and to name them. Once named, biological and ecological research reveals their properties, interactions and significances. Given the incompleteness of the fungal inventory, this trend is likely to continue.[475] Widespread concern about species extinction legitimises inventorying although a complete stocktake of the world's fungi is unlikely. Mycologist, David Hawksworth, estimated the Australian fungal inventory will not be complete until 3025.[476] While molecular advancements have accelerated the taxonomic process since Hawksworth's estimate almost twenty years ago, they have also revealed his estimate of the number of species to be conservative.[477] Completing the inventory is therefore a daunting prospect compounded by declining support for taxonomy.

The history of mycological taxonomy represents more than a mere categorisation of life. It is also a history of how fungi have been perceived and interpreted in different places over time, as new opportunities to mine their microscopic and molecular depths arise. Commonly portrayed as routine fact-gathering, the rigorous, conceptual and creative dimensions of mycological taxonomy often go unrecognised. Historian of science, Robert Kohler, defends the highly creative nature of taxonomy as intrinsic to the categories through which the world is perceived and understood.[478] He posits:

> We may think that sorting species is entirely a matter of defining things. That, after all, is how species appear in the taxonomic literature: as elaborate word pictures of defining features. But the actual process of sorting is more a matter of recognizing gaps and discontinuities between things. In ordering a world of more or less continuous variation, what counts is the ability to perceive gaps–the negative spaces between species.[479]

Taxonomic history also reveals which species existed (or were at least observed) at

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[474] Nisbett, *The Geography of Thought*, xvi.
[475] Ainsworth, *History of Mycology*, 4.
[476] Hawksworth, "Orphans in 'Botanical' Diversity," 115.
[477] Blackwell, "The Fungi," 426.
[478] Kohler, *All Creatures*, 227.
[479] Ibid., 232.

other times, reflecting changes in cultural history as different types of fungi became the focus of research. Europeans observed fungal micro-features in the late 1600s with the invention of the microscope although it was much later until their functions were fully understood.[480] By the nineteenth century European mycologists were receiving fungus specimens for identification from across the globe.[481] However, the first knowledge of fungi is thought to have begun thousands of years ago by various widely separated people (e.g. China, Australia, Austria) including Australian Aboriginal people.[482] European recording of Australian fungi began in the late eighteenth century. While Australia presented a bounty of bizarre biota to the European settlers, fungi received little attention in the immediate decades following settlement, with only three species of agarics being recorded. It was another four decades following Labillardière's discovery of *Aseroë rubra* in 1792 until further species were described by Miles Berkley based on specimens sent to Kew.[483] Tom May, Heino Lepp, Ian Pascoe and others have comprehensively documented the history of Australian taxonomic mycology and the shifting motivations for collecting and naming fungi.[484] May describes how few fungi were deliberately collected during the era of exploration (1788-1842) as early expeditions focussed on exploitable resources.[485] During the nineteenth century biological inventorying included fungus collections with most specimens sent to European mycologists for identification.[486] Mordecai Cooke's *Handbook of Australian Fungi*, published in 1892, represented the first monograph to bring together nineteenth century efforts to document Australian fungi.[487] However, it was the appointment of agricultural scientist, Daniel McAlpine, to the Victorian Department of Agriculture in 1890 that established systematic mycology in Australia.[488] Taxonomic focus shifted in the twentieth century when it again became more utilitarian in the research of species relevant to agriculture, forestry and medicine, undertaken mainly by the Council for Scientific and Industrial Research.[489] In the last three decades, the publication of field

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[480] Lepp, "Snippets of Mycological History," 2.
[481] Ibid.
[482] Heino Lepp, pers. comm., 21 December 2015.
[483] May, "Documenting the Fungal Biodiversity of Australasia," 333.
[484] e.g. May, "Documenting the Fungal Biodiversity of Australasia;" May and Pascoe, "History of The Taxonomic Study of Australian Fungi;" May, "History of the Australian Agaricales;" Pascoe, "History of Systematic Mycology in Australia".
[485] May, "Documenting the Fungal Biodiversity of Australasia," 335.
[486] May, "History of the Australian Agaricales," 266.
[487] May, "Documenting the Fungal Biodiversity of Australasia," 334.
[488] Ibid.
[489] Ibid. The Council for Scientific and Industrial Research changed its scientific research charter to become the Commonwealth Scientific and Industrial Research Organisation (CSIRO) in 1949.

guides and founding of Fungimap have seen a rise in public interest and inventorying of fungi.

As fungus enthusiast, Michael Kuo notes, taxonomy does not represent organisms, but rather, the ways in which they are perceived and organised.[490] Classification, posits natural historian, John Wright, is therefore ultimately a matter of (informed) opinion.[491] The invention of the microscope and understanding of microstructural components of fungi, followed by DNA analyses resulted in new groupings from Linneaus' macroscopic morphology-based taxonomy. Disagreement about what constituted 'evidence' – 'molecules versus morphology' – says biologist, Carol Yoon, 'was a battle between what we are sure of, what we see and sense with our own eyes and ears . . . and what molecular biologists offered as evidence, something literally invisible: DNA, and the wildly abstract data it provided'.[492] An even more vexing question is what actually constitutes a species.

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'But species are real!' implored David in the darkness. Mycologist, David Minter, founder of the International Society for Fungal Conservation, vehemently espoused the tangibility of species relative to more abstract concepts such as biodiversity. David and I drove in his rattly old car to his coastal hometown of Whitby, having just attended the Autumn Open Meeting of the British Mycological Society in London. During our five-hour journey we hammered out the various arguments for fungal conservation at species and ecosystem levels. As ideas collided in my brain, I started to wonder if species really were real. I have held them in my hands and felt them live and die but the taxonomic jury is still out as to what exactly constitutes a species. A vast literature wrestles the swathe of concepts that attempt to stabilise the definition. However, with species often described as a 'moving target' or 'transient entity,' taxonomy will always be a 'work in progress'.[493] Darwin knew the concept was mutable. Ernst Mayr tried to capture it and triggered 'decades of proliferating and conflicting species definitions, as well as endless argument over them, in what is possibly the most despised of evolutionary conundrums . . . the "species problem"'.[494] As John Wright notes, 'at the last count, there were

[490] Kuo, "Mushroom Taxonomy".
[491] Wright, *The Naming of the Shrew*, 35.
[492] Yoon, *Naming Nature*, 229.
[493] Wright, *The Naming of the Shrew,* 233, 7.
[494] Yoon, *Naming Nature*, 106.

twenty-six species concepts, twenty-five more than we would like'.[495]

Multiple concepts of species exist and examining them in detail is not the aim of this thesis, other than to recognise the challenges they impose in understanding fungi. David, however, was right. Species are still the predominant unit of conservation, and as Kohler notes, the most basic and stable category: 'It is the one and the only natural unit: that is, the one that actually exists in nature. Higher categories are human inventions designed for our own purposes, a cultural rather than a natural order'.[496] Cultural geographer, Jamie Lorimer says species offer an intuitive ontology serving as the primary unit for practical conservation as they 'provide readily accessible units for establishing targets and monitoring progress'.[497] However, the more I discussed these issues with mycologists, the more I realised that the 'challenge of species' lay not with species per se, but with how they are perceived. Although, as Wright notes, multiple species concepts exist, mycologists are less perplexed. A major difference between fungi and other organisms, particularly vertebrates and vascular plants, is that these other groups are already known and named. Taxonomic arguments about known organisms mostly relate to the reshuffling of described taxa.[498] However, as most fungi are undescribed, an all-encompassing species concept that incorporates their variety of lifecycles presents greater challenges, and in turn confounds how we think about other life-forms. I realised how uncertainty about what constitutes a species could shape how people understand and relate to fungi and influence conservation decisions. Species concepts have been debated from philosophical and biological perspectives based on ecological parameters, phenotypic similarity, evolutionary principles, reproductive isolation and various combinations of each.[499] Mycologists Tom Harrington and David Rizzo note that traditional characters such as morphology might prove inadequate for delineating fungus species because of their capacity to speciate at a rapid rate relative to other organisms.[500] In their efforts to find a suitable population-based species concept for fungi, Harrington and Rizzo differ from many other mycologists in giving greater focus to phenotypic characters, relying less on molecular markers. They maintain that

> ecological adaptations are key to the processes of speciation, and characters associated with ecology should be used to define species. Limiting formal species descriptions to the

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[495] Wright, *The Naming of the Shrew*, 242.
[496] Kohler, *All Creatures*, 228.
[497] Lorimer, "What About the Nematodes?," 544.
[498] Harrington and Rizzo, "Defining Species in the Fungi," 19.
[499] Ibid., 2.
[500] Ibid.

> morphology of fungal fruiting structures ignores most of the biology of the species.[501]

The 'species issue,' it seems, hinges largely on communicating abstract concepts.

Within the various species concepts lies another challenge, premised on the assumption of the discrete individuality of organisms. Defining where a fungus (beyond its sporebody) begins and ends, or whether it is even an individual at all, confounds ideas about species and the individuality and plurality of organisms.

Bounded and boundless – individuality and plurality

Dawn released the morning through slats of yellow light. Through my camera viewfinder the world was colour-cast, courtesy of a 'controlled burn' further up the Snowy River catchment in Northeastern Victoria. Despite their tainted hue, collembolas loomed into focus tucked up between the lamellae of a Velvet Parachute (*Marasmius elegans*). Two lamellae westwards, an earwig detected my presence and shied backwards into its fungal refuge. The earwig, collembolas and churring choughs in the canopy appeared to comprise discrete individual entities, bound by their exoskeletons or feathered mantles. However, given the staggering array of organisms performing vital processes in their body cavities, none are truly individual. Similarly, the roots of almost every grass, shrub and tree around me intimately entwined with fungi. Myriad creatures traversed the inside and outside of my body as I lay in the leaf litter. Brushing a tick from my arm, I contemplated the *Umwelt* of von Uexküll's famous tick and also wondered how the local Gunaikurnai Aboriginal people might perceive this eccentric arachnid. Recent scholarship wrangles with ideas about individuality, plurality and hybridity and how they challenge taxonomic frameworks. Environmental philosopher, Mick Smith, ecologically adapts French philosopher, Jean-Luc Nancy's concept of 'being singular plural' among animal species.[502] Says Smith, 'the ecological relations are complex and in no sense equal or reciprocal or reducible to a simple metric,' arguing for a more ethically and philosophically inclusive way to imagine the notion of ecological community.[503] Smith's 'ecological community' contrasts with its common interpretations in conservation biology that: 'emphasise the value of species and ecosystems as separable from a sense of being in community with each singular being,' where plurality is emphasised at the expense of singularity.[504] Drawing on von Uexküll's idea of *Umwelt*, Smith posits: 'To think in terms of ecological community is

[501] Ibid., 20.
[502] Smith, "Ecological Community," 21.
[503] Ibid. 37.
[504] Ibid., 30.

to recognise "the sense of the world" in terms of such very different appearances, involvements, significances, and experiences'.[505]

Barad extends these ideas further offering an 'agential realist ontology based on the existence of phenomena rather than of independently existing things'.[506] She posits, 'individuals' do not preexist but rather materialise as a result of their intra-actions, emphasising, 'it is not that there are no separations or differentiations, but that they only exist within relations'.[507] Referring to the indeterminacy of amoeba, Barad purports 'they queer the nature of identity, calling into question the individual/group binary,' adding that this indeterminacy is, 'what's so spectacularly exciting from a scientific point of view'.[508] The nascent field of multispecies ethnography explores concepts of 'becoming' in describing 'new kinds of relations emerging from nonhierarchical alliances, symbiotic attachments, and the mingling of creative agents . . . in studying the contact zones where lines separating nature from culture have broken down'.[509] To date, its zoocentric focus has been largely limited to mammals. However, emerging interest in fungi is exemplified in anthropologist Anna Tsing's critique of human-fungus relationships in her notion of 'arts of inclusion,' albeit focussing mostly on the utilitarian values of *Tricholoma matsutake* sporebodies.[510]

Decrying the obsession with superlatives in the newspaper reporting of a large *Armillaria bulbosa*, paleontologist Stephen Jay Gould notes that the deeper fascination lies not with its size, but, 'in the striking way that this underground fungal mat forces us to wrestle with the vital biological (and philosophical) question of proper definitions for individuality . . . the central question . . . for applying Darwinian theory to nature'.[511] How can criteria be established for individuality that include less definable or vaguely 'bounded' organisms such as fungi that operate at different levels of biological organisation? How does Gould's giant *Amillaria bulbosa* that grew 'vegetatively' from a single source, fit within concepts of individuality in contexts such as biological theory, taxonomy or conservation? While botanists commonly use the terms genet and ramet to differentiate individuals arising from sexual or asexual reproduction, Gould suggests they do not solve conceptual problems of defining individuality, but simply

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[505] Ibid., 39.
[506] Barad, "Nature's Queer Performativity," 37.
[507] Kleinman, "Intra-actions," 77.
[508] Barad, "Nature's Queer Performativity," 26.
[509] Kirksey and Helmreich, "The Emergence of Multispecies Ethnography," 546.
[510] Lowenhaupt Tsing, *The Mushroom at the End of the World*; Tsing, "Arts of Inclusion".
[511] Gould, *Dinosaur in a Haystack*, 337-8.

provide names to ‘acknowledge the classical case of inherent ambiguity’.[512] However delving deeper and to complicate things further, it becomes apparent that there is also no one definition of individuality, with taxonomists using different terms to define different types of ‘individuality’. In some contexts genetic individuality is relevant, in others, physical individuality, and hence different terms exist to differentiate them.

Individuality underpins Darwinian theory (individual organisms as units of selection) and is a major means through which nature is understood. However, the ambiguity of fungi (along with numerous other organisms such as corals) suggests nature is not composed of clearly understood entities. Such complexities can complicate practices such as conservation that usually require defined notions of singularity. Determining rarity entails quantifying species by counting individuals. Red-listing a fungus species means applying criteria that assume individuality.[513]

Notions of fungal individuality become even blurrier when it comes to reproduction. Analogies to human sexuality and the limitations of the male-female binary do not translate easily to fungi.[514] Rather than sex or gender, mycologists generally refer to fungal ‘mating types’. While many of the so-called primitive fungi have only two mating types, others have multiple mating types with some like the Split Gill (*Schizophyllum commune*) having more than 28,000.[515] In 1959 mycologist, John Raper, began his presidential address to the Mycological Society of America:

> Sex, quite aside from its recreational possibilities, has profound and far-reaching biological significance, and the fungi, of all organisms the more diversified as regards sexual manifestations, afford the ideal materials for the dissection of the significance of sexual processes.[516]

Raper spoke of the ‘unparalleled versatility’ of fungi and a sexual ‘plasticity unequalled elsewhere,’ yet male-female binaries stubbornly persist in the teaching and understanding of biology.[517] This sexual ambiguity of fungi adds to the subconscious sense that something is odd about these organisms. They are not only indeterminate and obscure, but sexual aliens as well. However, while Raper recognised the extraordinary sexual plasticity of fungi, the distinction between sex, gender and mating types could be illusory. Great variety exists in the mechanics of fungal sexual reproduction but

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[512] Ibid., 340.
[513] For example, criteria used by the International Union for Conservation of Nature Red List to assess the extinction risk of species.
[514] Money, *Mushroom*, 12.
[515] Volk, “Fungus of the Month”.
[516] Raper, “Sexual Versatility,” 107.
[517] Ibid., 110.

essentially the processes are the same as for humans.[518] While acknowledging difference is necessary in having fungi recognised as unique from other forms of life, another approach might be to recognise how we are more like fungi than we think. In an evolutionary context, plant pathologist, George Hudler reminds us, '*Homo sapiens* may not be a higher form of life than fungi, but that they are instead equal partners on parallel roads'.[519] Could imagining fungi as something comparable to 'kin' allow for their more inclusive consideration? These ideas are explored in the following chapter.

Why names matter

Dozens of Fjällig bläcksvamp (*Coprinus comatus*) collapsed in an inky mess on the manicured lawns of the Linneaus Garden in the Swedish town of Uppsala. I imagined it as a foul act of fungal revenge for Linneaus' near abandonment of fungi in his *Species Plantarum*.[520] Not looking too appetising in their final stages of decay, I opted instead for a traditional Swedish kardemummabröd (cardamom bread) at the Café Linné. Carl von Linné, also known by his Latin name, Carl Linnaeus (1707-1778), is most well known for his system of binomial nomenclature that still forms the basis of taxonomic naming procedures today. Although the practice of natural history has changed, Linneaus' bionomial nomenclature underpins the biological sciences and is the universally accepted standard of the scientific community.[521] Linneaus revolutionalised classification by providing a common language, naming 4,400 animal species and 7,700 plants. However, he largely overlooked fungi, describing only about eighty species.[522] John Wright notes, it was not as if fungi were unknown, citing Pier Antonio Micheli's *Nova plantarum genera* of 1729 that listed nine hundred species including lichens.[523] Likewise, mycologist, Heino Lepp, scathingly condemns Linneaus as contributing nothing to the study of fungi, 'whereas Micheli rose to the challenge with both

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[518] Put simply, in fungi, two haploid nuclei (originating from two parent fungi) fuse to create a diploid nucleus (as occurs with humans). A unique feature of some fungi (e.g. Basidiomycota) is that fusion of the cytoplasm (plasmogamy) is separated in time from fusion of the nuclei (karyogamy), involving an extended 'dikaryotic' phase with two separate parental nuclei in each hyphal compartment. A diploid nucleus then generates haploid nuclei via the process of meiosis (as with humans). With some fungi, mating type is determined by a single factor that comes in variants (or alleles). These vary in number between fungi, but the basic principle is that two mycelia are compatible if they have different variants. In a human context, mating type is determined by one factor, with two variants, male and female (although arguably more). From a reproductive point of view, two humans are compatible only if they have different variants of mating type.

[519] Hudler, *Magical Mushrooms*, 7.

[520] Wright, *The Naming of the Shrew*, 203.

[521] Whatmore, *Hybrid Geographies*, 20-21.

[522] Wright, *The Naming of the Shrew*, 221.

[523] Ibid., 204.

intelligent curiosity and ingenuity'.[524] He notes it was Dutch mycologist, Christiaan Hendrik Persoon (1761-1836) and Swedish mycologist, Elias Magnus Fries (1794-1878) who laid the foundations of fungal taxonomy in the first half of the nineteenth century.[525]

Persoon's nomenclatural system for fungi marked the rise of modern systematic mycology. His first major work on fungal classification (and the first in modern fungal taxonomy) was published in 1794, followed by a 700-page book in 1801 entitled, *Synopsis methodica fungorum*.[526] Persoon classified fungi based on conspicuous morphological features, introducing the important concept of the hymenium.[527] Fries furthered Persoon's work, presenting a new systematic classification that included the use of spore colour, setting the path for future taxonomy and nomenclature. He began describing fungi from the age of fourteen, obtained his doctorate from Lund University in 1814 and between 1821 and 1832 published his major works, *Systema mycologicum* and *Elenchus fungorum*.[528] He went on to describe hundreds of species sent from around the globe. Fries only once ventured outside of Scandinavia and I wondered how he perceived these specimens – or more probably, the remnants of specimens ravaged by the biota resident in ships' hulls – dispatched from places as remote as Australia. As Tom May notes, this separation between collector and taxonomist meant some degree of misinterpretation was inevitable.[529] Fries lived most of his life in relative poverty and I cannot think of too many especially wealthy taxonomic mycologists today (other than some working in forensic mycology). More commonly, taxonomic mycology is a low-profile, under-recognised and undervalued pursuit, inspired by curiosity and driven by passion. It is often the manifestation of unflagging interest stemming from childhood. Taxonomists strive to find ways to share their concerns about the plight of biodiversity within the demands of objective science. As is the requirement of science, their privately held views, values and biocentrism are often obscured by 'more anthropocentric, utilitarian, scientifically respectable rationales'.[530] For many, conservation came first, for others, it makes (self-interested) sense to preserve the subject (ultimately specimens and collections) of one's study and income.

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[524] Lepp, "Snippets of Mycological History," 184.
[525] Ibid., 194.
[526] Ibid., 196.
[527] Ainsworth, *History of Mycology*, 70. The hymenium is the reproductive surface of a sporebody.
[528] Strid, "Elias Fries," 42, 46.
[529] May, "History of the Australian Agaricales," 269.
[530] Takacs, *The Idea of Biodiversity*, 11.

Naming provides the satisfaction of identity. It gives a fungus a place in the greater scheme and hierarchy of taxonomic mycology. Sociologist, Gary Fine argues that naming furnishes a fungus with meaning, relieving humans of the discomfort of ambiguity. Having a name increases the likelihood of inclusion – in human consciousness, in research and in conservation programs. 'Part of knowing is the act of naming' and things without names get pushed aside.[531] Moreover, says Robert Macfarlane, 'Without a name made in our mouths, an animal or a place [or a fungus] struggles to find purchase in our minds and our hearts'.[532] Having a name, of course, also eases communication as a shorthand way of referring to the same fungus without requiring long-winded descriptions. Naming is potent and satisfying. For some, assigning a name to a fungus, rather than leaving it unnamed, holds greater weight than accuracy. Says natural historian, Peter Marren, 'Truth in taxonomy is a many-sided thing. There are rules, of course, but there is also wide scope for interpretation'.[533] Tom May notes that many Australian fungus species described in the nineteenth century relied on a single specimen or collection. He examines the tension between the desire to name a presumably novel species and the ideal of examining further collections so as to better grasp the extent of variability within a species.[534]

Naming and claiming – scientific and vernacular names

'What's the use of their having names,' the Gnat said, 'if they won't answer to them?'

'No use to them,' said Alice; 'but it's useful to the people that name them, I suppose. If not, why do things have names at all?'[535]

Scientific names provide a consistent universal currency spanning language and culture. Or at least that is the theory. This ideal does not always manifest quite so smoothly in reality. Despite Linneaus' efforts to bring order to naming life, his system was complicated by inconsistent approaches to naming by different people, resulting in synonymy and homonymy. In an effort to standardise naming processes internationally, rules or 'codes' were developed over the centuries for animals, plants and bacteria, beginning with the Strickland code for zoologists in 1842. Fungi, however, missed out

[531] Arthur, *The Default Country*, 72.
[532] Macfarlane, *Landmarks*, 24.
[533] Marren, *Mushrooms*, 94.
[534] May, "Documenting the Fungal Biodiversity of Australasia," 337.
[535] Carroll, *Alice's Adventures*, 26.

on their own code and fell under the International Code for Botanical Nomenclature. Mycologists welcomed the revision of the botanical code at the International Botanical Congress meeting in Melbourne in 2011, which resulted in a new designation, 'The International Code of Nomenclature for algae, fungi and plants (Melbourne Code)'. As historians of science Libby Robin and Jane Curruthers note, the renaming of the code explicitly acknowledges fungi and algae not as 'botanical' organisms, but as organisms situated in other kingdoms.[536]

I loved scientific fungus names from a young age. Vernacular names were not really an option as few existed for Australian fungi at that time. The scientific names were rhythmic and mysterious and I revelled in the challenge of connecting their meaning to the fungus in front of me. It was a game of sorts. Knowing the names of the fungi I encountered mattered. It still does, but to a lesser extent. I now wonder whether it was as much about the linguistic joy of letting all those names roll around in my mouth as the revelations of relationships. Like Alice, I came to realise how names revealed more about *Homo sapiens* than the species themselves. Today I also seek to discover the individuality of each fungus, rather than just the features it shares with members of its species. Peculiarities capture my imagination more than commonalities. Tim Ingold recognises this limitation in the notion of a field guide. He points out the paradox of how field guides effectively deny uniqueness by overlooking idiosyncrasies, highlighting shared characteristics with others of the same kind. He contrasts this with the comparative entity of an address book that acknowledges singularity through individual names and addresses.[537] Ingold's observation is another example of how notions of 'species,' while inordinately useful, can also narrow the ways in which nature is understood. Moreover, how might this difference in the way humans are identified relative to other organisms perpetuate the divide between *Homo sapiens* and other species? I opened my *Field Guide to Tasmanian Fungi* (Gates and Ratkowsky) randomly, landing on page sixty-nine. The description for *Entoloma discrepans* reads:

> *Entoloma discrepans* Noordel. & G.M. Gates – This common little species (cap ca. 2 cm diam.) is quite distinctive due to the dark blackish blue colour of the cap and stipe (to 5cm long, 2–5mm wide) and the pinkish blue-grey gills which may or may not have a brown edge.

My field guide to mammals, *A Field Guide to the Mammals of Australia* (Menkhorst and Knight) oddly, does not include *Homo sapiens*, but if it did, in line with the fungus guide it might read something like:

> *Homo sapiens*, human – This common bipedal species (height c. 150-250 cm) is quite

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[536] Robin and Curruthers, "National Identity and International Science," 49.
[537] Ingold, *Being Alive*, 167.

> distinctive due to commonly wearing clothes. Males are usually slightly larger than females. Skin colour varies from pale through to dark brown.

Some people might feel robbed of their individuality by such a description. These brief descriptions are inadequate in defining what the fungus is or who we are. They are important and relevant in differentiating us as individual species, but we are evidently so much more than that defined in the description. It is ludicrous to suggest a field guide could describe every individual sporebody. The point is simply to provoke an awareness of how generalised descriptions entail a certain loss of individuality and while names matter, naming also strips away the autonomy of the individual and its idiosyncrasies. Yet one might also ask whether the peculiarities of the individual would be recognisable without the homogenising notion of species. A field guide that specifies a species' morphological limits (i.e. the possibilities and shared characteristics) could in fact prime one to spot the peculiar.

Efforts to assign English vernacular names to easily identifiable fungi began in the 1950s when plant pathologist Ernest Large made an impassioned plea for their coining.[538] Large's attempt was largely unsuccessful, possibly due to it being premature relative to public interest in fungi, or to lack of inspiration in his choice of names. In 2000 the British Mycological Society (BMS) joined the cause to search for innovative and memorable names, overseen by Scottish mycologist, Liz Holden, and first published in 2003. In Australia, only a handful of vernacular names for fungi have been used since the first settlers and these were based on European vernacular names. Names such as Beef-Steak Fungus (*Fistulina hepatica*) appeared in the *Victorian Naturalist* as early as 1885.[539] Botanist, Jim Willis, was possibly the first to publish vernacular names such as Pixie's Parasol (*Mycena interrupta*) and Blackfellow's Bread (*Laccocephalum mylittae*) in an article in the Victorian Naturalist in 1934, later published in his 1950 edition of *Victorian Toadstools and Mushrooms*.[540] In 2003, fungus enthusiast Ian McCann published many more vernacular names in his field guide *Australian Fungi Illustrated*. Published in 2005, *Fungi Down Under* developed these further. Editors, Pat and Ed Grey described how they examined genera used by the BMS and then added conspicuous features of Australian fungi to develop additional vernacular names. For example, Little Ping Pong Bat (*Dictyopanus pusillus*) was inspired by the shape of the sporebody; Golden Splash Tooth (*Mycoacia subceracea*) based on the colouration and 'toothed' hymenia; and Velvet Parachute (*Marasmius elegans*) refers to the felty texture

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[538] Marren, *Mushrooms*, 56.
[539] "The Field Naturalists' Club of Victoria," *The Victorian Naturalist*, 2 (3 July 1885): 29-36.
[540] Willis, "The Agaricaceae," 298. Blackfellow's Bread was renamed Native Bread.

of the pileus.[541] Others also participated in the naming process. Fungus enthusiast, Cecily Falkingham, suggested Ruby Bonnet (*Mycena viscidocruenta*) and Tom May and Pat and Ed Grey coined Tea-Tree Fingers (*Hypocreopsis amplectens*) to reflect the clasping finger-like lobes of the sporebody and the Heath Tea-Tree (*Leptospermum myrsinoides*) with which it grows. Mycologist Tom May concedes that while he was not initially in favour of vernacular names, he recognises their value in making fungi more widely accessible.[542]

Adopting new names and language takes time. In Australia, mycologists and the ageing population of field naturalists usually prefer their long-held scientific names to the recently assigned vernacular names. However, the timing of the publication of vernacular names in *Fungi Down Under* coincided with growing public interest in fungi. These names are being adopted, for example, by the wider public who attend my fungus forays, who do not have a history of using scientific names. Vernacular names also need to be appealing if they are to be accepted. In describing historian Alex Chisholm's role in developing vernacular names for birds, Libby Robin notes, 'his views on "elegance"', "euphony" and "language" influenced final decisions. He was known as a trenchant critic of names if they failed to engage the observer'.[543] Scientific and vernacular names variously resonate for different users. For forayers, scientific accuracy is paramount. Foragers have different priorities. Gary Fine observed foragers often prefer vernacular names as they change less often than scientific names: 'Stability is more important than a scientific naming practice grounded in truth'.[544] He notes that if the goal of vernacular names is to facilitate communication, then naming should be tied to routine language practice.[545] Unlike scientific names, there are no codes for vernacular names. They are not 'official'. It is more about common use and accessibility. Tom May comments: 'After all the care in making the names, when out with the Field Nats, I have heard Pat Grey calling *Oudemansiella radicata* "Oody Roody" rather than "Rooting Shank". This is my favourite sort of common name, one that is actually used day to day'.[546] Unstable taxonomy presents inevitable tensions. While scientific name changes often frustrate fungus enthusiasts, May describes how a 'better' circumscription of a species is more informative about its properties and is

[541] Pat and Ed Grey, pers. comm., 4 November 2015.
[542] Tom May, pers. comm., 27 October 2015.
[543] Robin, *The Flight of the Emu*, 65.
[544] Fine, *Morel Tales*, 233.
[545] Ibid., 229.
[546] Tom May, pers. comm., 27 October 2015.

hence an improvement. He also recognises the need for mycologists to more effectively communicate taxonomy in balancing information and usability.[547]

Although most scientific names arose before vernacular names in post-colonial Australia, in many parts of the world vernacular names were the *lingua franca* for hundreds if not thousands of years before scientific names. Like Barbara and her *Semmelstoppelpilz* from chapter four, Valentina Pavlovna Wasson also preferred vernacular names, considering them more accurate and reflective of the accumulation of deep local knowledge:

> The names evoke for Russians the edible qualities of the various kinds, but semantically they refer primarily to the habitat and essential character of the species. Several of the folk-names for mushrooms in the Russian language could have come into acceptance only after age-long intimacy. The scientific nomenclature of the Western mycologists, devised over the past century, is superficial by comparison with some of the Russian common names. The pseudo-classical terms of the scientists being keyed often to accidental attributes, the aspects that the untutored eye of the early mycologists first remarked.[548]

Few mycologists probably share her view and taxonomy has doubtlessly become more precise in the sixty years since she made this comment, but as natural historian John Wright remarks, naming is a ‘human activity, not a biological one’.[549] Scientific and vernacular names do not compete for ‘accuracy’ and each serve different purposes. Vernacular names have their place in returning fungi to the people, releasing them from the obscurity of taxonomy.

There is also a case for not naming. Seeking fungi is not only about arriving at an end point of a name. It is also about remaining interested in the elusive. Fungus enthusiasts and field mycologists bemoan LBMs (little brown mushrooms), which, like little brown birds, are notoriously difficult to identify. It seems that not being able to put a name on a fungus makes it less satisfying, less meaningful, even less worthy. Yet the fungus that eludes identification might also hold more fascination. Such fungi bring me to the forest each day. They share something with the blank parts on the map. Both keep the forest and its inhabitants endlessly alluring. As Robert Macfarlane argues, this is not to reduce the significance of naming and there is: ‘no opposition between precision and mystery, or between naming and not knowing’.[550] Tom May notes that a fungus without a name can compel one to observe it more closely, hence inspiring an interaction.[551]

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[547] Ibid., 21 January 2016.
[548] Wasson and Wasson, *Mushrooms, Russia and History*, 17.
[549] Wright, *The Naming of the Shrew*, 242.
[550] Macfarlane, “The Word-Hoard”.
[551] Tom May, pers. comm., 12 January 2016.

Tallying fungi

Not unusually, it was raining in London. Stepping off the train at Kew station, I landed in a giant puddle and my boots filled with water. The pub on the platform, 'Tap on the Line,' seemed like a good place to take shelter. I gazed at the eclectic collection of botanical illustrations on the walls and huddled nearer the fire. A good strong cup of tea and I quickly revived and headed back into the rain to find my bed-and-breakfast accommodation. Arriving at the Richmond address scrawled in my notebook to the scream of death metal, I wondered if I had written it down wrongly, but rapped on the door anyway. A hairy giant with a face full of piercings and a Flying-V guitar eventually appeared, flipped the door open with his boot and beckoned me inside. He was not exactly the 'genteel botanical type' I had expected and inordinately more charming. I then had a flashback to once being on a train in Appenzell . . . .

I had not come to Kew Gardens to look at plants, but was here to visit the Fungarium. Curator, Begoña Aguirre-Hudson, shared the woes of her job in managing 1.25 million fungus specimens and seemed slightly perplexed that I did not have a list of specimens to view. The truth was, I wanted to see them all. Not individually, but to see where Australia's first collected fungi now resided. Begoña led me on a whirlwind tour through the sea of 12,500 green specimen boxes. She then vanished, leaving me to explore this hyperspace of historical specimens. I rummaged around the climate-controlled collection of boxes housing centuries of sporebodies from every corner of the world, now in their final resting place in the bowels of London. I slid open drawer after drawer and opened box after box, peering in to see the names of fungi, places and people who collected them, handwritten in ink, or stamped out on an early Olivetti. Opening one box, I saw familiar club-shaped sporebodies and parasitised caterpillars. A little shrivelled but otherwise in remarkable condition well over a century later, the steep copperplate label read: '*Cordyceps gunni,* Franklin Village, Tasmania, collected by W. K. Hawkes and Dr Milligan'.[552] I tried to imagine the people and the circumstances in which these fungi were collected in Australia, packaged up and sent to Kew. The Kew collection is not only the world's largest collection of dried fungi but also one of the oldest, founded in 1879 (the plant herbarium was founded in 1852). Heino Lepp remarks that given the English settlement of Australia, it is unsurprising that English mycologists published ninety-eight percent of new species in the second

[552] The collection was undated, but Hawkes lived from 1805-1882 and further records show that he found *C. gunnii* in his garden in Franklin, Tasmania in 1844. Hannaford, *Sea and River-side Rambles*, 104. This species was named in honour of the eminent Launceston naturalist and museum director, Ronald Gunn.

half of the nineteenth century. Hence, most Australian type collections from that time lay within the very boxes surrounding me.[553] For hours I was captivated by the surprises to be discovered in each green box. They also reminded me of exactly the kind of person I am not. I deeply appreciate the value of the collection, however, in chapter eight I explore what happens to a fungus when it becomes a 'specimen'.

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Although Labillardière discovered *Aseroë rubra in* 1792, it took a further two centuries for the distribution of this and other fungus species to be mapped. Today (26 November 2015), the *Atlas of Living Australia* lists 875 records for the occurrence of *A. rubra* in Australia. Historical understanding of biodiversity, says Robert Kohler, is founded on the history of collecting and collections.[554] Over the last two decades Fungimap has driven the collection of Australian fungus records. Early Fungimap newsletters document this effort toward building a picture of fungus diversity and distribution. On the 27 May 2013 a fungus known as *Marasmius* sp. "angina", became the hundred thousandth dot on the fungal map.[555] A group of enthusiasts and mycologists who were attending a foray as part of the seventh Fungimap conference found the specimen in the Tarra-Bulga National Park, Victoria. This dot represented a significant achievement for Fungimap and knowledge of Australian fungus distribution, most of it being voluntarily contributed. Citizen science programs and online data repositories have sprung up like mushrooms in recent decades, capturing an interested public keen to contribute their bit of local knowledge to the bigger biodiversity mapping picture. Collecting, classifying, naming and mapping have also radically and rapidly changed in recent decades. Kohler describes how collecting has been revived through the availability of cheap mechanised methods of DNA fingerprinting. Consequently, the reconfiguring of earlier classifications from morphology-based taxonomy uncovers new relationships. Today, it is not just specimens from nature that are collected, but bits of DNA from historical specimen collections. Says Kohler:

> Molecular taxonomists are recapitulating the field collecting of past centuries, but without going afield: their expeditions are to museum storerooms . . . Biologists now inventory banks of data, as survey collectors once inventoried the living ark of nature. Genome-mapping

[553] Lepp, "The Study of Australian Fungi".
[554] Kohler, *All Creatures*, 2.
[555] Coined by Gordon Beaton, "angina" refers to the purple pileus, which he saw as reminiscent of skin colour changes during an angina attack. Moison and May, "Fungimap's 100,000th Record," 14.

> projects could be seen as a kind of survey collecting, the difference being that genome mappers quietly ignore natural variability, whereas field naturalists make it the object of their study.[556]

The green boxes of the Fungarium suddenly took on a whole new significance.

Quantifying fungi provides a vital means to track and enumerate changes in population distributions. Numbers contextualise fungi in other ways. They offer an objective and valuable justification for placing a particular fungus species on a Red List. Karen Barad posits: ‘measurement is a meeting of the “natural” and the “social”. It is a potent moment in the construction of scientific knowledge – it is an instance where matter and meaning meet in a very literal sense’.[557] Without quantifying fungi it would be extremely difficult to get an overview of distributions and how they might change over time. Concepts such as rarity could not easily be determined and conservation measures like Red-Listing would not be possible. Science is not ‘about numbers’ as often claimed, rather they are simply a way of analysing things. However, after two hundred and fifty years of taxonomy, the great majority of life remains unknown.[558] The big picture understanding of fungi requires both quantification along with other ways of understanding them. As Libby Robin remarks,

> if we measure environments using countable phenomena, and fail to notice subjective human factors in environmental change, we are blind to the numenon of places. We forget what drives what we notice and measure. Complex ecosystems are irreducibly interconnected and much more than the sum of their physical elements.[559]

Counting needs to be enriched with points of view grown from direct experience. Chris Maser and colleagues remind us that the cumulative effects of nature cannot be tallied:

> All things operate synergistically as cumulative effects that exhibit a lag period before fully manifesting themselves. Cumulative effects, which encompass many little, inherent novelties, cannot be rendered statistically, because ecological relationships are far more complex and far less predictable than our statistical models lead us to believe.[560]

In the final chapter I ask what counts and what can be counted.

What makes a mushroom?

Grouping objects together based on their appearance is a common human tendency and was the premise of early taxonomy. As John Wright notes, it is unsurprising that different groups of fungi have evolved to appear morphologically similar, given they

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[556] Kohler, *All Creatures*, 282.
[557] Barad, *Meeting the Universe Halfway*, 67.
[558] Krishnamurthy and Francis, “Utility of DNA Barcoding,” 1902.
[559] Robin, “Counting our Blessings”.
[560] Maser, Claridge and Trappe, *Trees, Truffles and Beasts*, 12.

face the same or similar challenges.[561] Gross morphology, however, proved to be a poor indicator of relationships. Understanding and classification of life changed radically fifty years ago with the discovery of DNA. Sequencing of DNA opened incredible new worlds, improving the chance to know the extent of life on earth. It provides not just an overview of the diversity of species within ecosystems, but also the means to evaluate genetic variability within species.[562] Molecular technology has also revolutionalised fungal systematics by elucidating phylogenetic relationships from new perspectives. Molecular techniques complement morphological studies of fungi especially when cryptic species complicate species determination. Consequently, sequencing exposes fungus species never before seen.[563] Moreover, the staggering number of species revealed through molecular techniques using soil samples overcomes the problem of sampling sporadic and ephemeral sporebodies. DNA barcoding techniques also offer the advantage of speed and efficiency. Because conservation biology is a crisis discipline, rapid and informative techniques are necessary in the race to document species and attempt to slow their loss. Rapid molecular sampling provides 'snapshot' impressions of diversity. This is especially useful in assessing effects of disturbances such as fire and the scales at which to apply conservation efforts. Consequently, DNA barcoding is now used globally to identify and categorise species for biodiversity assessments and conservation.[564]

While taxonomy is becoming increasingly integrative incorporating both morphological approaches and molecular techniques, how has the discovery of DNA affected the way fungi are perceived? Over the past half century, in the endeavour to understand life, scientists have broken down systems and organisms into their component parts. However, neither can be fully understood by their parts. Given these parts are now fairly well known, some scientists are suggesting it is time to reassemble them again. Recognising the benefits of molecular science, systems biologist, Denis Noble, asks how molecular knowledge could be used to extend understanding of life by scaling up and applying systems thinking:

> We know a lot about molecular mechanisms. Now the challenge is to extend that knowledge up the scale . . . . Molecular biology requires a certain way of thinking. It is about the naming and behaviour of the parts. We reduce each whole to its component parts and define them exhaustively. Biologists are now perfectly used to that thinking and the interested lay public

[561] Wright, *The Naming of the Shrew*, 249.
[562] Krishnamurthy and Francis, "Utility of DNA Barcoding," 1902.
[563] Fungal Barcoding Database, "About the Project".
[564] DNA barcoding is the use of short standardised segments of the genome for identification of species in all the Kingdoms of Life. Fungal Barcoding Database, "About the Project".

has caught up, too. So we are now ready to move on. Systems biology is where we are moving to. Only, it requires a quite different mind-set. It is about putting together rather than taking apart, integration rather than reduction. It starts with what we have learned from the reductionist approach; and then it goes further. It requires that we develop ways of thinking about integration that are as rigorous as our reductionist procedures, but different. This is a major change. It has implications beyond the purely scientific. It means changing our philosophy, in the full sense of the term.[565]

Databases provide stores of knowledge but the genome is just one type of database.[566] Human geographer, Sarah Whatmore, cautions we must also listen to the voices of the biophilosophers, 'to retrieve the effectivity of the organism from the haystack of genes; cells and populations that have become the preferred units of biological analysis'.[567] What really makes a mushroom? Surely it is more than a soup of proteins. Its development requires more than its genome. In a useful metaphor in arguing for a systems approach to understanding life, Noble posits:

On its own, the stretch of DNA code for a gene is like a word without the semantic frame of its language. The system provides the semantic frame and gives the gene its functionality, its meaning. Equally, the system cannot exist without the genes. But there is nevertheless an asymmetry. The logic of successful systems that win in the competition for survival lies in the system, not the genes. What the genes do is to contain the database from which the system can be reconstructed.[568]

The revelations from molecular research of fungus and plant species richness have stimulated new enquiry into the intricacies of holobionts, changing the ways in which bionts are understood to function and interact.[569] Relationships between species are becoming better understood than ever, but do people relate to them, do they care?[570] Molecular taxonomy shunted *Homo sapiens* a step further away from a sensate understanding of life. Through the glass window of their 'aquarium' laboratory at Kew, I watched the white-coated scientists silently move about and wondered if their separation from the grubby origins of their subjects influenced their perceptions of fungi. What happens when humans become outside observers, rather than part of the world? As Barad contends,

on an agential realist account of technoscientific practices, the 'knower' does not stand in a relation of absolute externality to the natural world being investigated—there is no such

565 Noble, *The Music of Life*, x-xi.
566 Ibid., 10
567 Whatmore, *Hybrid Geographies*, 33.
568 Noble, *The Music of Life*, 21.
569 Lynn Margulis' concept of the holobiont (coined in 1991) describes the partner organisms, or *bionts* that operate together as a complex assembly.
570 Wright, *The Naming of the Shrew*, 124-5.

> exterior observational point. It is therefore not absolute exteriority that is the condition of possibility for objectivity but rather agential separability—exteriority within phenomena.[571]

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The advancements of molecular taxonomy provide a way to understand the evolutionary relationships of species. Taxonomy is a foundation of how life is understood assisting practical applications for conserving biodiversity. The thrill of discovering the name *Armillaria luteobubalina* has never left me and the joy of learning new unfamiliar names tantalises every forest foray. As Wright notes, 'names are not appellations, but things in themselves. Each has its own history and revealing etymology'.[572] Somewhere in one of those 12,500 green boxes at Kew or among the Australian repositories, lies a specimen forever linked with each fungus name wedged in my head. And somewhere linked to each specimen, is or was a person who wanted to give it an identity and context within the greater scheme of life. All have contributed to the understanding of fungi and the chance for their future survival.

Classifying fungi also needs to provide meaning. For many people, scientific classification has less relevance than the categories differentiating, for example, edible from toxic species. Most of the ways the world is categorised, such as items on a supermarket shelf, come back to pragmatism. After all, the first classification of plants and probably that of fungi, was based on their medicinal qualities. Molecular taxonomy reveals evolutionary histories of species that conflicted with the sense of natural order of categorising life, as it might have appeared to an observer. Yoon discusses the transition from a more intuitive understanding of life based on von Uxküll's idea of *Umwelt* to scientific ways of knowing:

> The story of taxonomy . . . is not merely a tale of the triumph of rationality and reason. It is also the story of humanity's inadvertent and unwise abandonment of the human umwelt . . . Taxonomy had begun marching toward its status as a modern science, and with every step it was moving further from the way in which humanity had always ordered, named, and understood the living world.[573]

I am not advocating Yoon's idea of reinstating *Umwelt* and a more instinctive approach to understanding life in favour of science. Rather, I ask how all these forms of knowledge, underpinned by scientific understanding, could collectively augment a more comprehensive, inclusive and sensitive approach. The next chapter explores some of

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571 Barad, "Posthumanist Performativity," 828.
572 Wright, *The Naming of the Shrew*, 267.
573 Yoon, *Naming Nature*, 213.

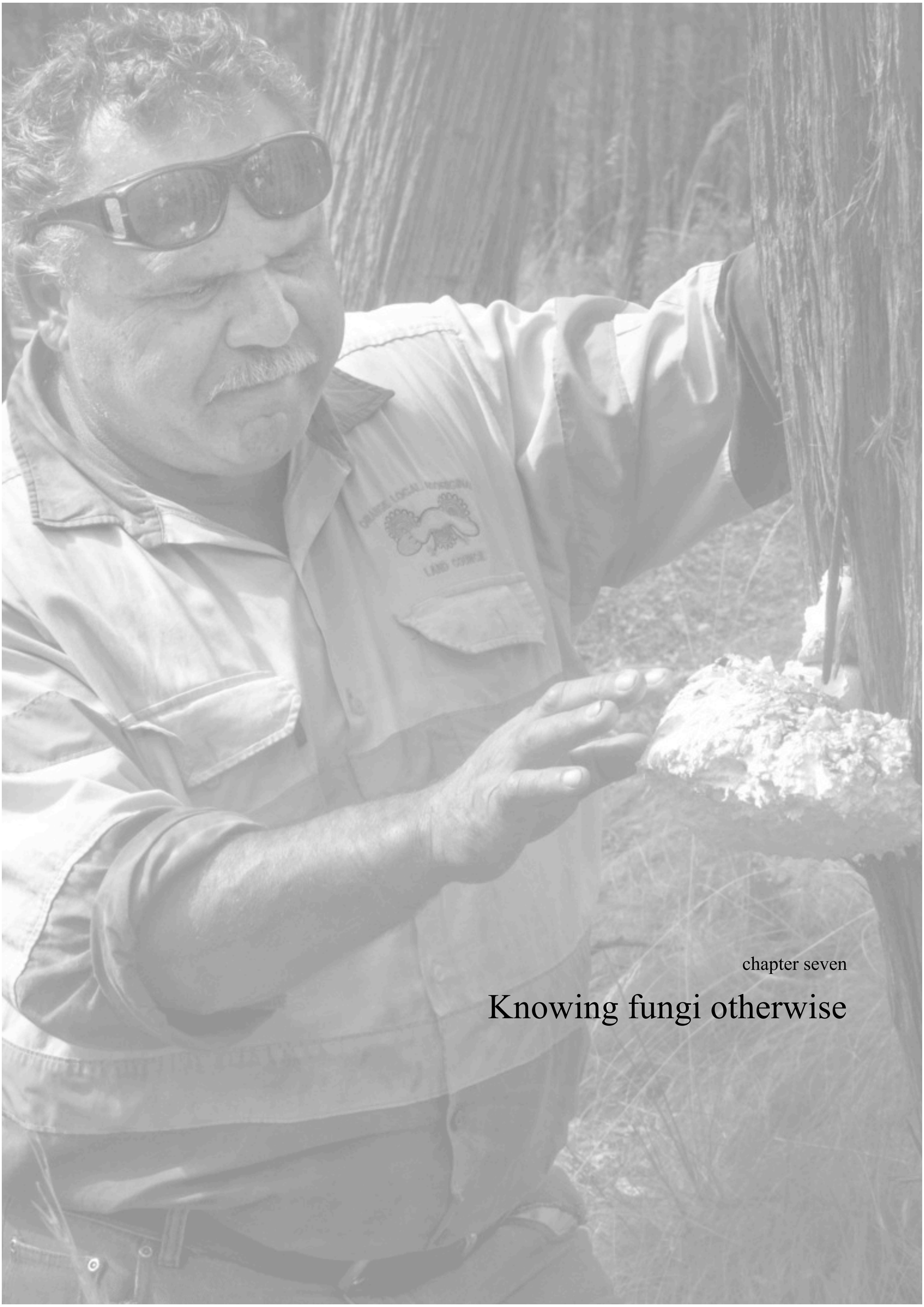
these other ways of understanding and ordering fungi.

Undersides

'I wanted to transfuse myself thus into all of nature, to experience what it was like to be an old boletus mushroom with its spongy yellow underside,' writes Vladmir Nabokov.

Much about fungi is hidden; in the subterrain, in microscopic worlds, or on sporebody undersides. The intimate textures of lamellae, spines, pores and silken folds reveal themselves to a finger run gently beneath a pileus.

An agaric's parallel blades are slaves to gravity. In the process of hydraulic expansion, a sporebody twists and distorts in an effort to keep them perfectly plumb as it heaves through the soil. The plasticity and flexibility of sporebodies underpins the miracle of spore release.



chapter seven

Knowing fungi otherwise

In a dusty neglected corner of the Museo Civico di Storia Naturale di Milano, the Natural History Museum of Milan, I unearthed what is possibly the earliest attempt to classify fungi. Long before Darwin, Linneaus, Micheli, Aristotle or even Pliny, an unknown author constructed a classification system incorporating folk beliefs, sensate observation and ways of evaluation, revealing much about early perceptions of fungi. Translated from Latin, this twelve-category system grouped fungi using the following criteria:

1. Damp ones
2. Soft ones
3. Those that reek
3. Those that turn to stone
4. Those caused by lightening
5. Those growing where deers rut
6. Those with maggots
7. Those that exhale gas
8. Those in a circle
9. Those that arise from the spittle of a deity
10. Those that cause blindness
11. Repugnant ones
12. Those found by a dragon's lair

The above classification, is of course, entirely fictitious. It was concocted while perched on a dilapidated fishing jetty on the Tambo River in East Gippsland, both of which are real. It is a fungal reimagining of Argentinian writer, Jorge Luis Borges' oft-quoted whimsical categorisation published in 1942 in *El idioma analítico*, from the fictive *Emporio celestial de conocimientos bene volos* (The Celestial Emporium of Benevolent Knowledge). This seemingly absurd fungus categorisation simply aims to prompt a reconsideration of the ways fungi are ordered according to Western taxonomic mycology. Are there limitations to the current system? What alternatives exist? What makes a particular way of grouping fungi resonate for some people and not others? Why do some see divisions while others focus on relationships?

The twelve groups above were not entirely randomly concocted. Each derives from the ways in which fungi were distinguished in fungal myths. Such myths arose from real or imagined impressions of fungi, many relating to cultural values such as edibility. The need for humans to eat existed long before the need to categorise for reasons of science. Mycologists, Rolfe and Rolfe noted in 1925: 'The employment of fungi as food is a very ancient practice, whose beginnings are lost in the mists of antiquity, and which is probably as old as man himself'.[574] Nearly three centuries earlier, Clusius (1601) differentiated 'Fungi Esculenti' (edible) and 'Fungi noxii et perniciosi' (harmful).[575] Some of the earliest written differentiation and naming of fungi emerged from former Czechoslavakia. Czech linguist Josef Hladký notes that in the fourteeth century, Czech language distinguished at least forty different species of mostly edible fungi.[576] Mycologist, Heino Lepp, considers the *Glossarius* (c. 1360) in which they appeared, to be the most comprehensive list of fungus species in any published work until Clusius' 1601 publication, with more fungus names in fourteenth century Czech than in Latin.[577] As extensively discussed by anthropologist Brian Morris in his seminal paper, 'The Pragmatics of Folk Classification,' opinion varies as to whether folk classifications arise from pragmatic interest in utilitarian values (e.g. Bronislaw Malinowski) or from an essentially intellectual concern for the 'search for order' (e.g. Claude Lévi-Strauss).[578] Taxonomy is as old as language itself. Understanding the value of different systems requires appreciation of both utility and science as a means of categorisation. Many taxonomies including those of Aboriginal Australians do not follow hierarchical Linnean approaches but instead reflect tangled skeins of connections. Moreover, some such as the Chewa people of Malawi consider fungi (correctly) to be more like animals than plants, which Morris suggests is probably widespread in traditional cultures.[579] Folk concepts of classification often operate on entirely different logics to Western taxonomy; being characteristically flexible rather than fixed, with ambiguous and overlapping categories; lateral rather than hierarchic, and inclusive of functional criteria.[580]

How do the many ways to know and order life intersect? Where do intuition and information meet? Where does the science of taxonomy converge with the wider public interest in fungi that relies on a more democratic, tangible and negotiable system for

[574] Rolfe and Rolfe, *Romance of The Fungus World*, 166.
[575] Ainsworth, *History of Mycology*, 243.
[576] Hladký, *The Czech and English Names of Mushrooms*, 100.
[577] Lepp, "Snippets of Mycological History". Lepp describes the *Glossarius* as being attributed variously to Bartolomejz Chlumce, Claretus de Solentia or Mistr Klaret dated about 1360.
[578] Morris, "The Pragmatics of Folk Classification," 45.
[579] Ibid., 53.
[580] Ibid., 58.

giving things names and meaning? Concepts of knowledge change. As Karen Barad notes, making knowledge is not simply about generating facts.[581] Moreover, how should facts be prioritised in creating knowledge? Some forms of fungal knowledge only emerge through extended direct interaction in local places. They are forged by those who see, feel, smell, touch (and have been touched by) all the expressions of that place and its fungi over extended time. Such things are not necessarily measurable, or even recordable. Appreciating fungi is an art as much as a science. Aesthetic experience deepened by scientific knowledge arguably offers the richest understanding of fungi and the forest. Elucidating its processes, while not robbing it of its enchantment, is the point where science and aesthetics meet. Philosopher Holmes Rolston III posits:

> Science, however necessary, is never sufficient. Forests must be encountered. Forests are constructed by nature, and science teaches us how that is so. Yet forests by nature contain no aesthetic experience; that has to be constructed as we humans arrive. Knowledge of the forest as an objective community does not guarantee the full round of aesthetic experience, not until one moves into that community oneself . . . we initially may think of forests as scenery to be looked upon. That is a mistake. A forest is entered, not viewed. It is doubtful that one can experience a forest from a roadside pullover, any more than on television.[582]

Fungi offer a window to the imagination. The striking and often mysterious nature of fungi has seen the fantastic play a prominent role in ongoing attempts to render fungi comprehensible. However, this also makes them prone to simplified analogies with the risk they might be taken as reality and used beyond their intention. Fungi attract ill-formulated and often deliberately misleading pseudoscientific 'theories' to convey ideas such as psychic intelligence. Coupled with the hallucinogenicity of some fungi, the commercial exploitation of the gullible through spurious claims of their power has cast them in dubious territory. Understanding other ways of knowing fungi requires receptivity to other logics and a sensitive sensorium, buttressed by constructive scepticism. How can other forms of knowledge open up new possibilities for rethinking fungi and ecological systems in more expansive and inclusive contexts? Does one truth have privilege over another? This chapter explores ways of knowing fungi through multiple knowledge systems that incorporate indigenous and local knowledge alongside Western taxonomic schema. I met with farmers, artists and Aboriginal people among others to learn from their stories and experiences. I focus particularly on the need to reawaken the senses.

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[581] Barad, *Meeting the Universe Halfway*, 91.
[582] Rolston III, "Aesthetic Experience in Forests," 161.

A farmer's way of knowing

In early autumn 2014, I arrived at the Woodstock-on-Loddon public hall in Central Victoria. The old redbrick building sat among exhausted paddocks, whipped on every side by a bitter wind. The building was the local school until 1902 when the supply of children ran low. Today it serves as an important community hub. Twelve years of drought, however, had taken its toll on the landscape and its inhabitants. This was not exactly ideal 'mushroom country'. I was returning to present an evening seminar on fungi and soil health for the farming community. An afternoon spent combing the remnants of the local box ironbark forests produced just two shrivelled sporebodies. Fortunately, a foray into the wetter forests further south the previous day had procured a few more.

I arrived early to set up my specimens in a display. The door was open although nobody was about; a heartening expression of rural trust. I dragged the old wooden trestle tables into position, covered them with white butchers' paper and laid out my specimens. After pushing them round into a pleasing arrangement based partly on taxonomy but mostly aesthetics, I wrote the scientific and vernacular names beneath each one. It was a lean display, but still contained twenty or so different species. I strewed some magnifying glasses among them and wedged a bit of moss – a hopeful touch of green – in between.

The gravel crunched outside and a moment later Judy Crocker blew in through the door. A local dynamo, Judy generates more energy than her slight frame can contain. After moving to the region twenty years ago, she immediately set about restoring local farm and forest landscapes. Judy also quickly fell into the role of administrating various local Landcare and conservation networks. Unafraid to speak her mind, she expertly rallies local innovators and extracts government money for conservation projects. Most of what she does happens behind the scenes. Holding communities together. Human and otherwise. Judy wants the best for the farmers, the community, the remnant forests, her beloved Stone Curlew (*Burhinus grallarius*) and their elusive fungal associates.

Judy's emails arrive round the clock. I suspect she lies awake most nights with at least one ear cocked, listening hopefully for the haunting call of the Stone Curlew to penetrate the night air. She mostly lies awake in vain, but never gives up. The bird once thrived in the local forests, but habitat destruction along with the ravenous appetites of feral cats and foxes reduced the population to just a few birds. Thankfully for the curlews, Judy thinks big, on small scales. Landscape scales. She recognises connectivities. Unseen networks. She finds ways to link curlews with fungi in funding applications. Many might not see the connections, but Judy capitalises on the shared enigmatic nature of curlews and fungi and their interdependencies.

Judy greeted me warmly throwing a strong and wiry arm around my neck then glanced at the display of sporebodies.

'Goodness me,' she exclaimed, 'you've put names on them all!'

I hesitated, flummoxed. 'Ah yes, I guess people like to know what they're called,' I replied.

Judy squinted, 'Oh not these farmers,' she asserted, 'they don't care what they're *called*. They want to know what they *do*'.

My oversight stemmed from my more regular interactions with mycologists, naturalists and foragers. Fungus identity is everything to these folk. Without a name, a fungus cannot be placed on a list or popped in the pan. But the farmers fitted neither category. They had little interest in naming or eating fungi. Most simply wanted to know what they do. Soils are what they care about and what fungi do in soils. Like the farmers, I suspect the fungi also do not care what they are called. After all, whatever we call them, fungi will still do what they do.

These farmers grew mixed cereals and sheep. While a few had succumbed to the drought, in Judy's words, most got wiser. Experimental and innovative, they investigated new approaches, working to restore soil ecologies. Judy described them as a tenacious bunch, always battling the vagaries of the Australian climate:

> Right through the drought they worked jolly hard, but it didn't destroy them, just gave them some more messages – that they need more paddock shelter and more cover on the ground. To be careful about overgrazing. And instead of worrying about the sheep, they should worry about the soil.

The farmers have worked with Judy for over a decade to improve their understanding of how soils work; observing, experimenting, monitoring. These are long worn and weathered soils and many farmers supplement them. Some try biological approaches, others opt for fertilisers, irrigation and chemicals. A handful is also interested in fungi, even if by default, recognising how fungi once did the job of today's fertilisers and irrigation. Except fungi do it better. The use of heavy machinery that compacts soil, chemicals and the waterlogging effects of irrigation collectively purged fungi from most agricultural soils. These farmers wanted to know how to get them back. They wanted to know how they might improve their soils and the quality and yield of their crops, and they wanted suggestions for practical actions. Judy explained how the farmers focus on the tangible relevance of species within production systems, adding that 'everything with a practical use will be treasured and survive'. Fancy fungus names were of little help.

More gravel crunched as a fleet of utes and four-wheel-drives pulled up out the front of the hall. Blokes in flannelette shirts and women carrying 'a plate' shuffled in.[583] We exchanged greetings and the enthusiastic grip of farmer handshakes crushed my hand. I watched on curiously as some inspected the display, but Judy was right. It was not what they came for. More importantly, the questions came thick and fast about how to encourage fungi on their farms. How could they get them back in their remnant woodlands and paddocks? And then came the mushroom jokes . . . .

'Restoring' fungi is not like revegetating where you can essentially provide seedlings, tree guards, dig some holes and start planting. Creating habitats and conditions to encourage fungi is more difficult. Speed of colonisation represents one challenge. Some saprobic (decomposing) fungi move in fast and stabilise disturbed soils. They rely on numbers, producing lots of sporebodies and working swiftly. However, those forming relationships with plants (mycorrhizal fungi) need time to meet and get to know each other. While revegetating produces relatively rapid and visible results, re-establishing fungi is more about providing the substrates, habitats and conditions as well as removing the stresses, then waiting for the fungi to arrive. They operate on different scales. Even if fungi do establish, they only produce sporebodies – or become obvious – under particular conditions. Many do not produce visible aboveground sporebodies at all, particularly in these drier ecosystems. Seeing or measuring the effects of such efforts can therefore be less immediately satisfying. In a sense it relies on a certain level of 'trust' that the fungi do good things in soil, along with a great deal of patience.

Fungi that grow in agricultural soils differ from those in forests. Those that form relationships with crops are mostly arbuscular mycorrhizal fungi, although these grow in forests too. They are so-called because of the 'tree-like' structure or 'arbuscle' created by branching hyphae inside the plant root cell, where carbon and nutrient exchange occurs. Little is known about the distribution of these fungi in Australian agricultural landscapes or how to use them in restoring degraded agricultural systems. Mycologists are only beginning to understand how different fungi respond to the effects of cultivation, grazing, fertilisers and other disturbances. Typically microscopic and rarely forming visible sporebodies, they are beyond the scope of this research. However, whether in forest ecosystems or agroecosystems, they do much the same thing –

[583] This Australian idiom implies something edible is on the plate, not just a piece of crockery.

forming relationships with plants, facilitating nutrient uptake, suppressing plant pathogens, structuring soils and filtering water. Although it is a tough task to change established farming practices many generations old, Judy persists. She knows if she can enlighten a few about the importance of caring for soils, more will follow. Judy remarked:

> Howard Hepburn was the one farmer that got the message and his biological farm trial site was amazing. Howard used to sit out there in his ute and look at it and then ring me up and say, "I'm just looking at this amazing paddock!" And when I walked out in the paddock it had a different feel about it. You know the feel of healthy soil on a farm? And when you put in a shovel in it you'd get the fungi, those white strands.[584]

With a box of left-over home-made lamingtons, I climbed into my ute and slowly drove home through the moonless forest. The scent of eucalypt collided with something long dead and mammalian wafting in through the open window. Then a kangaroo loomed in the headlights and I braked, swerved and slid into the verge. The lamingtons took flight. The kangaroo bounced away and I got out to fully register the dark embrace of the night forest. The inky blackness swallowed my feet but a waft of dry bush scents cleansed my nostrils as I went for a wander. I thought about Judy's and the farmers' interest in fungi, the tired mushroom jokes and the power of these communities to make real change. Almost two-thirds of Australia's land is under farming production.[585] Australia's agricultural history has irreparably scarred landscapes and communities. These farmers want to turn things around. I recalled the stories we shared, realising how we related to fungi through different systems of language and meaning. My mission was to fathom where they met and how to maximise different types of understanding to restore fungi in these landscapes.

As my eyes adjusted to the darkness, something ahead faintly glowed. Ghost fungi (*Omphalotus nidiformis*) I wondered? Heading towards the glow, sticks cracking loudly beneath my feet, I realised it was something large and flicked on my torch. An old mine shaft, overflowing with computers and an embrangle of other refuse reflected my torchlight, hurting my night eyes. I turned it off again and suddenly aware of the deep penetrating cold, stumbled back through the blackness to the ute. Standing perfectly still in the silent forest, I felt the weight of the darkness settle on my shoulders and listened out for Judy's curlews, but could only hear the distant rumble of trucks on the highway. The fungi, the curlews and the forest contend with a lot, but Judy and the farmers filled me with a sense of hope and possibility.

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[584] Judy Crocker, informal conversation with the author, 15 April 2014.
[585] Australian Government, "Australian Farming and Agriculture".

Knowing beyond naming

How could the melding of taxonomic mycological understanding and experiential knowledge of fungi foster greater recognition of their significance? Revisiting dominant knowledge frameworks and recasting assumptions reveals new knowledge, as well as going beyond *knowing* to 're-configure how we experience something sensorily, how we attend to things'.[586] Margaret Somerville's idea of postmodern emergence challenges existing frameworks of knowledge to 'open up and disrupt taken-for-granted ways of interpreting the world . . . making spaces for existential doubts and uncertainties'.[587] She maintains that things also exist in a non-language space 'that cannot be spoken, the in-between spaces that have no name or are too difficult to name'.[588] Even the best scientific tools are not finely honed enough to reveal everything about fungi. The farmers I work with in the field challenge hegemonic scientific discourses that place fungi in taxonomic scales. Rather, they frame fungi within living landscapes, often recognising other kinds of associations. Different aspects of the landscape hitch together in unexpected ways. Their knowledge derives from intimate knowledge of place over time that cannot be fully appreciated on an annual fungus survey. Symbioses have been verified through the microscope and the precise details of their exchanges determined in the laboratory, but the greater significance of their existence is apparent in the field. As fungus enthusiast and pathologist Denis Benjamin contends, 'you only see what you look for. You only look for what you know'.[589] In discussing the relationships between researchers and the communities and landscapes with which they interact, environmental historian Lynne Heasley advocates the democratisation of knowledge through participatory research, commenting: "scholarly expertise should not subordinate the experiences and knowledge of ordinary people".[590]

No equivalent word for fungi exists in English to describe what birdwatchers refer to as jizz. Jizz embodies a combination of learned and intuitive knowledge that includes detail, but focuses on the bigger picture of form, movement and habit. Birdwatchers often recognise a bird by its jizz rather than through extended contemplation. Fungal *jizz* (or perhaps *fizz* for short) includes gestalt plus elements such as form, growth, texture, smell, habitat, 'behaviour,' as well as all the things that make it not something else. It develops from lived experience. It grows from daily wandering,

586 Sellbach, "Sex, Flies and Fairytales".
587 Somerville, "Postmodern Emergence," 226.
588 Ibid., 236; Somerville, "Waiting in the Chaotic Place of Unknowing," 214.
589 Benjamin, *Musings of a Mushroom Hunter*, 20.
590 Heasley, "Walking Contested Land," 528.

sensing and fine-tuning. Gayle Osborne, who coordinates the Central Victorian forest conservation group, Wombat Forestcare, lives on a property adjoined on all sides by the forest. The rough bush track that is her driveway sports a car wreck with four sunglasses-wearing skeletons, but there is no need to be alarmed. Gayle encourages all to experience her beloved forest, commenting: 'It is a forest that's quite addictive. Once you get used to it you know where every little thing grows, and where to expect to find things. But it also has a lot of hidden treasures. It's actually quite a surprising forest'.[591] Gayle has an intimate knowledge of the forest's inhabitants including fungi that she says grew from direct daily involvement.

Drawing on the ideas of Gilles Deleuze and Félix Guattari, anthropologist Tim Ingold considers there are three ways of regarding an animal – either as a pet, a classified species, or thirdly, as 'a going on: not as a living thing of a certain kind but as the manifestation of a process of becoming, of continuous creation, or simply of *being alive*'.[592] While not too many people keep fungi as pets, many relate to them as a classified species.[593] Fewer regard them as simply *being alive*. Objectifying of fungi is epitomised by the gamut of miraculous forms that once assigned a name, get swept into the garbage at the end of our Mycological Society meetings in Switzerland. It is not merely wasteful or reckless, as knowledge is gained and data are recorded. Both contribute to the recognition and conservation of fungi. Yet there is something deeply disturbing about the process that mirrors the scientific view, objectifying and reducing them from fungi to discarded specimens.

Aboriginal knowing

The recording of *Aseroë rubra* in 1792 marked a significant event in Australian mycological history. What happened, however, in the sixty thousand odd years prior, sometime during which Australian knowledge of fungi really began? What did Aboriginal Tasmanians know about *A. rubra*? What, if anything, did they call it and how was it regarded?

Labillardière's diaries show no evidence that he sought knowledge about *A. rubra* from the local Ninene women of southern Tasmania.[594] While women were (and in some places still are) the keepers of fungal lore in many cultures, as historian Gary

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[591] Gayle Osborne, interview with the author, Glenlyon, 9 May 2013.
[592] Ingold, *Being Alive*, 174. Italics original.
[593] Ibid. Ingold refers to classified species as, "the anonymity of an appellative" as part of the "colonial project of control by classification".
[594] Ryan, *The Aboriginal Tasmanians;* Plumwood, "Wilderness Scepticism," 653.

Presland notes, the early male explorers focussed their attention on Aboriginal men who partook in more obvious activities such as hunting and fishing (although Ninene women hunted too; seals in fact).[595] Consequently, the opportunity to tap into indigenous knowledge of *A. rubra* slipped by. However, according to settler and 'Protector of Aborigines,' George Augustus Robinson, Aboriginal Tasmanians used fungi as food, medicine and tinder. In 1831 he observed: 'Various are the fungus which the natives eat, and all are known to them by different qualities which they possess, and all are known by different names'.[596] Tasmanian Aboriginal use of fungi was also recorded by botanists, James Backhouse and Ronald Campbell Gunn. Among the most commonly reported species used by Aboriginal people were the underground species, Native Bread (*Laccocephalum mylittae*) and the Beech Orange (*Cyttaria gunnii*), the latter growing in association with the Southern Hemisphere beeches, *Nothofagus*. Many fungi had Aboriginal names, which settler George Fletcher Moore listed in 1842 including: *Butogo*, *Dtalyil*, *Bwy-ego*, *Metagong*, *Nogo*, *Numar*, *Whodo*, *Koragong* and *Wurdo*, all being defined as edible.[597]

Fifteen hundred kilometres north from where Labillardière recorded *A. rubra*, the Gulari (Lachlan) and Murrumbidgee Rivers flow east-west across the extent of the Wiradjuri Aboriginal region that once had a distinct river community of Wiradjuri speaking people.[598] The Wiradjuri nation consisted of hundreds of groups extending from the Murray River in the south, skirting the edges of the mountains to the east, northwards to Dubbo and westwards across the plains to Willandra Creek near Mossgiel.[599] Following a tour of her flourishing vegetable garden, Wiradjuri elder and artist Trisha Carroll, showed us her most recent paintings. Trish scolded her escapee chooks and recited stories of snakes intruding in her yard. Then it was time to talk about fungi. Trish pulled out a dried punk (probably *Laetiporus portentosus*) that resembled a hunk of polystyrene and tossed it at me. She recounted how they gathered punks as children to use as a source of light. Her partner Sedric, recollected how he too collected punks as a child, soaked them in kerosene, lit them and kicked them round like a

[595] Presland, "The Place of Fungi". Moreover, according to Lyndall Ryan, Labillardière's Rousseauian beliefs about gender roles and disapproval of women's involvement beyond being family caregivers is likely to have influenced his belief about whether they held knowledge of any significance.
[596] Plomley, *Friendly Mission,* cited in Kalotas, 269-95. Robinson recorded Aboriginal names for fungi in several diary entries but provided too little information to extrapolate the species, except for *Ninghi* from Bruny Island (30/5/1829) that could have been a species of *Fomes*, *Trametes* or *Fistulina hepatica*. He also made reference to Aboriginal use of what was most likely the Beech Orange (*Cyttaria gunnii*).
[597] Moore, *A Descriptive Vocabulary*, 135.
[598] Kabaila, *Wiradjuri Places*, 10.
[599] Greenwood, "Land of the Wiradjuri".

football.[600] The combustible nature of punks and their and use by Aboriginal people as an alternative to tinder was also recorded in early settler diaries. In 1843 Backhouse wrote: ‘on a Myrtle, we met with a large fungus, such as is eaten by the natives in cases of extremity. It is known in the colony by the name of Punk, and is white and spongy; when dried it is commonly used instead of tinder’.[601] James Backhouse, Ronald Gunn and Joseph Milligan reported punks being used as food, but all reports came from Tasmania. Whether Aboriginal people from the mainland used this fungus as food is unknown. As with other cultures across the globe, some Aboriginal groups did not use fungi, regarding them suspiciously and associating them with evil spirits as discussed in chapter five. Given Australia’s extensive environmental and cultural variation and changes since European settlement, the observations of the early explorers and settlers are unlikely to reflect Aboriginal use of fungi today or in the vast parts of the continent where no observations were recorded. As archaeologist, Peter Hiscock argues, enormous regional variation exists in the way different Aboriginal people use resources.[602] Aboriginal social systems are not fixed or inflexible, but rather are characteristically dynamic, adaptable and transformative.[603] He describes this constant cultural evolution noting: ‘Archaeology reveals occupation of landscapes, abandonment of landscapes, fundamental changes in the way people moved through, made use of and thought about their environment’.[604] We examined Trish’s punk, which in its dried state looked utterly unpalatable. Trish shook her head and could not tell me any more about how Aboriginal people might have used this or other fungi. Any further knowledge, it seemed, was long gone.

The following day I met with Angus Arnott from the Orange Local Aboriginal Land Council. Gus introduced me to the team of Wiradjuri men who work to bring back Country through revegetation and restorative practices in the Mandurama scrub (or Lot 260, DP750408 as the Council refers to it). I wondered what ‘bringing back Country’ really meant. Margaret Somerville describes Country as deriving from a specific material landscape with its ‘own life force, energies, connectivities’ that embody ‘all that exists within it’.[605] If the knowledge of fungi was gone, how could Country be

[600] Punks are combustible without the addition of kerosene and burn relatively slowly and so might have also been a way to carry fire.
[601] Backhouse, *Narrative of a Visit to the Australian Colonies*, 119. Anthropologist, Henry Roth also described its use as tinder in 1899. Roth, *The Aborigines of Tasmania*.
[602] Hiscock, “Creators or Destroyers?,” 45.
[603] Ibid., 46.
[604] Ibid., 51.
[605] Somerville, “Water in a Dry Land,” 60.

‘brought back’ or ‘reanimated’ without also attending to this fundamental scaffold that holds terrestrial ecosystems together? I glanced at the clear sky as the four-wheel-drive kicked up a plume of dust on the red scar of a road. The scent of flowering Yellow Box *(Eucalyptus melliodora)* floated on the warm wind. I began to wonder about our chances of finding fungi. Although the tract of remnant Box Gum woodland was diverse in plant species, age structure and had plenty of wood on the ground, the dry weather suppressed the emergence of sporebodies. The dappled sunlight made them even harder to spot. Wandering around and about and within we came across the Scarlet Bracket Fungus (*Pycnoporus coccineus*) forming a shelf of bright orange arcs on a log. We squatted down to feel its texture and I asked the fellas if they knew whether it was used by the Wiradjuri, but they shrugged and shook their heads. Teal-coloured stains on another log hinted at the presence of the Green Elf Cup (*Chlorociboria aeruginascens*). I pushed my fingers into the log’s rotting innards where we found curled up millipedes, but sporebodies eluded us. Further up the track we examined the remnants of a white punk projecting from the trunk of a Red Stringybark (*Eucalyptus macrorhyncha*). I was excited when Greg Ingram suggested the Wiradjuri used bracket fungi like steps to climb trees when looking for bees. This was something I had never heard before and I marvelled at the agility and nimble-footedness this feat must have required. Sitting beneath a Candlebark (*Eucalyptus viminalis*) we talked about fungi as wrens zigzagged through the undergrowth. Elder, Pat French, recalled his father showing him how to recognise edible and poisonous fungi, but conceded the knowledge was largely lost. I felt the profound depth of loss in imagining how in a country with potentially the most species-rich mycota, fungal knowledge of one of the world’s oldest continuous cultures had been largely erased since European settlement. While not all Aboriginal people used fungi, it is likely that for some, they were a regular part of life. I thought about Aboriginal connections to landscape and the irony of how collective flows of knowledge connecting country and kin through spiritual, emotional and physical storylines are mirrored by fungal mycelia. Both are invisible and both have been repressed by overt and slow violence.

Aboriginal names exist for individual species of fungi, but in a way very different to how they are understood according to Western taxonomy. This ties directly to Aboriginal notions of Country. Country is a fluid concept, encapsulating literal and imagined places, histories, affiliations, reciprocities, synergies, flows, rules for living, all rich with memory and story and much more. It is fundamentally about care. About life. About common sense. Country is also animate, sentient and has agency.

Geographer Jessica Weir, considers it is about 'being alive and having the capacity to act'.[606] In describing Aboriginal ways of practicing knowledge, critical theorist, Stephen Muecke says: 'Aboriginal philosophy is all about keeping things alive in their place'.[607] This applies to all aspects of Country. Fungi are part of Country too. But perhaps like animals, they cannot be regarded in isolation or within the limitations of being mere 'species,' nor lumped as just 'fungi'. Other knowledge frameworks are alive with understanding. Speaking of animals, traditional custodian of Ngemba country of Northwestern NSW, Paul Gordon, says: 'Some animals can't just be classed as fauna, they're my mob, my relations'.[608]

It requires a challenging shift to incorporate ways of understanding the world that might seem alien to the assumed authority on knowledge asserted by science. Notions of Country align more closely with instinctual ways of understanding and relating to life, without the overlay of Western taxonomy that 'cleanses' the facts from values and also strips context.[609] Understanding species as kin gains amplitude in the context of extinction. Mick Smith questions how the gravitas of a lost species can be fully realised if its phenomenal world has never been considered and it exists only as a Latin name in a book.[610] Anthropologist Deborah Bird Rose, conveys this fundamentally different way of regarding species in her comment: 'losing kin is not the same as losing the abstraction of a species'.[611] Rose describes her understanding of Aboriginal notions of species in her observation:

> for them the process of naming the world is far less interesting than talking about how the world works, how things fit together. So the name of the plant, and the standard kind of information – habitat, flowering for example, was kid's stuff to them; they were happy enough to share it, but what really interested them was a whole set of other questions. They talked about what uses they put the plant to, and how it figures in kinship, and song and ceremony. They talked about the plant's own kinship with other plants, and also about all the other creatures who also have an interest in the plant and who benefit from the plant's existence. And they talked about the plant's communicative agency: what, if anything, does this plant tell? In short, they were interested in systems, not labels.[612]

Rose describes an Aboriginal way of understanding nature that focusses strongly on interrelations. She recounts another way and context of sensing, relating and

[606] Weir, "Connectivity," 157.
[607] Muecke, *Ancient and Modern*, 27.
[608] *Monthly* video, "Deborah Rose".
[609] Nowotny, *Insatiable Curiosity*, 16.
[610] Smith "Ecological Community," 23.
[611] *Monthly* video "Deborah Rose".
[612] Rose, "Rainbirds: Organising the Country," 191.

understanding. However, her assessment overlooks scientific taxonomy as also being about relationships and systems and precisely about 'how the world works' and 'how things fit together'. Names are not merely abstruse labels, but each forms a description that alludes to cultural and biological aspects and everyday experience that maintain conduits to nature.[613] Aboriginal people use them too. Each approach enriches the ways in which the world is understood. Some might be considered more typically European or Aboriginal, but all are simply human. Recognising how they complement each other to foster mutual contribution toward a more sensitive understanding of nature, matters more than focussing on difference.

Feeling like a mushroom – sensory knowing[614]

How is the world perceived if not sensorily? For something to make *sense* in its truest definition, it must be related to the senses. The senses not only detect our surrounds but sensation, or aesthesis, forms the very core of embodied experience. Knowledge is held within the forests to be 'read' through the senses. To try and understand something without fully engaging the senses or connecting with the world, can only offer a diminished possibility. Or rather, removing oneself from what is trying to be understood, seems utterly sense-less. As Barad says, 'We do not obtain knowledge by standing outside of the world; we know because "we" are of the world. We are part of the world in its differential becoming'.[615]

However, some people trust what they regard as 'objective knowledge' in preference to their own senses. While foraying I have noticed them refer to field guide descriptions rather than sensing the fungus. They opt to read about its texture, for example, rather than simply feeling it. This sign of estrangement and the need for interpretation reflects Judith Wright's concern for the 'deprivation of the life of the senses and the feelings'.[616] To *know* fungi is to tune to the amalgam of sensation, experience, instinct, 'fizz' and their synergies, along with scientific understanding. Science writer, Eric Wagner puts it aptly: 'I thought of that space peculiar to natural history, where what is formally known about an animal blurs with what is informally felt, and knowledge can become something like grace'.[617] What Wagner distils as

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[613] Marren, *Mushrooms*, 45.
[614] Aldo Leopold's idea of "thinking like a mountain" has been regularly borrowed to describe thinking about all sorts of other things. I adapt it further to move beyond mere cognitive "thinking" to more emotional and sensate "thinking" that includes feeling in "Feeling like a Mushroom".
[615] Barad, "Posthumanist Performativity," 829.
[616] Wright, *Because I was Invited*, vii.
[617] Wagner, "Whale Watch," 26.

‘grace’ is precisely what cannot be properly explained. It is also what needs to be felt if one is to move beyond mere cognitive understanding toward an ethic of care.

Reigniting the senses most easily begins with sight, with looking, but more importantly, with seeing. Sight is the dominant sense. Most people locate a sporebody in the forest by sight. However, *seeing* is more than sensing with the eyes and encompasses sensing and feeling more broadly. It is about consciousness. ‘We’ll see,’ answered my friend Helen when I suggested we head out foraying. What she meant had little to do with seeing, but with how she felt. Seeing is an art that comes from being within, not from externally observing. Said writer and art critic John Berger, ‘seeing which comes before words, and can never quite be covered by them, is not a question of reacting to stimuli. We only see what we look at’.[618] Echoing Berger’s words, Somerville notes, ‘the art of seeing begins with a daily active engagement with local places. Looking is an act of choice, always about relation, a relation between things and ourselves. It is a relation of colour, of touch, of texture and of pleasure’.[619] Only after prolonged ‘looking’ does one start to ‘see’ fungi. It requires developing a ‘search image’ along with knowing when and where to look, orienting to strata and stillness. Search image adjusts with season and landscape change. This involves *sensing* fungal clues, tracks and traces, tuning to their affordances. Fungal traces are often more apparent than their hidden mycelium or sporadic sporebodies. Over time, one sensitises to subtleties and nuances, to presences and absences, to connectivities and complexities, ‘details born of long acquaintance and repeated seeing’.[620] While most fungi exist out of sight beneath the ground, they form relationships with more readily apparent organisms. Others inhabit particular substrates and under specific environmental conditions; it might be a *Banksia* cone, or a herbivore scat, or where the air is clean. Or by dragons’ lairs. It is about tuning to those details too.

Fine-tuning to fungi

Near the confluence of Sailors and Wombat Creeks in the Hepburn Regional Park, Victoria, artist Irene Salmont witnessed the delight of fungal life magnified times ten. I passed her my magnifier and pointed to a fruiting lichen on an overhanging Blackwood branch. Irene’s head and the magnifier bobbed in and out as she tried to find focus. Then a great whoop signalled success, alerting the other forayers to her discovery. Bent

[618] Berger, *Ways of Seeing*, 8.
[619] Somerville, *Wildflowering*, 82.
[620] Macfarlane, *Landmarks*, 214.

double, nose jammed into the wet branch, her knuckles whitened with her tightening grip on the magnifier as the exclamations of discovery continued. The other forayers patiently waited their turn, but I could see that Irene would only surrender the magnifier and access to her micro-wonderworld in her own good time. Something captured her curiosity and imagination that she was unwilling to relinquish. Something precious. Something not describable in words. Telling someone how something appears through a magnifier is deficient. There is a particular rush that comes with seeing something come into fine focus and it being like something you could never have imagined. It also comes from seeing something reassuringly familiar. But already, my attempt to describe it in words is lame.

The weather bureau had forecast perfect weather for our foray: morning fog and the chance of afternoon showers. The curdling mists swaddling the forest failed to dampen spirits as we followed the contour of the hill then dropped down to the creekline. A solitary raven croaked and shook the moisture from its glossy plumage. Foggy mornings are ideal for taking people through the forest because of the spiders. Spiders and fog. We stopped to admire how they had rigged the forest with their ornate and mysterious logic. Through their webs, made visible though droplets of condensed fog, the spiders made us aware of their abundant presence. We could only guess at how many millions of spiders must live in this one forest. The fog shrunk our horizons, bringing our focus in closer. Our pace soon slowed to a point where each step became a conscious decision, to step this way or that or to walk another way between the trees, to avoid destroying these astonishing constructions. Sometimes while avoiding one web, another stroked our faces, wrapping around our necks like filigree scarves. Each stroking was also an act of harm, however accidental. Yet therein lies the irony of the forayer, who Gary Fine describes as 'simultaneously reverential and destructive'.[621] We discussed how the webs mirrored the underground webs of mycelia, coursing through the soil in our imaginations. The webs focussed our attention, increased our awareness of their being as well as guiding our eyes to the fungi adorning the forest floor. Young Parasol Mushrooms, *Macrolepiota clelandii*, poked through the leaf litter like ornate drumsticks, their pilei (caps) having not yet expanded. Clusters of brilliantly purple coral fungi, probably a *Ramaria*, expanded in a ring. Then more, in hues of orange, salmon and persimmon. Pestle-shaped puffballs huddled in a heap like miniature maces. Lichens and jellies, leathers and crusts splotched and textured the surfaces of logs in an unthinkable profusion of forms. Hours passed on hands and knees, pressed against tree

[621] Fine, *Morel Tales*, 37.

trunks and clambering beneath logs, meandering randomly through the forest as though following the traces of unseen snails. The limited horizons drew us toward detail. With one sense restricted by the fog, other senses heightened. We squatted down to feel the leathery texture of the Black Tooth, *Phellodon niger*, and sniff the cucumber scent of the sticky stipes of the Yellow-stemmed Mycena, *Mycena epipterygia*. I used to focus on imparting fungus names on forays, the usual 'end product' of such endeavours.[622] I still do, but more so I strive to bring them into the orbit of consciousness, imagination and care.

Scenting fungi – reigniting smell

Cathy Sharp held a Horse Dung Fungus (*Pisolithus tinctorius*) to Nirmal Harsh's nose and tried to convince him it smelt like chocolate. Nirmal raised a questioning eyebrow, threw back his head and laughed. He was obviously not convinced. Cathy and Nirmal roamed the forests of the Çiçekli region of southern Turkey with seventy-five other fungus conservationists as part of the Third Congress of the International Society for Fungal Conservation. The scent of the Horse Dung Fungus is described by enthusiast, Michael Kuo as 'mild at first, becoming fragrant and, in maturity, foul'.[623] I am not sure at which developmental phase the smell of chocolate might arise, but it reflects the changing nature of fungal scents and the subjectivity of olfactory perception. Its appearance also triggers mixed responses. Mycologist David Arora, refers to the Horse Dung fungus as a 'dusty monstrosity' and 'dead man's foot,' while simultaneously appraising it as 'one of the most enthralling' fungi with a 'beautiful metallic lustre'.[624] Moreover, its drab facade belies the spectacular mosaic to be discovered within, created by an aggregation of spore pouches (locules) in different stages of ripening.

Memory and knowledge are triggered by the senses, especially smell. Perception of smell combines both the sensation of the odour along with its associated emotions, intimately linking memory and the past more powerfully than ideas.[625] Given olfactory stimuli pass through the emotional centres of the brain, it is unsurprising that smells arouse strong emotional reactions.[626] Naturalist Dianne Ackerman considers, 'unlike other senses smell has no interpreter. The effect is immediate and undiluted by

[622] Santaoja, "Nature, Disenchanted?,".
[623] Kuo, "*Pisolithus tinctorius*".
[624] Arora, *Mushrooms Demystified*, 712.
[625] Classen, Howes and Synnott, *Aroma*, 2.
[626] Moore, *The Hidden Power of Smell*, 37.

language, thought or translation'.[627] While sight is usually the dominant sense, forests can also be navigated by their cavalcade of scents. Finding and recognising fungi means tuning to this vast olio of smells, making the use of smell deliberate rather than accidental.

Smell is not recorded by scientific instruments as commonly occurs with sight. While olfactometers do exist, they do not comprise forayers' field kits as often as cameras. Rather, we rely on the highly sensitive instrument wedged between our eyes along with our memories to record fungus scents. Names might be elusive, but one rarely forgets the smell of particular fungi. *Tricholoma sulphureum*, for example, is likely to be forever branded in the nostrils and memory of anyone who ventures closely enough to get a whiff. Also known as the Sulphur Knight, its penetrating foetid smell is described as being like burnt hair or gas tar but with a sickly sweetness caused by the compound skatole, which as the name suggests, occurs in dung. Of the thousands of sporebodies that have passed my nose, this one wins first prize for sparking dramatic reactions, closely followed by various stinkhorns.

Once considered lay knowledge, smell played a greater role in evaluating the health of places and objects. Along with taste, it was also more important in identifying fungi. In many Western cultures, technology eliminates or masks odours deemed disagreeable, like fungi (mould) for instance. Cultural intolerances to particular smells and the consequent reconfiguring of environments has atrophied sensitivity to smell, as reflected in the lack of olfactory language.[628] When it comes to smelling fungi, many people are out of tune, or rather out of *smell*. Unsurprisingly, indigenous cultures including Aboriginal Australians who live in close association with the land use smell to find fungi. Robinson, recorded Aboriginal use of smell in locating the underground species, Native Bread, *Laccocephalum mylittae*. At the headwaters of the Prosser River in Tasmania on 26 October 1831, he noted how, 'the native women went to look for bread fruit: if they pass where this plant is they find it out by smelling it'.[629] Aboriginal people also seek out underground sporebodies by pushing a stick into the ground then smelling the end of the stick.[630] While some people might sniff a piece of fruit at the market to check for ripeness, few people today locate fungi or any food in the 'wild' by smell. But when it comes to survival, it might pay to go bush with a woman, as

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[627] Ackerman, *A Natural History of the Senses*, 11.
[628] Chiang, "The Nose Knows," 406. Also see description of Otways foray in chapter four.
[629] Plomley and Cameron, *Plant Foods of the Tasmanian Aborigines*, 7.
[630] Ibid., 11.

women's superior sense of smell including for sniffing out fungi is well known.[631]

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Elspeth Carmichael was the oldest among our group of expatriate forayers gathered in the redolent forests of the French Jura. Despite being in her eightieth year, she moved through the forest with grace and deftness, barely disturbing a leaf, that comes with doing it for a lifetime. I plucked a small white mushroom, asked the forayers to smell it and pass it on. I watched as their expressions conveyed a definite recognition of smell. Yet describing it proved more challenging, eyes rolling upwards as though to check if the scent might be caught somewhere in the canopy with a name tag. With a gentle knowing nod as she held the mushroom beneath her nose Elspeth, unlike the others, showed no uncertainty. After giving them a chance to first respond, she paused momentarily then assuredly announced, 'Well it smells exactly like old semen. Spermatic is the word'. Her response met with bouts of laugher, expressions of disgust and nods of agreement. The fungus was the White Fibrecap, *Inocybe geophylla*. The genus is known for its range of smells with some, particularly those of the Rimosae clade, being famously spermatic. Many field guides – particularly British ones – describe this scent as 'earthy,' 'like bleach,' or more vaguely as 'unpleasant,' 'disagreeable' or 'putrid'. A Victorian hangover perhaps. This group of small, poisonous and unspectacular fungi, denigrated by David Arora as a 'large, listless and luckluster assemblage of mundane, malodorous brown mushrooms,' is one of the most surprising and extraordinary for those with a nose for fungi.[632] One might even say breathtaking.

All senses are subjective, but smell seems to be the most subjective of all. Opinions about the smell of a particular fungus vary more than those about colour, form or texture. Assessments are also more vague, with fungus smells often described simply as unpleasant or indistinct. Opinions also differ as to whether fungus odours are

[631] Lehrner, "Gender Differences in Long-term Odor Recognition Memory," 17.
[632] Arora, *Mushrooms Demystified*, 455. As an example of "fine-tuning" to smell, Alexander and Stuntz's description of *Incocybe pirosma* reads: "Odor very characteristic, not strong, but very penetrating, spermatic for an instant when the context is first exposed, but immediately becoming quite complex, predominantly a mixture of raphanoid and resinous with a trace of acetic acid, having a very decided pungency which quickly produces a tingling sensation in the back of the throat". Smith and Stuntz, "New or Noteworthy Fungi," 104.

agreeable or not, except it seems, when it come to stinkhorns.[633] Fungi provide the opportunity to discover an olfactory treasury and accompanying lexicon. Developing a nose for fungi does not mean randomly sniffing, but actively smelling with a sense of anticipation based on knowledge of a range of possibilities. Among the many fungus smells are those likened to animals, usually either fishy or shrimp-like, or like rotting flesh, or honey. Other familiar scents are compared to plants including garlic, cucumber, artichoke, radish, apricots, ripe pears, cabbage, potato, fenugreek, cocoa, coconut, bitter almond, liquorice, anise, cloves and curry. There are those with a distinctively chemical edge, typically described as being like iodine, chlorine, naphthalene, sulphur, acetone or urea. Many smell mealy (like flour). Others are especially aromatic reminding one of bubblegum, cheap soap or perfume. The odd one smells like burnt hair. Many smell foetid or rancid. Some very small mushrooms produce big smells, like the Little Stinker, *Marasmiellus affixus*, described as being like rotten cabbage or old wet nappies. European truffles are often characterised as being pheromonal, with one forayer describing their scent as being an unnerving mix of sex and death.

Why is smell little utilised as a means of knowing fungi? Admittedly, and perhaps thankfully, not all fungi reek as pungently as the Sulphur Knight, but every fungus has a smell, an 'olfactory signature,' however pronounced or subtle. Is the value of smell diminished because of its subjectivity? Is it because the smell of a fungus is hard to pin down and not neatly definable, but more typically dynamic and changeable as with Kuo's description of the Horse Dung Fungus? Fungal odours often reflect direct emotional reactions and there is no quantifiable empirical method for measuring smell. Cultural historian Constance Classen and colleagues posit that sight is deemed the 'pre-eminent sense of reason and civilization, smell was the sense of madness and savagery'.[634] Certainly smell is regarded as the most 'primitive' or oldest sense. In field guides, if mentioned at all, smell usually comes last following descriptions of visual and textural features. The Australian field guide *Fungi Down Under* lists smell for less than a fifth of species, the rest presumably being indistinct. Yet the subjectivity of smell is what also makes it so revelatory. How a scent is perceived and regarded is culturally and historically influenced. Hence, the descriptions and metaphors depicting fungal

[633] A mistake I have only ever made once was to include the unopened "eggs" of *Aseroë rubra* in a fungus display I was setting up the night before a workshop. Not only did they "hatch" overnight and arouse every blowfly in the district, but the impenetrable stench permeated every corner of the 200 square metre room and assaulted the nostrils of every participant who dared step through the door.
[634] Classen, Howes and Synnott, *Aroma*, 4.

odours provide insights into the thinking and values of different people and cultures. Odours thus link environmental and social history because although they are physical phenomena, their significances are socially constructed.[635]

Closely connected to smell, taste is also important for identifying fungi, although usually by those who know which fungi should never be tasted (such as the Funeral Bell, *Galerina marginata*), as small amounts accidentally ingested could be lethal. Using taste to identify fungi is more about sensation than flavour. The tongue provides a sensitive organ to detect particular sensations such as pungency or astringency. Only the tiniest bits are placed on the tongue, as some sensations develop slowly, such as the searing acerbity of the Peppery Milkcap, *Lactarius piperatus*. Sense of taste also links fungi most closely to the possibility of it being food. Taste, however, is not a reliable determinant of edibility. The Death Cap, *Amanita phalloides*, apparently tastes pleasant despite its lethality, as reported by those lucky enough to have lived to comment.

Getting back in touch

Slender white trunks of Manna Gums (*Eucalyptus viminalis)* disappeared into the mist like gothic candelabras. The imposing boulders of Dog Rocks on Mt Alexander in the granite country of Central Victoria, or Lanjanuc to the Jaara Jaara people, form a sacred ceremonial ground. It is tactile territory and I watched forayers' hands stray across the surfaces of rocks that we wandered among. Plunging one's hands into the earth, to connect by touch and feel its textures and release its scents, is one of the great pleasures of being in the bush. I watched curiously as the forayers engaged their senses. Some commented on the smell or the light, the occasional one bent down to feel something. Others took a more passive approach, shying away from the sensory, avoiding smelling or touching, zipping up their jackets to the bottom lip with the first drops of rain. We peered into a bole on an ancient Red Gum (*Eucalyptus camaldulensis*). Disc-shaped apothecia (reproductive structures) of an *Usnea* lichen circled an abandoned cicada exuvia (exoskeleton). The sticky kidney-shaped sporebodies of the Bitter Oysterling (*Panellus stipticus*) clustered on the underside among the bristly stubble of moss sporophytes. We ran our fingers over the many textures, feeling their subtle differences.

The metaphor of 'losing touch' refers to not being in contact with someone for awhile. Have we literally lost touch with fungi? A tension exists in negotiating tactile interaction with fungi when many are slimy and represent textures associated with

[635] Chiang, "The Nose Knows," 406.

things undesirable, dirty or poisonous, as discussed in chapter four. Galleries and museums are only slowly inviting the opportunity to touch but parents still warn children not to touch things perceived as dangerous, such as fungi, even when they are not. Like Irene's experience with the magnifier, the subtleties of tactile qualities are especially hard to communicate in words. How can the difference between a buttery, mucilaginous, gelatinous or waxy texture of a fungus be precisely communicated without one's fingers feeling these differences? Such knowledge is relative, comparative, repetitive and contextualised. It is negotiated with others who might be present in that particular moment, also running their fingers, or perhaps a cheek, over the fungus. As with other senses, feeling fungi requires a re-calibration, a fine-tuning and openness to an expanded range of possibilities. It develops through practice, through sensorial sharing of experience and knowledge. Touch is not only about contact and also operates in two 'directions,' as Mick Smith notes: 'We might, for example, think of touching and being touched by others where "being touched by" may have both the connotation of contact, of something communicated, and/or of being emotionally touched or affected'.[636] Touching fungi is one way to become more familiar with them, opening the way to being touched *by* them.

As far as I am aware, sporebodies do not sing, which is one of several reasons why they attract less attention than birds. Sound is not as directly important as other senses in knowing fungi yet it still contributes. For example, the stipes of fungi containing sphaerocysts (cells that give them a brittle texture) make a characteristic snapping sound when broken. But more importantly, deep listening to the forest collectively contributes to understanding fungi (as well as alerting one to when a deer is about to leap overhead if lying in the undergrowth photographing fungi). The silence of fungi, at least to human ears, is also something essential about them. It allows space for relief from the unwanted stimulation of white noise; space for deep introspection and contemplation. Fungi reveal themselves quietly.

The sensory extent of sporebodies is staggering. Sensing the forests engages senses plus imagination and anticipation. And paying attention. Ecologist and writer Emerson Blake notes: 'It's in paying attention that the boundary between us and the rest of the world is shifted. It's in paying attention that we are moved to reimagine what is possible'.[637]

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[636] Smith "Ecological Community," 22.
[637] Blake, "Preamble," 1.

Urging minds differently

Writer Robert Macfarlane explains how the lived experience of a forest goes beyond mere cognitive knowing. He says: 'Woods like other wild places, can kindle new ways of being or cognition in people, can urge their minds differently'.[638] Macfarlane's 'new ways of being' are undefined but perhaps relate to the combination of what stirs the imagination and touches the heart, collectively making the experience meaningful. In discussing the assigning of meaning, whether moral, sensory or aesthetic, Gary Fine says, 'the act of distinguishing objects allows one to separate them by meaning. Yet by itself the ability to distinguish is not sufficient for the establishment of meaning. These distinguishing features must be given significance'.[639] They must be made meaningful. Edmund Husserl's concept of *Lebenswelt* (lifeworld) is useful in imagining more inclusive ways of knowing fungi and for making them meaningful. However, as linguists George Lakoff and Mark Johnson caution, *meaning* is not the same as *meaningful*.[640] To find fungi meaningful is what keeps us returning to the forest. Nothing exists within the dynamism of one's *Lebenswelt* without it being directly sensed, experienced or lived. Like affect, *Lebenswelt* is that which is experienced before, yet goes beyond, analytical understanding. Ecologist and philosopher David Abram, describes it as the 'world of our immediately lived experience, as we live it, prior to all our thoughts about it . . . prior to conceptually freezing it into a static space of "facts"'.[641] The difficult to articulate, intense and heightened feeling experienced from the summit of alpine peaks that feels like euphoric elation approaches the German word, *Alprausch*. An equivalent intoxicating sensation, a welling sense of excitement and visceral bodily longing is also aroused when entering particular forests to look for fungi.[642] It arises perhaps from the extreme sensory stimulation coupled with the imaginative power of forests. It is about allowing oneself to respond to the magnetic pull of the forest, registering it as feelings as well as facts. Is this intensity of feeling, this profound touching of the heart and openness to possibility what lies at the core of ecological literacy?

Geographer Jules Pretty, laments how humans increasingly suffer from 'extinction of experience'.[643] He considers that only through close observation,

[638] Macfarlane, *The Wild Places*, 98.
[639] Fine, *Morel Tales,* 59.
[640] Lakoff and Johnson, *Metaphors We Live By*, ix.
[641] Abram, *The Spell of the Sensuous*, 40.
[642] In German it could be coined as a *Pilzrausch*, or in English, perhaps a *Mushrush*.
[643] Pretty, *The Earth Only Endures*, 158.

interaction and being shaped by 'local natures' can ecological literacy flourish, positing: 'ecological or land literacy is not just what we know, but how we respond, how we let the natural world shape us and our cultures'.[644] It is a two-way process. Ecological literacy embodies the knowledge, humility, reciprocity and care of what is often termed – and often denigrated – as traditional knowledge.

Judith Wright was greatly concerned about what is lost when the world is studied in increasingly specialised or limited ways. She said: 'one of the first obstacles in the way of getting this full view is the proliferation and increase of specialization with less and less interconnection . . . and the classificatory approach is still dominant'.[645] Interdisciplinarity might need to move a little more toward the adisciplinarity of pre-enlightenment times, when knowledge was collected and assimilated by philosophers, scientists, artists and often polymaths. Such knowledge was grounded in acute and repeated observation, before the constraints of the specialist scientist who is required to consider observations as valid only if they can be repeated with ninety-five percent accuracy. A more adisciplinary approach to fungi might allow multiple knowledges, logics and frameworks to unveil their greater significances.

Slow motion mushrooms

I glanced at the sun. The dozen forayers and I had been in the field for over an hour and not yet managed to move beyond the Sanatorium Lake carpark atop Mt Macedon, Victoria. Squatting around the wooden carpark barrier we admired a row of Mycenas pushing through a crack and assembling in a perfect line. Beneath the Black Wattles (*Acacia mearnsii*) fringing the carpark, finger-like projections of the Vegetable Caterpillar (*Cordyceps gunnii*) poked through the leaf litter. As our eyes adjusted to the inconspicuous sporebodies, they seemed to miraculously, even macabrely, multiply. One after another they loomed among the segmented claret-coloured seedpods that ironically resembled the parasitised caterpillars from which the fungi feasted in the dark depths of the soil. Along the carpark perimeter *Geastrum* Earthstars, like miniature spaceships, unfurled the star-like rays of their peridia (outer skin). One seldom works up a sweat foraying for fungi. It is not about speed, but slow movement and close observation. In a fast-forward world, 'fungus foraying therapy' could be a new tonic for slowing down.

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[644] Ibid.

[645] Wright, *Because I was Invited*, 192-193.

Time stands still in the middle of the forest, which is fortunate as it takes time for the forest to become familiar. The media on the other hand along with supposedly time-saving technological gadgetry create an artificial sense of speed and urgency, rushing us on from being in the moment. In *Slow Violence*, writer Rob Nixon asks how environmental time is perceived and inhabited, documenting the disjunct between the 'thrall to speed and spectacle' of the media and the challenge of portraying slow and invisible environmental issues that are characteristically 'demanding on our attention spans'.[646] As geomorphologist David Montgomery concurs, 'the slower the emergency, the less motivated we are to do anything about it'.[647] This is true for environmental crises and also for simply knowing nature. Knowing fungi is about doing time. As with most things, it grows from attentive observation over extended time. I receive emails with requests for 'a quick run-down' of edible species, but pruning facts is not what it is about, especially when poor decisions based on superficial knowledge could prove fatal. Accelerated approaches can only ever offer an abbreviated account, a truncated version of nature. They cannot be known and understood straight away. Only through the necessary investment of time – through patience – do facts become knowledge and shift further to genuine understanding. Social theorist and ecocritic Linda Williams, describes notions of time and speed in the context of environmental art. Describing the 'tensions between the countervailing cultural tendencies of affective poetics and public accessibility,' she examines the effectiveness of 'fast' and 'slow' art in eliciting public response to environmental issues at a time of rapid environmental change. While fast art is generally publicly accessible, it risks becoming lost in translation as 'readily decipherable public icons rather than primarily works of imagination or vision'.[648] While often intensely affective and representing the more provocative and poetic end of the aesthetic spectrum, slow art translates less effectively to broader audiences. Such 'slow art of imaginative persuasion,' however, creates more space for ecocritical reflection, resonating more slowly in minds and hearts and consequently evoking deeper and more profound effects.[649] Although the ephemeral sporebodies of most fungi are short-lived, knowing fungi involves slowing down. It can be years, even decades in between seeing some fungi. Only through taking the time for reflective contemplation might fungi be reimagined in other ways.

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[646] Nixon, *Slow Violence*, 200.
[647] Montgomery, *Dirt: The Erosion of Civilisations*, xiii
[648] Williams, "Affective Poetics," 19. The engineer-assembled "sculptures" notoriously plonked on roundabouts of country towns being one such example.
[649] Ibid. 23.

For at least sixty thousand years, Aboriginal Australians have inhabited the continent. Theoretically, Aboriginal knowledge of fungi is that old. Much of it, it seems, was lost with the changes wrought by European settlement of Australia. These changes radically altered landscapes, places also inhabited by fungi. However, landuse practices are changing and those returning to country, conservationists, farmers and others are including fungi in their efforts to restore ecosystems. Late at night on the fourth of October 2014, an email arrived from Judy Crocker. 'Finally I heard a Curlew flying over our house from the west late one night, shrieking like a banshee . . . this long time single bird has finally found a young mate just east of here'.

Collecting

Collecting is discovery. It creates stories and histories, knowledge and nutrition – and dirty fingernails.

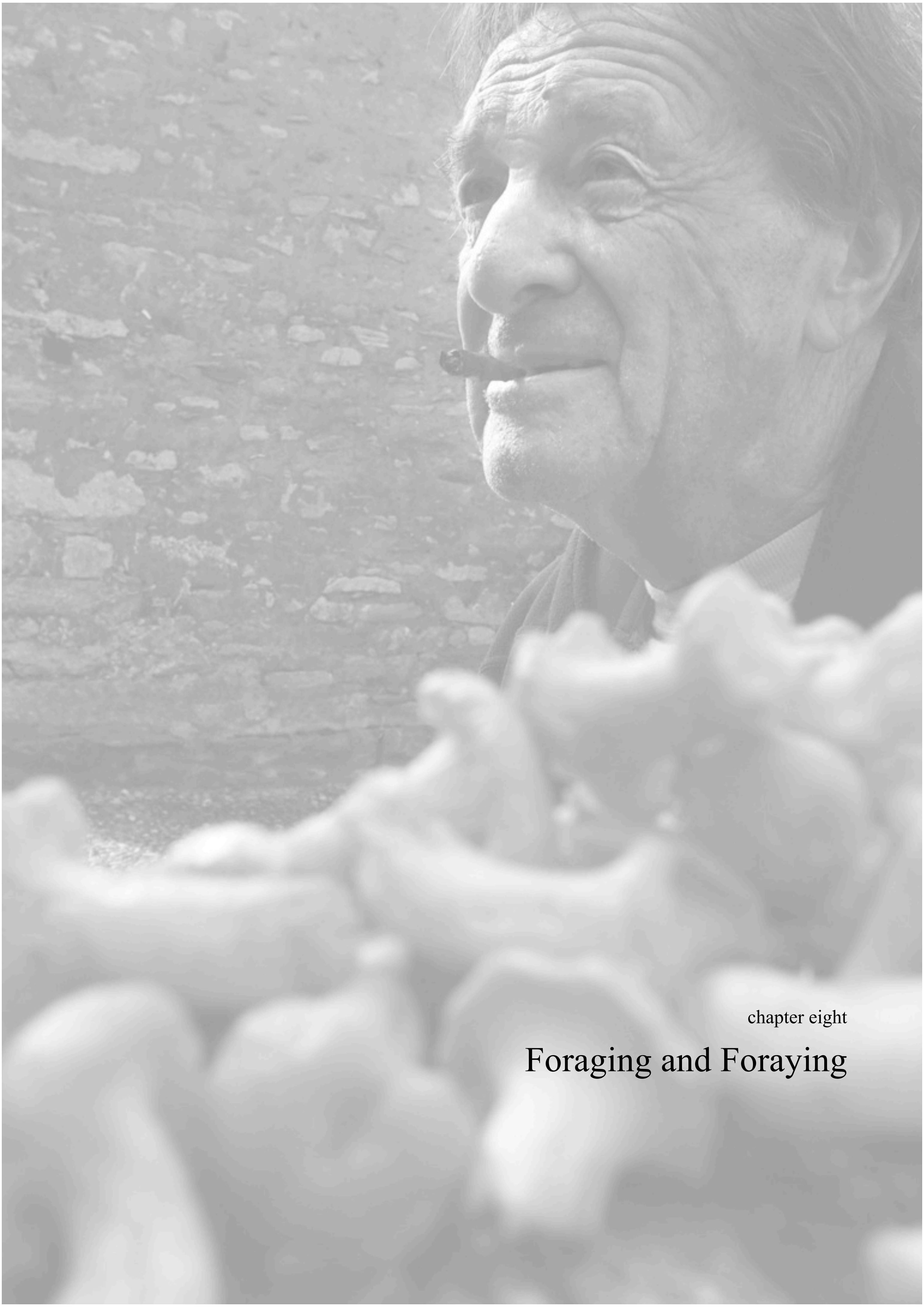
Collecting has a different purpose and significance with ephemeral objects.
For foragers, it is less about the urge to preserve. Relationships formed with collected mushrooms are intimate but often fleeting.

For forayers, the impetus is to give permanence, albeit desiccated, to these evanescent forms. But even those fungi relegated to the universal perpetuity of a scientific repository may encounter the ravages of other hungry opportunists.


Reticularia
umbrina
Hackney marshes
June/83
S(M)175286


Herbst trompete
100 gr
4.50


Pleurotus
Austernseitlinge
Ausland
100gr.
2.80



chapter eight

Foraging and Foraying

Train-stopping mushrooms

'Mushrooms! I'd stop the bloody train for mushrooms!'

Meet Pete. Peter Stewart from Cowra, NSW. Quick with a quip and a laugh, he's a born storyteller. Among his eclectic professions Pete drove freight trains, dug graves and cooked spaghetti, but now he mostly 'fixes stuff'. We met serendipitously. I was pulling on my boots to head off in search of fungi. He was about to fix stuff. Right then he was enjoying a cup of tea and a bit of bun at the kitchen table of the farm of mutual friends near Mandurama, NSW. It was April Fool's Day, but Pete wasn't joking about stopping the train.

> Yeah, I'd stop the bloody train for mushrooms. I'd say to me mate, "look at all them mushies over there in the paddock!" I'd take a big wooden tucker box so we had something to put 'em in, and we'd stop the train, and off we'd go, over the fence. Then we'd 'ave to make the train go a bit faster to make up time. But it was all down hill to Cowra. Mushrooms eh! I love the bloody things I tell ya. I love 'em on toast.

The thought of a freight train driver stopping a train in order to pick mushrooms amounted to the most radical expression of passion for these organisms I had yet to encounter. However, like Dorothy Hunter and her 'trusty back paddock mushies' from chapter five, Pete's foraging was not always adventurous. Across the kitchen our friend Mandy Martin prepared quinces for cooking and asked Pete if he would like to take some home. 'No I bloody don't!' he replied, vehemently shaking his head and launching into another animated yarn about driving along with a mate who spotted a quince tree in a paddock. So over the fence they went again and his mate picked the quinces and passed one to Pete. 'I bit into the thing and it was that bloody hard I thought I'd bitten into the branch! Na, I don't like 'em. I'll stick with me mushies'.[650]

This chapter takes us into the field in search of fungi with all kinds of folk. I explore the motivations for seeking fungi and the many ways in which they are regarded. Among the moss and mushrooms we delve into the cultural divides and ideologies, the intersections and tensions, the different reasons for collecting fungi and how relationships with fungi develop in different places over time.

While the terms 'foray' and 'forage' are often used simultaneously, I refer to a foray as a field trip to look for fungus specimens of (usually scientific) interest. A forage focusses on collecting edible species for consumption. Many people strictly foray or forage, but some enjoy both. I am less interested in what separates them as where the two converge, so I ventured out with mycological societies, forayers and

[650] Peter Stewart, informal conversation with the author at "Pennyroyal", Mandurama, 1 April 2015.

foragers. During workshops across Victoria and New South Wales as well as Central-Northern Europe, I observed and queried the motivations of hundreds of people. Early reports of fungus excursions in Australia revealed that the division between forayer and forager is perhaps more recent than assumed. Then there are those who neither foray nor forage, but choose to be in the field with fungi for other reasons. They include all sorts of artists and aesthetes and those who simply enjoy being in the forest. Among them, are the unassuming ‘quiet observers’ whose fine-scale observations accumulate over lifetimes. On my desk is a list of fungi handwritten by Marj May. Marj painted, illustrated and listed her way through every fungus she came upon over decades roaming the dry and dusty woodlands near her Inglewood home in North Central Victoria. Others seek fungi as a challenging and compelling photographic subject with most forays accompanied by the sound effects of snapping shutters.

The field means different things to different people and is experienced and regarded in untold ways. It incorporates all the places fungi inhabit as discussed in chapter three. I reiterate the importance of being physically present in the field, my own thousand days in the forest being at the heart of this research. Only through physical presence can one move from analytical abstracted observer to receptive multisensory participant.

Mushrooms and meaning

The bride winced as her heel sunk in the mud, only narrowly averting a messy misadventure. Mt Macedon, with its spectacular autumn display of turning leaves, is not just a fungal hotspot but a bridal one as well. Fungi, however, are more adept at forest dispersal than brides. Bemused, the forayers made way for the wedding procession, before returning to the more engaging pursuit of finding fungi.

The twenty forayers came along for different reasons. Most were keen to see as many different fungi as possible. Two or three hovered close behind, noting every word, jotting down notes. A few carried field guides, annotating pages as they went. One consulted a fungus app on her mobile phone. Many took photos. Some made lists. Another waved around an oversized magnifier like a magic wand. One person insistently asked with each fungus encountered, whether they could eat it, persisting with the questioning despite my rarely being able to give a satisfactory answer. Another collected every fungus found ‘just in case’ they could later determine it was edible.

There are more reasons for foraying than listing or collecting mushrooms. Some people happily stroll along at the back of the pack, keenly listening, content to just be in the bush. For them, being around fungi is not about lists, photos or collecting, but just about being around fungi. Others enjoy the social aspect of sharing knowledge in the forest. For some, an element of risk-taking tantalises the experience. Like bird-observing, fungus-foraying has its origins in natural history, 'undertaken at least partly, for the joy of the individual, and does not necessarily require the precision of science'.[651] Sociologist Gary Fine, coined the term *Naturework* to describe the process of attributing meaning to environmental experiences.[652] He defines it as a rhetorical resource with which people 'make sense of their relationship to the environment . . . and situate themselves within this world'.[653] Through his research with the Minnesota Mycological Society, Fine observed the significance of social networks among those seeking fungi noting: 'for many, the social surround deepens and enlivens the ecological surround, and transforms it,' providing opportunity to encounter 'objects of symbolic potency'.[654] Anthropologist Sveta Yamin-Pasternak similarly found, 'in addition to its dietary contribution, mushroom gathering is also valued as a social, spiritual, and recreational activity which cultivates particular relationships between the people and the land'.[655]

Fungologists seeking funguses – foraying for fungi

The term 'foray' was probably first used in the context of fungi slightly earlier in the United Kingdom than in Australia. In 1868 the Woolhope Naturalists' Field Club used the word 'foray' to describe a field day of 'fungologists' seeking 'funguses'.[656] The foray, however, was in fact as much a forage, with detailed accounts of the identification and collection of edible fungi and concluding with a fungus feast.

This blending of foraying and foraging also characterised early field trips of the Field Naturalists Club of Victoria (FNCV). Since the first issues of the Club's journal, *The Victorian Naturalist* in 1884, fungi were noted both for their scientific features and edibility.[657] The foray report from The Queen's Birthday Excursion to Lilydale lists numerous fungi by both scientific and vernacular names, focussing largely on differentiating edible and poisonous species:

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[651] Robin, *The Flight of the Emu*, 264.
[652] Fine, *Morel Tales,* 259.
[653] Ibid., 2.
[654] Ibid., 21.
[655] Yamin-Pasternak, "How The Devils Went Deaf," iv.
[656] "The Foray Among the Funguses," 184.
[657] Prior to this, fungi appeared among the first pages of its predecessor, the *Southern Science Record* in 1880, although not in the context of edibility.

> There were over thirty-five Agarics found, these include many edible kinds as well as the common mushroom, the white lady, and the beautiful *Cantharellus*; gay coloured ones, as the bright red, yellow, and green *Russulas*, the luminous *Panus incandescens*, the dainty little gray Agaric, smelling as sweet and strong as violets, the delicate *Xerotus*, the fast fading *Corprinus*, the tiny exquisite blue Agaric (*Leptoma*) of Mr. Tisdall's paper, some whose acrid taste, gave warning of poison, and a large violet-coloured Agaric which is edible; the three *Boleti* did not look or smell so tempting as usual. About ten *Polypori*, of these *P. Cinnabarinus* attracting most attention, with its bright red colour; the specimens of *Fistulina hepatica*, the celebrated beef-steak fungus were too old to be eaten; a purple *Trametes*: two *Hydnums* one jelly-like, pale lavender spines, very good eating . . . a white jelly-like *Tremella* which can be eaten when fresh, the net puff ball, *Ileodictyon gracile* which is eaten by the New Zealanders.[658]

Since the founding of the FNCV in 1880, fungi featured in the exhibits and presentations of monthly meetings. At the meeting on Monday 8th of September 1884, Mr H. W. Watts provided '42 species of Microfungi, mounted for the microscope'.[659] The February 1885 issue reported: 'Mr Tisdall contributed a paper on the "Fungi of Mt Baw Baw," in which he described about twelve species of the genus *Agaricus* . . . [and] concluded with general directions as to the selection of edible fungi'.[660] Knowledge of fungi grew fast and in March 1886 erudite enthusiast, Miss M Campbell exhibited 'a collection of about 350 species of Victorian fungi, dried and mounted, twenty of them being hitherto unrecorded for Victoria,' followed by a talk at the April meeting entitled, 'Notes on edible fungi'.[661] The report notes:

> the authoress having first given a general outline of her studies respecting fungi, described in a popular manner about ten species which are common in Victoria, and are usually regarded as poisonous, but which, she stated, if eaten when young and fresh, are harmless.[662]

The edibility of fungi is rarely a theme of the FNCV fungi group today. Rather, it aims to 'make the Kingdom Fungi more visible by widening people's knowledge of fungi in the field . . . to improve the knowledge and understanding of the distribution and ecology of Victorian fungi'.[663] In fact, the 'Fungi Collecting Policy' stipulates: 'The Field Naturalists Club of Victoria promotes the conservation of our environment. Picking mushrooms for consumption, on whatever scale, does not fit in with this goal

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658 "The Queen's Birthday Excursion to Lilydale," *The Victorian Naturalist*, 2, no. 3 (July 1885): 34.
659 "The Field Naturalists' Club of Victoria," *The Victorian Naturalist*, 1, no. 9 (September 1884): 82.
660 "The Field Naturalists' Club of Victoria," *The Victorian Naturalist*, 1, no. 14 (February 1885): 157.
661 "The Field Naturalists' Club of Victoria," *The Victorian Naturalist*, 2, no. 11 (March 1886): 126.
662 "The Field Naturalists' Club of Victoria," *The Victorian Naturalist*, 2, no. 12 (April 1886): 149.
663 Field Naturalists Club of Victoria, "Fungi Group".

and is not permitted during any of our forays'.[664] I was curious to understand why and at what point the group's focus shifted and so I combed the *Victorian Naturalist* archive for clues. During the twentieth century, mycologist Ethel McLennan and botanist Jim Willis among others made occasional references to edibility. An advertisement by Kodak in the 1959 and 1960 issues featured a fungus photo captioned: 'The edible Parasol Mushroom, *Lepiota gracilenta'*. References to the edibility of fungi dwindled in the second half of the twentieth century, the last being in an excursion report from the Flinders Ranges in the August-September 1971 issue.[665] The author, Katharine Hough, mentions the Morel, *Morchella conica*, commenting: 'Having sampled the culinary delight of these cooked in butter, the writer found it difficult to pass on and leave them growing'.[666] Around this time, notions of 'the bush', conservation and nature were shifting.[667] The decline of references to edibility in the journal coincided with the beginning of the 'environment movement' and 'ecological consciousness' in Australia, spurred by the success of the Little Desert campaign that saved it from agricultural development and established it as a National Park in 1968.[668] At a time when new understanding of the significance of 'wild places' was being explored, the Park became an icon of hope for the power of political lobbying for conservation.[669] The FNCV has been active in advocating for flora reserves including in the Little Desert since the early 1950s and established the Victorian National Parks Association in 1952.[670] The decline of edible mushroom collecting by Club members could have been influenced by conservation but it might also have reflected new uncertainties about taxonomic knowledge.

European mycologists made the first identifications of Australian fungi based on morphological similarity to European species, from which assumptions about edibility were transferred. However, gradually it became apparent that Australian species thought to be the same as European species, were in fact different. This had practical consequences for those seeking edible fungi as species previously thought to be edible,

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[664] Ibid.

[665] Some later issues mention edible fungi in contexts not related to their collection by Club members, for example, the historical use by Aboriginal Australians. Mycologist, Teresa Lebel also mentions edible truffles in the context of commercial production of *Tuber* species in Lebel, "Native Truffles," 39.

[666] Hough, "Excursion to the Flinders Ranges," 136.

[667] Robin, *Defending the Little Desert*, 141

[668] Ibid., 151.

[669] Ibid., 151-152.

[670] Ibid., 12, 37.

now assumed new identities and hence their edibility became uncertain.[671] Growing taxonomic knowledge of Australian fungi and ambiguity surrounding their edibility probably influenced the disappearance of references to edibility in the journal. There were, however, people who knew about the edibility of Australian fungi. Glaringly absent from these accounts in the *Victorian Naturalist* are references to Aboriginal knowledge of the edibility of native Australian fungi. While a handful of references to European observations of Aboriginal use of fungi exist, there is no suggestion of knowledge sharing between Aboriginal and European people. For example, a report from Henry Tisdall on the 'Fungi of North Gippsland' reflects an exchange between two European Australians regarding Aboriginal knowledge of Native Bread (*Laccocephalum mylittae*), but does not suggest any knowledge transfer between European Australians and Aboriginal people: 'as Mr [Alfred] Howitt assures me that they are eaten in large quantities by Aboriginals, they may have some way of finding them'.[672] The nineteenth and twentieth century field naturalists' lack of engagement with traditional knowledge contributed to the poor understanding of the edibility of Australian native fungi today.

In recent decades, groups like Fungimap and Field Naturalists Clubs have adopted a more scientific approach to their forays, usually with a designated leader, recorders and photographers. The primary aim is to collect fungus records, which fungus enthusiast Pat Leonard, defines as 'an observation of a fungus at a particular place and time that normally includes the species name of the fungus, its location, details of the habitat, who collected it and . . . who confirmed the identification'.[673] Records include written descriptions, illustrations, photos and/or specimens. Protocols exist for labelling specimens and recording data. Following forays, forayers regularly burn the midnight oil working on microscopic validations at home, labelling and drying specimens, writing foray reports and preparing data and voucher specimens to send to repositories such as herbaria and the *Atlas of Living Australia*. This procedure is much the same for European forays in which I have participated from the Swiss Jura to the Turkish Sapphire Coast, to the Swedish Skåne County, to the Scottish Isle of Arran. However, there are differences.

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[671] For example, the toxic native Australian Ghost Fungus, *Omphalotus nidiformis*, was originally classified in the genus *Pleurotus* (as *Pleurotus nidiformis*), which contains several edible species. This name change only occurred in 1994.
[672] Tisdall, "Fungi of North Gippsland," 109. Alfred Howitt was an explorer, naturalist and anthropologist known for his sympathetic regard for Aboriginal people (Griffiths, *Forests of Ash*, 27).
[673] Leonard, "Keeping Records on a Foray," 19.

On a magnificently sunny autumn morning in September 2013, I alighted from the bus at Hagaberg, about forty kilometres southwest of Stockholm and spotted the forayers straight away. It was not just the embroidered mushrooms on their jackets, their fancy lace-up gumboots or collection baskets slung over arms. Whether a Mycological Society, *Svampklubb*, *Société Mycologique* or *Pilzverein*, there is a particular 'fungus enthusiast look' that transcends cultures.[674] Each year the Swedish Mycological Society (founded in 1979) runs a *Mykologiveckan*, or Mycological Week, where forayers meet from across the country and I managed to secure a spot to attend in exchange for providing photography.

Mattias Andersson, chairman of Stockholm Mycological Society (founded in 1879) greeted me warmly and bustled me into a van between sisters, Helena and Bibi Wallqvist. Then the quizzing began. As with mycological field events I have attended in other European countries, it seemed I was the only foreigner among the seventy participants. I sensed that 'outsiders' rarely showed an interest in the anomalous subject of their curiosity. Participants questioned my interest in 'their Swedish fungi' and keenly shared their stories. Whizzing past glistening lakes and forests of turning birch, we arrived at the Stora Alsjön Nature Reserve.[675] Recognised for its natural values, the reserve harbours the highest number of Red-Listed fungi in coniferous forests within the Södertälje municipality. Baskets and backpacks were loaded with collection gear, thermoses and sandwiches. The group then dispersed into the forests and mires and among the lichen-carpeted boulders to search for fungi. Specimens were collected and lists made, including the Red-Listed *Boletopsis grisea*, *Tricholoma colossus* and *Sarcodon squamosus.* Following lunch on the sun-warmed rocks on the shores of Lilla Horssjön, we returned to the workroom where microscopic determinations proceeded long into the evening. As with most mycological societies, some folk examine all fungi and others specialise in particular groups. Birgitta Wasstorp is one of Europe's most experienced *Russula* experts, Bo Nylén specialises in the genus *Agaricus*, Åke Strid

[674] Unlike birders who mostly look upwards for their colourful and charismatic birds, fungus enthusiasts more commonly look downwards for Linneaus' "thievish and voracious beggars," the unclean excrescences of decay, and are commonly ridiculed and belittled. Mycologist, William Hay recognised in 1887 how "the individual who desires to engage in the study of them must boldly face a good deal of scorn . . . and is actually regarded as a sort of idiot among the lower orders" (Hay, *Textbook of British Fungi*, 6). Likewise, Margaret Plues also noted how the stranger, "blinded by conventionalities," sneered at those expressing an interest in fungi (Plues, *Rambles*, 245). "Fungus freak" is among the more benign names I hear in reference to forayers today. Groups with shared special interests often tend toward symbioses, but fungus enthusiasts, perhaps like their subjects, seem particularly prone to peculiar expressions of their passion.

[675] Stora Alsjön is among Sweden's 3200+ nature reserves and 28 National Parks that protect about 12 percent of the country's ecosystems.

with *Aphyllophorales*, Lennart Söderberg with *Ramaria* and Lennart Vessberg with *Hygrocybe.* Mattias Andersson is an expert on fungal dyes. In a similar format to many mycological gatherings, each day began with a foray to various designated field sites with over seventy surveyed during the week. However, over the following days I observed something I had not noticed at other mycological gatherings in Europe or Australia. Many forayers carried specimen boxes brimming with fungi for examination along with baskets crammed with edible species destined for the pan. While some folk were distinctively forayers or foragers, many were both. Fungus enthusiast, Jan Karp, grinned happily as he showed me his bounty of chanterelles (C*antharellus tubaeformis* and *C. cibarius*). I wondered how foraying and foraging were accommodated by the group, only to discover the famous Swedish mycologist Elias Fries, both studied and consumed fungi.

Strange and new-fangled meates – foraging for fungi[676]

Fries contributed greatly to systematic mycology in Sweden and throughout the world, as well as popularising edible fungi.[677] Whether Fries believed the promotion of edible fungi could stimulate their mycological study is impossible to know, but he obviously saw no divide between researching and eating them. Sweden is unusual in that the history of eating mushrooms traces a different path from many European countries. Once more typically a subsistence food of the rural poor elsewhere in Europe, it was the city elite who first discovered a taste for fungi in Sweden. Historian Anders Hirell notes the first written record of edible mushroom consumption was from the dinner table of the Royal Court of Stockholm on 10 July 1636.[678] Such recording continues today. So which mushrooms passed the royal lips on 10 July 1636? It was described only as *Riskor*. Hirell suspects it is commonly assumed to be *Lactarius deliciosus* although *Riskor* refers to several *Lactarius* species. He describes how prior to this time, the people of Fennoscandia, along with those of Belgium, Northern Germany and England, did not regard mushrooms as food: ‘it was said, that the ordinary countryman could use almost everything as a substitute for normal food. He could eat grass, straw, bark, roots,

[676] The subtitle is a reference to John Gerard’s description of fungi in *Gerard's Herball* of 1597 in which he said: “fewe of them are good to be eaten; and most of them do suffocate and strangle the eater. Therefore I giue my simple aduice unto those that loue such a strange and newfangled meates, to beware of licking honie among thornes, least the sweetness of the one do not countervaile the sharpnes and pricking of the other”. Gerard, *Herball*, 1384-5.
[677] Strid, “Elias Fries,” 48.
[678] Anders Hirell, pers. comm., 30 July 2015. Trans., by Hirell, *Den Svenska Matsvampens Historia*.

leather boots, sawdust – even horse excrement – but not mushrooms'.[679] Two centuries later in 1837, Fries wrote the first descriptions of edible mushrooms in the academic literature and in 1860 the Swedish Royal Academy of Sciences commissioned him to produce a book on edible mushrooms.[680] A more affordable book by fungus enthusiast Johan Wilhelm Smitt was published in 1863.[681] During the nineteenth century further guidebooks appeared and public authorities sought to popularise fungi among the wider population. Attitudes toward fungi, however, changed very slowly. While mushrooming did eventually catch on among the general populace, Hirell considers that even today, wealthier and well-educated city folk constitute the majority of mushroom foragers.[682]

Unlike in Sweden, Russian knowledge of fungi initially grew from desperate want. As the Wassons note, people with an abundance of food rarely 'brave the initial perils of the mushroom world'.[683] Wild edible mushrooms are typically sought for subsistence or as a gourmet extravagance, reflecting a cultural paradox as a symbol of both poverty and affluence.[684] Depending on the social context, mushrooms range from emergency food to the highlight of a festive table.[685] At the intersection of Sweden and Russia, Finland reflects a meeting of traditions, with eastern Finns showing little early interest in eating fungi like their Swedish counterparts, while the Karelian people formerly from the Russian Federation brought with them traditions and knowledge of wild mushroom collecting.[686] Choice of species is also strongly cultural. Local traditions and tastes coupled with commerce with directly neighbouring countries, influence species choice more strongly than species distribution (availability). That is, even when the same species grow in the same countries, preferences differ.[687] Edible fungi provide vital nutrition in times of food scarcity and not just in Russia and Eastern Europe. Art patron Simone Chételat, recounted stories of collecting *Hallimasch* (*Armillaria mellea,* Honey Mushroom) during lean times in Switzerland following the Second World War. She described how it became a regular part of her family's diet as a

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[679] Ibid.
[680] Sveriges ätliga och giftiga svampar (trans. Sweden's Edible and Toxic Mushrooms).
[681] *Skandinaviens förnämsta ätliga och giftiga svampar Populär framställning, utgivfven som förklaring öfver en större färftryckt planche* (trans. Scandinavia's Most Important Edible and Toxic Mushrooms: A Popular Presentation, Published as a Large Wall Chart Printed in Colour).
[682] Anders Hirell, pers. comm., 9 January 2016.
[683] Wasson and Wasson, *Mushrooms, Russia and History*, 37.
[684] Yamin-Pasternak, "A Means of Survival," 96.
[685] Ibid.
[686] Boa, *Wild Edible Fungi*, 3.
[687] Peintner et al., "Mycophilic or Mycophobic?".

substitute for meat.[688] When I asked if she liked it, her face screwed up with disgust as she recalled the process of repeated boiling to lessen bitterness, which also reduced it to an unpalatable mush. Eating *Hallismasch* was clearly not about culinary enjoyment but a necessary source of nourishment. Few people eat *Hallimasch* in Switzerland today.[689] Desperation forced people to forage for a greater range of species and in greater quantities. Yamin-Pasternak describes how during the 'hunger years' following the Soviet collapse (1990s), the Chukotka people of the far northeast of the Russian Federation collected a wider variety of mushrooms. She also identified the transition to more innovative techniques for preparing mushrooms in response to the lesser variety of food.[690]

Today, Western European mushroom markets sell a significantly greater variety of mushroom species than Eastern European markets.[691] Mycologist Ursula Peintner sees curiosity and the excitement of culinary discovery as the driver of new tastes, rather than necessity.[692] While gourmands in Australia discover wild fungi as a bourgeois speciality, for those like Simone in Switzerland and others in some parts of Fennoscandia, fungi still carry the stigma of famine food. Being low in fat and carbohydrates, fungi offer relatively few calories and low nutritional value relative to the labour required to collect and prepare them. For many in the Western world, the symbolic notions of wild edible mushrooms represent more than the sensual aspect of flavour and texture to include what Fine describes as the quality of 'gatheredness': 'What is important in the "taste" of mushrooms is the means by which they are gathered, and the symbolic value of that collection, rather than taste per se . . . the context of taste comes from the experience of the collector'.[693] Mushroom consumers regularly joke about the garlic and butter with which mushrooms are commonly cooked as being the most flavoursome part of the mushroom meal. Likewise, Yamin-Pasternak

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[688] Mushrooms are not a true meat substitute from a nutritional perspective given their lack of protein, but were perhaps conceptualised as meat given the texture, flavour and "heaviness" (indigestibility) of many mushrooms species.

[689] Based on personal observations of the species brought to the fungus inspectors for identification over many years. Also note, *A. mellea* is a species complex. Interestingly, in Italy, after the five most popular mushrooms sold in Europe (*Boletus edulis* group, *Cantharellus cibarius, Lactarius deliciosus, Morchella esculenta* and *Agaricus campestris*) *A. mellea* (along with St George's Mushroom, *Calocybe gambosa*) is the next most popularly traded mushroom. Peintner et al., "Mycophilic or Mycophobic," 8.

[690] Yamin-Pasternak, "A Means of Survival," 102.

[691] Peintner et al., "Mycophilic or Mycophobic".

[692] Ursula Peintner, pers. comm., 17 January 2016.

[693] Fine, *Morel Tales*, 79.

considers that nutritional value goes beyond quantifiable calories with social and cultural influences determining perceived nutrition, flavour and enjoyment.[694]

Among the most prized of all fungi, Morels (*Morchella*) and Truffles (*Tuber*) fetch a high price in fancy restaurants, their consumption being a sign of social status. Morels top the half a dozen dried mushrooms species on offer in Swiss supermarkets, selling at around three hundred Swiss Francs a kilo (AUD 425). Ironically (or perhaps not), the Russian and Eastern Europeans who export them regard them as a food for the poor.[695] Yamin-Pasternak says,

> in the end, it is neither the ecological settings nor the broad cultural dispositions that determine the status of a particular food, but rather a particular constellation of the ecological and culinary spheres of knowledge, history of cross-cultural and intercommunity contacts, dietary preferences, consumption patterns, and people's ingenuity and adaptive techniques.[696]

Deep cultural connections with wild edible fungi exist throughout Europe, but how do these translate to Australian contexts?

On morel grounds

Few things faze Jill McFarlane. There's not much she can't do, or won't at least try. She finds humour in adversity, even when reciting the story of flipping her car while dodging a kangaroo on a back road and spending the night upside down, until a sockless man in Blundstone workboots came to her rescue. Having explored far-flung corners of the world, back home in Kingower in Northern Victoria, Jill is actively involved in local conservation groups.[697] Jill first invited me to talk about fungi to the Wedderburn Catchment Management Network in 2010 and I have been returning to the region each autumn since. Jill appreciates how local communities drive conservation and has a deep understanding of environmental and sociological issues. She's not afraid to speak her mind making a dramatic protest when a landowner felled ancient local Red Gums (*Eucalyptus camaldulensis)*. Jill is interested in fungi because she is interested in everything about how ecosystems work. It is people like Jill and Judy Crocker and Gayle Osborne from previous chapters who have the insight and imagination to get fungi on the conservation agenda. Sitting at her dining room table at Passing Clouds Winery, we talked about fungi and her recent trip to Botswana as Bogong moths

[694] Yamin-Pasternak, "A Means of Survival," 101.
[695] Ibid., 104.
[696] Ibid., 105. Peintner and colleagues note the particularity of mushroom choice in their finding that half of all the European mushrooms authorised to be commercialised (134 taxa) are done so in only one or two European countries.
[697] Jill also served on various boards including the North Central Catchment Management Authority and the Victorian Environmental Assessment Council.

slammed their furred thoraxes against the window. Then in a sudden breathtaking swish of wings, an owl swooped past snatching at the giant moths. Jill seemed to attract such thrilling and enigmatic happenings, giving one a sense that anything is possible. A stone's throw from her place, the Kooyoora State Park encircles Box and Ironbark woodland, picturesque granite tors and sites of Aboriginal significance. The region draws waves of different people beginning with the Jaara Jaara Aboriginal people who sought water and rock shelters. In the late 1850s gold miners rushed to the area in search of the precious metal. Today hikers, horse-riders and rock-climbers explore the surrounds. A newer group also visits the park – commercial Morel hunters.

At the park's entrance reads a sign: 'Native plants, fungi and wildlife are protected'. As explored throughout this thesis, fungi rarely figure in biodiversity conservation. The specific reference to fungi on the sign piqued my curiosity, particularly in the context of the Morel seekers. I headed to the Parks Victoria office at Inglewood to talk to the rangers. Head Ranger Martin Woodward gave me a rundown of the park's history (established in 1985) and described how an article published in a Melbourne newspaper in the 1990s touting the commercial value of Morels, 'triggered an explosion of interest'.[698] Commercial pickers from Melbourne quickly tapped into this novel resource. Concerns about their effect on the fungi and ecology of the park prompted a licensing system in attempt to regulate harvesting. I asked Martin's colleague, ranger Susie Deason, if she considered Morel harvesting to be a problem and if people breached licences. Susie shrugged and confessed there was no way it could be properly monitored due to the large area managed by few rangers, adding that curbing other forms of poaching such as that of geckoes and parrot eggs was a higher priority. What happens when mushrooms gathered as part of small-scale local traditions become a commercially-exploitable commodity? I got the impression from the Kooyoora rangers that two types of Morel pickers exist – those who pick for food and those who pick for money. For generations, local folk have collected a few Morels each spring, just enough for the family. Many belong to the 'Friends of Kooyoora' (established in 1987). They do the hard-slog voluntary conservation work and a few Morels seemed like a small reward for their efforts. The commercial pickers usually come from elsewhere and pick significantly larger quantities to supply Melbourne restaurants. The *Kooyoora State Park Management Plan* lists 'illegal harvesting and lack of knowledge of fungi' as a 'risk of most concern to vegetation'.[699] Does regular large-scale

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[698] Martin Woodward, conversation with the author, Inglewood, 10 April 2014.
[699] Parks Victoria, *Kooyora State Park Management Plan*, 27.

harvesting threaten Morels or could it, in fact, enhance fruiting, as is the case with some cultivated mushrooms?[700] Many mycologists concur that removing sporebodies does not compromise sporebody production.[701] The oft-cited study by mycologist Simon Egli and colleagues found that long-term (29 years) systematic harvesting of fungus sporebodies did not reduce yields or species richness.[702] A ten-year research project targetting Chanterelle harvesting in North America produced similar results.[703] Disturbance to the forest floor through over-trampling that damages habitat and mycelium was of more concern than harvesting sporebodies. No such research has been conducted in Australia. Mycologist Nicholas Money, however, is not convinced that harvesting has no effect.[704] He believes the reduced reproductive capacity of a fungus due to sporebody collecting is 'potentially as costly to the fungus as egg collecting is for songbirds.[705] Money cautions against blind trust in the way nature is measured, reminding us of the dire consequences of past assumptions about 'inexhaustible resources' in the context of the global decline in fish stocks. Furthermore, getting a clear and accurate picture of mushroom harvesting is not easy. The consequences of intensive sporebody collection are difficult to isolate from the more broad-reaching effects of habitat loss through intensive agriculture and forestry, land and air pollution, exacerbated by the erratic nature of fungus fruiting. Whether long-term harvesting effects are detectable within the abovementioned research timeframes is uncertain. As Rob Nixon argues throughout his book, *Slow Violence*, gradual environmental changes slip below the radar, overshadowed by dramatic event-oriented catastrophes.[706] The incremental decline of fungi beneath the soil might take decades if not centuries to manifest as aboveground visible damage.

Do Morels carry the same allure in Australia as elsewhere in the world? Ranger Wendy Murphy asked the Friends of Kooyoora folk about their experiences with Morels on my behalf, commenting, 'by what I've heard people say it was quite big secret family business collecting these things'. Lynette Rose recalled, 'I went out a few times with different people collecting Morels. Each family had their own secret spot to go collecting and you were not allowed to tell any one else where these spots were. Some people climbed right in to the back blocks to collect them'. The feisty Jill

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[700] Moore, Robson and Trinci, *Twentieth Century Guidebook to Fungi*, 273.
[701] Ibid.
[702] Egli et al., "Mushroom Picking," 271.
[703] Norvell, "Loving the Chanterelle to Death?," 18.
[704] Money, "Why Picking Wild Mushrooms May be Bad Behaviour," 134.
[705] Ibid., 133.
[706] Nixon, *Slow Violence*.

Mcfarlane said: ‘I admit picking them from a neighbour’s property joining the Kooyoora Park, but have threatened death to any of my friends who showed interest!’ However, not all of the Kooyoora folk shared an appreciation of the edibility of Morels. Marj May prefers to identify and paint Morels than eat them, commenting, ‘the 1985 season was the only time I have attempted to eat Morels. They were collected by Toppy and Vern A’Hearne, whom I believe collected them each season. I must say I found them quite disgusting eating’.[707] As far as I can trace, the Kooyoora situation is the only incidence in Australia of a licence system being introduced based on concerns about overharvesting fungi. However, it seems Morels do not hold the same cultural resonance in Australia as they do in America.[708] Or at least not yet. Regulations for edible fungus harvesting and commerce exist in more than half of the European countries, the first being enacted in the Austrian-Hungarian empire in 1820. Other countries soon followed suit.[709] Many arose to avert poisoning and in recent decades in response to conservation concerns. Today in the United Kingdom, ‘codes of collection’ limit quantities harvested and urge a soft-footed approach. Some Swiss cantons restrict collection days and mushroom quantities. Italy imposes collection fees in various provinces. Germany, Austria, Switzerland, France, Estonia, Croatia, Serbia, Poland and the Czech Republic prohibit collection in some protected areas including National Parks. Each of these countries has population densities far greater than Australia and all but the UK have long traditions of harvesting edible mushrooms as food. In Australia, it is illegal to pick Morels, or any fungi, on crown land without a licence, but few people are aware of this law and it is seldom policed. The whereabouts and threat status of fungi including Morels in these drier regions of Victoria are poorly known. Mycologist Tom May commented that the rarity of some species means too many Morel omelettes could wipe them out.[710] Mycologists and fungal conservationists who develop fungus distribution maps question whether to include Morel because of concerns about over-harvesting. Moreover, recent taxonomic work on Morels has revealed many cryptic species. Until more is known about the number of species and whether individual species favour particular habitats or geographies, it is very difficult to determine conservation status. I asked Martin about the situation today with Morel collection in Kooyoora. He replied that while the initial explosion of interest had ‘blown over,’ local people still collected Morels. Did commerical harvesting serve a passing gastronomic

[707] Marj May, pers. comm., 19 November 2014.
[708] Fine, *Morel Tales*, 88.
[709] Peintner et al., “Mycophilic or Mycophobic,” 4.
[710] Roslyn Grundy “And the Morel of the Story: Tread Wearily,” *Age*, 17 September 1996.

fad or did regulation push it underground? Or did those out for a quick buck move on to more lucrative enterprises? In America, mushroom picking (including Morels, Chanterelles, Ceps and Matsutake) has burgeoned into an export industry worth hundreds of millions of dollars and picking is highly regulated.[711] In England, debates rage about over-picking, inappropriate regulation and environmental consequences.[712] The long-term environmental and social consequences are little known. Like Australia, America and England were not traditionally mycophilic countries and the rapid growth in interest occurred in just three decades. I wondered how the future might unfold in Australia and if in the case of increased foraging, what we could learn from the American and British experiences.

Unlike most fungi, Morels fruit in spring. They also fruit after fire. This is common knowledge among Morel hunters. Fungus enthusiast Langdon Cook, recounts the sophistication with which American Morel hunters track fire.[713] Fungus enthusiast Giuliana Furci described the ecological damage associated with the deliberate lighting of fires to stimulate Morel fruiting in Chile.[714] This is not a new problem, as nature writer Margaret Plues noted in 1865 in the Yorkshire Dales, England: 'It was found that the fungus [Morels] flourished in the greatest luxuriance on wood ashes, and such was the rage for the delicacy that large portions of the forest used to be burned down annually, on purpose to secure a large crop of Morels'.[715] Similar practices have been documented in nineteenth century Italy and France.[716] Fungus enthusiast Eugenia Bone, describes her experiences of scouting an 'especially devastated area' (by fire) in Montana for Morels and the hundreds of pickers that descend on burned forests.[717] As I write, at the end of December 2015, fires ravage the Otway Ranges in southern Victoria. One hundred and sixteen houses burnt to the ground but biodiversity losses are not tallied. Forests are at their most vulnerable following fire when soils destabilise and trees lose mycorrhizal partners. Additional disturbance by foragers could hamper forest recovery. Animals that survive the fire, risk death by starvation. I wonder how they would fare if Morels became as popular as in America, especially given the increased

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711 Bone, *Mycophilia*, 98.

712 For example, Damian Carrington, "Illegal Foragers are stripping UK Forests of Fungi, *Guardian*, 24 October 2014, http://www.theguardian.com/environment/2014/oct/24/illegal-foragers-are-stripping-uk-forests-of-fungi; Juliet Jowit, "Wild Mushroom Foraging is Damaging Forests," *Guardian*, 24 October 2010, http://www.theguardian.com/environment/2010/oct/24/wild-mushroom-foraging-hurts-forests.

713 Cook, *The Mushroom Hunters*, 237.

714 Giuliana Furci, "unpublished paper".

715 Plues, *Rambles*, 293.

716 Davidson, *The Oxford Companion to Food*, 532.

717 Bone, *Mycophilia*, 116.

intensity, frequency and extent of wildfire in recent years. While Australian mammals mostly eat hypogeous (underground) fungi, perhaps they would not ignore a Morel if it were all that was on offer. Arson is increasing in Australia and approximately half of all vegetation fires (20,000-30,000 per year) are deliberately lit.[718] Another incentive to strike a match is probably not such a good idea.

High altitude hunting

Teresio Valsesia's cigar stuck to his bottom lip. When he opened his mouth to speak, it magically stayed in place. Teresio leant against the village fountain in the northern Italian hamlet of Macugnaga-Borca. The water rushed out clear and cold, direct from the ice-covered Monte Rosa looming before us. His deeply lined faced looked as though it were hewn from the same geology that formed the imposing massif. Teresio held the delicate Chanterelles (*Cantharellus cibarius*) between his thick fingers, dashed them beneath the water, then placed them on the marble pillar of the fountain. The whole time his cigar barely moved.

Teresio was not in a hurry. I was thrilled as I wanted to know about his Chanterelles. A slow smile spread across his face as he recited foraging stories. Teresio knew the forests well, having once walked six thousand kilometres over the Alps and across the country. He collected other fungi too including *Porcini* (*Boletus edulis*) and *Sanguinaroi* (*Lactarius deliciosus*), but Chanterelles were his favourite.[719] All three have been held in high esteem across centuries and cultures. Almost five hundred years earlier, the German botanist Valerius Cordus (1515-1544) wrote, 'the best edible fungi are named Pfifferlinge [*Cantharellus cibarius*] and Reitzken [*Lactarius deliciosus*]'.[720] Among Europeans, Swedes most famously crave Chanterelles, with stall after stall of the Östermalms Saluhall market in Stockholm piled high with these orange treasures in early autumn. In Russia, the Wassons claim that Chanterelles yield pride of place to *Ryzhik* (*Lactarius deliciosus*).[721] *Lactarius deliciosus* and *Suillus luteus* were the most valued edible species in the Italian region of Calabria prior to the realisation of the culinary superiority of *Porcini* (*Boletus edulis*) in 1940 by migrant coal miners from the northern province of Liguria.[722] Of the 268 mushroom taxa commercially available in

[718] Muller, "Using Crime Prevention," 797.
[719] *Lactarius deliciosus* is also known as *Fonghi dal pin, Sanguinoso, Rossella, Apitinu, Cummarine* and has at least a dozen other vernacular names within regional Italy. *Boletus edulis* is a species complex.
[720] Heino, *Snippets of Mycological History*, 60.
[721] Ibid.
[722] Sitta and Floriani, "Nationalization and Globalization Trends," 309.

27 European countries, only two, *Porcini* and the Chanterelle (*Cantharellus cibarius*) are sold in all, attesting to their popularity.[723] Teresio squinted as he glanced up at the ridgeline and asked where we were headed. He then beckoned us to wait a moment and disappeared down the cobbled alley. Returning a few minutes later with an outstretched hand, he imparted a copy of *Il Sentiero Naturalistico di Macungnaga Monte Rosa*, a book he had written about the nature trails of the region. The subtitle read: *Ambiente, Storia, Flora, Fauna*. Where were the *Funghi* I wondered, but perhaps that was a silly question. We thanked him and he waved us goodbye and returned to tend his Chanterelles, as we headed for the ridge.

The previous evening, as the valley swallowed the last of the sunshine and instantly chilled the air, we checked into the 1970s timewarp of Hotel Albergo Alpi. It seemed everywhere I turned I met with mushrooms. From the balcony, I spied bags of dried *Porcini* hanging in the *alimentari* window across the road. Delectable aromas of Piedmontese cuisine floated up the stairs and I joined the other hungry hikers in the dining room. I gazed around at the gilded mirrors and still life paintings of hunters and the broken-necked hunted, eyes permanently fixed on the diners below. The waitress swept in with an oversized plate of *Funghi Porcini trifolati* (sautéed *Boletus edulis*). I stared at them in dismay, knowing I would barely be able to make a dent in the overly generous portion and the long mountainous ascent awaited us in the morning. However, to leave these reverential mushrooms uneaten would severely offend Italian gastronomic codes, so I gave them my best shot.

The old *mulattiere* (mule paths) and smugglers' routes led us through abandoned hamlets huddled into the hillside. We climbed a broken stile and wandered among the remains of old farm terraces, lichen-flecked walling and onwards through the copper light of forests of larch, chestnut and beech. Everywhere there were fungi, more perhaps than I have ever encountered. Amethyst Deceivers (*Laccaria amethystina*) hid in the dappled sunlight. Slugs slid over purple russulas with luxuriant slowness. Fat *Porcini* sat defiantly in the middle of the track, as if daring to be plucked. It is the kind of fungus that could it sing, would be a swarthy baritone. Trooping Funnels (*Clitocybe geotropa*) circled the forest in giant rings. Witches butter (*Exidia glandulosa*) dribbled off branches like gobs of expectorated phlegm. Then another, whose name always eludes me, but smells unforgettably like fenugreek. Anarchic snarls of mycelium coursed through fallen logs and in between, transpired the golden trumpets of Teresio's Chanterelles. A wolf whistle pierced the silent forest. My hiking companions beckoned

[723] Peintner et al., "Mycophilic or Mycophobic," 4.

me on. What cruelty! How dismaying it was to leave these fungus-filled forests, but we needed to get to our destination by darkness.

Alpe Colma di Prei rifugio perches on the ridge between the valleys of Antrona and Anzasca. Across the range shafts of light picked out a smirr before blackening in a kind of meteorological abracadabra. Like fungus sporebodies, these are mercurial landscapes to be lived in the moment. We kicked off our boots and joined hut-keepers, Olindo and Patrizia Gurgone, who prepared dinner and reeled off stories as the aroma of baking bread escaped the wood oven. Through my more adept Italian-speaking hiking companions, I urged them to ask about mushrooms. For Olindo, *Porcini* were gold. He shrugged and laughed when asked about collection permits, which cost thirty euro a year. Olindo's insouciance suggested foraging was considered a right for anyone who lived in the mountains, not something to be regulated. He described with animated enthusiasm the joy of collecting, preparing and eating wild mushrooms as well as where to find them . . . perhaps. In the corner sat their elderly neighbour, Sergio Bionda, who lived further along the ridge. Sergio watched on quietly, listening to the conversation and offering just the occasional nod or grin. No-one mentioned politics or ventured into larger topics. It was autumn, and the conversation focussed on mushrooms. Fungi are not just food, but a deeply held cultural tradition. A way of life. An assumed privilege.

In the Piedmont, mushroom stories are as common as the chantries and chapels etched into the side of sheer rock mountain faces. The region and its fungi became famous through gastronomist, Antonio Carluccio, who roamed the mountains further south near Borgofranco d'Ivrea searching for fungi since childhood. Carluccio celebrated his passion for fungi with over half a century of collecting, cooking, writing and television appearances. Carluccio's notion of 'the quiet hunt' captures the serenity of foraging in the turning forests in the most introspective of seasons, autumn.[724] Yet it was not so long ago that the Italian mountains were considered off-limits, harbouring all manner of unknown dangers, which paradoxically also added to their allure. Historian Marco Armiero, explores the contradictory meaning of 'wild' and how the mountains and 'wildness' conflict with the ideas of Italian identity, yet the fungi (especially truffles) of these mountains are so exalted today that the edible mushroom industry seethes with shadowy subcultures of theft and fraud.[725] Whether one is partial to the taste of *Porcino* or not, there is something immensely satisfying about the feel of this

[724] Carluccio says "the quiet hunt" was inspired by Mikhael Gorbachev's description of the Russian expression for mushroom hunting. Carluccio, *Complete Mushroom Book*, 8.
[725] Armiero, *A Rugged Nation*, 5.

paunchy weighty mushroom in the hand. As the night wore on, Sergio slid his empty grappa glass across the table, jerked his chin in a gesture of goodbye and wandered home across the ridge. Olindo stood outside staring into the night, humming and smoking. The crooked line of the range rubbed against the darkness. Fifteen minutes later came a flash in the distance. Olindo flashed his torch in reply, yelling '*buona notte'* into the blackness. Sergio had made it home.

Wild desires and treacherous gratifications[726]

There is something deeply primal about foraging for 'wild' food that goes beyond it being free. In Australia, it is rarely about subsistence, more commonly reflecting new cultural desires to discover old traditions, reconnect with nature or expand culinary repertoires. For some, it is part of the drive toward self-sufficiency that grew with Rachel Carson's writings and the back-to-the-land movement of the 1960s, along with the more recent guerilla gardeners who grow food in neglected public spaces. Permaculture also had an influence. Since its Italian origins in the 1970s, the now global Slow Food rhetoric attempts to redefine gastronomy through close scrutiny of the ways in which food is produced and consumed. Increasing resistance to industrial agriculture and the monopoly of supermarkets dictating food production, make wild food an attractive alternative.

Tucked up a back lane in the city of Hobart, a chic restaurant menu boasted 'finest quality wild mushrooms'. Once denigrated as a colloquial backwater, Tasmania's popularity today as a producer of high quality food attracts diners keen for new gastronomic discoveries and is the focus of the summertime *Taste of Tasmania* festival, held along Hobart's waterfront for almost three decades. The clean nature-based branding by Tourism Tasmania buoys the rise of the twenty-first century hunter-gatherer, spurred on by celebrity chefs and the increasing popularity of local and seasonal foraged fare. Notions of what constitutes 'wild' and 'wilderness' have been interminably debated in academic spheres in recent decades, but the wider public seems keener than ever to buy 'wild,' authentic or not.

My 'wild' mushroom ragoût at the hip restaurant was tasty but challenged notions of 'wild'. Some surreptitious dissection at the dinner table and waitress interrogation revealed Portobelli (*Agaricus bisporus*), Oyster Mushrooms (*Pleurotus ostreatus*), Shiitake (*Lentinula edodes*) – all commercially produced – with a sprinkling

[726] The sub-title is borrowed from John Farley, who in 1784 in *The London Art of Cookery* referred to mushrooms as "treacherous gratifications".

of Saffron Milk Caps (*Lactarius deliciosus*) collected from Pine plantations on Hobart's outskirts, presumably representing the 'wild' component. The idea of wild-picked fungi, it seems, engages the imagination as much as the stomach. I wondered how much of the appeal was about wild food or the idea of wild eating. Can most folk really distinguish between a commercially grown and wild-picked mushroom and does it matter? In reality, wild food has become gourmet food. It is perhaps as much about convincing oneself that they emanate from somewhere called 'the wild' and being prepared to pay for it; the ragoût being more expensive than the fish, which were considerably more 'wild'. Over the last three decades, the 'food and lifestyle' sections of weekend newspapers have dramatised the mythologising of fungus foraging. With all the trappings of traditional French or Italian foraging, journalists even claim being blindfolded en route to covert foraging locations. Secrecy and territoriality certainly characterise European foraging particularly for Truffles and *Porcini*. Poisoning of truffle sniffer dogs in Italy is not uncommon "as truffle hunters step up their campaign to protect their lucrative caches".[727] However, given that in Australia two of the most sought after species (Saffron Milk Caps and Slippery Jacks) grow in association with Radiata Pine plantations, it follows that if you can discern a Pine tree from a Gum tree you have a reasonable chance of finding them. Mystique, risk and sense of adventure are evidently effective flavour enhancers. Ease of identification and abundant fruiting patterns mean these species are usually among the first 'wild' mushrooms Australians learn to identify, providing a comforting sense of certainty and achievement. However, some still get it wrong.[728]

A newspaper article by Australian chef and restaurateur Stephanie Alexander epitomises the tensions between fungus foragers and mycologists.[729] European foraging traditions do not easily translate to Australia where edibility of native species is largely untested and the level of public knowledge is generally low. In the article, mycologist Ian Pascoe, expressed his concern about foraging given the prevalence of toxic Australian fungi, adding that the public are often poor observers and unlikely to have the required skills to differentiate species.[730] Since the mid 1980s, Saffron Milk Caps

[727] Bruce Johnston, "More Dogs Die as Truffle Turf War Escalates," *Telegraph* (London) 26 October 1999.

[728] Although no hard data exist, the Field Mushroom, *Agaricus campestris*/*A. arvensis*, is still probably the most commonly consumed wild mushroom in Australia. However, increased prevalence of the toxic Doppelgänger, *Agaricus xanthodermus*, could be contributing to the rising popularity of the more easily identificable Saffron Milk Cap and Slippery Jack.

[729] Stephanie Alexander, "A Stalk on the Wild Side," *Age*, 5 August 1988.

[730] Ibid.

began appearing in newspaper articles promoting their culinary qualities. However, despite the precision of available information on this species, a lack of care in naming, describing and depicting it is disquietingly commonplace. For example, one article stated: ‘People can eat the saffron milk cap (*Lactarius deliciosus*) which is a yellow mushroom often found in Pine forests’.[731] Inconsistent colour of fungi along with varying perceptions make it an unreliable characteristic for identification, but generally, the colour of *L. deliciosus* is described as orange (oxidising to green).[732] Describing it only as yellow (and failing to mention the conspicuous colour change) risks confusion with other more obviously yellow or yellowish species such as Sulphur Tufts (*Hypholoma fasciculare*) and the more morphologically similar species, the Roll Rim (*Paxillus involutus*). Both also grow in association with exotic trees and both are poisonous. Further inaccuracies confused fungus identities. An erratum correcting a wrongly named species, then presented photos of the Saffron Milk Cap alongside the toxic species, the Yellow Stainer (*Agaricus xanthodermus*), but with captions switched.[733] Identifying edible fungi requires precise knowledge yet articles about edible fungi often omit scientific names that would allow readers to verify vernacular names. Given the ubiquity of toxic species, writing about edible fungi in the public domain entails a certain responsibility. However, it often gets confused with heroics and the exploitation of mushroom knowledge as sacred lore cloaked in authority and exclusivity. In 2013 a celebrity chef and restaurateur wrote about foraging for Saffron Milk Caps in an Adelaide news-magazine.[734] He also boasted about eating the Fly Agaric (*Amanita muscaria*). Long histories of Fly Agaric consumption exist in Russia and some Eastern European and South American countries, predominantly for their hallucinogenic effect. However, recommending this toxic species as ‘delicious’ in a nation unaccustomed to fungus foraging seems foolhardy. Fungi need modest, contextual and generous stories, rather than risqué heroics.

Poisoning risks aside, newspapers flaunt feel-good foraging stories but rarely balance them with ecological or conservation perspectives. The United Kingdom, another traditionally mycophobic country, represents an interesting example of how things might have been done differently. This cultural change toward fungus foraging in

[731] “Play it Safe with Field Mushrooms,” *Gippsland Mirror*, 2 March 2005.
[732] A dozen field guides selected at random in English and German reflected the great colour variation over the lifespan of sporebodies of this species, generally describing it as orange, and never only as yellow. See appendix 8.
[733] “Mistaken Mushrooms,” Gippsland Mirror, 9 March 2005.
[734] Jock Zonfrillo, “Chewing the Fat,” *Adelaide Review*, 16 May 2013. The Fly Agaric is highly toxic raw and requires extensive treatment to render it edible.

the UK in recent decades has triggered bitter debate about the social and ecological effects of foraging. Passing of blame for reduced yields and subsequent regulation is commonplace.[735] However, could low-level foraging for wild edible fungi serve a dual purpose of providing food and inspiring a conservation ethic? Conservation-recreation arguments have long shown that animal hunters are more likely to be conservationists than non-hunters.[736] 'Ecoagricultural' landscapes that incorporate agriculture and wild foods prompt a reconsideration of relationships between biodiversity conservation and agriculture.[737] Could such arguments afford fungi greater recognition? Ecologist, Sophia Lund remains sceptical in the Swedish context, the country where foraying and foraging appeared well aligned. Lund argues that foragers tend to pick very few species, all which commonly grow in managed forests with conservation rarely coming into the picture. She concedes: 'I guess if some of these species like the Chanterelle (C*antharellus tubaeformis* and *C. cibarius*) were threatened, pickers might become interested in conservation'.[738] Swedish mycologist Åke Strid, also considers the relationship between mycologists and foragers to be fraught.[739] Sweden is an interesting case in that the *Allemansrätten* allows right of public access to private land including the picking of flowers, berries and mushrooms, giving foragers are freedom not enjoyed elsewhere.[740] As knowledge of the edibility of native Australian fungi is minimal, arguments against foraging more commonly revolve around human poisoning risks than environmental concerns. Given Australia's high diversity of fungi, relatively low human population density and growing interest in both fungi and conservation, perhaps fungi provide an untapped opportunity to explore beneficial and sustainable relationships between foraging and conservation.

Rethinking fungal expertise

'It's not the expertise that counts; it's the quality of your wondering'.[741]

From foragers Pete Stewart and Teresio Valsesia, to the mycologists roaming Stora Alsjön, to the Mt Macedon forayers and the Wiradjuri fellas returning to Country,

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[735] For example, Polish people are singled out as "the problem" in this debate: "Association of British Fungus Groups," accessed 5 January 2016, http://www.abfg.org/bap/viewtopic.php?f=99&t=1247.
[736] For example, Cooper et al., "Are Wildlife Recreationists Conservationists?," 446.
[737] Scherr and McNeely, "Biodiversity Conservation and Agricultural Sustainability," 477.
[738] Sophia Lund, interview with the author, 27 September 2013, Hagaberg, Sweden.
[739] Åke Strid, interview with the author, 27 September 2013, Hagaberg, Sweden.
[740] This also applies in Finland, Iceland, Norway, Scotland, Estonia, Latvia and Lithuania.
[741] Tredinnick, *Writing Well*, 144.

people seek fungi in the field for diverse reasons. All bring different ways of knowing fungi. Some, the experts or professionals, get paid for their knowledge, while amateurs (also called naturalists, citizen scientists, recreational foragers or not categorised) are unpaid but also hold expertise. I prefer to think of 'amateurs' as fungus *enthusiasts* to encompass their passion, broad range of interests and knowledge, as well as to diminish the amateur-professional divide. Vast knowledge on the distribution and natural history of fungi exists in the minds, memories and unpublished records of enthusiasts. It is held in the sophisticated knowledge of place, understood with the mind, the body and the senses and not necessarily as scientifically organised data.

Frictions between enthusiasts and mycologists mostly arise around differing standards of taxonomic competence. Mycologist, Paul Cannon recounted the polarisation within the British Mycological Society. He described laboratory-based mycologists' concerns about the 'inexpertise of amateurs' in the field as compromising the society's scientific credibility.[742] However, mycologists and naturalists often work in concert, mostly through the contribution of data collected by naturalists in the field. As Tom May notes, 'amateurs' have been used to collect fungus specimens since Hooker and von Mueller and the vast number of specimens lodged in herbaria reflect their efforts.[743] Ian Pascoe described the serendipitous nature of mycology and how the interests of 'amateurs' strongly influence what gets studied professionally.[744] Paradoxically, 'field and lab' have become synonymous with amateur and professional. Yet, as I have questioned throughout this thesis, can fungi be fully understood separate from their environmental context? Those in the field develop a particular kind of 'expertise' driven by passion for discovery. Historian Libby Robin cites ornithologist, Allan McEvey who considered: 'It's a strange irony, isn't it, that the amateur is the one who loves (from the Latin) and the professional doesn't have to love it – but if professionals aren't truly amateurs then they ought not to be in the job'.[745] Mycologists study the complexities of fungi and their relationships to a greater depth and breadth than most novices. Expertise, however, is more than facts and knowledge, but is also about perception. What matters, says Tim Ingold:

> is not greater accumulation of mental content . . . but a greater sensitivity to cues in the environments and a greater capacity to respond to these cues with judgment and precision. The difference . . . is not one of how *much* you know but of how *well* you know . . . Thus

[742] Paul Cannon, informal conversation with the author, Kew, London, 16 October 2013.
[743] May, "Documenting the Fungal Biodiversity of Australasia," 345.
[744] Pascoe, "History of Systematic Mycology in Australia," 263.
[745] Robin, *The Flight of the Emu,* 209.

> knowing is relating the world around you, and the better you know, the greater the clarity and depth of your perception.[746]

Knowledge of nature was once largely collected by naturalists. Rarely 'professionals,' they provided knowledge before the increasing sophistication of scientific analyses in the late twentieth century contributed to the amateur-professional divide and the redefining of expertise. Australian mycology is hindered by lack of funding, public understanding and interest. The rise of 'citizen science' through organisations such as Fungimap involves public effort in monitoring and increasing scientific literacy. The ubiquity of the Internet, social media and nature platforms enables contributors to place records in the public domain, allowing for mass data collection. However, limitations exist given most citizens lack formal mycological training. Fungi present additional challenges relative to other groups of organisms due to the relatively high species richness, large number of rare or little-known species and unstable taxonomy.[747] Experts must then 'validate' the identifications of the massive amount of records produced. Nevertheless, Australian fungus distribution knowledge flows largely from the voluntary efforts of enthusiasts, with the benefits of mass data contribution outweighing limitations.

Could the focus on the accuracy of species identification, however, distract from bigger picture phenomena and also overlook local knowledge? As Robin notes,

> the science of ecology has developed as a very specific science of place . . . In short there is a veritable suite of preconditions making it difficult to transfer ecological knowledge of one place to another without the interpretation of a locally *expert* ecologist.[748]

Australian ecosystems are by nature highly idiosyncratic. Generalised models of ecosystem function do not always apply without specific spatial and temporal contexts. Given the vastness and diversity of the Australian continent, in some regions, so-called situated knowledge (knowledge relevant to a particular place and situation) is likely to be the sole source of understanding of local fungi.[749] Such knowledge could improve the capacity to interpret ecosystem dynamics and change at fine-scales over extended time. Relative to professional mycology where Australia's few mycologists and researchers are based in institutions predominantly in cities, citizen science has the geographic advantage of tapping into knowledge spread far and wide. However, the taxonomic imperative of citizen science risks overshadowing other forms of knowledge

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[746] Ingold, *Being Alive,* 161-2.
[747] Molina et al., "Addressing Uncertainty," 136.
[748] Robin, "Resilience in the Anthropocene, 48. Italics original.
[749] Such knowledge is often idiographic, or qualitative, and might not be regarded as "scientifically valid".

about local fungal ecologies. Now that science has effectively captured the interest of citizens to partake in research, how could it be elaborated beyond the orthodoxies and assumptions surrounding reductive knowledge to incorporate other knowledge systems to better understand fungi? How might they also include aspects of ethics and care and greater possibilities to respond to the urgency of environmental issues? Rather than citizen science, toxicologists Mike and Kim Fortun's idea of 'civic science' that 'questions the state of things rather than a science that simply serves the state,' seems like an insightful approach.[750] Drawing on Michel Foucault they describe it as the 'product of an "imaginary", in which different modes and products of sense making come together'. Civic science focuses more on the participant and the interplay of historical, social, cultural and political forces that influence how science is fashioned, and how ethics of care shift over time and place.[751] As a more reflexive and reciprocal approach it incorporates reflection and negotiation rather than imposing a given view on the wider public. As one of the first advocates for the inclusion of different forms of social knowledge in the public understanding of science, Brian Wynne, Emeritus Professor of Science Studies, argues for 'more culturally rooted and legitimate forms of collective public knowledge'.[752] Historian Sverker Sörlin, also argues for a reconfiguring of environmental expertise to be more inclusive of knowledge beyond science. He sees the widening of the realm of environmental knowledge with a more integrative and reflexive approach as necessary to deal with the complexity of environmental issues and the failure of established forms of expertise to find solutions.[753] He considers, 'expertise and evidence are concepts that tend to favor the quantifiable and formal . . . Numbers seem, prima facie, to many to carry more credibility than things expressed in words'.[754] Understanding fungi requires numbers and words, along with all the ways that cannot be expressed with either. As a challenge to civic science's challenge to science, the role of rational thought and the importance of asking the 'right questions' needs to be carefully incorporated. However, just as important as information, is imagination. We need science, senses, imagination and as social-environmental researcher Minna Santaoja suggests, ways to account for irony and metaphor, as well as expressions of enchantment.

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[750] Fortun and Fortun, "Scientific Imaginaries," 50.
[751] Ibid., 44.
[752] Wynne, "May the Sheep Safely Graze?," 46.
[753] Sörlin, "Reconfiguring Environmental Expertise," 21.
[754] Ibid., 22.

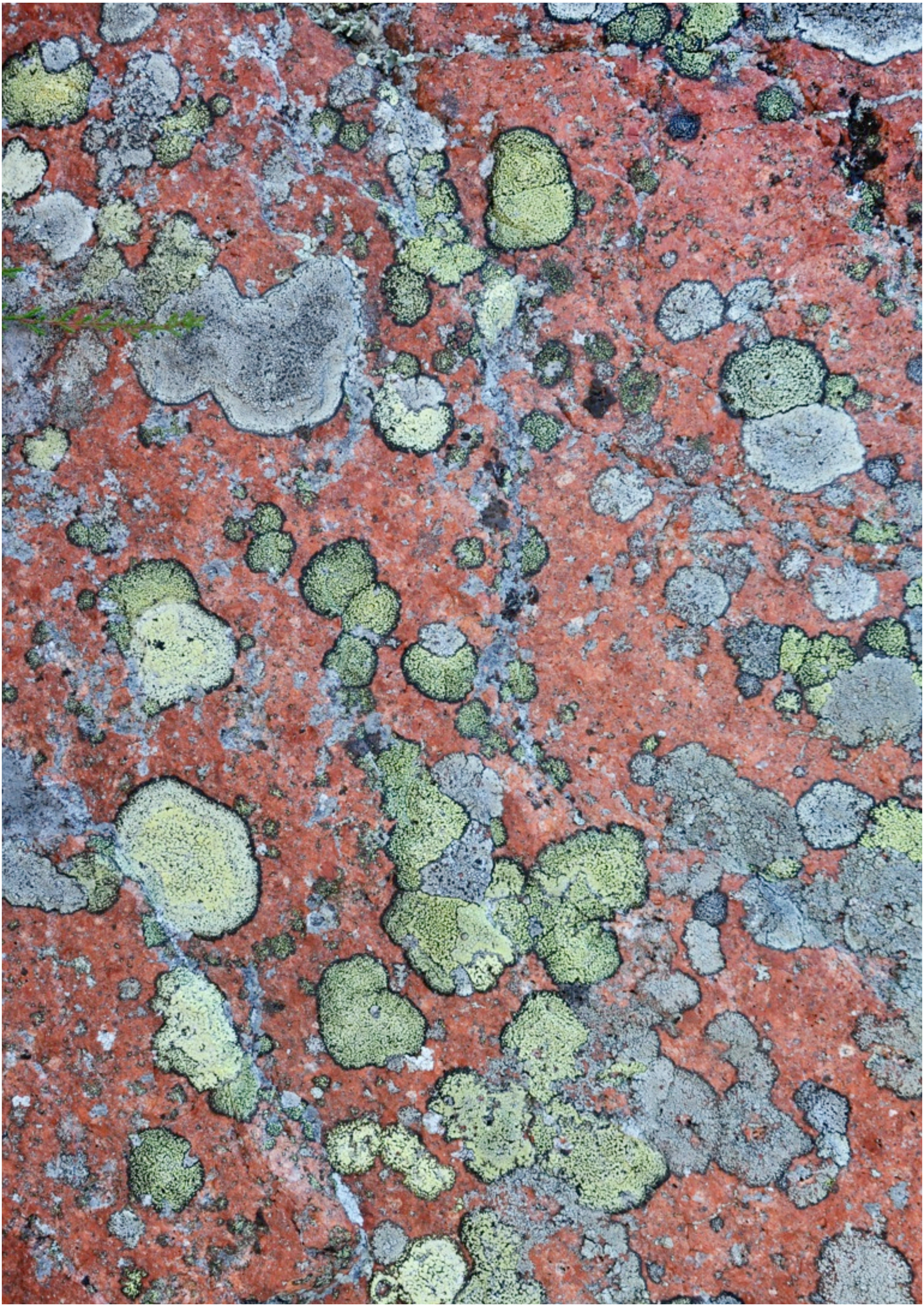
In autumn 2012, long-time fungus enthusiasts Thelma Argall and Win Pietsch drove across from Stawell to join a fungus workshop at Inglewood in North-central Victoria. I watched as they browsed the display. Thelma, the partner of Ian McCann who produced the well known field guide *Australian Fungi Illustrated*, picked up my battered and heavily annotated copy as a cascade of desiccated lichen fragments tumbled out. The guide has survived years of field trips and unintentional maltreatment in all weather. A week later, a parcel arrived with an immaculate new copy and a friendly note from Thelma. Flicking through the new copy I imagined how she and Ian located all these fungi over years of wandering their beloved Grampians Ranges, identified them and captured them in their guide. I also thought about how field guides sometimes get elevated beyond their role as a 'guide'. As predominantly urban inhabitants, Australians need guidance in the field. We need field guides, those who know names, those who know when and where to find fungi, those with inhabitant knowledge who spot the tracks and traces, those who recognise and understand relationships and those who remind us to tune to the senses. All these forms of knowledge represent ways of knowing fungi that come only from being in the field. But what if we went into the forest with a different kind of field guide, a palimpsest, an imaginative guide? It could combine insights from multiple knowledge systems presented in different ways. It might contain provocative questions that prompt sensate engagement with each fungus. It would aim to not just name the fungi enountered, but also restore them in the imagination and heart. It would contextualise them with their creatures that five-year-old Angelica Elliot recognised in chapter one. The guide would be expansive, not reductive, allowing fungi to be defined and understood in various ways, perhaps as we knew them in childhood, enriching knowing them only by name. It would somehow combine the many ways of knowing, assembling knowledge, expertise and stories from all those who go to the field. It would recognise that wisdom is as important as logic.

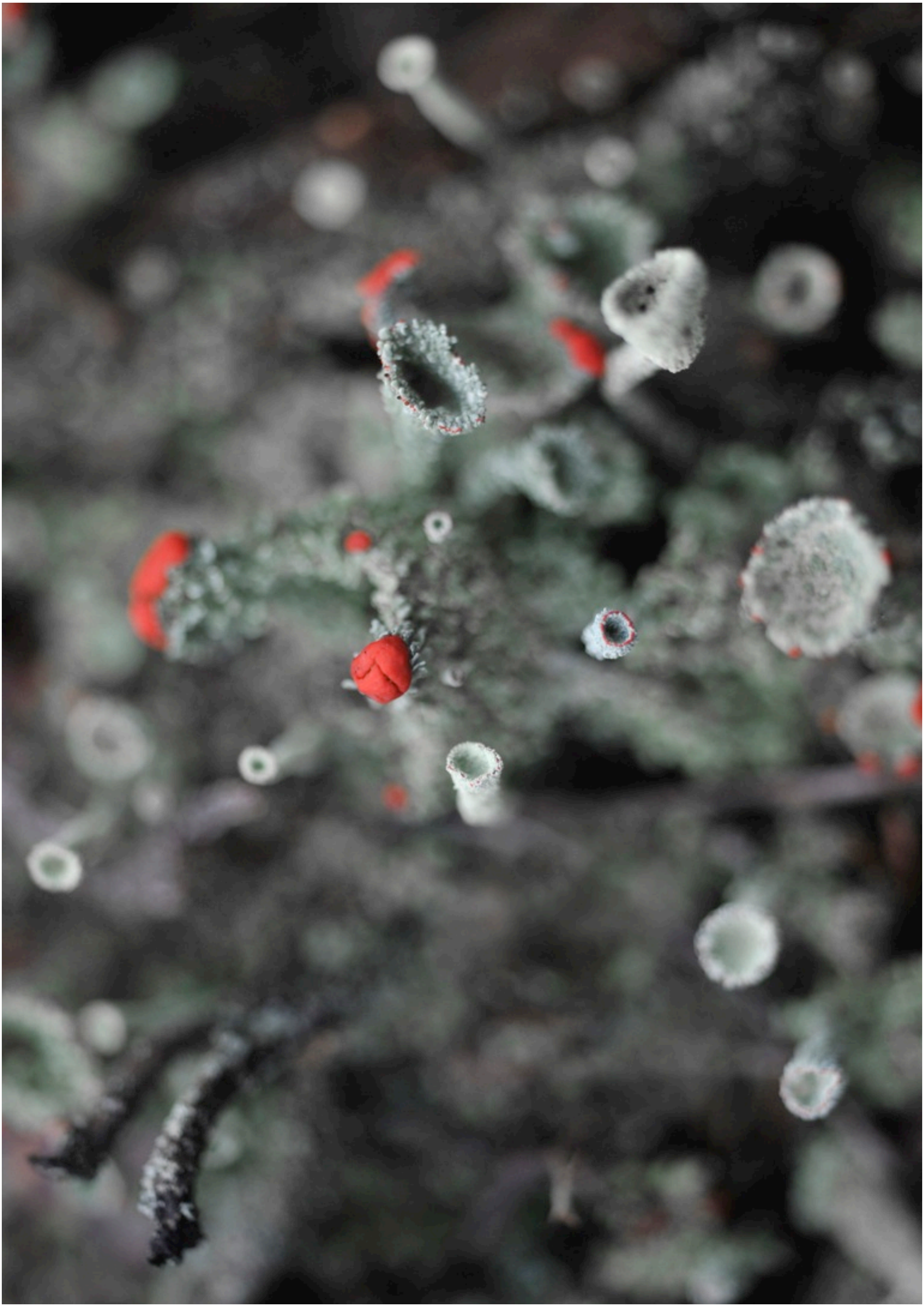
Lichenised Lives

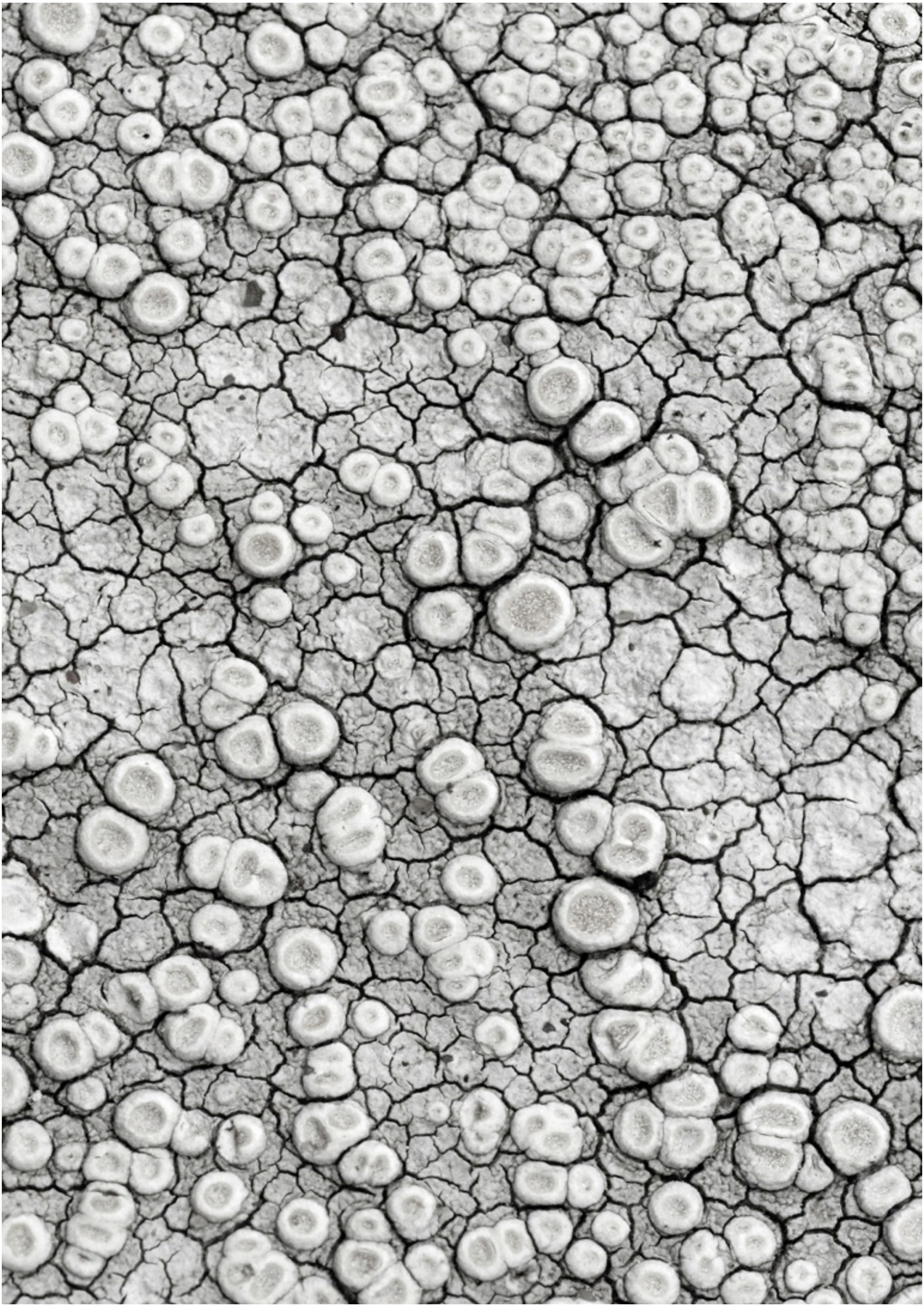
Etching gravestones, patterning rock and upholstering forest floors, lichens are among the first terrestrial colonisers.

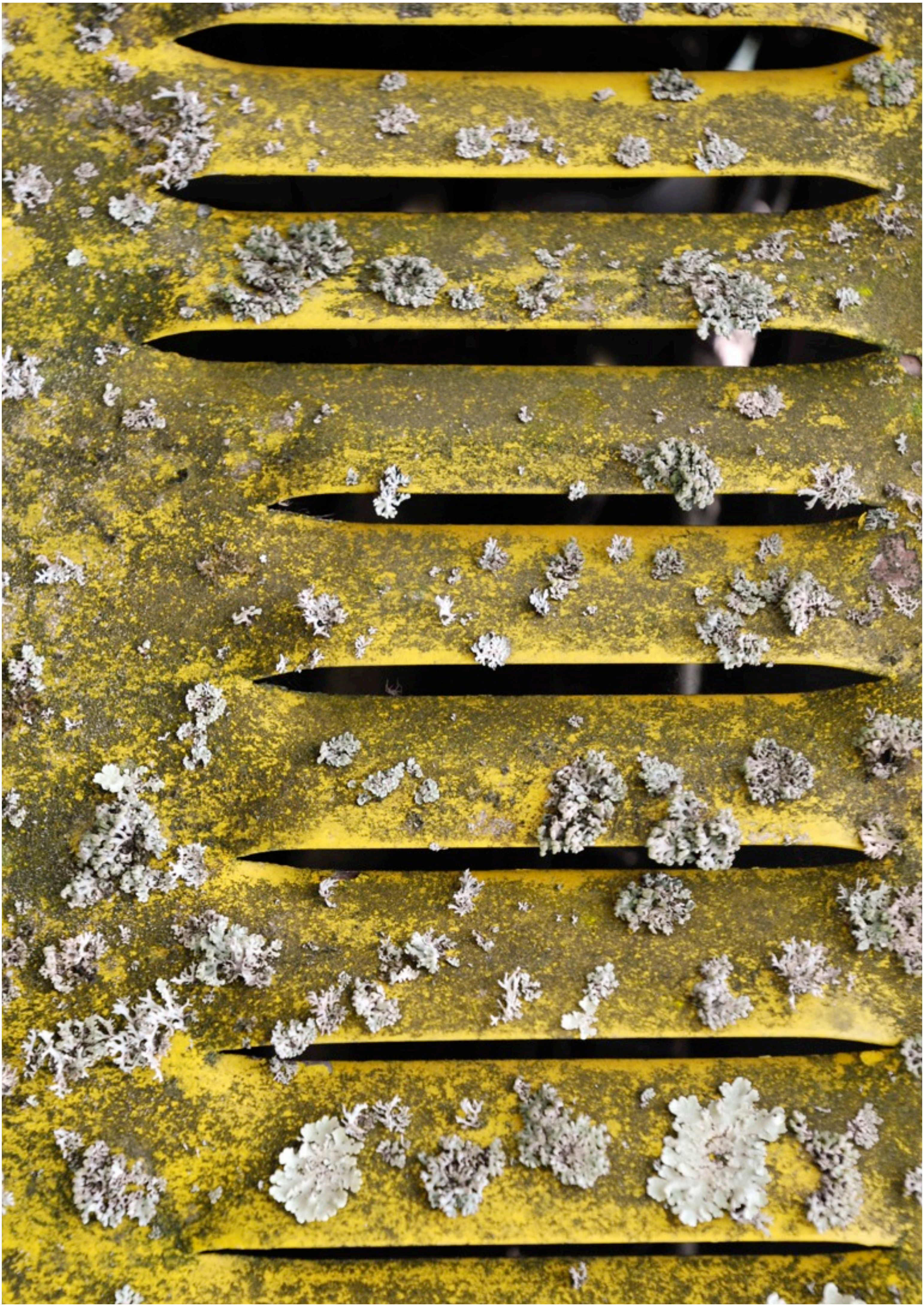
In their slow and steady creep, lichens dismantle wood and stone, creating soil and the possibility for the succession of life to follow.

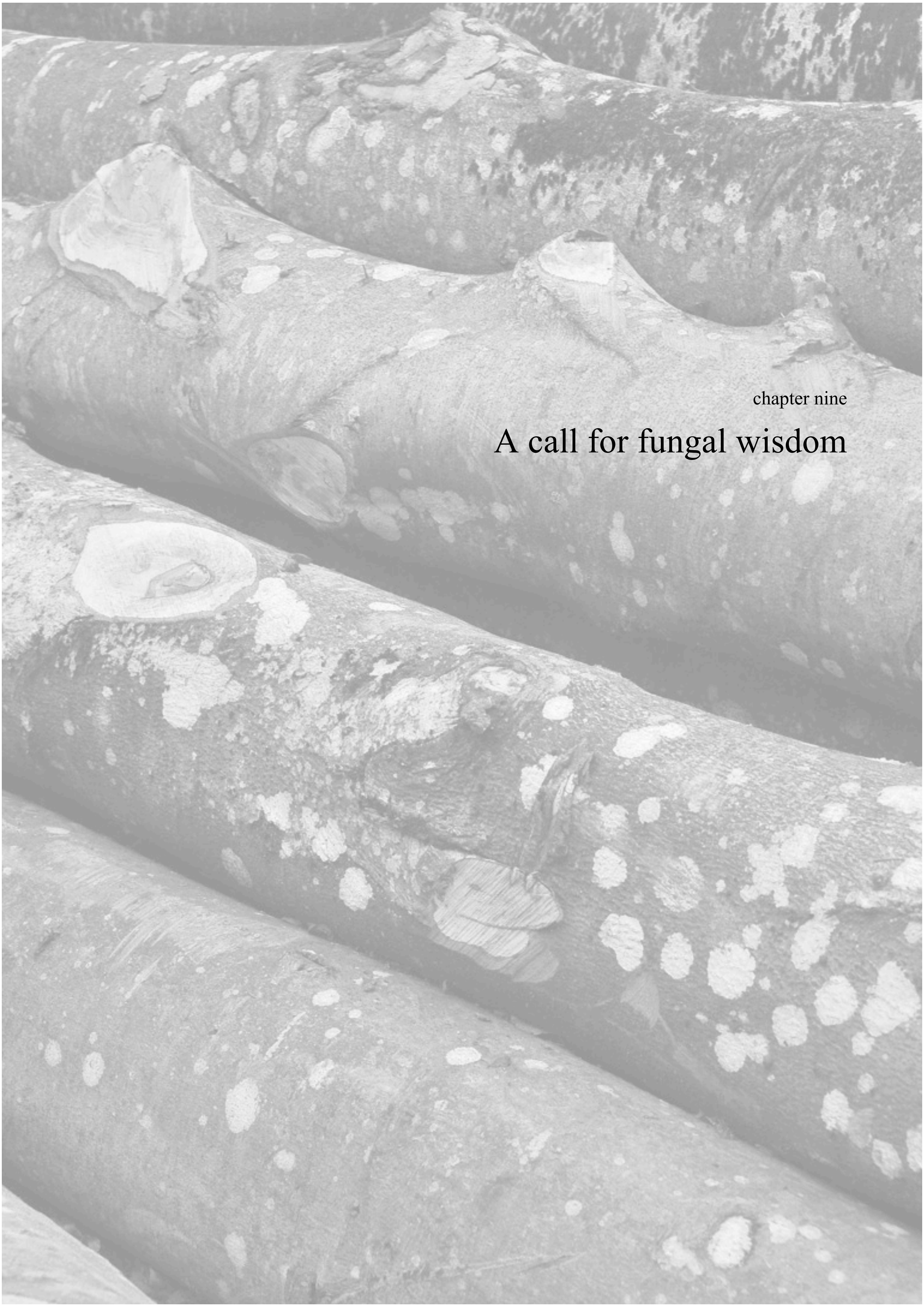
In a perfect example of cooperation and survival, lichens occupy extreme and often specialist niches by exploiting the advantages of communal living, slipping into a state of suspended animation when times get tough.











chapter nine

A call for fungal wisdom

Fungi in a changing world

The webcam at the *End der Welt* did not capture the razing – the erasing – of the forest. It did not capture the forester with his pink fluorescent paint selecting for death. Wandering among the numb trunks and shattered remnants, I struggled to resist solastalgic despair.[755] A forest is more than its trees and fungi and other components. As Robert Macfarlane says, 'thought, like memory, inhabits external things as much as the inner regions of the human brain . . . When woods and trees are destroyed . . . imagination and memory go with them.[756] I had come to know these trees and their fungi individually over fifteen years of interaction, but this is not just about 'my' patch of forest. Globally, more trees are felled each year than planted and old forests function very differently to newly planted trees.[757] Thankfully, it was not the end of the world at the *End der Welt*. Fungi were already emerging and trying to restore the havoc. However, given the expected decline of European Beech (*Fagus sylvatica*) due to climate change-induced drying, 150 year old Beech trees are probably a thing of the past in these low-elevation forests.[758] I am hoping I have captured some of the stories of the old forest, its fungi and people in this thesis.

This final chapter looks at fungi in a time of increasing globalisation and rapid change, bringing together the perceptions and understanding of those who partook of my thousand days in the forest.[759] I have written about what I consider to be pertinent to the enquiry of this research, as well as what I care about, while endeavouring to retain the authenticity of participants' perceptions. The result is an attempt to elucidate the difference between definitive and expansive perceptions of nature and how the manifest indeterminacy of fungal development highlights the need for a broader understanding and enhanced language. Fungi offer a metaphor for connectivity, spontaneity and unpredictability; a way to attune to the dynamism of natural systems and move beyond ideas of balance and control in biodiversity conservation. My hope lies in the belief we

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755 Solastalgia refers to environmental philosopher Glenn Albrecht's concept of environmentally-induced distress, where people suffer a sense of hopelessness and powerlessness to halt environmental destruction. Albrecht, "Solastalgia," 41.

756 Macfarlane, *The Wild Places*, 100.

757 Ecologist David Lindenmayer and colleagues have documented the decline of old trees worldwide. They describe the inestimable value of old trees to great range of animals that rely on hollows and crevices for shelter, nesting, roosting and other reasons of which we are probably unaware. Lindenmayer, Laurance and Franklin, "Global Decline in Large Old Trees," 1305.

758 Oeschger, *CH2014-Impacts*, 79. Beech was the dominant species in this forest.

759 "Anthropocene" refers to a proposed epoch (including the present time) that marks human-influenced effects on the geological record. When the Anthropocene started remains in debate, but is generally considered to coincide with the industrial revolution in Europe (c. 1800).

find the curiosity and imagination to rethink fungi not just for a more sensitive coexistence, but as a model for an enriched understanding of all life.

This chapter brings together thesis themes to tackle two main questions. First, I examine current approaches to fungal conservation in a rapidly changing world, questioning whether existing paradigms such as biodiversity and Red Lists still hold traction. How can old questions be newly inflected to reconcile reductionist science and holistic culture? It begins with looking at how knowledge can be transfigured and differently scaled to augment the taxonomic understanding of fungi.

Second, I examine which frameworks or paradigms could be most helpful in imagining fungi in more inclusive concepts of life. Revisiting notions of Natural Inclusionality (Rayner), Meshwork (Ingold), Intra-action (Barad) and Ecological Community (Smith), I ask what fungi can contribute, both ecologically and allegorically for new ways of being in a time of increasing uncertainty and change. I pose these questions not to provide definitive answers, but as a springboard to interrogate barriers to more imaginative ways of regarding the planet.

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As I write during Australia's warmest October on record, another El Niño event begins.[760] While El Niño is part of a natural cycle, human-induced climate change affects not only animals and plants but fungi too, altering patterns of fruiting and decomposition.[761] Wildfires are predicted to intensify in frequency and extent as a result of climate change. Some fungi cope with fire but others such as lichens are less resistant.[762] The rare Tea-tree Fingers, *Hypocreopsis amplectens*, is not necessarily sensitive to fire itself, but grows only in habitats unaffected by fire.[763] Like animals and plants, fungi respond to stresses, however, beyond their tolerance limits they also become prone to extinction. As historian of science Libby Robin notes, 'resilience is the

[760] In temperate Australia the El Niño-Southern Oscillation typically brings a prolonged period of warming with reduced rainfall, a shift in temperature extremes, increased fire danger and increased frost risk. Australia is expected to experience more days with severe fire danger due to climate change. Australian Government Bureau of Meteorology, "What is El Niño?".

[761] Kauserud et al., "Climate Change and Spring-Fruiting Fungi," 1169.

[762] Lichens take longer to regenerate not only because they are less fire resistant, but because they lose substrates such as old wood. Scott et al., *A Conservation Overview*, 2. Some fungi respond to fire (often described as phoenicoid or pyrophilous fungi) such as Native Bread (*Laccocephalum mylittae*) by producing sclerotia as a "reserve" against hard times and are often among the first to fruit after fire.

[763] This species is listed as vulnerable under the Victorian Flora and Fauna Guarantee Act 1988 (as *Hypocreopsis* sp. 'Nyora') and has only been found in association with mature, unburnt, healthy tea-tree (*Leptospermum myrsinoides*). Johnston et al., "*Hypocreopsis amplectens*," 717.

stretch of the system, what it can absorb and adapt to, but it is not an infinite property'.[764] Moreover, forest management practices in Australia such as fuel-reduction burning are largely modelled around vegetation communities or the specific requirements of endangered mammals and hence might not be optimal for fungi.[765]

Soil disturbance affects fungi. Shove a spade through the gossamer-like mycelial mesh and it breaks. Whether the fungus dies or regenerates depends on the severity and extent of disturbance. Habitat degradation, fragmentation and loss present the greatest threat to fungi and most agricultural and forestry practices destroy or radically diminish their habitats. While Australian fungi are thought to be widespread, the fragmenting of landscapes isolates populations and their vectors, making them prone to 'secret extinctions,' disappearing unnoticed.[766] Despite these challenges, Australia is possibly better positioned than any country in the world to set a precedent for fungus conservation and biodiversity conservation more generally. Australia has the tremendous advantage of being one of two, among the seventeen nations considered as megadiverse, with a developed and industrialised economy.[767] Factors such as Australia's affluence, technological capacity, high level of public scientific literacy, systematically designed protected areas and civil stability offer the prospect of the world's best conservation. However, as mycologist David Minter contends, unless fungi are taken into account, the ecosystem approach to conservation is so severely compromised as to be invalid.[768]

A fiscal fungal fantasy

Mycologists lament the lack of money to fund fungal conservation. However, what if a giant Lewis Carroll-style puffball heaved itself through the earth and puffed out millions of dollars instead of spores – all tagged for fungal conservation? How could they best be allocated in favour of fungi? Mycologists would probably advocate greater scientific understanding of fungi. Areas such as taxonomy, distribution, ecology and phylogenetics could all be better known. Threats to fungi are broadly understood although not at a species level or within particular habitat types and also require further

[764] Robin, "Resilience in the Anthropocene," 47.
[765] Clarke, "Catering for the Needs of Fauna in Fire Management," 385. The destruction of prime fungal habitats such as leaf litter, coarse woody debris and understory vegetation through inappropriate burning regimes could seriously affect particular fungal groups such as wood decay species.
[766] Maser, Claridge and Trappe, *Trees, Truffles and Beasts*, 168. Australian fungal conservation initiatives in recent decades are listed in appendix 9.
[767] Robin, The Rise of the Idea of Biodiversity," 32; Robin, *How a Continent*, 175.
[768] Minter, "A Future for Fungi".

research. While fungi currently receive implicit theoretical protection in some Australian biodiversity legislation under the umbrella of species or habitats, the specific conservation needs of fungi are not known and might not always correlate with those of surrogates.[769]

Beyond mycological research, would the puffball coffers also stretch to the political, philosophical, aesthetic, social and cultural dimensions of fungi? While mycological knowledge grows, little is known about how fungi are more broadly perceived and valued. More scientific knowledge of fungi is needed but will it make people care? Garnering interest in fungi is incredibly difficult as reflected in the greater support for the well-being of charismatic groups of organisms.[770] Philosopher Daniel Fouke considers the disproportion between the seriousness of environmental problems and the level of moral concern manifests in situations where they are 'difficult to visualise, require specialized knowledge to understand, and do not easily arouse the moral emotions, imagination, and sentiments'.[771] He thus (albeit inadvertently) describes fungi. It is impossible to care about something if its existence is unknown. Immediate and direct threats such as a burning forest or flooding river are the kind of dramatic events considered as 'news,' usually enumerated solely in relation to *Homo sapiens*. The catastrophic explosion of the Chernobyl nuclear reactor in 1986 reverberated across the globe. However, thirty years on, the slow insidious absorption of caesium-137 and other radioisotopes by fungal mycelia are only realised by the few with a Geiger counter, or indirectly through mediated scientific knowledge relayed via the media.

Fungal conservation and climate change share similar communication challenges. Ecologist, Andreas Fischlin, describes how only weather, not climate, is directly experienced (climate being merely the statistical average of weather) and therefore the significance of climate is commonly underestimated.[772] Similarly, fungi are rarely (consciously) experienced directly and are largely intangible for many people.

[769] May, "Documenting the Fungal Biodiversity of Australasia," 346. The Environment Protection and Biodiversity Conservation Act 1999 lists two species of fungi as a threat while no species are listed for protection, suggesting not only a lack of understanding but reinforcing deeply entrenched negative attitudes toward fungi. As with the conservation management documentation discussed in chapter four, fungi are largely perceived as a "problem to be managed", i.e. a threat to "biodiversity".

[770] Birds, for example, hold greater appeal than fungi. BirdLife Australia (originally the Royal Australasian Ornithologists Union, founded in 1901), has over 10,000 members and 65,000 supporters. While it is difficult to make a direct comparison, almost twenty years on, Fungimap has less than 200 members. BirdLife Australia, *Annual Report 2014*; Birdlife Australia History, accessed 31 January 2016, http://birdlife.org.au/who-we-are/our-organisation/history/.

[771] Fouke, "Humans and the Soil," 147.

[772] Fischlin, "Future Climates".

Other than the rare few fungus advocates, arousing interest in fungi relies on the mediated representation of what sociologist Ulrich Beck refers to as the 'Problem of Second Hand Non-Experience'. Beck explores how perception is affected by 'expropriation of the senses'. When the world is presented through theoretically calculated models and scenarios in highly mediated form without direct sensory experience, Beck describes how it is not just 'second-hand experience,' but second-hand *non*-experience'.[773] This reliance on science to relay future risks has fuelled climate change deniers who, unable to directly sense the issue, attempt to discredit the science. Likewise with fungi, if they are not sensorily experienced, being represented only by DNA sequences, lists and models, they risk being perceived as abstruse. Ethical environmental decisions require deep sensorial connection. Only by being embedded in the world, by experiencing it first-hand rather than through second-hand non-experience, might we pause to consider ethical dimensions. Part of the problem is, as Robin reflects, 'We google things instead of learning about them emotionally'.[774]

Moreover, fungi do not always operate in the scales applied to other biota or those imposed by economic models. Many fungi have fleeting sporebodies but long lives. Likewise, their small sporebodies belie their often-vast mycelia, upending scales of time and space. Forestry time scales, for example, can conflict with fungal time scales. Negotiating forestry timescales with the appropriate level of scalar resolution for long-lived organisms or those that require old habitats (like some fungi) usually sees economic imperatives win out. Suitable spatial scales – whether species, hosts, habitats, corridors, reserves, ecosystems, landscapes or continents – are hard to apply across different climates and situations, reinforcing the limitations of generalised ecological theories for less known organisms like fungi. Fungi are only slowly creeping into conservation decision-making and one place where they are receiving attention is Fennoscandia. Fennoscandia has some of the most progressive and developed fungal conservation initiatives in the world, so I headed to Sweden to talk to mycologist and conservation expert, Anders Dahlberg.[775]

Lists and the list-less

In true Swedish autumn tradition, Anders cooked me Chanterelles for dinner. I relished them. It was the reindeer sliding around on my plate next to them that I was less sure

[773] Heise, *Sense of Place and Sense of Planet*, 151.
[774] Libby Robin, informal comment at "Landscape, Environment, Emotion conference," Pori, Finland, 25 September 2013.
[775] Heilmann-Clausen et al., "A Fungal Perspective on Conservation Biology," 3.

about. We then got down to the business of fungal conservation. Conservation issues are much the same for fungi as other organisms and most mycologists opt for habitat protection as the best approach.[776] However, as many fungi have narrow habitat requirements (such as native grasslands) they are prone to slip through more generalised conservation initiatives, relying on reserves that protect particular habitat types.[777] Anders is like a human grasshopper and the following day I battled to keep pace with his giant strides as we traversed the Vamsta Conservation Reserve in the Swedish northern Upland. The reserve has managed to escape large-scale logging, preserving a stand of old Spruce and Pine trees and their fungal partners, including the Pig's Ear, *Gomphus clavatus,* listed as endangered in seventeen European countries.[778] While conservation planning of protected areas seldom considers fungi, Fennoscandia, a handful of European countries and Australia have all successfully established reserves predominantly or exclusively on the basis of their mycological values.[779]

Biodiversity conservation is an agreed objective of the 192 signatories of the Convention on Biological Diversity (ratified 1993). What does that mean in reality? Justifying why biodiversity matters or should be conserved is extremely difficult. It is like trying to describe why soil, air, or water matter. No list of reasons does it justice. Anders Dahlberg and his colleagues broadly sum it up by saying: 'Biodiversity matters for a whole variety of reasons: ethically, emotionally, environmentally and economically'.[780] While conservation initiatives usually operate at a local level, they are influenced by international obligations, hence the importance of such global treaties.[781] Lists of threatened and endangered species that evaluate extinction risk have become a standard of conservation. They are often among the few ecological tools available for scientific, political and social decision-making on species. Founded in 1948, the International Union for Conservation of Nature (IUCN) is recognised as the authoritative voice of scientists, uniting over a thousand organisations to address biodiversity issues.[782] The IUCN publishes Red Lists of Threatened Species as a means to document the conservation status of different species and prioritise conservation

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[776] Minter, "Fungal Conservation in Cuba," 184.
[777] Dahlberg, Genney and Heilmann-Clausen, "Developing a Comprehensive Strategy," 56.
[778] European Council for the Conservation of Fungi, Newsletter, 2.
[779] Dahlberg, Genney and Heilmann-Clausen., "Developing a Comprehensive Strategy," 58. The other countries are Switzerland, Germany, Estonia, Belgium, Romania and the UK. In 2000, an urban bushland reserve in Lane Cove, Sydney was listed on the Register of National Estate on the basis of an endangered fungal community (Hygrocybeae). Kearney and Kearney, "Significance of the Hygrocybeae," 64.
[780] Dahlberg, Genney and Heilmann-Clausen, "Developing a Comprehensive Strategy," 51.
[781] Ibid.
[782] Robin, "The Rise of the Idea of Biodiversity," 25.

actions.[783] However, Red Lists are not systematic evaluations of the sweep of different groups of organisms. Rather, they are populated by species that represent the particular interests of people and conservation groups concerned about extinction risk. Unsurprisingly, fungi received little attention on such lists until recently. In response to the near exclusion of fungi from the IUCN Lists, Anders and colleagues initiated the Global Fungal Red List in 2013. The project coordinates the nomination of threatened fungus species for global Red-listing and aims to increase awareness of fungal conservation. Although listing offers a species no legal standing, it theoretically allows for its inclusion on the international conservation agenda.[784]

Anders is a progressive conservationist who thinks big. His dynamic approach does not attempt to conserve areas as they are or once were. Fennoscandia provides a model of integrative biodiversity conservation where animals, plants and fungi receive equal priority. Although every fifth fungus species in Sweden is Red-listed, Anders knows that if fungi are to be included in conservation initiatives, different groups of organisms need to be considered together. He emphasises the importance of retaining Aldo Leopold's 'cogs and wheels,' focussing not only on rare species but also ones that are common but declining, or are geographically restricted.[785] While these species often comprise a relatively small proportion of overall species richness, they usually contribute greatly to the structure, biomass and dynamics of ecosystems. They are also most affected by habitat fragmentation and loss.[786] Focussing on rare or endangered species therefore only addresses part of larger biodiversity conservation issues. Conservation also occurs on private land and Anders' non-prescriptive approach sits well with landowners. He supports people to initiate and drive conservation actions, his challenge then being to scale-up local knowledge nationally and globally.

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[783] The IUCN Red List (Red being an acronym for Rarity, Endangerment and Distribution Data) aims to "convey the urgency of conservation issues to the public and policy makers, as well as help the international community reduce species decline and extinction". IUCN, "Global Fungal Red List Initiative".

[784] In June 2015, the first two austral species were listed as endangered on the IUCN Red List of Threatened Species. The Bunyip Egg (*Claustula fischeri*) is only found at six sites in Australia (all in Tasmania) and eleven in New Zealand. IUCN, "*Claustula fischeri*". The second, *Boletopsis nothofagi*, is believed to be endemic to New Zealand, described in 2012 and recorded only at two locations. IUCN, "*Boletopsis nothofagi*".

[785] The famous quote from Aldo Leopold's, *A Sand County Almanac*, 190, "To keep every cog and wheel is the first precaution of intelligent thinking," reflects his view of components of larger ecosystems as worthy of conservation, even when their significance is not known. Common species such as House Sparrows and Starlings are also declining and they too appear on Red Lists. Paul Brown, "Sparrows and Starlings on Red List of Endangered Birds," *Guardian,* Friday 16 August 2002, http://www.theguardian.com/uk/2002/aug/16/ruralaffairs.science.

[786] Gaston, "Valuing Common Species," 154.

However, since the IUCN's first list over half a century ago, many are questioning whether lists have proved effective enough in conserving biodiversity. Lists serve a purpose of prioritising species for conservation but also have their limitations. Some critics claim they perpetuate the very hierarchies recognised as problematic in the way nature is understood and treated: they create an economy of death.[787] Others dispute the effectiveness of lists because sometimes they are inappropriately used in decision-making, for example, in resource allocation for conservation projects or in reserve design.[788] Others still warn against their potential for exploitation when rarity inflates the economic value of a species and subsequently increases the threat of poaching (anthropogenic Allee effect).[789] Meanwhile, list-less lifeforms that are unlikely to ever receive a name yet alone appear on a list, continue to go unnoticed.

Do marginalised organisms such as fungi risk slipping even further into obscurity by a listing process that prioritises the chosen few? The near absence of fungi on lists reinforces arguments for their listing. On the other hand, it also offers the opportunity to pause and consider whether listing is the best investment of fungal conservation efforts. While lists supposedly provide equality among species, lean conservation budgets usually favour charismatic or 'grievable' species (i.e. predominantly mammals and birds) over more obscure organisms like fungi. At a meeting on fungal conservation in London in 2014, Dutch mycologist Thom Kuyper asked, 'what are we going to do after Red Lists?'[790] As Kuyper argued, lists have no legal standing and no management or protection guarantee. They are effectively wish lists. As Swedish mycologist Åke Strid suggested, 'a list is only a proposal. After that is the hard part'.[791] At what point might lists no longer be the best approach and how will that point be recognised and reconciled? How or will ethical questions come into play? At a meeting of the International Society for Fungal Conservation in Turkey in 2014, Swiss mycologist Beatrice Senn threw her arms in the air and proclaimed, 'nine hundred and thirty seven fungi are listed in Switzerland – now what?' As one of only two professional mycologists working on macrofungal conservation in Switzerland, she has a hard task prioritising species on her long list. Senn concedes that existing conservation measures cannot guarantee the survival of all species. Like Anders, she models organisms that share habitats and threats as a means to amalgamate conservation

787 Lopez and Gillespie, "Introducing Economies of Death".
788 Possingham et al., "Limits to the Use of Threatened Species Lists," 503-504.
789 e.g. Courchamp et al., "Rarity Value;" Prescott et al. "Change in IUCN Status," 248.
790 British Mycological Society Autumn Open Meeting, 29 November 2014, Kew Gardens, London.
791 Åke Strid, interview with the author, 20 September 2013, Hagaberg, Sweden.

efforts.[792] As Europe's leading fungus conservationists their approaches represent the best possibilities to conserve species, processes and ecosystems.

Should countries like Sweden, Switzerland and the Netherlands continue to add to their already long lists, or give greater focus, for example, to fungal flagships or indicator species that symbolise certain habitats and conditions?[793] The effects of intensified urbanisation, forestry and agriculture have reduced fungal diversity in several European countries since the 1950s, prompting the initiation of the European Council for the Conservation of Fungi in 1985.[794] Although Australia has fewer anthropogenic pressures than Europe, it also has less mycological knowledge and cultural interest in fungi. There are also more unidentified fungi coupled with the challenge of understanding fungi within a highly variable climate. Environmental consultant Chris Maser and colleagues argue for the need to look after ecosystem processes.[795] However, the challenge for the broader public in relating to processes often conceived as abstract (or unappealing, like fungal rotting) compared with definable species, is well-critiqued. Nevertheless, species-level conservation can inspire broader ecosystem thinking. The Fungimap mapping program, for example, assists fungus enthusiasts to identify easily recognisable target species and this interest often develops beyond species to ecosystems. Likewise, Judy Crocker's gangly-legged curlew has proved an effective proxy in increasing knowledge about fungi and forest ecosystems more broadly. That said, and while acknowledging that public support drives conservation, inappropriate conservation strategies should not be employed simply because they are more comprehensible to the public.

This is not to suggest abandoning species-based approaches. Lists in themselves are not necessarily failing, but the emphasis might need to swing more strongly toward what Åke Strid mentions as 'the hard part,' that is, to action. A more affirmative biopolitics that focuses on survival rather than extinction, founded on science but premised on human care and action, could offer greater possibility for the survival of all life and not just the listed few. This prompts the question of whether the concept of biodiversity still holds the same relevance and sway as when it was coined in 1985 by Walter Rosen, as a contracted form of biological diversity. The concept was

[792] Senn-Irlet, "From Red Lists to Conservation Actions".
[793] Some fungi, such as polypores (e.g. *Phellinus ferrugineofuscus*) are already being used as indicators of old growth forests in Europe.
[794] David Moore et al., "Preface," ix.; Dahlberg, Genney and Heilmann-Clausen, "Developing a Comprehensive Strategy for Fungal Conservation," 53.
[795] Maser, Claridge and Trappe, *Trees, Truffles and Beasts*, 6.

immediately vaulted into popular conservation debates by prominent biologists Thomas Lovejoy, Edward O. Wilson and Michael Soulé. Concepts change over time and biodiversity has become increasingly politicised and financialised. As Robin notes, 'the 1980s reinvention of the idea of biodiversity changed ecological science and redefined the expertise required to achieve its aims'.[796] The 1960s-style biodiversity conservation model that focussed on nature shifted to be more inclusive of *Homo sapiens* in recent decades. It hence requires expertise in both natural and social systems to achieve ecological, ethical and economic outcomes.[797] Is the concept of biodiversity becoming counter-productive to efforts to conserve the diversity and abundance of life? Environmental and human rights lawyer, David Takacs provokes a closer scrutiny of the conceptual difficulties of the term asking, 'why has this neologism proven so successful in attracting concern, financing, and action for conservation?'[798] Through a series of interviews with conservation biologists, Takacs presents a semantic critique of the political and economic tensions inherent in the term and biologists' challenges in balancing scientific objectivity with passionate environmentalism. As species loss accelerates, what happens to the biota of biodiversity when the term is commodified by capitalist frameworks that measure a species' worth by its profit potential? Slippages also occur between the theory and practice of biodiversity conservation. As human geographer Jamie Lorimer recognises in his exploration of taxonomic partialities in biodiversity conservation, there is a divide between 'the theory of biodiversity . . . and the practical understandings of biodiversity that emerge from the messy and situated practices of biodiversity conservation'.[799] Wrestling biodiversity back from the abstractions of politics and economics to a human scale, biologist Nico Döring considers that while few people can adequately explain biodiversity, most of us can probably feel it.[800] Yet touching and being touched by it, both literally and emotionally, is exactly what is missing from the enumerating, listing and modelling of biodiversity, which is part of the 'Trust in Numbers' policy-making described by historian, Theodore Porter.[801]

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[796] Robin, "The Rise of the Idea of Biodiversity," 31.
[797] Ibid., 33.
[798] Takacs, *The Idea of Biodiversity*, 41.
[799] Lorimer, "What About the Nematodes," 540.
[800] Döring, "River System".
[801] Porter, *Trust in Numbers*.

Reassessing biodiversity

Australia's Biodiversity Conservation Strategy 2010-2030 defines biodiversity with the standard three-level definition of genetic, species and ecosystem diversity, yet fails to explicitly include fungi. The Strategy then quickly justifies biodiversity in terms of ecosystem services provided to humans.[802] Biodiversity is convenient, quantifiable and justifiable in terms of human needs, premised on the notion of species as the seldom questioned currency of conservation. However, not all consider it to be an effective approach to conserving the diversity and abundance of life. Philosopher Freya Matthews asks whether an ethic of biodiversity is enough. She argues that an environmental ethic should be framed as a moral defense of living things in their own right, a more generalised respect for life, rather than just instances of species.[803] However, conservation biology, which developed alongside the concept of biodiversity, according to one of its founders, Michael Soulé, focuses on species and populations, not individuals. He maintains that

> biologists recognize that conservation is engaged in the protection of the integrity and continuity of natural processes, not the welfare of individuals . . . the ethical imperative to conserve diversity is distinct from any societal norms about the value or the welfare of individual animals or plants . . . and they should remain politically separate.[804]

Robin tackles the question of biodiversity another way by asking how biodiversity differs from the diversity of life. She describes how biodiversity is more than an ecological concept and is also a measure of environmental crisis: 'it became more than a mere measure of nature: it became a moral entreaty to respond to the "environmental crisis" that was understood and defined in terms of loss of natural variety'.[805] What happens to nature when it is turned into biodiversity, counted, listed and prone to 'the loss of the affective dimensions of nature in the rush to predict the future and model it'?[806] Species loss is a central theme of the Anthropocene narrative that examines how scientific and ethical issues come into play. Matthews maintains that although people's natural intuition leans toward a moral obligation to life, the tendency is to prioritise species rather than organisms as individuals or communities. The problem she identifies with this way of thinking is that it fundamentally disregards life:

> even if at a very reduced scale of instantiation, in other words, we may destroy organisms and communities and populations with impunity, provided we do not in the process

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[802] NRMMC, *Australia's Biodiversity Conservation Strategy*, 11-12.
[803] Matthews, "From Biodiversity to Bio-proportionality?".
[804] Soulé, "What is Conservation Biology?," 731.
[805] Robin, "The Rise of the Idea of Biodiversity," 26.
[806] Robin, "Counting our Blessings".

> extinguish entire species or forms of life. This de facto though usually tacit environmental ethic, enters public discourse through the scientific but interestingly normative category of biodiversity. Biodiversity functions in public and policy discourse not merely descriptively but also prescriptively.[807]

Matthews challenges instrumentalist concerns about ecological functionality where arguments for biodiversity are premised on human survival. She identifies the dominance of climate change on the environmental agenda as perpetuating anthropocentric thinking because it shifts the focus away from fostering respect for life. She reasons that if people assume that the ecological integrity of the biosphere is protected by climate change actions, then they are less likely to develop a specifically environmental ethic, as biodiversity is assumed to 'ride on the coat tails of our own efforts to ensure our own human self preservation'.[808] Her arguments echo those of Judith Wright four decades earlier who saw rationality as overshadowing the feeling and imagination intrinsic to 'a sense of the total value of life'.[809] Curbing anthropogenic environmental change and species extinctions requires new thinking, but it also requires 'old feeling' based on respect for all life.

Is 'species' the appropriate unit to address the complexities of environmental issues and can ethical dimensions also be incorporated? Soulé sees the combining of scientific and ethical aspects as a mixing of issues. However, their separation also sustains the abstraction of species. The enumeration of life attracts growing criticism. Geographer, Sarah Whatmore pertinently asks, what counts and what can be counted? She questions how to reconcile the 'scientific calculi that pervade public life and which consistently reduce ethical questions about what counts, to empirical questions about what can be counted'.[810] Mycologist Alan Rayner also denounces economic approaches that simplify and misrepresent ecosystem interactions. Says Rayner:

> so deeply embedded has conventional mathematical misrepresentation of nature become in our modern scientific, economic and technologically dominated culture that as long as it remains unquestioned, it can only reinforce the simplistic representation of a local figure as a discrete individual identity.[811]

Others question whether science is necessarily measuring the 'right' things. Neuroscientist Tony Broe considers 'one of the problems with science, is that it only investigates things it can measure . . . and one of the things it has not been able to

[807] Matthews, "From Biodiversity to Bio-proportionality?".
[808] Ibid.
[809] Wright, *Because I was Invited*, 194.
[810] Whatmore, *Hybrid Geographies*, 33.
[811] Rayner, "Sustainability of the Fitting".

measure well is unfairness . . . so science has a limited role'.[812] A new collective of thinkers from multiple disciplines is tackling the ways in which biodiversity is understood and accounted for as part of the growing Anthropocene narrative.

Whatever . . . Whenever . . . A fungal Anthropocene

Coined by Paul Crutzen and Eugene Stoermer in 2000, the Anthropocene paradigm has been adopted within academia and beyond for its suitability as a heuristic device to address anthropogenic changes to the earth and atmosphere.[813] Those with a scientific understanding of the daunting statistics recognise it as a severe warning for the impending planetary meltdown. For technologists, the Anthropocene represents innovation, power and possibility. For environmental humanists, it is an opportunity to bring together 'a range of new experts and new planetary discourses'.[814] Many see it as a call to action. The burgeoning Anthropocene literature presents cutting-edge ideas but also bristles with controversial and contradictory claims, including the endless debate over the appropriateness of the name. All reflect the desire to find a rhetorical device with which to name, comprehend and hopefully prevent the slow-motion-unravelling of the planet. Although efforts have been made to convey the concept to the wider public – for example, the exhibition, 'Welcome to the Anthropocene: The Earth in Our Hands,' held at the Deutsches Museum in Munich over 2014-2016 – it has yet to gain much purchase outside of academia. While, the metaphor of the Anthropocene is being explored and depicted by humanists and artists, geologists and other scientists remain more divided and defensive.[815]

Advocates of the Anthropocene paradigm maintain it encourages a more responsible way of inhabiting the planet. Science journalist Christian Schwägerl, for example, posits, 'the contemplation of the Anthropocene idea triggers strong, ethics-driven reactions and a strong impulse of caring . . . it exposes us all and asks for responsibility. It invites commitment and responsible behaviour instead of demanding it.[816] Drawing on Jane Bennett's concept of vital materiality, Schwägerl sees it as a new rubric for working with nature that honours life in all its forms by which he reasons,

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[812] ABC, "Tony Broe On The Midday Interview".
[813] Crutzen and Stoermer, "The Anthropocene," 17.
[814] Robin, "Resilience in the Anthropocene," 45.
[815] Robin et al., "Three Galleries of the Anthropocene," 2. Finney and Edwards (2016) are still cautious about whether stratigraphers should approve it at all.
[816] Schwägerl, *The Anthropocene*, xi. Along with palaeontologist Reinhold Leinfelder, Schwägerl was involved in conceptualising the "Welcome to the Anthropocene" exhibition.

represents the antithesis of anthropocentrism.[817] Similar claims about responsibility and ethics have been made about other concepts such as biodiversity. For example, two decades ago, conservation biologist and Soulé's colleague, Reed Noss, optimistically maintained that the idea of biodiversity would open up broader thinking and force us to consider a greater range of species, including those less well understood, such as bacteria and fungi.[818] The 'us' he refers to might have been conservation biologists or those compiling species lists at the IUCN, however, whether the concept mobilised public interest in the unseen majority of organisms is questionable. Such concepts do not apply equally in space and time, or across different cultural strata, values and mores. While the concept of biodiversity has been adopted as a measure of global environmental management it has also delivered its environmental injustices. For example, as discussed in chapter seven, Australian Aboriginal understanding of nature does not equate with Western scientific notions of biodiversity. This conceptual misalignment means Aboriginal voices have struggled to be heard in conservation management.[819] Africa and South America present numerous similar examples of the discord between indigenous understanding of nature and Western notions of biodiversity and conservation. Consequently, in some situations the commitment to the ideal of biodiversity has perpetuated the species extinction crises that it sought to ameliorate, by producing and sustaining criminality, through marginalising local communities and devaluing nature outside protected areas.[820] Such power and knowledge inequalities in the territorialising of nature have been extensively critiqued, prompting a reconsideration of environmental justice issues within biodiversity conservation.[821]

Critics of the Anthropocene concept commonly claim that it entrenches anthropocentric thinking. Anthropologist and philosopher Bruno Latour, questions whether the Anthropocene simply 'foreground[s] the human agent under another shade'.[822] He refutes that living in the Anthropocene directs our attention to much more than a reconciliation of nature and society arguing that it does not overcome the divide but instead, bypasses it entirely. Sociologist of science Eileen Crist, is equally sceptical. She regards the 'merger between the social and the natural' as espoused by the

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[817] Schwägerl, *The Anthropocene*, xi
[818] Takacs, *The Idea of Biodiversity*, 49.
[819] Robin, "The Rise of the Idea of Biodiversity," 33.
[820] e.g. Duffy, *Nature Crime*, 61-62.
[821] e.g. Gissibl, Höhler and Kupper, "Towards a Global History of National Parks," 11.
[822] Latour, "The Anthropocene".

Anthropocene discourse as not being about mutual integration at all, but rather about a 'takeover,' where nature is reduced to resources and the functions of nature to 'ecological services'.[823] Sociologist Jason Moore presents some of the most astute arguments and while recognising the benefits of the Anthropocene metaphor in communicating climate change, he condemns the dominant narrative for failing to address the 'naturalized inequalities, alienation, and violence inscribed in modernity's strategic relations of power and production'.[824] As a point of departure from several other critics, Moore explores historical materialism, criticising the lack of historical and geographical analyses that instead have been replaced by time, space and quantification.[825] He exposes the gap between the Anthropocene's philosophies and practices, the inherent contradictions in the positioning of *Homo sapiens*, and the assigning of responsibility to humanity as a 'collective' actor rather than the forces of capital and empire.[826] So where do fungi fit in?

I see fungi as bringing two important ways of thinking to this time of increasing uncertainty where borders between nature and culture are increasingly blurred. First, as a means of appreciating the indeterminate, interconnected and unbounded nature of life as exemplified by fungal mycelia; and second, as a call to abandon the illusion of the constancy and predictability of nature so as to move beyond notions of control. Today, with the advantage of hindsight amplified by the urgent need to respond to environmental degradation, a more mycelial way of thinking offers the possibly for a differently imagined future. Ideas, however, need enacting through practical application. My attempt to present fungi both as organisms worthy of regard and also as an allegorical framework for examining limited concepts of nature, brings people directly and physically to the dirt. To the fungi. Through my forays I endeavour to reignite a new imaginative sensorium, underpinned by sound scientific understanding of the interdependencies that intimately link us to the earth, to present a more tangible and embodied myco-aesthesis. This means fostering sensation as paramount to the experience, as perception assimilated to visceral sensation.[827] Nuanced appreciation and an ethic of care begins with curiosity and intimate sensory exploration.

Thinking of the fungal traits of indeterminacy and unpredictability as the norm rather than the exception, helps shift away from notions of certainty and balance in

[823] Crist, "On the Poverty of Our Nomenclature," 143.
[824] Moore "The Capitalocene".
[825] Moore, "Anthropocene or Capitalocene?".
[826] Ibid.
[827] Ryan, "Towards Intimate Relations," 30.

nature. However, for some the transition in thinking might be challenging given, as Robin says, ‘the idea of the balance of nature has driven the descriptions of natural history since antiquity. Balance has such intrinsic appeal that it often goes unquestioned’.[828] The adaptability of Australia’s desert creatures offers the opportunity to enhance thinking and increase human willingness to accommodate change. Says Robin, ‘Pulse and reserve systems are not so much about the rain or boom conditions, but rather about the spaces between booms . . . All [animals] have to be able to snap into active mode very quickly whenever the season arrives – not annually, but *whenever*’.[829] Fungi require the same ingenuity and flexibility, helping to recast the misconception of the predictability of life. Australian fungi in particular epitomise adaptive flexibility as ‘highly evolved’ organisms invalidating early colonists’ notions of Australian nature as degenerative and primitive.[830] Yet these distinctive qualities of being exceptional and highly adaptive seldom figure in the thinking of global conservation initiatives. Says Robin, ‘the limits and exceptions of the Australian environment are now potentially Australia’s greatest contributions to the global journey toward “sustainability”’.[831] The ‘unruliness’ of fungi (from a human perspective) offers a way to deal with environmental uncertainty that engages imagination and shifts away from the default ‘management mentality’. It also helps us accept the illusory and fragile nature of human control.

Like certainty, the legitimacy of ‘efficiency’ is seldom questioned. Efficiency typically enforces routine and the finding of the shortest possible route. It is not characteristically imaginative or innovative and rarely involves attentive care. Ideas about variability and uncertainty might be hard to sell to land managers because as Robin notes, they contest corporate efficiency.[832] ‘Efficient management’ with the desire to control, limits thinking to functionality from a human perspective and tends to overlook the unexpected. Yet environmental unpredictability sits at the heart of human relationships with nature.[833] Tolerating uncertainty underpins the resilience and persistence of fungi. Mycologist David Moore attributes the developmental success of fungi to their ability to cope with uncertainty in what he describes as ‘tolerance of imprecision,’ as reflected in their survival almost unchanged over vast geological time.

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[828] Robin, “Resilience in the Anthropocene: A Biography,” 54.
[829] Ibid., 57. Italics original.
[830] Griffiths, *Hunters and Collectors*, 12. As discussed in the context of hypogeous fungi such as truffles in the section “Retreating underground” in chapter three.
[831] Robin, *How a Continent*, 215.
[832] Ibid., 55.
[833] Beinart, “Reflecting on Unruliness,” 69.

He says, ‘the agaric forms which were caught in amber 90 million years ago had already seen the dinosaurs come to rule the Earth. The same agarics survived whatever catastrophe saw an end to the terrible lizards, and then witnessed, in their own quiet way, the rise of mammals and appearance of the thinking primates’.[834] As Moore contends, fungi will be around long after the last *Homo sapiens*. The ‘thinking primates’ might need to think a little differently if we fancy a continued shared existence.

Fungal futures in the age of the selfie stick

Historian of science, Jürgen Renn, claims that ‘the Anthropocene is a process that reflects about itself’.[835] There is certainly an epidemic of narcissism in our era, reflected not so much in Narcissus’ pool, but in sales of selfie sticks. The symbolic hockey stick curves depicting the accelerated environmental change of the Anthropocene possibly go unnoticed in the near-sightedness of those waving selfie sticks in an ever-more materialistic society. A symbol of the Age of Entitlement, the selfie stick and the obsession with self erode the humility, empathy and responsibility required for an environmental ethic. The reduced capacity of the narcissist to form emotionally intimate relationships with other humans, let alone with a fungus and its cowpat sanctum, does not accord with conserving the planet.

What kind of thinking is needed to dislodge humans from an imaginary apex of an increasingly individualistic society and reinsert them in the meshwork? The interlacing threads of Rayner’s idea of Natural Inclusionality, Tim Ingold’s notion of Meshwork, Barad’s Agential Realism and Mick Smith’s Ecological Community help displace the centrality of *Homo sapiens* by having a different starting point, placing emphasis on the open-endedness of life and inherent inclusionality, not on a single species. Offering a more *mycelial* approach, these ideas reposition humans within the Meshwork and inspire a reconsideration of agency. Rayner’s Natural Inclusionality focusses on the ‘enormous significance of indeterminacy or “open-endedness” amongst all kinds of life forms’.[836] Likewise, Barad says, ‘intra-acting responsibly as part of the world means taking account of the entangled phenomena that are intrinsic to the world’s vitality and being responsive to the possibilities that might help us flourish’.[837] She considers that ‘responsibility is not an obligation that the subject chooses but rather an incarnate relation that precedes the intentionality of consciousness . . . not a calculation

[834] Moore, “Fungal Morphogenesis,” 17.
[835] Cited in Schwägerl, “Neurogeology,” 34.
[836] Rayner, *Degrees of Freedom*, vii.
[837] Barad, *Meeting the Universe Halfway*, 396.

to be performed . . . an enabling of responsiveness'.[838] Ingold reminds us that we have forgotten how to be alive in the world. Through their combined ideas of intra-actions and movement, indeterminacy and heterogeneity, unpredictability and flows, each challenges the foundations of perception and exceptionalism of *Homo sapiens*. All offer ways of thinking and perceiving that shift the responsibility to the individual, giving little focus to technological solutions. As critical theorist Stephen Muecke contends, 'we have found time after time a change of perception can create a new paradigm in history'.[839]

Barad argues: 'It is not possible to extricate oneself from ethical concerns and correctly discern what science tells us about the world.[840] Refusal to exclude emotions dismissed by science might make bad science, but it offers another kind of intelligence. A more human intelligence. Rayner concurs that we need to move from alienated observers or abstracted 'exhabitants,' to recognise and participate as inextricably involved inhabitants.[841] Likewise, Mick Smith's idea of Ecological Community invites an 'ecology of ethics' that he considers 'lies precisely in not isolating individuals from this background as intentional *objects* or as members of formal categories, but in appreciating the not entirely comprehensible ways in which these individuals also constitute a part of a community of myriad beings'.[842] All advocate for greater curiosity, imagination and receptivity to multiple knowledge systems.

Despite the Australian 'myco-enlightenment' that began in the 1980s, biodiversity conservation initiatives remain fixated with fungi as a cause of environmental problems. This limited approach could borrow from the abovementioned frameworks for rethinking fungi in environmental issues. For example, reimagining the Chytrid Fungus (*Batrachochytrium dendrobatidis*) that affects amphibians through Barad's idea of intra-action presents a different scenario to the regular villain-oriented conception of Chytridiomycosis in current conservation. In itself, Chytridiomycosis in isolation is not a terribly destructive disease. Rather, it is part of complex intra-actions between the fungus, amphibians and humans, along with a suite of other factors including climate and environmental change. It is not just a disease, but also a phenomenon that occurs between intra-acting components. Approaches to thinking about Chytridiomycosis need to recognise it as a symptom of a whole lot of intra-

[838] Barad, "Quantum Entanglements," 265.
[839] Muecke, *Ancient and Modern*, 23.
[840] Barad, *Meeting the Universe Halfway*, 37.
[841] Rayner, "Sustainability of the Fitting," 15.
[842] Smith, "Dis(appearance)," 41.

actions, rather than a cause. These relate particularly to anthropocentric modification of habitats, increased vectors and ease of dispersal, along with the weakened resilience of amphibians – that is, the human-generated conditions that allow the disease to flourish. Thinking of them as interactions rather than intra-actions exposes the human tendency to dichotomise, separating things that are co-constitutive, as well as deferring responsibility. By studying the intra-actions, agency emerges, highlighting how all contributors are implicated and questioning how responsibility should be distributed. Such an approach reduces the tendency to view the world through binaries of cause and effect. Understanding fungi requires multiple lenses. Using them as a framework for imagining the future needs new perceptions and concepts.

Looking with the heart – from managing to caring[843]

It was eighteen months since the 'controlled burn' in Shelbourne Nature Conservation Reserve in North-Central Victoria. Judy Crocker and I wandered between the blackened eucalypt trunks now fuzzed green with epicormic growth. The forest floor showed fewer signs of life and looked like it had been concreted. We squatted down and tried to poke our fingers into the 'soil' but it was literally baked hard like ceramic. Only the very occasional Sweet Bursaria (*Bursaria spinosa*) managed to push through the resistant seal. We did not find a single sporebody or even the suggestion of fungi. This was the result of a 'controlled burn' where any aspect of 'control' seemed like a lark. Judy sighed with frustration, commenting that everything about the way in which the burn was done was negligent. Care-less.[844] The blackened forest represented a prime example of conflicting 'management' regimes where managing for fire (i.e. primarily for the protection of *Homo sapiens*) conflicted with managing for other species and habitat. Judy described how the local conservation group had been monitoring curlews in the very area that was burnt, lambasting the authority's lack of pre-burn investigation and consultation. She described how inappropriate burning led to severe and ongoing erosion, thwarting conservation efforts and contaminating local farmers' water supplies.[845] Judy had been assured that the area to be burnt was checked for curlew nests. The problem was, the authorities looked in the trees, not on the ground, where curlews nest. Judy shook her head in disbelief at the lack of proper research and

[843] The subtitle was inspired by de Saint-Exupery, *Mais les yeux sont aveugles. Il faut chercher avec le cœur*, trans., But the eyes are blind. One must look with the heart. de Saint-Exupery, *Le Petit Prince*.
[844] The burn was approved by the Department of Environment, Land, Water and Planning (DELWP) in agreement with Parks Victoria.
[845] Judy Crocker, conversations, 8 April 2014 and 22 October 2015. The "Department" is DELWP.

preparation – the same research and preparation that she is required to do for environmental grant applications. The experience with Judy in the forest epitomised management itself as a threat. This forest desperately needed a break from management. Inappropriate burning regimes as part of management were reducing the forest's resilience and driving a wedge between authorities and communities. I thought of Annie Dillard's words: 'Keeping the subsoil world under the trees in mind, in intelligence, is the least I can do'.[846] Yet such intuitive thinking seemed remote from the way the forest was being managed. Despite her frustrations, Judy persists in her effort to seek common ground in negotiating ecological considerations and political motivations. However, such stories are commonplace. Gayle Osborne from Wombat Forestcare also expressed concern about the lack of understanding of forest ecology and particularly the role of fungi by land managers, commenting:

> I don't think the functional value of fungi is understood at all by land managers, by those in fuel reduction burn crews, or any other part of DSE. I don't think they have any idea that fungi are important . . . that they support a massive amount of the life system and their protection is ultimately important . . . We have the same issues with other things we can't see, such as microbats that are eating a massive amounts of insects, keeping insect populations under control. But because they're not seen, they're not valued.[847]

Poor forest 'management' typically has an homogenising effect, simplifying forest structure, fragmenting habitats, dislocating ecosystem processes and increasing fragility. It also pushes *Homo sapiens* into a tail-chasing spiral of endless investment of energy to rectify the damage caused through 'management,' usually to satisfy predominantly political goals that seldom match ecological realities. Management that fails to adequately support forest processes and relationships is unsustainable:

> "management," after all, is only a metaphor we use to justify an impact on a system. The concept of management deludes us into thinking we are somehow in *control of nature*. The historical focus in forestry has been too much on attempting to control the trees, and too little on taking care of the forest.[848]

Part of management is to accept the dynamism and unpredictability of natural systems and to find ways to work with them, to care, rather than through attempts to quell them. Says Robin in the context of extinction, 'the last individual stands as a locus for the world without science, and the world we care about, rather than manage'.[849]

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[846] Dillard, *Pilgrim at Tinker Creek*, 96.
[847] Gayle Osborne, interview with the author, Glenlyon, 9 May 2013. The "DSE" is now DELWP.
[848] Maser, Claridge and Trappe, *Trees, Truffles and Beasts*, 228.
[849] Robin, "Counting our Blessings".

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'The world unravelled from reason,' said Dillard.[850] Has the world also unravelled from care? Many pioneering ecological thinkers, artists, writers and conservationists share a belief in the need to shift from a conquering mentality to one of humility and ecological empathy. Most argue that an environmental ethic relies on a sense of emotional connectedness, based on feelings as much as reason.[851]

Calls for 'environmental care' are not new. Landcare, Forestcare, Oceancare, Rivercare, Beachcare, Soilcare, Aircare and the like are all well intentioned and all claim and aim to care. But what is the nature of such caring? What does it really mean to *care*? It is not enough to be merely 'concerned' or to 'manage'. Concern suggests a degree of worry, legitimate as it is, but care implies a more profound sense of attachment accompanied by responsibility (in the sense of the capacity to respond). Care transpires in different ways. Landcare arose from a Western idea of caring, as a managerial paradigm that flipped indigenous notions of 'caring for country' upside down.[852] As Robin suggests, caring might be more about paying attention, about noticing and 'keeping track' rather than trying to manage via an ideal of control. Care without controlling offers possibilities for humility. Says Robin, a world that is cared for might not require management in the same way.[853] It asks for emotional intelligence and personal connections as part of 'management outcomes'. This is not to negate the tireless and selfless actions of the thousands of Landcarers across the country who respond precisely to the abovementioned 'attachment and responsibility' and a deep and profound love of the land.

Care is difficult to articulate, not only because it is not entirely rational or quantifiable, but because it is prone to moralism and virtuousness. But care is bigger than that. It is about injustices and commitment to their rectifying. Care typically focuses on *Homo sapiens*, but disregarded organisms especially need care. The 'cleansing' of facts from emotion that is the way of science rarely invites subjective notions of care as a valid justification for conservation. Yet most field mycologists I have spoken with were drawn to the profession not just because of interest but because

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[850] Dillard, *Pilgrim at Tinker Creek* , 32.
[851] e.g. Perkins, "Measuring Love and Care for Nature," 455.; Callicott, "Introduction," 3; Orr, "Love it or Lose it," 415.
[852] Libby Robin, comment made during the Landscape, Environment, Emotion conference, Pori, Finland 25 September 2013. The notion of "Country" as discussed in chapter seven presents another way to consider caring.
[853] Ibid.

they cared. Philosopher of science, Vinciane Despret poignantly captures the meaninglessness of a world without care in her comment:

> to "de-passion" knowledge does not give us a more objective world, it just gives us a world "without us"; and therefore, without "them" . . . And as long as this world appears as a world "we don't care for", it also becomes an impoverished world, a world of minds without bodies, of bodies without minds, bodies without hearts, expectations, interests, a world of enthusiastic automata observing strange mute creatures; in other words, a poorly articulated (and poorly articulating) world.[854]

Care is not an attachment or an overlay superimposed on top of rational understanding, but a deeply and intuitively felt sense. Telling people to care is pointless. It is not a matter of cognition, of something understandable rationally. The only way to move from facts to care is via feeling that usually arises from direct experience. By shifting from sympathy to empathy. Empathy is about relationship building and social change. I based this research specifically in the field because I wanted to observe people's perceptions not just cognitively, but emotionally. Only through multisensory experience and the capacity for empathy does an ethic of care stand a chance.

Fungal spots can ruin the roses, indeed wipe out the orchard. Of more concern is the human blindspot – a blindspot to not just a kingdom of organisms entitled to human concern, but what they offer allegorically as another way of thinking. Fungi challenge us to consider that despite human efforts to control and order, it is the indeterminate, unruly and unspectacular that hold ecosystems together.

Re-enchanting the fungal imagination

Nature is commonly experienced in highly mediated ways – insulated against uncertainty, the seasons, the darkness, the perceived dangers and discomforts. Mediation not only distances but also robs imagination. Imagination is vital to finding the language, poetry and sensoria to express perceptions and envisage the future. However, our data-choked world values information more highly than imagination, even though imagination is often a precursor to knowledge. Imagination is needed to reconfigure outdated paradigms. It is not to resort to fantasy. Anthropologist Arjun Appadurai proposes what he calls the 'new role' of imagination, commenting: 'the imagination is now central to all forms of agency, is itself a social fact, and is the key

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[854] Despret, "The Body We Care For," 131.

component of the new global order'.[855] Catholic priest and ecotheologian, Thomas Berry recognised the lack of imagination as a source of disregard and destructive tendencies toward the planet:

> our primordial spontaneities, which give us delight in existence and enable us to interact creatively with natural phenomena, are being stifled. Somehow we have become autistic. We don't hear the voices. We are not entranced with the universe, with the natural world. We are entranced instead with domination over the natural world, with bringing about violent transformation.[856]

Some people struggle to acknowledge the extent of environmental decline without such knowledge eroding the capacity to act. The Anthropocene narrative commonly condemns scientists for crippling action with their forecasts of apocalyptic peril, yet scientists' warnings fall mainly on deaf ears. Despite efforts to convey the urgency and enormity of addressing an overburdened world, warnings go unheeded. Environmentalist Bill McKibben went so far as to suggest the only way scientists might get their message across is to go on strike.[857] If the Anthropocene discourse moves beyond the tussle for the legitimisation of particular brands of knowledge to arrive at true interdisciplinarity, then it might become a real force for change.

Changing thinking and feeling requires inspired language. Wright, Barad, Rayner, Ingold, Malouf, Macfarlane and others in this thesis all nurture language. Chapter four explored the limitations of fungal language and the need to replenish and reanimate it to mirror the dynamism of fungi. Fungal language needs enlivening to convey not just the science of fungi, but other stories too. Change happens not only through laws and policies, but stories and conversations. Macfarlane considers that by 'instrumentalising nature, linguistically and operationally, we have largely stunned the earth out of wonder'.[858] Science provides the rudiments, but it is the stories that make emotional sense – that inspire the wonder – that can lead to action. Writer David Malouf sums it up with his comment,

> I think the whole idea of human sovereignty or dominance and a right to this and a privilege over the rest of the natural world, is a very deep rooted attitude that we have that we can find in our language and all kinds of places and we have to try, in a sense, to systematically uproot this and that means thinking and speaking differently. So I think at the symbolic level, as it were, it has to do with language, with meanings, with schemes, with ways of thinking of about relationships between humans and the non-human world.[859]

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[855] Appadurai, "Disjuncture and Difference," 5.
[856] Berry, *Listening to the Land*, 36.
[857] McKibben, "Time for Climate Scientists to go on Strike".
[858] Gunn, "Landmarks Review".
[859] Malouf, "David Malouf on Australian Culture and Writing".

Real hope lies in these deeper realms of language and imagining. Hope is one of those intangible things that begs for logic and then for something less tangible; something based in emotions and belief. Hope arises from the capacity to feel and care. It relies on past experience to project it into the future. Its antitheses – hopelessness and despair – erase the present rendering the future intangible. It also brings us back to the notion of uncertainty. Embracing hope requires getting comfortable with uncertainty. Opening up to possibility. Anthropologist and curator Kirsten Wehner maintains that to be hopeful one first needs to believe that change is possible; then comes the challenge of infusing hope with urgency.[860] Urgency arises from apprehension of the problem, says Wehner, and hope arises from finding ways to address it.[861]

In his opening line to *A Sand County Almanac*, Aldo Leopold wrote: 'There are some who can live without wild things, and some who cannot'. Chief Scientist of The Nature Conservancy, Peter Kareiva appears to be one of the former. His proposal that conservationists abandon notions of the intrinsic value of nature suggests his contentment with the idea of a 'managed' wilderness-free Anthropocene, but others need bigger, more hopeful and imaginative visions.[862] Historian William Cronon's seminal essay 'The Trouble with Wilderness' outlined the perils of idealised notions of wilderness as unpeopled and provoked an extensive discourse.[863] Imperialist ideas of separation and idolisation of nature as 'wilderness' and subsequent territorialisation and injustices (especially the preclusion of indigenous subsistence) have been exhaustively critiqued, influencing conservation practices today. However, it might be time to find the middle ground. As science journalist Brandon Keim says, 'without ideals of wilderness and wildness as guides, the compass spins astray'.[864] Keim cautions against the ideologies of some green modernists that shun what they claim to be conservationists' idealised notions of wilderness. He disputes that most conservationists are unrealistic and while some 'might fixate on the pristine, most possess a love of wilderness and a far more pragmatic appreciation of wilderness'. This is also my experience, with most conservationists I encountered being both pragmatic and realistic. As Rachel Carson advocated, hope and care comes from the capacity for a sense of

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[860] Kirsten Wehner, comment at "The Anthropocene in Museums" conference, Munich, 3-4 December 2014.
[861] Ibid.
[862] e.g. Kareiva, Marvier and Lalasz "Conservation in the Anthropocene;" Andrew Revkin, "Critic of Conservation Efforts Gets Critiqued," *New York Times*, 10 April 2012. http://dotearth.blogs.nytimes.com/2012/04/10/peter-kareiva-critic-of-environmentalism-gets-critiqued/?_r=0.
[863] Cronon, "The Trouble with Wilderness".
[864] Keim, "Earth is not a Garden".

wonder. And for many, a sense of wonder needs to transcend ideas of a ‘managed’ Anthropocene.

This is a call for fungal wisdom. A call for wisdom forged from collective insights, attentive care and resourceful hope. A call to transcend fear of the unpredictable and uncomfortable, to embrace uncertainty and adaptability. It is an attempt to tap into the social imaginary and not just rational minds. Many of the perceptions, stories and myths around fungi arose from the nature of their seemingly spontaneous appearance and subsequent disappearance. These qualities of fungal spontaneity and ambiguity are precisely what make them compelling, challenging accepted thinking and making us uncomfortable. This is not to suggest we abandon rationality and return to superstition, but an encouragement to loosen the reins. It is an invitation to imagine an approach to conservation that begins with mycelium and then extends infinitely. Thinking through a fungal paradigm encourages us to embrace the unknown, to seek a more inspired framework with which to imagine the future.

Ultimately, fungus civilisations beneath the soil will rise and fall and persist whether *Homo sapiens* notices them or not. For all the high-tech capability of modern times, I propose the challenge to invent a device to increase attentiveness and care. It could materialise as a pair of glasses that allowed us to peer into the soil’s depths and see the complexities of life it embraces. If we could sensorialise the invisible, we might not just think, but feel differently about this hidden labyrinthine world that reflects the interrelationships of human societies and our fundamental inseparability.

Bibliography

This bibliography contains a list of sources that have been directly cited in this thesis. In keeping with the Chicago Manual of Style guidelines, newspaper articles are not included in the bibliography but appear in footnotes.

Abram, David. *The Spell of the Sensuous*. New York: Random House Inc., 1996.

Ackerman, Diane. *A Natural History of the Senses*. New York: Vintage Books, 1995.

Ainsworth, Geoffrey and Alfred S. Sussman, eds. *The Fungi: An Advanced Treatise.* New York: Academic Press, 1965.

Ainsworth, Geoffrey. *Introduction to the History of Mycology.* Cambridge: Cambridge University Press, 1976.

Al-Fatimi, Mohammed, Walter Jülich, Rolf Jansen, and Ulrike Lindequist. "Bioactive Components of the Traditionally Used Mushroom *Podaxis pistillaris.*" *Evidence-based Complementary and Alternative Medicine* 3, no. 1 (2006): 87-92. doi:10.1093/ecam/nek008.

Albrecht, Glenn. "Solastalgia: A New Concept in Human Health and Identity." *Philosophy, Activism, Nature* 3 (2005): 41-55.

Anderson, Sandra, Lynda Carey, Kay Cullen, Serenella Flackett, Alice Grandison, eds., *The Chambers Dictionary*. New Dehli: Allied Publishers Private Ltd., 2006.

Appadurai, Arjun. "Disjuncture and Difference in the Global Cultural Economy." *Public Culture* 2, no. 2 (Spring 1990): 1-24.

Armiero, Marco. *A Rugged Nation, Mountains and the Making of Modern Italy: Nineteenth and Twentieth Centuries*. Cambridge: The White Horse Press, 2011.

Arora, David. *Mushrooms Demystified*. New York: Ten Speed Press, 1986.

Arthur, Jay. *The Default Country: A Lexical Cartography of Twentieth Century Australia*. Sydney: UNSW Press, 2003.

Association of British Fungus Groups. "Observations autumn 2012." Accessed 5 January 2016. http://www.abfg.org/bap/viewtopic.php?f=99&t=1247.

Atkinson, George. *Mushrooms: Edible, Poisonous, Etc.* New York: Andrus and Church Publishers, 1900.

Australian Broadcasting Commission News. "Climate Change: Barack Obama and David Attenborough Meet to Discuss the Future of the Planet." Accessed 29 June 2015. http://www.abc.net.au/news/2015-06-29/barack-obama-david-attenborough-talk-climate-change-white-house/6580448.

Australian Broadcasting Commission. “Tony Broe on The Midday Interview.” ABC Classic FM, accessed 08 October 2015. http://www.abc.net.au/radio/programitem/pe5AQp2AAD?play=true.

Australian Government. “Australian Farming and Agriculture: Grazing and Cropping.” Accessed 23 December 2015. http://www.australia.gov.au/about-australia/australian-story/austn-farming-and-agriculture.

Australian Government Bureau of Meteorology. “What is El Niño and What Might it Mean for Australia?” Accessed 25 October 2015. http://www.bom.gov.au/climate/updates/articles/a008-el-nino-and-australia.shtml.

Backhouse, James. *Narrative of a Visit to the Australian Colonies.* London: Hamilton, Adams and Co., 1843.

Baker, Tony. “Origins of the Word ‘Mushroom.’” *Mycologist* 3, no. 2 (1989): 88-90.

Baker, Tony. “The Word ‘Toadstool’ in Britain.” *Mycologist* 4 (1990): 25-29.

Barad, Karen. *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning.* London: Duke University Press, 2007.

Barad, Karen. “Nature’s Queer Performativity (authorized version).” in *Kvinder, Køn og forskning/Women, Gender and Research Feminist Materialisms* 1-2: (2012): 25-53.

Barad, Karen “Posthumanist Performativity: Toward an Understanding of How Matter Comes to Matter.” *Signs: Journal of Women in Culture and Society* 28, no. 3 (2003): 801-831.

Bean, Anthony. “A New System for Determining Which Plant Species are Indigenous in Australia.” *Australian Systematic Botany* 20 (2007): 1-43.

Beiler, Kevin, Daniel Durall, Suzanne Simard, Sheri Maxwell and Annette Kretzer. “Architecture of the Wood-Wide Web: *Rhizopogon* spp. Genets Link Multiple Douglas-Fir Cohorts.” *New Phytologist* 185, no. 2 (2010): 543-553.

Beinart, William. “Reflecting on Unruliness.” In “Unruly Environments,” edited by Siddhartha Krishnan, Christopher L. Pastore and Samuel Temple. *RCC Perspectives* 3 (2015): 69-74.

Bell, Ann. *Dung Fungi: An Illustrated Guide to Coprophilous Fungi in New Zealand*. Wellington: Victoria University Press, 1983.

Benjamin, Denis. *Musings of a Mushroom Hunter*. USA: Tembe Publishing, 2010.

Bennett, Jane. *Vibrant Matter: A Political Ecology of Things*. Durham and London: Duke University Press, 2010.

Berger, John. *Ways of Seeing*. Middlesex, England: Penguin Books Limited, 1972.

Berkeley, Miles Joseph. *Introduction to Cryptogamic Botany*. New York: H. Balliere Publisher, 1857.

Berry, Thomas. Interview with Derrick Jensen in Derrick Jensen, *Listening to the Land: Conversations about Nature, Culture and Eros*. Vermont: Chelsea Green, 2002.

Birdlife Australia History. Accessed 31 January 2016. http://birdlife.org.au/who-we-are/our-organisation/history/.

BirdLife Australia. *Annual Report 2014*. Carlton, BirdLife Australia, 2014.

Blackwell, Meredith. “The Fungi: 1,2,3 . . . 5.1 Million Species?” *American Journal of Botany* 98 (2011): 426-438.

Blake, H. Emerson. “Preamble.” *Orion* (January-February 2015): 1.

Boa, Eric. *Wild Edible Fungi: A Global Overview of Their Use and Importance to People*. Food and Agriculture Organisation of the United Nations: Rome, 2004.

Boddy, Lynne. “Fungi: The Unsung Heroes of the Planet.” *Philosophy, Activism, Nature* 10 (2013): 112-118.

Bon, Marcel. *Pareys Buch der Pilze*. Hamburg and Berlin: Verlag Paul Parey, 1988.

Bone, Eugenia. *Mycophilia: Revelations from the Weird World of Mushrooms*. New York: Rodale, 2011.

Briggs, Raymond. *Fungus the Bogeyman*. London: Hamilton Hamish, 1977.

Buchanan, Peter and Tom May. *Claustula fischeri*. The IUCN Red List of Threatened Species 2015: e.T75720773A75720776. Accessed 28 January 2015. http://www.iucnredlist.org/details/75720773/0.

Buller, Arthur Henry. “The Fungus Lore of the Greeks and Romans.” *Transactions of the British Mycological Society* 5 (1914-1915): 21-66.

Büntgen, Ulf, Simon Egli, J. Julio Camarero, Erich M. Fischer, Ulrich Stobbe, Håvard Kauserud, Willy Tegel, Ludger Sproll and Nils C. Stenseth. “Drought-Induced Decline in Mediterranean Truffle Harvest.” *Nature Climate Change* 2, no. 12 (2012): 827-829. doi: 10.1038/nclimate1733.

Callicott, J. Baird. “Introduction.” In *Environmental Philosophy: From Animal Rights to Radical Ecology,* edited by Michael Zimmerman, J. Baird. Callicott, George Sessions, Karen J. Warren and John Clark, 3-11. Englewood Cliffs, NJ: Prentice-Hall, 1993.

Camara, Anthony. “Abominable Transformations: Becoming-Fungus in Arthur Machen’s *The Hill of Dreams*.” *Gothic Studies* 16, no. 1 (2014): 9-23.

Cannon, Paul. "Kew Gardens: Beyond the Gardens: The Fungarium." Vimeo video, 5:34. http://vimeo.com/36422624.

Cannon, Paul, Nigel L. Hywel-Jones, Norbert Maczey, Lungten Norbu, Tshitila, Tashi Samdup and Phurba Lhendup. "Steps Towards Sustainable Harvest of *Ophiocordyceps sinensis* in Bhutan." *Biodiversity and Conservation* vol. 18, no. 9 (2009): 2263-2281.

Carluccio, Antonio. *Complete Mushroom Book: The Quiet Hunt*. London: Quadrille Publishing, 2003.

Carroll, Lewis. *Alice's Adventures in Wonderland and Through the Looking Glass.* Millers Point, NSW: Murdoch Books, 2011.

Carruthers, Jane. "Environmental History with an African Edge." In *The Edges of Environmental History: Honouring Jane Curruthers*, edited by Christof Mauch and Libby Robin, 9-16. *RCC Perspectives* no. 1, 2014.

Carson, Rachel. *Silent Spring*. London: Penguin Books, 1962.

Centre for Disease Control and Prevention, "*C. neoformans* Infection Statistics." Accessed 30 September 2015. http://www.cdc.gov/fungal/diseases/cryptococcosis- neoformans/statistics.html.

Channing, William Ellery. *Thoreau The Poet-Naturalist; With Memorial Verses*. London: Forgotten Books, 2013. (Original Work Published 1873). http://www.forgottenbooks.com/readbook_text/Thoreau_The_Poet-Naturalist_With_Memorial_Verses_1000116308/287.

Chinatruffles.com. "Truffle Timeline: More than 4000 Years of History." Accessed 8 August 2015. http://chinatruffles.com/15-0-truffle-timeline.htm.

Chew, Matthew and Manfred Laubichler. "Perceptions of Science: Natural Enemies: Metaphor or Misconception?" *Science* 301 (2003): 52-53.

Chiang, Connie Y. "The Nose Knows: The Sense of Smell in American History." *Journal of American History* 95, no. 2 (September 2008): 405-416.

Clarke, Michael F. "Catering for the Needs of Fauna in Fire Management: Science or Just Wishful Thinking?" *Wildlife Research* 35 (2008): 385-394.

Classen, Constance, David Howes and Anthoy Synnott. *Aroma: The Cultural History of Smell*. New York: Routledge, 1994.

Cleland, John Burton. *Toadstools and Mushrooms and Other Larger Fungi of South Australia*. Adelaide: South Australian Government Printer, 1976 [1934].

Cole, F Mary. "A Puppy Death and *Amanita phalloides*." *Australian Veterinary Journal* 70, no. 7 (1993): 271-272.

Cook, Langdon. *The Mushroom Hunters: On the Trail of an Underground America*. New York: Ballantine, 2013.

Cooke, Mordecai. *Handbook of Australian Fungi*. London: Williams and Norgate, 1892.

Cooke, Roderic. *Fungi, Man and His Environment.* London: Longman, 1977.

Cooper, Caren, Lincoln Larson, Ashley Dayer, Richard Stedman, Daniel Decker. "Are Wildlife Recreationists Conservationists? Linking Hunting, Birdwatching, and Pro-Environmental Behavior." *Journal of Wildlife Management*, 79, no. 3 (2015): 446-457.

Cope, Rhian B. "Mushroom Poisoning in Dogs." *Veterinary Medicine* (February 2007): 95-100.

Courchamp, Franck, Elena Angulo, Philippe Rivalan, Richard J Hall, Laetitia Signoret, Leigh Bull and Yves Meinard. "Rarity Value and Species Extinction: The Anthropogenic Allee Effect." *PloS Biology* 4, no. 12 (2006). doi: 10.1371/journal.pbio.0040415.

Crist, Eileen. "On the Poverty of Our Nomenclature." *Environmental Humanities* 3 (2013): 129-147.

Cronon, William. "A Place for Stories: Nature, History, and Narrative." *Journal of American History* 78:4 (March, 1992): 1347-1376.

Cronon, William. "The Trouble with Wilderness; or Getting Back to the Wrong Nature." In *Uncommon Ground: Rethinking the Human Place in Nature*, edited by William Cronon, 69-90. New York and London: W. W. Norton & Co., 1996.

Crutzen, Paul J. and Eugene. F. Stoermer. "The Anthropocene." 9 *IGBP Newsletter* 41, no. 17 (2000): 17-18.

Dahlberg, Anders, David R. Genney and Jacob Heilmann-Clausen. "Developing a Comprehensive Strategy for Fungal Conservation in Europe: Current Status and Future Needs." *Fungal Ecology* 3 (2010): 50-64.

Dark, Jill. "Red Wattlebirds and Toadstools." *Fungimap Newsletter* 17 (August 2002).

Darwin, Charles. *Journal of Researches into the Natural History and Geology of the Countries Visited During the Voyage of H.M.S. Beagle*. Cambridge: Cambridge University Press, 1845.

Das Wörterbuch der Idiome. Accessed 09 June 2015 http://idiome.deacademic.com/2187/Pilz.

Davidson, Alan. *The Oxford Companion to Food*. Oxford: Oxford University Press, 2014.

Davis, Mark A., Matthew K. Chew, Richard J. Hobbs, Ariel E. Lugo, John J. Ewel, Geerat J. Vermeij, James H. Brown et al. "Don't Judge Species on Their Origins." *Nature* 474 (2011): 153-4.

Davis, Michael, Robert Sommer and John A. Menge. *A Field Guide to Mushrooms of Western North America*. Berkley and Los Angeles: University of California Press, 2012.

de Saint-Exupéry, Antoine. *Le Petit Prince*. New York: Reynal and Hitchcock, 1943.

Dean Moore, Kathleen and Michael P. Nelson. "Introduction: Toward a Global Consensus for Ethical Action." In *Moral Ground, Ethical Action for A Planet in Peril,* edited by Kathleen Dean Moore and Michael P. Nelson, xv-xxiv. San Antonio: Trinity University Press, 2010.

Department of Primary Industries, Parks, Water and Environment. *Natural Heritage Strategy for Tasmania 2013–2030*. State of Tasmania: Tasmania, 2013.

Despret, Vinciane. "The Body We Care For: Figures of Anthropo-zoo-genesis." *Body and Society* 10 nos. 2/3 (2004): 111-134.

Dickie, Ian and Peter Johnson. *Invasive Fungi Research Priorities, with a Focus on* Amanita muscaria. Landcare Research Contract Report LC0809/027. New Zealand: Landcare Research New Zealand Ltd, 2008.

Dillard, Annie. *Pilgrim at Tinker Creek*. New York: Harper Collins Publisher, 1974.

Doley, Rebekah. "Pyromania: Fact or Fiction." *British Journal of Criminology* (2003): 797-807.

Döring, Nico. "River System Between Natural Flow and Anthropogenic Changes: The Example of the Isar River." Unpublished paper presented at European Society for Environmental History Conference, Munich, 21-24 August 2013.

Douglas, Mary. *Purity and Danger: An Analysis of the Concepts of Pollution and Taboo*. London: Routledge, 1966.

Doyle, Arthur Conan Doyle. *Sir Nigel*. London: Smith Elder and Co., 1906.

Duffy, Rosaleen. *Nature Crime: How We're Getting Conservation Wrong.* New Haven and London: Yale University Press, 2010.

Dunk, Christopher, Teresa Lebel and Philiip Keane. "Characterisation of Ectomycorrhizal Formation by the Exotic Fungus, *Amanita muscaria* With *Nothofagus cunninghamii* in Victoria, Australia." *Mycorrhiza* 22 (2012): 135-147.

Dunlap, Tom. “Thinking with Birds.” In *The Edges of Environmental History: Honouring Jane Curruthers*, edited by Christof Mauch and Libby Robin, 25-29. *RCC Perspectives* no. 1, 2014.

Egli, Simon, Martina Peter, Christoph Buser, Werner Stahel and Francois Ayer. “Mushroom Picking Does Not Impair Future Harvests: Results of a Long Term Study in Switzerland.” *Biological Conservation* 129 (2006): 271-276.

European Council for the Conservation of Fungi. Newsletter 13 (December 2003).

Falconer, Ruth, James Brown, Nia White and John Crawford. “Biomass Recycling and the Origin of Phenotype in Fungal Mycelia.” *Proceedings of the Royal Society* 272 (2005): 1727-1734.

Fenner, Charles. *Mostly Australian*. Melbourne: The Hassell Press, 1945.

Fesmire, Steven. “Ecological Imagination.” *Environmental Ethics* 32 (2010): 183-203.

Field Naturalists Club of Victoria. “Fungi Group.” Accessed 9 October 2015. http://www.fncv.org.au/fungi-group/.

Fine, Gary Alan. *Morel Tales: The Culture of Mushrooming*. USA: Harvard University Press, 1998.

Finney, Stanley and Lucy E. Edwards. “The ‘Anthropocene’ Epoch: Scientific Decision or Political Statement?” *GSA Today* vol. 26, no. 3-4 (March-April 2016): 4-10.

Fischlin, Andreas. “Future Climates.” Presentation at Understanding Ecology Through the Humanities conference, Zurich, 19 June 2013.

Fisher, Matthew C., Daniel A. Henk, Cheryl J. Briggs, John S. Brownstein, Lawrence C. Madoff, Sarah L. McCraw and Sarah J. Gurr. “Emerging Fungal Threats to Animal, Plant and Ecosystem Health.” *Nature* 484 (2012): 186-194. doi:10.1038/nature10947.

Fortun, Kim and Mike Fortun. “Scientific Imaginaries and Ethical Plateaus in Contemporary U.S. Toxicology.” *American Anthropologist* 107, no. 2 (March 2005): 43-54.

Fouke, Daniel. “Humans and the Soil.” *Environmental Ethics* 33, no. 2 (2011): 147-161.

Freycinet National Park Wye River State Reserve Management Plan. Accessed 19 December 2014 http://www.parks.tas.gov.au/file.aspx?id=6542.

Friebes, Gernot and Ilse Wendekin. “Erstnachweis von *Podaxis pistillaris* in Europa.” *Zeitschrift für Mykologie* 80, no.1 (2014): 81-92.

Fuhrer, Bruce. *A Field Guide to Australian Fungi*. Melbourne: Bloomings Books, 2005.

Fungal Barcoding Database. Accessed 25 May 2015. http://www.fungalbarcoding.org/.

“Fungi, These are Australian.” *Australian Women’s Weekly*. 15 May 1957.

Gaston, Kevin J. "Valuing Common Species." *Science* 327, no. 8 (January 2010): 154-155. doi:10.1126/science.1182818.

Gates, Genevieve and David Ratkowsky. *Field Guide to Tasmanian Fungi*. Hobart: The Tasmanian Field Naturalists Club Inc., 2014.

Gavran, Mijo. *Australian Plantation Statistics*. ACT: Australian Government, 2013.

Geml, József, Rodham E. Tulloss, Gary A. Laursen, Nina A. Sazanova and D. Lee Taylor. "Evidence for Strong Inter- and Intracontinental Phylogeographic Structure in *Amanita muscaria*, a Wind-Dispersed Ectomycorrhizal Basidiomycete." *Molecular Phylogenetics and Evolution* 48 (2008): 694-701.

Genevier, Léon Gaston. "Étude sur les Champignons Consommés à Nantes sous le nom de Champignon Rose ou de Couche (*Agaricus campestris* L.)." *Bulletin de la Société Botanique de France* 23 (1876): 28-35.

Gerard, John. *Herball*. London: Bonham and John Norton, 1597.

Gerhardt, Ewald. *Der Grosse BLV Pilzführer für Unterwegs*. Munich: BLV Buchverlag, 2011.

Gibson, James. *The Ecological Approach to Visual Perception*. New York: Taylor and Francis Group, 1986.

Gissibl, Berhard, Sabine Höhler and Patrick Kupper. "Towards a Global History of National Parks." In *Civilizing Nature: National Parks in Global Historical Perspective*, edited by Berhard Gissibl, Sabine Höhler and Patrick Kupper. New York and Oxford: Berghahn Books, 2012.

Gould, Stephen Jay. *Dinosaur in a Haystack*. Middlesex: Penguin Books, 1997.

Graham, Mary. "Some Thoughts About the Philosophical Underpinnings of Aboriginal Worldviews." *Worldviews: Environment, Culture, Religion* 3 (1999): 105-118.

Grampians National Park Management Plan. Accessed 19 December 2014. http://parkweb.vic.gov.au/__data/assets/pdf_file/0018/313281/grampians-np-mp.pdf

Great Otway National Park & Otway Forest Park Management Plan. Accessed 19 December 2014. http://parkweb.vic.gov.au/__data/assets/pdf_file/0019/313282/great-otway-np-mp.pdf.

Greenwood, Paul. "Land of the Wiradjuri." Accessed 19 December 2015. http://www.riverina-e.schools.nsw.edu.au/documents/40634443/40634886/wiradjuri_book_pdf.pdf.

Grey, Ed and Pat Grey. "*Auriscalpium* sp. 'Blackwood' Jack Cann Reserve, Blackwood." Unpublished manuscript, 11 October 2014. Microsoft Word file.

Grey, Pat and Ed Grey. *Fungi Down Under*. Melbourne: Fungimap, 2005.

Grey, Ed. "Have You Seen an *Auriscalpium* Species Like This?" *Fungimap Newsletter* 47 (2012).

Griffiths, Jay. "Kith." Accessed 08 July 2015. https://www.youtube.com/watch?v=nW6Ozjjp3Co.

Griffiths, Tom. *Forests of Ash: An Environmental History*. Cambridge: Cambridge University Press, 2001.

Griffiths, Tom. *Hunters and Collectors: The Antiquarian Imagination in Australia*. Cambridge: Cambridge University Press, 1996.

Gunn, Kirsty. "Landmarks Review: Robert Macfarlane Finds Poetry in the Peatlands." Accessed 4 November 2015. Updated 8 March 2015. http://www.theguardian.com/books/2015/mar/08/landmarks-review-robert-macfarlane.

Hall, Ian. *Saffron Milk Cap* (Lactarius deliciosus), *Identification, Habitat and Cultivation*. Dunedin: Truffles & Mushrooms Consulting Ltd, 2011.

Hall, Ian and Gordon Brown. *Taming the Truffle: The History, Lore, and Science of the Ultimate Mushroom.* Portland. OR: Timber Press Inc., 2007.

Hall, Ian, Steven Stephenson, Peter Buchanan, Wang Yun and Anthony Cole. *Edible and Poisonous Mushrooms of the World*. Cambridge, Timber Press Inc., 2003.

Hannaford, Samuel. *Sea and River-side Rambles in Victoria*. Geelong: Heath and Ramble, 1860.

Harrington, Tom C. and David M. Rizzo, "Defining Species in the Fungi." In *Structure and Dynamics of Fungal Populations*, edited by James J. Worrall, 43-71. Dordrecht: Kluwer Press; 1999.

Harrison, Robert Pogue. *Forests: The Shadow of Civilization*. Chicago: The University of Chicago Press, 1992.

Hawksworth, David. "Orphans in 'Botanical' Diversity," *Mulleria* 10 (1997): 111-123.

Hay, William A. *An Elementary Text-book of British Fungi*. London: Swan Sonnenschein, Lowrey and Co. Paternoster Square, 1887.

Head, Lesley. "Decentering 1788: Beyond Biotic Nativeness." *Geographical Research* 50 (2012): 166-178.

Heasley, Lynne. "Walking Contested Land: Doing Environmental History in West Africa and the U.S.." *Environmental History* 10:3 (2005): 510-531.

Heilmann-Clausen, Jacob, Elizabeth Barron, Lynne Boddy, Anders Dahlberg, Gareth Griffith, Jenni Nordén, Otso Ovaskainen, Claudia Perini, Beatrice Senn-Irlet, Panu Halme. “A Fungal Perspective on Conservation Biology.” *Conservation Biology* (2014): 1-8. doi: 10.1111/cobi.12388.

Heinsius, Theodore. *Volksthümliches Wörterbuch der Deutschen Sprache, mit Bezeichnung der Aussprache etc.* Hanover: Hahn, 1820.

Heise, Ursula. *Sense of Place and Sense of Planet: The Environmental Imagination of the Global*. Oxford: Oxford University Press, 2008.

Hender, Elizabeth, Tom May and Suzanne Beulke. “Poisoning Due to Eating Fungi in Victoria.” *Australian Family Physician* 29, no. 10 (October 2010): 1000-1004.

Henrici, Alick. “Notes and Records.” *Field Mycology* 9, no. 1 (2008): 28-30.

Hirell, Anders. *Den Svenska Matsvampens Historia: Nedslag Och Utvikningar Från 1600-Tal Till Nutid*. Stockholm: Carlsson Bokförlag, 2013.

Hiscock, Peter. “Creators or Destroyers? The Burning Questions of Human Impact in Ancient Aboriginal Australia.” *Humanities Australia* 5 (2014): 45.

Hladký, Josef. *The Czech and the English Names of Mushrooms*. Brno: Masarykova Univerzita, 1996. https://digilib.phil.muni.cz/handle/11222.digilib/103588.

Horak, Egon. “A Contribution Towards the Revision of the Agaricales (Fungi) from New Zealand.” *New Zealand Journal of Botany* 9, no. 3 (1971): 403-462.

Horak, Egon. “Mycogeography in the South Pacific Region: Agaricales, Boletales.” *Australian Journal of Botany*, Supplementary Series 10 (1983): 1-41.

Hough, Katharine. “Excursion to the Flinders Ranges.” *The Victorian Naturalist* 89 (May 1972): 128-137.

Howard, Jeff. “Michael Egan, Barry Commoner and the Science of Survival: The Remaking of American Environmentalism.” *Sustainability: Science, Practice and Policy* 6, no. 1 (Spring 2010): 45-55.

https://digilib.phil.muni.cz/handle/11222.digilib/103588.

Hyde, Kevin. “Intertidal Fungi from Warm Temperate Mangroves of Australia, Including *Tunicatispora australiensis*, gen. et sp. nov.” *Australian Systematic Biology* 3 (1990): 711-718.

Hudler, George. *Magical Mushrooms, Mischievous Molds*. Princeton: Princeton University Press, 1998.

Imholtz, August A. Jr.. “Fungi and Place-Names, the Origin of Boletus.” *American Journal of Philology*, 98, no.1 (Spring, 1977): 71-76.

Ingold, Cecil. *Dispersal in Fungi*. London: Oxford University Press, 1953.

Ingold, Tim. *Being Alive: Essays on Movement, Knowledge and Description.* New York: Routledge, 2011.

Institute for Environmental Protection and Research. "History of Italian Mycology and First Contribution to the Correct Nomenclature of Fungi." *Handbook and Guidelines* 104 bis/2013. Rome: ISRA, 2013.

International Union for Conservation of Nature. Global Fungal Red List Initiative. Accessed 20 October 2015. http://iucn.ekoo.se/en/iucn/welcome.

Jackson, Michael D. *At Home in the World*. London: Duke University Press, 1995.

Jehne, Walter. "The Role of Fungi in Soil Health." Unpublished paper presented at Fungimap Conference, Hobart 26 April 2012.

John Webster. "Presidential Address: Coprophilous Fungi." *Transactions of the British Mycological Society*, 54, no. 2 (1970): 161-180.

Johnston, Peter R., Tom W. May, Duckchul Park and Egon Horak. "*Hypocreopsis amplectens* sp. nov., A Rare Fungus From New Zealand and Australia. *New Zealand Journal of Botany* 45 (2007): 715-719.

Jordan, Michael, *Encyclopedia of Fungi of Britain and Europe.* London: Frances Lincoln Ltd., 2004.

Kabaila, Peter Rimas. *Wiradjuri Places: The Lachlan River Basin*. ACT: Black Mountain Projects, 1996.

Kabir Peay, Christopher Baraloto and Paul Fine. "Strong Coupling of Plant and Fungal Community Structure Across Western Amazonian Rainforests." *The International Society for Microbial Ecology Journal* 7 (2013): 1852-1861.

Kalotas, Arpad. "Aboriginal Knowledge and Use of Fungi." In *Fungi of Australia* IB, edited by Anthony Orchard, 269-95. Melbourne: CSIRO, 1996.

Kareiva, Peter, Michelle Marvier and Robert Lalasz. "Conservation in the Anthropocene: Beyond Solitude and Fragility." The Breakthrough Institute. Accessed 16 January 2016. http://thebreakthrough.org/index.php/journal/past-issues/issue-2/conservation-in-the-anthropocene.

Kärnefelt, Ingvar and Patrik Frödén. "Erik Acharius: The Last of the Linnean Pupils". *Svenska Linnésällskapets årsskrift* (2007): 105-131.

Kauserud, Havard, Einar Heegaard, Mikhail A. Semenov, Lynne Boddy, Rune Halvorsen, Leif Chr. Stige, Tim H. Sparks, Alan C. Gange and Nils Chr. Stenseth. "Climate Change and Spring-Fruiting Fungi." *Proceedings of the Royal Society B* 277 (2010): 1169-1177.

Kearney, Ray and Elma Kearney. “Significance of the Hygrocybeae Community of Lane Cove Bushland Park Listings.” *Australian Mycologist* 19 (2000): 64-70.

Keim, Brandon. “Earth is Not a Garden.” *Aeon Online*. Last modified 18 September 2014. http://aeon.co/magazine/science/green-modernism-would-kill-off-the-wilderness/.

Keizer, Gerrit J. “Hildegard of Bingen: Unveiling the Secrets of a Medieval High Priestess and Visionary.” In *Entheogens and the Development of Culture: The Anthropology and Neurobiology of Ecstatic Experience*, edited by John A. Rush, 85-210. Berkeley, California: North Atlantic Books, 2013.

Kendrick, Bryce. *The Fifth Kingdom*. Newburyport: Mycologue Publications, 1992.

Kent H. McKnight, Vera B. McKnight, Roger Tory Peterson. *A Field Guide to Mushrooms: North America*. New York: Houghton Miffin Company, 1998.

Kirksey, Eben and Stefan Helmreich. “The Emergence of Multispecies Ethnography.” *Cultural Anthropology* 25, no. 4 (2010): 545-576.

Kleinman, Adam. “Intra-actions.” *Mousse* 34 (2012): 76-81.

Kohler, Robert E. *All Creatures: Naturalists, Collectors, and Biodiversity, 1859-1950*. Princeton: Princeton, University Press, 2006.

Korf, Richard P. “*Cyttaria* (Cyttariales): (Pezizales, Sarcoscyphaceae).” *Australian Journal of Botany, Supplementary Series* 10 (1983): 77-87.

Krishnamurthy, P. Krishna, and Robert A. Francis. “A Critical Review on the Utility of DNA Barcoding in Biodiversity Conservation.” *Biodiversity Conservation* 21 (2012): 1901-1919.

Krombolz, Julius Vincenz. “Naturgetreue Abbildungen und Beschreibungen der Essbaren, Schädlichen und Verdächtigen Schwämme.” *Annals and Magazine of Natural History* 14, no. 92 (1844): 351-352.

Kueffer Christoph and Brendon Larson. “Responsible Use of Language in Scientific Writing and Science Communication.” *Bioscience* 64 (2014): 1-6.

Kull, Kalevi. “Jakob von Uexküll: An Introduction.” *Semiotica* 124-1/4 (2001): 1-59.

Kuo, Michael. “Mushroom Taxonomy: The Big Picture.” Last modified March 2014. http://www.mushroomexpert.com/taxonomy.html.

Kuo, Michael. “Mushroom Expert, *Pisolithus tinctorius*.” Accessed 22 December 2015. http://www.mushroomexpert.com/pisolithus_tinctorius.html.

Labillardière, Jacques. *Voyage in Search of La Pérouse.* Piccadilly: John Stockdale, 1800.

Lakoff George and Mark Johnson. *Metaphors We Live By.* Chicago: University of

Chicago Press, 2003.

Latour, Bruno. "The Anthropocene and the Destruction of the Image of the Globe." Gifford lecture series 'Facing Gaia,' The University of Edinburgh, published 1 March 2013. https://www.youtube.com/watch?v=4-l6FQN4P1c.

Laurance, William F., Keith R. McDonald and Richard Speare. "Epidemic Disease and the Catastrophic Decline of Australian Rain Forest Frogs." *Conservation Biology* 10, no. 2 (April 1996): 406-413.

Laux, Hans. *Der Kosmos Pilzatlas*. Stuttgart: Franckh-Kosmos Verlags, 2006.

Lawson, Henry. *The Bush Undertaker and Other Stories*. Pymble, NSW: Angus and Robertson, 1994. https://ebooks.adelaide.edu.au/l/lawson/henry/while_the_billy_boils/book2.10.html.

Lay, Bronwyn. "Juris Materiarum. Empires of Earth, Soil and Dirt." PhD thesis, European Graduate School, 2015.

Lebel, Teresa. "Native Truffles of Australia." *The Victorian Naturalist,* 118, no. 2 (2001): 38-44.

Leho Tedersoo, Tom May and Matthew Smith. "Ectomycorrhizal Lifestyle in Fungi: Global Diversity, Distribution, and Evolution of Phylogenetic Lineages." *Mycorrhiza* 20 (2010): 217-263.

Lehrner, Johann. "Gender Differences in Long-term Odor Recognition Memory: Verbal Versus Sensory Influences and the Consistency of Label Use". *Chemical Senses* vol. 18, no. 1 (1993): 17-26.

Lekh, Batra. "Edible Discomycetes and Gasteromycetes of Afghanistan, Pakistan and North-western India." *Biologia 29 (Lahore)* (1983): 293-304.

Leonard, Pat. "Keeping Records on a Foray." *Fungimap* Newsletter 39 (January 2010), 19.

Leonard, Pat L., Sapphire McMullan-Fisher, Tom May, and Peter Buchanan. *Boletopsis nothofagi*. The IUCN Red List of Threatened Species 2015: e.T80188388A80188393. Accessed 28 January 2015 http://dx.doi.org/10.2305/IUCN.UK.2015-4.RLTS.T80188388A80188393.en.

Leopold, Aldo. *A Sand County Almanac*. New York: Oxford University Press 1949.

Lepp, Heino. "Desert Truffles: Australia and the Kalahari." anbg.gov.au. Last modified 29 January 2009. http://www.cpbr.gov.au/fungi/case-studies/desert-truffles-aust.html.

Lepp, Heino. "Dung Fungi." anbg.gov.au. Last modified 22 January 2013. https://www.anbg.gov.au/fungi/ecology-dung.html.

Lepp, Heino. "Episodes in Australian Lichenology." cpbr.gov.au. Last modified 4 April 2011. http://www.cpbr.gov.au/lichen/history-2.html.

Lepp, Heino. "Mycogeography: Australia and Nearby." anbg.gov.au. Last modified 22 January. http://www.cpbr.gov.au/fungi/mycogeography-nearby.html.

Lepp, Heino. "Mycogeography within Australia." anbg.gov.au. Last modified 22 January 2013. https://www.anbg.gov.au/fungi/mycogeography-australia.html.

Lepp, Heino. "Snippets of Mycological History." Unpublished document, 2014. Microsoft Word file.

Lepp, Heino. "The Study of Australian Fungi." anbg.gov.au. Last modified 22 January https://www.anbg.gov.au/fungi/history-20-cent.html.

Lepp, Heino. "Truffle-like Fungi in Australia." anbg.gov.au. Accessed 19 July 2015. http://www.cpbr.gov.au/fungi/mycogeography.html.

Letcher, Andy. *Shroom: A Cultural History of the Magic Mushroom*. Great Britain: Faber and Faber Limited, 2006.

Lindenmayer, David, William Laurance and Jerry Franklin. "Global Decline in Large Old Trees." *Science* 228 (2012): 1305-1306.

Lockwood, Jeffrey. *The Infested Mind: Why Humans Fear, Loathe, and Love Insects*. Oxford: Oxford University Press, 2013.

Lopez, Patricia J. and Kathryn A. Gillespie. "Introducing Economies of Death." In *Economies of Death: Economic Logics of Killable Life and Grievable Death*, edited by Patricia Lopez and Kathryn A. Gillespie. New York: Routledge, 2015.

Lorimer, Hayden. "Cultural Geography: The Busyness of Being 'More-than-Representational'." *Progress in Human Geography* 29, no. 19 (2005): 83-94.

Lorimer, Jamie. "What About the Nematodes? Taxonomic Partialities in the Scope of UK Biodiversity Conservation." *Social and Cultural Geography* 7, no. 4 (August 2006): 539-558.

Louwhoff, Simone. "An Introduction to the Lichens." *Fungimap Newsletter* 39 (2010).

Lowenhaupt Tsing, Anna. *The Mushroom at the End of the World: On the Possibility of Life in Capitalist Ruins*. Princeton: Princeton University Press, 2015.

Lumbach, Thorsten, Peter Buchanan, Tom May and Greg Mueller. "Phylogeography and Biogeography of Fungi." *Mycological Research* 112, no. 4 (2008): 423-424.

Lunchtime Colloquium: Harriet Ritvo, Rachel Carson Center Environment and Society. Accessed 09 August 2015. https://www.youtube.com/watch?v=90zyylSgnPY.

Lyons, Dana. “Cows with Guns.” The Music of Dana Lyons.” Accessed 6 June 2015, http://www.cowswithguns.com/product/digital-singles/cane-toad-muster/.

Maas, Rudloph. “Notes on Hydnums–XI.” *Persoonia* 9, no. 4 (1978): 491-500.

Macfarlane, Robert. *Landmarks*. UK: Hamish Hamilton, 2015.

Macfarlane, Robert. “Landspeak.” *Orion*, May-June 2015: 7-8.

Macfarlane, Robert. *The Old Ways: A Journey on Foot*. London: Penguin Books, 2013.

Macfarlane, Robert. *The Wild Places*. London: Granta Books, 2007.

Macfarlane, Robert. “The Word-Hoard: Robert Macfarlane on Rewilding Our Language of Landscape.” Last modified 27 February 2015. http://www.theguardian.com/books/2015/feb/27/robert-macfarlane-word-hoard-rewilding-landscape.

Macknight, Campbell. *The Voyage to Marege: Macassan Trepangers in Northern Australia.* Melbourne: Melbourne University Press, 1976.

Maguire, Garry. “Luminous Ghost Fungus.” Springbrook Research Centre. Accessed 14 August 2015. http://springbrook.info/research/luminous_ghost_fungus.htm.

Maitland, Sara. *Gossip from the Forest: The Tangled Roots of our Forests and Fairytales*. London: Granta, 2012.

Malouf, David. Interview “David Malouf on Australian Culture and Writing.” Midsummer Writers’ Festival. Last modified 2 May 2013. Accessed 1 April 2015 https://www.youtube.com/watch?v=Np_oqLOIeW0.

Manchester, Sarah and James M Bullock. “The Impacts of Non-Native Species on UK Biodiversity and the Effectiveness of Control.” *Journal of Applied Ecology* 37 (2000): 845-864.

Marley, Greg. *Chanterelle Dreams, Amanita Nightmares.* Vermont: Chelsea Green Publishing, 2010.

Marren, Peter. *Mushrooms*. Dorset: British Wildlife Publishing, 2012.

Maser, Chris, Andrew Claridge and James Trappe. *Trees, Truffles and Beasts: How Forests Function.* New Brunswick: Rutgers University Press, 2010.

Matthews, Freya. “From Biodiversity to Bio-proportionality?” Keynote address at 5th ASLEC-ANZ Biennial Conference, ANU, Canberra 19-21 June 2014. Accessed 16 August 2015. https://aslecanz.wordpress.com/5th-aslec-anz-biennial-conference/.

Matthews, Freya. *The Ecological Self*. London: Routledge, 1991.

May, Tom. “Articles About Fungi in Old Australian Newspapers.” *Fungimap Newsletter* 40 (April 2010): 7-9.

May, Tom. “Documenting the Fungal Biodiversity of Australasia: from 1800 to 2000 and Beyond.” *Australian Systematic Botany* 14 (2001): 329-356.

May, Tom. “Fungi.” In *A Conservation Overview of Australian Non-Marine Lichens, Bryophytes, Algae and Fungi,* edited by George Scott, Tim J. Entwisle, Tom W. May and G. Neill. Stevens, 49-74, Canberra: Environment Australia, 1997. https://www.environment.gov.au/node/14676.

May, Tom. “History of the Study of the Australian Agaricales.” In *History of Systematic Botany in Australasia,* edited by Philip Short, 265-272. Melbourne: Australian Systematic Botany Society, 1990.

May, Tom and Pam Catcheside. “Introducing Five New Lichen Target Species.” *Fungimap Newsletter* 39 (2010).

May, Tom and Ian Pascoe. “History of the Taxonomic Study of Australian Fungi.” In *Fungi of Australia IA Introduction: Classification*, edited by Anthony E. Orchard, 171-206 Melbourne, CSIRO: 1996.

May, Tom. “Where Are The Short Range Endemics Among Western Australian Macrofungi?” *Australian Systematic Botany* 15 (2002): 501–511.

McCarthy, Patrick. *Checklist of the Lichens of Australia and its Island Territories*. Canberra: Australian Biological Resources Study, 2016. http://www.anbg.gov.au/abrs/lichenlist/introduction.html.

McKibben, Bill. “Time for Climate Scientists to go on Strike.” MSNBC. Accessed 07 February 2016. http://www.msnbc.com/msnbc/time-for-climate-scientists-to-go-on-strike#51339.

McKnight, Kent, Vera McKnight and Roger Tory Peterson. *A Field Guide to Mushrooms: North America*. Houghton Mifflin Harcourt: Boston 1998.

Mead, Donald J. *Sustainable Management of* Pinus radiata *Plantations*, FAO Forestry Paper 170. Rome: Food and Agriculture Organisation of The United Nations, 2013.

Menkhorst, Peter and Frank Knight. *A Field Guide to the Mammals of Australia*. Melbourne: Oxford University Press, 2004.

Minter, David. “A Future for Fungi: The Orphans of Rio.” International Society for Fungal Conservation. Accessed 6 January 2015. http://www.fungal-conservation.org/blogs/orphans-of-rio.pdf.

Minter, David. “Fungal Conservation in Cuba.” In *Fungal Conservation: Issues and Solutions*, eds. David Moore, Marijke Nauta, Shelley Evans and Maurice Rotheroe, 182-196. Cambridge: Cambridge University Press, 2011.

Minter, David. "Fungal Conservation Needs Help from Botanists." *Plant Biosystems: An International Journal Dealing with all Aspects of Plant Biology* 145 (2011): 945-949.

Moison, Alena and Tom May. "Fungimap's 100,000th Record." *Fungimap Newsletter* 51 (December 2013): 14.

Molina, Randy, Thomas R. Horton, James M. Trappe and Bruce G. Margot. "Addressing Uncertainty: How to Conserve and Manage Rare of Little-Known Fungi." *Fungal Ecology* 4 (2011): 134-146.

Moncalvo, Jean-Marc and Peter Buchanan. "Molecular Evidence for Long Distance Dispersal Across the Southern Hemisphere in the *Ganoderma applanatum-australe* Species Complex (*Basidiomycot*a)." *Mycological Research* 112 (2008): 425-436.

Money, Nicholas. *Mr Bloomfield's Orchard: The Mysterious World of Mushrooms, Molds and Mycologists*. New York: Oxford University Press, 2012.

Money, Nicholas. *Mushroom*. New York: Oxford University Press, 2012.

Money, Nicholas. "Obituary, Cecil Terence Ingold (1905-2010)." *Nature* 465 (24 June 2010): 1025.

Money, Nicholas. *The Triumph of the Fungi: A Rotten History*. USA: Oxford University Press, 2006.

Money, Nicholas. "Why Picking Wild Mushrooms May be Bad Behaviour." *Mycological Research News* 109, no. 2 (February 2005): 131-135.

Montgomery, David. *Dirt: The Erosion of Civilisations*. California; University of California Press, 2007.

Moore, David. *Fungal Biology in the Origin and Emergence of Life*. United Kingdom: Cambridge University Press, 2013.

Moore, David. *Fungal Morphogenesis*. Cambridge: Cambridge University Press, 1998.

Moore, David. "Tolerance of Imprecision in Fungal Morphogenesis." In *Proceedings of the Fourth Conference on the Genetics and Cellular Biology of Basidiomycetes*, edited by Leo Van Griensven and J. Visser, 13-19. Horst, The Netherlands: The Mushroom Experimental Station, 1998.

Moore, David, Geoffrey Robson and Anthony Trinci. *Twentieth Century Guidebook to Fungi*. Cambridge University Press: Cambridge 2011.

Moore, David, Marijke Nauta, Shelley Evans and Maurice Rotheroe. "Preface." In *Fungal Conservation: Issues and Solutions*, edited by David Moore, Marijke

Nauta, Shelley Evans and Maurice Rotheroe, 1-6. Cambridge: Cambridge University Press, 2011.

Moore, George Fletcher. *A Descriptive Vocabulary of The Language in Common Use Amongst the Aborigines of Western Australia.* London: WM.S. Orr and Co., Paternoster Row, 1842.

Moore, Jason W. “Anthropocene or Capitalocene? Why Nature Matters in the Making and Unmaking of the Modern World, and Not in the Way You Might Think.” Accessed 2 February 2016. https://www.youtube.com/watch?v=p2EbJPyyxOU.

Moore, Jason W. “The Capitalocene, Part 1: On the Nature and Origins of Our Ecological Crisis.” Accessed 2 February 2016. http://www.jasonwmoore.com/uploads/The_Capitalocene___Part_II__June_2014.pdf.

Moore, Paul A. *The Hidden Power of Smell: How Chemicals Influence Our Lives and Behaviour*. New York: Springer, 2015.

Moore, Skye and Pam O’Sullivan. *A Guide to Common Fungi of the Hunter-Central Rivers Region*. NSW: Hunter Local Land Services, 2014.

Morgan, Adrian. “Who Put the Toad in the Toadstool?” *New Scientist* 25 (1986): 44-47.

Morris, Brian. “The Pragmatics of Folk Classification.” *Journal of Ethnobiology* 4, no. 1 (May 1984): 45-60.

Muecke, Stephen. *Ancient and Modern: Time, Culture and Indigenous Philosophy*. NSW: UNSW Press, 2004.

Mueller, Gregory, Gerald Bills and Mercedes S. Foster. *Biodiversity of Fungi: Inventory and Monitoring Methods*. Burlington MA: Elsevier Academic Press, 2004.

Muller, Damon A. *Using Crime Prevention to Reduce Deliberate Bushfires in Australia*. Canberra: Australian Institute of Criminology, 2009.

Mulligan, Martin and Stuart Hill. *Ecological Pioneers: A Social History of Australian Ecological Thought and Action*. Cambridge: Cambridge University Press, 2001.

Mycio, Mary. *Wormwood Forest: A Natural History of Chernobyl*. Washington: Joseph Henry Press, 2005.

Mycobank, International Mycological Association. “Fungal Databases, Nomenclature and Species Banks.” Accessed 12 October 2014. http://www.mycobank.org/Biolomics.aspx?Table=Mycobank&MycoBankNr_=309398.

Natural Resource Management Ministerial Council, *Australia’s Biodiversity Conservation Strategy 2010-2030*. ACT: Commonwealth of Australia, 2010.

New South Wales Department of Primary Industries. "Radiata Pine, 'The Remarkable Pine'." Primefact 646. NSW: DPI, 2008.

Nisbett, Richard. *The Geography of Thought: How Asians and Westerners Think Differently . . . and Why*. New York: Free Press, 2003.

Nixon, Rob. *Slow Violence and the Environmentalism of the Poor*. London: Harvard University Press, 2011.

Noble, Denis. *The Music of Life: Biology Beyond Genes*. Oxford: Oxford University Press, 2006.

Norvell, Lorelei. "Loving the Chanterelle to Death? The Ten-Year Oregon Chanterelle Project." *McIlvania* 12, no. 1 (1996): 6-25.

Nowotny, Helga. *Insatiable Curiosity: Innovation in a Fragile Future*. London: MIT Press.

Nuytinck, Jorinde. "*Lactarius* Section *Deliciosi* (Russulales, Basidiomycota) and its Ectomycorrhiza: A Morphological and Molecular Approach." PhD thesis, Ghent University, 2005.

Oeschger Centre for Climate Change Research, Federal Office for the Environment, MeteoSwiss, Centre for Climate Change Modelling, Agroscope and ProClim. *CH2014-Impacts: Toward Quantitative Scenarios of Climate Change Impacts in Switzerland*. Bern: OCCR, 2014.

Orchard, Anthony. "Dung Hunters Wanted." *Fungimap Newsletter* 4 (1997): 11-14.

Orr, David W. "Love it or Lose it: The Coming Biophilia Revolution." In *The Biophilia Hypothesis*, edited by Stephen. R. Kellert, and Edward. O. Wilson, 415-440. New York: Island Press, 1993.

Paine, Barry. "The Rotten World Around Us." BBC documentary. Great Britain: British Broadcasting Corporation, 1980. Available on YouTube, http://www.youtube.com/watch?v=ZCz36LfN3uI.

Parbery, Ian and W. Sheather. "Aspects of Australian Mycology 1800-1900." In *History of Systematic Botany in Australasia*, edited by Philip Short, 253-258. Melbourne: Australian Systematic Botany Society, 1990.

Parks Victoria, *Kooyora State Park Management Plan*. Melbourne: Parks Victoria, 2010.

Parks Victoria. *Victoria's State of Parks Report*. Parks Victoria: Melbourne, 2007.

Pascoe, Ian. "History of Systematic Mycology in Australia." In *History of Systematic Botany in Australasia*, edited by Philip Short, 259-264. Melbourne: Australian Systematic Botany Society, 1990.

Pavlovna Wasson, Valentina and Robert Gordon Wasson. *Mushrooms, Russia and History* Volumes I and II. New York: Pantheon Books, 1957.

Peintner, Ursula, Stefanie Schwarz, Armin Mešić, Pierre-Arthur Moreau, Gabriel Moreno and Philippe Saviuc. "Mycophilic or Mycophobic? Legislation and Guidelines on Wild Mushroom Commerce Reveal Different Consumption Behaviour in European Countries." *PLOS One* (May 21, 2013). doi: 10.1371/journal.pone.0063926.

Perkins, Helen E. "Measuring Love and Care for Nature." *Journal of Environmental Psychology* 30 (2010): 455-463.

Petersen, Ronald H. "The Typification of Hydnum Linn. per Fries: Time for Stability." *Taxon* 26, no. 1 (1977): 144-146.

Phillips, *Roger. Mushrooms.* London: Pan Macmillan Ltd, 2006.

Pinker, Steven. "An Adaptation to the Cognitive Niche." In *Language Evolution*, edited by James R. Hurford and Frederick J. Newmeyer, 16-37. Oxford: Oxford University Press, 2005.

Plomley, Brian and Mary Cameron. *Plant Foods of the Tasmanian Aborigines*. Launceston: Queen Victoria Museum, 1993.

Plues, Margaret. *Rambles in Search of Flowerless Plants*. London: Journal of Horticulture and Cottage Gardner Office, 1865.

Plumwood, Val. *Feminism and the Mastery of Nature*. London: Routledge, 1993.

Plumwood, Val. "Wilderness Scepticism and Wilderness Dualism." In *The Great New Wilderness Debate*, edited by. J. Baird Caldicott and Michael P Nelson, 652-690. London: University of Georgia Press, 1998.

Porter, Theodore M. *Trust in Numbers: The Pursuit of Objectivity in Science and Public Life*. Princeton: Princeton University Press, 1995.

Possingham, Hugh, Sandy J. Andelman, Mark Burgman, Rodrigo A. Medellin, Larry L. Master and David A. Keith. "Limits to the Use of Threatened Species Lists." *Trends in Ecology and Evolution*, 17, no. 11 (2002): 503-507.

Power Thesaurus, *Fungus Synonyms*. Accessed 13 May 2014. https://www.powerthesaurus.org/fungus/synonyms.

Prescott, Graham W., Paul. J. Johnson, Andrew J. Loveridge and David W. Macdonald. "Does Change in IUCN Status Affect Demand for African Bovid Trophies?" *Animal Conservation* 15 (2012): 248-252.

Presland, Gary. "The Place of Fungi in Aboriginal Economic Practices." Unpublished talk at Fungimap 7 conference, Rawson, Victoria 24 May 2013.

Pretty, Jules. *The Earth Only Endures: On Reconnecting with Nature and Our Place In It*. London: Earthscan, 2007.

Pringle, Anne and Else C. Vellinga. "Last Chance to Know? Using Literature to Explore the Biogeography and Invasion Biology of the Death Cap Mushroom *Amanita Phalloides* (Vaill. Ex Fr. : Fr) Link." *Biological Invasions* 8 (2006): 1131-1144.

Pyšek, Petr, David Richardson, Marcel Rejmánek, Grady Webster, Mark Williamson and Jan Kirschner. "Alien Plants in Checklists and Floras: Towards Better Communication Between Taxonomists and Ecologists." *Taxon* 53 (2004): 131-143.

Rahn, Suzanne. "Beneath the Surface with Fungus the Bogeyman." *The Lion and the Unicorn* 7/8 (1983-1984): 5-19.

Ramsbottom, Johnathan. "Mushrooms and Toadstools." Unusual Foods For Human Consumption." *Symposium Proceedings* 12 (1953): 39-44.

Raper, John R. "Sexual Versatility and Evolutionary Processes in Fungi." *Mycologia* 51, no. 2 (1959): 107-124.

Raverat, Gwen. *Period Piece*: *A Victorian Childhood* (Bath: Clear Press Ltd, 2003).

Rayner, Alan. *Degrees of Freedom: Living in Dynamic Boundaries.* London: Imperial College Press, 1997.

Rayner, Alan. "Interconnectedness and Individualism in Fungal Mycelia." In *A Century of Mycology*, edited by Brian Sutton, 193-232. Cambridge: Cambridge University Press.

Rayner, Alan. "Life in a Collective: Lessons from the Fungi." *New Scientist* 120 (1988): 49-53.

Rayner, Alan. "Space Cannot Be Cut: Why Self-Identity Naturally Includes Neighbourhood." *Integrative Psychological and Behavioural Science* 45, no. 2 (2011): 161-184. doi:10.1007/s12124-011-9154-y.

Rayner, Alan. "Sustainability of the Fitting." Keynote address at the 8th World Congress on Action Learning and Action Research, 6-9 September, 2010, Melbourne.

Rea, Carleton. *British Basiomycetae: A Handbook to the Larger British Fungi*. Cambridge: Cambridge University Press, 1922.

Relman, David. "'Til Death Do Us Part': Coming to Terms with Symbiotic Relationships." *Nature Reviews* 6 (October 2008): 721-724.

Relph, Edward. “A Pragmatic Sense of Place” In *Making Sense of Place: Exploring Concepts and Expressions of Place Through Different Senses and Lenses*, edited by Frank Vanclay, Matthew Higgins, and Adam Blackshaw. Canberra: National Museum of Australia Press, 2008. http://www.arch.ksu.edu/seamon/relph20th.htm.

Richardson, David, Nicky Allsopp, Carla M. D’antonio, Suzanne J. Milton and Marcel Rejmánek, “Plant Invasions: The Role of Mutualisms.” *Biological Reviews* 75, no. 1 (2000): 65-93.

Robin, Libby. “Battling the Land and Global Anxiety: Science, Environment and Identity in Settler Australia.” *Philosophy, Activism, Nature* 7 (2010): 3-9.

Robin, Libby. “Paradox on the Queensland Frontier.” *Australian Humanities Review* vol. n/a. (2000). http://www.australianhumanitiesreview.org/archive/Issue-September-2000/robin1.html.

Robin, Libby. “Being First: Why the Americans Needed it, and Why Royal National Park Didn’t Stand in Their Way.” *Australian Zoologist* 36, no. 3 (2013): 321-331.

Robin, Libby. “Counting our Blessings.” Unpublished presentation at Landscape, Environment, Emotion Conference, Pori, Finland 25 September 2013.

Robin, Libby. *Defending the Little Desert: The Rise of Ecological Consciousness in Australia*. Melbourne: Melbourne University Press, 1998.

Robin, Libby. “Destroying Vermin and Noxious Weeds: Ugliness, Pollution, Tidiness and Other Sensibilities.” Controlling Aliens? Workshop, 1 November 2012, Stockholm.

Robin, Libby. “Domestication in a Post-Industrial World.” Unpublished paper presented at UCLA 24 February 2015. Sawyer Seminar on the Environmental Humanities.

Robin, Libby. “Emu: National Symbols and Ecological Limits.” In *Boom and Bust: Bird Stories for a Dry Country,* edited by Libby Robin, Robert Heinsohn and Leo Joseph, 242-265. Melbourne: CSIRO Publishing, 2009.

Robin, Libby. *The Flight of the Emu: A Hundred Years of Australian Ornithology 1901-2001*. Carlton South: Melbourne University Press, 2001.

Robin, Libby. *How a Continent Created a Nation*. Sydney: UNSW Press, 2007.

Robin, Libby. “Resilience in the Anthropocene: A Biography.” In *Rethinking Invasion Ecologies from the Environmental Humanities*, edited by Jodi Frawley and Iain McCalman, 45-63. Abingdon, UK and New York, USA: Routledge, 2014.

Robin, Libby. “The Rise of the Idea of Biodiversity: Crises, Responses and Expertise.” *Quaderni* 76 (autumn 2011): 25-37.

Robin, Libby, Dag Avango, Luke Keogh, Nina Möllers, Bernd Scherer and Helmuth Trischler. “Three Galleries of the Anthropocene.” *Anthropocene Review* 1, no. 3 (2014): 207-224. doi:10.1177/2053019614550533.

Robin, Libby and Jane Curruthers. “National Identity and International Science: The Case of *Acacia*.” *Historical Records of Australian Science* 23 (2012): 34-54.

Robin, Libby and Mike Smith. “Introduction: Boom and Bust.” In *Boom and Bust: Bird Stories for a Dry Country*, edited by Libby Robin, Robert Heinsohn and Leo Joseph, 1-5. Melbourne: CSIRO Publishing, 2009.

Rolfe, Robert T. and Frederick W. Rolfe. *The Romance of The Fungus World: An Account of Fungus Life In Its Numerous Guises, Both Real And Legendary*. London: Chapman and Hall Limited, 1925.

Rolls, Eric. *A Million Wild Acres: 200 Years of Man and an Australian Forest*. Sydney: Hale and Iremonger, 2011.

Rolston III, Holmes. “Aesthetic Experience in Forests.” *Journal of Aesthetics and Art Criticism* 56, no. 2 (1998): 157-166.

Ronel, Avitall. “Walking as a Philosophical Act.” Last modified 26 December 2014. https://www.youtube.com/watch?v=6lJQNe0c2rI&feature=youtube_gdata.

Rose, Deborah Bird. “Indigenous and Western Understandings of Nature.” ACU National. Accessed 12 October 2015, https://www.youtube.com/watch?v=qp3Ktlfy0Hw.

Rose, Deborah Bird. “Rainbirds: Organising the Country.” In *Boom and Bust: Bird Stories for a Dry Country*, edited by Libby Robin, Robert Heinsohn, Leo Joseph, 185-204. Melbourne: CSIRO Publishing, 2009.

Roth, Henry L. *The Aborigines of Tasmania*. Halifax, England: F. King and Sons, 1899.

Royal Botanic Gardens Victoria. “VicFlora: Flora of Victoria.” Accessed 13 March 2016. http://data.rbg.vic.gov.au/vicflora/flora/about.

Ryan, Frank. *Darwin’s Blind Spot: Evolution Beyond Natural Selection*. New York: Houghton Mifflin, 2002.

Ryan, John. “Towards Intimate Relations: Gesture and Contact Between Plants and People.” *Philosophy, Activism, Nature* 9 (2012): 29-36.

Ryan, John. “Which to Become? Encountering Fungi in Australian Poetry.” *Rupkatha Journal on Interdisciplinary Studies in Humanities* 4, no. 2 (2012).

Ryan, Lyndall. *The Aboriginal Tasmanians*. St Leonards: Allen and Unwin, 1996.

Salgado-Salazar, Catalina, Amy Rossman and Priscila Chaverri. "Not as Ubiquitous as We Thought: Taxonomic Crypsis, Hidden Diversity and Cryptic Speciation in the Cosmopolitan Fungus *Thelonectria discophora* (Nectriaceae, Hypocreales, Ascomycota)." *PLoS One* 8, no. 10. doi: 10.1371/journal.pone.0076737.

Santaoja, Minna. "Nature, Disenchanted?" Unpublished paper presented at NIES Seminar, Pori, Finland, 25-27 September 2013.

Sapp, Jann. *Evolution by Association: A History of Symbioses*. New York: Oxford University Press, 1994.

Sapp, Jann. "The Dynamics of Symbiosis: An Historical Overview." *Canadian Journal of Botany* 82 (2004): 1046-1056.

Schaechter, Elio. *In the Company of Mushrooms: A Biologist's Tale*. Harvard, Harvard University Press: 1998.

Scherr, Sara and Jeffrey A. McNeely. "Biodiversity Conservation and Agricultural Sustainability: Towards a New Paradigm of 'Ecoagriculture' Landscapes." *Philosophical Transactions B* 363 (2008): 477-494.

Schwägerl, Christian. "Neurogeology: The Anthropocene's Inspirational Power." In *Anthropocene: Envisioning the Future of the Age of Humans*, edited by Helmuth Trischler, 29-37. Munich: Rachel Carson Center for Environment and Society, 2013.

Schwägerl, Christian. *The Anthropocene: The Human Era and How it Shapes Our Planet*. London: Synergetic Press, 2014.

Sellbach, Undine. "Sex, Flies and Fairytales." The Philosopher's Zone. http://www.abc.net.au/radionational/programs/philosopherszone/sex2c-flies2c-and-fairytales/5519320.

Senn-Irlet, Beatrice. "From Red Lists to Conservation Actions: How to Deal with 3700 Endangered Species in Switzerland." Unpublished paper presented at the Third International Congress on Fungal Conservation, 11-15 November 2014, Turkey.

Seppelt, Rod. "Lichens of Macquarie Island." *Tasmanian Naturalist* (July 1984): 15-16.

Shannon Park and D'Entrecasteaux National Park Management Plan. Acccessed 19 December 2014. http://www.dpaw.wa.gov.au/images/documents/parks/management-plans/decarchive/shannon_and_dentrecasteaux_national_parks_management_plan_71

Sharp, Cathy. "Status of Fungal Conservation in Zimbabwe." *Fungal Conservation* 3 (2013).

Šiffalovičová, Martina. “Karpatendeutsche Phraseologie.” PhD thesis, Universität Bielefeld, 2008. http://d-nb.info/995662983/34.

Sitta, Nicola and Marco Floriani. “Nationalization and Globalization Trends in the Wild Mushroom Commerce of Italy with Emphasis on Porcini (*Boletus edulis* and Allied Species).” *Economic Botany* 62, no. 3 (2008): 307-322.

Smith, Alexander and Daniel E. Stuntz. “New or Noteworthy Fungi from Mt Rainer National Park.” *Mycologia* 42 (1950): 80-134.

Smith, Mick. *Against Ecological Sovereignty.* Minneapolis: University of Minnesota Press, 2011.

Smith, Mick. “Dis(appearance): Earth, Ethics and Apparently (In)Significant Others.” *Australian Humanities Review* 50 (2011): 23-44.

Smith, Mick. “Ecological Community, The Sense of the World, and Senseless Extinction.” *Environmental Humanities* 2 (2013): 21-41.

Solnit, Rebecca. *Wanderlust: A History of Walking*. London: Verso, 2002.

Somerville, Margaret. “Postmodern Emergence.” *International Journal of Qualitative Studies in Education* 20, no. 2 (March-April 2007): 225-243.

Somerville, Margaret. “ ‘Waiting in the Chaotic Place of Unknowing’ ”. Articulating Postmodern Emergence.” *International Journal of Qualitative Studies in Education* 21, no. 3 (May-June 2008): 209-220.

Somerville, Margaret. *Water in a Dry Land: Place-Learning Through Art and Story*. New York: Routledge, 2013.

Somerville, Margaret. *Wildflowering: The Life and Places of Kathleen McArthur*. Queensland: University of Queensland Press, 2004.

Sörlin, Sverker. “Reconfiguring Environmental Expertise.” *Environmental Science and Policy* 28 (2013): 14-24.

Soulé, Michael. “What is Conservation Biology?” *Bioscience* 35 (1985): 727-734.

Stamets, Paul. *Mycelium Running: How Mushrooms Can Help Save the World*. USA: Ten Speed Press, 2005.

Stamets, Paul. *Psilocybin Mushrooms of the World*: *An Identification Guide.* Berkeley: Ten Speed Press, 1996.

Staples, Joan. “Val Plumwood, Philosophy and the Natural World.” The Philosopher’s Zone. Accessed 31 March 2013. http://www.abc.net.au/radionational/programs/philosopherszone/philosophy-and-the-natural-world---val-plumwood/3291526#transcript.

Stephenson, Steven. *The Kingdom Fungi: The Biology of Mushrooms, Moulds and Lichens*. London: Timber Press, 2010.

Stevenson, Greta. "The Agaricales of New Zealand: II." *Kew Bulletin* 16, no. 1 (1962): 65-74.

Stirling Ranges and Porongurup National Parks Management Plan. Acccessed 19 December 2014. https://www.dpaw.wa.gov.au/images/documents/parks/management-plans/decarchive/stirling-porongorup_nps.pdf.

Strid, Åke. "Elias Fries: About the Man and His Life." *Acta Universitatis Upsaliensis Symbolae Botanicae Upsalienses* 3 (1995): 39-57.

Sullivan, Heather. "Dirt Theory and Material Ecocriticism." *Interdisciplinary Studies in Literature and the Environment*. 19, no. 3 (2012): 515-531.

Suzuki, David and Wayne Grady. *Tree: A Life Story*. Canada: Greystone Books, 2004.

Takacs, David. *The Idea of Biodiversity: Philosophies of Paradise*. Baltimore and London: The John Hopkins University Press, 1996.

Taylor, Thomas, Sharon Klavins, Michael Krings, Edith Taylor, Hans Kerp and Hagen Hass. "Fungi from the Rhynie Chert: A View from the Dark Side." *Transactions of the Royal Society of Edinburgh: Earth Sciences* 94, no. 4 (2003): 457-473.

Tisdall, Henry. "Fungi of North Gippsland." *Victorian Naturalist*, 2, no. 9 (January 1886): 109.

Toporov, Vladimir. (translated by Stephen Rudy) "On the Semiotics of Mythological Conceptions About Mushrooms." *Semiotica* 53, no. 4 (1985): 295-357.

Trappe, James. "A.B. Frank and Mycorrhizae: The Challenge to Evolutionary and Ecologic Theory." *Mycorrhiza* 15 (2005): 277-281.

Trappe, James. "Why Earth Needs Truffles." Unpublished presentation given at the Linnean Society, London 17 October 2013.

Trappe, James, Andrew Claridge, Deborah Claridge and Lynette Liddle. "Desert Truffles of the Australian Outback: Ecology, Ethnomycology, and Taxonomy." *Economic Botany* 62 (2008): 497-506.

Tredinnick, Mark. "Belonging to Here: An Introduction." In *A Place on Earth: An Anthology of Nature Writing from Australia and North America*, edited by Mark Tredinnick, 1-47. Sydney: University of New South Wales Press, 2003.

Tredinnick, Mark. *Writing Well: The Essential Guide*. Cambridge University Press: Cambridge, 2008.

Trim, Geoffrey, Heino Lepp, Matthew J. Hall, Robin V. McKeown, Geoffrey W. McCaughan, Geoffrey G. Duggin and David G. Le Couteur. "Poisoning by *Amanita phalloides* ("deathcap") Mushrooms in the Australian Capital Territory." *Medical Journal of Australia* 171, no. 5 (1999): 247-249.

Tsing, Anna. "Arts of Inclusion, or, How to Love a Mushroom." *Australian Humanities Review* 50 (2011): 5-21.

Tsing, Anna. "Dancing the Mushroom Forest." *Philosophy, Activism, Nature* 10 (2013).

Tsing, Anna. "Unruly Edges: Mushrooms as Companion Species." *Environmental Humanities* 1 (2012): 141-54.

Tyrrell, Ian. *True Gardens of the Gods: Californian-Australian Environmental Reform, 1860–1930*. London: University of California Press, 1999.

Väliverronen, Esa. "Biodiversity and the Power of Metaphor in Environmental Discourse." *Science Studies* 11, no. 1 (1998): 19-34.

Vanclay, Frank. "Place Matters." In *Making Sense of Place: Exploring Concepts and Expressions of Place through Different Senses and Lenses*, 3-11, edited by Frank Vanclay, Matthew Higgins, and Adam Blackshaw. Canberra: National Museum of Australia Press, 2008.

Vellinga, Else V., Benjamin E. Wolfe and Anne Pringle. "Global Patterns of Ectomycorrhizal Introductions." *New Phytologist* 181 (2009): 960-973.

Viess, Debbie. "Acute Toxicty of Phalloidins: Amatoxin's Silent Partner." New York Mycological Society. Accessed 29 September 2015. http://newyorkmyc.org/acute-toxicity-of-phalloidins/.

Volk, Tom. "Tom Volk's Fungus of the Month." Accessed 10 July 2015. http://botit.botany.wisc.edu/toms_fungi/feb2000.html.

von Bingen, Hildegard. Translated by Bruce W. Hozeski. *Hildegard's Healing Plants: From Her Medieval Classic Physica*. Boston: Beacon Press, 2002.

von Mueller, Ferdinand. "Notes on Victorian Fungs." *The Victorian Naturalist* 2 (May 1885 to April 1886): 76-80.

von Uexküll, Jakob. "An Introduction to Umwelt." *Semiotica* 124-1/4 (2001): 107-110.

Wagner, Eric. "Whale Watch." *Orion* (July-August 2015): 21-27.

Wakild, Emily. "The Challenge of Scale in Environmental History: A Small Meditation on a Large Matter." In *Crossing Mountains: The Challenges of Doing Environmental History*, edited by Marcus Hall and Patrick Kupper, 19-29. Munich: Rachel Carson Centre Perspectives, 2014.

Wasson, Gordon. *Soma: Divine Mushroom of Immortality*. New York: Harcourt Brace Jovanovich, 1968.

Weir, Jessica. "Connectivity." *Australian Humanities Review* 45 (2008): 153-164.

Whatmore, Sarah. *Hybrid Geographies: Natures, Cultures, Spaces*. London: Sage Publications, 2002.

Whittaker, Robert. "New Concepts of Kingdoms and Organisms." *Science* 163 (1969): 150-160.

Williams, Linda. "Affective Poetics and Public Access: The Critical Challenges of Environmental Art." *Australian Journal of Ecocriticism and Cultural Ecology* 3 (2013-2014): 16-30.

Williams, Tim. *A Dictionary of the Roots and Combining Forms of Scientific Words*. England: Squirrox Press, 2005.

Willis, Arthur John. "The Ecosystem: An Evolving Concept Viewed Historically." *Functional Ecology* 11, no. 2 (1997): 268-271. doi:10.1111/j.1365-2435.1997.00081.

Willis, James H. "The Agaricaceae or 'Gilled Fungi': Some Species Common in Victoria." *The Victorian Naturalist*, L, no. 12 (5 April 1934): 264-305.

Winston, Black. "Forget Folk Remedies, Medieval Europe Spawned a Golden Age of Medical Theory." *Conversation*. Accessed 16 June 2015. http://theconversation.com/forget-folk-remedies-medieval-europe-spawned-a-golden-age-of-medical-theory-21202.

Wladyslaw, Wojewoda and Dariusz Karasinski. "Invasive Macrofungi (Ascomycota and Basidiomycota) in Poland." *Biological Invasions in Poland* 1 (2010): 7-21.

Wood, David. "Philosopher's Zone." ABC Radio National. Accessed 7 January 2016. http://mpegmedia.abc.net.au/rn/podcast/2015/04/pze_20150426.mp3.

Woodward, Marcus. *Leaves from Gerard's Herball: Arranged for Garden Lovers*. New York, Dover Publications Inc., 1969.

Worster, Donald. *The Wealth of Nature: Environmental History and the Ecological Imagination*. Oxford: Oxford University Press, 1993.

Wright, John. *The Naming of the Shrew: A Curious History of Latin Names*. London: Bloomsbury, 2014.

Wright, Judith. *Because I was Invited*. Melbourne: Oxford University Press, 1975.

Wright, Judith. "The Upside-Down Hut." In *The Writer in Australia: A Collection of Literary Documents, 1865-1965*, edited by John. Barnes. Melbourne: Oxford University Press, 1969.

Wynne, Brian. "May the Sheep Safely Graze? A Reflexive View of the Expert-Lay Knowledge Divide." In *Risk, Environment and Modernity: Towards a New Ecology*, edited by Scott Lash, Bronislaw Szerszynski and Brian Wynne, 44-83 London: Sage, 1996.

Yamin-Pasternak, Sveta. "A Means of Survival, A Marker of Feasts: Mushrooms in the Russian Far East." *Ethnology* 47, no. 2 (Spring 2008): 95-107.

Yamin-Pasternak, Sveta. "Ethnomycology: Fungi and Mushrooms in Cultural Entanglements." In *Ethnobiology,* edited by Eugene Anderson, Deborah Pearsal, Nicola Hunn and Nancy Turner, 213-29. United Kingdom: Wiley, 2011.

Yamin-Pasternak, Sveta. "From Disgust to Desire: Changing Attitudes Toward Beringian Mushrooms." *Economic Botany*, 62, no. 3 (2008): 214-222.

Yamin-Pasternak, Sveta. "How The Devils Went Deaf: Ethnomycology, Cuisine and Perception of Landscape in the Russian North." PhD thesis, University of Alaska Fairbanks, 2007.

Yoon, Carol Kaesuk. *Naming Nature: The Clash Between Instinct and Science*. New York: W.W. Norton and Company Inc., 2009.

Young, Anthony M. *A Field Guide to Fungi of Australia.* Sydney: UNSW Press, 2005.

Appendices

Appendix 1
Fungus names used in this thesis

All species mentioned in this thesis are included in this appendix. It includes both scientific names and where they exist, Australian vernacular names. Vernacular names referred to in British and American English and other languages are also included with the following language codes: UK = British English; USA = American English; AAL = Australian Aboriginal languages; DE = German; CH-DE = Swiss German; F = French; I = Italian; SE = Swedish; R = Russian.

Scientific Name	**Australian Vernacular Name**	**Other vernacular names used in this thesis**
Agaricus arvensis	Horse Mushroom	
Agaricus bisporus	Button Mushroom	Champignon (F)
Agaricus campestris	Field Mushroom	
Agaricus xanthodermus	Yellow Stainer	
Amanita muscaria	Fly Agaric	Fliegenpilz (DE)
Amanita phalloides	Death Cap	Grüner Knollenblätterpilz (DE)
Armillaria bulbosa		
Armillaria luteobubalina	Australian Honey Mushroom	
Armillaria mellea	Honey Mushroom	Hallimasch (DE)
Aseroë rubra	Anemone Stinkhorn	
Auricularia spp.		
Auricularia auricula-judae	Wood Ear	
Auriscalpium barbatum		
Auriscalpium sp. 'Blackwood'		
Auriscalpium vulgare	Earpick Fungus	
Batrachochytrium dendrobatidis	Chytrid Fungus	
Battarrea spp.		
Boletellus obscurecoccineus	Rhubarb Bolete	
Boletopsis grisea		Tallgråticka (SE)
Boletus edulis		Steinpilz (DE); Porcino (I)
Boletus satanus		Satan's Bolete (USA)
Caloplaca spp.		
Calostoma spp.	Stalked Puffball	
Cantharellus cibarius	Chanterelle	Eierschwämmli (CH-DE)
Cantharellus tubaeformis	Chanterelle	Kantarelle (SE)
Chalciporus piperatus	Peppery Bolete	
Cheilymenia stercorea		
Chlorociboria aeruginascens	Green Elf Cup	
Cladia retipora		
Cladonia coccifera		Red Pixie Cup (UK)
Cladonia rangiferina		Reindeer Lichen (UK)
Clathrus ruber	Red Cage	
Clitocybe geotropa		Trooping Funnel (UK)
Clitocybe nebularis		Giant Cloud Funnel (UK)
Coprinus cinerus		Gray Shag (USA)
Coprinus comatus	Lawyer's Wig Ink Cap	Fjällig bläcksvamp (SE)
Coprinellus disseminatus		Fairy Bonnets (UK)
Cordyceps gunnii	Vegetable Caterpillar	
Cortinarius austrovenetus	Green Skinhead	
Cortinarius rotundisporus	Elegant Blue Webcap	
Craterellus cornucopioides	Black Chanterelle	Trompette de la Mort (F)
Cruentamycena viscidocruenta	Ruby Bonnet	
Cryphonectria parasitica		Chestnut Blight (USA)
Cryptococcus spp.		
Cyttaria darwinii		

Daedaleopsis confragosa		Blushing Bracket (UK)
Daedalea quercina		Oak Mazegill (UK)
Cyttaria gunni	Beech Orange	
Descolea		
Elderia arenivaga		
Exidia glandulosa		Witches' Butter (UK)
Favolaschia calocera	Little Ping Pong Bat	
Favolus pusillus var. *palidus*		
Fistulina hepatica	Beefsteak Fungus	
Flavoparmelia		
Fomitopsis pinicola	Red-Belt Conk	
Fungus erinaceus		
Ganoderma spp.		
Geastrum floriforme	Daisy Earthstar	
Geastrum fornicatum	Arched Earthstar	
Geastrum triplex	Collared Earthstar	
Gomphus clavatus	Pig's Ear	
Gymnopilus junonius	Spectacular Rust Gill	
Hebeloma aminophilum	Ghoul Fungus	
Hebeloma crustuliniforme	Fairy Cakes/Poison Pie	
Helvella macropus	Felt Saddle	Graue Langfuss Lorchel (DE)
Hericium coralloides	Coral Tooth	
Hydnum repandum	Wood Hedgehog	Semmelstoppelpilz (DE) Pied de mouton (F)
Hygrocybe spp.	Wax Cap	
Hygrophorus spp.		
Hymenogaster spp.		
Hymenoscyphus epiphyllus		
Hypholoma fasciculare	Sulphur Tuft	
Hypocreopsis amplectens	Tea Tree Fingers	
Kuehneromyces mutabilis		Sheathed Woodtuft (UK)
Laccaria amethystina		Amethyst Deceiver (UK)
Hypoxylon multiforme		BirchWoodwart (USA)
Laccocephalum mylittae	Native Bread	
Lacrymaria spp.		
Lactarius deliciosus	Saffron Milk Cap	Sanguinaroi (I); Ryzhik (R)
Lactarius quietus		Oak Milk Cap (UK)
Laetiporus portentosus	White Punk	
Laetiporus sulphureus	Sulphur Polypore	
Lanzia echinophila		
Leccinum scabrum	Birch Bolete	
Lentinula edodes		
Lentinus fasciatus		
Lepista nuda	Blewitt	
Lycoperdon perlatum	Common Puffball	
Macrolepiota clelandii	Parasol Mushroom	
Marasmiellus		
Marasmius elegans	Velvet Parachute	
Marasmiellus affixus	Little Stinker	
Marasmius crinisequi	Horsehair Fungus	
Morchella conica	Morel	
Morchella	Morel	
Mucronella pendula	Icicle Fungus	
Mycena capillaripes		Pinkedge Bonnet (UK)
Mycena clarkeana		
Mycena crocata		Saffrondrop Bonnet (UK)
Mycena epipterygia	Yellow-stemmed Mycena	
Mycena interrupta	Pixies' Parasol	
Mycena subgalericulata		
Mycena viscidocruenta	Ruby Bonnet	

Mycoacia subceracea	Golden Splash Tooth	
Mycoclelandia bulundari		
Neobulgaria pura		Beech Jellydisc (UK)
Nephroma australe	Kidney Lichen	
Ochrolechia parella		Crab's Eye Lichen (UK)
Omphalotus nidiformis	Ghost Fungus	Mettagong, Chinga (AAL)
Ophiocordyceps sinensis		
Ophiostoma spp.	Dutch Elm Disease	
Oudemansiella mucida		Porcelain Fungus (UK)
Oudemansiella radicata	Rooting Shank	
Parasola plicatilis		Pleated Inkcap (UK)
Paxillus atrotomentosus		
Paxillus involutus	Roll Rim	
Phallus impudicus		Common Stinkhorn (UK)
Phellodon niger	Black Tooth	
Phellorinia herculeana		
Phlebopus marginatus	Giant Bolete	
Phytophthora cinnamomi	Dieback	
Pisolithus tinctorius	Horse Dropping Fungus	
Pleurotus ostreatus	Oyster Mushroom	
Pneumocystis carini		
Podaxis pistillaris	Desert Black Head	
Podoserpula pusio	Pagoda Fungus	
Poronia erici	Dung Button	
Pseudohydnum gelatinosum	Toothed Jelly Tongue	
Psilocybe subaeruginosa		
Puccinia psidii		
Pycnoporus coccineus	Scarlet Bracket Fungus	
Rhizocarpon geographicum		Map Lichen (UK)
Ramaria capitata var. capitata		
Russula cyanoxantha		The Charcoal Burner (UK)
Sarcodon squamosus		Motaggsvamp (SE)
Sarcoscypha austriaca		Scarlet Elfcup (UK)
Scutellinia scutellata	Eyelash Pixie Cup	
Schizophyllum commune	Split Gill	
Serpula lacrimans	Dry Rot Fungus	
Sporormiella		
Stereum hirsutum	Hairy Curtain Crust	
Stereum ostrea	Golden Curtain Crust	
Strobilomyces strobilaceus	Old Man Of The Woods	Gemeiner Strubbelkopfröhrling (DE)
Stropharia aeruginosa		Verdigris Roundhead (UK)
Suillus granulatus	Slippery Jack	
Suillus luteus	Slippery Jack	
Thelephora palmata		Earthfan (UK)
Trametes versicolor	Rainbow Fungus	
Tremella fuciformis	White Jelly	
Tricholoma colossus		Jättemusseron (SE)
Tricholoma sulphureum		Sulphur Knight (UK)
Tricholoma matsutake	Matsutake	
Tricholoma terreum	Grey Ghost	
Tuber aestivum		Summer Truffle (UK)
Tuber magnatum		White Truffle (UK)
Tuber melanosporum	Perigord Truffle	
Tuber uncinatum		Burgundy Truffle (UK)
Usnea longissima		Old Man's Beard (UK)
Volvariella volvacea	Paddy Straw Mushroom	
Xanthoparmelia		
Xanthoria elegans		
Xylaria hypoxylon	Candle Snuff Fungus	

Appendix 2
Summary of National Park Management Plan data

Forty National Park Management Plans (NPMP) were examined from 28 countries, representing Europe, the Caribbean, Asia, Oceania and the Americas. Selection was based on their availability on the internet and also of translators for those not written in English or German.

Ten countries have Red Lists and some others have provisional lists (e.g. UK) or other types of protective lists (e.g. USA).

Of the 10 countries that had Red Lists, 100% made reference to fungi in their NPMPs. Of the 18 countries that did not have Red Lists, four (Ireland, USA, NZ, Jamaica) made reference to fungi in their NPMPs.

National Park Management Plan (NPMP)	Country	Fungi in NPMP	Country has Red List	URL
Northumberland NPMP	England	No	No	http://www.northumberlandnationalpark.org.uk/lookingafter/ npmanagementplan
Yorkshire Dales NPMP	England	No	No	http://www.yorkshiredalesmanagementplan.org.uk/
Wiklow Mountains NPMP	Ireland	Yes	No	http://www.wicklowmountainsnationalpark.ie/documents/ WMNPManagementPlan_000.pdf
Loch Lomond and the Trossacs NP Partnership Plan Strategic Environmental Assessment	Scotland	No	No	http://www.lochlomond-trossachs.org/nationalparkplan/
Denali National Park and Preserve. Final Backcountry MP	Alaska	No	No	http://www.nps.gov/dena/parkmgmt/upload/Denali%20 Backcountry%20Management%20Plan.pdf
Foundation Document Bryce Canyon National Park	USA	Yes	No	http://www.nps.gov/brca/parkmgmt/planning.htm
Grand Canyon National Park Foundation Statement	USA	Yes	No	http://www.nps.gov/grca/parkmgmt/gmp.htm
Great Otway NP & Otway Forest Park MP	Australia	No	No	http://parkweb.vic.gov.au/__data/assets/pdf_file/0019/ 313282/great-otway-np-mp.pdf
Whanganui NPMP	NZ	Yes	No	http://www.doc.govt.nz/about-doc/policies-and-plans /national-park-management/whanganui-national-park-management-plan/
Fiordland NPMP	NZ	Yes	No	http://www.doc.govt.nz/about-doc/policies-and-plans/ national-park-management/fiordland-national-park-management-plan/
Banff NPMP	Canada	No	No	http://www.pc.gc.ca/eng/pn-np/ab/banff/plan/gestion-management.aspx
Jasper NPMP	Canada	No	No	http://www.pc.gc.ca/eng/pn-np/ab/jasper/plan.aspx
Kruger NPMP	South Africa	No	No	http://www.sanparks.org/assets/docs/conservation/park_ man/knp-management-plan1.pdf
Karoo NPMP	South Africa	No	No	http://www.sanparks.org/assets/docs/conservation/park_ man/karoo_approved_plan.pdf
Nationalparkverwal-tung Bayerisher Wald	Germany	Yes	Yes	http://ec.europa.eu/environment/life/project/Projects/index .cfm? fuseaction=home.showFile&rep=file&fil=NLP_Plan-Entwurf95NATD000070.
Nationalparkplan für den Nationalpark Hainich	Germany	Yes	Yes	http://ec.europa.eu/environment/life/project/Projects/index .cfm? fuseaction=home.showFile&rep=file&fil=NLP_Plan-Entwurf95NATD000070.
Müritz Natipnalparkplan Leitbild und Ziele und Bestandanalyse	Germany	Yes	Yes	http://www.mueritz-nationalpark.de/cms2/MNP_prod/MNP /de/Service/Veroeffentlichungen/Nationalparkplan/_ Dokumente/Nationalparkplan_Band_2.pdf
Management Plan of Kemeri National Park	Germany	Yes	Yes	http://ec.europa.eu/ourcoast/download.cfm?fileID=911

Plitvice Lakes NPMP	Croatia	Yes	Yes	http://www.np-plitvicka-jezera.hr/en/park-management/management-plan/
Westside National Park Andros Island Draft MP	Bahamas	No	No	http://www.bnt.bs/UserFiles/HTMLEditor/Westside%20Management%20Plan_Draft%20Plan__August%202012-1.pdf
Pirin NPMP	Bulgaria	Yes	Yes	http://www.donauauen.at/dateien/2216_Managementplan_download_1.12.09.pdf
Management Plan Nationalpark Donau-Auen	Austria	No	No	http://www.donauauen.at/dateien/2216_Managementplan_download_ 1.12.09.pdf
Blue and John Crow Mountains NPMP	Jamaica	Yes	No	http://www.conservation-development.net/Projekte/Nachhaltigkeit/DVD_12_WHS/Material/files/WCMC_Nanda_Devi_Valley_of_Flowers.pdf
Nanda Devi & Valley Of Flowers NPMP	India	No	No	http://www.conservation-development.net/Projekte/Nachhaltigkeit/DVD_12_WHS/Material/files/WCMC_Nanda_Devi_Valley_of_Flowers.pdf
Management Plan of Balpakram National Park and the Buffer Areas of Elephant Reserve in South Garo Hills District	India	No	No	not available online
Plan of Management for National Park Pripyatski Volume 1 and 2	Belarus	Yes	Yes	http://www.npp.by/upload/Plan%20ypravlenij%201.pdf
Regulations of Federal State Organization "National Park "Ugra"	Russia	Yes	Yes	http://base.consultant.ru/cons/cgi/online.cgi?req=doc;base=EXP;n=460701
Regulations on the Federal State Organization National Park Buzuluksky Bor	Russia	Yes	Yes	http://buzulukskiybor.ru/assets/files/Goovij-pererabotpnnij-Office-Word.pdf
Plan of Development Paanajarvi National Park	Russia	Yes	Yes	http://parks.karelia.ru/rus/img/paan.pdf
Management Plan for National Park Djerdap	Serbia	Yes	Yes	http://www.npdjerdap.org/publikacije/dokumenta_2014/pu_2014.pdf
Management Plan for National Park Fruska Gora	Serbia	Yes	Yes	http://www.npfruskagora.co.rs/images/stories/1/1/program2014.pdf
Management Plan for National Park Kopaonik	Serbia	Yes	Yes	http://www.npkopaonik.com/index.php?option=com_phocadownload&view=category&id=3:programi&Itemid=205
Parco Nazionale delle Foreste Casentinesi, Monte Falterona, Campigna	Italy	Yes	Yes	not available online
Management Plan of Karula Nationl Park 2008-2018	Estonia	Yes	Yes	not available online
Thingvellir National Park Managment Plan 2004-2024	Iceland	No	No	http://www.thingvellir.is/media/14035/Manplan_web200406011330.pdf
Codrington Lagoon NPMP 2009-2019	Antigua and Barbuda	No	No	http://gefantigua.org/wp-content/uploads/2010/11/Final-CLNP-Mgt-Plan1.pdf
Management Plan for Lawachara National Park	Bangla-desh	Yes	No	http://www.nishorgo.org/tbltd/upload/pdf/0.67932800%201354826677_ 4.1_Management%20plans%20for%20Lawachara%20National%20Park.pdf
Management Plan Simen Mountains National Park and Surrounding Rural Area	Ethiopia	No	No	http://www.cde.unibe.ch/v1/CDE/pdf/Hurni%201986%20Management %20plan%20Simen%20Mountains%20National%20Park%20and%20 surrounding%20rural%20area.pdf
Bieszczady NP Management Plan	Poland	Yes	Yes	http://www.krameko.com.pl/bdpn/BdPN/PLAN_OCHRONY_ BDPN/BdPN_PROJEKT_ROZPORZADZENIA_Tresc.pdf

Appendix 3
Recent interdisciplinary books about fungi

Gary Fine, Greg Marley, Langdon Cook, Antonio Carluccio and Eugenia Bone target general audiences in exploring the pursuit of edible fungi. Mycologist, Ian Hall and colleagues have produced various books on edible and poisonous mushrooms as well as guides to cultivation. Mycologist, Nicholas Money, traces the history of mycology and the effects of both microfungi and macrofungi on human lives. The use of psychedelic fungi has been explored in recent decades by Paul Stamets and Andy Letcher, following on from Gordon Wasson's 1960s publications. Mycologist Geoffrey Ainsworth produced a history of mycology while natural historian, Peter Marren wrote a more generic history of fungi focussed on Great Britain. Anthropologist Anna Louwenhaupt Tsing brings a fungus (*Tricholoma matsutake*) and humans together in contexts of place, memory and multi-generational human-fungus interactions.

Ainsworth, Geoffrey. *Introduction to the History of Mycology*. Cambridge: Cambridge University Press, 1976.

Bone, Eugenia. *Mycophilia: Revelations from the Weird World of Mushrooms*. New York: Rodale, 2011.

Carluccio, Antonio. *Complete Mushroom Book: The Quiet Hunt*. London: Quadrille Publishing, 2003.

Cook, Langdon. *The Mushroom Hunters: On the Trail of an Underground America*. New York: Ballantine, 2013.

Fine, Gary Alan. *Morel Tales: The Culture of Mushrooming*. USA: Harvard University Press, 1998.

Hall, Ian and Gordon Brown. *Taming the Truffle: The History, Lore, and Science of the Ultimate Mushroom*. Portland, OR: Timber Press Inc., 2007.

Hall, Ian, Steven Stephenson, Peter Buchanan, Wang Yun and Anthony Cole. *Edible and Poisonous Mushrooms of the World*. Cambridge, UK: Timber Press Inc., 2003.

Letcher, Andy. *Shroom: A Cultural History of the Magic Mushroom.* Great Britain: Faber and Faber Limited, 2006.

Lowenhaupt Tsing, Anna. *The Mushroom at the End of the World: On the Possibility of Life in Capitalist Ruins*. Princeton: Princeton University Press, 2015.

Marley, Greg. *Chanterelle Dreams, Amanita Nightmares.* Vermont: Chelsea Green Publishing, 2010.

Marren, Peter. *Mushrooms*. Dorset: British Wildlife Publishing, 2012.

Money, Nicholas. *Mr Bloomfield's Orchard: The Mysterious World of Mushrooms, Molds and Mycologists*. New York: Oxford University Press, 2012.

Money, Nicholas. *Mushroom*. New York: Oxford University Press, 2012.

Money, Nicholas. *The Triumph of the Fungi: A Rotten History*. USA: Oxford University Press, 2006.

Stamets, Paul. *Psilocybin Mushrooms of the World*: *An Identification Guide.* Berkeley: Ten Speed Press, 1996.

Appendix 4
Workshop, seminar, foray and conference presentation list

Much of the material in this thesis was drawn from these events: as anecdotal observations, informal conversations, semi-structured interviews, surveys, group discussions and later correspondence.

Date	Location	Country	Event	Title
5 April 2013	Mt Macedon, Vic	Australia	Foray	A Fungal Foray Among the Messmates and Mannas
6 April 2013	Woodend, Vic	Australia	Workshop	An Introduction to a Curious Kingdom
7 April 2013	Woodend, Vic	Australia	Workshop	A Deeper Exploration of a Curious Kingdom
16 April 2013	Lockwood, Vic	Australia	Seminar	Fungi and Old Trees
18 April 2013	Trentham, Vic	Australia	Seminar	Fungi of the Wombat Forest
20 April 2013	Trentham, Vic	Australia	Workshop	An Introduction to a Curious Kingdom
21 April 2013	Trentham, Vic	Australia	Workshop	A Deeper Exploration of a Curious Kingdom
27 April 2013	Creswick, Vic	Australia	Workshop	An Introduction to a Curious Kingdom
28 April 2013	Creswick, Vic	Australia	Workshop	A Deeper Exploration of a Curious Kingdom
1 May 2013	Swan Hill, Vic	Australia	Workshop	Meeting the Mallee's Mushrooms
2 May 2013	Glenlyon, Vic	Australia	Workshop	Mushroom Encounters: Fungus Workshop & Feast
3 May 2013	Glenlyon, Vic	Australia	Workshop	Mastering Mushrooms: Fungus ID Workshop
4 May 2013	Glenlyon, Vic	Australia	Workshop	A Sense For Mushrooms: Fungus ID Workshop
5 May 2013	Trentham, Vic	Australia	Foray	Foray Among The Funguses
10 May 2013	Creswick, Vic	Australia	Foray	A Foray in La Gerche's Forests
18 May 2013	Apollo Bay, Vic	Australia	Foray	Fungal Ecology and Identification Workshop
25 May 2013	Rawson, Vic	Australia	Workshop	A Sense for Fungi: Intro to the Kingdom Fungi
21 August 2013	Munich	Germany	Conference presentation	Mycosynergies: Nature's Forgotten Circulatory System
19 September 2013	Stockholm	Sweden	Seminar	Black Diamonds and Witches' Rings
23 September 2013	Hagaberg	Sweden	Seminar	Fungal Icons From Downunder
25 September 2013	Turku	Finland	Conference presentation	Touching the Dirt
2 November 2013	Magglingen	Switzerland	Foray	Forest Fungus Foray
3 November 2013	Vesancy	France	Foray	Family Fungus Foray
15 November 2013	Gövoka Bay	Turkey	Conference presentation	Myco-entanglement: Perceptions of Fungi in Biodiversity Conservation
27 February 2014	Sydney, NSW	Australia	Conference presentation	Encountering The Fungally-Entangled Anthropocene
8 April 2014	Lockwood, Vic	Australia	Seminar	The Secret Lives Of Eucalypts & Beneficial Fungi
12 April 2014	Woodend, Vic	Australia	Workshop	Fungi: An Introduction to a Curious Kingdom
15 April 2014	Woodstock, Vic	Australia	Seminar	Saviours of The Soil: Understanding The Role of Fungi in Terrestrial Ecosystems
16 April 2014	Mt Alexander, Vic	Australia	Workshop	Fungi: An Introduction to a Curious Kingdom
18 April 2014	Trentham, Vic	Australia	Workshop	Fungi: An Introduction to a Curious Kingdom
19 April 2014	Trentham, Vic	Australia	Workshop	The Bizarre & The Beautiful: A Deeper Exploration of a Curious Kingdom
24 April 2014	Brisbane, Qld	Australia	Conference Presentation	Mind The Gap: Exploring The Space Between Fungal Interest and Conservation
1 May 2014	Anglesea, Vic	Australia	Workshop	Fungi: An Introduction to a Curious Kingdom
3 May 2014	Apollo Bay, Vic	Australia	Workshop	Discovering The Fungi of the Southern Otways
7 May 2014	Leonards Hill, Vic	Australia	Foray	The Fungal Forest
8 May 2014	Dandenongs, Vic	Australia	Foray	A Forest Foray
10 May 2014	Creswick, Vic	Australia	Workshop	Black Diamonds & Witches' Rings: A Foray Into The Curious Kingdom Of Fungi
17 May 2014	Kergunyah, Vic	Australia	Workshop	Fungi: An Introduction to a Curious Kingdom
19 June 2014	Zurich	Switzerland	Conference presentation	Visualising Across Borders
20 June 2014	Zurich	Switzerland	Foray	Myco-Entanglement: The Terrestrial Fungal Matrix
9 July 2014	Guimarães	Portugal	Conference presentation	Fungal Conservation In Environmental History
13 September 2014	Magglingen	Switzerland	Foray	A Foray Among the Funguses
14 September	Versancy	France	Foray	Discovering The Fungi of the French Jura

2014				
18 October 2014	Mt Mussy	France	Foray	Fungus Foray at Mt Mussy
29 November 2014	Kew	England	Conference presentation	A Few Observations on Fungal Conservation Across Hemispheres
11 March 2015	Carlton, Victoria	Australia	Seminar	A Foray In The Fungal Realm
18 March 2015	Tumut, NSW	Australia	Workshop	Fungi: An Introduction to a Curious Kingdom
19 March 2015	Stanley, Vic	Australia	Workshop	Fungi: An Introduction to a Curious Kingdom
22 March 2015	Tumbarumba, NSW	Australia	Workshop	Fungi: An Introduction to a Curious Kingdom
23 March 2015	Mullengandra, NSW	Australia	Workshop	The Bizarre and The Beautiful: A Deeper Exploration Of A Curious Kingdom
09 April 2015	Crowther, NSW	Australia	Workshop	Fungi: An Introduction to a Curious Kingdom
11 April 2015	Bowning, NSW	Australia	Workshop	Fungi: An Introduction to a Curious Kingdom
12 April 2015	Wagga Wagga, NSW	Australia	Workshop	Fungi: An Introduction to a Curious Kingdom
15 April 2015	Mt Alexander, Vic	Australia	Workshop	Fungi: An Introduction to a Curious Kingdom
18 April 2015	Apollo Bay, Vic	Australia	Foray	Discovering The Otways Fungi
24 April 2015	Trentham, Vic	Australia	Foray	The Fungal Forest: Foray in the Wombat Forest
24 April 2015	Trentham, Vic	Australia	Seminar	A Foray Into Fungal Underworlds
25 April 2015	Trentham, Vic	Australia	Workshop	Meeting With Mushrooms: Fungus ID Workshop
26 April 2015	Baringhup, Vic	Australia	Foray	Eddington Red Gum Forest Fungus Foray and Survey
28 April 2015	Maldon, Vic	Australia	Workshop	Fungi: An Introduction to a Curious Kingdom
29 April 2015	Shelbourne, Vic	Australia	Foray	Shelbourne Forest Fungus Foray
1 May 2015	Mt Macedon, Vic	Australia	Foray	The Fungal Forest: Fungus Foray at Mt Macedon
2 May 2015	Lancefield, Vic	Australia	Seminar	Fungal Friends and Fungal Fiends
3 May 2015	Creswick, Vic	Australia	Workshop	A Mushroom Encounter
4 May 2015	Eddington, Vic	Australia	Seminar	Fungi In The Landscape
5 May 2015	Collingwood, Vic	Australia	Seminar	Black Diamonds and Witches' Rings: A Fungal Foray
10 June 2015	Zurich	Switzerland	Conference presentation	Australian Fungal Conservation Review
19 September 2015	Lugano	Switzerland	Foray	A Foray in the Sensual
24 September 2015	Uppsala	Sweden	Seminar	Fungal Conservation Across Hemispheres
24 September 2015	Uppsala	Sweden	Seminar	Australian Fungal Conservation
8 April 2016	Corowa, Vic	Australia	Workshop	Photographing Fungi
9 April 2016	Howlong, Vic	Australia	Workshop	Photographing Fungi
14 April 2016	Anakie, Vic	Australia	Workshop	Fungi in Focus
16 April 2016	Apollo Bay, Vic	Australia	Workshop	Photographing Fungi
17 April 2016	Gellibrand, Vic	Australia	Foray	A Foray Among the Funguses
23 April 2016	Trentham, Vic	Australia	Foray	Fungus Foray in the Wombat Forest
24 April 2016	Lockwood, Vic	Australia	Workshop	Photographing Fungi
25 April 2016	Trentham, Vic	Australia	Foray	Fungus Foray in the Wombat Forest
28 April 2016	Woodend, Vic	Australia	Foray	A Foray Among the Funguses
30 April 2016	Baynton, Vic	Australia	Workshop	The Fungi: An Introduction to a Curious Kingdom
2 May 2016	Euroa, Vic,	Australia	Seminar	Fungal Responses to Drought
6 May 2016	Strathbogie, Vic,	Australia	Workshop	The Fungi: An Introduction to a Curious Kingdom
7 May 2016	Holbrook, NSW	Australia	Workshop	Fungi in Focus
9 May 2016	Albury, NSW	Australia	Workshop	The Fungi: An Introduction to a Curious Kingdom
11 May 2016	Albury, NSW	Australia	Foray	Fungus Survey
12 May 2016	Holbrook, NSW	Australia	Workshop	The Fungi: An Introduction to a Curious Kingdom
14 May 2016	Bonegilla, Vic	Australia	Workshop	The Fungi: An Introduction to a Curious Kingdom
18 May 2016	Mandurama, NSW	Australia	Foray	Fungus Foray in the Mandurama Scrub
20 May 2016	Canberra, ACT	Australia	Seminar	A Thousand Days in the Forest
29 May 2016	Creswick, Vic	Australia	Workshop	A Foray Among the Funguses
30 May 2016	Creswick, Vic	Australia	Workshop	A Foray Among the Funguses
01 June 2016	Melbourne, Vic	Australia	Workshop	A Thousand Days in the Forest

Appendix 5
Papers and images published during PhD research (March 2013 to July 2016)

Peer Reviewed Papers and Book Chapters

Pouliot, Alison. "The Fungal Garden." *Australian Garden History* 27, no. 1 (2015): 15-17.

Hall, Mark, Philippe Forét, Christof Kueffer, Alison Pouliot and Caroline Wiedmer. "Seeing the Environment Through the Humanities: A New Window on Grand Societal Challenges." *Gaia* 24/2 (2015): 134-136.

Pouliot, Alison. "Environmental Justice for Unregarded Others: Human Responsibility For A Forgotten Kingdom in World Conservation and Agriculture." In *Looking Within: Finding an Environmental Justice and Global Citizenship Lens,* edited by Karen Druffle. 67-74. Interdisciplinary Press: Oxford, UK, 2013.

Pouliot, Alison. "Intimate Strangers of The Subterrain: A Mycelial Metaphor for Connectivity." *Philosophy, Activism, Nature* 10 (2013): 15-22.

Pouliot, Alison and John Ryan. "Fungi: An Entangled Exploration." *Philosophy, Activism, Nature* 10 (2013): 1-5.

Peer Reviewed Photo Essays

Pouliot, Alison. "A Meander in the Mycosphere." *Intervalla* 3 (2015): 13-25.

Pouliot, Alison. "Anthropocene Autoscene." *Landscapes: The Journal for the International Centre for Landscape and Language* 6, no. 1 (2014).

Pouliot, Alison. "Fleeting Lives." *Philosophy, Activism, Nature* 10 (2013): 133-136.

Non-Peer Reviewed Papers and Articles

Pouliot, Alison. "Scenting the Wombat." *Wombat Forestcare Newsletter* 35 (March 2016): 1-2.

Pouliot, Alison. "Endless Forms Most Bizarre." *Australasian Plant Conservation* 24, no. 3 (Dec 2015-Feb 2016): 14-15.

Pouliot, Alison. "Unearthing: A Foray into Fungal Underworlds" *Earthsong* 3, no.1 (2015): 12-15.

Pouliot, Alison. "Two Bob for the Wombat? Beyond Ecosystem Services." *Wombat Forestcare Newsletter* 34 (December 2015): 3-4.

Pouliot, Alison. "Dead But Not Redundant." *Wombat Forestcare Newsletter* 33 (September 2015): 1-2.

Pouliot, Alison. "Where Beauty Meets Bizarre." *Wombat Forestcare Newsletter* 32 (June 2015): 1-2.

Pouliot, Alison. "Idle Wandering in the Wombat." *Wombat Forestcare Newsletter* 30 (March 2015): 6-7.

Pouliot, Alison. "Rethinking the Fungal Dimension of Biodiversity." *Park Watch* 257 (2014): 30-31.

Pouliot, Alison. "Combating Amnesia: The Wombat Forest and Shifting Baseline Syndrome." *Wombat Forestcare Newsletter* 31 (December 2014): 7-8.

Pouliot, Alison. "A Forgotten Kingdom." *Wildlife Australia*. (Spring 2014): 12-17.

Pouliot, Alison. "Small Things Considered." *Wombat Forestcare Newsletter* 29 (September 2014): 1-2.

Harris, Sarah and Alison Pouliot. "From Forest Floor." *Bendigo Magazine* 35 (2014): 42-43.

Pouliot, Alison. "Listening to Old Trees." *Wombat Forestcare Newsletter* 27 (June 2014): 1-3.

Pouliot, Alison. "Fungi, Keystones of Evolution and Earth Processes." *Fungal Conservation* 4 (February 2014): 8-11.

Pouliot, Alison. “Mycoentanglement: Public Perceptions of Fungi in Biodiversity Conservation.” *Fungal Conservation* 4 (February 2014): 46-52.

Pouliot, Alison and Valérie Chételat. “Seeking the Wombat Forest’s Most Alluring Fungi.” *Wombat Forestcare Newsletter* 28 (June 2014): 9-10.

Pouliot, Alison. “Report from the Third International Congress on Fungal Conservation, Turkey 11-15 November 2013.” *Fungal Conservation* 4 (February 2014): 2-6.

Pouliot, Alison, Tom May, Sapphire McMullan-Fisher, Peter Buchanan, Lyn Allison, Jasmin Packer. “It’s Time for a Global Strategy for Plant and Fungus Conservation.” *Australasian Plant Conservation*. 22, no. 4 (2014): 22-23.

Pouliot, Alison. “A Galaxy of Earthstars.” *Fungimap Newsletter* (December 2013): 16-17.

Pouliot, Alison. “Back to Dirt: Soil Fertility and the Small-Scale Farmer.” *Town and Country Farmer* (Aug-Sept 2013): 51-53.

Pouliot, Alison. “Nooks and Grannies: The Wombat’s Woody Elders.” *Wombat Forestcare Newsletter* 26 (December 2013): 1-3.

Pouliot, Alison. “Ancient Alliances in a Modern Day Wombat: A Review of ‘Fungal Biology in the Origin and Emergence of Life *Wombat Forestcare Newsletter* 25 (September 2013): 1-3.

Pouliot, Alison. “Targetting the Wombat’s Fungi.” *Wombat Forestcare Newsletter* 25 (September 2013): 9.

Pouliot, Alison. “Report from the Australian Fungimap Conference.” *International Society for Fungal Conservation* Newsletter 3 (2013): 33-37.

Pouliot, Alison. “Hope and Conservation.” *Wombat Forestcare Newsletter* 23 (March 2013): 1-3.

Non-Peer Reviewed Photo Essays

Pouliot, Alison, "Six Short Lives." *Wombat Forestcare Newsletter* 36 (June 2016): 10.

Pouliot, Alison. “Drought.” *Australian Book Review* 366 (November 2014).

Other Published Images – Front Covers

Der Bund Newspaper (August 2015)

Horizons: The Swiss Magazine for Scientific Research 100 (March 2014).

Wildlife Australia (Spring 2014).

Australian Government, Bureau of Meteorology, *Biodiversity Profiling: Components of a Continental Biodiversity Information Capability.* Canberra, Bureau of Meteorology, 2013.

Images and articles also published in:

Bureau of Meteorology publications (Canberra)
Organic Gardener (Sydney)
der Bund (Bern, Switzerland)
Daylesford Advocate (Daylesford)
Southern Weekly (Albury)
Age (Melbourne)
Midland Express (Castlemaine)
Moorabool News (Ballan)
Loddon Times (Newstead)
Bendigo Advertiser (Bendigo)
Castlemaine Independent (Castlemaine)
Meredith and District News (Meredith)
Town and Country Farmer (Woodend)
Backyard Farmer (Trentham)

Commissioned Fungus Field Guides (DL format depicting 100 species)

Fungi of the Southwest Slopes and Upper Murray Region of NSW, 2016 (commissioned by Local Land Services, NSW).

Fungi of the Box Ironbark Forests and Woodlands of Central Victoria, 2016 (commissioned by Mid Loddon Conservation Management Network).

Fungi of the Wombat Forest and Macedon Ranges, 2014 (commissioned by Wombat Forestcare).

Articles and images provided to various blogs

Wedderburn Conservation Management Network. "Fungus Guide." Last modified 3 March 2016. http://www.wedderburncmn.org/fungi-guide.

One Million Women. "Mushroom Madness: Foraging for Edible fungi". Last modified 3 March 2016. http://www.1millionwomen.com.au/blog/mushroom-madness-your-guide-foraging-edible-fungi/.

Verein für Pilzkunde Biel and Umgebung (Switzerland). Fungus images. Last modified 23 February 2016. http://www.seelandpilze.ch/index.php/de/.

The Field Institute. Fungus images. Last modified 28 November 2015 http://www.thefieldguides.com.au/visit/top-5-foraging-tours-australia/.

Fungimap. "Fungi Infiltrate Landcare." Last modified 5 August 2015. http://fungimap.blogspot.ch/search/label/Fungi%20foray%20or%20survey%20report.

Centre for Environmental History. "From Fungal Fields." Last modified 27 July 2015 http://ceh.environmentalhistory-au-nz.org/stories-from-the-field/from-fungal-fields/.

Upper Spring Creek Landcare Group and Mid Loddon Conservation Management Network. "Red Gum Fungus Stories". Last modified 9 July 2015. http://usclandcare.org.au/?p=883.

Naturwissenschaften, Switzerland, various images. Last modified 24 June 2015. http://www.naturwissenschaften.ch/organisations/saguf/projects/environmental_humanities.

Secrets Magazine, "The March of the Mushrooms". Last modified 2 March 2015. http://secretsmagazine.com.au/2015/03/the-march-of-the-mushrooms/.

Fungimap. "Bellarine Coast Fungus Workshop." Last modified 2 December 2014. http://fungimap.blogspot.ch/search/label/Fungi%20workshop%20report.

Fungimap. "A New Fungus Poster: Fungi of the Mount Alexander Region." Last modified August 2014. http://fungimap.blogspot.ch/2014/08/a-new-fungus-poster-fungi-of-mount.html.

Fungimap. "Heading Into the Field in Holbrook." Last modified October 2014. http://fungimap.blogspot.ch/2014/10/heading-into-field-in-holbrook.html.

Fungimap. "The Svampvanner." Last modified 16 October 2014. http://fungimap.blogspot.ch/2013/10/the-svampvanner-mushroom-friends.html.

Fungimap. "Special Issue on Fungi in Philosophy, Activism, Nature." Last modified 18 March 2014. http://fungimap.blogspot.ch/search/label/Fungi%20publication%20notice.

Travelling Scientist. "Fungal Futures" KTH Website, published 14 Jan 2014. https://www.kth.se/blogs/travellingscientist/2015/01/alison-pouliot-fungal-futures/.

Appendix 6
Representation of search terms in Australian National Park Management Plans

All States and Territories had some form of conservation legislation in place at the time the Plans were written. Sixty percent were written since 2000, the year that Australia's national Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) was enacted. All Plans were written within the last twenty-five years, during which time knowledge of Australian fungi has developed considerably.

The following search terms were used for flora, fauna and fungi:

Taxonomic Group	**Search Terms**
Fauna	animal, fauna, wildlife, vertebrate, mammal, bird, fish, amphibian, reptile, insect
Flora	flora, plant, vegetation, vascular, tree, grass, shrub, fern, flower, moss
Fungi	fung*, mushroom, lichen, mycota, saprophyte, mycorrhiza, mycelium, toadstool, mould, truffle.

Name of National Park Management Plan (NPMP)	State	Year published	No. Pages	Fungi	Fauna	Flora
Alpine NPMP	VIC	1992	318	4	502	453
Bago Bluff NP Plan of Management	NSW	2007	29	0	75	98
Baw Baw NPMP	VIC	2005	76	2	125	192
Brisbane Water NP Plan of Management	QLD	1992	30	0	42	43
Final draft Management Plan for Canberra Nature Plan [Canberra Nature Park]	ACT	1998	53	0	24	33
Mgt Plan for Parks of the Coffin Bay Area	SA	2004	66	4	239	246
Tasmanian Wilderness World Heritage Area Management Plan [Cradle Mountain NP]	TAS	1999	214	7	421	335
Croajingalong NPMP	VIC	1996	59	8	129	94
Shannon Park & D'Entrecastueaux NPMP	WA	1987	168	6	107	213
Frecyinet NP Wye River State Reserve MP	TAS	2000	118	1	196	333
Girraween NPMP	QLD	2010	39	2	97	154
Grampians NPMP	VIC	2003	82	10	101	229
Great Otway NP & Otway Forest Park MP	VIC	2009	120	1	206	206
John Forrest NPMP	WA	1994	114	4	166	196
Karijini NPMP	WA	1999	99	0	254	272
Kosciuszko NP Plan of Management	NSW	2006	348	5	588	519
Kwiambal NP & Ashford Caves Crown Reserve Draft Plan of Management	NSW	2004	46	0	75	110
Lamington NPMP	NSW	2011	43	4	116	115

Leeuwin-Naturaliste NPMP	QLD	2011	107	3	118	110
Litchfield NP Draft Plan of Management	NT	2011	74	0	156	61
Little Desert NPMP	VIC	1996	56	1	102	161
Maria Island NP & Ile Des Phoques Nature Reserve MP	TAS	1998	120	3	259	258
Mary River NP Draft Joint Mgt Plan	NT	2011	76	0	242	41
Mt Buffalo NPMP	VIC	1996	67	0	84	125
Mt Field NP, Marriotts Falls State Reserve & Junee Cave State Reserve	TAS	2002	85	1	228	165
Parks & Reserves of the Tweed Caldera	NSW	2004	115	3	219	256
Mummel Gulf NP & State Conservation MP	NSW	2012	36	1	61	50
Murujuga NPMP	WA	2013	120	2	149	160
Namadgi NP Plan of Management	ACT	2010	226	1	400	413
Norfolk Island NPMP	NAT	2008	108	3	183	208
Serpentine NPMP	WA	2000	66	3	102	177
Snowy River NPMP	VIC	1995	58	2	66	86
Stirling Ranges & Porongurup NPMP	WA	1999	104	16	138	330
Tasman NP & Reserves MP	TAS	2011	120	1	193	157
Thirlmere Lakes NP New Plan of Management	NSW	1997	32	0	85	56
Uluru-Kata Tjuta NPMP	NT	2010	199	0	275	180
Wilsons Promontory NPMP	VIC	2002	75	4	140	150
Witjara NPMP	SA	2009	87	0	253	270
Wollemi NP Plan of Management	NSW	2001	69	2	94	108
Wyrrbalong NP Plan of Management	NSW	1995	29	0	70	66
Total				**104**	**7080**	**7429**
Average number of references per plan				**2.6**	**177**	**186**

Appendix 7

Additional flora and fauna references outside of defined reference terms that appear in Bago Bluff National Park Management Plan.

Organism	Number of References
Fungi	
No terms found	
Flora	
Gum	4
Blackbutt	9
Stringybark	1
Brushbox	1
Eucalyptus	5
Lantana	1
Weed	2
Sclerophyll	1
Backhousia sciadophora	1
Syncarpia glomulifera	1
Canthium vaccinifolium	1
Harpullia hillii	1
Deeringia arborescens	1
Leionema elatius	1
Marsdenia liisae	1
Callistemom acuminatus	1
Acomis acoma	1
Boronia chartacea	1
Cynachum elegans	1
Eucalyptus fergusonii	1
Hibbertia hexandra	1
Parsonia dorrigoensis	2
Senna acclinis	4
Sporobolus fertilus	1
Lantana camara	1
Ageratina adenophora	1
Callistemon linearifolius	3
Melaleuca groveana	3
Hakea archaeoides	4
Total	**56**
Fauna	
Possum	2
Phascogale	1
Planigale	1
Potoroo	1
Pademelon	1
Wallaby	1
Cat	2
Fox	3
Dog	2
Cattle	1
Dove	3
Kite	1
Curlew	1
Bittern	1
Parrot	1

Cockatoo	1
Owl	6
Bat	10
Koala	2
Myotis	2
Glider	4
Quoll	3
Frog	3
Robin	1
Pitta	1
Skink	1
Gecko	2
Snake	2
Ptilinopus magnificus	1
Calyptorhynchus lathami	1
Tyto tenebricosa	1
Tyto novaehollandiae	1
Ninox strenua	1
Miniopterus schreibersii	1
Miniopterus australis	1
Scroteanax rueppellii	1
Phascolarctos cinereus	1
Myotis adversus	1
Petaurus australis	1
Dasyurus maculatus	1
Tregellasia capito	1
Pitta versicolor	1
Sericulus chrysocephalus	1
Todiramphis macleayii	1
Eulamprus murrayi	1
Petaurus norfolcensis	1
Cercartetus nanus	1
Litoria revelata	1
Tropidechis carinatus	1
Salturarius swainii	1
Lophoictinia isura	1
Atichornis rufescens	1
Burhinus grallarius	1
Ixobrychus flavicollis	1
Kerivoula papuensis	1
Lathamus discolor	1
Ptilinopus regina	1
Litoria brevipalmata	1
Phascogale tapoatafa	1
Mormopterus norfolkensis	1
Cercartetus nanus	1
Canis familiaris	1
Vulpes vulpes	1
Chalinolobus dwyeri	1
Macropus parma	1
Felis catus	1
Petaurus norfolcensis	1
Planigale maculata	1
Potorous tridactylus	1
Pteropus poliocephalus	1
Scotoeanax rueppellii	1
Thylogale stimatica	1
Hoplocephalus stephensii	1
Total	**106**

Appendix 8
Colour references to *Lactarius deliciosus* in selected field guides

Author	Title	Colours used to describe the colour of *Lactarius delicisous*
Gates and Ratkowsky	A Field Guide to Tasmanian Fungi	bright carrot orange, bruises green.
Young	A Field Guide to Fungi of Australia	pinkish orange to pale orange or apricot, green.
Fuhrer	A Field Guide to Australian Fungi	orange, carrot-coloured, green.
Moore & O'Sullivan	A Guide to the Common Fungi of the Hunter-Central Rivers Region (Australia)	pink-orange to pale-apricot, blotched orange, green, noting it can age to yellowish. Blotched or entirely green.
Arora	Mushrooms Demystified	dull orange to carrot-orange to orange brown.
McKnight et al.	A Field Guide to Mushrooms: North America	orange overall, green.
Jordan	Encyclopedia of Fungi of Britain and Europe	salmon-pink, carrot-coloured, green.
Bon	Pareys Buch der Pilze	ochre-orange to red.
Carluccio	Complete Mushroom Book	deep-red orange, saffron-orange, turns green.
Gerhardt	Der Grosse BLV Pilzführer	orange-red to orange-yellow.
Laux	Der Kosmos Pilzatlas	orange with red-yellow zones, pale orange, ochre-orange, green.
Davis et al.	A Field Guide to Mushrooms of Western North America	orange of various shades, staining green.

Appendix 9
Achievements in Australian fungal conservation since the 1980s

Achievements in Australian Fungal Conservation	**Description**
Conservation Overview	Chapters on fungi and lichens were included in the 1997 report, 'A Conservation Overview of Australian Non-Marine Lichens, Bryophytes, Algae and Fungi,' edited by George Scott, Tim J. Entwisle, Tom W. May and G. Neill. Commissioned by Environment Australia.
Fungimap http://fungimap.org.au/	Fungimap Inc. is a national fungus-mapping program founded in 1996 that engages fungus enthusiasts to provide fungus location data on 200 target species. To date there are more than 100,000 records that provide an important baseline for assessing distributions and monitoring environmental change. Additionally, Fungimap provides information, training & input into conservation policy development. The Conservation and Biodiversity Subcommittee aims to improve the status of fungus conservation in Australia by promoting threatened fungi; facilitating the listing of threatened species; preparing submissions for government biodiversity and conservation policy; and providing advice on fungi in habitat restoration and management. It is also planning to appoint a fungus conservation coordinator. Fungimap has produced hardcopy and online field guides, a fungus survey manual, newsletters and has held eight national conferences.
Legislative listings	Fourteen fungus species and two communities of fungi have been listed under various pieces of state level protective legislation. Most are listed under N.S.W. legislation, and the majority are species of *Hygrocybe*.
Interactive Catalogue of Australian Fungi http://www.rbg.vic.gov.au/dbpages/cat/index.php/fungicatalogue	An Interactive Catalogue of Australian Fungi (ICAF) commenced in the early 1980s. The catalogue provides the currently accepted names of Australian fungi including synonyms and literature references (last updated in 2004). The on-line ICAF includes 3,214 species of macrofungi and is being updated as part of Atlas of Living Australia (ALA). The new interface, AusFungi, will include all groups of non-lichenised fungi and fungoid organisms.
Atlas of Living Australia http: //www.ala.org.au/	The ALA is the first national collaborative project that incorporates all major groups of fungi. Fungimap has been collecting Australian fungus species records since 1996 which have been incorporated into the ALA.
The *Fungi of Australia* series http://www.publish.csiro.au/nid/22/sid/25.htm	The *Fungi of Australia* book series documents Australian fungi providing systematic data for conservation and biotechnology. The first three taxonomic volumes have been published (smut fungi, *Septoria*, and Hygrophoraceae). Australian lichens have been well-documented in five volumes of the *Flora of Australia* series.
Fungibank: The Commonwealth Scientific and Industrial Research Organisation (CSIRO)	Fungibank was an initiative of Australia's national government body for scientific research, the CSIRO. Fungibank provided information on the importance and benefits of native fungi in the management and restoration of landscapes as well as advice on sourcing and propagating native fungi. The project is no longer actively maintained.
Australian Fungi website: Australian National Botanic Gardens (ANBG) https://www.anbg.gov.au/fungi/	This comprehensive website documents the history, ecology, taxonomy and many other aspects of Australian fungi.
Forestcheck https://www.dpaw.wa.gov.au/about-us/science-and-research/landscape-conservation-research/183-forestcheck	Forestcheck is an integrated, long-term monitoring project that provides information about changes and trends in biodiversity associated with forest activities. Forestcheck evaluates relationship between fungal biodiversity and forest disturbance/health and advises on fungal pathology in southwestern Australian forests.
University of Sydney Fungal Biology Homepage http://bugs.bio.usyd.edu.au/learning/resources/Mycology/contents.sht	This website assists students to develop their understanding of fungi.

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Royal Botanic Gardens (RBG), Melbourne: Educational projects	The RBG Melbourne have initiated two inspirational projects, the first, called *Hidden in Plain View*, is a travelling exhibition of cryptogams and was shown at nine galleries in four states and visited by 80,000 people during 2009-2010. The second project, *Forgotten Flora,* is an educational kit with posters and projects for schools.
Regional fungal studies groups	Regional and local fungus interest groups have been formed in most states, starting with the Sydney Fungal Studies Group (around the 1980s) and including the Fungi Group of the Field Naturalists Club of Victoria, Queensland Mycological Society, Adelaide Fungal Studies Group and Perth Urban Bushland Fungi Project (funding ceased and activities are now under Western Australian Field Naturalists Club). See: https://fungimap.org.au/index.php/get-involved/regional-groups
Australasian Mycological Society (AMS) http://www.australasianmycologicalsociety.com/	The AMS formed in 1993 and has a fungal conservation special interest group.
International Society for Fungal Conservation (ISFC) http://www.fungal-conservation.org/	Australia is represented in the ISFC. This society formed in 2012 and is the first in the world entirely devoted to fungal conservation.
Australia's first designated reserve based on an endangered fungus community	In 2000, a Sydney parkland, Lane Cove Bushland Park, was listed on the Register of National Estate based on an endangered fungus community (Hygrocybeae). This designation set a precedent in Australia, being the first (and only) reserve listed based on a fungal community.
Online Platforms http://www.bowerbird.org.au/ https://natureshare.org.au/	Various online platforms and fora that include fungi such as Bowerbird (funded by Museum Victoria, CSIRO and the ALA). Natureshare focuses on Victorian species.
FunKey: Key to Agarics	"FunKey" is an interactive key to more than 150 genera and selected species of Australian agarics. It includes over 1000 photographs and drawings, a glossary and an extensive introduction to agaric classification and identification characters.
Global Fungal Red List listings	The first two austral species were listed as endangered on the IUCN Red List of Threatened Species (Bunyip Egg, *Claustula fischeri* and *Boletopsis nothofagi*).

Appendix 10

Image Captions for Photo Essays

Endless forms most bizarre