Wild MUSHROOMING

A GUIDE *for* FORAGERS

Alison Pouliot & Tom May

Wild
MUSHROOMING

‘We may read over, with the most sedulous attention, Batarra, Micheli, Gleditsch, and Haller, or turn over the multitudinous plates of Schaeffer to little purpose: to know the Fungi well we must watch them daily and yearly; in short *we must live with them*’.

William Curtis (1777) *Flora Londinensis*, vol. 5. William Curtis, London.
Text accompanying plate [70], *Agaricus aeruginosus*.

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Front cover: A selection of edible fungi (photo by Alison Pouliot).
Back cover: Mixed mushrooms frying in the pan (photo by Alison Pouliot).

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Acknowledgement
CSIRO acknowledges the Traditional Owners of the lands that we live and work on across Australia and pays its respect to Elders past and present. CSIRO recognises that Aboriginal and Torres Strait Islander peoples have made and will continue to make extraordinary contributions to all aspects of Australian life including culture, economy and science. CSIRO is committed to reconciliation and demonstrating respect for Indigenous knowledge and science. The use of Western science in this publication should not be interpreted as diminishing the knowledge of plants, animals and environment from Indigenous ecological knowledge systems.

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Disclaimer

Information in this book regarding the edibility and toxicity of fungi is believed by the authors to be true and accurate at the time of writing. Readers are advised that taxonomy, nomenclature and toxicology are constantly developing and species names and knowledge about edibility and toxicity change accordingly. Although the book includes known common toxic lookalike species, further toxic species are likely to exist. Consuming wild fungi carries risk and readers are advised to read the section on pp. 49–51.

In particular, readers' attention is drawn to the warning that the consumption of even a small portion of some toxic fungi can cause organ damage or death. Hence, every forager should first learn the toxic species, especially those that are potentially fatal, before foraging for fungi. No simple rules exist for distinguishing edible mushrooms from poisonous mushrooms. To minimise poisoning risk, always assume a mushroom is toxic, unless an authoritative source definitively states it is edible. While the edibility/toxicity of many Northern Hemisphere species is reasonably well established, less is known about Australian fungi, and it is not possible to directly extrapolate this knowledge to Australian fungi.

Accordingly, neither the authors nor the publisher accepts any legal responsibility or liability for any loss, damage or injury arising from any error in or omission from the information contained in this book or from the failure of the reader to understand or accurately interpret information.

Wild mushrooms are the focus of this book but information is also presented on some cultivated mushrooms. Cultivated species provide the benefit of availability and certainty about identity. The recipes included in Chapter 10 utilise a variety of wild and cultivated species. Where recipes include wild foraged species, they can often be replaced by cultivated species.

Note: Tom May is a Principal Research Scientist at Royal Botanic Gardens Victoria and an Honorary Associate of the Victorian Poisons Information Centre, but his contributions to Wild Mushrooming have been made in his own time, and the views expressed in this work do not necessarily represent the views of these organisations.

Chapter 1

The rise of wild mushrooming in Australia

A fungal awakening

Deep in the bush, tiers of luminous ghost mushrooms adorn an old stump. On a busy urban street, lawyer's wigs push through the disturbed soil of a newly constructed roundabout. And in the blistering sands of the Australian desert, a black powderpuff stands tall, despite the extreme heat. Although fungi are often overlooked, there are few environments they have not managed to colonise. The production of sporophores (spore-producing structures such as mushrooms) and the dispersal of spores characterise fungi as some of the oldest and most widespread organisms. With their myriad colours and forms, fungi captivate and enchant, provide delicious food, and occasionally, send the feckless forager to the grave. Welcome to the Kingdom Fungi.

Roaming the autumn forests in search of fungi is an increasingly popular Australian pastime. While fungi have mostly been the domain of naturalists and scientists, a growing band of foragers is discovering the delights of wild edible fungi. Humans foraged for wild foods until cultivation and agriculture became the way of life for most people. Foraged fungi provide subsistence food and cherished delicacies, psychotropics and pharmaceuticals. In developing countries, they help alleviate hunger and poverty. In the developed world, they are consumed mostly as a gourmet speciality. While many countries have long traditions of eating wild edible fungi, this is less common in English-speaking countries, including colonial and post-colonial Australia.

Australia's food industry is rapidly evolving. The movement of people and food across the world has seen new food cultures emerge and revived old ones. The 'foodie phenomenon' is flourishing. A growing do-it-yourself culture has contributed to a resurgence of foraging as a way to source local, seasonal and unadulterated food. Gastronomy is omnipresent on all media platforms. Chefs increasingly use foraged fungi, now a selling point of many high-end restaurants.

Stories about the edibility of fungi have appeared in Australian newspapers since the 1830s. However, in the last three decades the 'food and lifestyle' sections of weekend newspapers have embraced wild edible fungi with newfound zeal. Since the publication of Richard Mabey's *Food for Free* in 1972, numerous European and American books on foraging have been published. The now global Slow Food movement advocates foraged food as an alternative to industrialised agriculture. For some people, foraging for fungi and other

◄ *Macrolepiota clelandii* (Australian parasol) – a mushroom whose name and edibility has been clarified in recent decades.

foods is part of the drive towards self-sufficiency, parallelling guerrilla gardeners who grow food in neglected public spaces. For others, the return to foraging recognises the value of Indigenous ecological knowledge. While tasty, fungi are low in fat and carbohydrates. They offer relatively few kilojoules and little nutritional value relative to the labour required to collect them. For many in the Western world, wild edible fungi provide more than flavour and texture, with the 'foraging experience' itself being richly symbolic.

Australia is a fungal paradise. About 5000 species of larger fungi (those with visible sporophores) have been described across the continent and this number is increasing. Although the significance and distribution of Australian fungi are becoming better understood, little is known about their edibility outside Indigenous communities. In contrast, fungi are widely used by other cultures across continental Europe (particularly in Slavic countries), Russia and in some African, South-east Asian and South American (especially the Venezuelan Amazon) regions. Despite the lack of widespread knowledge about the edibility of most native Australian fungi, the edibility of a handful of exotic species that grow in Australia is well established. However, edibility and palatability are not the same thing and while most species are not inherently poisonous, many are too rare, small, tough or tasteless to consider eating. This book helps the reader differentiate the desirable from the deadly.

Slow mushrooming

Learning to identify fungi accurately takes time. Central to the philosophy of this book is our recommendation that foragers take a slow and judicious approach: a 'fungal apprenticeship' of sorts. Building comprehensive knowledge reduces both poisoning risk and environmental harm. This begins with understanding the ecological significance of fungi in the context of their environments. Fungi are not isolated entities but live in close association with other organisms and their habitats. Being able to recognise, for example, the plant species or habitat types with which a particular fungus associates is essential to accurate fungus identification.

This is the first guidebook to provide comprehensive information about the edibility of fungi found in Australia. The timing is significant as it reflects both a growing mycological knowledge and the groundswell of interest in foraging for wild food. This book could not have been written sooner. Writing about fungi in Australia is not just a matter of transferring knowledge from elsewhere but allowing local knowledge of Australian fungi to develop, as new understanding about their life histories, taxonomy and distribution emerges.

This book differs from other Australian fungus field guides in that it focuses on a small group of edible fungi (and their toxic lookalike species). Additionally, a handful of species with 'emerging knowledge' regarding their edibility, as well as a selection of cultivated species are discussed. Unlike most field guides that contain up to several hundred species, this book urges readers to concentrate on learning fewer species thoroughly, rather than many species superficially. After all, it is better to leave an edible species uneaten than mistakenly consume a toxic one.

Identifying fungi grows from direct experience in the field and astute observation over time. Only by taking time can one become familiar with the important diagnostic features and extent of variation that can occur within a single species. These differences occur depending on the developmental stage of the sporophore; where and in what it is growing; as well as differing exposure to wind, rain and sun.

Fungus, sporophore, mushroom or toadstool?

As with any specialised field, particular terms and concepts are necessary to describe fungi. While we have tried to avoid jargon as much as possible, technical accuracy is important to enable readers to cross-reference information with other texts and sources. Various terms for fungi are explained in the information box below and the Glossary.

Scientific names are the internationally accepted standard, but vernacular names (common names) make fungi more accessible to wider audiences. Whether one chooses to use scientific or vernacular names, what matters most is that the species referred to is clear. We refer to each species by the currently accepted scientific name and the most commonly used vernacular name appropriate to the Australian context of this book. Keep in mind that the majority of fungi in Australia do not have vernacular names, but some have several, which can differ across regions. Because names change over time and place, we have also included synonyms (earlier scientific names) and other vernacular names in use. See Chapter 6 for further discussion of names. Conventions for names are explained in the information box on the following page.

Terms for fungi

- *Fungus* (pl. *fungi*) refers to the entire organism, including its mycelium and reproductive structures.
- *Mycelium* (pl. *mycelia*) is the matrix of threadlike branching fungal cells known individually as a hypha (pl. *hyphae*) that constitute the feeding body.
- The word *mushroom* commonly refers to a 'cap-and-stalk' style reproductive structure of a fungus. However, the reproductive structures of fungi also have other forms, such as puffballs, discs, cups and corals. Hence, we use the more inclusive term *sporophore* to refer to all the various forms of reproductive structures (often inappropriately called *fruiting bodies*).
- The word *toadstool* once referred to poisonous mushrooms but is now seldom used.
- *Mycota* (all the fungi of an area) is the fungal equivalent of fauna and flora. Some authors use the term *funga* in this context.
- The word *foraying* refers to searching for fungi of scientific interest whereas *foraging* specifies searching for edible species.

Conventions for names of fungi

- The book follows the scientific convention of italicising scientific names (with the first letter of the genus capitalised) and using lower case for vernacular names (except when they contain a proper noun). The genus name is usually abbreviated when it appears more than once. For example, *Agaricus campestris* is written in full on first mention and abbreviated to *A. campestris* on subsequent mentions in nearby text. Further species within an aforementioned genus also appear in the abbreviated form, e.g. *A. xanthodermus*.
- The abbreviation, 'spp.' means more than one species within a genus, e.g. *Suillus* spp. could refer to *S. granulatus* and *S. luteus*.
- Vernacular and scientific names are used in different ways throughout the book to maximise readability and scientific accuracy. Generally, on first mention of a species within a chapter, both scientific and vernacular names are given (except where there is no vernacular name). On repeated mentions of a species, only the scientific name is used. In Chapter 8, only scientific names are used to simplify the text. In the recipes in Chapter 10, vernacular names are mostly used.

Ecological foraging

Our starting point in developing this guide to wild edible fungi is their ecology and conservation. Sustainable foraging hinges on foragers' appreciation of the ecological significance of fungi and potential impacts of their harvesting. This book has been researched over many years and in conversation with a range of experts who know and understand fungi, including mycologists, naturalists and conservationists, forayers and foragers, chefs, toxicologists and toxinologists. All have brought their expertise to the discussion, enabling the best possibilities for fungi and their environments to thrive. Not everyone agrees that foraging is a good thing, usually because of conservation concerns. However, foraging is increasing in Australia regardless of whether one agrees with it or not. Hence, we endeavour to unite foraging and conservation by recognising common ground and potential reciprocal benefits, while anticipating issues that could arise from foraging.

Fungi are sensitive organisms. Like animals and plants, they are vulnerable to habitat disturbance. Some countries have environmental and social problems due to insensitive and exploitative harvesting of wild edible fungi. Most European countries have fungi on Red Lists (inventories of the conservation status of species) because of their elevated extinction risk. This has resulted from large-scale effects of agriculture, forestry, urbanisation and subsequent climate change that reduce the quality and extent of habitat but foraging also has effects. Foraging and fungal conservation, however, are not necessarily mutually exclusive. As fungus conservationists, we take conservation concerns seriously. Informed and responsible collection offers the best chance for both fungal conservation and fruitful foraging. The aim is to avert the chance of Australia following a similar path to other countries, where over-harvesting has divided cultures, caused environmental damage and threatened fungi, resulting in regulation of fungus harvesting. Given the vastness of the Australian continent and the scarce resources allocated to conservation, regulation is unlikely to be effective in the Australian context. The onus is therefore on the individual to forage conscientiously and responsibly. Australia has the opportunity to learn from the oversights of other countries and ensure safe and enjoyable foraging practices align with the ongoing survival of Australia's unique mycota.

Australian knowledge of edible fungi

While Australians, especially those in rural areas, have picked field mushrooms for generations, mushrooming is more typically associated with continental European and other immigrant cultures. Today in Australia, foraging is usually driven by curiosity and the desire for new culinary experiences rather than necessity. The thrill of the 'hunt' is deeply primal and foraging also provides the opportunity to discover old traditions and new terrains.

Australia's geographical isolation and varied environments, climates and conditions have produced a diverse and particular mycota, among the most diverse in the world. Most Australian fungi are yet to be scientifically named and described. In the absence of records of Indigenous practice, the edibility of most species is unknown. Hence, wild mushrooming is different in Australia compared to Europe, because there are different fungi and more species. There is also little cultural tradition of eating fungi among most post-colonial Australians. This means fungi have not been part of inherited knowledge, education or general awareness in the same way as in continental Europe. Long histories of cultural interest in fungi in continental Europe stimulated their scientific research. This led to the founding of mycological societies and gave rise to resources such as field guides. Australia is in an early phase of discovery, but it is an exciting transitional time with many possibilities to learn both from Indigenous knowledge and from elsewhere.

Many books on fungi describe how they have been eaten for thousands of years in places such as Chile, China, ancient Greece and Rome. Less often discussed is that Indigenous Australians could have been among the first people to eat fungi. However, the oral transfer of knowledge between generations means fungus consumption is virtually undocumented in written records. We incorporate what is known about Indigenous Australians' use of fungi in published literature throughout the book. Although fungi are less commonly associated with deserts than forests, most of the scant knowledge about Indigenous Australians' use of fungi refers to desert species, particularly desert truffles (at least seven species are known, including *Elderia arenivaga* and *Mycoclelandia bulundari*). In temperate regions, early European settlers, most notably James Backhouse, documented Indigenous Australians' use of edible fungi such as *Laccocephalum mylittae* (native bread), *Fistulina hepatica* (beefsteak fungus) and *Cyttaria gunnii* (beech orange). Fungi are also used for their medicinal qualities and other purposes. The spores of *Podaxis pistillaris* (black powderpuff), for example, are used to darken the white whiskers of Indigenous Australian men and to repel flies. *Trametes coccinea* (scarlet bracket) is known for its antibiotic qualities for curing sores and mouth ulcers. Other species such as *Laetiporus portentosus* (white punk) were used as tinder and to carry fire. As with indigenous cultures all over the world, some Aboriginal and Torres Strait Islander groups avoided fungi. There were those who made use of their utilitarian values and those who abstained because of cultural beliefs.

Australian field naturalists have long been interested in fungi. For example, the Field Naturalists Club of Victoria (FNCV) has held fungus forays since its founding in 1880 and has had a separate fungus group since 2004. Active fungal studies groups exist in most Australian states and territories. Many hold forays to help members improve their identification skills and to collect information about species distribution. Nationally, Fungimap is a non-government organisation that promotes public interest in fungi and contributes to conservation policy development. Reports from the FNCV journal *The Victorian Naturalist* in the nineteenth century reveal that field naturalists also collected fungi as food. However, the focus of fungal studies groups in Australia today is the scientific study of fungi, with none providing information on the edibility of fungi. Public interest in fungi has grown since the 1980s and stimulated the production of fungus field guides, but edibility is mentioned only in the rare exception.

Humans and fungi cross continents

Fungi, along with animals and plants, have been accidentally and deliberately introduced to Australia, especially since the first European settlers. This has probably happened in northern Australia for thousands of years as part of trading relations between Indigenous Australians and Indo-Pacific Islanders. However, few early European explorers and settlers either noticed or paid attention to fungi. Those who did sent them to Europe for identification, as there was no recognised mycological expertise in Australia. By the time they made the long journey by sea to Europe, specimens were usually in poor condition, often desiccated or ravaged by insects. Hence, it would have been challenging for European mycologists to make accurate identifications. Most of the early describing and naming of fungi was based on general morphology (form) and comparison with known European species. Not only names but knowledge about edibility was 'transferred' to the Australian fungi they identified. Expertise has grown in Australia since the first local mycologists began making observations on fresh specimens in the 1880s. In recent decades, scientists have developed new techniques for classifying fungi that rely less on morphology and place more weight on genetic evidence. Consequently, Australian species previously thought to be the same as European ones have been found to be different and given new names accordingly. The edibility of these species, previously thought to be the same as the European species, remains uncertain. Knowledge about the edibility of Australian fungi (other than Indigenous knowledge) is therefore only starting to emerge.

Following the Second World War, successive waves of European migrants brought new knowledge about edible fungi to Australia. While this knowledge is valuable, poisoning risk also increases when both people and fungi switch continents. Species differ across continents but can appear superficially similar and identifications can therefore be easily confused. Around one-quarter of the current Australian population was born in other countries, and nearly half of all Australians have at least one parent who was born elsewhere. Migrants are especially prone to poisoning because of the mismatch between foraged species in their countries of origin and the greater number and different variety of species found in Australia. A prime example is the confusion between the edible *Volvariella volvacea* (paddy straw mushroom), widely cultivated in Asia, and the toxic *Amanita phalloides* (deathcap), a mushroom introduced to Australia. This latter species is responsible for most fatalities from eating mushrooms worldwide. Given its lethality, it is one of the most important species every forager should learn to identify.

The most commonly foraged edible mushroom in Australia is probably the field mushroom (strictly *Agaricus campestris*, but this vernacular name in practice is applied to other species such as *A. arvensis* and *A. bitorquis*). However, changes in both agricultural practices and the built environment have resulted in different environmental conditions. The new conditions have favoured the toxic lookalike species, *A. xanthodermus* (yellow stainer), which has subsequently become more prevalent. Many foragers are not able to differentiate field mushrooms from yellow stainers, suggested by the fact that yellow stainers cause the majority of poisonings in southern Australia. While not lethal like the deathcap, this species can produce unpleasant gastrointestinal symptoms. This confusion reinforces the importance of learning not just the characteristics of edible fungi but also those of their toxic lookalike species. Given the uncertainties associated with the identification of field mushrooms and the lack of knowledge about the edibility of most Australian native species, other more easily recognisable species such as the introduced *Lactarius deliciosus* (saffron milkcap) and *Suillus luteus* (slippery jack) are becoming popular alternatives.

Foraging is an immensely enjoyable and low-risk activity for those who take a precautionary approach. It takes time and attention to develop the level of skill to make definitive identifications. Each species profiled in the book is comprehensively described and illustrated to give the reader an impression of the range of morphological variability (differences in shape, texture and general appearance) and colours that can occur within a species, along with the variation at different developmental stages. Foragers also need to know when to look as well as the types of habitats and associated vegetation where particular fungi are likely to be found.

Detailed profiles of toxic and edible mushrooms are provided in Chapters 8 and 9. Selecting the species to profile for this book was a long process of deliberation. Many considerations were taken into account including well-established edibility; palatability; ease of identification; the minimal chance of confusion with toxic lookalike species; and relative abundance. Further edible species are described in lesser detail along with information about commercially available species. Safely identifying edible fungi also means being able to recognise similar-looking toxic species and these are discussed alongside their edible counterparts, as well as in Chapter 8, which is dedicated to toxic fungi. The book concludes with advice on the preparation, preservation and cooking of fungi. A handful of generous mycophiles have contributed their favourite mushroom recipes for you to try. We hope the book provides a useful starting point for a long life of safe and pleasurable foraging.

Chapter 2
What fungi are

Fungi confound. Ask people what fungi are and it becomes quickly apparent that they are often misunderstood to be other organisms, such as plants or bacteria. Their stationary presence among vegetation saw fungi classified as plants by Swedish biologist Carl Linneaus in the eighteenth century. It was not until after the middle of the twentieth century that they were assigned their own kingdom – the Kingdom Fungi. Despite constituting one of the largest and most pivotal kingdoms of organisms on the planet, fungi largely go unnoticed. Appreciating what fungi are, where they fit into the scheme of life and what they do is key to understanding both their ecological and cultural significance.

While it is reproductive structures such as mushrooms and puffballs that alert us to the presence of fungi, for a moment, let's head underground. For most of their lives, fungi exist as a web of long branching filamentous tubes called hyphae. Hyphae collectively form the fungus mycelium and are the basic units of fungal life. The mycelium is the growing and feeding part of a fungus and is typically found in soil, wood or other organic matter. If you gently lift the leaf litter in the bush or on the forest floor, you are likely to see the fine cobweb-like strands of mycelia. Foragers return to favourite spots each autumn because they know the location of the underground mycelium by the presence of the fungus' sporophores. While sporophores might last for only weeks or days, the mycelium can persist for years, even hundreds or thousands of years.

The most familiar fungi are those that produce mushrooms. Edible mushrooms are the goal of most foragers. However, the fungal arena is vast and includes microscopic fungi that inhabit terrestrial and aquatic environments, as well as yeasts that can be found in diverse liquid environments. Some yeasts cause diseases in humans, but others have been actively harnessed in the production of food and beverages. What better way to enjoy the forest bounty of foraged mushrooms than to savour them with a fine wine or cool beer, freshly baked bread and a selection of cheeses? For these additional treats, we can thank the actions of fungi such as yeasts.

What are fungi made of?

Although fungi were long classified as plants, their evolutionary history reveals them to be more closely related to animals. To put it another way, the mushrooms in your pea and porcini risotto have more in common with you than the peas. In the evolutionary tree of life, plants separated and headed their own way fairly early on, around 1.5 billion years ago, while the ancestors of animals and fungi continued on a separate path together before diverging about a billion years ago.

◄ A mycelium – the mass of branched, tubular filaments (hyphae) that forms the 'feeding body' of a typical fungus.

Fungi share a molecule called chitin with various invertebrate animals such as arthropods (insects, crustaceans and their kin). Discovered by French chemist Henri Braconnot in 1811, chitin is a polysaccharide that provides the structural scaffold of fungus cell walls, giving them rigidity and structural support. Chitin, also known as 'animal fibre' (from its occurrence in arthropods), is a tough molecule that is extremely insoluble in most organic solvents. Unsurprisingly, humans have difficulty digesting it. While we have an enzyme called chitinase that can degrade chitin and assist in the digestive process, this enzyme is generally fairly inactive. Chitin content varies among fungus species depending on their growth form, with some being more digestible than others. Eating large amounts of even the most edible and delicious mushrooms can result in chronic indigestion. Cases of so-called 'mushroom poisoning' could sometimes have more to do with gluttony. The poisons information authorities of some countries, such as Switzerland, produce lists of species that are suspected of causing fungus poisoning. Along with toxic species, regular candidates on the list include *Boletus edulis* (penny bun) and *Cantharellus cibarius* (golden chanterelle). Both species are edible and keenly foraged. There could be several reasons for the appearance of these edible species on these lists. It could be mistaken identity, bacterial or other contamination, or, simply, over-consumption. Therefore, eat mushrooms sparingly.

How fungi feed

To understand what fungi 'do' means understanding how they feed. Unlike plants that are producers, fungi (and animals) do not photosynthesise but use external food sources for energy. They are known as heterotrophs. Fungi gain nutrition by absorbing both organic and inorganic compounds from the environment. One group of fungi known as saprotrophs obtain food by secreting digestive enzymes directly into the non-living organic matter in which they live. This includes decaying plant and animal matter. Saprotrophs break down complex molecules such as proteins, carbohydrates and fats into simple organic molecules that are then absorbed. As the only organisms able to break down both lignin and cellulose, saprotrophs are enormously important in the recycling of organic matter. Without the work of saprotrophic fungi, organic matter would not decompose and vital nutrients would be locked up and unavailable to plants and animals. While the capacity of fungi to rot wood is often viewed negatively, it is a vital part of natural ecosystem processes and also provides habitats for the great suite of animals that use cavities in wood. Most fungi are saprotrophs and *Agaricus* (field mushrooms), *Lepista* (blewits), *Coprinus* (inkcaps) and *Macrolepiota* (parasols) are among the edible saprotrophs described in this book.

Dismantling of organic matter by fungi is an important part of the process through which soils are formed (pedogenesis). Soil is the most biologically diverse and productive part of almost every terrestrial ecosystem. Fungi provide soil architecture through their expansive scaffolds of mycelia that bind soils; aerate them by creating spaces between particles; and filter water. However, mycelium is damaged or destroyed when soils are disturbed through processes of physical dislodgement such as tilling, compaction, waterlogging or chemical contamination. Poor foraging practices that disturb soils and mycelium also compromise the ability of fungi to survive and support ecosystems.

Mutually beneficial relationships

Many fungi obtain nutrition by forming symbioses (alliances) with other organisms. Mutualisms are symbioses that provide mutual benefits to both partners. These provide the advantage of being able to expand the range of habitats and conditions in which neither partner could exist on their own. The earliest alliance was probably between filamentous fungi and photosynthetic algae, known as lichens. Other symbioses exist in the form of mutualisms between fungi that occupy the guts of ruminants such as cows. These fungi break down cellulose and other plant compounds into nutrients that are available to the cow. In return, the cow gut provides both a habitat and food source for the fungi. However, of more interest to the forager are unions between fungi and the roots of plants. They are called mycorrhizal symbioses (*myco* meaning fungus and *rhiza* meaning root).

Mycorrhizal partnerships developed early in terrestrial colonisation (> 600 million years ago). Over 50 000 fungus species are thought to form partnerships with different plants from most major groups, numbering more than 300 000 species. In these mutually beneficial relationships, 'goods and services' are exchanged between partners. By associating with plant roots, fungi effectively expand the surface area of the root system via their mycelial networks, facilitating water and selective nutrient uptake. Additionally, mycorrhizal fungi protect plants from environmental stresses and soil-borne pathogens. In return for their work, plants provide fungi with sugars produced through photosynthesis. These relationships maximise the efficiency and growth of both partners and are crucial to ecosystem function and resilience.

Mycorrhizal relationships have evolved in different ways. Ectomycorrhizal fungi form an external sheath around plant roots, growing between the outer cells of the plant root tip. Ectomycorrhizas often form between fungi and trees such as *Allocasuarina* (sheoak), *Eucalyptus* (eucalypt), *Pinus* (pine) and *Quercus* (oak). In contrast, arbuscular mycorrhizal fungi directly penetrate the walls of plant root cells, usually forming tree-like structures called arbuscles. Arbuscular mycorrhizas are found in over 80% of plants including many crop species. Other types of mycorrhizas form between fungi and particular types of plants such as orchids (orchid mycorrhizas) or those in the heath and heather family (ericoid mycorrhizas). Many mycorrhizal fungi associate with particular plant genera or families although some are found with a wider variety of plants. Generally, Australian native plants associate with native fungi, while exotic plants associate with exotic fungi. For example, under *Eucalyptus* we find the Australian fungi *Amanita xanthocephala* and *Austropaxillus infundibuliformis*. In contrast, in their native area in the Northern Hemisphere and in Australia, *Amanita phalloides* (deathcap) is usually with *Quercus* (oak) while *A. muscaria* (fly agaric) grows with a variety of exotic trees. However, when introduced to one region from another, fungi sometimes switch partners. This is happening with *A. muscaria*, which now associates with Australian native *Nothofagus* (southern beech) along with exotic *Pinus* and *Betula* (birch).

Understanding mycorrhizal relationships has obvious benefits for the forager. Being able to identify trees saves the forager from aimless wandering in habitats where a sought-after fungus does not grow, because mycorrhizal partners are absent. Recognising mycorrhizal partners and habitat types helps foragers understand ecosystem function as well as how to minimise foraging impacts, which is the theme of the next chapter.

Chapter 3
Fungi in Australian biodiversity conservation

An Australian approach

Foragers have their favourite foraging locations to which they return each season. A great disappointment for any forager is to discover that a special patch has been destroyed. Whether the damage is due to poor forest management, destructive recreational activities or the disregard of other foragers, our favourite fungus spots are precious and require care and protection. It makes sense for foragers to embrace fungus conservation to ensure the survival of not just their pursuit but all fungi and the ecosystems they inhabit. Biodiversity conservation has driven our thinking in the writing of this book and we present a specifically Australian approach to foraging, underpinned by a strong conservation ethic. This chapter provides foragers with an overview of fungus conservation in Australia and offers foraging insights from elsewhere.

The protection of plants and animals has been the focus of biodiversity conservation in Australia and worldwide. People generally extend their sympathies more readily to koalas or quolls – the so-called charismatic megafauna – or endearing orchids than stinkhorns or slime moulds. Rallying conservation support for familiar plants and animals is easier than for unfamiliar fungi, let alone the seemingly abstract ecological processes they provide. However, given the intrinsic interconnectedness between fungi and other organisms, conserving fungi is vital to their existence and that of all biodiversity.

Australia is internationally regarded as progressive in its conservation initiatives, yet fungi are largely overlooked. Mycology is not taught as a separate discipline at any level of Australian education and fungi are not generally part of public environmental awareness. Consequently, Australia has little mycological expertise. Moreover, as Australia becomes increasingly urbanised, many people have fewer opportunities to connect with nature. This disconnection usually precludes interest in nature or conservation. Unlike animals and plants, few fungus species are listed under state conservation legislation and none under national legislation. On the rare occasion fungi are mentioned in conservation strategies, it is almost always in the context of pathogenic species. These pathogens are perceived as a 'threat to biodiversity', rather than being recognised for their important mutualisms and ecological significance. When pathogenic species are portrayed as the 'fungal norm', all fungi are inadvertently lumped in the same basket as 'problematic'. This approach not only misrepresents fungi scientifically but also warps public understanding of them.

Conservation has shifted in recent decades from a focus on individual species to a more pragmatic habitat and ecosystem scale. However, knowledge of specific fungi is needed to determine whether surrogate approaches for conserving a diversity of fungi are effective. For

◄ *Cyttaria gunnii* (beech orange) grows only in association with *Nothofagus* (southern beech) in cool temperate rainforests of south-east Australia.

example, little is known about the successional development of fungus communities or their habitat preferences. Likewise, their disturbance thresholds or the scale at which habitats need to be conserved are poorly understood. Moreover, forest management practices in Australia such as prescribed burning are largely modelled around vegetation communities or the specific requirements of endangered mammals. Whether fungi are being covered by this approach is unknown. In particular, the destruction of prime fungus habitats through inappropriate burning regimes could affect fungi that grow on plant matter from leaf litter to large logs. Underlying all these issues is the lack of appreciation of the value of fungi as part of biodiversity. Fortunately, the situation is changing.

New conservation initiatives are starting to recognise fungi. The Global Fungal Red List Initiative coordinates the nomination of threatened fungus species to the International Union for the Conservation of Nature (IUCN) Red List of Threatened Species. Although listing offers a species no legal standing, it raises awareness of fungi on the international conservation agenda and can prompt assessments under national and state legislation. In June 2015, the first two Southern Hemisphere species were included on the IUCN Red List – *Claustula fischeri* (bunyip egg) has only been found at 15 sites in Australia and two in New Zealand; and *Boletopsis nothofagi* has only been found in New Zealand at two sites. The low numbers of individuals and loss of habitat quality threaten both species. In 2019, a further 51 species from Australasia were added to the IUCN Red List. Listing will ideally lead to long-term monitoring of population trends and amelioration of threats.

Foraging in the UK and the USA – learning from elsewhere

English-speaking cultures are well known for their general ambivalence towards fungi. Although Australia has little history of fungus foraging to inform the recent rise in interest, opportunities exist to learn from elsewhere. Foraging both for personal use and as an income source has grown rapidly in the UK and the USA in recent times. This has not been without environmental and social implications, mainly because of unchecked commercial exploitation. In the Pacific North-west of the USA, mushroom harvesting (mostly matsutake, morels, chanterelles and ceps) has burgeoned into an industry worth hundreds of millions of dollars annually and is highly regulated. The scale and intensity of harvesting has raised concerns about the effects of forest disturbance on fungi and long-term environmental consequences. Like Australia, these countries were not traditionally mycophilic and the rapid growth in harvesting occurred in three decades.

Foraging in continental Europe has been documented for centuries. Today, most European countries have foraging codes of practice and many have foraging regulations. These regulations aim to protect fungi and their environments and minimise poisoning risk to humans. They include restrictions on mushroom-harvesting quantities and techniques, collection days and times, the species collected (especially those on Red Lists) and various other prohibitions. However, despite these well-intentioned measures, debates rage about potential environmental consequences. Conservation managers in the UK report a dramatic escalation in commercial harvesting. Many are concerned about the extent of 'by-catch' – to borrow from the fishing industry – where commercial foragers indiscriminately remove all sporophores, regardless of whether they are edible or poisonous, then sort them later, discarding most in the process. Others question the potential effect of overharvesting on old forest trees. Then there are those who lament the reduced experience for other forest visitors, who miss the opportunity to see fungi because of heavy harvesting by foragers. Most British people are not typically foragers and when continental Europeans are observed to forage in ways considered inappropriate or harmful to nature, accusations can quickly flare into hostile cultural disputes. Most likely, the unscrupulous actions of a few are causing problems for the majority. However, the repercussions reverberate widely.

Whether the overharvesting of fungi is inconsequential relative to the effects of forestry, agricultural chemicals and fertilisers and the over-arching issue of climate change is not fully understood. In Central European forests, for example, the effects of nutrient enrichment (eutrophication), rather than foraging, are considered the main reason for changes in ectomycorrhizal fungus communities. The absence of research in Australia means the potential effects of foraging are largely unknown. Australia currently has no guidelines or recommendations for the collection of wild edible fungi although all fungi are implicitly protected on public land. Given the increase in foraging and scant inclusion of fungi in conservation, foraging knowledge and protocols should ideally develop alongside fungal conservation initiatives. This book supports that process.

Discussions around conservation and foraging can be challenging. Ultimately, it is an ethical debate. Justifying conservation of fungi or any part of nature hinges on how nature is valued. The near absence of fungi in conservation legislation or biodiversity monitoring heightens the difficulty of conserving them. Although some people consider conservation and foraging to be mutually exclusive, successful conservation has embraced more unlikely bedfellows. For example, in what is colloquially referred to as 'khaki conservation', conservation programs have been established on military land. Similar conservation initiatives exist with partners in the mining and agriculture industries. Progressive conservation means advancing former approaches and forging new alliances. It means integrating scientific knowledge and government decision-making, which admittedly is difficult given the mismatch between long-term conservation timeframes and the short electoral cycles of governments. However, progressive fungal conservation also means being conservative – conserving environments until we can at least establish what fungi exist, what makes them thrive and what causes them to perish.

Potential effects of foraging

Is there evidence of negative impacts from foraging? Let's consider this question in three parts:

1. Potential effects on fungi.
2. Potential effects on other organisms and ecosystems.
3. Potential social, societal and cultural effects.

Harvesting has direct effects on fungi through removing sporophores and indirect effects from disruption to the environment during the harvesting process. Whether the harvesting of sporophores affects the viability of mycelia depends on the spatial extent, regularity and level of disturbance during harvesting. It is largely a matter of degree. Theoretically, removing sporophores reduces the number of mature spores that are available for distribution and consequently the reproductive potential of a fungus. However, in certain environments in the Northern Hemisphere, these potential effects do not appear to be reducing sporophore abundance. A long-term (29 years) study in Switzerland found that systematic harvesting of fungus sporophores of 436 species did not reduce yields or species richness. A 10-year research project targetting chanterelle harvesting in North America produced similar results. Lack of observed effects on sporophore abundance may be due to some fungi being long-lived, with year to year growth occurring via expansion of their mycelia. In these cases, establishment of new mycelia from spores would be a rare occurrence, despite the production of vast quantities of spores. In the long term, continued harvesting may affect the genetic structure of fungus populations, a characteristic not explored for most species. While sporophore harvesting did not appear to affect future sporophore production in the abovementioned research, further investigation is required in Australian ecosystems.

The foraging process itself can be detrimental to the environment. Disturbance to the forest floor through trampling by foragers can damage mycelia and compact the soil, subsequently altering water filtration, the availability of oxygen and microhabitat structure. Foragers can also introduce toxins, pathogens and invasive species. However, as with pioneer plants and animals some level of disturbance could stimulate the production of sporophores, such as with some *Coprinus* and *Coprinellus* (inkcaps). For other fungi, beyond their disturbance thresholds, physical disturbance destroys mycelium and reduces the viability of fungus habitats.

Despite the findings from the Northern Hemisphere research, mycologists and conservationists remain concerned about the effects of harvesting on the reproductive potential of fungi. Getting a clear and accurate picture of mushroom harvesting effects is challenging. The paucity of baseline fungus distribution data makes it difficult to detect population trends. For example, increased sampling effort can present an apparent but misleading increase in abundance, even when populations are declining. The consequences of intensive harvesting are also difficult to isolate from the more broad-reaching effects of habitat loss through intensive agriculture and forestry, urbanisation, land and air pollution and consequent climate change. Moreover, because fungi produce sporophores erratically and seasons are becoming less predictable, potential effects of foraging are difficult to distinguish. These challenges in detecting impacts or change can be wrongly interpreted to mean 'no impact'. The incremental decline of fungi beneath the soil might take decades if not centuries to manifest as reductions in aboveground yield of sporophores. Hence, the importance of taking a precautionary approach, especially given that gradual environmental changes often go unnoticed, overshadowed by more visible or dramatic event-oriented environmental catastrophes.

How might foraging affect other organisms and ecosystems? Fungi, especially truffles, provide an important food source for over 40 Australian mammal species (including rare ones such as bettongs and potoroos). Invertebrates also eat fungi. Mites and springtails graze on fungus spores and sporophores provide refuge for the larvae of invertebrates such as beetles and flies. In doing so they contribute to sporophore decay, releasing nutrients into food webs. Each sporophore collected by foragers is potential food for other organisms, hence we suggest collecting only what you can reasonably consume.

Deliberate modification of environments to make target fungus species easier to find, or to stimulate sporophore production, affects other species and ecosystems. The use of rakes to find truffles, for example, can disturb or destroy mycelia and other leaf litter inhabitants. The destruction of mycelia disrupts mycorrhizal links between fungi and trees, reducing the health and resilience of ecosystems. Raking has been explicitly prohibited in several European countries for this reason. The use of fire by morel harvesters to stimulate sporophore production affects not only other fungus species but also entire ecosystems. In Chile, a campaign is underway to curb the ecological damage associated with the deliberate lighting of fires under the misconception it activates morel production. Given Australia's extreme volatility to fire, we would never want this to happen here.

The societal effects of foraging in the UK and USA stem from different cultural beliefs about fungi. Issues arise from divergent harvesting practices but also because of varying levels of knowledge about the edibility of fungi. Given Australia's increasingly multicultural society, these issues need to be taken into account. Almost seven million people in Australia's resident population (29%) were born in other countries. With a population of over half a million people, those of Chinese ancestry are the third largest migrant group in Australia (after people from the United Kingdom and New Zealand).

Major threats to fungi

- Wholesale removal of native vegetation is a significant threat to fungi Australia-wide.
- Physical soil disturbance through activities such as compaction, tilling and irrigating.
- Changes to soil chemistry through application of chemicals, fertilisers, soil liming etc.
- Removal of organic matter (such as leaf litter, fallen wood, logs etc.) through 'cleaning up' of bushland and firewood collection.
- Roadworks, trail- and mountain-bike tracks along with forestry activities such as log landings that compact soil and open canopies leading to changes to micro-climates.
- Habitat fragmentation and loss of connectivity.
- Loss of symbionts (plants as hosts of parasitic and mycorrhizal fungi; and animals as dispersers of, for example, truffle-like fungi).
- Weedy fungi that can replace native fungi, such as *Amanita muscaria* (fly agaric) in *Nothofagus* (southern beech) rainforest and *Favolaschia calocera* (orange ping-pong bat) in woody substrates.
- Inappropriate fire regimes, such as when applied at a coarse scale to meet management targets.
- Over-harvesting of edible fungi and destructive harvesting practices such as raking, lighting fires and other techniques that disturb soils and other fungus habitats.
- Climate change.

Risk can be amplified when both foragers and fungi arrive in Australia from elsewhere. A noteworthy example involves *Amanita phalloides* (deathcap). Deaths have occurred due to the mistaken identification of this species because it appears superficially similar to a popular edible species (*Volvariella volvacea*, paddy straw mushroom) that grows in Asia. How or exactly when the deathcap arrived in Australia in not known, but its distribution is increasing, especially in areas of high human population density. As foraging and immigration both increase, new issues arise, as does the need for multilingual foraging information.

Further divides exist between people with different interests in fungi. Some naturalists and mycologists who are concerned about the conservation of fungi vehemently oppose foraging. Others express their concern about the prevalence of toxic Australian fungi and the generally low level of fungus identification skills among foragers. Misinformation about fungi on internet platforms and in print media can confuse things further. Identifying edible fungi requires accurate knowledge and writing about them in the public domain entails a certain responsibility. Heroics and romanticised notions of mushroom knowledge as sacred lore can sideline the need for sound identification skills. Nevertheless, the internet and print media are valuable sources of information about edible fungi for the discerning user.

Tensions also exist between those who forage for private use and those who forage for commercial gain. These disputes can become territorial. Foragers' discarded latex gloves and large piles of mushroom 'offcuts' are a common sight in Central Victorian pine plantations. Commercial foragers, local residents and immigrant mushroomers clash in accusations of blame. Meanwhile, some plantation owners are becoming wary and prohibiting access to their plantations. Pine plantations are monocultures of trees and have little biodiversity value relative to native bush. Low-level foraging in plantations is unlikely to cause significant environmental impact of conservation concern. However, whether all foragers differentiate exotic plantations from native bush and treat the latter in the same way should they forage native fungus species remains to be seen. Encouraging an ethic of care around fungi, forests and foraging practices could ease tensions and reduce the need for regulation. As foraging gains popularity in Australia, opportunities exist to develop a specifically Australian approach contextualised within local environments and informed by foraging practices elsewhere.

Conservation considerations for Australian foragers

Foraging in Australia is different to that in other countries. To begin with, Australia currently has less public interest in foraging and far fewer foragers. It has low population density and vastly more fungus habitat (forests and woodlands etc.) compared to the UK (Australia is more than 31 times larger with about a third of the population of the UK). The USA is marginally larger than Australia but has over 14 times the population. Unlike in the UK and USA, most foraging in Australia does not occur in native bush but is generally restricted to pine plantations and in other areas where exotic trees grow. This could change as knowledge develops about edible native species. In the context of truffles, given that no native Australian truffle species are broadly valued for their culinary qualities, the raking argument is perhaps not relevant in Australia at this time. On the other hand, the morel issue could be pertinent.

Morels are the only fungi in Australia that were assigned their own licensing system, following rangers' concerns about commercial harvesting in a Victorian state park. Given the predicted increase in the extent, frequency and impact of wildfire in Australia resulting from climate change, protection of vulnerable post-fire environments from morel foraging pressures could become a priority. Moreover, recent taxonomic work on morels has revealed many cryptic species. Their conservation status cannot be determined until more is known about the taxonomic boundaries between species and whether individual species favour particular habitats or geographies.

Drawing sound conclusions about potential effects of foraging in Australia is difficult. However, anticipating potential scenarios offers the possibility to avert the kinds of issues that occur in the UK and the USA. Notwithstanding, Australian cultures, environments and mycota are different to those of the UK and USA. Getting an impression of potential impacts of harvesting begins with understanding the nature of the mycorrhizal relationships including habitat requirements, reproductive biologies and the effects of forest management practices. It also requires knowledge about the conservation status of foraged species and other species that could be affected by foraging. This means rallying governments to train and appoint more mycologists and engaging with foragers to incorporate their knowledge and experience. The rise in informed and sensitive foraging could be the catalyst that stimulates scientific research into fungi and their conservation.

Given that people have been in Australia for at least 60 000 years, fungi are likely to have been used for millennia. However, Indigenous knowledge of fungi was probably lost with the arrival of Europeans and the consequent dispossession and disruption of culture. Indigenous Australians consume fungi, but which species were eaten in the past is largely unknown, apart from historical records of consumption of a few species such as *Cyttaria gunnii* (beech orange) and *Laccocephalum mylittae* (native bread). In desert regions today, truffle fungi are still eaten and are known to be collected by women.

Ethnomycological (human use of fungi) research with Indigenous Australians is scant. Arpad Kalotas's 1996 paper, 'Aboriginal use of Australian fungi' is the most comprehensive account of Indigenous Australians' use of fungi. Jim Trappe and colleagues have also documented Indigenous use of truffle fungi as food and totems. Other knowledge about Indigenous Australians' use of fungi is anecdotal and largely inaccessible. Hence, almost all knowledge relevant to the forager is informed by current Australian mycological knowledge or that translocated from elsewhere.

The following chapter introduces foragers to the major groups of fungi.

Challenges for foragers in Australia

- Low biomass of sporophores relative to European countries.
- Setting realistic expectations about the quantity of the harvest.
- Low number of known edible species and the lack of knowledge about edibility.
- Lack of resources such as field guides, experts, identification services.
- Climate limitations – generally shorter seasons when fungi reproduce.
- Foraging legalities – foraging is prohibited on public land without a permit

Chapter 4
Major groups of fungi

Foragers search for mushrooms, as they are the most conspicuous part of a fungus, and, of course, the bit they want to eat. However, the best foragers understand more about fungi than just their reproductive structures. Directly observing how fungi live, behave and respond to their environments is key to identifying them. You can learn to identify fungi from reading books, but the best knowledge comes from being present in the places where fungi grow. This means being able to recognise the plants and habitats, seasons, climate and weather with which different fungi are found.

Prior to developing an interest in mushroom foraging, you might have been a bird watcher, rockpool rambler or naturalist. If so, your field skills will hold you in good stead. That said, fungus foraging is different. Most notably, there is no comprehensive field guide for Australian fungi. Given that most Australian species are yet to be named, a field guide can only be a representation of the great diversity of species, that is, a *guide*, not a complete inventory. However, this adds to their allure and the possibility of discovering a rare or new species.

Where to start? Begin by developing a feel for the kingdom. Become familiar with the range of sporophore forms. From there, a good approach is to learn one species at a time. Become familiar with the morphology, colour, growth form, life stages, habitat preferences and any idiosyncrasies of your target species. As you study it over several seasons and in different places, you will develop an appreciation of the range of morphological variation within the species as well as the range of habitats and conditions in which it grows. Remember to invest as much effort in learning to recognise toxic lookalike species, as these often get overlooked in the focused pursuit of edible species.

Morphogroups

Organisms are understood and categorised in different ways. The use of *morphogroups* reflects a way of grouping fungi based on their general morphology (form) and appearance, rather than their underlying evolutionary relationships. Morphogroups are essentially arbitrary categories of convenience. Although each group is not definitive and some overlap, they help foragers become familiar with general sporophore anatomy and the different forms. Sporophore morphology was first used before powerful microscopes and molecular techniques allowed for more refined ways of understanding the evolutionary relationships among different fungi. This approach is similar to how we learn about any group of organisms. For example, there are over 800 species of birds in Australia. Few people sit down with a bird guide and start at page one and go through the entire book and learn every species individually, or the families to which birds are assigned. Rather, we are more likely to

◄ The umbrella-shaped agaric is the most familiar sporophore form.

get an impression of generic groups, say, parrots or owls or raptors or waterfowl. With fungi, start by noting whether, for example, a fungus has lamellae (agaric) or pores (bolete) or a coralline form (coral fungi) in order to assign it to a morphogroup. Within each morphogroup, one might then learn particular fungi of interest, for example edible species along with their poisonous lookalike species. The edible fungi in this book are spread across a range of morphogroups including agarics, chanterelles, boletes, hydnoid fungi, jelly fungi, puffballs, truffles and morels. The list of morphogroups below is not exhaustive. It provides an overview of the major features of morphogroups that contain edible and toxic fungi, along with other morphogroups that might be encountered.

All the species described in this book can be placed in one of two phyla (high-level groups in the fungal classification) based on how they produce spores. Those belonging to the phylum Basidiomycota (e.g. agarics, chanterelles, boletes, jelly fungi and puffballs) produce their spores on the exterior of microscopic club-shaped cells called basidia. A larger phylum (although with fewer edible species) called Ascomycota contains fungi that produce spores inside microscopic sac-like cells called asci (e.g. cup and disc fungi and morels). Although differentiating fungi by phyla is not so relevant to the forager, this approach to ordering aligns with many existing field guides, enabling easier cross-referencing. Another way of categorising fungi is by size. Macrofungi have readily visible sporophores (all the fungi in this book) while microfungi form sporophores not readily visible to the naked eye.

Sporophore forms for each group are illustrated on pages 26 and 27. Foragers have much to gain from studying a range of fungi in the field and assigning them to different morphogroups.

Basidiomycota

Basidiomycota produce spores on the exterior of microscopic basidia. Many Basidiomycota are macrofungi but some, such as rust and smut fungi (not covered in this book), are microfungi.

Agarics (fungi with lamellae)

Agarics, known colloquially as mushrooms, are the most commonly foraged fungi. Most have a pileus under which are lamellae – thin blades projecting downwards covered by the fertile spore-producing surface (hymenium). Most have a stipe that is attached centrally or laterally to the pileus. The texture is usually fleshy. Agarics can be further divided into groups such as milkcaps (*Lactarius* and *Lactifluus*), brittlegills (*Russula*), waxcaps (*Hygrocybe*) or honey fungi (*Armillaria*).

Chanterelles

Chanterelles are similar to agarics in overall form and texture but have shallow irregular ‘lamellae folds’ under the pileus rather than distinctive lamellae. They typically form funnel-shaped sporophores. Chanterelles are among the most sought-after edible fungi in places such as Scandinavia and although they also grow in Australia, are far less common.

Boletes (fleshy pore fungi)

Boletes are similar to agarics in overall form but are characterised by a spongy surface of pores on the underside of the pileus. Each pore forms the opening of a short vertical tube. The pore surface of some boletes changes colour when bruised, which is a useful identification feature. Boletes are fleshy and typically grow relatively large and have stipes that are attached centrally to the pileus. Most are mycorrhizal, but a few grow in rotting wood. The highly revered edible *Boletus edulis* (penny bun) is perhaps the most well-known bolete in the world.

Polypores (tough pore fungi)

Like boletes, polypores have pores but are typically tough rather than fleshy. They vary in texture from leathery to woody and many are perennial. They mainly appear on dead trees or fallen wood and occasionally on living trees. Some are parasites, but most decay already dead wood. Most polypores lack stipes and are broadly (laterally) attached to logs, trunks and branches. Many take the form of brackets projecting horizontally from the wood.

Hydnoid fungi (spine or tooth fungi)

Hydnoid fungi have spines or 'teeth' on the fertile surface and grow in the ground or wood. Some resemble a typical mushroom in shape and others form brackets or adhering crusts. They vary in texture from tough to fleshy to leathery. In Europe, most spine fungi are rare and included in Red Lists.

Stereoid fungi (leathers)

Stereioid fungi have a smooth fertile surface and often form brackets with no distinctive stipe. They mostly grow in wood and have a leathery texture.

Coral fungi (corals)

Coral fungi are a colourful group ranging from simple single cylindrical sporophores to large complex branched coral-like structures. Their texture is usually fleshy. The fertile tissue covers the whole sporophore other than the stipe.

Jelly fungi (jellies)

Jelly fungi are gelatinous in texture and appearance and are often contorted into bizarre shapes. They grow on old logs and stumps. While many jelly fungi are edible, they are often flavourless or unpalatable and are more typically used to add texture to a dish.

Phalloid fungi (stinkhorns)

Stinkhorns often display bizarre forms accompanied by intense and often unpleasant odours. Sporophores develop in egg-like sacs. Mature spores form a mass called a gleba that becomes foul-smelling and slimy. The odour attracts insects, which assist in spore distribution. While some phalloids are reputedly edible in their immature form, few foragers entertain stinkhorns as desirable edible fungi.

Birdsnest fungi (birdsnests)

These tiny fungi consist of cup-like sporophores that contain spore-filled capsules (peridioles). Together they resemble miniature egg-filled birds' nests. Spores are dispersed when a raindrop falls into the 'cup', splashing out the peridioles. They are not edible.

Puffballs

Puffballs, as their name suggests, are typically ball-shaped. Within the puffball, mature spores form a powdery gleba (spore mass). Spores 'puff' out through an apical opening or cracking of the outer membrane (peridium). Puffballs grow in soil or wood; some sit flat on the substrate while others are stalked (*Podaxis*). There may be one or more layers surrounding the gleba. *Geastrum* (earthstars) have an outer layer that opens out giving them a distinctive star-shaped appearance. While puffballs such as *Lycoperdon pratense* are edible when young, others such as *Scleroderma* (earthballs) are toxic. All puffballs are inedible once the developing spore mass has matured and become powdery.

False-truffles

False-truffles produce spores on microscopic basidia (in contrast to true truffles that form spores in asci – see the following section). Sporophores are hypogeous (buried in soil or at least under the litter layer). Most are globose or roughly globose, from pea to walnut size, and appear in a range of colours (e.g. white, orange and purple). The interior may be powdery at maturity (*Mesophellia*) or consist of convoluted plates creating labyrinthine chambers lined with spore-producing tissue. False-truffles often have strong odours and rely on being eaten by animals for dispersal.

Ascomycota

Ascomycota produce spores inside microscopic asci. Most Ascomycota are microfungi, including moulds and mildews (not covered in this book).

Cup and disc fungi

Cup and disc fungi are cup- or saucer-shaped and grow in soil, wood or dung. Spores develop on the inside surface of the sporophore. They commonly appear after fire in Australia. Most are too small to be of interest to the forager.

Beech oranges

Beech oranges form clusters of distinctive globular to pear-shaped sporophores. Their pitted external surfaces give them the appearance of a golf ball. Beech oranges grow in association with *Nothofagus* (southern beech) and are eaten by some Indigenous Australians.

Truffles (true truffles)

True truffles are Ascomycota. Sporophore remains enclosed, with a fleshy interior of spore-producing tissue that is often veined or marbled. True truffles include the genus *Tuber* (with renowned culinary appeal) and native desert truffles such as *Elderia* that are consumed by some Aboriginal people. False-truffles (see above) may appear similar, but their interior often has labyrinthine chambers.

Club and pin fungi

As their names suggest, these fungi arise as spindle-shaped structures, often as a simple single club or pin, but other times they are forked or branched. Spores form on the outside surface of the upper section of the sporophore. Club fungi are mostly larger than pin fungi, but both are typically small. Pins usually have a definable 'head'. Although a few club fungi are used in traditional medicine in other countries, they are generally not sought as food by foragers.

Vegetable caterpillars

Vegetable caterpillars produce simple or branched clubs arising from the mummified remains of invertebrates or, in some parts of the world, truffles. *Ophiocordyceps sinensis* is an Asian species highly esteemed in China.

Morels

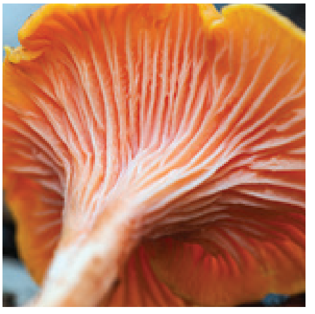
The distinctive honeycomb-like network of ridges and pits on the pileus makes morels easily recognisable. Although highly regarded as edible fungi, they can be poisonous if eaten raw or under-cooked. The taxonomy of morels is in a state of flux and is currently being researched in Australia and elsewhere in the world.

The following chapters provide details of how to identify fungi beyond morphogroups.

Major morphogroups of macrofungi

Basidiomycota


Agarics.


Chanterelles.


Boletes.

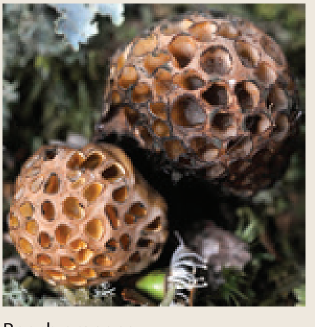

Coral fungi.

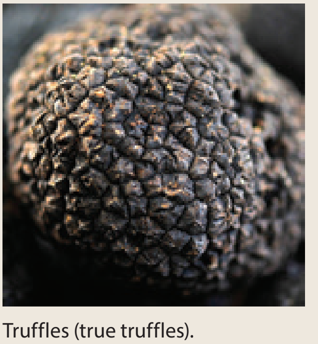

Jelly fungi.


Phalloid fungi.

Ascomycota


Cup and disc fungi.


Beech oranges.


Truffles (true truffles).

Polypores.

Hydnoid fungi.

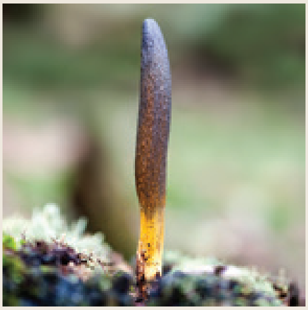
Stereoid fungi.

Birdsnest fungi.

Puffballs.

False-truffles.

Club and pin fungi.



Vegetable caterpillars.

Morels.

Chapter 5
Features of fungi

Fungi are diverse and variable organisms. Identifying most to species level in the field is difficult. In addition, there are no special tricks to determine if a fungus is edible or toxic. It would, of course, be convenient if there were a 10-point checklist of features indicating the edibility or toxicity of every mushroom. It would also make this book considerably shorter. Unfortunately, that is fanciful. Many cultures have their idioms, sayings or 'old wives' tales' that supposedly indicate edibility or toxicity. These often relate to the colours or particular parts of mushrooms. They also relate to other phenomena such as thunderstorms, witches' spells, proximity of a mushroom to a dragon's lair, or a mushroom's capacity to blacken a silver coin (although in today's contactless payment era, finding a coin might be harder than finding a mushroom). While many are whimsically fictitious and arose before the scientific understanding of fungi, some hold truths relevant to the particular place (and only that place) where a species is found. The danger arises when these beliefs are translocated to other places where different species grow. Although appealing for their imaginative nature, such idioms are not reliable indicators of edibility. The first step to determining whether a mushroom is edible is to work out its name. The only way to do that is to use its particular features to accurately identify it. Once its identity is determined, then consult resources such as mycologists, reputable field guides or scientific literature for information regarding its edibility.

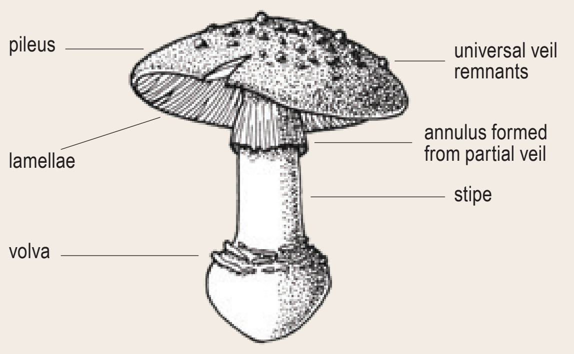
Today, mycologists often use molecular techniques to accurately identify fungi. However, many fungi can be identified in the field using multiple senses, including almost all the edible species and their toxic lookalike species in this book.

Morphological features – finding one's way around a mushroom

The great variety of forms, colours and 'behaviours' of fungus sporophores have evolved in response to one purpose – to maximise the potential to release spores. Understanding the complexities of fungus reproduction is not necessary for identifying fungi, although having some idea of how they grow and reproduce certainly helps.

Most of the edible fungi described in this book are agarics. A few are from other morphogroups. Generally speaking, what is commonly termed a mushroom or an agaric refers to a sporophore with a pileus (cap), stipe (stalk) and a hymenium (fertile surface) that covers radiating lamellae (gills) on the underside (see illustration following). Other morphogroups contain sporophores with a pileus and stipe but an underside with a hymenium covering pores, spines or folds or lining pores. Across morphogroups, one or two protective veils may be present. A partial veil protects the developing hymenium. As the pileus grows and expands, the partial veil ruptures, usually leaving an annulus (ring, as in

◄ Identifying fungi in the field.



Major parts of an agaric.

Agaricus) or ring-zone (as in *Cortinarius*) on the stipe. A universal veil envelops the entire sporophore (as in *Amanita*). As the sporophore expands, the universal veil ruptures to leave a sac-like cup at the base of the stipe called a volva. Remnant patches of the veil often remain on the surface of the pileus. Both a volva and patches on the pileus can be seen in *Amanita* (see pp. 84 and 90).

Colour

Colour is usually the first thing that alerts us to the presence of a sporophore, especially conspicuously coloured ones that contrast with the environment. This is perhaps why *Aseroe rubra* (anemone stinkhorn) with its striking red colouration (and peculiar form and intense odour) was the first species to be scientifically recorded in Australia (by Jacques Labillardière in 1792 in southern Tasmania). If you ask someone to describe a fungus, they usually mention colour first. Fungi are appealing for their astonishing range of colours and colour changes. However, while colour is important for identifying fungi, it can be an unreliable feature because of the great variability that can occur within a species. Moreover, many fungi share similar colours. Hence, flipping through a field guide looking for similarly coloured species is not a reliable way to make an accurate identification.

Colour changes occur in several ways. With many fungi, they are a natural part of the developmental process (e.g. *Lepista nuda*, blewit), regardless of environmental influences. With some species, the tissue oxidises when exposed to air and the associated colour changes are important diagnostic features. Colour changes can be instantaneous or more gradual, depending on the species. For example, several native Australian boletes stain blue or red almost instantly when cut or rubbed while *Lactarius deliciosus* (saffron milkcap) oxidises to green more slowly, usually after several hours. Others change colour with exposure to sun, wind or rain as colours wash out or bleach. The toxic *Amanita muscaria* (fly agaric), for example, can vary from various shades of red or orange to yellow or white, with spots or without spots, depending on the degree of exposure to sun, wind and rain. As well as the pileus and stipe, the lamellae of some species can also change colour, especially as spores are released. Lamellae covered with mature spores can appear to be a different colour.

Given everyone sees colour a little differently, it is inevitably influenced by perception. Colour also appears different under low light or filtered light, especially when filtered through a closed canopy. That said, the human eye is much better at compensating for colour aberrations than one's camera. Keep in mind that cameras and printers are not always correctly calibrated and hence 'colour-cast' images are common online and in field guides.

Variation in pileus form, texture and colour of *Amanita muscaria* (fly agaric).

Moreover, the image or handful of images depicting a species in a field guide can seldom show its range of colour variation. This reinforces the great benefit of observing one species exposed to varying conditions in the field. When trying to determine the colour of your specimen, observe it in daylight (not under artificial light), either in bright but cloudy conditions or in the shade. This also applies to photographing fungi in the field.

Given the great variation in colour and colour perception, always consider colour in tandem with morphology (form).

Let's work systematically through a specimen with a pileus and stipe and examine some of the important morphological features. The pileus varies enormously between species, and within the one species during different developmental stages. Exposure to varying environmental conditions also affects appearance. Use a hand lens (at least ×5 magnification) to observe features. Note that the accompanying images illustrate only some of the variation in form and further possibilities exist.

First look at the shape of the pileus. Is it convex, conical, bell-shaped, plane (flat), uplifted (funnel-shaped), cylindrical or different again? Is the centre umbonate (with a raised, central bump) or umbilicate (with a central dip)?

Is the margin (edge of the pileus) regular or wavy, inrolled or striate (striped or furrowed)?

Pileus margin inrolled.

Pileus with umbo and striate margin.

Is the colour consistent across the pileus? Or is it hygrophanous (watery or translucent when moist and opaque when dry, sometimes giving the specimen a two-tone appearance with darker and lighter areas)? Does it have concentric zones?

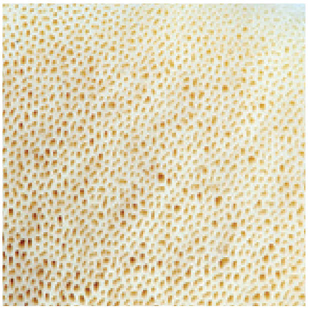
Pileus hygrophanous.

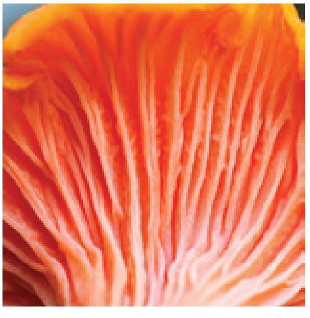
Pileus with concentric zones.

Note the texture of the pileus surface (see p. 37).

Look under the pileus at the area where the spores are produced (the hymenium). Use a mirror where possible rather than removing every specimen. Are there lamellae, spines ('teeth') or pores?


Lamellae.


Pores.

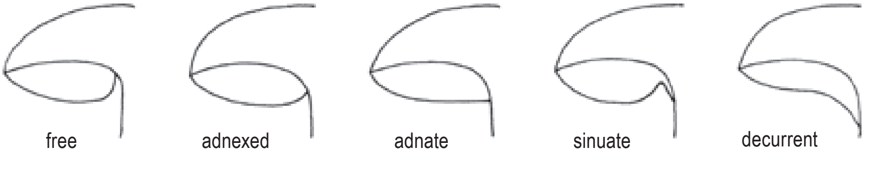

Skin folds.


Spines.

If lamellae, note whether or not they attach to the stipe (most do), and if so, how they attach to the stipe. Lamellae attachment can best be seen in a section by cutting the sporophore in half from the pileus through the stipe.


Lamellae – free from stipe.


Lamellae – attached to stipe.



Lamellae attachment to stipe in cross-section.

What colour are the lamellae? Are they straight, wavy or forked? Are they widely spaced, closely spaced or crowded?


Lamellae widely spaced.


Lamellae closely spaced.

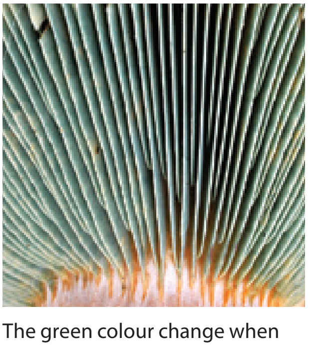

Lamellae crowded.

Is the edge (viewed under a hand lens) straight, wavy or with teeth like a miniature saw? Are longer lamellae interspersed with shorter ones (lamellulae)? Are they thick or thin? Do they exude liquid when broken?


Thick lamellae with lamellulae.

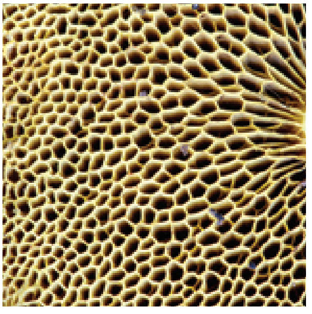

Thin lamellae with lamellulae (and exuded latex).

Do the lamellae change colour when bruised? If the specimen has pores, what colour are they and do they change colour when bruised?

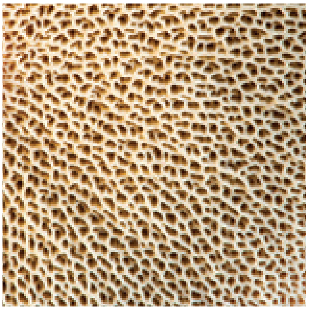

The green colour change when bruised occurs gradually with *Lactarius deliciosus*.


Some boletes immediately stain blue when bruised.

Are the pores evenly, irregularly or radially arranged? Are they round, elongated or angular? Are they relatively large or small? Are they evenly sized? Occasionally, as in *Fistulina*, each pore is the opening of a separate, small, cylindrical structure.



Pores large and angular.



Pores irregularly shaped and radially arranged.

Pores small and round.

Pores at the openings of separate cylindrical structures.

Several of these features are relative and can be difficult to determine until you have become familiar with a range of different hymenia.

Now have a close look at the stipe. Note its height, width, colour, whether it is attached centrally or laterally to the pileus.

Note whether there is an annulus (remnants of a membranous partial veil) or ring-zone (remnants of a cortina, which is a cobweb-like partial veil)). If an annulus is present, is it membranous (skin-like), fibrillose (composed of fine fibrils or hair-like), collar-like, sheathing or skirt-like? Are there tooth or cog-like projections along the margin or on the underside? Whereabouts on the stipe does it occur? Is there one or two?

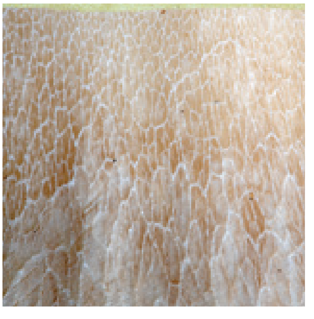

Stipe with cortina remnants (with tan spores).


Stipe with flaring annulus.


Stipe with annulus that has cogged margin.

Look closely at the surface of the stipe. Do this by carefully removing a specimen from the substrate using the flat side of a knife (be sure to include the base of the stipe). Is the stipe surface smooth, fibrillose, scaly or reticulated (with a raised network-like pattern)? Are there pits or is there a pattern of bands? Does it have a downy or glutinous covering?


Stipe with banding pattern.


Stipe with network-like reticulations.


Stipe with pits.

Is the stipe the same width along its length or does it taper downwards or upwards?

Now look at the base of the stipe. Is it swollen, bulbous, club-like, tapering or of an even width? Does it have a volva (remnants of the universal veil around the base of the stipe)? Does it have mycelium attached to it? If so, is it white or yellow? Are there rhizomorphs (fine, ropy aggregates of hyphae) attached to the base?


Stipe base swollen, with volva.


Stipe base tapering.

Now break the stipe. Did it 'splinter' into long fibres or crumble into pieces? Is it hollow or solid?

The above features are mostly visual, but identifying fungi is also about engaging other senses.

Texture

Touch reveals much about texture that is not always apparent to the naked eye. Feel the texture of the pileus of your specimen. Is it, for example, smooth, suede-like or satin-like? Is it greasy, waxy, buttery, viscid (sticky when moist) or glutinous (slimy)?

Alternatively, is it velvety? You can feel this and if you look with a hand lens you will notice a 'pile', like velvet. Or is it fibrillose (with fibres), granulose (with granules), scaly (with the surface lifting up as scales) or warty (the 'warts' being remnants of the veil)?

Smooth pileus.

Warty pileus.

Scaly pileus.

Fibrillose pileus.

Let your fingers do the work by running them lightly over the surfaces of different fungi and noting the great variation and subtle differences in texture. Close your eyes when doing so to intensify the touch sensation. If you struggle to describe the texture, think of things it feels like (i.e. similes), for example, like velvet or like suede, or like wax.

Smell and taste

The senses of smell and taste also help to identify fungi. However, taste is only used once one has a detailed mycological overview of the Kingdom Fungi as some species, such as *Amanita phalloides* (deathcap) should never be tasted. Hence, we focus more on smell. Given few fungus guides give much attention to smell, we include a bit more information to help you develop your 'fungal nose'.

Australian foragers tend to rely less on smell compared to foragers from elsewhere. For example, the first thing many European foragers do when identifying a fungus is to hold it directly to their nose. However, those who have probably been smelling fungi the longest are Indigenous Australians. Early European settler and 'Protector of Aborigines', George Augustus Robinson, documented Aboriginal Tasmanians' use of smell to find fungi such as *Laccocephalum mylittae* (native bread). The edible underground sclerotium of this species was located by pushing a stick into the ground, then removing it and smelling the end of the stick.

Smell is usually regarded as more 'subjective' than visual or textural perceptions of fungi. This is apparent in the greater variation in people's descriptions of odours, relative to those for visual and textural characteristics. The odour of many fungi also changes in different developmental stages. The odour of the deadly deathcap, for example, is variously described as honey-like, sickly-sweet, like rose petals or cadaverous, depending on different perceptions and developmental stages at which it is smelt. Most people rely more actively on sight than smell. However, developing one's sense of smell not only makes one a more astute forager but also enriches the experience of being in the bush.

Many fungi have particular odours. Some are strong and recognisable – albeit not always easily describable – while others are more subtle, in which case they are commonly described in field guides as 'indistinct'. Terms such as *phenolic* or *raphanoid* might be unfamiliar and metaphors such as 'like disinfectant' or 'like radish' can help make odours more familiar. Keep in mind that some people are susceptible to persuasion. Sometimes when you are struggling to detect or describe the odour of a fungus, you might concur with someone else's suggestion, even when not convinced. This can inadvertently lead to the misidentification of a species. If, for example, someone is unable to smell the phenolic odour of the toxic *Agaricus xanthodermus* (yellow stainer) and simply describes it as 'earthy' or mushroomy, other people sometimes agree, rather than acknowledging they cannot detect or define an odour. Consequently, it could be mistaken for an edible *Agaricus*. The yellow stainer is responsible for most mushroom poisonings in Australia, suggesting that some foragers are not aware of its phenolic odour, are unable to detect it, or are prone to persuasion by others.

Along with people's naturally varying ability to detect odours, sense of smell varies greatly with experience, age, diet, health (e.g. sinus and other upper respiratory infections, hormonal disturbance, head injury, conditions such as Alzheimer's disease or Parkinson's disease, grief, or use of medications such as antihistamines and antibiotics) and habits (e.g. smoking). Environmental conditions such as temperature and humidity, or exposure to fumes or chemicals, also affect sense of smell.

As any winemaker, tea connoisseur or perfumier will tell you, developing one's sense of smell takes time, practice and experience. You can develop your 'fungal nose' by smelling each fungus you encounter and trying to describe it. Then read various descriptions of the odours for that species and see if they match your perception. Try to smell fresh specimens as mushroom odours can disappear or become less distinct (although some intensify) as specimens age or dry out. Likewise, with old specimens, you are likely to smell more generic odours of decomposition, rather than distinctive odours particular to the species. Knowing what odours to expect when identifying fungi is also a helpful aid to identification. That said, be cautious not to be swayed by your expectation of how a species is *supposed* to smell. Moreover, never make assumptions about there being a relationship between odour and edibility. Particular odours do not necessarily equate with edibility, even when those odours mimic edible plants or other foods. Inexperienced foragers sometimes comment that a sporophore 'smells good enough to eat'. Although it might smell pleasant or mushroomy, this does not mean it is edible. Likewise, toxins – even deadly ones – are not detectable by taste, the deathcap being a prime example.

Here are a few typical odours with some examples of fungi that produce them.

- Phenolic (*Agaricus xanthodermus*). This is an important one to recognise given the prevalence of this species, its toxicity and the high incidence of poisoning caused by its ingestion. A phenolic odour is also sometimes described as carbolic, sharp, medicinal, like iodine, like disinfectant, like Band-Aids, or like a hot car engine. Despite being distinctive, many people have difficulty detecting this odour.
- Farinaceous – floury or mealy (like poultry feed). This odour is common to many different genera (*Agrocybe praecox*, *Clitopilus prunulus*, some *Inocybe*, some *Tricholoma*) and is pronounced in *Psilocybe subaeruginosa*.
- Foetid – often defined as foul, unpleasant, rancid or rotten (*Amanita*, *Cortinarius perfoetens,* various *Russula* and especially stinkhorns).
- Fragrant, perfumed or fruity (*Craterellus cornucopioides, Lepista nuda*).
- Spermatic, like semen (some *Inocybe* – note all *Inocybe* should be considered toxic).
- Fishy (some *Russula*).
- Like anise (some *Agaricus*).
- Like bitter almond (Some *Agaricus*, for example *A. arvensis*. This species is edible, but some people consider the bitter almond odour makes it unpalatable).
- Like bleach or chlorine (some *Mycena*).
- Like cucumber (e.g. *Mycena epipterygia*).
- Raphanoid or radish-like (e.g. *Mycena vinacea*, *Volvopluteus gloiocephalus*).
- Like raw potatoes (some *Amanita*).
- Like formic acid – which is like squashed ants (some *Amanita*).
- Like fenugreek or curry powder (*Cortinarius austroalbidus*, *Piptoporus australiensis*).
- Like garlic (some *Mycena*, sometimes *Marasmius oreades*).
- Like artichoke (*Cyptotrama asprata*).
- Like bubble gum or boiled sweets (*Entoloma aromaticum*, some *Russula*).
- Like rotting cabbage (*Marasmiellus affixus*).
- Like burnt grass (*Gliophorus graminicolor*).
- Like apricots (some *Cantharellus*).
- Like rotting flesh (stinkhorns such as *Aseroe rubra*, *Clathrus archeri*).
- Like sour milk (*Ileodictyon*).
- Like faeces (*Colus hirudinosus*).

What is the best way to smell a sporophore? Stick your nose in it. Resist the temptation to smell it like you might a rose, by wafting it past your nose at a distance. Smell either the upper side of the pileus (not the lamellae where you are likely to get a nostril full of spores) or the base of the stipe. Odour is often released by breaking the flesh away. Put your nose as close as possible. Make sure you are not going to inhale a millipede and then take sharp deep sniffs, so the scent molecules travel via your nostrils to the scent receptors in the bridge of your nose. These receptors are good at detecting new odours but tend to fatigue quickly, so pause before trying again. If it is cold, placing the sporophore in a container in your pocket to warm it up may make odours more obvious. If it smells vaguely like nicotine or hand lotion, you are not smelling the sporophore. You might also try 'dwelling on your smelling', that is, make smelling deliberate rather than incidental or involuntary. Pay attention to all the different odours as you forage, not just of fungi but all those in your surrounds such as plants, soils, animals and how these change after rain or during intense heat. Describing and naming them and locating their source are good ways of training your nose and your ability to detect more nuanced or subtle fungus odours as well as their associations.

Odours are also powerful memory prompts. Using multiple senses to identify a species locks information more keenly in your memory. Once you have smelt the odours of some particular fungi, both the odour and the name of the fungus will be forever burnished in your memory. If not convinced, try it out with *Aseroe rubra* (and don't say we didn't warn you).

Smell and taste are closely related, but tasting sporophores can reveal characteristics, such as bitterness, piquancy or pungency that are difficult to detect by smell. To reiterate, only those foragers who have a good knowledge of the larger fungi should taste fungi as even small portions of some toxic fungi accidentally swallowed can sicken. Remember when tasting a sporophore that you are NOT eating it, or even tasting it. Rather, the tongue serves as a sensitive organ to test if the sporophore is bitter, acrid, acerbic or causes a burning sensation. To taste a fungus, place a small piece of the pileus on the tip of your tongue for ~10 seconds before spitting it out. Do not swallow. Species like *Lactifluus piperatus* or *Armillaria luteobubalina* will leave a searing bitter burning sensation. You might at this point be asking yourself if you want to use the sense of taste to help identify fungi. As with smell, taste is not a reliable determinant of edibility. Because a particular specimen does not make you feel like your tongue is being singed with a hot iron, it does not mean it is edible.

Safer than taste, make smelling a part of your technique for identifying fungi. Smell is also closely linked to emotions and is hence an effective memory trigger, but that's a whole other book. Remember to take the time to stop and smell the fungi!

The information in the previous pages is not a comprehensive list of sporophore characteristics. It simply provides an impression of the sorts of attributes to consider when reading species descriptions and using diagnostic keys. If you ask these questions and note the details each time you forage, you will gradually accumulate comprehensive knowledge of the range of morphological variation within your target species. Keep in mind that fungus descriptions and dimensions in field guides usually refer to the average size or size range, or most typical morphology under 'normal' conditions. No guide can account for the spectrum of variation within a species. This knowledge comes from your own observation and experience. Do not expect your specimen will necessarily look like the image of that species in your book. Rather, we recommend that you continue to collect information each time you forage for your target species, even when you consider it to be familiar. Some might consider this to be tedious and reduce the pleasure and spontaneity of the foraging experience. However, your identification skills will grow more rapidly, allowing you to move on to learning other edible species. Remember to record your findings in as many ways as possible. Sketches and photographs along with written descriptions help consolidate knowledge. Also note the environmental conditions such as when it last rained and the moistness of the soil – and take a child with you. With their keen eyesight and sense of discovery, children are generally good fungus spotters.

Spore prints

Spore colour is a major diagnostic feature of many keys and field guides. It is generally a more reliable feature than sporophore colour because it is usually less variable. Spore prints are a valuable way to become familiar with the great range of different spore colours. Before you collect the specimen, check to see if spores have accumulated on the stipe or directly beneath the fungus (on soil, wood or vegetation or on the pileus of another sporophore lower down). This is more apparent with some species than others, for example, with the white spores of *Armillaria luteobubalina* (Australian honey fungus), the black spores of *Coprinus comatus* (lawyer's wig), or the rust coloured spores of *Gymnopilus junonius* (spectacular rustgill). If you cannot see any spores, find a suitable specimen with which to make a spore print, that is, one that is not too young or where the lamellae are obscured by a veil, or too dried out, or one that is too old and has ceased to release spores.

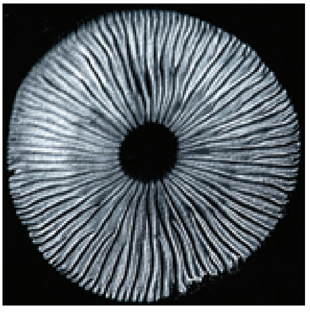
Spore prints can be made in various ways. Given about half of the larger fungi have white spores, white spore prints can be difficult to see on white paper. Therefore, one suggestion is to take a piece of white paper and a piece of black paper and tape them together. Carefully cut the stipe from the pileus using a sharp knife, cutting it as close as possible to the lamellae (or pores etc.). Place the pileus (lamellae side down) on the paper, with the half of the pileus positioned on the white paper and half on the black paper. Cover the pileus with a bowl or glass to prevent drying. Leave undisturbed for several hours. Depending on the age of your specimen, a spore print will appear anywhere between 1 and 24 hours. Alternatively, place your specimen on a piece of glass. A white spore print can then be viewed by placing the glass on a dark background.

Given colour is subjective, spore colour descriptions in field guides inevitably vary to some degree. However, observing spore colour is a good exercise in becoming more exact in recognising and describing colour. For example, describing spore colour simply as 'brown' is not precise enough. The spores of *Cortinarius* are rusty brown, those of *Agaricus* are closer to chocolate brown and those of other species are variously described as purple brown, yellow brown, pale brown, blackish brown, red brown, dark brown, olive brown, light brown, tan brown, grey brown, dingy brown, cinnamon brown, dull brown, pinkish brown or flesh brown. Hence, one needs to look at many different spore colours to get a comparative sense of the extent of variation. Note that spore print colour is affected by the number of spores in the deposit. A spore print with more spores will appear darker (and truer in colour) than one with fewer spores.

What does spore colour tell you? It simply provides another characteristic to help identify a specimen. For example, if your specimen produces a white spore print, you can eliminate all those fungi with differently coloured spores (~50%). Alternatively, if your spore print is pale greyish green, you can eliminate over 99% of fungi. Spore print colours for some of the major genera in this book are listed in the following information box.

Cortinarius spores on a pileus deposited by the mushroom positioned above.

Rust brown spores of a *Cortinarius*.



White spores of the *Oudemansiella gigaspora* group (rooting shank).

Purple brown spores of *Hypholoma fasciculare* (sulphur tuft).

Spore print colour of major genera in this book

White	*Amanita*, *Cantharellus*, *Hydnum*, *Lactarius*, *Lepiota*, *Macrolepiota*, *Mycena*, *Omphalotus*, *Oudemansiella*, *Russula*
Green	*Chlorophyllum molybdites*
Pinkish brown	*Entoloma*, *Lepista*
Chocolate brown	*Agaricus*
Rust brown	*Cortinarius*, *Gymnopilus*
Cinnamon brown	*Austropaxillus*, *Chalciporus*, *Cortinarius*, *Suillus*
Olive brown	*Boletus*
Purplish black	*Hypholoma*, *Psilocybe*
Black	*Coprinellus*, *Coprinopsis*, *Coprinus*, *Leratiomyces*, *Panaeolus*, *Parasola*

Chemical tests

Chemical spot tests can help identify fungi in the field, although are not necessary for the forager seeking the species described in this book. For example, colour changes on application of chemicals such as ammonium hydroxide (NH_4OH), potassium hydroxide (KOH) and iron salts ($FeSO_4$) can differentiate some genera and species of boletes and agarics. Some mycologists carry these reagents in their field kits, as colour changes can be more obvious with fresh specimens. Various chemicals are also used in the preparation of samples for microscopic examination. The fine detail of spores and other fungus structures is usually translucent and can be much seen better when stained. For example, Melzer's reagent stains the ornamentation on spores of *Russula* and its relatives dark blue. Consult mycological texts for more information about reagents and techniques for using them.

Having covered some of the features of fungi, the next chapter examines the ways in which fungi are named and identified.

Chapter 6
Names and identification

Naming fungi

Foragers are often frustrated by the seemingly constant changes to fungus names. Learning new names and giving up old ones might seem unnecessary. However, new names reflect new knowledge and understanding recent discoveries helps to adjust to novel names. There are two main reasons for name changes: nomenclatural and taxonomic.

Nomenclatural changes result from the application of rules about names. One of the rules is that the earliest name for a given species must be used (the principle of priority). Another rule is that there cannot be two species with the same name. Nomenclatural changes are rare, and there are mechanisms to protect the names of well-known species of economic or other importance.

Most name changes are taxonomic and result from changes in how the limits of taxa (such as genera or species) are drawn by scientists. As research reveals relationships, classifications can change. A particular species may no longer fit in its old genus, and may be moved to another genus, or placed in an entirely new genus. For example, when *Coprinus* was restricted to *Coprinus comatus* (and a few closely related species), numerous other species were moved to genera such as *Coprinopsis* (see pp. 118 and 150). In contrast, sometimes the species of two or more genera may be found to belong together in one genus. This 'splitting' and 'lumping' (of both genera and species) is to some degree a matter of opinion. However, all the names adopted in this book are widely accepted by mycologists. For fungi profiled in Chapters 8 and 9, the reasons for adoption of the current name are discussed under the heading 'Classification'.

When classifying fungi, mycologists create taxonomic units based on evolutionary relationships. They aim to create a classification where each genus contains species that are more closely related to each other than they are to species in another genus. This approach is applied across all levels of the taxonomic hierarchy from phylum to genus and section. Reconstructing relationships in fungi is challenging due the paucity of fossils and the frequency of parallel evolution. Similar sporophore forms, such as mushrooms, puffballs and false-truffles have evolved several times in different parts of the tree of life. That these morphotypes were instances of parallel evolution was initially suggested by dissimilarities in microcharacters between sporophores of the same morphotype. Analysis of DNA sequence data confirmed these suggestions and revealed further cases of parallel evolution. For example, the genera *Chlorophyllum* and *Agaricus* both contain a mix of mushroom and false-truffle species.

◄ *Coprinopsis picacea* (magpie inkcap) was moved from *Coprinus* to *Coprinopsis* in 2001.

At the species level, evidence from multiple genes can be used to identify distinct evolutionary lineages, called phylogenetic species. Phylogenetic species, defined on DNA sequence data, may match exactly to species as characterised by morphology, or related phylogenetic species may lack obvious morphological differences. Closely related species that differ in subtle ways are called cryptic species. When species have no or slight morphological differences, they are nevertheless often distinguishable based on their distinct geographical distributions and/or ecologies (such as symbionts, for mycorrhizal species).

DNA

Throughout the profiles in Chapters 8 and 9 you will come across references to the use of DNA sequences in defining the limits of both genera and species. Mushrooms are rather simple structures compared to flowering plants (with all the different combinations of petals, sepals, anthers and stamens etc., along with variation in leaf morphology). DNA is proving especially useful to distinguish species in fungi as it is the blueprint for the organism and codes for all characteristics not just those that are visible.

DNA sequences are also increasingly being used to identify fungi. So-called DNA 'barcodes' are short sections of DNA that can be readily retrieved from samples (sporophores, soil etc.) and vary enough to be diagnostic at species level. Global sequence databases such as GenBank hold millions of sequences (more than 13.5 million, across all genes, for fungi alone). It is possible to take a newly generated barcode sequence and compare it with GenBank for the best match (e.g. using the 'BLAST' program). However, care is needed in interpreting BLAST matches because the degree of similarity required to place a sequence confidently within a species varies across different groups of fungi. In addition, there are numerous species of fungi yet to be sequenced for the barcode, including common and widespread species – therefore a match may not be obtained. Best practice is to lodge a specimen in a reference collection at a botanic garden or department of agriculture to back up DNA-based identification.

Citation of names

Scientific names for fungi follow those for all other organisms, consisting of a genus name followed by a species name (also referred to as a species epithet) – as in *Agaricus campestris*. Groups of related genera are placed in families, which have the ending '-aceae', as in Agaricaceae. Some genera are divided into 'sections', which are groups of closely related species. An example is *Amanita* section *Phalloideae*, containing the deathcap mushrooms such as *Amanita phalloides*. Groups of similar species that are difficult to distinguish on the basis of their morphology are referred to as 'group', as in the *Paxillus involutus* group.

Formal citations for names, including authors and place of publication, can be found in AusFungi (see 'Further reading'). Synonyms are alternative names to the name that is currently accepted and in use. Synonyms may also include alternative generic placements, that is, where a currently accepted name was placed in a different genus in the past. Where synonyms have been used recently, we provide them in parentheses after an equals sign. For example, '*Galerina marginata* (= *G. autumnalis* and *G. unicolor*)' means that all three names refer to the one species, the currently accepted name of which is *G. marginata*.

For alternative generic placements, we provide only the genus name after an equals sign. *Echinoderma asperum* (= *Lepiota*) means that the species currently known as *Echinoderma asperum* was formerly known as *Lepiota aspera*. Note that the ending of the species name may be different in alternative genera. This is because scientific naming conventions require the species part of the name to agree with the gender of the genus.

Field guides

Field guides for fungi differ to those for animals and plants. For example, good bird field guides contain all Australia's bird species. Fungus field guides contain only a selection of Australia's fungus species because there are many thousands of species (even among macrofungi) and many are yet to be described.

At the time of writing, about eight guides to fungi that grow in Australia are in print (along with various fold-out 'quick-guides'). Some of these guides indicate edibility or toxicity for a few species but not consistently within or between guides. Note that knowledge of edibility and toxicity is evolving. Given the state of flux of Australian taxonomy, species names inevitably change from one guide to another. Therefore, it is a good idea to crosscheck names against sources such as the Atlas of Living Australia and AusFungi.

Keys

Diagnostic keys are much more reliable for identifying a fungus than simply comparing it with pictures in field guides. They proceed on the basis of eliminating possible names until you arrive at a match. Keys are a great way to improve your observation skills; however, they take time and patience to learn how to use as they usually incorporate technical terminology.

When using keys try to resist the temptation to 'fit' your specimen to a description when keying out a fungus. One way to minimise this is to write a description and make a sketch of your specimen before you key it out. This lessens the chance of being wrongly swayed by the options as presented in the key. Once you have a name for your specimen, compare the information you compiled with descriptions, illustrations and photographs in your field guides under that name. Also look at closely related species and those of similar appearance, especially toxic lookalike species to ensure you have not misidentified your specimen.

Be aware that keys only include known species. They also cannot usually incorporate the full range of variation within a species. Keys to species of fungi in Australia are mostly found in technical works, although some field guides include keys to selected genera. The multi-access key FunKey provides comprehensive information on the genera of Australian agarics. MycoKey is another multi-access key, covering more than 2600 species of fungi from Europe. While many fungi are widespread at the genus level, Australia has a distinctive mycota and many unique species. Hence, be cautious when using Northern Hemisphere keys as they are likely to contain species that do not occur in Australia, and many species that only occur in Australia (or in the Southern Hemisphere) will not be in those keys.

Chapter 7
Finding fungi

The desire to forage

Imagine the perfect foraging experience. It is an exquisite autumn afternoon and you are sharing the experience with your favourite friends. Best of all, the forest is brimming with mushrooms. It does not take long until your basket is full, but given there are so many more mushrooms, you fill a second and a third basket as well. In all, it is a deeply gratifying experience and you revel in the smug satisfaction of having scored such a bounty. However, somewhere in the distant corner of your mind lurks an annoying flicker of doubt. Wisely, before eating the fungi, you consult a mycologist to be sure you had identified them correctly. That's when everything goes wrong.

The mycologist informs you that your three baskets are full of toxic mushrooms. You then realise it could have gone much more wrong. The crushing disappointment of having collected three baskets of poisonous mushrooms, perhaps heightened by an element of embarrassment, sometimes makes foragers reject being told that they are toxic. However, no matter how much you might want your precious cache of toxic mushrooms to be edible, the power of thought alone cannot render them so. It is common to hear inexperienced foragers comment that a particular mushroom 'looks edible' or 'smells edible', when it is not. While mushrooming has a certain 'intuitive' aspect, and in a sense could be considered an *art* as much as a science, remember that 'intuition' comes from extensive experience and critical observation, not from the possession of a special mushroom-intuition gene. Be wary of those who claim an 'intuitive' or 'instinctive' ability to recognise edible mushrooms. Likewise, be alert to those deemed as 'expert' simply because their country of origin has a mushrooming tradition. The French, for example, have long traditions of foraging and many French foragers know a lot about fungi, that is, fungi that grow in France. In comparison, Australia has far more as well as different species and little is known about their edibility and toxicity.

In addition to lack of knowledge, some other challenges exist for foragers in Australia including managing expectations, disappointment and risk.

Managing risk and setting expectations

All activities, including mushroom foraging, involve risk. Every forager needs to consider the risks involved. Foraging risks can arise from various sources such as those associated with activities in outdoor environments, but in this instance, we refer to risks related to the confusion between edible and toxic species.

The best way to manage risk is to accept total responsibility. In some countries such as Switzerland, foragers can reduce risk by seeking help from an expert such as a Pilzkontrolleur

◄ Basket of mushrooms.

(mushroom inspector). While such experts are a great boon in minimising poisoning risk and sharing their knowledge with novices, there are limitations to these types of quick transactions where the edibility or toxicity of a species is simply confirmed. While the forager can enjoy the certainty and confirmation of the edibility of a specimen presented, this does not guarantee the forager then has the knowledge to identify edible species themselves.

The information in this book aims to inform the reader of the inherent risks of foraging and how to manage those risks. Developing skills for the accurate identification of fungi is the starting point. We provide the most recent scientific information about the edibility and toxicity of particular species that grow in Australia. However, each person must make the decision whether to forage or not, based on the inherent risk. Your level of skill and the choice of foraged species can reduce the risk, but *not* foraging is the only way to eliminate that risk. There is always the option to enjoy a forest wander and then purchase mushrooms from the supermarket on the way home.

While the number of toxic fungus species in Australia is likely to be low, some known toxic species such as *Agaricus xanthodermus* (yellow stainer) are relatively common and abundant. They also typically grow in areas of high human population density such as urban areas. Deadly toxic species are relatively few. However, the deadly toxic *Amanita phalloides* (deathcap) is also relatively common and abundant, especially in urban areas, and appears to be increasing in distribution. Risk differs for each individual depending on the target species and the likelihood of confusion with toxic lookalike species. For example, *Lactarius deliciosus* (saffron milkcap) is less likely to be confused with toxic lookalike species compared with edible *Agaricus* (field mushrooms), which have fewer distinguishing features and are therefore more difficult to distinguish from their toxic lookalikes. Foragers can reduce risk by carefully targetting edible species that have many obvious distinguishing features and few toxic lookalike species (e.g. *Coprinus comatus*, lawyer's wig). It is a gradual step-by-step process of starting with species appropriate to your level of knowledge and skill.

In addition to managing risk, foragers need to set their expectations realistically, especially regarding the number of mushrooms they are likely to find. In Europe and North America, sporophore productivity can be high, as attested by the piles of edible sporophores collected on single outings. We observe that although mushroom species diversity is high in Australia, sporophore productivity in native forests is generally relatively low. In contrast, productivity of exotic mushrooms in plantations of exotic trees, such as pines, can be much higher. Watering of lawns and gardens can also increase the likelihood of finding mushrooms.

Systematic observations are not available across different Australian climate zones, but relatively low sporophore density could relate to the dryness of the climate and the highly variable and unpredictable weather. Indeed, the high diversity of truffle-like fungi, even in temperate regions of Australia, can be considered an evolutionary response to climate extremes and uncertainties. Finding low numbers of sporophores, even at the 'peak' season, can result in disappointment when Australian foragers' expectations are based on a European ideal, rather than an Australian reality. Media accounts of foraging that portray European rather than Australian situations contribute to misconceptions. Foragers are encouraged to set reasonable expectations about the number of sporophores they might find and remember that the typical elusiveness of many Australian fungi is part of the thrill of the hunt.

Is foraging a dangerous pastime? Only if you are a poor observer or take a lackadaisical approach. While the probability of confusing an edible species with a deadly toxic one is relatively low (because few species are deadly), the implications of doing so can be fatal (i.e. low probability, high impact). Foraging is a slow and careful process of identifying and eliminating. It is a gradual acquiring and building of knowledge. It is a craft. If you are judicious and attentive, it is not so difficult to differentiate a handful of edible species. The following information will help get you started.

How to find fungi – what to look for and what to ask

Developing the skills to find fungi requires slowness, not speed. The beginner forager is often recognisable by the frenzied pace with which they dash from one spot to another. However, important details are often lost with haste. Finding fungi combines mycological knowledge, patience and attentive observation of fungi and their habitats. By recording your observations about the range of morphological variation within a species, as well as the range of habitats in which it grows, your identification skills improve. This archive of knowledge increases your ability to anticipate when and where particular fungi are likely to be found. For example, *Macrolepiota clelandii* (Australian parasol) often appears early in the season and frequently in disturbed, human-modified environments such as grassy road verges, parks and gardens. Searching for a particular species rather than for just any fungi sharpens your focus. It also provides the gratification of finding the species for which you were searching. While you only want to collect the best specimens, observe all those that you find, noting their different developmental stages and how the species responds to different environmental conditions.

As you wander through the environment, become attentive to your surrounds and how they influence the distribution of your target species. Consider the following.

Substrate type

Does the target fungus grow in soil, wood, leaf litter, grass, or dung?

Does it grow on living trees or standing or fallen wood? If on living trees, whereabouts on the tree does it grow?

If on wood, what sort of wood? If on fallen wood, note whether the wood is in an early or advanced state of decay (use your knife or a finger to probe wood to assess the state of decay).

If growing in the ground, is the ground disturbed, damp or dry? Is there a leaf litter layer and is it scant or deep?

Are there signs of fire? If so, are they recent?

Associated vegetation

Is the target fungus among grass in a lawn or in an environment with trees? If near trees, is it in association with particular tree genera? Remember that the root system of a tree can grow beyond the edge of the canopy and mycorrhizal fungi extend the tree root system even further. Therefore, note all the tree species within the vicinity of the sporophore as it might not be growing in association with the tree species closest to which you find it. This is particularly important if you are foraging along the edges of two different habitat types, such as where a pine plantation adjoins native bush.

Growth form

Does the target fungus species grow singly (solitary) or gregariously and is it in clusters or in a ring? How many sporophores did you see?

Note any other historical or prevailing environmental conditions or details that could influence the distribution of your target species.

When asking these questions, the answers will be revealed by using multiple senses as described in Chapter 5.

When to find fungi

The appearance of sporophores is often unpredictable. Not being sure of what you will find is what lures foragers continually back to the bush. As seasons become more variable, it is increasingly difficult to predict when and where to find sporophores. Temperature and rainfall are two of the most important determinants for triggering sporophore production. As these fluctuate within and between years, so does the reproductive response of fungi. Time and experience help us anticipate when and where sporophores are likely to appear, by accumulating observations of habitats and conditions in which they grow. Of course, there is often an element of luck and being 'in the right place at the right time'.

Almost all the fungi described in this book appear in autumn in southern Australia, although they can pop up at other times of the year depending on environmental conditions. As with plants and animals, fungi have various 'reproductive strategies'. Some fungi reproduce early in the autumn (e.g. *Agaricus bitorquis*) and some towards the end (e.g. *Lepista nuda* and *Hydnum crocidens* group). Others (e.g. *Morchella*) appear in spring. Depending on the weather, some will have several 'flushes' throughout the autumn (e.g. *Lactarius deliciosus*). In the case of extreme dryness, some fungi will not produce any sporophores at all in some years. Generally speaking, sporophores appear earlier in the season in wetter forests (e.g. temperate rainforests in Southern Victoria) than in drier woodlands and forests (e.g. box and ironbark woodlands in Northern Victoria). Likewise, sporophores tend to appear earlier in exotic plantations (e.g. *Pinus radiata* plantations) than in native bush. Climate varies considerably over the continent and in northern Australia the mushroom season is earlier, peaking in February. Most sporophores are short lived. Some last only hours and others such as bracket fungi can persist for several years. Sporophores of fleshy macrofungi typically last from several days to a couple of weeks.

Online resources such as the Atlas of Living Australia (ALA) and iNaturalist contain records of when and where different species have been found. Study these and note when most records were made for your species of interest. For example, most ALA records for *Macrolepiota clelandii* (Australian parasol) are in May, with fewer records for the other months. These records can be helpful in giving you an impression as to when particular species are likely to appear, but the best records are your own observations.

Where to find fungi – fungus habitats and distribution

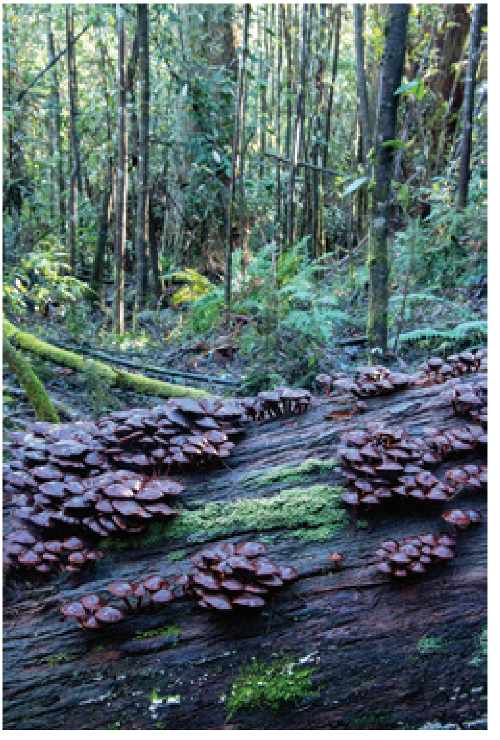
This book is aimed at fungus foragers in the southern temperate region of Australia. Given that most fungi are widely distributed, many species will also be found in northern Australia. Several species in this book also occur in other regions of the Southern Hemisphere and many have global distributions.

Australia's climate and landscapes are highly variable. This contributes to not only the megadiversity of fungi but also their unpredictability. Fungi have colonised almost every terrestrial habitat on the planet, as well as freshwater and marine habitats. They are found from sand dunes to alpine tundra. Most of the edible species in this book grow in woodlands and forests (often referred to simply as 'the bush'), grasslands, exotic plantations or human-modified environments such as parks and gardens. The ways that fungi feed, whether saprotrophic or mycorrhizal, influence where they are found.

Many fungi in this book such as *Agaricus* species, *Coprinus comatus*, *Macrolepiota clelandii* and *Marasmius oreades* are saprotrophic (feed on dead organic matter) and commonly appear in grassed areas, although they also grow in a range of different environments. Experienced foragers do not just look for sporophores but also for clues that they might be present or soon appear. For example, with some saprotrophic fungi, as the mycelium feeds and expands, distinctive 'rings' of darker or lighter grass are apparent, even before the sporophores appear above the ground (see fairy rings under *M. oreades* on p. 174).

Environments can be more or less favourable to fungi depending on how they are 'managed'. Grass in parklands, golf courses and agricultural areas is usually irrigated or treated with nitrates and phosphates (fertilisers) or other chemicals. Fungi can be sensitive to fertiliser and chemicals. One species that appears to tolerate these additives is *Agaricus xanthodermus* (yellow stainer), a species you definitely do not want to eat.

Forest management practices also influence the presence of fungi. Inappropriate fire regimes (too hot, too frequent, too extensive) limit most other than pyrophilous fungi (those adapted to fire) at least in the short-term. Poor forestry practices such as clear felling, or selective felling that causes the destruction of non-target trees, understorey vegetation and soil compaction, negatively affect fungi. The extent of habitat disturbance also influences the composition of fungus species. Forestry practices that cause high levels of disturbance can inadvertently provide favourable conditions for some fungi (e.g. *Armillaria*) while limiting or eradicating others. Loss of canopy reduces organic matter destined for the forest floor. Consequent increased sunlight exposes the forest floor to drying, and favours 'weed' species such as blackberry. Forests subjected to destructive activities such as trailbike riding, four-wheel driving, grazing by hard-hooved mammals or other activities that cause soil compaction and vegetation destruction are usually not ideal places to look for fungi. Some fungi such as *Fistulina hepatica* (beefsteak fungus) and *Pleurotus ostreatus* (oyster mushroom) depend on old wood. Foresters and gardeners who 'tidy up' remove the habitat and food source necessary for the survival of these fungi. Observe and research your foraging environments and become aware of how these activities influence the likelihood of finding fungi.

Other fungi in this book such as *Boletus edulis* (penny bun), *Suillus luteus* (slippery jack) and *Lactarius deliciosus* (saffron milkcap) grow in mycorrhizal relationships with particular trees. Knowing which tree genera or species they occur with determines where to forage. This knowledge also helps to eliminate potential lookalike species that have different mycorrhizal partners. For example, *L. deliciosus* grows in association with the tree genus *Pinus* (pine) including the plantation species, *P. radiata* (radiata pine). The toxic *L. pubescens* (downy milkcap) forms a relationship with *Betula* (birch). If you are foraging in a pine plantation, you will not find *L. pubescens*; however, if you are in a garden with both *Pinus* and *Betula*, both fungus species could be present and you need to be sure you can differentiate them (see p. 145).

Fungi grow in the bush but also in urban environments such as parks and gardens, especially those that have been mulched. In the words of mycologist, Else Vellinga, woodchips are 'fast food' for fungi. Keep in mind that gardeners armed with chemical sprays, as well as dogs, frequent those environments too. If you chance upon some edible fungi, ensure they are not growing in an area that could be contaminated.

The adjacent images illustrate some of the many habitat types in which different fungi grow.

Where can you forage? The legalities of collecting fungi

Although fungi grow in a great range of habitats, in short, do not forage in places where it is not allowed. Environmental protection laws and regulations in Australia are convoluted and administered by several legislative instruments and regulatory bodies at all three levels of government. National parks, state forests, state parks and conservation reserves are all regulated differently. The situation is complicated further because fungi are usually wrongly classified as plants and are rarely explicitly mentioned in conservation and biodiversity protection initiatives. However, as part of biodiversity, fungi are implicitly protected (even if not explicitly mentioned) by the same laws that protect native animals and plants on all public land in Australia. Removing any lifeform from any public land and particularly from any national park or conservation reserve in Australia is prohibited. Breaching the law can have significant consequences.

Permits to collect in conservation reserves are available in each state and territory, but these are for scientific or educational collection of fungi and are not relevant to most foragers. Therefore, the best option is simply to forage on private land. If it is not your land, you will require permission of the landowner to do so, otherwise you could be criminally charged. Inform yourself and know what you are doing. If foragers are respectful of these protocols and laws, then hopefully the strict foraging regulations that exist in other countries will not be necessary in Australia. It will also contribute to the conservation and ongoing survival of fungi – and hence foraging – as discussed in Chapter 3.

◄ Clockwise from top left: *Geastrum* (earthstars) growing in a *Pinus radiata* (pine) plantation; Fallen trees in wet native eucalypt forests provide habitat for a great range of saprotrophic fungi, including these *Hypholoma*; Woodchips favour early colonising species in genera such as *Agrocybe*, *Coprinopsis*, *Leratiomyces*, *Psathyrella*, *Psilocybe*, *Stropharia* and *Volvopluteus*, to name a few; Mycorrhizal fungi (*Russula*, *Tricholoma* and others) growing in association with exotic conifers in parkland.

Code of practice for foragers

The aim of a code is to recommend practices that minimise disturbance to fungi and their environments. Most of these principles are simply common sense and courtesy.

- Seek permission from the property owner if not on your own land.
- Cause minimal disturbance to the environment. Do not disturb soil, leaf litter, remove wood or turn over logs and not replace them.
- Check that the area you are collecting from is not contaminated (e.g. verges on busy roads, old landfill tip sites, highly managed parks, gardens or golf courses).
- Only collect target species and take only as many as you will consume that day. Leave plenty for wildlife.
- Allow sporophores time to release their spores by not collecting immature sporophores (buttons). Buttons can be difficult to identify as they often have not yet developed important diagnostic features and can be easily confused with toxic fungi.
- Carry a field guide such as this one and identify fungi *in situ*.
- Respect and protect all fungus species including poisonous ones.
- Fungi are appreciated by different people for different reasons, often simply for their beauty. Consider their interests too and be sure to minimise the visual effects of your harvesting (e.g. do not leave sporophores overturned. Dispose of any 'trimmings' or offcuts discretely in the immediate area).
- Take all your rubbish home (such as latex gloves worn by some foragers).
- Be aware of local laws and by-laws.

Foragers sometimes upset conservationists, mycologists and others by not being discriminate enough in what they collect. In their eagerness to maximise a haul of fungi, some foragers collect every sporophore they encounter, then separate edible from toxic species later. Others get over-zealous and collect more sporophores than they can possibly consume. Therefore, to keep the peace with all those interested in fungi, including the great range of fungivorous animals, be discriminating. Collect only edible species, only as many as you can consume that day, and only specimens in the best condition.

A suggested 'code of practice' for common sense foraging is outlined in the information box above.

Collecting fungi

Do your preparation before you leave, so you know where to go (including any necessary permissions to be on the land), when to go, and which species you are seeking.

Although autumn weather is often mild and stable, foraging in Australia's highly variable climate means accepting the discomforts and uncertainties of unexpected weather and bush conditions. Be prepared and suitably attired. Be aware of risks and dangers, and carry everything you need including food, water, first aid and whatever equipment and devices you need to find your way and communicate if necessary. If you are inexperienced in the bush, develop basic bush survival skills and ensure you have the basic gear.

Experienced foragers leave no trace of their presence. Be careful not to disturb the environment when traversing the forest or removing sporophores. Opinions differ about

Equipment and safety checklist for foragers

For collecting, carrying and transporting fungi:
- a knife
- a small brush to remove any debris from the sporophores in the field (or a knife with blade and brush)
- a wicker basket
- a compartmentalised box (e.g. tackle box) for keeping specimens separate (only use for transporting rather than storing specimens as they do not 'breathe' and specimens will be prone to bacterial decomposition)
- paper bags, waxed paper or tinfoil (for separating specimens for later identification).

For identifying and recording information:
- a field guide or app (note many apps require internet reception, which you might not have in the field)
- a field notebook – important for the dedicated and serious forager
- a camera or mobile phone
- a ×10 hand lens
- a small mirror (for viewing the underside of mushrooms without having to remove them from the substrate).

For comfort and safety:
- appropriate field clothing
- water and food
- maps, compass and GPS
- first aid kit
- means of communication (e.g. mobile phone)
- matches, sunscreen, insect repellent, salt (for leeches).

To avoid introducing pathogens:
- only enter the bush with clean boots and equipment as contaminated gear can introduce pathogens such as myrtle wilt
- ideally, disinfect boots and gear with 70% methylated spirits before entering and leaving a site

whether to cut or to pull a sporophore out of its substrate. The answer depends on your level of skill in identifying fungi. If, for example, you have collected saffron milkcaps for a good while and can confidently separate this species from other toxic fungi (e.g. *Austropaxillus infundibuliformis*, *Gymnopilus junonius*, *Lactarius pubescens*, *Paxillus involutus* group or orange *Cortinarius*) you might prefer to cut through the stipe above the base. This minimises disturbance to the ground and mycelium and also keeps dirt and debris out of the lamellae, making it easier to prepare for cooking. However, if you are less skilled at identifying fungi, remember that for many species the stipe, and in particular the base of the stipe, has many important identification features. Therefore, it is best to remove complete sporophores from the ground so you or an expert can examine them in their entirety.

If you are learning a new species and want to take specimens home to examine later, keep them separate from the edible species in your basket. Only collect for your own personal use. Resist collecting for your neighbour or others who might be less excited about receiving the excesses of your marvellous bounty. Only collect larger quantities if you are committed to drying or pickling them, have the time, and are set up to do so.

Collect perfect specimens that are not too young or too old. Immature specimens can be difficult to identify if the important diagnostic features are not yet apparent. They will also not have released their spores. In the same way you would not select an apple at the market that was bruised and damaged and beyond its best, pick only sporophores in perfect condition. Other than losing their characteristic flavour and texture, older specimens will have already begun to decay and are likely to harbour other fungi (such as moulds on the surface), bacteria and invertebrates such as fly larvae.

If you enjoy wild fungi but do not have the skill to forage for your own, purchase them fresh from speciality shops, markets and some greengrocers. Usually only a limited range of species is available, mostly *Lactarius deliciosus* and *Suillus* spp. Wild dried fungi from other countries such as *Boletus edulis* are available in Australia. In addition, various pickled wild mushroom products are available in supermarkets and speciality food shops. Dried and pickled wild mushrooms from Europe and elsewhere are often sold in mixtures. We do not recommend mixing different species from your own collections until you are proficient at identification. However, commercial mixtures can be an interesting way to sample different species. See also information on cultivated fungi in Chapter 9.

Foraging for edible fungi is an incredibly satisfying and rewarding pastime. It fulfills desires to be self-sufficient and rekindles the childhood joy of the 'treasure hunt'. For many people, it is an opportunity to spend time outdoors with friends and family. Wandering through the forest on an autumn afternoon in focused pursuit of your dinner can become an all-consuming obsession, albeit a healthy one. Claims about the nutritional and health benefits of fungi abound. Regardless of whether you find edible fungi or not, the greatest health benefit arises from the experience of being in the bush and the feeling of wellbeing this inspires. Most important of all, enjoy the foraging experience and the opportunity to discover Australia's unique and diverse mycota.

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Chapter 8
Poisonous fungi

Fungi produce a great array of complex chemical compounds. While many have been harnessed by the medical and pharmaceutical industries for our benefit, others can be dangerously harmful. A mushroom toxin is defined here as any compound that produces an abnormal effect on the body. Mushroom poisoning (mycetism) occurs when mushrooms containing toxins are ingested. This chapter provides information and advice about toxic fungi with the aim of reducing risk to foragers.

The exact number of species worldwide that are toxic to humans is unknown, although 100 species is a commonly cited estimate. This is probably an underestimate given over 400 species are reported as poisonous in China alone. In Australia, few species have been confirmed as toxic, but some toxic species such as *Agaricus xanthodermus* are relatively common and can grow in great abundance, often in urban areas where many people could encounter them.

No simple rules exist for distinguishing edible mushrooms from poisonous mushrooms. To minimise poisoning risk, always assume a mushroom is toxic, unless an authoritative source definitively states it is edible. While the edibility/toxicity of many Northern Hemisphere species is reasonably well established, it is not possible to directly extrapolate this knowledge to Australian fungi. We simply do not know whether native Australian species are toxic until someone consumes them. To complicate matters, some genera (such as *Amanita*) contain both highly toxic and esteemed edible species. Even in groups that contain many edible species, such as the boletes, a few species in various genera (such as *Neoboletus* and *Rubroboletus*) are toxic.

Poisoning risk from consuming fungi is commonly overstated. Severe cases of mushroom poisoning and fatalities are extremely rare in Australia. Gastrointestinal distress is the most common outcome from eating poisonous mushrooms. Mushroom poisoning often receives alarmist press that creates misunderstanding about risk and overshadows the far greater number of poisonings from common household products. While incidences of poisoning from mushrooms in Australia are relatively few (although probably under-reported), they are likely to increase with the growing interest in foraging.

The chance of consuming a toxic fungus is relatively small, but the outcome can be catastrophic or fatal. The consumption of even a small portion of some toxic fungi can cause organ damage or death. Symptoms caused by certain mushroom toxins can be extremely traumatic and distressing with few treatment options available. Hence, every forager should first learn the toxic species, especially those that are potentially fatal. If you do not have sufficient knowledge about fungus identification or are uncomfortable with your level of risk, do not forage for fungi.

◄ The deadly poisonous *Galerina marginata* (funeral bell).

Causes of fungus poisoning

Poisoning from eating mushrooms occurs for various reasons and in various circumstances as summarised below.

Mistaken identity

Mushroom poisoning most commonly occurs when a poisonous mushroom is confused with an edible one of similar appearance. In Australia this mostly occurs when *Agaricus xanthodermus* is confused with edible species of *Agaricus*; *Omphalotus nidiformis* is confused with edible *Pleurotus*; or toxic species of *Chlorophyllum* are confused with edible *Macrolepiota*.

Mistaken identity involving hallucinogenic mushrooms

There have been cases of people intending to collect a hallucinogenic mushroom but experiencing severe symptoms after eating a different toxic fungus, collected by mistake.

Accidental ingestions by children

Situations involving young children account for the majority of calls to poisons information centres in Australia about fungi. However, there are few confirmed cases where ingestion of known toxic mushrooms produced symptoms consistent with the species involved. First, this is because children rarely ingest mushrooms, even when observed with mushrooms in their mouths. Second, the mushrooms involved are typically common species of parks and gardens, many of which are innocuous (e.g. *Bolbitius titubans*, *Coprinellus micaceus*), although some are toxic (e.g. *Amanita muscaria*).

Insufficient information

Some poisonings occur when people eat toxic fungi that they consider to 'look' or 'smell' edible.

Sensitivity

Many widely eaten and well-known edible mushroom species are reported as causing symptoms in some people, usually at low rates of around one or two in 100. These unusual reactions are sometimes referred to as 'allergies' to certain species. However, true allergic reactions involve the immune system. Hence, unless immune responses are confirmed (see next paragraph), unusual reactions are best referred to as sensitivity of the digestive system. Potential causes of heightened sensitivity to certain mushrooms include: (1) dose-related effects, where modest amounts do not elicit symptoms, but large amounts do, (2) interactions with alcohol or medications, and (3) differential production of enzymes that metabolise compounds (either breaking down toxins, or producing toxins from harmless precursors), which could be genetic or environmentally mediated. One example of sensitivity is a rare inherited condition where absence of the enzyme trehalase leads to an inability to metabolise the sugar trehalose, found in most fungi. Another example is morel neurologic syndrome, an unexplained phenomenon experienced by a small proportion of people consuming morels in the genus *Morchella*.

Allergic reactions

Just as plant foods can cause allergies in a small number of people, some mushrooms appear to cause genuine allergic reactions. In susceptible people, handling sporophores can cause reddening, swelling and itching of the skin. For example, the slimy covering of several species of *Suillus* can cause contact dermatitis. However, some instances of dermatitis, such as Shiitake mushroom dermatitis are considered not to be allergies but are a delayed response to particular compounds, in this case lentinan. A particular immune response, the Paxillus syndrome, is responsible for a potentially fatal outcome from consuming members of the *Paxillus involutus* group. Repeated consumption stimulates an autoimmune reaction leading to haemolytic anaemia.

Contamination

Poor handling, collection, transport, storage or processing of mushrooms can lead to contamination. Food poisoning can be caused by contaminating microorganisms rather than toxins inherent in the mushroom. Contamination of mushrooms by bacteria (e.g. *Clostridium*, *Salmonella*, *Staphylococcus*), or fungi (e.g. moulds) may cause food poisoning due to growth of microorganisms in the body and/or by introducing toxins produced by them. Such poisonings typically result in short-lived gastrointestinal distress manifesting as nausea, vomiting and/or diarrhoea. The authors have personally observed the regularity with which foragers collect edible mushrooms in poor condition. This could result from unfamiliarity with how a mushroom in good condition should appear; reluctance to discard an edible mushroom one was able to identify, regardless of condition; or a lack of knowledge about correct methods for storage, transport and cooking. The fact that most people are able to select fruit and vegetables in good condition suggests a tension between expectation and disappointment. Hence, it is important for foragers to set their expectations realistically and only collect mushrooms in prime condition. In several European countries, contamination is the primary cause of poisoning from eating mushrooms.

Boletus edulis in prime condition and beyond its best.

Macroleptiota clelandii in prime condition.

Toxicity unrelated to the fungus

Innocuous mushrooms are sometimes wrongly blamed as the cause of food poisoning. This can occur when mushrooms are consumed as part of a meal containing foods such as meats or seafood, which are the more likely cause of the toxicity, due to microbial or other contamination.

Environmental toxins

Fungi can absorb and retain environmental toxins. Mushrooms picked from contaminated environments could contain residues of petrochemicals, herbicides, fungicides, pesticides, heavy metals, faeces, urine or other contaminants. For example, spraying with glyphosate (that often contains a dye) is implicated in reports of green *Agaricus* mushrooms in Australia. Processes such as washing, boiling and drying can decrease residues of some toxins for some mushroom species. However, picking mushrooms from uncontaminated environments is safer.

Over-consumption

Symptoms of indigestion from over-consumption of mushrooms are commonly confused with poisoning. Mushrooms contain chitin, a molecule that is largely indigestible. Even small quantities of edible mushrooms can cause indigestion for some people, hence enjoy them in modest amounts.

Psychosomatic effects

Sometimes people suffer psychosomatic symptoms after eating edible mushrooms because of doubt and subsequent anxiety about possible toxicity.

Fungus toxins, syndromes and symptoms

Every forager should be familiar with the symptoms caused by the major types of toxins, so as to be able to respond in suspected cases of poisoning. A new integrated classification system for mushroom poisoning has been recently developed by a team of international researchers, led by Australian clinical toxinologist Julian White. An overview of the system was published in 2019 (see 'Further reading'). The system includes 21 distinctive poisoning syndromes, arranged under six broad groups. Poisoning is classified based on clinical presentations (signs, symptoms and condition of patient). Full understanding of the syndromes requires an advanced level of medical knowledge. We have summarised pertinent information, listing toxins (where known), some of the more common and/or readily detectable symptoms and associated fungus species. Additionally, we contextualise the syndromes by indicating which species are known to occur in Australia. Although many of the species listed under the various syndromes do not occur in Australia, untested Australian native species could contain similar or as yet unknown toxins.

The new classification developed by White and colleagues incorporates new knowledge for better patient outcomes. Some older systems used the time from ingestion to the development of gastrointestinal symptoms as a reliable indication of prognosis. That is, a

Advice for minimising mushroom poisoning

- Folklore abounds with adages for differentiating edible and toxic fungi. Most arose before any scientific understanding of fungi existed. Moreover, almost all those we hear in Australia originated elsewhere and are not relevant to fungi that grow in Australia.
- Be wary of misguided generalisations about particular morphological features, colours or scents supposedly equating with edibility.
- Only trust suitably knowledgeable people when seeking help with mushroom identification. Misplaced trust and other people's mistakes have led to fatalities. Likewise, remember that wishful thinking does not render a toxic mushroom edible.
- Humans respond to toxins in different ways; tolerances and symptoms may vary in how they manifest. Babies and toddlers, the elderly and people in poor health are especially vulnerable.
- Note that pre-existing and concurrent medical problems (e.g. renal failure, immune system disorders, lupus) may cause unusual symptoms in association with mushroom poisoning. Interactions with medications can also affect responses.
- Be aware that different species of mushrooms can grow close together. The sporophores of edible *Lactarius deliciosus* and toxic *Amanita muscaria* often grow so close they are touching.
- Novice foragers should avoid all small brown mushrooms.
- Never make assumptions about the edibility of a mushroom that looks similar to an edible species you have picked in another country.
- Be aware that edible and deadly species can exist within the same genus (e.g. *Amanita*).
- Never eat wild-picked mushrooms raw.
- If submitting mushrooms for identification (such as to a fungarium), collect them in a separate container to your edible mushrooms. To assist their accurate identification, be sure to label and prepare them in accordance with instructions from the institution.
- Photograph sporophores in the field to aid identification.
- When eating a mushroom species for the first time, consume only a very small quantity.
- Only eat on species. Allow 72 hours before eating another species because if toxins are present, it can take this long for effects to manifest. Always keep and refrigerate some uncooked specimens for identification by a mycologist if symptoms develop.

short latent phase (up to 6 hours) before expression of symptoms was thought to indicate a better outcome (i.e. less likely to be a severe toxin like amatoxins that are more often characterised by a delayed reaction). While the time between ingestion and onset of symptoms is important to note, it does not necessarily predict outcomes, because some patients with early gastrointestinal symptoms develop significant systemic toxicity. Also note that as knowledge about toxicity evolves, some species once considered edible (e.g. *Paxillus involutus* group) have since been found to be poisonous, even fatal.

The new classification presents an organised strategy to assist patient care decisions. This book provides information for species identification, not patient care strategies, hence we do not address treatment for poisoning (see p. 81 for advice if poisoning is suspected). The time periods until symptoms manifest that are mentioned in the text below refer to post-ingestion.

Group 1 – Cytotoxic (cell destroying) mushroom poisoning

Toxins in this group cause major specific internal organ pathology, leading to liver damage (hepatotoxicity) or kidney damage (nephrotoxicity).

Group 1A – Primary hepatotoxicity

Suspected toxin: Amatoxins, comprising at least eight toxins (including various amanitins) that cause potentially lethal hepatotoxicity even in low doses.

Symptoms: Amatoxins inhibit protein synthesis, affecting cellular function. Tissue throughout the body may be damaged including the heart, brain, lungs, intestines, pancreas, adrenal glands and muscles, either directly, due to the amatoxins or as a result of liver and/or kidney failure.

Amatoxins are of most concern to foragers due to the difficulty of quick detection because symptoms are commonly delayed (by which time toxins have been absorbed by the body).

A typical scenario manifests in four stages:

1. After 6–24 hours, amatoxins affect kidneys and liver although usually no symptoms are apparent.
2. Gastrointestinal distress occurs that might include violent vomiting, bloody watery diarrhoea and severe abdominal cramps, typically followed by dehydration, accelerated pulse and lowered blood pressure.
3. Symptoms often subside for 24–48 hours and it might appear the patient is in recovery.
4. A relapse then occurs, followed by jaundice and liver and kidney failure. Coma and death could follow.

Fungi: *Amanita*, notably *A. phalloides*, also *A. verna*, *A. virosa* and others; *Galerina*, including *G. marginata*; *Lepiota*, notably *L. brunneoincarnata* and *L. helveola*; and *Pholiotina*.

Australian context: Species in Australia known to contain amatoxins include *A. phalloides*, *G. marginata* and members of the *L. helveola* group. Other species in these genera have not been systematically tested and could potentially contain amatoxins. *Amanita phalloides* is responsible for the majority of fatalities in Australia. Poisoning cases in Australia have also been attributed to members of the *L. helveola* group.

Group 1B – Primary nephrotoxicity

Suspected toxin: Aminohexadienoic acid (AHDA).

Symptoms: Direct renal damage as an acute effect.

Fungi: e.g. *Amanita pseudoporphyria* and *A. smithiana*.

Australian context: There are no reports of AHDA occurring in Australian *Amanita* but given the diversity of the genus (>100 species already known), AHDA-containing species could exist.

Group 1C – Delayed primary nephrotoxicity

Suspected toxin: Orellanine.

Symptoms: Delayed renal failure, 4–15 days post-ingestion.

Fungi: Orellanine is known from members of *Cortinarius* section *Orellani*, notably the Northern Hemisphere *Cortinarius orellanus* and *C. rubellus* (= *C. speciosissimus*).

Australian context: The Australian species *C. eartoxicus* contains orellanine. A case of renal failure following consumption of *C. eartoxicus* in Tasmania has been documented (see p. 77).

Group 2 – Neurotoxic (nerve tissue-affecting) mushroom poisoning

Neurotoxins incorporate a broad group that cause primary neurotoxicity.

Group 2A – Hallucinogenic mushroom poisoning

Suspected toxin: Psilocybins, psilocins, gymnopilins.

Symptoms: Psilocybins, psilocins, gymnopilins and related compounds cause hallucinations and other psychoactive effects. Symptoms generally occur rapidly (10–30 minutes) and include illusions (visual, auditory, or tactile), true hallucinations (less than 50% of cases), altered sense of time and space and euphoria. Other symptoms can include aggression, fear, anxiety, ataxia (loss of coordination), pupil dilation, nausea, vomiting, parasthesia (prickling sensation), tachycardia, hypertension, cardiac arrhythmias and myocardial ischaemia (reduced blood flow to the heart).

Fungi: Species of genera such as *Conocybe*, *Copelandia*, *Gymnopilus*, *Panaeolina*, *Panaeolus* and *Psilocybe*.

Australian context: Species within the above-mentioned genera occur in Australia. Symptoms have been attributed to consumption of several species including *Copelandia cyanescens* (= *Panaeolus*), *Panaeolina foenisecii* (= *Panaeolus*), *Psilocybe cubensis* and *P. subaeruginosa*.

Group 2B – Autonomic toxicity mushroom poisoning

Suspected toxin: Muscarines.

Symptoms: Appear rapidly (15 minutes–2 hours) and typically last for several hours. They include the triad of increased salivation, sweating and lacrimation. Other symptoms can include gastrointestinal distress including nausea and vomiting, confusion, euphoria, loss of muscular coordination, decreased blood pressure, profuse sweating and chills, visual distortions and a feeling of strength. Recovery is usually within 24 hours, but death can occur from respiratory failure, although this is rare.

Fungi: Species of the genera *Clitocybe*, *Inocybe* and *Mycena*. Muscarine also occurs in negligible quantities in *Amanita muscaria*, *Boletus*, *Hygrocybe*, *Lactarius* and *Russula*.

Australian context: Species in all these genera occur in Australia, but toxicity of native species is almost completely unknown. At least one exotic *Inocybe*, *I. curvipes*, has caused poisoning in Victoria. A case from Queensland involving autonomic toxicity mushroom poisoning was suggested to be caused by a mushroom possibly belonging to the genus *Rubinoboletus* (see p. 79).

Group 2C – Central nervous system neuroexcitatory mushroom poisoning

Suspected toxin: Muscimol and ibotenic acid.

Symptoms: Neuroexcitatory effects, sometimes including hallucinations. Symptoms occur rapidly (within minutes to 3 hours) and can be highly variable, often including a drowsy period followed by manic excitement, elation, disorientation and agitation. Other symptoms may include nausea, vomiting, diarrhoea, abdominal pain, rash, sweating, ataxia, dizziness, convulsions and coma. Severe poisoning can be lethal.

Fungi: Include *Amanita ibotengutake*, *A. muscaria* and *A. pantherina*.

Australian context: Mushrooms containing muscimol and ibotenic acid in Australia include *A. muscaria* and poisonings have occurred from ingestion of this species.

Group 2D – Morel neurologic syndrome

Suspected toxin: Unknown.

Symptoms: A combination of gastrointestinal, neurological and a range of other effects including dizziness and ataxia, sweating, fainting, hyperthermia or hypothermia and salivation. Symptoms appear to increase in severity if the fungi are consumed raw or in large quantities, even when cooked.

Fungi: Species from the genus *Morchella*. Only some people appear to be susceptible.

Australian context: Gastrointestinal symptoms following the consumption of *Morchella* have been anecdotally reported in Australia, but there have been no reports of neurological effects. The taxonomy of *Morchella* is in a state of flux in Australia (see p. 225).

Group 3 – Myotoxic mushroom poisoning

Rhabdomyolysis (muscle necrosis) is a primary feature of this group.

Group 3A – Rapid onset myotoxicity

Suspected toxin: Cycloprop-2-ene carboxylic acid.

Symptoms: Gastrointestinal (potentially severe nausea, vomiting, diarrhoea) usually occurring within 2 hours. Most cases resolve within 24 hours, without rhabdomyolysis, but, in some cases, rhabdomyolysis occurs along with more extreme symptoms such as renal failure, elevated potassium in blood and cardiovascular collapse. Fatalities have been reported.

Fungi: *Russula*, including *R. subnigricans*.

Australian context: *Russula subnigricans* does not occur in Australia. Although no Australian *Russula* species are reported as toxic, foragers should not infer they are edible.

Group 3B – Delayed onset myotoxicity

Suspected toxin: Causative toxins are not well understood, although recent research indicates that saponaceolides (terpenes) could potentially be involved in at least some species.

Symptoms: Delayed onset fatigue and myalgia (muscle pain) 1–3 days after consumption of several consecutive meals of mushrooms, followed by increasing weakness, leg stiffness, dark urine, sometimes associated with facial redness, mild nausea (but not vomiting) and profuse sweating; usually resolving within 15 days. Cases of breathing difficulty, hyperthermia, acute myocarditis (inflammation of heart muscle), renal failure, cardiac failure, elevated potassium in blood and fatal cardiac collapse have been recorded.

Fungi: *Tricholoma* such as *T. terreum* and *T. equestre* (= *T. auratum*), although classification of the latter species as toxic is controversial. Some species of *Boletus* and *Leccinum* have also been implicated.

Australian context: It is not known whether Australian *Boletus*, *Leccinum* and *Tricholoma* contain toxins that could cause this syndrome.

Group 4 – Metabolic toxicity mushroom poisoning

This group contains a variety of poisoning syndromes, assembled for convenience rather than reflecting close clinical similarities.

Group 4A – GABA-blocking mushroom poisoning

Suspected toxin: Gyromitrins.

Symptoms: Breakdown products of gyromitrins block synthesis of the compound GABA (a neurotransmitter), resulting in multi-organ effects. Symptoms occur 5–12+ hours post-ingestion with gastrointestinal effects (nausea, vomiting, bloating, bloody diarrhoea, abdominal pain, dehydration). Symptoms of more severe poisoning include vertigo, sweating, fever, double vision, headache, stammering, ataxia, haemolysis (destruction of red blood cells), hypoglycaemia (low blood glucose), reduced oxygen in blood, hepatic damage (usually within the first 48 hours); in rare cases progresses to a terminal neurological phase with delirium, convulsions, circulatory collapse, respiratory arrest, coma and death.

Fungi: Species containing gyromitrins, notably selected *Gyromitra* such as *G. esculenta*.

Australian context: *Gyromitra tasmanica* (previously reported as *G. esculenta*) grows in Australia, but its toxicity is unknown. No poisonings have been recorded.

Group 4B – Disulfiram-like mushroom poisoning

Suspected toxin: Coprines.

Symptoms: Coprines cause a disulfiram-like reaction if alcohol is consumed within 72 hours (before or after) eating the mushrooms. Coprine inhibits an enzyme necessary for the conversion of alcohol into acetic acid. It acts in a similar way to the drug disulfiram that is used in the treatment of alcoholism. Symptoms occur within minutes of consuming alcohol and are generally brief (<30 minutes) but can persist for 24 hours. They include blotchy reddening rash of trunk and limbs, facial flushing, possibly also headache, breathing difficulty, sweating, nausea, vomiting, tachycardia, premature ventricular contractions, atrial fibrillation, vertigo and a metallic taste; coma is uncommon to rare.

Fungi: Notably *Coprinopsis atramentaria* (= *Coprinus*). Similar symptoms are reported from consumption of *Echinoderma asperum*, but the toxin is not known.

Australian context: *Coprinopsis atramentaria* and *E. asperum* grow in Australia, but no cases of poisoning have been reported.

Group 4C – Polyporic mushroom poisoning

Suspected toxin: Polyporic acid.

Symptoms: Late onset (~12 hours), including a range of gastrointestinal, neurological effects and multi-organ effects (an important diagnostic feature being purple urine). The syndrome resolves over 2–7 days.

Fungi: Notably *Hapalopilus rutilans.*

Australian context: *Hapalopilus rutilans* has not been confirmed as occurring in Australia.

Group 4D – Trichothecene mushroom poisoning

Suspected toxin: Trichothecenes.

Symptoms: Multi-organ failure, which can commence soon after exposure (such as through drinking an infusion), particularly bone marrow failure and lamellar desquamation (shredding and reddening) of palms, soles of feet and face. Death may occur.

Fungi: Notably *Trichoderma cornu-damae* (= *Podostroma*).

Australian context: *Trichoderma cornu-damae* has recently been recorded in northern Australia. There are no reported cases of poisoning.

Group 4E – Hypoglycaemic mushroom poisoning

Suspected toxin: Unusual amino acids.

Symptoms: Rapid hypoglycaemia. A constellation of rapid onset symptoms includes palpitations, dizziness, shortness of breath, abdominal pain and sudden loss of consciousness. Death can occur within a few hours of ingestion in severe cases.

Fungi: Associated with mushrooms from China, notably *Trogia venenata* (>300 deaths reported).

Australian context: *Trogia venenata* has not been recorded in Australia. It is not known whether Australian *Trogia* contain these toxins.

Group 4F – Hyperprocalcitoninemia mushroom poisoning

Suspected toxin: Unknown.

Symptoms: In an isolated case series from France, seven patients developed hyperprocalcitoninemia (elevated serum prolactin in the blood). Symptoms include early gastrointestinal effects (vomiting, diarrhoea) after ~2 hours and low-grade fever. Symptoms rapidly resolved after 24 hours.

Fungi: *Rubroboletus satanas* (= *Boletus*).

Australian context: *Rubroboletus satanas* has not been confirmed as occurring in Australia.

Group 4G – Pancytopenia mushroom poisoning

Suspected toxin: Unknown.

Symptoms: This rare poisoning is described from two cases in Japan, following prolonged consumption of a decoction made from *Ganoderma neojaponicum*. Symptoms included fever and both cases spontaneously resolved over 1–2 weeks.

Fungi: *Ganoderma neojaponicum*.

Australian context: *Ganoderma neojaponicum* has not been recorded in Australia. Chinese medicinal preparations often contain multiple *Ganoderma* species. It is not known whether preparations available in Australia contain *G. neojaponicum.*

Group 5 – Gastrointestinal irritant mushroom poisoning

This large group includes a wide variety of mushrooms that cause gastrointestinal symptoms without other significant effects. This latter distinction is important clinically, because many types of mushroom poisoning cause gastrointestinal effects in addition to primary toxicities. Gastrointestinal effects are important clinical features of poisoning but can be confusing because they occur variably in so many types of poisoning.

Suspected toxins: Various and in many cases not yet identified.

Symptoms: Include variable gastrointestinal effects, such as nausea, vomiting, diarrhoea, abdominal pain/cramps and, in severe cases, the potential for dehydration effects secondary to gastrointestinal fluid loss. Onset times vary, though in most cases is acute (1–3 hours). Generally, resolves within 3–4 hours, sometimes up to 48 hours.

Fungi: Associated with a wide variety of species, the most severe symptoms are caused by *Chlorophyllum molybdites, Entoloma sinuatum* and *Tricholoma pardalotum.*

Several mushrooms occurring in Australia affect the gastrointestinal system including *Agaricus xanthodermus* (toxin: phenol), *Chlorophyllum brunneum*, *C. molybdites*, *Hypholoma fasciculare* and *Omphalotus nidiformis*.

Group 6 – Miscellaneous adverse reactions to mushrooms

This group contains types of mushroom 'poisoning' that do not fit within the previous five groups.

Group 6A – Shiitake mushroom dermatitis

Suspected toxin: Lentinan.

Symptoms: Acute dermatitis. Symptoms occur 1–2 days after ingestion of raw or cooked shiitake mushrooms, with sudden onset of whip-like linear wheals on limbs and/or trunk and/or face/neck, which resolve over days or weeks.

Fungi: *Lentinula edodes.*

Australian context: *Lentinula edodes* does not grow wild in Australia but is a popularly cultivated species. It is also sold dried in Asian groceries.

Group 6B – Erythromelalgic mushroom poisoning

Suspected toxin: Acromelic acid.

Symptoms: An erythromelalgic-like syndrome that presents several days post-ingestion, including reddening, swelling and burning pain in the extremities that can spontaneously resolve over subsequent weeks.

Fungi: Notably *Paralepistopsis acromelalga* and *P. amoenolens* (both originally placed in *Clitocybe*).

Australian context: *Paralepistopsis* has not been reported from Australia. It is not known whether Australian *Clitocybe* contains acromelic acid.

Group 6C – Paxillus syndrome

Suspected toxin: Unknown.

Symptoms: Gastrointestinal distress and an autoimmune haemolytic anaemia after repeated exposure, sometimes with a long gap before serious symptoms developing. The syndrome causes a potentially fatal immune response due to the breakdown of red blood cells.

Fungi: *Paxillus*, notably *P. involutus*. This species is now regarded as a species complex (see pp. 126–131). It is not known which species of the *P. involutus* group cause Paxillus syndrome.

Australian context: Members of the *Paxillus involutus* group grow in Australia and have been confused with the edible species *Lactarius deliciosus*.

Group 6D – Encephalopathy syndrome

Suspected toxin: Possibly hydrocyanic acid (HCN).

Symptoms: This syndrome is speculatively considered to be the result of HCN poisoning. Symptoms are delayed (days to weeks post-ingestion) and include cramps and progression to coma. Numerous cases were reported from Japan within a short period around 2004, with fatal cases particularly in patients with pre-existing kidney disease. It is unclear if this was an isolated problem or is an ongoing poisoning risk.

Fungi: *Grifola frondosa*, *Pleurocybella porrigens* and *Pleurotus eryngii*.

Australian context: It is not known whether Australian *Grifola* contain HCN. *Pleurocybella porrigens* has not been recorded in Australia. Cultivated *P. eryngii* is available in Australia.

Building knowledge about toxic fungi in Australia

To add a mushroom to the list of toxic species, the following information is necessary: (1) confirmed identification of fungus, ideally with accompanying specimen, (2) certainty about ingestion, (3) presence of symptoms and (4) exclusion of other causes for the symptoms. Greater certainty of toxic properties comes from repeated cases showing similar symptoms, coupled with chemical characterisation of the toxin/s, with toxin properties consistent with the observed symptoms. However, the toxin is not known for several species, especially those causing gastrointestinal irritant mushroom poisoning. A given mushroom species can be screened for known toxins, but new toxins are still being discovered. Identification of toxic species can be complicated when multiple species have been ingested or by atypical and idiosyncratic reactions.

Poisons information centres are the first point of contact for people who have ingested toxic fungi. In Australia, the first centre was established in New South Wales in 1966. Currently, four centres (in New South Wales, Queensland, Victoria and Western Australia) service all regions of Australia. Mycologists have been informally consulted in suspected cases of mushroom poisoning since the 1970s. More recently, a mycologist is formally available on-call in some states to assist poisons centres with cases of mushroom poisoning.

Poisons centres keep records about suspected causes of poisonings. However, these are usually only in general categories, such as 'mushrooms'. In many mushroom poisoning incidences, the mushroom species is unknown and no specimen is provided. Where there is a specimen, a mycologist is usually required to definitively identify it. However, there are few mycologists with the necessary expertise and experience to identify what are often only mushroom fragments. Moreover, timeframes in which to respond to poisoning incidents are usually tight. This means that few published reports on cases of suspected mushroom poisoning contain the ideal combination of detailed medical history in combination with definitive identification of mushrooms that were known to be ingested.

Overview of toxic and potentially toxic mushrooms

From a review of published and unpublished information on Australian cases, we have identified 24 mushrooms that have caused poisoning (six identified only to genus level). These are summarised in the following table. We also indicate some mushrooms that are known to be toxic but have not been connected with any reported cases.

Most calls to poisons information centres relating to adults with symptoms involve *Agaricus xanthodermus*, *Chlorophyllum brunneum, C. molybdites* or *Omphalotus nidiformis*. Calls about *Amanita phalloides* are rare, but outcomes are serious, including some fatalities.

Symptoms occurring after ingestion of mushrooms that grow in Australia have been connected to seven of the 21 known mushroom poisoning syndromes. Four further syndromes are associated with species known from Australia, but cases have not yet been reported (see table pp. 74–75). For autonomic toxicity mushroom poisoning, cases involving *Amanita preissii* and a suspected species of *Rubinoboletus* have not confirmed the presence of muscarine, the toxin responsible for the syndrome, although the symptoms were consistent with those caused by ingestion of muscarine-containing mushrooms. In a few cases, symptoms did not match mushrooms collected at the time of the poisoning (see particularly *Amanita volvarielloides*, p. 76). The toxic status of some species may be updated, or the identity of suspected mushroom species revised, with further cases.

Discussion of species known or suspected of causing poisoning in Australia is arranged below by genus. Be aware that within a particular genus, different species may cause different syndromes, especially for *Amanita*. Remember that the toxicity of most Australian mushrooms has not been tested and therefore the absence of species from the discussion below does not imply they are edible.

Mushrooms known or suspected to have caused poisoning in Australia
See above (p. 64) for full details of syndromes. (Species with an asterisk (*) occur in Australia but poisonings caused by them have not been reported.)

Syndrome	Symptoms	Toxins	Species
Primary hepatotoxicity	Latent period, then severe vomiting/ diarrhoea, liver damage; often causing death	Amatoxins	*Amanita phalloides*, possibly other *Amanita* species, *Galerina marginata*,* *Lepiota helveola* group, *Pholiotina filaris**
Delayed primary nephrotoxicity	Delayed acute renal failure; may lead to death	Orellanine	*Cortinarius eartoxicus*
Hallucinogenic mushroom poisoning	Hallucinations, agitation, abdominal pain, tachycardia, hypertension, cardiac arrhythmias etc.	Psilocybins, psilocins	*Copelandia cyanescens*, *Psilocybe cubensis*, *P. subaeruginosa*, *Panaeolina foenisecii*
Autonomic toxicity mushroom poisoning	Includes the triad of increased salivation, sweating and lacrimation; other symptoms can include nausea and euphoria	Muscarines and related toxins	*Amanita preissii*, *Inocybe curvipes*, ?*Rubinoboletus*
Central nervous system neuroexcitatory mushroom poisoning	Short latent period, similar to alcohol intoxication, sometimes hallucinations, manic excitation, then deep sleep	Ibotenic acid, muscimol	*Amanita muscaria*
Morel neurologic syndrome	Combination of gastrointestinal, neurological and a range of other symptoms including hyperthermia or hypothermia and salivation	Not known	Various species of *Morchella**
Delayed onset myotoxicity	Delayed onset fatigue and myalgia after consumption of consecutive meals of mushrooms; followed by various other symptoms	Possibly saponaceolides	*Tricholoma terreum**
Disulfiram-like mushroom poisoning	Blotchy reddening rash of trunk and limbs and facial flushing; other symptoms can include sweating, nausea and tachycardia	Coprines	*Coprinopsis atramentaria*,* *Echinoderma asperum**
Trichothecene mushroom poisoning	Multi-organ failure, particularly bone marrow failure, shredding and reddening of palms, soles of feet and face; may lead to death	Trichothecenes	*Trichoderma cornu-damae**

Syndrome	Symptoms	Toxins	Species
Gastrointestinal irritant mushroom poisoning	Gastrointestinal (e.g. nausea, vomiting, diarrhoea, abdominal pain/cramps)	Various, often not known	*Agaricus xanthodermus* (toxin is phenol), *Agaricus* sp., *Chlorophyllum brunneum*, *C. molybdites*, *Hebeloma crustuliniforme* group,* *H. mesophaeum* group,* *Hypholoma fasciculare*, *Lactarius pubescens*,* *Leucocoprinus birnbaumii**, *Lycoperdon subincarnatum**, *Macrolepiota dolichaula*, *Omphalotus nidiformis* (toxin suspected to be illudin), *Scleroderma* spp.
Paxillus syndrome	Gastrointestinal distress and an autoimmune haemolytic anaemia after repeated exposure	Not known	*Paxillus involutus* group
Not assigned to a syndrome	Gastrointestinal symptoms	Not known	*Amanita xanthocephala* and unidentified species of *Ramaria* and *Tricholoma*

Agaricus

The genus *Agaricus* contains well-known edible species, but also toxic species such as *A. xanthodermus*. Most cases of poisoning from ingesting mushrooms are caused by *A. xanthodermus*, which contains phenol. Therefore, getting to know this species (along with *Amanita phalloides*) is an essential first step before consuming any wild fungi. *Agaricus xanthodermus* is a member of *Agaricus* section *Xanthodermatei*, most species of which show bright yellow staining, especially when the flesh of the stipe base is rubbed. All members of section *Xanthodermatei* should be regarded as toxic, and to be on the safe side any *Agaricus* that stain bright yellow should be avoided. Be aware there are some red-staining members of section *Xanthodermatei*. There are also some toxic species in other sections, such as *A. bresadolanus* (= *A. romagnesii*) in section *Spissicaules*, although this species is not known from Australia. Recently, an undescribed Australian red-staining species has been discovered that contains phenol and has caused poisonings.

Amanita

The genus *Amanita* is of most concern because:

- The toxins in some species cause extreme poisoning injuries including death.
- The extent of injuries is often masked by the delayed onset of symptoms.
- The sporophores are more likely to attract attention as they are often large and conspicuous with some superficially resembling field mushrooms.
- They grow in close association with edible species (e.g. *A. muscaria* grows in close association with *Lactarius deliciosus*).

Around 100 species of *Amanita* have been recorded in Australia. Those that have caused poisoning are *A. muscaria*, *A. phalloides*, *A. preissii* and *A. xanthocephala*. Further poisoning cases implicate other species of *Amanita* (see *A. volvarielloides* and also *Rubinoboletus* below). Four different syndromes are caused by different species of *Amanita*: primary hepatotoxicity (amatoxins, as in *A. phalloides*), central nervous system neuroexcitatory mushroom poisoning (ibotenic acid and muscimol, as in *A. muscaria*), autonomic toxicity mushroom poisoning (muscarines, as presumed to occur in *A. preissii*) and primary nephrotoxicity mushroom poisoning (the toxin is AHDA, as in *A. pseudoporphyria* and *A. smithiana*; not recorded from Australia to date).

Within *Amanita*, the section *Phalloideae* contains the deadly poisonous species such as *A. phalloides* that are responsible for primary hepatotoxicity. There are eight native Australian species of section *Phalloideae* (see p. 89). One of these native species is *Amanita marmorata* (= *A. marmorata* subsp. *myrtacearum* and *A. reidii*), originally described from South Australia, but also occurring as an exotic species with *Eucalyptus* elsewhere, such as Hawaii and South Africa. Different species in section *Phalloideae* have different combinations of phallotoxins (such as phallacidin and phalloidin) and amatoxins (such as the amanitins). *Amanita phalloides* contains both types of toxin, but only less toxic phallotoxins were detected in a recent study of five native Australian species, including *A. marmorata*. A report of the presence of amatoxins in *A. marmorata* from South Africa has not been corroborated. *Amanita marmorata* had been listed as ‘deadly poisonous’, on the basis of this report. However, no cases of toxicity after ingestion of this species from Australia or elsewhere have been documented. In Australia over the last three decades, consumption of *Amanita phalloides*, which contains high levels of amatoxins, has caused at least six fatalities and several near fatalities.

The common and widespread *Amanita xanthocephala* is reported as toxic from a single case. A German immigrant consumed a small amount and reported gastrointestinal symptoms. She considered it edible because it lacked an annulus and at that time such species were placed in the genus *Amanitopsis*, which contained the edible *Amanita vaginata* (= *Amanitopsis*). The toxin was not identified.

There are two reports of poisoning by mushrooms identified as *Amanita preissii*, a large white to cream species from Western Australia. In the first, two people were poisoned. In the second, six people who purchased wild-collected mushrooms from a roadside stall experienced increased salivation and sweating that were attributed to the presence of muscarine in the mushrooms. Toxins present in *A. preissii* have not been confirmed from chemical analysis.

A near-fatal case attributed to mushroom poisoning in New South Wales exemplifies the potential danger of consuming *Amanita*, but also the difficulties of connecting specific mushrooms with symptoms. A Laotian immigrant regularly consumed a soup prepared from wild-collected fungi, including species of *Amanita*. On one occasion, the man experienced extreme liver damage consistent with amatoxin poisoning. Mushrooms collected by a mycologist at the site where the man had foraged included a new species, *A. volvarielloides*. However, toxin testing of *A. volvarielloides* was inconclusive. Therefore, a direct link could not be established between a known mushroom with confirmed toxins and the observed symptoms. However, given that various wild species were collected, there may well be amatoxin-containing species yet to be recognised among native Australian species of *Amanita*.

Amanita contains some of the most dangerous toxic species around the world. Every forager should learn to recognise this genus. Given that several native species of *Amanita* are known or suspected to be toxic, we strongly advise against consuming any species of *Amanita*.

Chlorophyllum* and *Macrolepiota

Chlorophyllum and *Macrolepiota* are similar in overall appearance to *Lepiota*, but generally produce larger sporophores. *Chlorophyllum brunneum* and *C. molybdites* are poisonous. The related genus *Macrolepiota* contains the edible *Macrolepiota clelandii* but also the toxic *M. dolichaula*, with reports of toxicity to humans and animals. Further research is required on identification and toxicity of the Australian species under this name as a mushroom cultivated in Asia has also been identified as *M. dolichaula*.

Cortinarius

Several *Cortinarius* species in section *Orellani*, such as *Cortinarius eartoxicus*, *C. orellanus* and *C. rubellus* contain the highly nephrotoxic compound, orellanine (see p. 67). Ingestion causes delayed acute renal failure (delayed primary nephrotoxicity), which can be fatal. *Cortinarius eartoxicus* was originally described from Tasmania and may also occur in south-east Australia. This species was implicated in the poisoning of two people, one of whom suffered delayed renal failure (one week after ingestion) and required a kidney transplant. Several other cases reported from Australia of acute renal failure are consistent with the effects of orellanine. In each case, supposed hallucinogenic mushrooms were ingested, but no hallucinations were experienced. The identity of the mushrooms remains unknown.

The toxic *Cortinarius* species of section *Orellani* are reddish or orange brown, small to medium-sized mushrooms. In Europe and North America, they have been confused with highly sought-after edible genera such as *Cantharellus* (chanterelles). In Australia, *Cantharellus* is not common and is unlikely to be confused with toxic *Cortinarius*, which also appear to be uncommon. However, those seeking hallucinogenic mushrooms could easily confuse them with small brown toxic cortinars.

Cortinarius can often be distinguished in the field by the presence of a cortina (cobweb-like partial veil) in young specimens. As the pileus enlarges, remnants of the cortina are usually retained on the stipe with rust-coloured spores caught up in them. Although a few European *Cortinarius* are known to be edible, little is known about the toxicity of Australian species. We advise against consuming any *Cortinarius*.

Galerina

Some *Galerina* including *G. marginata* (= *G. autumnalis* and *G. unicolor*) contain significant quantities of highly toxic amatoxins that cause primary hepatotoxicity. *Galerina marginata* is reported from Australia, along with some closely related species such as *G. patagonica* (toxicity unknown). There are no confirmed cases of toxicity from ingestion of *Galerina* in Australia. Most *Galerina* have small sporophores with a rusty brown spore print and are therefore less likely to be confused with the mainly larger edible species in this book.

Gyromitra

The species of *Gyromitra* occurring in Australia was initially identified as the Northern Hemisphere *G. esculenta*, but is in fact a distinct austral species, *G. tasmanica*. Toxicity of the Australian species is not known, but *G. tasmanica* should be treated as potentially toxic.

Hypholoma

Ingestion of *Hypholoma fasciculare* (= *Naematoloma*) has been recorded as causing gastrointestinal symptoms in Australia and elsewhere.

Inocybe

Inocybe includes several toxic muscarine-containing species in the Northern Hemisphere (causing autonomic toxicity mushroom poisoning). More than 130 native species of *Inocybe* grow in Australia. While none have been assayed for muscarine and none are reported as toxic, all should be regarded as suspect until further investigation. Several species of Northern Hemisphere *Inocybe* have been introduced to Australia, where they occur with exotic trees such as *Quercus* (oak) and *Pinus* (pine). The exotic species confirmed from Australia are *Inocybe curvipes*, *I. mixtilis*, *I. rufuloides* and *I. sindonia* (previous records of *I. eutheles* and *I. patouillardii* could refer to the latter species). One documented poisoning case involved *Inocybe curvipes*, which grows in association with *Pinus*, *Quercus* and *Salix* (willow).

***Lepiota helveola* group**

Lepiota contains several highly toxic species including *L. brunneoincarnata* and *L. helveola*. Identification to species level is difficult and therefore we refer to the *L. helveola* group. Several cases of human and animal poisoning by *Lepiota* species in this group have been reported from South Australia. Members of the *L. helveola* group contain amatoxins such as amanitins causing primary hepatotoxicity. For at least some of the Australian cases, presence of amanitins was confirmed. Consumption of even small amounts may lead to violent vomiting and unconsciousness. Fatalities have occurred in other countries. In Australia *L. helveola* group has been found in lawns and gardens. *Lepiota* is superficially similar to *Macrolepiota*, which differs by the larger and taller sporophores.

Morchella

Morels in the genus *Morchella* are generally considered edible, but there are occasional reports of gastrointestinal symptoms following consumption of Australian morels. Morel neurologic syndrome has occurred following consumption of morels in other countries. See p. 68.

Mycena

The Northern Hemisphere species *Mycena pura* (= *Prunulus*) and some related species in *Mycena* section *Calodontes* contain small quantities of muscarine. Several Australian species including *M. vinacea* and *M. clarkeana* have been placed in section *Calodontes*, but whether they contain muscarine is unknown. Older records of *M. pura* from Australia most likely refer to native species such as *M. vinacea*.

Omphalotus nidiformis

The native species *Omphalotus nidiformis* causes a severe gastrointestinal reaction. See profile p. 120.

***Paxillus involutus* group**

At least some of the exotic species of the *Paxillus involutus* group cause a potentially severe haemolytic anaemia (Paxillus syndrome). See profile p. 127.

Pholiotina

Pholiotina filaris (= *Conocybe filaris*, sometimes placed under *P. rugosa*) is a small, brown mushroom with a prominent annulus on the stipe. It contains appreciable quantities of highly toxic amatoxins that cause primary hepatotoxicity. Taxonomy of Australian *Pholiotina* needs to be clarified, but *P. filaris* has been reported in Australia from both urban areas and wetter native forests.

Ramaria

The coral fungus genus *Ramaria* is known to contain both edible and toxic species. Ingestion of some toxic *Ramaria* can cause profuse diarrhoea. In Australia, some native species of *Ramaria* have been anecdotally mentioned as edible. However, since there is a range of Australian species that have unknown toxicity, consuming *Ramaria* is not recommended. In addition to the occurrence of toxic species in this genus in the Northern Hemisphere, two reports support this caution. The first report deals with cattle poisoning in several South American countries attributed to consumption of *Ramaria toxica*, found there in association with *Eucalyptus*. Given *Ramaria* forms ectomycorrhizal relationships, it is probable *R. toxica* is an Australian species exported to South America along with its *Eucalyptus* partner. Poisoning symptoms in animals do not always mirror those in humans, but the severity of the syndrome, which can be fatal to cattle, suggests a dangerous toxin. The second report (in an online blog, which does need corroboration) is an account of a severe skin reaction (blistering) following eating a small raw piece of an orange *Ramaria* collected in New South Wales.

Rubinoboletus

A death reported in Queensland in 2004 was attributed to consumption of a bolete leading to a severe muscarinic syndrome (autonomic toxicity mushroom poisoning). The case notes mention symptoms consistent with muscarine poisoning, including excessive salivation. Amanitin (cause of primary hepatotoxicity) was not detected post-mortem; but tests for muscarine were not mentioned. A specimen of the bolete was tentatively identified as *Rubinoboletus*. Later reports mention that *Amanita* species were also present at the site where the mushrooms consumed in the meal were collected. While muscarine occurs in some bolete species, it is typically in trace amounts. *Clitocybe*, *Inocybe* and *Mycena* are the genera with species containing sufficient amounts of muscarine to cause severe symptoms. The genus *Rubinoboletus* is now considered a synonym of *Chalciporus*, but we continue to refer to the bolete attributed as cause of this case as *Rubinoboletus* pending confirmation of its identity.

Scleroderma

All species of *Scleroderma* (earthballs) are believed to be toxic. The toxins have not been identified, but poisoning is characterised by the relatively fast onset of symptoms (30–45 minutes) including moderate to severe gastrointestinal effects, perspiration, pallor, weakness and unconsciousness. Consumption of *Scleroderma* has caused several poisonings in Australia, but the species involved are not known. Australian collections are often labelled *Scleroderma cepa* or *S. flavidum* (both originally described from the Northern Hemisphere), but taxonomy of the Australian species needs revision.

When mature, species of *Scleroderma* can be confused with puffballs, such as the edible *Lycoperdon pratense* (see p. 221). In addition, some species of *Scleroderma* are hypogeal (underground) and others may be partially hypogeal when young. Consequently, *Scleroderma* can also be confused with edible truffles (which are hypogeal). One of the authors was asked to confirm identification of a ‘truffle’ that had been given the OK by a chef at a French restaurant in Victoria, who marvelled at the truffle-like odour – except it was toxic *Scleroderma*. True truffles (*Tuber*) do not become powdery at maturity and the interior spore-producing tissue is often marbled with fine paler veins. *Scleroderma* species are mycorrhizal, growing in association with trees such as eucalypts. *Tuber* species only grow in Australia in ‘truffle orchards’ where exotic trees such as *Corylus* and *Quercus* have been inoculated with the fungus.

Trichoderma

The highly toxic *Trichoderma cornu-damae*, cause of trichothecene mushroom poisoning, was originally described from Asia. It was first reported from the wet topics of Queensland in 2019. Despite considerable media attention at the time, cases of exposure to this bright red club fungus are not known from Australia.

Tricholoma

Although some exotic species of *Tricholoma* such as *T. terreum* are regarded as edible in some field guides, this species has been implicated as a cause of delayed onset myotoxicity when consumed in several consecutive meals. This syndrome has not been reported in Australia. However, one account of consumption of a *Tricholoma* collected in the south-east of South Australia mentioned symptoms including diarrhoea, sweating, difficulty in focusing and pupillary constriction. It is not known whether it was a native or exotic species.

Hallucinogenic mushrooms in *Psilocybe* and other genera

Several native and exotic species of *Copelandia* and *Panaeolina* (both placed in *Panaeolus* by some authors) as well as *Psilocybe* are deliberately consumed in Australia for their hallucinogenic properties. These fungi are occasionally ingested accidentally due to confusion with edible mushrooms. Hallucinogenic species often stain blue. However, blue mushrooms exist in genera known to contain toxic species, such as *Cortinarius* and *Entoloma*. The highly toxic *Galerina marginata* closely resembles some species of *Psilocybe*.

Other toxic mushrooms

Various exotic mycorrhizal mushrooms growing with exotic trees in Australia are known to be toxic, but there are no confirmed cases of poisoning from them (e.g. *Hebeloma crustuliniforme* group, *H. mesophaeum* group and *Lactarius pubescens*). Widespread saprotrophic mushrooms that are recorded as toxic elsewhere, but with no confirmed cases of poisoning in Australia include *Coprinopsis atramentaria*, *Echinoderma asperum* (= *Lepiota*), *Leucocoprinus birnbaumii* and *Lycoperdon subincarnatum*. All these mushrooms cause gastrointestinal irritant mushroom poisoning, except for *C. atramentaria* and *E. asperum*, which cause disulfiram-like mushroom poisoning.

Responding to suspected mushroom poisoning

In cases of mushroom poisoning, correct identification of the ingested species by a mycologist (via a poisons information centre) is critically important. Different mushrooms cause different toxin syndromes, hence definitive identification of the mushroom (or mushrooms in case of multiple species ingested) allows for more targeted treatment with better patient outcomes. Moreover, where harmless species are involved (commonly with toddlers) rapid identification means valuable resources in emergency departments of hospitals are not tied up unnecessarily and families are relieved of worry. If the mushroom cannot be definitively identified, it is still important to rule out species capable of causing death, especially *Amanita phalloides*.

How to respond to a suspected mushroom poisoning

- If person is suspected of consuming a deathcap *Amanita phalloides* seek immediate help. Call 000. DO NOT DELAY.
- Otherwise, call the Poisons Information Centre Hotline: 13 11 26 (all states and territories).
- Note symptoms and the time between ingestion and onset, the number of mushrooms consumed and whether or not they were cooked.
- Medical staff may take stomach or stool samples to aid identification. However, if possible, collect further material of the mushroom that was consumed from the original foraging location. Store mushroom samples and/or uneaten portions of meals in fridge (not frozen) in paper bag or breathable container. Poisons information centres will make contact with mycologists who can identify samples.

How to read a profile

Detailed profiles are provided for the following toxic fungi:

- *Amanita phalloides*
- *Amanita muscaria*
- *Agaricus xanthodermus*
- *Chlorophyllum brunneum*
- *Chlorophyllum molybdites*
- *Coprinopsis atramentaria*
- *Omphalotus nidiformis*
- *Paxillus involutus* group.

The most toxic species *Amanita phalloides* is presented first, followed by a second species of *Amanita* (*A. muscaria*). The remaining species and species groups are presented alphabetically.

Each profile here and in Chapter 9 (edible fungi) is written in a standardised format. Profiles begin with the current scientific name and vernacular names. Each name is followed by any recently used synonyms to allow cross-referencing with other field guides that might use alternative names. For toxic species, the toxic syndrome caused by the species is included.

This information is followed by a checklist of features of the particular species. Mycological terms are used for precision and are defined in the glossary (also see Chapter 5).

It is important that you can recognise ALL the features listed in the checklist and hence it helps to examine several sporophores at different developmental stages.

Features described in a given checklist are illustrated on the facing page in the same sequence as in the checklist.

Within each profile, the checklist of features provides information about the habitat, symbiont, substrate and habit, along with morphological features. For mushrooms, features are given in the following sequence:

HABITAT	describes the typical environment in which the species grows and whether it is saprotrophic, mycorrhizal or parasitic.
SYMBIONT	for mycorrhizal species, the associated tree species.
SUBSTRATE	what it grows on.
HABIT	whether solitary, scattered or gregarious and whether clustered or in rings.
PILEUS	size, shape, colour, surface features, margin features.
LAMELLAE	attachment to stipe, density (e.g. crowded or distant), colour; edge features. For species that do not have lamellae, PORES or SPINES are described.
STIPE	size, shape, colour, surface features; characters of annulus and/or volva, if present.

FLESH thickness, texture, colour, presence/absence of staining (best observed by rubbing or on cut flesh).

SPORE PRINT colour (a critically important feature sometimes overlooked as it can take time to determine spore colour through a spore print).

ODOUR and TASTE (the latter is not given for toxic species).

PHENOLOGY the time of year when the species can be found (given for southern Australia). The time will generally be earlier for species found in northern Australia.

For the jelly fungus (*Tremella fuciformis*) and the puffball (*Lycoperdon pratense*) the whole sporophore is described, followed by specific parts relevant to these kinds of fungi.

In the checklists, note that dimensions of sporophores are ranges or maximums. Keep in mind that sporophore development can be affected by climatic and other environmental conditions. Depending on nutrient availability and exposure to weather, a mycelium can produce reduced or especially large sporophores. Also note that colour can vary greatly and the images in this book cannot reflect the entire colour range for a particular species. Foragers should take variation into consideration when identifying fungi and become familiar with the range of size, shape and colour of each species.

The next section of each profile includes:

NAME – the authorship and derivation of the name.
DISTRIBUTION – including status in Australia as native or exotic.
CLASSIFICATION – where species and genera fit in the current classification.
IDENTITY – identification of the species as it occurs in Australia.
AUSTRALIAN SPECIES – discussion of related species in Australia.

For a few species, interesting aspects of biology such as fairy rings, deliquescence, bioluminesce and yeasts are discussed under those headings.

Distribution information is based on our personal observations combined with critical examination of data held by the Global Biodiversity Information Facility (GBIF) and the Atlas of Living Australia (ALA). Records in the latter source based on environmental DNA are omitted, because we consider their identification to be unreliable. Where DNA sequences are mentioned, they are available in GenBank, a publicly accessible online database. Book titles mentioned in the text are sometimes shortened, especially for older works.

For the profiles of edible fungi in Chapter 9, information is also provided on potential lookalike species, some of which are profiled on the following pages.

If you suspect you
have eaten a deathcap,
call 000.

Amanita phalloides

deathcap
deathcap amanita
deathcap mushroom
green deathcap

Poisoning syndrome: Primary hepatotoxicity (see p. 66).

The deathcap was accidentally introduced from the Northern Hemisphere and first recorded in Australia in the 1960s. It grows with oak trees and has spread to several large cities in south-east Australia including Adelaide, Launceston, Melbourne and Canberra as well as regional cities and towns in central Victoria. This species causes most fatalities from mushroom ingestion in Australia and worldwide. Deathcaps contain several types of toxins that cause cell death, catastrophic liver or kidney failure and death.

◄ The deadly poisonous *Amanita phalloides*.

Amanita phalloides

Checklist of features

HABITAT	In parks, gardens and nature strips with exotic trees. Mycorrhizal.
SYMBIONT	Exotic *Quercus* (oak), commonly *Q. robur*, but also a variety of European, North American and Asian oak species.
SUBSTRATE	On the ground.
HABIT	Solitary, scattered or gregarious.
PILEUS	4–16 cm diameter, ovoid or hemispherical at first, then convex, expanding to broadly convex then plane, colour highly variable, from white, pale yellow, pale brown to various shades of green, often mottled or streaked, generally paler with age or drying, surface smooth, viscid when wet, shiny or with metallic lustre when dry, often fibrillose; occasionally with thin white membranous patches (remnants of universal veil) or with veil remnants hanging from edge.
LAMELLAE	Free from stipe, close or crowded, white.
STIPE	5–18 cm long, 1–2.5 cm diameter, equal or tapering to apex, with bulbous base, white or tinged yellowish green, often with fine patterned fibrils or scaly ornamentation appearing as zig-zag banding; with white membranous partial veil at first that forms skirt-like annulus on upper stipe, often disappearing with age or collapsing on the stipe; with white sac-like volva at the base, which may be buried in soil and not obvious.
FLESH	White throughout, not changing colour when bruised.
SPORE PRINT	White.
ODOUR	Indistinct or slightly sweet at first, then strong and unpleasant (like rotting potato) with age and drying.
PHENOLOGY	Found most often in March, April and May, but appears throughout the year after rain, including in summer.


Emerging sporophore.


Immature ovoid sporophore emerging from universal veil.

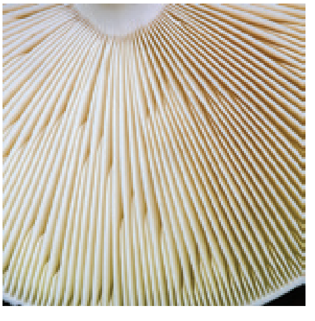

Convex pileus of maturing sporophore.


Plane pileus of mature sporophore.


Mature sporophore affected by weather – note dry, faded pileus.


Partial veil erupting.


Skirt-like annulus on upper stipe, tinged yellowish green.


Lamellae close, white.


Stipe with zig-zag banding.


Bulbous base of stipe and pronounced volva.


Sac-like volva.


Cross-section.

Name

For fungi, algae and plants, Swedish botanist Carl Linnaeus's *Species Plantarum* of 1753 is the starting point for modern nomenclature. Names published before this are not regarded as valid. However, older works, dating back to the middle ages and into antiquity, illustrated and named fungi. One such is the *Botanicon Parisiense* published by French botanist and physician Sébastien Vaillant, in 1727. In this work, Vaillant provided a black and white illustration of a mushroom with a well developed volva at the base of the stipe, which he called *Fungus phalloides*. It was found under chestnut trees at Versailles, on the outskirts of Paris. Swedish mycologist Elias Fries took up Vaillant's epithet *phalloides* when he described *Agaricus phalloides* in his 1821 work *Systema Mycologicum*, also mentioning several other pre-existing names. Fries's work has a special status for the naming of fungi, and so his choice of *phalloides* takes precedence over these other names. *Agaricus phalloides* was moved to the genus *Amanita* by German botanist Johann Link in 1833. The name *Amanita* derives from the Greek *amanitai*, a fungus. The epithet *phalloides* means phallus-like, presumably in reference to the young pileus.

Distribution

Amanita phalloides is native to Europe, where it is widely distributed from southern Scandinavia to the Mediterranean Sea and east to the Voronej region in the far west of Russia. In its natural area of distribution, *A. phalloides* associates with a variety of symbionts, including the broadleaved trees *Betula*, *Castanea*, *Fagus* and *Quercus* and the conifer *Picea*.

Establishing the native distribution of fungi that have the capacity to spread to new environments is difficult. For mycorrhizal mushrooms such as *Amanita*, evidence that a species is exotic comes from three sources: plant associations (exotic fungi tend to occur with exotic symbionts), the time of first records and the genetic structure at the population level. Given its distinctiveness and strict occurrence with *Quercus*, the absence of records from Australia until the 1960s Australia indicates *A. phalloides* is introduced.

In North America, occurrences of *A. phalloides* on the east coast are considered to represent introductions, as they are in parks and plantations. However, on the west coast *A. phalloides* is found not only with exotic trees but also with *Quercus agrifolia*, a native tree. Recent analysis of the gene variants present in populations of *A. phalloides* from the west coast of North America suggests the species is introduced there, as well as on the east coast, and has jumped from European to American *Quercus*. This hypothesis is consistent with the observed gradual spread of the species since the first record from California in the 1930s, estimated at around 5 km per year.

In Australia, *A. phalloides* has a patchy distribution in the south-east of the continent from South Australia to the Australian Capital Territory, including Tasmania. In Victoria, it is reported from numerous suburbs in Melbourne, mainly in the east, and from several regional centres such as Gisborne, Castlemaine and Bendigo. In Tasmania, the only reports are from Launceston; in South Australia it is known only from Adelaide; and in the Australian Capital Territory all reports are from Canberra. Records from outside of these specific areas, such as from south-west and north-east Victoria, are incorrect or unsubstantiated. However, given the relatively recent appearance of the species in Adelaide (first reported in the 2000s) and Launceston (first reported in the 2010s), *A. phalloides* can be expected anywhere in south-east Australia where *Quercus* grows.

Classification

Amanita phalloides belongs to *Amanita* section *Phalloideae*, collectively known as lethal amanitas. Recent research on species of *Amanita* in this section has revealed a surprising diversity, with 28 species recognised, half of which are relatively recent discoveries. *Amanita phalloides* as defined by DNA sequences and morphology is native to Europe whose closest relative is *A. subjunquillea*, the East Asian deathcap, found in China, Korea and Japan.

A reconstruction of the evolutionary history of the lethal amanitas based on information from DNA sequences suggests a single origin of the group. The ancestor of the group is thought to have evolved around 65 million years ago in the palaeotropics somewhere in Asia or Australia. The group eventually spread to Europe, and Central and North America. Several closely related pairs of species occur in adjacent regions of the globe, such as in East Asia and North America. Migration of ancestral species from East Asia to the Americas could have been via the Bering Land Bridge, which existed around 20 million years ago.

Identity

No DNA sequences are available from Australian collections of *A. phalloides*. However, the features of sporophores, the occurrence with *Quercus* and the evidence of toxicity in Australian material all match with the characters of the species as it is known in Europe.

Australian species

The Australian species of section *Phalloideae* are *Amanita austrophalloides*, *A. djarilmari*, *A. eucalypti*, *A. gardneri*, *A. marmorata*, *A. millsii*, *A. murinaster* and *A. neomurina* (= *A. murina*). Within section *Phalloideae*, all Australian species for which DNA sequences are available are closely related to each other and to species from East Asia. The native species resemble *A. phalloides* by having a well-developed volva at the base of the stipe, but they grow in association with native plants such as *Allocasuarina*, *Corymbia* (bloodwood) and *Eucalyptus*. In addition, only *A. austrophalloides* has a greenish pileus; all the other native lethal amanitas have a pileus that is white, pale yellow, pale grey, pale brown or brown. There are no documented cases of ingestion of any of the native species and their toxicity to humans is unknown (also see p. 75).

Amanita muscaria

fly agaric
fly amanita

Poisoning syndrome: Central nervous system neuroexcitatory mushroom poisoning (see p. 68).

Amanita muscaria is the most well-known and mythologised mushroom worldwide. This classic and charismatic 'fairy-tale mushroom' captures attention and imagination due to its striking appearance and psychoactive properties. It has been used since ancient times by shamans, priests and sorcerers. However, ingestion may cause symptoms including seizures and coma – in rare cases leading to death.

◄ The toxic *Amanita muscaria* is the most well-known mushroom worldwide.

Amanita muscaria

Checklist of features

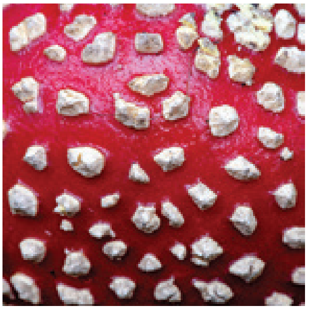
HABITAT	In plantations, parks, gardens and lawns in association with exotic trees, also in native cool temperate rainforest. Mycorrhizal.
SYMBIONT	Exotic conifers, primarily *Pinus radiata*, and deciduous trees, including *Betula* and *Quercus*, as well as the native Australian *Nothofagus* (southern beech).
SUBSTRATE	On the ground, often among pine needle litter.
HABIT	Solitary, scattered or gregarious, sometimes in rings.
PILEUS	5–26 cm diameter, ovoid or hemispherical at first, becoming convex, expanding to broadly convex then plane, sometimes uplifted in old age, deep to bright red, fading to orange, yellow or white with exposure to rain and sun, surface covered in cottony pyramid-shaped or angular white to yellow warts (universal veil remnants), often washed off by rain; margin sometimes grooved.
LAMELLAE	Free from stipe or slightly attached, close or crowded, white, lamellulae frequent.
STIPE	5–20 cm long, 1–3 cm diameter, equal or tapering to apex, with bulbous base, white to off-white, surface smooth or slightly woolly; at first with white membranous partial veil that forms a skirt-like, often yellow-edged, toothed or ragged annulus on upper stipe, often disintegrating with age; with volva in the form of concentric bands of block-like universal veil remnants at top of bulb.
FLESH	White throughout, not changing colour when bruised.
SPORE PRINT	White.
ODOUR	Indistinct to mild earthy.
PHENOLOGY	Appears in autumn and early winter (mostly April to June), rarely at other times.

Also see the composite image of pileus variation on p. 31.


Button stage enclosed in white universal veil.

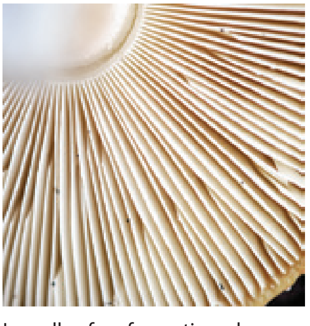

Pileus hemispherical when young.


Pileus plane, bright red with conspicuous warts when mature.


Pileus with white angular warts.


Pileus with warts rubbed or washed off.

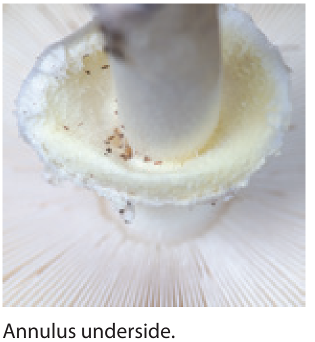

Pileus uplifted and faded when old.


Lamellae free from stipe, close, lamellulae frequent.


Cross-section showing enlarged stipe.


Stipe with concentric bands of universal veil remnants.


Annulus, toothed, yellow-edged.


Annulus underside.


Bulbous base of stipe.

Name

Agaricus muscarius was one of the relatively few fungi named by Linnaeus in *Species Plantarum* in 1753. At that time almost all fungi with lamellae were placed in *Agaricus*. The epithet *muscarius* refers to *musca*, a fly, in reference to the use of this mushroom soaked in milk to attract and kill flies. This practice is also the source of the vernacular name 'fly agaric'. Sale of fly agarics in the Frankfurt region for use as a fly-killer was mentioned by Dutch botanist Charles L'Escluse in the section on fungi in *Rariorum Plantarum Historia*, published in 1601.

In 1783, French naturalist Jean-Baptiste Lamarck transferred the epithet *muscarius* to the genus *Amanita* in his work *Encyclopédie Méthodique*. However, Lamarck used the name *Amanita* for all species of agarics in preference to *Agaricus* as he considered *Agaricus* to apply to polypores and boletes (see discussion of the name *Agaricus* on p. 100). The modern sense of *Amanita*, specifically for mushrooms with a partial and universal veil, developed later and the placement in *Amanita* was widely accepted by the late 1800s. For derivation of the name *Amanita* see *A. phalloides* (p. 88).

Distribution

Amanita muscaria is an ectomycorrhizal fungus native to temperate areas of the Northern Hemisphere. It was introduced to Australia and the first reliable reports of its presence are from the 1920s, always in association with exotic trees. Records before this time, such as by Scottish botanist Robert Brown, all appear to be misidentifications of native fungi, most likely *A. xanthocephala*. Introduction of mycorrhizal fungi such as *A. muscaria* (and *A. phalloides*, *Lactarius deliciosus* and species of *Suillus*) probably occurred when living plants were imported in soil before the introduction of plant quarantine regulations.

In several locations in Tasmania and Victoria, *A. muscaria* occurs in rainforest under native *Nothofagus*, well away from any exotic trees. DNA sequences from the sporophores of *A. muscaria* observed under *Nothofagus* match sequences from mycorrhizas on root tips of the trees. This switching of tree partners has the potential to displace native fungi that associate with *Nothofagus*. In addition, there are reports of *A. muscaria* switching to *Eucalyptus*, but only where both fungus and tree are exotic, such as in South America.

In Australia, *A. muscaria* is reported from south-west and south-east Australia, as far north as south-east Queensland. Distribution is patchy in Western Australia (the Perth region and a few other locations such as Manjimup) and South Australia (the Adelaide region, Fleurieu Peninsula, Kangaroo Island and the south-east). In contrast, there are numerous records from across Tasmania (including King Island), except for the Midlands, and across Victoria, except for the north-west and alpine regions. In New South Wales it occurs in the east of the state, inland to Tumut in the south and Gyra in the north, including the Australian Capital Territory, where it is common around Canberra. In Queensland, it occurs only around Springwood and Toowoomba.

Classification

Even though *A. muscaria* is iconic and easily recognisable, its taxonomy remains unsettled. Sporophores vary considerably in appearance with developmental stage and environmental conditions (see p. 31). In addition, the colour of the pileus and the colour of the pileus warts vary. This variation has been recognised by acceptance of several varieties within the species. However, recent analysis of DNA sequences across multiple genes has revealed eight distinct evolutionary lineages within mushrooms with the appearance of *A. muscaria*. Mycologists refer to such lineages as 'phylogenetic species', especially where there is no corresponding difference in appearance. Gene flow is a mechanism that holds together distant populations across the range of a species and prevents speciation. There is no evidence of gene flow among the eight phylogenetic species, even when their geographical ranges overlap.

Some of the phylogenetic species occupy particular habitats and/or are associated with particular trees. One phylogenetic species occurs in subalpine North America and Eurasia, with dwarf shrubs in the genera *Dryas* and *Salix*. Another is restricted to the south-east of the USA, where it occurs in forests dominated by *Carya* (hickory), *Quercus* and *Pinus*. Some of the phylogenetic species are now recognised at species rank, including *Amanita regalis* (royal fly agaric) and *A. persicina* (peach-coloured fly agaric), both of which were formerly treated as varieties of *A. muscaria*. The true *A. muscaria* is common and widespread, occurring across temperate regions of North America, Europe and Asia.

Identity

DNA sequences from several Australian collections of *A. muscaria* match the common phylogenetic species found across North America, Europe and Asia. However, available genetic data do not suggest a particular region of origin for the Australian occurrences. Given its wide distribution and variety of tree partners, as well as the various trading routes with Australia, it may have been introduced from anywhere within its range across the Northern Hemisphere. In future, analysis of a range of genes may allow pinpointing of the origin of exotic fungi such as *A. muscaria*.

Australian species

More than 100 species of *Amanita* have been described already from Australia. Most are white, grey or brown. The only Australian species with a bright red pileus is *A. xanthocephala* (vermillion grisette). This differs from *A. muscaria* in several characters including the smaller size (pileus no more than 5 cm in diameter), absence of an annulus and the coloured margin of the volva at the stipe base. The exotic *A. rubescens* (blusher) has a similar pattern of dense, pale pileus scales as in *A. muscaria*, but the pileus surface is reddish brown rather than bright red. *Amanita rubescens* is rare in Australia, only occurring in the Adelaide region in association with exotic trees such as *Castanea* (chestnut).

Agaricus xanthodermus

(Possible synonym: *Agaricus arvensis* var. *iodiformis*)
yellow stainer
yellow staining mushroom

Poisoning syndrome: Gastrointestinal irritant mushroom poisoning (see p. 71).

Agaricus xanthodermus is more common than edible *Agaricus* species. Growing widely across urban areas and often in large troops in gardens, lawns and nature strips, it causes most mushroom-related poisonings in Australia. The vibrant chrome yellow staining that occurs on bruising and the phenolic odour differentiate it from edible *Agaricus*. That said, the relatively high incidence of poisonings from this species suggests that these features are not always obvious. Symptoms are gastrointestinal including nausea, stomach cramps, vomiting and diarrhoea.

◄ *Agaricus xanthodermus* causes the majority of poisonings from ingestion of wild fungi in Australia.

Agaricus xanthodermus

Checklist of features

HABITAT	Common in urban environments such as parks, gardens, nature strips, road verges and edges of sports fields, also paddocks. Saprotrophic.
SUBSTRATE	On the ground, among grass or mulch.
HABIT	Solitary, scattered or gregarious, often clustered together in large rings, arcs or troops.
PILEUS	Pileus 3–20 cm diameter, when young typically marshmallow-shaped or squarish in profile, then broadly convex, to broadly umbonate to plane, white or off-white becoming greyish buff or brown, especially with age, often with brown tints towards centre, turns yellow when bruised especially near the edge, surface dry, smooth or with scattered fibrils, often scaly or cracking with age or drying; margin incurved when young.
LAMELLAE	Free, crowded, white at first, then pinkish, darkening with age to chocolate brown then blackish brown at maturity.
STIPE	5–15 cm long, 1–2 cm diameter, cylindrical, more or less equal in width above slightly enlarged base, surface smooth, sometimes shiny; with white, flaring, membranous annulus that is double-layered, with continuous ridge of tissue on underside near stipe, when intact with small scales between ridge and pileus edge, often collapsing with age.
FLESH	Flesh thick grading to thin in pileus margin, white throughout, turns vibrant chrome yellow immediately when bruised, especially in base of stipe when rubbed or split in two, can be much less apparent when dry, yellow stain gradually fades to dull brown.
SPORE PRINT	Purplish brown to chocolate brown.
ODOUR	Distinctive, phenolic (of phenol), also described as chemical, carbolic, metallic, sharp or like disinfectant or iodine. Sometimes difficult to detect, most apparent if base of stipe is crushed.
PHENOLOGY	Typically found in autumn but occurs throughout the year after sufficient rain.


Marshmallow-shaped and white when young.


Pileus with square profile.


Pileus broadly umbonate.


Pileus smooth.


Pileus cracked.

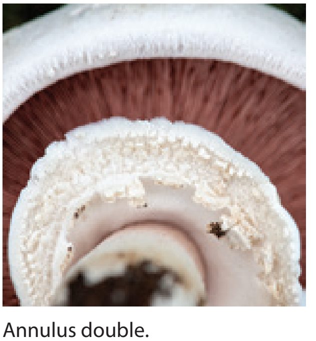

Pileus browning with age.


Lamellae pale pink.


Lamellae crowded, free, chocolate brown.


Closed veil when immature.


Annulus flaring, membranous, with scales on underside.


Annulus double.


Bruising vibrant chrome yellow.

Name

Agaricus xanthodermus was first described by Gaston Genevier in 1876 in an article about mushrooms consumed in the district around Nantes in France. It is surprising that such a distinctive fungus as *A. xanthodermus* was not formally named until this time, but Genevier mentions several illustrations of his new species that had appeared in older works, some misidentified as *A. arvensis*. The distinction between *A. xanthodermus* and *A. arvensis* remains important for foragers – the first is toxic, the second is edible (see p. 184).

The roots of the name *Agaricus* go back to antiquity. As with other ancient words for fungi, such as *Boletus* (see p. 196), the original meaning does not necessarily match the modern usage. Greek physician Dioscorides compiled information about medicinal plants and fungi in *De Materia Medica*, written around 50 CE. This work contains an entry for an organism called *Agaricum* in Latin and *Agaricon* in Greek. Accompanying illustrations suggest a bracket fungus, and 'agarikon' is now used as the vernacular name for *Fomitopsis officinalis* (= *Laricifomes*), a polypore with medicinal properties that grows on conifers. In *Species Plantarum*, published in 1753, Linnaeus arbitrarily took up the name *Agaricus* for agarics rather than polypores. This is the sense in which the name is used today, narrowed to only the field mushroom *Agaricus campestris* and its closest relatives. The epithet *xanthodermus* means yellow skin, referring to the bright yellow stain when the surface of the sporophore is bruised.

Distribution

Agaricus xanthodermus is native to Europe and North America. The first report of *A. xanthodermus* from Australia was by John Cleland in *Toadstool and Mushrooms of South Australia*, published in 1934. Cleland also mentioned a variant of *A. arvensis* from Sydney that smelt of iodoform (a disinfectant compound containing iodine). This variant was named *Agaricus arvensis* var. *iodiformis* in 1918 by Cleland in collaboration with botanist Edwin Cheel and may represent an earlier occurrence of *A. xanthodermus* in Australia. The lack of records from the nineteenth century and the constant association with disturbed environments indicate that *A. xanthodermus* is exotic.

In Australia, *A. xanthodermus* is found in south-west Western Australia (generally near the coast) and is widespread in eastern Australia. In South Australia it occurs frequently around Adelaide, south to the Fleurieu Peninsula, north to the Barossa Valley and inland to Murray Bridge; also in the far south-east. In Tasmania, it is reported from scattered localities across the state, less commonly in the west. In Victoria, it is common throughout the state, except for the north-west and the alpine region. In New South Wales, it occurs along the east coast, as far inland as the Australian Capital Territory. In Queensland, it is common in the far south-east, north to the Sunshine Coast and inland to the Bunya Mountains.

Classification

Careful study of morphology coupled with analysis of DNA sequences is slowly bringing clarity to the taxonomy of *Agaricus*. New species continue to be described, even from mycologically well-known areas such as western Europe, and especially from Asia. Ten of the sections of *Agaricus* are currently known from Australia. Yellow-staining species are known from six of these sections: *Arvenses*, *Bivelares*, *Hondenses*, *Leucocarpi, Minores* and *Xanthodermatei* – therefore an *Agaricus* that stains yellow is not necessarily a close relative of *A. xanthodermus*. The yellow staining shown by species in section *Xanthodermatei* tends to be bright but fades rapidly to a brownish colour or back to the original colour. In contrast, the reaction of species in other sections is less intense but longer lasting and old sporophores can be yellow (as in *A. arvensis*).

Identity

Because *A. xanthodermus* is variable in form, and symptoms following ingestion are inconsistent, it is often assumed to be a complex of species. However, much of the variation in appearance can be explained as developmental and/or environmental. Watching a cluster of sporophores of *A. xanthodermus* develop from buttons until they finally collapse demonstrates this. Young, pure white sporophores become brown when old, at least in the centre, and sometimes deeply cracked. The partial veil stretches, breaks and ultimately collapses. Even when the surface stain is not evident, there is usually a yellow staining reaction in the base of the stipe, when the cut surface is rubbed. DNA sequences from around 30 Australian collections of *A. xanthodermus* are extremely similar to each other, and to sequences from European collections. This suggests *A. xanthodermus* is a highly variable species rather than belonging to a species complex. Other members of section *Xanthodermatei* in Australia look different, especially when young.

From the first description of *A. xanthodermus* there have been conflicting reports about its toxicity. Genevier noted that while some people consumed it with impunity, it could also cause indigestion or more serious symptoms. The fact that some can eat *A. xanthodermus* without discomfort seems surprising, as others who eat it can experience symptoms so unpleasant that they swear off eating mushrooms for life! Toxicity is believed to be due to phenol, which occurs in sufficient concentrations to cause gastrointestinal distress. The absence of ill effects from consuming *A. xanthodermus* in some people could occur for several reasons. First, phenol concentration is known to vary between sporophores. Second, there could be a dose effect, where small quantities do not elicit gastrointestinal symptoms. Third, preparation methods such as frying may reduce the phenol concentration (although this is yet to be experimentally proven). Fourth, some people may have a genuine lack of sensitivity to the toxin. Lastly, some people might have thought they had eaten *A. xanthodermus* but in fact had consumed an edible *Agaricus* such as *A. arvensis*. Regardless, it is imperative that forayers can recognise *A. xanthodermus* if they wish to consume any species of *Agaricus*.

Australian species

Among species of *Agaricus* in Australia, the closest in appearance to *A. xanthodermus* are the edible species that have a white pileus, at least when young (*A. campestris*, *A. arvensis* and *A. bitorquis*). These are distinguished by the lack of bright yellow staining and the form of the annulus. Within the section *Xanthodermatei*, there are several other species reported from Australia, including *Agaricus endoxanthus* (= *A. rotalis*) and *A. moelleri* (= *A. praeclaresquamosus*). For Australian *Agaricus* in other sections, see the profile of *Agaricus* (p. 187).

Chlorophyllum brunneum

(Formerly known in Australia as *Macrolepiota rhacodes*)
shaggy parasol

Poisoning syndrome: Gastrointestinal irritant mushroom poisoning (see p. 71).

Chlorophyllum brunneum was probably introduced to Australia and has been recorded under various names since the late nineteenth century. Some field guides list it as edible although often with caveats about it causing gastric upset in some people. In Australia, incidents of poisoning have definitely occurred, hence we list it as a toxic species.

◄ A young emerging sporophore of *Chlorophyllum brunneum*.

Chlorophyllum brunneum

Checklist of features

HABITAT	In urban environments such as parks, gardens and compost heaps, also in farmland. Often in relatively dry microhabitats such as beneath *Cupressus* (cypress). Saprotrophic.
SUBSTRATE	On the ground, among mulch or leaf litter.
HABIT	Solitary, scattered or gregarious, in rings, troops or sometimes in caespitose or overlapping clusters.
PILEUS	7–20 cm diameter, convex to blocky when young, expanding to broadly convex or nearly plane with age, surface dry, smooth at first, dull greyish brown in the button stage, soon developing coarse brown to greyish brown concentrically arranged scales, except for central cinnamon brown disc where surface remains intact, surface beneath scales radially fibrillose and whitish; margin incurved at first.
LAMELLAE	Free, crowded, white becoming dingy brown with age.
STIPE	5–16 cm long, 1–3 cm diameter, more or less equal in width above, enlarged below to abruptly, often marginate, bulbous base, white, bruising orange then red, darkening to brown, surface smooth; with thick, white partial veil that breaks to form prominent, moveable, white or brownish, membranous, felty simple annulus.
FLESH	Thick, white, discolouring orange then red, darkening to brown.
SPORE PRINT	White.
ODOUR	Not distinctive.
PHENOLOGY	Occurs throughout the year, most often in autumn, but also appears in late spring and summer after rain.


Sporophores in overlapping clusters.

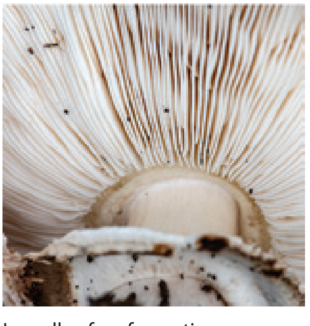

Button stage with smooth pileus and bulbous stipe base.


Pileus surface cracks as it expands to reveal white flesh.


Close-up of scales that form as pileus expands.


Pileus with scales in concentric rings and central umbo.


Central brown disc in older sporophore.


Lamellae free from stipe, crowded, white.


Reddish brown staining on bruised lamellae.


Bulbous stipe base with red staining.

Name

The species epithet *brunneum*, meaning brown, was first used in the name *Lepiota brunnea* introduced by American mycologists William Farlow and Edward Burt in 1929, in reference to the distinct brown patch in the pileus centre. The epithet was used at the level of variety in the name *Macrolepiota rhacodes* var. *brunnea*. However, in 2002 mycologist Else Vellinga working at University of California Berkeley, transferred the epithet to *Chlorophyllum*. The name *Chlorophyllum* was originally introduced for a species with green spores, hence the derivation of the name, from the Ancient Greek *chloros* (green) and *phyllon* (leaf, in reference to the lamellae). Today, species with both green and white spores are contained within *Chlorophyllum*. This results in the genus name not matching the properties of all its species. Nevertheless, the rules of nomenclature (naming) require retention of the original name.

Distribution

Chlorophyllum brunneum is native to temperate Europe and North America, where it is found on the east and west coasts. In Australia, it is an exotic species, always growing in parks and gardens and other human-modified environments. In Australia, *C. brunneum* is reported infrequently in south-west Western Australia, but occurs widely in south-east Australia, including in Tasmania. In mainland eastern Australia, it extends from Adelaide to south-east Queensland. Most records are from cities, such as Canberra, Sydney and Brisbane, and it is particularly common in greater Melbourne. An isolated report from *Eucalyptus* woodland on Cape York Peninsula is likely to be a misidentification.

Classification

The limits of the genus *Chlorophyllum* are discussed under the following profile for *C. molybdites*. The classification of species within the genus has undergone significant revision in recent decades. First reported from Australia as *Agaricus rhacodes* in 1892, for many years, the large shaggy parasol found in Australia was identified as *Lepiota rhacodes*, *Macrolepiota rhacodes* or *Chlorophyllum rhacodes*. In the early 2000s, generic limits and species concepts in *Chlorophyllum* and *Macrolepiota* were revised using DNA sequence data. These revisions revealed that lurking within what people had been calling *C. rhacodes* were two other species, *C. brunneum* and *C. olivieri*. Reports of *C. rhacodes* from Australia are incorrect and all previous records seem to be of *C. brunneum*. *Chlorophyllum brunneum* has a marginate bulb at the stipe base (i.e. with an abrupt transition from the lower stipe to the bulb) in contrast to the gradually widening bulb at the stipe base of *C. rhacodes*.

Note also that the spelling of '*rhacodes*' has been revised recently. In 1835, Italian doctor and mycologist Carlo Vittadini described the base name for *Chlorophyllum rhacodes* as *Agaricus* '*rachodes*', taking the species epithet from an Ancient Greek word meaning ragged. This spelling was taken up by many later authors, but the alternative spelling '*rhacodes*' was sometimes used. In 2018, after debate among nomenclature specialists about transliteration of Greek to Roman alphabets, the spelling was fixed as *rhacodes*. Hence, the spelling of the Australian species *Chlorophyllum nothorhacodes*, originally spelt '*nothorachodes*', should also be amended.

Identity

Morphological characters of Australian collections of *C. brunneum* match those of material from the Northern Hemisphere. In addition, DNA sequences from four Australian collections (from Western Australia and Victoria) match closely with a sequence obtained from a collection from California.

Australian species

Two other species of *Chlorophyllum* are known from Australia: *C. molybdites* and *C. nothorhacodes*. *Chlorophyllum molybdites* is readily distinguished from *C. brunneum* by the green spore print and the lamellae that darken with age, usually with a greenish tinge. *Chlorophyllum nothorhacodes* is an enigmatic species, known from a single collection from Canberra in the Australian Capital Territory. A DNA sequence from this collection does not match sequences from *C. brunneum* nor sequences from any other known species of *Chlorophyllum*. The sequence indicates that the closest relative of *C. nothorhacodes* is *C. olivieri* from the Northern Hemisphere. In macroscopic appearance, *C. nothorhacodes* is very similar to *C. brunneum*, differing only by the bulbous base that gradually widens rather than being marginate. Some differences in microscopic characters also exist. Given that *C. nothorhacodes* has large sporophores with a pileus reaching 28 cm in diameter, it would not be easily overlooked. Hence, it is unlikely to be a native species. The only collection came from a garden in Canberra, which also supports an exotic origin. From where in the world it originates remains a mystery.

Chlorophyllum molybdites

false parasol
false green parasol
green spored lepiota
green spored parasol
vomiter

Poisoning syndrome: Gastrointestinal irritant mushroom poisoning (see p. 71).

This striking and imposing fungus often forms large fairy rings on lawns. Although it appears superficially similar to *Macrolepiota clelandii* (Australian parasol), closer inspection reveals the distinctive green lamellae of mature sporophores and greyish green spore print. Young sporophores can appear like *Coprinus comatus* (lawyer's wig). *Chlorophyllum molybdites* has caused poisonings in Australia and is the most common cause of mushroom poisoning in the USA.

◄ The toxic *Chlorophyllum molybdites* has been mistaken for edible *Agaricus* and *Macrolepiota*.

Chlorophyllum molybdites

Checklist of features

HABITAT	In urban areas in parks, sporting grounds and nature strips, most often in lawns, sometimes in garden beds. Saprotrophic.
SUBSTRATE	On the ground, among grass or sometimes mulch.
HABIT	Solitary, scattered or gregarious, often in large numbers in arcs, rings, troops or clusters of overlapping sporophores.
PILEUS	10–30 cm diameter, globose, ovoid, convex or broadly conical when young, then broadly convex to plane, off-white to brown, dry, smooth in button stage, as pileus expands, cuticle cracks forming concentric circles of coarse fawn to brown to pinkish to tan scales, concentrated towards the centre, often with dull brown umbo, surface beneath scales finely fibrillose, white to pale tan; margin often slightly upturned, sometimes shaggy from veil fragments when young.
LAMELLAE	Free or slightly attached to stipe, crowded, at first white or off-white to cream, becoming greyish green to olive brown.
STIPE	5–25 cm long, 1–2 cm diameter, more or less equal in width above the slightly enlarged to sub-bulbous base, white above annulus; with prominent, moveable, white or brownish membranous, felty annulus.
FLESH	Thick, white throughout, usually staining red or reddish brown.
SPORE PRINT	Pale green or greyish green. This spore colour is unusual and is hence a distinctive feature.
ODOUR	Described as mushroomy, grassy, acrid or not distinctive.
PHENOLOGY	Occurs throughout the year, usually January to May, most often in February.


Often in arcs or rings.

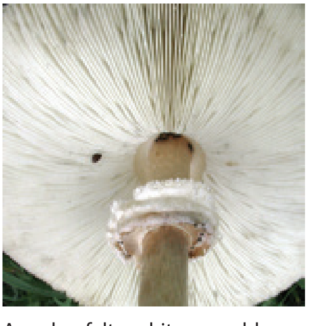

Sporophores in overlapping clusters.


Pileus ovoid when young.

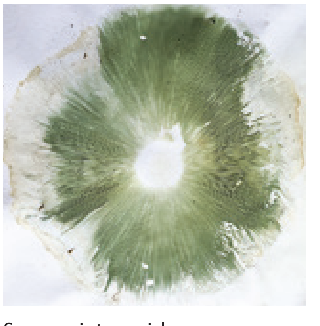

Pileus centre all brown when young.


Lamellae green at maturity.


Stipe base bulbous.


Annulus, felty, white, movable.


Stipe stains red.


Spore print greyish green.

Name

German botanist Georg Meyer named *Agaricus molybdites* in *Primitiae Florae Essequeboensis*, published in 1818. This work dealt with plants and fungi from the European colony at the mouth of the Essequibo River, now part of Guyana in northern South America. The dozen or so species of fungi described by Meyer were among the earliest to be formally named from South America. The epithet *molybdites* refers to the lead-grey colour of the young lamellae. In 1889, English mycologist George Massee placed *A. molybdites* into the new genus *Chlorophyllum*, named in reference to the green lamellae at maturity.

Distribution

Although the original collection of *C. molybdites* comes from Guyana, there are relatively few records of the species from South America and most are from near-coastal areas on the east coast, as far south as Buenos Aires. It is widespread in Central and North America and is presumably native to those areas. In the USA, *C. molybdites* is one of the most commonly reported mushrooms on the citizen science recording platform iNaturalist, with around 3500 sightings reported to date. There are scattered records from Africa, Asia and islands in the Pacific, especially Hawaii. Most observations from around the world are from parks and gardens in urban areas.

Establishing the original distribution of widespread fungi such as *C. molybdites* is challenging. Even in the late seventeenth and early eighteenth centuries, when fungi from outside Europe were beginning to be formally named, large-scale disturbance of vegetation was occurring through land-clearing for plantations in tropical countries. It is possible that the original collection from Guyana was already an introduction. Comparison of the genetic variation occurring in populations across different regions can shed light on the status of organisms as native or exotic. Less variation usually occurs in exotic populations. As yet, few such studies have been carried out for fungi (one example is *Amanita phalloides*; see p. 88).

In Australia, *C. molybdites* is reported north of about latitude 36 degrees South, around the coast from Esperance in the west to the south coast of New South Wales, encompassing the Kimberley coast in northern Western Australia, the north of the Northern Territory and coastal Queensland (including the tip of Cape Yorke Peninsula). It is particularly common in south-east Queensland and the north coast of New South Wales. There are also records from inland regions such as the Riverina in New South Wales and towns such as Alice Springs (Northern Territory) and Kalgoorlie (Western Australia).

Classification

The green spore print colour was the main distinguishing character of the genus *Chlorophyllum* when it was first introduced. Spore print colour remained a key character until analysis of DNA sequence information from around the year 2000 resulted in two surprising rearrangements to the limits of the genus. First, *Endoptychum agaricoides*, which has completely enclosed spore-producing tissue, but spores with similar microscopic features, was found to belong in *Chlorophyllum*. We now know species with enclosed spore masses, including false-truffles, have evolved from mushroom ancestors in many genera. In Australia truffle-like species can be found in a variety of genera, otherwise comprising mushrooms, including *Cortinarius*, *Laccaria* and *Russula*. The second surprise was that several species with a white spore print formerly placed in *Macrolepiota* were also found to be close relatives of *C. molybdites*. As a result, several species were transferred from *Macrolepiota* to *Chlorophyllum*, including *C. brunneum* and *C. rhacodes* (= *Macrolepiota*). This meant that the colour of the spore print was no longer a reliable distinction between *Chlorophyllum* and *Macrolepiota*. As is often the case when classifications have been rearranged when incorporating evidence from DNA sequences, other morphological characters turn out to be useful for separating the two genera. In particular, the pileus covering in *Chlorophyllum* is made up of club-shaped cells, while in *Macrolepiota* it is composed of cylindrical cells.

Identity

Chlorophyllum molybdites is a highly distinctive mushroom, especially when the green spore print is taken into account, in combination with the microscopic features such as the flattened end to the spores. All characters of Australian material match those of collections from the Americas. In addition, DNA sequences from Australian collections of *C. molybdites* from Queensland and the Northern Territory closely match sequences from numerous other collections from around the globe. In Australia, *C. molybdites* behaves as a typical exotic species, found only in modified environments and not in intact native vegetation.

Australian species

For other species of *Chlorophyllum*, see the profile for *C. brunneum*. In Australia, there are other mushrooms with an olive brown spore print (such as *Austropaxillus*), but the only other species with a distinctly green spore print are *Melanophyllum haematospermum* and *Amanita austroviridis*. *Melanophyllum haematospermum* is not likely to be confused with *C. molybdites*, as it occurs in native forests (not in lawns or gardens) and is much smaller (pileus to 3.5 cm), with a powdery pileus surface and lamellae that are a rich reddish brown colour when mature. *Amanita austroviridis* is a large, all-green mushroom that grows in native woodland in near-coastal areas, especially with *Allocasuarina*.

Coprinopsis atramentaria

(Synonym: *Coprinus atramentarius*)
common inkcap
inkcap

Poisoning syndrome: Disulfiram-like mushroom poisoning (see p. 69).

Coprinopsis atramentaria separates the drinkers from the abstainers. It contains a compound called coprine that affects the way alcohol is processed in the body. An alcoholic drink 72 hours either side of eating it can cause nausea, vomiting and a range of symptoms including coma. *Coprinopsis atramentaria* has been confused with *Coprinus comatus*. While they grow in similar habitats and both deliquesce, *Coprinopsis atramentaria* can be distinguished by its smooth, greyish-brown pileus, smaller size and less cylindrical shape.

◄ A cluster of young *Coprinopsis atramentaria*.

Coprinopsis atramentaria

Checklist of features

HABITAT	In garden beds, track edges, compost heaps, vacant ground, paddocks, grassy areas and other disturbed environments, occasionally pushing through bitumen; also in native forests, along track sides. Saprotrophic.
SUBSTRATE	On the ground, in association with buried wood and organic matter, such as dead roots around stumps.
HABIT	Scattered or densely gregarious, often in tight clusters or 'tufts' of multiple sporophores, rarely solitary.
PILEUS	2–8 cm high, to 10 cm diameter, deeply conical to ovoid ('bullet-shaped'), then bell-shaped or convex to plane, flaring and becoming tattered at margin, deliquescing and rolling up as expanding, lead grey or brownish grey, surface faintly striate, grooved or smooth, sometimes with brown central disc and often finely scaly around centre.
LAMELLAE	Free, occasionally attached, crowded, white at first then pinkish grey, rapidly blackening as they deliquesce.
STIPE	5–15 cm long, 0.5–1.5 cm diameter, equal or enlarged towards or tapering at base, white, surface smooth or finely fibrillose; partial veil fibrillose and evanescent or leaving narrow ring or ridged zone on mid to lower stipe; occasionally with rudimentary volva.
FLESH	In pileus thin, soft, white to pale grey; in stipe fibrous, hollow.
SPORE PRINT	Black.
ODOUR	Not distinctive.
PHENOLOGY	Appears throughout the year, most often in autumn.


Often in tight clusters.

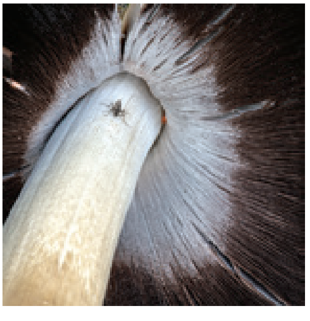

Pileus bell-shaped, flaring at margin with age.


Pileus with small scales and brown central disc.


Pileus faintly striate.


Pileus streaked.


Pileus margin flaring, tattered as maturing.


Lamellae crowded, changing from pinkish grey to black with age.


Lamellae black with age.


Lamellae becoming 'inky' in final stages.


Smooth white stipes exposed as the pileus deliquesces.


Ridged zone on lower stipe.


Stipe hollow, tapering at base.

Name

Coprinopsis atramentaria was first described as *Agaricus atramentarius* by French mycologist Pierre Bulliard in one of the volumes of *Herbier de la France*, published around 1786. Fries placed it in *Coprinus* in *Epicrisis Systematis Mycologici*, published in 1838. Finnish mycologist Petter Karsten created the genus *Coprinopsis* in 1881 for a few species of *Coprinus*. However, for the remainder of the nineteenth and the entire twentieth century most mycologists continued to call it *Coprinus atramentarius*. In 2001, when Coprinus was restricted to the species around *Coprinus comatus*, Canadian mycologist Scott Redhead and colleagues transferred the species to *Coprinopsis*. The genus *Coprinopsis* was named for the resemblance to *Coprinus*. The epithet *atramentarius* derives from the Latin *atramentum* a black liquid such as ink.

Distribution

The natural distribution of *Coprinopsis atramentaria* is Europe and North America. It is commonly found in Australia in disturbed sites, such as nature strips, lawns and roadsides. It can also be found along tracks in cool temperate rainforest. *Coprinopsis atramentaria* seems to be an exotic species, perhaps established here long enough to spread into native vegetation. Alternatively, there may be more than one species, one exotic and one native. *Coprinopsis atramentaria* has spread to other regions of the Southern Hemisphere, including New Zealand and South Africa.

Coprinopsis atramentaria is found across south-west and south-east Australia. In Western Australia it is infrequently reported in near-coastal areas. In South Australia it occurs around Adelaide and in the far south-east. In Tasmania it is commonly reported, except in the north-east. In Victoria it is widespread, except in the east. Along the east coast it has a scattered distribution as far north as Brisbane and inland to the Australian Capital Territory.

Deliquescence

Coprinopsis, *Coprinellus* and *Coprinus* and to some extent *Parasola* exhibit deliquescence. This is a fascinating phenomenon that has evolved multiples times in mushrooms. To understand the mechanics of deliquescence, first we need to consider what happens in a normal mushroom that does not deliquesce. The lamellae of a mushroom are covered by a hymenium composed of a dense layer of basidia, the cells that produce spores. Spores are shot off the basidia and travel a small distance (less than a tenth of a millimetre) horizontally before the effects of gravity kick in and they drift downwards between the vertically oriented lamellae. Once spores fall from between lamellae, they are dispersed by air currents. When you look at the pattern of lamellae from below, there are often short lamellulae interspersed at regular intervals between the full-length lamellae. There may even be several series of lamellulae. These lamellulae maximise the area of spore-producing tissue, while allowing sufficient space between the lamellae for spores to be shot off basidia. If lamellae and lamellulae are too close, spores will land on the opposite lamellae.

In *Coprinopsis* and other mushrooms that deliquesce, the lamellae are initially packed so tightly that there is no space between for spores to fall. As the sporophore matures, the edge of the pileus curls outwards which slightly increases the circumference and consequently the space between the lamellae at their lower edge. Spores mature in a narrow, dark zone at the lower edge of the lamellae and are shot off in the normal manner. Autodigestion of the lamella commences at the lower edge, transforming basidia that have released spores into a liquid. This process continues upwards until there is no lamellar tissue remaining. The liquid drops that form in the zone of autodigestion are sometimes misunderstood to be the method of spore dispersal but contain few spores. In fact, a spore print can be obtained from deliquescent mushrooms such as *Coprinopsis* if an intact sporophore is positioned upright under a glass jar.

Classification

As discussed under *Coprinus comatus* (p. 150) the genus *Coprinus* previously contained many species but is now restricted to *C. comatus* and a few allies. Other species formerly in *Coprinus*, such as *Coprinopsis atramentaria*, are placed in the Psathyrellaceae, in the genera *Coprinopsis*, *Coprinellus* and *Parasola*. *Coprinopsis* and *Coprinellus* differ in microscopic characters and are difficult to tell apart in the field, although some of the individual species are quite distinctive. *Parasola* is recognisable by the deeply grooved pileus resembling a Japanese parasol.

Identity

Characters of Australian collections of *C. atramentaria* match descriptions based on Northern Hemisphere material, as far as macroscopic and microscopic characters. There are no DNA sequences available from Australian collections.

Australian species

Coprinopsis, and the related genera *Coprinellus* and *Parasola*, are not well known in Australia except for a few common species. There could be considerable diversity among native species that is yet to be documented as exemplified by the following two recent discoveries. An unidentified species of *Coprinopsis* was detected as the mycelial stage in the mound of soil accumulated at the entrance to a bilby tunnel; and the newly described *Coprinopsis austrophlyctidospora* was found in Western Australia – it is an 'ammonia-fungus' in which sporophore production is stimulated by the addition to soil of nitrogen-containing compounds, such as urine. The most frequently recorded species of *Coprinellus* is *Coprinellus micaceus* (= *Coprinus*) and the species of *Parasola* most often recorded is *P. plicatilis* (= *Coprinus*). In *Coprinopsis* there is a group of species, the 'pied' *Coprinopsis*, which resemble *Coprinus comatus* when young due to a scaly pileus. However, scales of *Coprinus* are formed by lifting up of the pileus surface whereas in *Coprinopsis*, scales are remnants of a membranous universal veil. In the pied *Coprinopsis*, as the pileus expands, the scales become isolated, forming a striking combination of pale scales against the darker pileus surface. The pied *Coprinopsis* include *Coprinopsis picacea* (= *Coprinus*, magpie inkcap) and *Coprinopsis stangliana* (= *Coprinus*, pied inkcap). Both are reported from Australia as presumed introductions, but the identity of Australian collections is yet to be confirmed with DNA sequences.

Omphalotus nidiformis

(Synonym: *Pleurotus nidiformis*)
ghost fungus

Poisoning syndrome: Gastrointestinal irritant mushroom poisoning (see p. 71).

The ghost fungus is one of only a handful of bioluminescent mushrooms in Australia. It grows in western and eastern Australia in a great variety of habitats from coastal scrub, to subalpine environments. This species attracts crowds to 'ghost mushroom tours' in South Australia in what is perhaps Australia's first example of 'myco-tourism'. It has been mistaken for edible species of *Pleurotus*, including the commercially produced *P. ostreatus* (oyster mushroom). Eating ghost fungi causes severe nausea and vomiting.

◄ Young *Omphalotus nidiformis* sporophores emerging from a tree trunk.

Omphalotus nidiformis

Checklist of features

HABITAT	In native woodland and forest, also in urban areas in parks and gardens with remnant and planted native trees. Saprotrophic.
SUBSTRATE	On wood, typically at the base of living or dead trees or on stumps, but in wet forests may grow on large pieces of fallen wood. Usually associated with native trees such as *Eucalyptus* but can occur on stumps of *Pinus*.
HABIT	Solitary or usually in groups, often in overlapping clusters.
PILEUS	10–30 cm diameter, fan-shaped to funnel shaped, colour highly variable, in centre with darker tones of orange, brown, grey, purple or blue-black, often with a mix of different tones, margin generally lighter, cream, surface dry, smooth; margin incurved, ageing to flat or curved upwards, often wavy.
LAMELLAE	Strongly decurrent, varying from closely spaced to distant, with various lengths, white to cream.
STIPE	Central or lateral to pileus, to 10 cm long or barely present, often stout, to 4 cm diameter, more or less equal in width or tapering to base, white to cream usually with darker reddish or greyish tones below, surface dry, smooth.
FLESH	Thin in pileus, white to cream, firm in stipe.
SPORE PRINT	White.
ODOUR	Not distinctive.
PHENOLOGY	Usually in autumn and winter, most often in May, but recorded throughout the year.

The most distinctive feature of *P. nidiformis* is the **bioluminescence**. The intensity of luminosity varies with age and in different parts of the sporophore, with the lamellae being the most strongly glowing part.


Often in overlapping clusters at the base of living or dead trees.


Sporophores funnel-shaped, darker in centre.


Pileus often becomes irregularly wavy with age.


Pileus in various shades of brown.


Pileus colour highly variable, but margin generally paler.


Sporophores often flecked with yellow tones.


Lamellae strongly decurrent, white.


Stipe when young with greyish tones near base.


Bioluminescence. Green colouration is intensified by long exposure time.

Name

Omphalotus nidiformis was one of the first Australian agarics to be scientifically named. The English mycologist Miles Berkeley described *Agaricus nidiformis* in 1844. The original collection was made by James Drummond, a botanical collector in the Swan River Colony, now Western Australia. *Omphalotus nidiformis* is a variable species especially as far as the range of pileus colour tones. At first, this variation was not appreciated and the species was re-described several times under names including *Agaricus illuminans*, *A. lampas*, *A. phosphorus*, *A. noctilucus* and *Panus incandescens*. All these other names refer to the bioluminescence of the sporophore. However, the epithet *nidiformis* means nest-shaped in reference to the shape of the pileus. *Agaricus nidiformis* was transferred to the genus *Pleurotus* by Saccardo in 1887, in his compilation of all fungi known at the time, the *Sylloge Fungorum*. However, for much of the twentieth century the species went by the name of *Pleurotus lampas*. The American mycologist Orson Miller recognised that the Australian ghost fungus belonged in the genus *Omphalotus* and transferred it to that genus in 1994. The name *Omphalotus* is derived from the Ancient Greek *omphalos* meaning navel and *otos* meaning ear, referring to the pileus which is has a central depression and is often laterally attached.

Distribution

Omphalotus nidiformis is found only in Australia. It is widespread throughout south-east Western Australia, and in eastern Australia occurs from the Eyre Peninsula in South Australia, along the east coast, to the Cairns region in north Queensland. It is common across Tasmania (except for the mid-west coast) and Victoria (except for the Mallee). Along the east coast of New South Wales and Queensland, it occurs up to 200 km inland, including in the Australian Capital Territory. The distribution in Queensland north of Fraser Island is patchy. However, apparent absences along the Queensland coast could reflect fewer people recording fungi in this region relative to the south of the country.

Bioluminescence

One of the most thrilling experiences in the Australian bush is coming across a cluster of glowing ghost fungi on a moonless night. The light emitted is strong enough to be visible some metres away, but the glow is amorphous and not immediately obvious as coming from fungal sporophores. Up close, there is enough light to read text. During the day, the glow becomes apparent in a darkened space after allowing a few minutes for your eyes to adjust to the dark

Bioluminescence occurs particularly among deep-sea creatures, where it has obvious advantages for communicating in a pitch-black environment. The phenomenon occurs in various unrelated fungi such as *Armillaria*, *Mycena* and *Omphalotus*. Bioluminescent organisms create light when enzymes called luciferases act on compounds called luciferins, in the presence of oxygen. For the ghost fungus, this biological (rather than merely chemical) process was demonstrated in experiments carried out in 1906 by botanist Alfred Ewart. For example, sporophores placed in boiling water immediately ceased glowing and did not glow when removed.

Why do fungi emit light? One hypothesis is that the glow attracts nocturnal insects, which assist spore dispersal. Experiments in tropical rainforests used artificial resin sporophores equipped with LEDs emitting the same light wavelength as bioluminescent mushrooms (to separate effects of light from effects of potentially attractive chemicals in sporophores). More insects were attracted to the fake fungi compared to dark traps. Furthermore, higher levels of the compounds involved in bioluminescence were found in sporophores at night. In contrast, experiments on Kangaroo Island could not detect any effect of ghost fungus bioluminescence on the number of insects attracted to sporophores compared with the background level of insect activity. Moreover, the glow of ghost fungi did not appear to vary across day and night. An alternative hypothesis is that the function of bioluminescence is to remove by-products of other cellular processes. As with all fungi, there is much to learn about the biology of this iconic Australian fungus.

Classification

Omphalotus and *Pleurotus* are similar in overall form. Both are fleshy and share decurrent lamellae and off-centre or laterally attached stipes. Due to this morphological similarity, for a long time, species of *Omphalotus* such as *O. nidiformis* were placed in *Pleurotus*, alongside edible species such as *Pleurotus ostreatus*. However, *Pleurotus*, which belongs in the Pleurotaceae, is distantly related, with DNA sequence data placing *Omphalotus* in the family Omphalotaceae. This family also contains other mushroom genera such as *Gymnopus*, *Lentinula*, *Marasmiellus* and *Rhodocollybia*. Some of these genera were formerly considered relatives of *Marasmius*, due to their tough texture. Bioluminescence is shared by several species of *Omphalotus*, as is the presence of compounds called illudins. These can have inhibitory effects on human cancer cells in laboratory test tube experiments but are also highly toxic. Illudins are probably what cause the unpleasant effects after consumption of ghost fungi.

Identity

Omphalotus nidiformis is distinct from other species of *Omphalotus,* such as the Northern Hemisphere *O. illudens* and *O. olearius*, both morphologically and when DNA sequences are compared.

Australian species

Omphalotus nidiformis is the only species of the genus *Omphalotus* occurring in Australia. Various species of *Pleurotus* and *Lentinus* are superficially similar, but these are distantly related.

Paxillus involutus group

brown rollrim
common rollrim
poison pax

Poisoning syndrome: Paxillus syndrome (see p. 72).

Traditionally eaten in Eastern Europe, at least some members of the *Paxillus involutus* group are now known to cause a potentially fatal immune haemolytic anaemia (the Paxillus syndrome). A high-profile case of poisoning occurred in 1944, when German mycologist Julius Schäffer died after eating it. Further deaths have been recorded in Eastern Europe and others have potentially gone undiagnosed due to the delayed onset of symptoms. In Australia, the *P. involutus* group has been confused with *Lactarius deliciosus*.

◄ *Paxillus involutus* is commonly found in public areas such as parks and gardens.

Paxillus involutus group

The *Paxillus involutus* group is a complex of closely related species of similar appearance. The group includes *P. involutus* as well as *P. ammoniavirescens*, *P. cuprinus* and *P. obscurisporus.* The features below refer to all species of the group.

Checklist of features

HABITAT	Common in lawns, parks, gardens and pine forests. Mycorrhizal.
SYMBIONT	Various exotic conifer and broadleaf tree genera, particularly *Betula pendula* (silver birch).
SUBSTRATE	On the ground.
HABIT	Solitary, scattered or gregarious, in groups, arcs or rings, sporophores often overlapping.
PILEUS	4–15 cm diameter, sometimes to 30 cm, convex to broadly convex, then plano-convex or centrally depressed to funnel-shaped, occasionally with a noticeable umbo, dull brown to dingy yellow brown or greyish brown, staining darker when bruised, surface viscid when wet, smooth or tomentose; margin strongly inrolled, remaining incurved at maturity, sometimes irregularly wavy or lobed with age, often with distinctive radial ribbing.
LAMELLAE	Strongly decurrent, close, forked, pale ochre, yellowish brown, pale olive or pale cinnamon, ageing to brown, bruising brown or reddish brown, often irregular and convoluted with anastomosing near stipe; separable from pileus and can be dislodged with pressure from a fingertip.
STIPE	Often relatively short, 6–12 cm long, 0.8–1.2 cm diameter, more or less equal in width or tapering towards base, often curved or crooked, light ochre at first, then brown to dark brown, darkening with age and bruising chestnut brown or blackish brown.
FLESH	Thick and firm, yellowish to buff brown, discolouring darker brown
SPORE PRINT	Yellow brown, olive brown or reddish brown.
ODOUR	Not distinctive or sometimes sour, sharp or slightly fragrant.
PHENOLOGY	Occurs throughout the year, mostly March to May.

Grows in association with exotic trees, commonly *Betula*.

Often in overlapping clusters, arcs or rings.

Pileus centrally depressed.

Pileus can crack with age or in dry weather.

Pileus margin strongly inrolled when young.

Cross-section showing brown discolouration.

Pileus margin irregular, remaining incurved at maturity.

Pilus margin with radial ridges.

Lamellae forked.

Lamellae sometimes convoluted or anastomosing.

Lamellae with brown staining.

Stipe often curved.

Name

Agaricus involutus was described by German natural scientist August Batsch in a volume of his *Elenchus Fungorum* published in 1786. This work was a compilation of the fungi from the region around Jena in Germany. Fries introduced the genus *Paxillus* in *Flora Scanicam* published in 1836. He transferred *Agaricus involutus* to *Paxillus* in *Epicrisis Systematis Mycologici*, published in 1838. The *Epicrisis* is an analysis of his previous work *Systema Mycologicum*. In *Systema Mycologicum*, Fries was influenced by the philosophy of Romanticism. One expression of this philosophy in biological classification was that groups often had similar numbers of elements. Many of the groups created by Fries had three or four members, or multiples of these numbers. Thus, there were four main classes within the fungi, four orders within each class and so on. At the genus level, for example, *Cantharellus* had three groups, each with 12 species. Within the large genus *Agaricus* there were 36 groups and the group containing *Agaricus involutus* was made up of eight species. In the *Epicrisis*, Fries relaxed his attempt to order the natural world within a strictly numerical framework. The name *Paxillus* is Latin, meaning a small stake or a peg and alludes to the short, stubby stipe. The epithet *involutus* refers to the involute (i.e. inrolled) pileus margin.

Distribution

The four species of the *P. involutus* group are ectomycorrhizal and native to the temperate zones of the Northern Hemisphere, including North America, Europe and East Asia. In these regions, more than one species of the group can be found in the same location. The four species associate with a wide variety of coniferous and broadleaved trees, including *Pinus*, *Betula*, *Fagus*, *Populus* and *Quercus*. *Paxillus cuprinus* and *P. obscurisporus* grow with broadleaved trees, while *P. ammoniavirescens* and *P. involutus* grow with both coniferous and broadleaved trees. There are subtle differences in the preferred microhabitat, with sporophores of *P. involutus* (in the current, narrow sense) tending to occur in shady places while those of *P. cuprinus* are often found in open situations. All occurrences of the *P. involutus* group in Australia are exotic, as sporophores are always associated with exotic trees.

In Australia, *Paxillus involutus* group is reported from south-western and south-eastern Australia. In Western Australia, it occurs in coastal areas in scattered locations from Perth to Albany. In south-east Australia, there are records from South Australia (Adelaide only), Tasmania (vicinity of Hobart and Launceston), Victoria (across the south of the state), Australian Capital Territory and New South Wales (far south-east and Blue Mountains). Some or all of these records could well refer to other species within the *P. involutus* group.

Classification

Paxillus belongs in the family Paxillaceae and is closely related to the bolete *Gyrodon*. In the Southern Hemisphere, several species resemble *Paxillus* because they have decurrent lamellae that are forked. Analysis of DNA sequences shows that these species are distantly related to *Paxillus* and belong instead in the family Serpulaceae where the genus *Austropaxillus* was created for them. Serpulaceae includes a mixture of ectomycorrhizal and saprotrophic genera. The closest relative of *Austropaxillus* is the genus *Serpula*, which forms flattened sporophores on wood.

Within *Paxillus*, recent analyses of a large series of collections using several DNA regions led to recognition of four species among material formerly referred to as *P. involutus*. These are *P. involutus*, *P. ammoniavirescens*, *P. cuprinus* and *P. obscurisporus*. Each displays subtle differences in the appearance of sporophores. For example, *P. involutus* in the strict sense is the only one of the four species to show an umbonate pileus when young. In *P. ammoniavirescens*, in the presence of ammonia vapour there is a fleeting green reaction, lacking in the other three species. The spore print of *P. ammoniavirescens* is ochre or tinged with olive, while the other species have reddish brown spore prints. However, many characters overlap among the four species and identification to a particular species in the field can be challenging.

It is not clear whether one, several or all members of the *Paxillus involutus* group are responsible for causing the Paxillus syndrome. Past cases were attributed to ingestion of *P. involutus*, but this identification needs to be reassessed in the light of the current classification.

Identity

Both *Paxillus ammoniavirescens* and *P. cuprinus* are reported from New Zealand and the latter species is reported from Tasmania. DNA sequences are available for four collections from the Australian Capital Territory, originally labelled *P. involutus*. Two of these sequences match best with *P. ammoniavirescens* and two match best with *P. obscurisporus*. The occurrence of *P. cuprinus* in Australasia is yet to be confirmed from DNA sequences.

Australian species

There are no native species of *Paxillus* in Australia. *Austropaxillus* is represented by several species that associate with native trees such as *Eucalyptus* and *Nothofagus*. The characters of *Austropaxillus infundibuliformis* are provided under the lookalikes of *Lactarius deliciosus*.

Further to the species profiled in the preceding pages, we remind readers of some other toxic species as illustrated overleaf (also see p. 73).

Galerina marginata contains amatoxins that can cause primary hepatotoxicity.

Some *Cortinarius* contain the toxin orellanine that can cause renal failure.

Amanita xanthocephala should be regarded as potentially toxic.

Mycena clarkeana could potentially contain muscarine.

Lactarius pubescens can cause blistering of the tongue.

Trichoderma cornu-damae contains trichothecenes that can cause multi-organ failure.

A *Ramaria* (coral fungus). *Ramaria* have been implicated in fatal cattle poisoning.

Scleroderma can cause gastrointestinal distress.

Chapter 9

Edible fungi and their lookalikes

The edibility of (some) fungi is probably why you bought this book. The previous chapters will have given you an understanding of the basics of fungus identification and how to recognise common toxic fungi. This chapter provides detailed profiles for 10 wild edible fungi: seven are species, one is a species group and two are dealt with as genera, each with several species. These profiles are followed by discussion of further species where knowledge about their edibility is starting to emerge. For those who enjoy eating mushrooms but prefer not to forage, we conclude with a discussion of commercially produced edible species.

Profile selection

The fungi in the 10 profiles were selected primarily for their well established edibility. Most have been introduced to Australia from countries with long histories of consumption. For example, there are records of *Lactarius deliciosus* being eaten in several European countries for at least a couple of centuries. Indeed, a first century fresco at the Roman town of Herculaneum depicts mushrooms closely resembling this species. In 1752, German mycologist Jacob Schaeffer described *Marasmius oreades* as edible and in 1780 Bulliard lauded it as 'of agreeable flavour'. Several *Agaricus* including the three profiled species have been eaten throughout Europe and the USA for at least a century.

Ease of identification and the minimal chance of confusion with toxic lookalikes influenced our selection of the profiled species and genera. Those with distinctive diagnostic characters and relatively few lookalikes were prioritised. We also considered relative abundance and the likelihood of foragers finding them. Several profiled mushrooms such as *Coprinus comatus*, *Lactarius deliciosus* and *Suillus* can produce sporophores in large quantities.

While palatability is a personal judgement, we have observed foragers' choice of species over many years both in Australia and elsewhere. Some *Agaricus* species are well known for their palatability attested by their commercial production. Species harvested in large quantities (such as *L. deliciosus* sold at some farmers' markets) also confirm their popularity. Chefs and cooks pointed us to local mushrooms such as *Macrolepiota clelandii*. Lastly, we have not included species where we consider there to be conservation concerns.

Detailed profiles are provided for the following edible fungi:

- *Coprinus comatus*
- *Lactarius deliciosus*
- *Lepista nuda*
- *Macrolepiota clelandii*
- *Marasmius oreades*

◄ *Boletus edulis* being trimmed in the field.

- *Agaricus*
- *Suillus*
- *Hydnum crocidens* group
- *Tremella fuciformis*
- *Lycoperdon pratense.*

This sequence follows the order in which morphogroups are presented in Chapter 4 – agarics, boletes, hydnoid fungi, jelly fungi, puffballs. Agarics are ordered based on what we consider to be the easiest through to the most difficult species or genera to identify in the field. We recommend novices begin with *Coprinus comatus*, then *Lactarius deliciosus* and continue through the suggested sequence.

In the previous chapter we explain how to read a profile. The process is the same for edible fungi. When using the checklist of features to identify a specimen, be sure you can recognise them ALL, as some could be common to other species including toxic ones.

Lookalikes

Each profile is accompanied by lookalike species, most of which are either known or suspected to be toxic. Eight of these lookalike species have a full profile in the previous chapter, in which case the checklists of distinctive characters are summaries. Note that the notion of a 'lookalike species' is arbitrary. Experienced foragers would consider there to be few lookalikes because they can recognise the important diagnostic features and morphological variation within a species at different developmental stages and due to environmental influences. Their experience allows them to anticipate which lookalike species could be growing in the vicinity of their target edible species. Be aware there could be further species considered to be lookalikes that are not covered in this book.

Typical environments where profiled fungi are found

Many edible species (and 'emerging edible species') described in this book grow in human-modified environments such as lawns (e.g. *Agaricus*, *Marasmius oreades*) parks and gardens (e.g. *Coprinus comatus*), pine plantations (e.g. *Suillus*, *Lactarius deliciosus*), recreation reserves and road verges. Others including *Hydnum crocidens* group grow in native forest. Some such as *M. clelandii* are often found in the interface of different environments, such as track edges and the grassy verges between pine plantations and native bush.

Being aware of the sorts of environments in which a species grows is as important as recognising its characteristic features. Knowledge of characteristic environments helps you become familiar with the species and enables you to eliminate toxic lookalike species that grow in different environments. The profiles in the following section indicate the habitats where each species or genus is most likely to grow, along with those of lookalike species.

Some *Agaricus* species are well known for their palatability.

Different appearance of mature and immature *Macrolepiota clelandii*.

Young sporophore of *Phlebopus marginatus*.

Phlebopus marginatus showing cracking caused by drying.

Lactarius deliciosus

saffron milkcap
milkcap
pine mushroom

Due to its conspicuous features and abundance, the saffron milkcap is an ideal species for those new to foraging. Its lurid orange latex and the striking green colour change of broken flesh make it easily recognisable. The saffron milkcap is probably the most commonly foraged edible fungus species in Australia after *Agaricus campestris* (field mushroom). It is one of the few non-cultivated species likely to be found in restaurants serving wild mushrooms.

◄ *Lactarius deliciosus* (saffron milkcap).

Lactarius deliciosus

Checklist of features

HABITAT	Pine plantations and gardens with exotic trees. Mycorrhizal.
SYMBIONT	Exotic *Pinus* (pine), commonly found in association with *Pinus radiata* (radiata pine).
SUBSTRATE	On the ground, among pine needle litter.
HABIT	Solitary, gregarious or in clusters of overlapping sporophores.
PILEUS	To 15 cm (occasionally 30 cm) diameter, convex with margin inrolled when young, becoming plane with depressed centre to funnel-shaped, with margin often wavy or uplifted in age, orange to pinkish orange, generally paler with age and drying, with concentric zones or bands of colour, and with pits or blotches, staining green when bruised, surface smooth.
LAMELLAE	Strongly decurrent, close to crowded, narrow (i.e. not deep from top to bottom), orange, staining green when bruised.
STIPE	2–8 cm long 1–3 cm diameter, equal or slightly enlarged at base, orange to orange-buff, staining green when bruised, surface smooth but with rounded blotches or pits.
FLESH	Firm, in stipe often hollow, more so with age, with chalky texture, crumbling when broken.
LATEX	Orange latex, usually obvious when lamellae or flesh broken, remains orange with exposure to air.
SPORE PRINT	White to pale cream.
ODOUR	Indistinct but lighter and more ‘fragrant’ or ‘fruity’ than the heavier mushroomy or earthy odour of *Agaricus campestris*.
PHENOLOGY	Occurs throughout the year, mostly in late autumn and winter in southern Australia.


Clusters of overlapping sporophores.

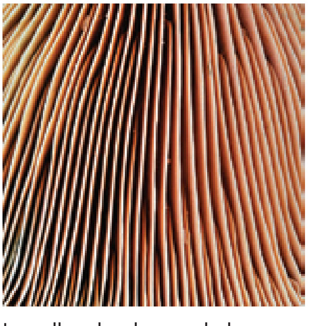

Pileus convex when young.

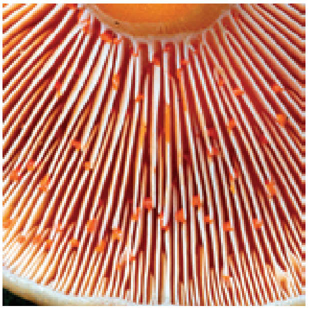

Pileus margin inrolled when young.

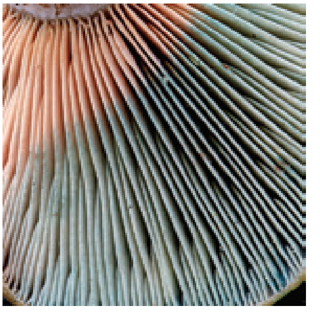

Pileus becoming funnel-shaped with age.


Pileus with concentric zones.


Pileus with pits and blotches.


Lamellae closely crowded.


Latex orange.


Green staining.


Stipe with pits.


Stipe chalky, hollow.


Stipe, chalky, hollow. Lamellae decurrent. Pileus margin inrolled.

Name

Lactarius deliciosus was first described by Linnaeus in 1753, as *Agaricus deliciosus.* It was transferred to the genus *Lactarius* by British mycologist Samuel Gray in 1821. Under his *A. deliciosus*, Linnaeus listed various phrase names used by older authors such as Italian botanist Pier Micheli. These names probably refer to species of *Lactarius*, but given the diversity now recognised in the genus we cannot be sure if they equate to the species *L. deliciosus* as it is understood today. Derived from Latin, the name *Lactarius* means 'milky' or 'made of milk'. It refers to the milk-like orange latex exuded when the flesh is damaged. The specific epithet *deliciosus* suggests Linnaeus favoured it as an edible species.

Distribution

Lactarius deliciosus is an ectomycorrhizal fungus native to Europe and perhaps also to Asia. In Australia, it is an introduced species that grows in great abundance with *Pinus* species originating from both Europe (e.g. *P. sylvestris*) and North America (e.g. *P. radiata*). It also occurs with other species of *Pinus* such as *P. pinaster* (maritime pine), *P. pinea* (stone pine) and *P. strobus* (eastern white pine). Sporophores appear as early as 2 years after planting of the partner tree and have been observed with trees at least 70 years old.

In Australia, *L. deliciosus* is reported from across south-east Australia from South Australia to New South Wales. In South Australia it occurs only in the vicinity of Adelaide and in the south-east. In Tasmania it can be found in scattered localities in the north and south of the state. In Victoria it is widespread south of the Great Dividing Range and also northwards in central Victoria. In New South Wales it is widespread within 100 km of the coast, including in the Australian Capital Territory, as far north as Newcastle; with a few scattered records in the north of the state, such as at Armidale and Taree.

Classification

Lactarius deliciosus belongs to the section *Deliciosi* of the genus *Lactarius*. This section is characterised by the presence of coloured latex, which often changes colour on exposure to air. Within this section, sporophores are usually relatively stocky. In addition, many species of the section have concentric zonation on the pileus and coloured shallow pits (scrobicules) on the stipe along with orange or red latex. About 30 species within the section are currently recognised around the world, all with native distributions in the Northern Hemisphere.

In Europe, after the description of *Lactarius deliciosus*, further species of section *Deliciosi* were distinguished on morphological characters. Examples are *L. deterrimus* (pileus not zoned, or only at the margin), *L. fennoscandicus* (pileus zoned but stipe rarely with pits), *L. salmonicolor* (pileus zoned, latex orange), *L. sanguifluus* (latex brownish red), *L. semisanguifluus* (latex orange, rapidly turning purplish red), and *L. quieticolor* (pileus zoned, latex orange). Some of these species have specific associations, such as *L. deterrimus* and *L. fennoscandicus* with spruce (*Picea*).

Analysis of DNA sequence data from members of *Lactarius* section *Deliciosi* has confirmed the limits of some long-established species, reduced other species to synonymy and revealed novel species with subtle morphological differences. These analyses also show that most species in section *Deliciosi* occur in only one continent. The name *Lactarius* *deliciosus* was previously applied to material from both Europe and North America, but according to DNA sequence data, the name should be restricted to European material, with American collections belonging to one or more as yet un-named species.

Identity

Although pine trees were introduced to Australia in the mid-nineteenth century, *Lactarius deliciosus* was not reported until the 1930s, in Victoria, by botanist Jim Willis. *Lactarius deliciosus* is the only species of section *Deliciosi* confirmed as occurring in Australia. In section *Deliciosi* as it is currently understood, the closest species to *L. deliciosus* in appearance are *L. quieticolor* and *L. salmonicolor*, both with zoned pileus and orange latex. However, *L. quieticolor* differs by the latex that turns red within ~20 minutes, the pileus with orange, brown or even bluish tints and the stipe that lacks or has only inconspicuous pits; while *L. salmonicolor* differs by the latex that turns reddish brown and the association with *Abies* (fir). Neither *L. quieticolor* nor *L. salmonicolor* nor any other related species of section *Deliciosi* such as *L. sanguifluus* have been confirmed as occurring in Australia.

Australian collections of *L. deliciosus* match descriptions of the species from Europe closely, especially in the orange latex that does not (or only slowly) turn red, the pitted stipe and the zoned pileus, as well as the association with *Pinus*. In addition, there is confirmation of the presence of *L. deliciosus* in Australia from a DNA sequence.

Australian species

Lactarius is characterised by chalky textured flesh, white spore print and presence of latex. The genus is not particularly diverse in Australia, with fewer than a dozen species formally described. The most similar species to *L. deliciosus* is the exotic *L. pubescens*, which occurs in association with birches in Australia. *Lactarius* is similar in the field to *Lactifluus*, a genus recently separated on the basis of DNA sequence data. Australian species of the two genera include the *Lactifluus clarkeae* group (some species with bright orange pileus, but not zoned), *Lactarius eucalypti* (small sporophore, pileus reddish, not zoned) and an undescribed native species close to the European *Lactifluus piperatus* (white sporophore, white latex, acrid taste). *Multifurca* is another closely related genus, also with white spores, but with or without latex. It is represented in Australia by one species *M. stenophylla* (pileus zoned, but pale yellow). *Russula* is also related but lacks latex.

Lookalike species

Four lookalike species commonly confused with *L. deliciosus* are summarised below. Paying attention to the habitat in which *L. deliciosus* grows reduces the possibility of encountering lookalikes such as *L. pubescens* and *Austropaxillus infundibuliformis* that grow in different habitats.

Lamellae distinctively forked.

Pileus margin with radial ribbing.

Paxillus involutus group (rollrims)

See full species profile in Chapter 8.

Features to note:

- Pileus dull brown, dingy yellow brown or greyish brown (not orange), bruising darker (not green), surface viscid when wet; margin strongly inrolled, remaining incurved at maturity, often irregularly wavy or lobed with age, often with radial ribbing.
- Lamellae distinctively forked, pale ochre to yellow brown, ageing to brown, bruising brown, often irregular and convoluted with anastomosing near stipe; separable from pileus.
- Stipe relatively short, often curved and tapering towards base, not pitted, light ochre, pallid to dingy brown, darkening with age, bruising dark brown.
- Flesh thick and firm (not chalky), yellowish, discolouring brown; not exuding latex.
- Spore print yellow brown, olive brown or reddish brown.

Colour typically yellow brown to dark brown.

Lamellae distinctively forked.

Austropaxillus infundibuliformis

Austropaxillus infundibuliformis belongs in the Serpulaceae. Most genera in this family are not mushrooms but have a poroid or irregular hymenium and there is no information on their edibility/toxicity. Therefore *A. infundibuliformis* should be treated with caution.

Features to note:

- Mycorrhizal with native plants such as *Eucalyptus*.
- Pileus convex to flattened when young, developing central depression to become funnel-shaped, yellow brown to dark brown, surface felty; margin irregularly wavy with age.
- Lamellae distinctively forked, pale cream to pale yellowish brown; separable from pileus and can be dislodged with pressure from a fingertip.
- Stipe yellowish, lighter near base, bruising dark brown.
- Flesh thick and firm (not chalky as in *Lactarius*), yellowish, discolouring brown; not exuding latex.
- Spore print rust brown.

Lactarius pubescens (downy milkcap)

If you were to accidentally consume this species, you would be immediately aware of an intense and unpleasant peppery burning sensation (that can cause blistering of the tongue).

Features to note:

- Mycorrhizal with *Betula*.
- Pileus convex then plane with depressed centre, cream or pale pink becoming pinkish brown or pale orange in centre when old (not as strongly orange as *L. deliciosus*), zones absent or faint, dry or viscid in centre, fibrillose then smooth; margin strongly inrolled and tomentose or woolly at first, less so with age.
- Lamellae adnate to decurrent (less so than in *L. deliciosus*), crowded, sometimes forked near stipe, cream or pale pink.
- Stipe surface dry, smooth to fibrillose, cream or pale pink, sometimes with a few darker rounded blotches.
- Flesh firm, white or off-white, does not stain green and exudes acrid-tasting white latex that does not change colour.
- Odour fruity or of pelargoniums.

Pileus margin downy, especially when young.

Latex white and not changing colour.

Amanita muscaria (fly agaric)

See full species profile in Chapter 8.

Weathered sporophores of *A. muscaria* viewed from above can appear superficially similar to *L. deliciosus* because the white warts can wash off in rain and the red colouration can fade to orange. A casual remark such as 'edible orange mushrooms grow in the pine forest' has resulted in confusion for novice foragers who have not examined the whole sporophore.

Features to note:

- Pileus ovoid or hemispherical at first, becoming convex, broadly convex then plane, deep to bright red, fading to orange, yellow or white, surface with cottony angular white to yellow warts; margin sometimes grooved.
- Lamellae white, lamellulae frequent.
- Stipe long (5–20 cm), base bulbous, white to off-white, surface sometimes slightly woolly; upper stipe with white membranous partial veil that forms a skirt-like annulus, often disintegrating with age; volva present in the form of concentric bands of block-like universal veil remnants at top of bulb.
- Flesh white throughout, not changing colour when bruised, without latex.

Pileus can lose warts and become uplifted and paler with age.

Weathered sporophores usually retain white lamellae, a white stipe with bulbous base and annulus remnants.

Coprinus comatus

lawyer's wig
inkcap
shaggy inkcap
shaggy mane

Inkcaps are so-named because of their unusual habit of 'auto-digesting' or 'deliquescing' as a means to aid spore release. When mature, the lamellae dissolve into an inky mass, the 'ink' of which was once used for writing. *Coprinus comatus* is also known colloquially as the lawyer's wig, in reference to the headwear worn in the courtroom. In Tuscany it was described as a 'fungus in great request' by botanist Benedetto Puccinelli in the mid-nineteenth century. Although widespread and easily recognisable, C. *comatus* is an overlooked edible species.

◄ *Coprinus comatus* commonly grows along path edges and in other human-modified environments.

Coprinus comatus

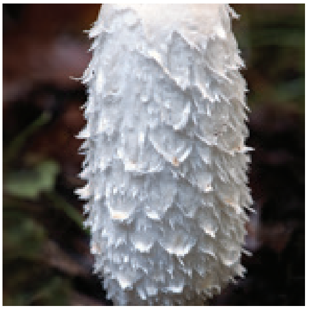
Checklist of features

HABITAT	Often found in disturbed environments, particularly in cities and towns, such as road verges, path edges, compost heaps, parks, gardens and sporting grounds, also paddocks. Saprotrophic.
SUBSTRATE	On the ground, among grass or mulch but also on bare soil. Does not grow directly on wood but feeds on organic matter in the soil.
HABIT	Solitary or in scattered or dense groups, sometimes in rings.
PILEUS	To 15 cm diameter, pileus much taller than wide when young, ovoid to cylindrical becoming rounded-conical or bell-shaped with age, often with a flaring margin, white or sometimes with brownish centre, surface smooth at first, but soon with tufted 'scales', can become radially split with age; margin auto-digests or deliquesces, rolling upwards at maturity, leaving only a small portion of the original surface.
LAMELLAE	Free, crowded, white, then pink or pinkish red, then black and 'inky' as they deliquesce, colour change progressing upwards from pileus margin, often with distinctive colour zones.
STIPE	To 30 cm long and to 22 mm diameter, evenly cylindrical, sometimes tapering towards apex, sometimes enlarged at base, white, surface smooth; with membranous partial veil that forms a small, fragile, white, movable annulus, which often slips down to base or falls off completely.
FLESH	Pileus somewhat fragile; stipe firm, hollow with long string-like strand of pithy fibrous tissue attached at the top; pileus and stipe separate easily.
SPORE PRINT	Black.
ODOUR	Earthy or mushroomy.
TASTE	Indistinct, mild or mushroomy.
PHENOLOGY	Occurs throughout the year, most often seen in April to June.

Commonly grows in dense clumps.

Sometimes grows in rings.

Pileus margin flaring and deliquescing.



Pileus cylindrical with white tufted scales.

Scales become brownish and flattened.

Pileus with brown centre.

Lamellae with distinctive colour zones.

Cross-section showing deliquescing lamellae.

Pileus margin deliquescing.

Exposed stipes with annulus remnants.

Annulus slipped to base of stipe.

Stipe hollow with pithy central 'string'.

Name

The name *Agaricus comatus* was introduced in 1780 by the Danish naturalist Otto Müller in the fifth volume of *Flora Danica*. It was transferred to the genus *Coprinus* by South African-born mycologist Christiaan Persoon in 1797, working at the time in Germany. Earlier names also existed, but *Coprinus comatus* was adopted by Fries in his *Systema Mycologicum* of 1821 and this is the name used today. The name *Coprinus* means belonging to (i.e. arising from) dung, a character shown by some species of the genus, but not by *C. comatus*. The epithet *comatus* means possessing tufts, in reference to the scaly pileus.

Distribution

Coprinus comatus is found around the world in all continents except Antarctica. The first report of *C. comatus* from Australia was in English mycologist Mordecai Cooke's *Handbook of Australian Fungi*, published in 1892. In the Australian newspaper press, it was first mentioned in the *Macleay Argus* in 1895. A species as conspicuous as *C. comatus* would be expected to feature in reports of Australian fungi published from the 1840s onwards. Therefore, the lack of records until late in the nineteenth century suggests it was introduced. The occurrence of *C. comatus* in Australia in disturbed sites, such as along the sides of new roads, where soil has been turned over, also supports an exotic origin. It is not found in undisturbed native vegetation.

In Australia, *C. comatus* occurs in south-west and eastern Australia. In Western Australia, it is found around the coast from Perth to Esperance. In eastern Australia, it is found from Eyre Peninsula in South Australia, throughout Tasmania and Victoria and coastal New South Wales, to south-east Queensland, around the Bunya Mountains. In the south of the continent, it extends well inland, for example to the Riverina district and the Flinders Ranges, but is absent from northern Western Australia, the Northern Territory and inland and northern Queensland (although it possibly occurs in north Queensland around Cairns). It frequently occurs in parks and gardens. Occurrences in the drier inland regions are usually in watered gardens.

Classification

For around two centuries the genus *Coprinus* was generally accepted as the repository for all black-spored species of mushrooms that deliquesce (see p. 118 for a discussion of deliquescence). When DNA sequence information became available for these mushrooms, mycologists were surprised to learn that deliquescence had evolved multiple times among black-spored fungi. In particular, a small number of species related to *Coprinus comatus*, were placed in the Agaricaceae, the same family as *Agaricus*. All other deliquescent species formerly placed in *Coprinus* are now placed in the Psathyrellaceae. In this family, the former members of *Coprinus* were split into several groups, interspersed by species of *Psathyrella*, a genus similar in the fragile texture and micro-characters, but not showing deliquescence.

There were vigorous arguments as to whether the name *Coprinus* should be used for deliquescent species in the Agaricaceae or applied to one of the groups in the Psathyrellaceae. Eventually, it was agreed to retain *Coprinus* for the group around *C. comatus*. Consequently, deliquescent species in the Psathyrellaceae are now placed in the three genera *Coprinellus*, *Coprinopsis* and *Parasola*. Some rearrangements to the limits of the genus *Psathyrella*. were also required.

Subsequent to rearrangements of the limits of genera on the basis of DNA sequence data, it is always interesting to re-examine morphological characteristics. Early mycologists such as Bulliard observed a stringy central thread within the hollow stipe of *C. comatus*. This feature was rediscovered in the newly restricted *Coprinus* and also found in *Montagnea*, a closely related genus of the Agaricaceae. *Montagnea* has dry lamellae at maturity, but otherwise is rather similar in appearance to *Coprinus*. This thread is not present in the deliquescent Psathyrellaceae.

Identity

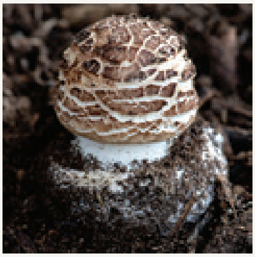
Although there are no DNA sequences available from Australia, collections of *C. comatus* from Australia closely match those from the Northern Hemisphere in macro- and micro-characters.

Australian species

The only other species of *Coprinus* confirmed from Australia is *C. sterquilinus* (midden inkcap), which is similar to *C. comatus* in overall appearance, including the presence of an annulus low on the stipe. However, it differs by growing on manure, often of horses; the mature pileus is less scaly; and it does not grow as tall as *C. comatus* (only to 10 cm). In addition, *C. sterquilinus* may have a well-developed rooting base to the stipe. *Coprinus sterquilinus* is much less often encountered than *C. comatus*. *Podaxis beringamensis* (termite powderpuff that grows on termite mounds) and *P. pistillaris* (black powderpuff) are relatives of *C. comatus* that are remarkably similar to it in their external appearance before maturity. However, they do not deliquesce. Instead, the spores form a powdery mass inside the thin, papery pileus, which eventually falls off to reveal the spore mass. Powderpuffs are fungi of arid regions and are common in central Australia.

Lookalike species

Three toxic lookalikes grow on the ground in similar disturbed habitats to *C. comatus*. Immature stages of *Chlorophyllum brunneum* and *C. molybdites* resemble unopened *C. comatus*, but the two species of *Chlorophyllum* do not deliquesce and do not have the distinctive cylindrical shape of *C. comatus*. *Coprinopsis atramentaria* differs principally by the lack of tufted scales on the pileus.



Pileus not deliquescing and with all-brown scales.

Bulbous stipe base with red staining.

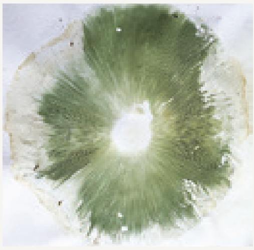
Chlorophyllum brunneum (shaggy parasol)

See full species profile in Chapter 8.

Features to note:

- Pileus convex to blocky when young, expanding to broadly convex or nearly plane with age, dull greyish brown in the button stage, soon developing coarse brown to greyish brown concentrically arranged scales, except for central cinnamon brown disc where surface remains intact, surface dry, beneath scales radially fibrillose and whitish; margin incurved at first.
- Stipe usually equal in width with enlarged to abruptly, often marginate bulbous base, bruising orange then red, darkening to brown; with white partial veil that breaks to form prominent, white or brownish, membranous, felty, annulus.
- Lamellae white becoming dingy brown with age.
- Flesh thick, white, discolouring orange then red, darkening wto brown.
- Spore colour white.

Lamellae greyish green at maturity.



Spore print greyish green.

Chlorophyllum molybdites (false parasol)

See full species profile in Chapter 8.

Features to note:

- Pileus globose, convex or broadly conical when young, then broadly convex to plane, dry, smooth in button stage, off-white to brown, as pileus expands cuticle cracks forming concentric circles of coarse fawn to brown to pinkish to tan scales, concentrated towards the centre, often with dull brown umbo, surface beneath scales finely fibrillose, white to pale tan; margin often slightly upturned, sometimes shaggy from veil fragments when young.
- Lamellae at first white to off-white or cream, becoming greyish green to olive brown.
- Stipe usually equal in width with slightly enlarged to sub-bulbous base; with prominent, moveable, white or brownish membranous, felty annulus.
- Flesh thick, white, usually staining red or reddish brown.
- Spore print pale green or greyish green.

Coprinopsis atramentaria (common inkcap)

See full species profile in Chapter 8, including discussion of other species of *Coprinopsis* (which are all smaller and do not combine scaly pileus surface and an annulus on the stipe).

Features to note:

- Sporophores to 8 cm high (not as tall as *Coprinus comatus*), deeply conical to ovoid, then bell-shaped (typically ('bullet-shaped', not cylindrical as in *C. comatus*), then convex to plane, flaring and becoming tattered at margin, lead grey, greyish or brownish grey, surface faintly striate, grooved or smooth, sometimes with brown central disc and often finely scaly around centre.
- Stipe to 15 cm long, smooth or finely fibrillose; evanescent annulus leaving narrow ring or ridged zone on mid to lower stipe; occasionally with rudimentary volva.
- Flesh in pileus thin, soft, white to pale grey; in stipe fibrous, hollow.

Coprinopsis atramentaria lacks the tufted scales of *Coprinus comatus*.

Ridged zone on lower stipe.

This species is not inherently toxic but when consumed with alcohol can cause disulfiram-like mushroom poisoning (see Chapter 8).

Lepista nuda

(Synonym: *Clitocybe nuda*)
blewit
wood blewit
field blewit

Chancing upon a ring of perfect purple blewits deep in the forest is an autumn foraging highlight. This distinctively fragrant species is sought after in Europe and the Americas and is gaining popularity in Australia. Some people, however, consider it to be too 'perfumed' as a culinary species. **It must be cooked before being eaten as it can cause severe indigestion if eaten raw.**

◄ A perfect purple *Lepista nuda* (blewit) in its prime.

Lepista nuda

Checklist of features

HABITAT	In a wide range of environments, including parks and gardens, road verges and other disturbed environments as well as native forests and woodlands. Saprotrophic.
SUBSTRATE	On the ground, among leaf litter or mulch, often with debris attached to base.
HABIT	Often in large troops or rings, also solitary or in small groups.
PILEUS	To 15 cm diameter, convex when young, becoming plane with age, often becoming irregular or wavy, pink, lilac or purple, browning with age, not or slightly changing colour on drying, surface smooth, often lustrous in appearance; margin inrolled at first.
LAMELLAE	Adnate to adnexed, sinuate or notched, close or crowded, pale pink to lilac, fading to buff or brown with age.
STIPE	3–11 cm long, cylindrical above, often enlarged at the base, concolorous or paler than pileus, surface smooth to slightly fibrillose, base sometimes covered with lilac downy covering; no annulus present.
FLESH	Firm, almost rubbery. Stipe darker at edge than in centre in cross-section.
SPORE PRINT	Pinkish brown.
ODOUR	Distinctive, variously described as perfumed, fragrant, fruity, floral or like orange juice.
PHENOLOGY	In southern Australia, usually found later in the season, in late autumn and winter (May to July) rather than autumn, and rarely at other times.

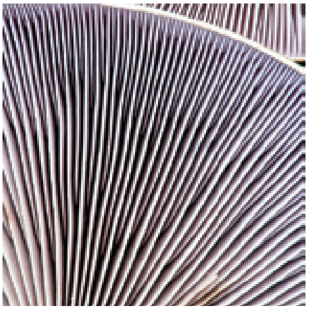

Pileus convex when young.


Pileus flattens, becomes irregularly shaped and turns brown with age.


Pileus margin incurved and irregular.


Pileus turns brown with age.


Sporophore irregularly shaped, browning with age.


Lamellae close, lilac.


Lamellae attached, stipe flesh mottled.


Stipe base with lilac, downy covering.


Stipe darker at edge than centre in cross-section.

Name

Lepista nuda was first described as *Agaricus nudus* by Bulliard in one of the volumes of *Herbier de la France*, published around 1790. Bulliard compared *A. nudus* to *A. violaceus* (now *Cortinarius violaceus*) emphasising the presence of a cobweb-like partial veil in the latter. Bulliard did not comment on the edibility of *A. nudus*, but it was noted as 'comestible' by Parisian mycologist François-Simon Cordier in his 1826 book *Guide de l'Amateur de Champignons.* Cooke transferred *A. nudus* to the genus *Lepista* in 1871. The name *Lepista* derives from a Latin word meaning goblet, in reference to the funnel-shaped pileus of some species. The epithet *nuda* means naked, in reference to the smooth pileus surface.

Distribution

Lepista nuda is widespread and commonly reported across east and west North America and western Europe. Outside of these areas, there are mostly scattered records from South America, Africa and Asia. However, it is commonly recorded from Australia, where it has a curious distribution in relation to the habitats where it is found. It occurs in relatively intact native vegetation, such as *Eucalyptus* forests and woodlands, including urban remnants, but also in plantations of exotic trees, parks and gardens. It was rarely reported in Australia before 1950, and early records, including the first two from 1929 and 1931 are mostly from suburbs of capital cities. Therefore, we consider it to be an exotic species that has successfully spread into native forests.

In Australia, *L. nuda* is found in south-east Australia from South Australia to south-east Queensland, including Tasmania. In South Australia, it is reported from around Adelaide and in the far south-east. In Tasmania, sightings are predominantly from the south and the north. In Victoria it is widespread apart from the north-west of the state. In New South Wales, including the Australian Capital Territory, most records are south of Newcastle, with inland occurrences to the Tumut region in the south. There is a large gap in the distribution along the east coast, between Newcastle and far north-east New South Wales/far south-east Queensland, where it occurs from Lismore north to Caloundra. A report from Western Australia needs confirmation.

Classification

Lepista nuda has been placed at various times in the genera *Tricholoma* and *Clitocybe*. It has a rather robust appearance reminiscent of some *Tricholoma* and the lamellae are not as obviously decurrent as in other species of *Lepista*. The genera *Lepista* and *Clitocybe* are distinguished by microscopic characters of the spores. However, different mycologists draw different boundaries between the two genera. Indeed, some merge the two. Spore print colour is white or cream in *Clitocybe* and some species of *Lepista*. Other species of *Lepista*, such as *L. nuda*, have a pinkish brown spore print. The genus *Clitocybe* was characterised initially by the combination of medium to large sporophores lacking a partial or universal veil, with decurrent lamellae and a white spore print. When relationships are examined using DNA sequence data, the clitocybe-like habit turns out to have evolved independently in several groups among the agarics. Various species have been separated from *Clitocybe* into genera such as *Infundibulicybe* (for *C. gibba*) and *Singerocybe* (for *C. clitocyboides*). The remaining core species of *Clitocybe* (*C. nebularis* and relatives) are closely related to *Lepista* and a few species of *Collybia* (e.g. *C. tuberosa*). However, the limits of the three genera remain uncertain. Therefore, we follow most recent guides in accepting *Lepista*, including *L. nuda*. The reliability of classifications, including of the *Clitocybe–Lepista* group, is likely to be improved by wider sampling of species and addition of further gene regions.

Identity

The appearance of collections of *L. nuda* from Australia matches that of the species as understood in Europe. DNA sequences are not yet available from Australian collections. *Lepista nuda* is a saprotroph that can be grown in pure culture. Research using an early form of DNA analysis (not involving sequencing) investigated the relationships of cultures isolated from sporophores from New South Wales and France, all identified as *L. nuda* by morphology. The Australian cultures had the same DNA features as cultures from France. Intriguingly, Australian cultures grew faster and at higher temperatures than those from France. Such differences may reflect adaption of an introduced species to novel environmental conditions. Alternatively, the species may have wider temperature tolerances in other parts of its natural range.

Australian species

Six species of *Lepista* have been reported as occurring in Australia. In addition to *L. nuda*, three of these were originally described from the Northern Hemisphere and are probably exotic to Australia. Among these, *Lepista luscina* (grey pileus with slightly depressed spots) is reported from lawns in a few localities in South Australia, Tasmania and Victoria. *Lepista endota* (pileus greyish brown with purple tint) is known from a single collection from Eucalyptus woodland in South Australia. *Lepista sublilacina* is smaller than *L. nuda* and has a strongly hygrophanous, lilac pileus that does not become brown with age. It is found in lawns in near-coastal locations on the east coast in scattered localities from Jervis Bay to Cairns, as well as in the south-east of South Australia. It was described originally from Australia but is very similar in appearance to *L. sordida* and may be a synonym of the latter species. Several species of *Rhodocybe* such as *R. amara* (= *Clitopilus acerbus*) resemble *Lepista* by having medium-sized sporophores with decurrent lamellae and a pinkish brown spore print. However, none of the Australian species of *Rhodocybe* have sporophores with purple tints.

Lookalike species

Wander around in the bush or among exotic trees and you are likely to encounter various fungi with purple, mauve or lilac colouration. Some resemble *L. nuda* in size and form, especially a few species in the genera *Cortinarius* and *Russula* as compared below. Among other purple mushrooms, species of *Mycena* are much smaller and *Leucopaxillus lilacinus* has a white spore print. Some boletes have a purple pileus, but these have pores on the underside.

Rust brown spores caught in cortina.

Brown lamellae and collapsed partial veil forming ring-zone.

Cortinarius (webcaps)

Confusion with *Cortinarius* (webcaps) is of most concern. Within this large genus of more than 2000 species worldwide, few species are considered edible, but some are known to be highly toxic. The edibility/toxicity of most Australian webcaps is unknown but there is one dangerously poisonous species, *C. eartoxicus* (see p. 77). Several purple Australian cortinars are frequently encountered in native bush including *Cortinarius archeri* (emperor cortinar), *C. alboviolaceus* (pearly webcap) and *C. austroviolaceus* (austral violet webcap). All could be confused with *L. nuda*.

Features to note:

- Pileus can be distinctively viscid or glutinous (but can feel satin-like in dry weather). Although *L. nuda* can be wet or even slightly slimy after rain, it is not glutinous.
- Lamellae usually brown at maturity, but may be tinted lilac or violet, especially when young.
- When young with cortina (cobweb-like partial veil), leaving 'ring-zone' on stipe. Look for rust brown spores trapped in fibres of the ring-zone. Occasionally, partial veil is membranous (e.g. *C. archeri*).
- Spore print rust brown to cinnamon.
- Odour usually not distinctive, rarely perfumed.

Leucopaxillus lilacinus with cream lamellae.

Leucopaxillus lilacinus (purple turnover)

Leucopaxillus lilacinus is a rare species of native forests of unknown edibility/toxicity.

Features to note:

- Pileus convex, expanding to flat or centrally depressed, purple, smooth; margin inrolled when young, grooved.
- Lamellae adnate to almost decurrent, sometimes forked or anastomosing, white to cream, bruising brown with age.
- Stipe stout with tapering or swollen base, white above and purple below, often with rusty stains.
- Spore print white to pale cream.

Russula (brittlegills)

Russula is a large genus of around 700 species worldwide. In Australia several purple species grow in association with both native and exotic vegetation. While it is fairly easy to recognise a *Russula* in the field, identifying to species level often requires microscopic examination. However, species level identification is not the imperative, rather what matters is being able to differentiate a *Russula* from *L. nuda*. One obvious way *Russula* differs from *L. nuda* is the brittle, chalky flesh that crumbles when broken (hence the vernacular name brittlegills). Also, note that lamellae of *Russula* are white or cream, as is the spore print. While both edible and toxic *Russula* species are known from Europe, the edibility/toxicity of Australian *Russula* species is unknown.

Features to note:

- Mycorrhizal with native or exotic trees.
- Pileus usually convex when young, becoming plane to uplifted with age, variously coloured, sometimes with white spots (flesh showing through from underneath due to invertebrate attack), surface texture variable but usually dry; margin not usually wavy or irregular.
- Lamellae adnexed, close or crowded, white, cream or pale yellow.
- Stipe usually smooth, dry. *Russula* with purple pileus often have white or pink stipe.
- Flesh brittle, chalky (not fibrous).
- Spore print white, cream or occasionally pale yellow.
- Odour usually not distinctive.

Pileus purple and stipe pink.

Pileus becoming uplifted.

Lamellae crowded, white.

Macrolepiota clelandii

(Formerly known in Australia as *Macrolepiota gracilenta*, *M. konradii*, *M. mastoidea* or *M. procera*)
Australian parasol
graceful parasol
bush parasol

This elegant mushroom is always a delight to find. The distinctive dark brown, central umbo, felty texture, white lamellae and long stipe with movable annulus make it easily recognisable. However, be aware of various superficially similar toxic lookalike species, especially *Chlorophyllum*. The Australian parasol was originally thought to be the same as the European species *Macrolepiota procera*. We now know this species does not grow in Australia.

◄ *Macrolepiota clelandii* is always a thrill to find for its elegance and stature.

Macrolepiota clelandii

Checklist of features

HABITAT	In native forests and woodlands, included grassy woodlands, often in disturbed environments adjacent to bushland such as grassy road verges, lawns in picnic areas and sporting grounds. Does not associate with any particular trees and can be found in open areas far from trees, although may also occur under the canopy of trees. Saprotrophic.
SUBSTRATE	On the ground.
HABIT	Solitary or in small groups, often widely separated.
PILEUS	To 25 cm diameter, at first ovoid with distinctive 'drumstick-like' appearance, becoming convex, flattening in maturity, with off-white or pale brown ground colour and conspicuous dark brown umbo, surrounded by 'chocolate chip' like brown squamules that can wash off with rain, surface texture soft, 'furry' or felty; margin often with fragments of partial veil.
LAMELLAE	Free, closely spaced, white, mottled pink, sometimes darkening to brown with age.
STIPE	To 20 cm long and 1.5 cm diameter, cylindrical, base often swollen, pale brown, surface smooth; with prominent annulus that is often loose and can be physically moved up and down the stipe.
FLESH	White-fawn, hollow in stipe.
SPORE PRINT	White to cream.
ODOUR	Indistinct.
PHENOLOGY	Usually found between mid-autumn and early winter but has been recorded throughout the year.


Immature drumstick form.


Pileus becomes convex.

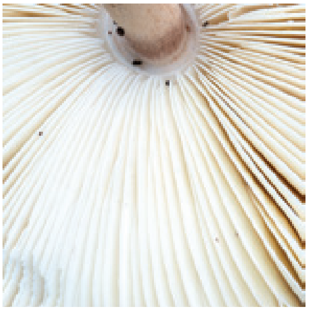

Pileus flattens with maturity.

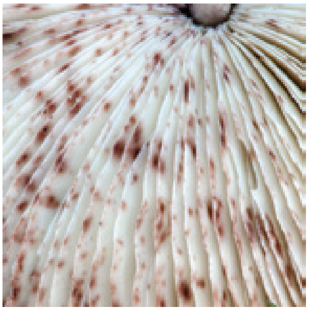

Umbo and squamules.


Umbo often dark.

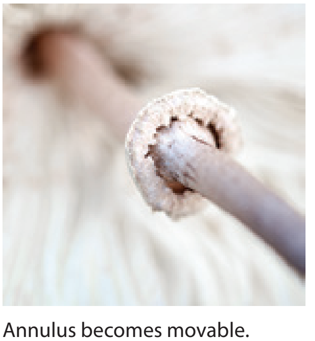

'Chocolate chip' squamules.


Felty pileus texture.


Lamellae closely spaced, free, white.


Ageing lamellae with pink mottling.


Prominent annulus.


Annulus becomes movable.


Stipe base swollen.

Name

The name *Macrolepiota* refers to the relatively large size of species in the genus, which otherwise resemble *Lepiota*, another genus of the family Agaricaceae. The epithet *clelandii* commemorates John Cleland, pioneer worker on Australian fungi, who published an account of the species in his 1934 book *Toadstools and Mushrooms of South Australia*, under the name *Lepiota procera*, a species of the Northern Hemisphere. In 1997, when revising Cleland's book, Australian mycologist Cheryl Grgurinovic realised that the local parasol was distinct and introduced the name *Macrolepiota clelandii*.

Distribution

Macrolepiota clelandii is native to Australia and New Zealand. It grows in native forest and woodland but often in places with some disturbance, such as along tracks and roads, or in clearings. In Australia, *M. clelandii* is reported from south-west and south-east Australia. In Western Australia, it is found in the south-west, usually near the coast. In south-east Australia, it occurs from South Australia (east of Adelaide, and in the south-east of the state) to south-east Queensland (as far north as Bundaberg; also with unconfirmed reports from north Queensland around Mackay and Cairns). It occurs across Tasmania and widely in Victoria, except for the drier, north-west of the state. The New South Wales distribution, including the Australian Capital Territory, is on the coastal side of the Dividing Range and on the inland slopes as far west as, for example, the Coonabarabran district.

Classification

Lepiotoid mushrooms are those with free, a central stipe, and a distinct annulus, but lacking a volva (as present in *Amanita*). The white-spored mushrooms with this set of characters often have a characteristic pattern on the pileus where there is a central disc of darker coloured tissue, surrounded by smaller scales of the same colour, over a pale background. These scales are not remnants of the universal veil, as can often be seen in species of *Amanita*, but form as a result of the break-up of the outer layer of the pileus as it expands. In the latter part of the nineteenth century most lepiotoid fungi with white spore print were placed in the genus *Lepiota*. Gradually, as microscopic characters were taken into account, various genera were segregated from *Lepiota*, among them *Macrolepiota*, established by German-born mycologist Rolf Singer in 1948.

In the latest classification of lepiotoid mushrooms, *Macrolepiota* is supported as an independent genus by DNA sequence data, with a notable exception: the 'shaggy parasol' with rather coarse pileus scales previously known as *Macrolepiota rhacodes* is now placed in *Chlorophyllum*, a genus originally created for a tropical lepiotoid species with a green spore print, *C. molybdites*. Furthermore, reports of *M. rhacodes* from Australia are incorrect, and the shaggy parasol in Australia is in fact *Chlorophyllum brunneum*.

Identity

For many years, from the mid-nineteenth century, the common parasol mushroom of southern Australia was reported under a variety of names of Northern Hemisphere parasols, at first in *Agaricus*, then in *Lepiota* and eventually in *Macrolepiota*. The names in *Macrolepiota* included *M. gracilenta*, *M. konradii*, *M. mastoidea* and *M. procera*. The reports were based on dried specimens sent to Europe for identification in the nineteenth century. In the first half of the twentieth century, local mycologists such as John Cleland and James Willis made careful observations on fresh material but continued to apply Northern Hemisphere names. In comparison to *M. procera*, the Australian parasol is subtly different – it usually does not grow as large (the pileus of *M. procera* can as much as 40 cm in diameter) and lacks the snake-like banding on the stipe typical of *M. procera*.

In 1997, Cheryl Grgurinovic studied microscopic features of mushrooms collected by Cleland, and found that his collections of parasol mushrooms differed in several respects from *M. procera* and other Northern Hemisphere species. Consequently, she introduced the name *Macrolepiota clelandii*. In 2003, Vellinga isolated DNA from a range of Australian specimens and confirmed that *M. clelandii* was a distinct Australasian species. In the field, the most variable feature is the degree of scaliness on the pileus surface. At first there are dense, darker scales around the central patch. In wet weather, the finer scales wash off, and only the central patch remains. Occasionally, the scales can be pale even in young sporophores.

Australian species

Only two other mushroom-shaped species in the genus *Macrolepiota* are currently confirmed from Australia. The first, *M. eucharis*, is known from only a few collections in the region around Cairns. It has a pileus up to 6 cm in diameter, with black scales, denser in the centre of the pileus and the flesh does not change colour. The second, *M. dolichaula*, has a large pileus, up to 20 cm in diameter, with pale scales, at most tinged pale yellowish brown; and there is no darker, central disc. When immature, the pileus of *M. dolichaula* is globose, and the stipe can be very long, even when the pileus is yet to expand, giving the immature sporophore a drumstick appearance. *Macrolepiota dolichaula* is found along the east coast from Gippsland in Victoria to far north Queensland, extending inland, such as around Canberra. In addition, three truffle-like species of *Macrolepiota* are known from Western Australia.

Lookalike species

Macrolepiota clelandii is a distinctive looking mushroom owing to its size, pronounced umbo, scales and persistent annulus. However, its appearance changes dramatically during development and there is also considerable morphological variation within the species. Hence, it can be confused with toxic species such as *Chlorophyllum brunneum* and *C. molybdites*. Both are relatively common and grow on the ground in similar disturbed habitats to *M. clelandii*.

Agaricus, *Amanita*, *Lepiota*, *Leucoagaricus* and *Melanoleuca* could also be confused with *Macrolepiota*. Note that various native *Amanita* grow in the same habitats as *M. clelandii*.

Lepiota helveola group are smaller in size than *Macrolepiota clelandii*.

Lepiota helveola group

Lepiota helveola group comprises species that contain deadly amatoxins causing primary hepatotoxicity (see p. 78). It is relatively rare in Australia. Species within the group are best distinguished microscopically. Sporophores are smaller than those of *M. clelandii*.

Features to note:

- In Australia, grows in lawns and gardens in urban areas.
- Pileus 1–5 cm diameter, hemispherical when young to convex, flattening with age, obscurely umbonate, sometimes with slightly depressed centre, fawn to flesh-coloured, umbo brownish violet, surface dry, tomentose before breaking up into dark scales.
- Lamellae free, at first crowded then more distant, white with reddish tints with age; margin pruinose.
- Stipe 2–4 cm long (0.4–1 cm diameter).
- Odour sweetish, weakly farinaceous.

Macrolepiota dolichaula is much paler than *M. clelandii*.

Macrolepiota dolichaula (white parasol)

See description on p. 167.

References to the edibility/toxicity of this species are conflicting (see p. 77). Because it has been implicated in gastrointestinal irritant mushroom poisoning, we list it as a toxic species. The most obvious differentiating features are the paler colour of the pileus and the smaller or absent central disc.

Features to note:

- Pileus to 20 cm diameter, globose when young, then convex to plane with small umbo, surface covered in small white scales, sometimes tinged yellowish brown, can wash off in rain (central disc not as distinct as in *M. clelandii* and scales not as dark); margin shaggy.
- Lamellae white to cream or pale pink.
- Stipe long (to 30 cm, exceptionally to 60 cm), even when pileus yet to expand.

Chlorophyllum brunneum (shaggy parasol)

See full species profile in Chapter 8. The rare *Chlorophyllum nothorhacodes* (of unknown toxicity/edibility) is very similar in appearance, differing only by the non-marginate stipe base.

Features to note:

- Pileus convex to blocky when young, expanding to broadly convex or nearly plane with age, dull greyish brown in button stage, soon developing coarse brown concentric scales, except for central brown disc where surface remains intact, surface beneath scales radially fibrillose and whitish; margin incurved at first.
- Stipe with enlarged to abruptly, often marginate bulbous base, bruising brown, with white partial veil that breaks to form prominent, white or brownish, membranous, felty, annulus.
- Lamellae white, becoming dingy brown with age.
- Flesh thick, white, discolouring orange then red, darkening to brown.

Coarse brown scales.

Central brown disc in older sporophore.

Chlorophyllum molybdites (false parasol)

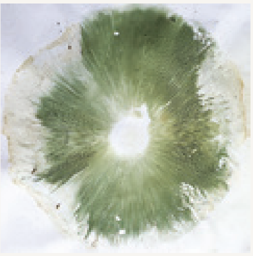
See full species profile in Chapter 8.

Although *C. molybdites* shares morphological similarities with *M. clelandii*, one easy way to differentiate them is to look for the greenish tinge to the lamellae of older sporophores of *C. molybdites*. However, this may not be apparent in young sporophores. A more reliable option is to make a spore print (see p. 41), which should be a greyish green colour.

Features to note:

- Pileus globose, convex or broadly conical, then broadly convex to plane, dry, smooth in button stage, off-white to brown, as pileus expands cuticle cracks forming concentric circles of coarse brown scales, concentrated towards the centre, often with dull brown umbo, surface beneath scales finely fibrillose; margin often slightly upturned, sometimes shaggy from veil fragments.
- Lamellae white to off-white or cream, then greyish green to olive brown at maturity.
- Stipe usually equal in width with slightly enlarged to sub-bulbous base; with prominent, moveable, white or brownish membranous, felty annulus.
- Flesh thick, white, usually staining red or reddish brown.
- Spore print pale green or greyish green.

Lamellae greyish green at maturity.



Spore print greyish green.

Marasmius oreades

fairy ring mushroom
fairy mushroom
fairy ring champignon
scotch bonnet

The fairy ring mushroom is a well-known edible species throughout the world and a favourite in France. It appears commonly in rings or arcs on lawns and in parks and gardens. Having a rather nondescript appearance and few obvious features, it is not for the novice forager. One distinctive characteristic distinguishing it from the many other small lawn mushrooms is the ability of dried specimens to revive when moistened.

◄ *Marasmius oreades* (fairy ring mushroom) often pops up on lawns and in gardens..

Marasmius oreades

Checklist of features

HABITAT	Common in grassy habitats in urban areas including lawns, nature strips, gardens, parks, sporting grounds as well as pastures. Saprotrophic.
SUBSTRATE	On the ground, among grass
HABIT	Usually in clusters and often in rings, arcs or lines.
PILEUS	1–6 cm diameter, at first convex or bell-shaped, then broadly convex or plane, usually with distinct umbo, yellowish buff, tawny or pale pinkish brown when wet, paler when dry (hygrophanous), surface smooth to matt; margin smooth, grooved or striate, incurved at first, turning upwards with age, often becoming undulating and sometimes irregular.
LAMELLAE	Adnexed, adnate or free, distant, broad, thick, cream or pale beige becoming pale yellowish brown with age, lamellulae present.
STIPE	2–8 cm long, to 5 mm diameter, slender, equal or tapering downwards, sometimes twisted or spiral, whitish or pallid, surface smooth or finely pruinose, sometimes tomentose near base; no veil, annulus or volva.
FLESH	Whole sporophore relatively tough. The stipe is fibrous and pliant, bending but not easily breaking.
SPORE PRINT	White.
ODOUR	Variously described as mushroomy or like sawdust, almonds (cyanide) or garlic.
PHENOLOGY	Mostly appears in autumn but can be found throughout the year, especially on watered lawns.

Often in rings, arcs, or lines.

Often in groups.

Pileus convex when young.

Pileus broadly umbonate when young.

Pileus margin turns up with age.

Pilus margin undulating and grooved.

Pileus hygrophanous.

Lamellae distant, varying lengths.

Stipe paler at apex, darker at base.

Name

English naturalist James Bolton described *Agaricus oreades* in *An History of Fungusses, Growing about Halifax* in 1792. He called it fairy agaric and noted it 'is more frequent in those green circles which we call fairy rings, than any other species'. The name *A. oreades* was transferred to the genus *Marasmius* in 1836 by Fries, where it has remained ever since. The name *Marasmius* derives from the Greek *marasmos*, meaning wasting away or withering. The specific name *oreades* is a Latinised form of a Greek word referring to mountain nymphs, the 'oreads'.

Distribution

The natural distribution of *M. oreades* extends across temperate areas of the Northern Hemisphere, including North America and Eurasia. Daniel McAlpine investigated fairy rings in bowling greens in Melbourne around 1900, caused by puffballs, and noted that *M. oreades* was not known in Australia. The first collection was made in 1917 in Sydney and reports from South Australia and Victoria followed in the 1930s. Its occurrence is consistent with it being an exotic species – it is found only in modified environments, and not in intact native vegetation. It is also regarded as exotic in New Zealand.

Marasmius oreades occurs in south-east Australia from South Australia (east of Adelaide, including the Murraylands) to south-east Queensland (as far north as the Sunshine Coast). Within this area it is found across Tasmania and Victoria and in the Australian Capital Territory and eastern New South Wales, where it occurs mostly east of the Dividing Range, but also in the Riverina. There are also reports from around Cairns, in far-north Queensland. It is not currently known from Western Australia, but its occurrence there would not be surprising. It typically occurs in higher rainfall regions. However, in the inland, it can grow in drier environments if there is additional moisture, such as on watered sporting grounds or near hard surface such as roads, which provide run off after rain.

Fairy rings

Fairy ring mushrooms are saprotrophs that grow in so-called 'fairy rings', producing multiple sporophores in a circular pattern, up to several metres or more in diameter. Sometimes, sporophores are produced in only part of the ring, forming arc-shaped groupings. In a fairy ring, at first, after spore germination, the mycelium occurs in a small area. Gradually, as nutrients are exhausted, new growth occurs on the outer edge of this area. This pattern of growth occurs year after year, and gradually the mycelium enlarges; always growing outward away from the area of depleted nutrients.

Fairy rings in grass have areas of both lush and suppressed grass growth. At times the ground may even be bare. Lush growth occurs in two zones on the outer and inner edges of the ring. This lush growth is suggested to be due to increased nutrient availability (on the inside from decay of the old mycelium and on the outside due to breakdown products of organic matter consumed by the fungus). A bare zone falls between the zones of lush growth and is thought to be due to the mycelium affecting water availability to the grass. Even when the mycelium is not producing sporophores, you can see the more intense green growth associated with fairy rings – a reminder to return in the mushroom season.

Fairy rings have a long association with folklore, such as alluded to by William Shakespeare in *The Tempest*, where demi-puppets (i.e. elves) 'By moonshine do the green sour ringlets make / Whereof the ewe not bites'.

Classification

The genus *Marasmius* was originally introduced for mushrooms that were marcescent (reviving after drying out); in contrast to the usual pattern of mushrooms being putrescent (decomposing rapidly after maturing). Once microscopic characters were taken into account, several genera with rather different micro-structure were separated from *Marasmius*, such as *Crinipellis*, *Gymnopus* and *Marasmiellus*. This left *Marasmius* defined by a combination of the marcescent sporophores and the pileus surface consisting of a layer of expanded cells. Often, these cells have tiny outgrowths, and can resemble miniature brooms. *Marasmius oreades* is placed in *Marasmius* section *Globulares*, which differs from other sections by the smooth cells in the pileus surface. Some sources place *M. oreades* in the genus *Scorteus*. However, when DNA sequence information is taken into account, there is no rationale for splitting off *Scorteus* from *Marasmius*.

Identity

All characters of Australian collections match those of *Marasmius* as found in the Northern Hemisphere. DNA sequences are not yet available from Australian collections of *M. oreades* but there is no reason to doubt the identification.

Australian species

Worldwide, *Marasmius* is more diverse in the tropics than in temperate regions; and this is also true in Australia. Most local species of *Marasmius* have a dark, thin stipe, often compared to a thick horsehair, as exemplified by *M. crinis-equi*. Some are brightly coloured, such as *M. haematocephalus*, with its intense magenta pileus (found on the east coast, north of Coffs Harbour). In southern Australia, few species are known. The most common is *M. elegans*, which is a similar size to *M. oreades*, but occurs in woodlands and forests rather than lawns, and has a reddish pileus and a two-tone stipe that is darker below.

Lookalike species

Marasmius oreades often produces fairy rings but this is not a distinguishing feature. Other species, including the toxic *Chlorophyllum molybdites* and *Agaricus xanthodermus*, can also appear in fairy rings on lawns. Various small brown mushrooms found in lawns superficially resemble *M. oreades*, especially when viewed from above. Some such as *Hebeloma, Inocybe* and *Psilocybe* have known toxicity. Others such as *Bolbitius*, *Lacrymaria* and *Pholiota* have unknown toxicity but are included here as they are common and can be confused with *M. oreades*. A spore print is helpful in identifying *M. oreades* as many of the lookalikes have brown or black spore prints. Other potential lookalikes include *Gymnopus* (often with markedly hairy stipe) and *Panaeolina foenisecii* and *Psathyrella candolleana* (both differing by the dark brown to black spore print).

Pileus radially fibrillose.

Inocybe (fibrecaps)

All *Inocybe* should be considered toxic. Especially, be aware of the toxic *I. curvipes* and *I. sindonia* that are associated with exotic trees and may occur in grassy areas in parks.

Features to note:

- Mycorrhizal with native or exotic trees.
- Pileus convex to plane, may be umbonate (as in *M. oreades*), cream or brown, sometimes purplish, surface typically finely radially fibrillose or fibrillose-scaly and may be radially fissured.
- Lamellae usually adnate, crowded; edge often finely toothed like a saw.
- Spore print brown.
- Odour may be strong, often spermatic.

Pileus pinkish brown.

Hebeloma (poisonpies)

Several species, including *H. crustuliniforme* group and *H. mesophaeum* group are found in lawns.

Features to note:

- Mycorrhizal with exotic broadleaved trees and conifers.
- Pileus slimy or sticky when fresh, pinkish brown.
- Lamellae pale, then pinkish brown; edge often irregular.
- Stipe pinkish brown (not tough like *M. oreades*); partial veil present or absent.
- Spore print brown.
- Odour often radish-like.

Lacrymaria (weeping widows)

The common species found in lawns is *Lacrymaria asperospora*.

Features to note:

- Often arising from bare soil, but also in grass and garden beds.
- Pileus surface fibrillose to fibrillose-scaly.
- Lamellae dark brown to black, often with beads of liquid.
- Stipe surface fibrillose to fibrillose-scaly; when young with cortina (cobweb-like partial veil) connecting pileus and stipe.
- Spore print dark purplish brown to black.

Distinctive cortina and dark lamellae.

Pholiota (scalycaps)

Scalycaps usually grow on wood, including decaying tree roots, but can appear in lawns.

Features to note:

- Pileus viscid or glutinous when fresh, usually yellowish brown.
- Pileus and stipe often scaly.
- Lamellae brown when mature but may be pale at first.
- Spore print brown.

Pileus slimy when fresh.

Bolbitius (fieldcaps)

The common species in lawns is *Bolbitius titubans* (= *B. vitellinus*).

Features to note:

- Pileus when young taller than broad (parabolic) and bright yellow, becoming pale brown in age, surface viscid when moist.
- Lamellae brown when mature but may be pale at first.
- Flesh fragile (not tough like *M. oreades*).
- Spore print brown.

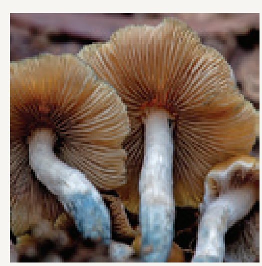
Sporophore is fragile and short-lived.

Psilocybe (goldtops)

The common species found in grassy areas is *Psilocybe subaeruginosa*.

Features to note:

- Often on wood chip mulch, or in grassy areas in bushland (*M. oreades* more common in lawns).
- Pileus conical to convex then plane, sometimes with umbo, yellowish brown to tan brown, drying much paler, surface viscid or greasy.
- Stipe to 20 cm long (taller than *M. oreades*), may bruise blue. When young with white cortina (cobweb-like partial veil) connecting pileus and stipe, breaking to leave faint ring-zone on upper stipe.
- Spore print dark purplish brown.
- Odour farinaceous.



Stipe stains blue when bruised.

Agaricus

A. campestris

field mushroom
meadow mushroom

A. arvensis

horse mushroom

A. bitorquis

pavement mushroom

The genus *Agaricus* includes the well-known edible field mushroom, horse mushroom and pavement mushroom but also the toxic yellow stainer. *Agaricus* is a large and cosmopolitan genus, conspicuous in urban, rural and forested environments. Edible *Agaricus* are probably the most commonly foraged mushrooms in Australia and many Australians having fond memories of foraging for field mushrooms in rural areas, on their farms or during holidays. The genus is highly recognisable, but identification of species is challenging.

◄ The genus *Agaricus* is characterised by lamellae that are free from the stipe and are pink when young becoming chocolate brown when mature; and a stipe that is centrally attached to the pileus, usually with a well-developed annulus.

Agaricus

Three edible *Agaricus* species that the forager is likely to encounter are profiled:

- *Agaricus campestris*
- *Agaricus arvensis*
- *Agaricus bitorquis*.

We deliberated for some time as to which *Agaricus* species to include in this book. Three species were chosen that exemplify the subtle variation in form among edible species of the genus that have a white to cream pileus. *Agaricus campestris* is probably the species most familiar to foragers. Indeed, *campestris* means 'living in the fields' and in Australia the 'good old field mushie' is likely to be the first and often the only mushroom that foragers think they are collecting. Hence, it might come as a surprise that there is uncertainty about where and how widely *A. campestris* is distributed in Australia. We also include *A. arvensis*, the horse mushroom, as this seems to be widespread and is probably consumed as often as *A. campestris*, under the mistaken idea that it is the 'field mushroom'. We include a further species, *A. bitorquis*, that is likely to be encountered by urban foragers.

Agaricus is challenging for foragers because it is difficult to identify to species level with field characteristics alone. Differences between species are subtle and macro-features can be highly variable depending on exposure to different environmental conditions. Sometimes, microcharacters are needed, or even DNA sequences, to be sure of identification. In addition, the taxonomy of the genus is incompletely researched in Australia. Consequently, many reports of *A. campestris* and other *Agaricus* species are incorrectly identified in field guides and data respositories such as the Atlas of Living Australia.

It is likely that a range of edible white *Agaricus* are mistakenly identified as *A. campestris*. There is also considerable potential for confusion with the toxic yellow stainer, *A. xanthodermus*. Although it is common to hear foragers comment, 'I only pick field mushrooms as they are the only ones I can identify', the practical reality is that frequent misidentifications of *A. xanthodermus* lead to poisonings every year.

Some authoritative references urge caution in consuming even edible species of *Agaricus* when collected from the wild. This is due to the propensity of some species to accumulate heavy metals such as lead and cadmium from the soil where they grow. In addition, many species of *Agaricus* contain the compound agaritine, which while not toxic can metabolise into carcinogenic hydrazines. The content of agaritine varies considerably but is particularly high in *A. arvensis* and its relatives. Agaritine concentration appears to be reduced significantly by refrigeration and cooking. To reiterate, be aware of the environment where you forage, especially avoiding potentially contaminated soil, such as reclaimed refuse tips. In addition, always cook wild-collected mushrooms and do not over-consume.

General features of the genus *Agaricus* are dot-pointed below, followed by profiles of the three edible species. Note that the toxic lookalike species *A. xanthodermus* is described in the profile on pp. 96 and the edible cultivated species *A. bisporus* is discussed on p. 226.

Agaricus

Features to note:

- Saprotrophic.
- Mostly medium to large sporophores.
- Pileus usually convex to flat or umbonate, white, buff, yellowish, yellow or reddish brown, grey or pinkish, surface smooth, scaly or radially fibrillose, dry.
- Flesh white, sometimes staining pink, red or yellow when bruised or with age.
- Lamellae free or nearly free, close, pallid or pinkish at first, then chocolate brown, then blackish brown at maturity.
- Stipe central, with prominent partial veil that forms a pendant (skirt-like) peronate (sheathing) or intermediate (flange-like) annulus on the stipe.
- Spore print chocolate brown.

General habitat and substrate for the genus *Agaricus*

All *Agaricus* are saprotrophic. They occur both in disturbed environments and native bushland but are particularly common in urban areas and in paddocks where stock are grazed. *Agaricus campestris* is found mostly among grass in lawns, nature strips, sporting fields and in paddocks. *Agaricus arvensis* is found in the same environments, perhaps more commonly in rural areas, but sometimes among grass or mulch under trees. *Agaricus bitorquis*, as indicated by the vernacular name 'pavement mushroom', prefers compacted soil at the edge of paths. The toxic *A. xanthodermus* is common in lawns but also occurs in woodchipped or mulched garden beds. It is the most common species of *Agaricus* in urban areas. *Agaricus* grows throughout the year if conditions are favourable (mild temperature and moisture) but are most often seen in late autumn and early winter in southern Australia, and in summer in northern Australia.

Characters that distinguish *Agaricus* species

Apart from shape, texture and colour of the pileus, the most important features to note when identifying *Agaricus* are: the structure of the partial veil; any distinctive odour (see p. 37 for discussion of detecting and describing odours); and any colour change when cut or bruised.

The annulus formed from the remains of the partial veil varies in:

- **direction**, that is, whether upward-flaring, downward hanging (skirt-like) or more or less perpendicular to the stipe (flange-like)
- **thickness**, from thin and fragile (often partially attached to pileus margin) to thick
- **complexity**, from simple to double-layered, with the lower layer breaking into segments that can be star-shaped, cog-like or form a rim, and
- **number**: sometimes there are two annuli (as in *A. bitorquis*).

Many species of *Agaricus* have a strong colour change when the surface of the pileus or stipe is bruised or scratched. The reaction is usually best seen in the flesh of the stipe base of sporophores that are cut in half. This is especially so for the yellow colour change in *Agaricus xanthodermus*. All *Agaricus* profiled below can become pinkish when waterlogged.

General features of *Agaricus*


Pileus convex.


Pileus flattening with age.

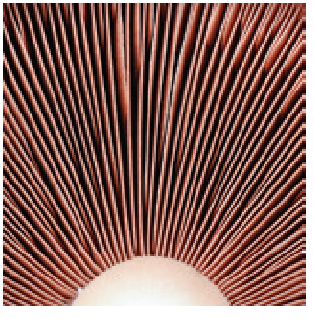

Flesh sometimes stains pink.


Pileus smooth.

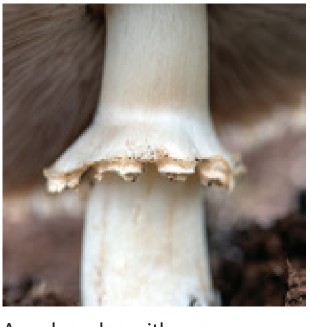

Pileus scaly.


Pileus radially fibrillose.


Lamellae free.


Lamellae pink.


Lamellae chocolate brown.


Annulus edge with cogs.


Annulus upward-flaring and double below.


Annulus skirt-like.

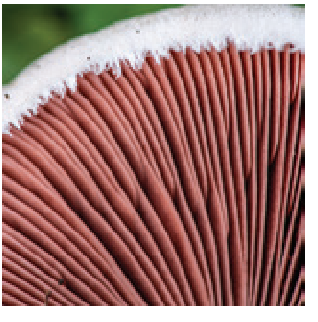
Agaricus campestris

Checklist of features

PILEUS	2–12 cm diameter, hemispherical (often remaining so for a long time) to convex to broadly convex to almost plane, often irregular in shape, sometimes with low umbo, white but often becomes pale brown or ash-grey, sometimes slightly pink when waterlogged, surface dry, smooth, silky-fibrillose or scaly; margin extending beyond lamellae and often ragged with veil remnants.
LAMELLAE	Free, crowded, pale pink, then deep pink slowly becoming chocolate brown, then blackish brown at maturity, lamellulae frequent.
STIPE	2–8.5 cm long, 0.8–2.5 cm thick, equal or sometimes tapering towards pointed base, white to light brown, surface smooth above veil, sometimes with fibrils or scales below; with thin, membranous, fragile partial veil that breaks to form an annulus about half way down stipe, that is skirt-like or flange-like, single-layered and with irregular, torn margin. Annulus may be minimal due to veil remnants adhering to pileus margin rather than stipe, or disappearing quickly.
FLESH	Firm, white throughout or slightly pinkish in upper stipe, not staining when bruised.
SPORE PRINT	Chocolate brown.
ODOUR	Mushroomy and pleasant.
PHENOLOGY	Occurring throughout the year, after rain; often in summer in northern Australia and mostly in autumn–winter in southern Australia.

Veil breaks to form flange-like annulus.

Cut flesh does not change colour.



Pileus fringed with veil remnants, lamellae pink.

Agaricus arvensis

Checklist of features

PILEUS	4–25 cm diameter, globose, ovoid or convex, expanding to broadly convex or plane, white to creamy-buff sometimes yellowish ochre in centre, surface dry, smooth or finely scaled, especially in centre, often cracking, especially in dry weather; margin incurved when immature and sometimes hung with veil remnants.
LAMELLAE	Free, close, off-white, then remaining pale grey or pale pink for a long time, becoming chocolate brown and finally blackish brown, lamellulae frequent.
STIPE	3–16 cm long, 1–4 cm thick, equal to tapering to an enlarged base, white or patchily pale yellow, surface mostly smooth, sometimes scaly below veil; with well-developed partial veil that breaks away to leave a large, hanging, membranous annulus which has upper surface smooth and lower surface with 'cog-wheel' layer next to stipe, sometimes beyond this with small scales.
FLESH	Thick, firm, white, when bruised unchanging or slightly yellowing (but never strong chrome yellow as in *A. xanthodermus*).
SPORE PRINT	Chocolate brown.
ODOUR	Distinctive, sweetish, aniseed or bitter almond-like.
PHENOLOGY	Found throughout the year, after rain, usually March to June, most often in May.

Pileus white.

Veil before breaking, showing two layers.

Lamellae dark at maturity.

Agaricus bitorquis

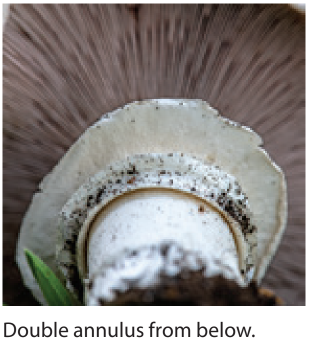
Mycologist David Arora considers *A. bitorquis* to be the best of the edible *Agaricus* that grow in the USA (which include all three *Agaricus* described here).

Checklist of features

PILEUS	4–12 cm diameter, globose then convex, expanding to broadly convex or plane, often with upturned margin, white to off-white, often with ochre or orange tints, can discolour pinkish with age or rain, surface smooth, dry, matt, finely scaly or flaky, sometimes cracking, often with adhering dirt and/or only partially emergent (i.e. only just breaks through soil surface).
LAMELLAE	Free, close or crowded, pale pink or greyish pink then reddish brown, then blackish brown at maturity, lamellulae frequent.
STIPE	2–5 cm long, 1–3 cm diameter, short and stout, equal or tapering to base, surface smooth or sometimes with fine, appressed scales at apex; with tightly sheathing veil that flares outwards and forms durable, persistent double annulus on stipe, upper annulus grooved at top; often deeper in ground than other *Agaricus*.
FLESH	Thick, firm, does not change colour or sometimes slightly reddish when bruised.
SPORE PRINT	Chocolate brown.
ODOUR	Not distinctive, faintly mushroomy or sometimes like bitter-almond
TASTE	Slightly nutty.
PHENOLOGY	Found throughout the year, after rain, but most often in autumn (March to May).


Often partially emergent with adhering dirt.


Greyish pink lamellae and double annulus.


Double annulus from below.

Name

Agaricus campestris was described in 1753 by Linnaeus in *Species Plantarum* and *A. arvensis* in 1774 by Schaeffer in his work on the fungi around Regensburg in Germany, *Fungorum qui in Bavaria et Palatinatu circa Ratisbonam Nascuntur*. Although it is a distinctive species, *A. bitorquis* was described relatively late. It was introduced in the genus *Psalliota* by French mycologist Lucien Quélet in 1884, and 3 years after was transferred to *Agaricus* by Italian mycologist Pier Saccardo in his *Sylloge Fungorum*.

For derivation of the name *Agaricus*, see the entry for *A. xanthodermus* (p. 100). Some *Agaricus* species have epithets referring to the habitats in which they grow. Thus: *campestris* (dwelling in fields or plains) and *arvensis* (growing in fields or cultivated lands). For *A. bitorquis*, the species epithet refers to the double annulus, *torques* being Latin for collar or necklace.

Distribution

The following distribution summaries are based on current records in the Atlas of Living Australia, but some distribution points in that source could be incorrect. *Agaricus campestris* is widespread in southern Australia – in scattered localities in south-west Western Australia; around Adelaide in South Australia; in scattered localities in Tasmania; throughout Victoria; and within 150 km of the coast in New South Wales (including the Australian Capital Territory) and south-east Queensland. Isolated reports from outside of this area, in north Queensland and central Australia, need confirmation. *Agaricus arvensis* occurs in south-east Australia, from Mount Remarkable in South Australia to the Sunshine Coast in south-east Queensland, including Tasmania. It is generally reported from near-coastal areas, but in Victoria occurs inland. It is likely that it also occurs in northern Western Australia and the Northern Territory. *Agaricus bitorquis* is rarely recorded, with sightings from the south coast of south-west Western Australia, Melbourne and Hobart. However, it is likely to be under-reported and could well occur more widely, especially in urban areas. Given their preference for disturbed sites, these three species, and most other *Agaricus* reported from Australia, are assumed to be exotic.

Classification

When Fries catalogued the known fungi of the world in *Systema Mycologicum*, published between 1821 and 1829, he placed most fungi with lamellae in the genus *Agaricus*. Within *Agaricus*, Fries separated subgroups according to characters such as the colour of the spore print and the presence or absence of partial and universal veils. Later in the nineteenth century, these subgroupings were raised to genus level, establishing many familiar agaric genera such as *Amanita*, *Mycena* and *Tricholoma*. At this time, *A. campestris* and related species were placed in the genus *Psalliota*, and the name *Agaricus* was no longer used. However, according to the rules of nomenclature a name of a genus cannot be discarded like this, and soon *Agaricus* was resurrected. There are around 25 sections recognised within the genus. Eleven of these sections are known to occur in Australia, some represented by as yet undescribed species.

Identity

For *A. campestris*, morphological features of Australian material match Northern Hemisphere material, especially the white pileus, relatively short stipe and simple annulus that breaks readily and may disappear, along with the lack of staining. However, DNA sequences are not available from Australian collections. For *A. arvensis*, DNA sequences from several Australian collections match closely to sequences from Northern Hemisphere collections. These Australian collections also match morphologically, especially in the white to pale yellow pileus, lack of strong staining and two-layered annulus with a central, thicker, star-shaped area. However, considerable variation can be observed among sporophores matching the overall appearance of *A. arvensis*. We have observed sporophores with a distinctly yellow pileus and sporophores with a coarsely scaly pileus. Details of the annulus structure also vary. In Europe, several other species in section *Arvenses* can be difficult to separate from *A. arvensis*, including *A. crocodilinus* and *A. macrocarpus*. None have been reported yet, but it would not be surprising if additional species of this group were found in Australia. Morphological characters of Australian *A. bitorquis* match information on the species from elsewhere, especially the growth in compacted soil in combination with the distinctive twin annulus. As yet, DNA sequences are not available from Australian collections.

Australian species

There are ~90 well known species of *Agaricus* in Europe, and numerous additional species in all regions of the world, including the tropics. At least a dozen species of *Agaricus* occur in urban areas and farm paddocks in Australia, nearly all of which appear to be exotic. Identifications of *Agaricus* species in field guides and fungaria are less reliable than for other species profiled in this book.

In addition to the members of section *Xanthodermatei* (see p. 101), the mushroom-like species of *Agaricus* reported from Australia belong in at least six sections: *Agaricus* (e.g. *A. campestris*), *Arvenses* (e.g. *A. arvensis, A. augustus*, *A. subrufescens* and *A. sylvicola*), *Bivelares* (e.g. *A. bitorquis* and the sand-dune inhabiting *A. devoniensis*), *Chitonoides* (e.g. *A. bernardii*), *Minores* (generally small species such as *A. purpurellus*) and *Sanguinolenti* (red-staining species such as *A. impudicus*, *A. langei* and *A. sylvaticus* (= *A. haemorrhoidarius*)). There are also DNA sequences from around a dozen collections (many from northern Australia) that do not match known species. Additionally, nine species of truffle-like fungi from Australia belong in *Agaricus*.

Apart from the truffle-like species, native *Agaricus* are not well known. *Agaricus austrovinaceus* (= *A. vinaceus*) is the only mushroom-like species of *Agaricus* described from Australia that has been re-collected since its original description. Much remains to be done to characterise the full diversity of the genus in Australia. For those interested in knowing more, see 'Works on *Agaricus*' in 'Further reading' (p. 305).

Lookalike species

Potential lookalikes for the three profiled *Agaricus* include species in the genera *Agaricus*, *Amanita*, *Chlorophyllum*, *Cortinarius*, *Hebeloma* and *Leucoagaricus*. *Agaricus xanthodermus* is the most commonly confused toxic species.

Bruises chrome yellow

Squarish when young

Agaricus xanthodermus

See full species profile in Chapter 8.

Features to note:

- Often clustered together in large rings, arcs or troops; commonly in urban environments, in lawns or garden beds among mulch.
- Pileus 3–20 cm diameter, rounded or irregularly convex, often marshmallow-shaped or squarish, especially when young, white but often with brown tints towards centre, staining yellow especially near edge, surface often scaly or cracking with age.
- Stipe with white, flaring, membranous, double annulus with ridge of tissue on underside, often collapsing with age.
- Flesh turns vibrant chrome yellow immediately when bruised, especially in stipe base.
- Odour distinctively phenolic (of phenol), described as chemical, carbolic, metallic, sharp, or like disinfectant or iodine.

Older, paler sporophores start to resemble *Agaricus*.

Cross-section showing white sac-like volva and white lamellae.

Amanita phalloides (deathcap)

See full species profile in Chapter 8.

Foragers need to be aware of the introduced *A. phalloides* because of its potentially lethal toxicity. Note that in some weather conditions, particular during summer, *A. phalloides* can produce pale sporophores that resemble *Agaricus*, especially from above.

Features to note:

- Mycorrhizal with *Quercus* (oak).
- Pileus hemispherical, then convex, expanding to broadly convex then plane, smooth, viscid when wet, shiny or with metallic lustre when dry, surface often fibrillose or mottled, colour highly variable, from white, pale yellow or pale brown to various shades of green.
- Lamellae white.
- Stipe with bulbous base, surface often with fine patterned fibrils or scaly ornamentation appearing as zig-zag banding; with white membranous partial veil that forms skirt-like annulus; with white sac-like volva.
- Spore print white.
- Odour indistinct or slightly sweet at first, then strong and unpleasant (like rotting potato) with age and drying.

Native Australian *Amanita*

Some native *Amanita* resemble *Agaricus* in size and general appearance, especially due to their white to cream pileus. All species of *Amanita* should be regarded as potentially toxic. Close inspection shows *Amanita* have many easily recognisable differentiating features such as warty pileus when young, white to cream lamellae, stipe with distinctively bulbous base (usually with a volva), white spore print and pronounced and often unpleasant odours. Most native *Amanita* are mycorrhizal and associate with native trees such as *Eucalyptus*. The exception is the non-mycorrhizal *A. nauseosa*, a foul-smelling species that grows in lawns and gardens.

Amanita can appear superficially similar to *Agaricus* from above.

Lamellae cream and stipe with bulbous base.

Leucoagaricus leucothites (white dapperling)

There are conflicting reports about the edibility/toxicity of this species. Many field guides list it as edible, while some say it is mildly toxic. Several give warnings about potential confusion with toxic *Amanita* and *Chlorophyllum*.

Features to note:

- Pileus to 20 cm diameter, convex to plane, white, cream or grey, smooth or becoming scaly.
- Lamellae white, becoming flesh-pink or pinkish tan (never dark brown as in *Agaricus*).
- Stipe with simple annulus (not double-layered as in some *Agaricus*).
- Spore print white to very pale pink (not dark brown as in *Agaricus*).

Lamellae white.

Annulus with rust brown spores. Stipe tapering towards base.

Remnants of membranous partial veil. Lamellae straw-coloured.

Cortinarius australiensis (skirt webcap)

Cortinarius species with a white pileus, especially *C. australiensis*, could be confused with *Agaricus* when viewed from above. *Cortinarius* can readily be distinguished by the rust brown spores, visible as a deposit on the well developed annulus. The edibility of *C. australiensis* is unknown but, given other species within the genus contain potentially lethal toxins, it should be avoided.

Features to note:

- Mycorrhizal with *Eucalyptus* (*Leptospermum* in NZ), often in large groups.
- Sporophore robust with pileus to 30 cm diameter, globose to convex, plane at maturity, white, sometimes with brown fibrils or squamules; partial veil membranous, often breaking to leave remnants on pileus margin.
- Lamellae adnate at first, then sinuate to nearly free, straw-coloured or pale brown to rust brown with age.
- Stipe thick, swollen in middle and usually tapering towards base, white; with membranous partial veil forming a thick, white annulus, usually with obvious deposit of rust brown spores.
- Spore print rust brown.
- Odour not distinctive.

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Suillus

S. luteus

(Synonym: *Boletus luteus*)
slippery jack
sticky bun

S. granulatus

(Synonym: *Boletus granulatus*)
weeping bolete
granulated bolete

Unlike mushrooms with lamellae, *Suillus* is a bolete whose sporophores have pores on the underside of the pileus. Their slimy nature (hence 'slippery jack') is revered by some and repulses others. *Suillus* seem to be more popular as edible mushrooms in Australia than in their native Northern Hemisphere countries. This may be due to the ease with which they are identified and the satisfaction derived, rather than inherent culinary qualities. That said, there are those who attest to their flavoursome quality once dried. **Note that the slimy covering of some *Suillus* can cause contact dermatitis (see p. 63). It is recommended to remove the slimy covering as well as the pore layer before cooking.**

◄ *Suillus luteus* is easily recognisable by its viscid pileus.

Suillus

Two known edible *Suillus* species, *S. granulatus* and *S. luteus*, are profiled as representatives of this diverse genus. Current research on *Suillus* in Australia (see below, p. 196) is showing that various additional species occur, many of which have probably being referred to as slippery jacks. In particular, two species of similar appearance to *S. granulatus* have been recently found in Australia (*S. collinitus* and *S. quiescens*).

Suillus luteus

Checklist of features

HABITAT	Grows with exotic pines in gardens and plantations. Mycorrhizal.
SYMBIONT	North American and European pines including *P. radiata* and *P. sylvestris*.
SUBSTRATE	On the ground.
HABIT	Solitary or more often gregarious in large overlapping clusters or rings
PILEUS	5–13 cm diameter, convex at first, becoming broadly rounded and flattening in maturity, greyish brown, reddish brown or purplish chestnut, surface viscid or glutinous, then shiny and smooth when dry; sometimes with partial veil remnants hanging from margin.
PORES	Small (2–3 mm), round, straw-coloured to yellow, becoming darker yellow then tan to olive with age; covered at first by partial veil.
STIPE	3–10 cm long, 1–3 cm diameter, cylindrical, enlarged towards base, white above, straw-coloured below, upper section with vinaceous brown glandular dots, greasy to sticky below; with large pale membranous, glutinous veil (unusual in boletes) that starts out white above, then develops violet brown shades on underside, leaving prominent purplish annulus.
FLESH	Firm, pale yellow or white, no colour change when bruised.
SPORE PRINT	Brown to dull cinnamon.
ODOUR	Earthy or mushroomy but otherwise not distinctive.
PHENOLOGY	Appears most often in autumn but also in winter.

Suillus granulatus

Suillus granulatus shares most of the above features with *S. luteus*. The main differentiating features are:

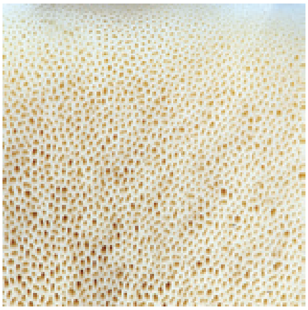
- Pileus reddish brown to yellowish brown.
- Pores of young sporophores release milky droplets that darken as they dry.
- Stipe lacks partial veil and annulus.

Grows in overlapping clusters.

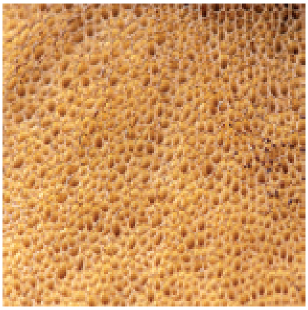
Pileus broadly rounded.

Pileus flattening in maturity.

Surface with glutinous covering.



Pores yellow.



Pores darken with age.

Upper stipe with glandular dots.

Large membranous partial veil with violet shades on underside.

Annulus prominent, purple.

Annulus lacking.

Milky droplets.

Cross-section.

Name

Suillus was used in 1729 by Micheli in *Nova Plantarum Genera* as part of phrase names (polynomials) such as *Suillus esculentus crassus viscidus* ... However, these polynomials pre-dated the introduction by Linnaeus in 1753 of modern binomial nomenclature as applied to names of algae, fungi and plants. In *Species Plantarum*, Linnaeus included several species now classified in *Suillus* in his new genus *Boletus*, including *Boletus granulatus* and *B. luteus*. Linnaeus placed in *Boletus* all the boletes known to him and also some polypores. *Suillus* was taken up again by the French botanist Henri Roussel in *Flore du Calvados*, published around 1796, in which he made formal transfers of *B. granulatus* and *B. luteus* to *Suillus*. The name *Suillus* derives from the Latin word *sus* meaning pig. The epithet *luteus* means yellow and the epithet *granulatus* means granular, in reference to the dotted stipe. In another case of Linnaeus re-purposing ancient terms for fungi, *Boletus* is a Latin word applied to the prized edible species *Amanita caesarea* rather than to boletes, as we use the term today.

Distribution

The ectomycorrhizal fungus *Suillus* is native to the Northern Hemisphere, where it associates with members of the Pinaceae, including *Pinus*, *Larix* and *Pseudotsuga*. Along with its conifer partners, *Suillus* has been introduced to various regions of the Southern Hemisphere. All species of *Suillus* in Australia are exotic, mostly originating from Eurasia, but a few (e.g. *S. quiescens*) are from North America. In their natural distribution, species of *Suillus* often have a particular set of symbionts within a genus or a section of a genus. However, *Suillus* that are introduced to new areas may switch partners. In Australia, several species of *Suillus* originating from Europe (including *S. granulatus*) associate with species of *Pinus* (e.g. *P. radiata*) that are originally from North America.

Pinus is widely planted in Australia, in plantations and in parks and gardens. It occurs throughout south-west Western Australia, and in eastern Australia from the Eyre Peninsula in South Australia to north Queensland, including Tasmania. It has been planted up to several hundred kilometres inland in South Australia, Victoria and southern New South Wales, but north of Fraser Island it is restricted to coastal areas.

The genus *Suillus* as a whole occurs throughout the area where *Pinus* is grown in Australia, but with a rather scattered distribution and with no sightings from Eyre Peninsula or York Peninsula in South Australia. Due to previous confusion about the correct identification of species of *Suillus* in Australia, existing mapping of specimen and observation records of individual species is unreliable. *Suillus luteus* is the exception because it is readily distinguishable by the purple annulus. This species is recorded from across south-west Western Australia, around Adelaide in South Australia and commonly around Hobart (Tasmania) and Melbourne (Victoria) and in the hinterlands of these cities. It also occurs in scattered locations in New South Wales, including the Australian Capital Territory, and rarely in south-east Queensland. DNA-sequenced specimens of *S. luteus* match this distribution, except that there are no confirmed specimens from Queensland. For other species of *Suillus*, DNA-sequenced specimens suggest wide distributions for *S. quiescens*

(Western Australia, South Australia, Victoria and the Australian Capital Territory) and *S. granulatus* (Tasmania, Victoria and New South Wales).

Classification

The limits of the genus *Suillus* have been stable for some time. *Suillus* is characterised by the slimy pileus surface and brown spore print as well as the association with species of Pinaceae. A recent study used DNA sequences from more than 1000 sporophore collections and soil samples to build a comprehensive picture of species diversity in *Suillus*. Around 100 species fall into three main groups. The Spectabilis group, including species such as *S. lakei*, associates with *Larix* and *Pseudotsuga*. The other two groups associate with *Pinus*. The Granulatus group contains species such as *S. granulatus* and *S. luteus*. In the Tomentosus group, the only species reported from Australia is *S. bovinus*. Differences between related species can be subtle, often relying on microscopic characters. Identification of fungarium collections from around the globe, including Australia, is now facilitated by availability of reference DNA sequences from a wide range of species.

Identity

DNA sequences (kindly provided ahead of publication by Rytas Vilgalys) confirm the presence in Australia of *Suillus collinitus*, *S. cothurnatus* (= *S. salmonicolor*), *S. lakei*, *S. granulatus, S. luteus* and *S. quiescens*.

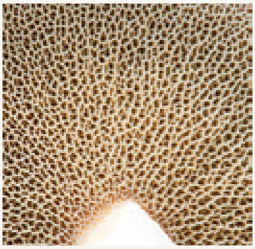
Australian species

Among the species of *Suillus* reported from Australia, all associate with *Pinus* except for *S. lakei*, which grows with *Pseudotsuga* (and has an annulus on the stipe). *Suillus luteus*, with its distinctive purple annulus, occurs with various *Pinus* species. Another species with an annulus is *S. cothurnatus*, which has orange flesh and is found in Queensland in association with *P. elliotii* and *P. banksiana*. *Suillus bovinus* is characterised by the decurrent pores that are relatively wide (to 2 mm diameter) and the stipe lacking an annulus and granules. Three rather similar species all lack an annulus but have a granular stipe surface. The first, *S. granulatus*, has pale flesh that becomes yellow; it associates with a variety of species of *Pinus*. The second, *S. collinitus*, differs by the pale purplish pink stipe base; it associates with *P. maritimus*. The third, *S. quiescens*, produces sporophores comparatively rarely in its natural distribution in North America and was only formally described in 2010. It has a relatively short stipe (hence possible confusion in the past with *S. brevipes*) and is commonly found in Australia with *P. radiata*.

Lookalike species

Suillus granulatus and *S. luteus* have no obvious lookalike species apart from other species of *Suillus*, none of which are reported as toxic. Another bolete, *Chalciporus piperatus* grows in the same habitats as *Suillus*.

Pileus much less viscid than *S. granulatus*/*S. luteus*



Pores angular, large, copper-coloured.

Chalciporus piperatus (peppery bolete)

There are mixed reports about the edibility/toxicity of *C. piperatus*. Some field guides describe it as unpalatably bitter or peppery, while others say it is edible if well cooked. Previously, considered mycorrhizal, it is more likely to be parasitic on the mycelium of *Amanita muscaria*, with which it is frequently associated.

Features to note:

- Pileus 2–7 cm diameter, colour varies from reddish brown to brick red or pinkish tan, surface smooth, slightly viscid when moist (never glutinous as in *Suillus*).
- Pores relatively large, wide, angular, slightly decurrent, copper to reddish brown, staining brown when bruised.
- Stipe 4–10 cm long, 0.5–1.5 diameter, cylindrical, equal, dry, smooth, base with bright yellow mycelium.
- Taste strong and unpleasantly acrid, bitter or peppery.

Blue staining.

This *Tricholoma* resembles *Suillus* only when viewed from above

Other potential lookalikes

Many brown boletes grow in association with native Australian trees. While native boletes do not grow in pine plantations where foragers commonly seek *Suillus*, they might be encountered on the perimeter of pine plantation where native bush is nearby. The edibility/toxicity of most Australian boletes is not known. Many stain blue when cut. The blue staining does not indicate toxicity or edibility, but simply distinguishes them from *Suillus granulatus* and *S. luteus*.

Brown is also a common colour for many agarics and some look superficially similar to *Suillus* if viewed from above, for example some *Cortinarius* and *Tricholoma*. However, as soon as you examine the underside it is apparent that there are lamellae rather than pores.

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Hydnum crocidens group

(Australian species were formerly identified as *H. repandum*, the wood hedgehog or sweet tooth and *H. rufescens*.)
echidna fungus

Several species in the genus *Hydnum* are known colloquially as hedgehogs in other countries. This metaphor dates back to at least 1697 from an illustration by the Sicilian naturalist, Paulo Sylvius Boccone. To give greater geographical relevance to the vernacular name, we suggest 'echidna fungus' to refer to the six species of the *Hydnum crocidens* group that grow in Australia. This easily recognisable group has spine-like projections on the underside of the pileus and offers interesting flavours and textures to the lucky forager who finds them.

◄ *Hydnum* has no known toxic lookalike species in Australia.

Hydnum crocidens group

Checklist of features

There are at least six phylogenetic species of *Hydnum* in Australasia that were previously lumped under the names *H. repandum* and *H. rufescens* (neither of which occur in the region). We refer to these six species as the *Hydnum crocidens* group. Within the group, there is considerable variation in pileus size and colour and in the way that the spine surface connects to the stipe (e.g. whether decurrent or not). There is not yet a clear connection between the morphological variation and the various species as defined by DNA sequences.

We suggest foragers focus on Australian *Hydnum* with the appearance of *H. repandum* (i.e. pale apricot to beige pileus) as these are reported in various sources as edible. The checklist below is based on collections that are similar in appearance to *H. repandum*.

HABITAT	Mycorrhizal with native trees.
SUBSTRATE	On the ground.
HABIT	Solitary, scattered or gregarious.
PILEUS	3–12 cm diameter, broadly convex, margin inrolled when young, flattening with age, often with central depression or funnel-shaped, irregularly shaped, wavy at margin, often distorted and fused with other sporophores, cream to beige to pale flesh-coloured, sometimes with darker circular patches, dry, surface smooth but often with bumps and cracks.
SPINES	Adnate to decurrent, 2–10 mm long and 2 mm thick, tapering to a rounded tip, close, white to cream.
STIPE	Central to strongly off-centre, 2–7 cm long, variable from stubby to elongate, base sometimes enlarged or rooting often with several sporophores joined at the base, cream to buff-yellow staining orange-ochre, surface smooth, dry; annulus lacking.
FLESH	In pileus, thick, firm, crumbles like chalk, creamy white-fawn, sometimes slowly bruising pale orange or brownish orange; spines brittle.
SPORE PRINT	Pale cream to white.
ODOUR	Indistinct or mildly fruity.
TASTE	Mild and sweetish but sometimes peppery to bitter.
PHENOLOGY	Sporophores appear between late summer and late autumn.

The checklist does not include features of collections with:

- Pileus reddish brown or chestnut (called *Hydnum crocidens* var. *badius* in New Zealand); or
- Pileus large and pale pink, spines decurrent (illustrated as *H. repandum* by Bruce Fuhrer in *A Field Guide to the Fungi of Australia*).


Grows singly or gregariously.


Sporophores often fused at base of stipe or pileus.


Pileus surface bumpy, beige, dry.


Pileus irregularly shaped.


Spines decurrent.


Spines close.


Stipe base swollen.


Stipe with brownish orange bruising.


Pileus margin incurved when young.

Name

The name *Hydnum* was used by Linnaeus in *Systema Plantatum* (1753) for various fungi with a spiny hymenium. The name is derived from the Ancient Greek *hudnon*, a word seemingly used by ancient writers such as Theophrastus for a type of truffle. This re-purposing is one of several cases where Linnaeus took up an existing name but applied it to an entirely different group of fungi. The common species of *Hydnum* in Europe is *H. repandum*, also described by Linnaeus in 1753. The species name *repandum* means turned up, referring to the shape of the pileus. Earlier names for *H. repandum*, in the form of phrase names rather than binomials, include *Erinaceus esculentus pallide luteus* as used by Micheli in his *Nova Plantarum Genera* of 1729. The word *erinaceus* is the Latin name for the hedgehog. The word *esculentus* means edible, and Micheli noted that the fungus was sold at the Tuscan markets. Two species described from Australia in the nineteenth century are *H. ambustum*, whose species epithet refers to the 'burnt' appearance of the pileus and *H. crocidens*, whose species epithet derives from the Latin *croceus*, yellow in combination with *dens*, tooth.

Distribution

Hydnum is found around the world in temperate regions. Within Australia, the genus as a whole (including all five phylogenetic species) is reported from south-west and south-east Australia and also north Queensland. In Western Australia, it occurs in forested areas from Perth to Two Peoples Bay. In South Australia, it is only reported from near Adelaide, the Fleurieu Peninsula, Kangaroo Island and the far south-west. In Tasmania, it is found all over the island with the exception of the Midlands. In Victoria it is widespread, mainly in the south. In New South Wales and Queensland, it occurs along the coast, as far inland as the Australian Capital Territory and north to Fraser Island; also with occurrences in the Cairns region. This pattern of distribution is similar to many other forest mushrooms and represents the temperate high-rainfall areas and the wet tropics of north Queensland. The gap in distribution across the Nullarbor Plain reflects the unsuitable conditions due to low rainfall and the lack of trees. However, other gaps in known distribution, such as in South Australia between Adelaide and the far south-east, could be due to fewer people actively recording fungi in this area. Distribution of individual phylogenetic species is not well known due to the small number of samples for which DNA sequences are available, but some phylogenetic species seem to be restricted to south-west Western Australia or Tasmania.

Classification

Hydnum belongs in the family Cantharellaceae as do the edible chanterelles in *Cantharellus*. The limits of the genus *Hydnum* have remained stable since it was distinguished from other spine-bearing mushrooms by its smooth spores. Previously, around a dozen species were recognised in the genus, often with wide distributions. However, information from DNA sequences suggests there may be as many as 60 species. In a given continent, there are numerous species, many formerly lumped under *H. repandum*. For example, in North America the number of accepted species was recently raised from five to 17, with 16 of these found only in that continent.

Identity

For many years, *Hydnum* in Australia were identified as the Northern Hemisphere *Hydnum repandum* (with pale ochre or pale apricot pileus) or *H. rufescens* (with terracotta or reddish brown pileus). The older names *H. ambustum* and *H. crocidens*, originally described from Australia, were incorrectly placed as synonyms of *H. repandum*. Recent analyses of DNA sequences indicate that there are at least six phylogenetic species of *Hydnum* in Australasia, of which five occur in Australia and four in New Zealand, with three shared between the two countries. *Hydnum repandum* and *H. rufescens* do not occur in the region.

Of the six phylogenetic species from Australasia, the first is distantly related to the others and belongs in the same group as *H. rufescens*. This first species has a reddish brown or dark brown pileus and occurs in Australia and New Zealand. In New Zealand, it is currently known as *Hydnum crocidens* var. *badium*. Two further species occur in Australia and New Zealand. The fourth species is known only from Western Australia. The fifth species is known from a single collection from Tasmania. The remaining species is the New Zealand *H. wellingtonii* (= *H. crocidens* var. *wellingtonii*) that associates with *Nothofagus*. It is not clear at the moment which of the six phylogenetic species in the *H. crocidens* group should be connected to the early Australian names *H. ambustum* and *H. crocidens*. The distinguishing morphological characters of the six phylogenetic species are also not clear at this stage.

Australian species

There are no other species of *Hydnum* in Australia apart from those in the *H. crocidens* group discussed above.

Lookalike species

Hydnum crocidens group is ideal for novice foragers as lookalikes are easy to distinguish. Other mushroom-shaped spine fungi in Australia belong to various unrelated families and few are fleshy. Sporophores of *Auriscalpium* (Auriscalpiaceae) have a rubbery texture. Sporophores of *Beenakia dacostae* (Clavariadelphaceae) are soft and the spines are olive brown at maturity. Two genera of the Bankeraceae, *Hydnellum* (brown spore print) and *Phellodon* (white spore print) are typically leathery in texture and the pileus is often concentrically zoned and dark brown, bluish or black. The odour is often of curry or fenugreek. The genus *Sarcodon* was formerly separated from *Hydnellum* on the basis of the fleshy rather than leathery sporophores. However, many species of *Sarcodon* were recently transferred to *Hydnellum*, and only the group of species around the Northern Hemisphere *S. imbricatus* remains in *Sarcodon*. In Australia, several undescribed species of large, fleshy spine fungi have been referred to as *Sarcodon*. On the basis of DNA sequences, all belong in *Hydnellum*. These fleshy species should not be targetted by foragers for two reasons. First, their edibility is unknown (most of the European species are unpalatable due to their bitterness). Second, some are extremely rare.

Tremella fuciformis

white brain
chrysanthemum mushroom
silver ear
silver ear fungus
snow ear
snow fungus
white brain jelly fungus
white jelly

Although common and conspicuous, the white brain is seldom collected as food in Australia. Various jelly fungi including this species have been cultivated in China and elsewhere in East Asia for centuries. It is commonly found in its dried form in Asian grocers in Australia. Although largely flavourless, it provides texture and serves as a substrate to absorb other flavours in the dish. It is often used in sweet dishes, especially dessert soup, but also in savoury dishes and adds a nice crunchiness to salads.

◄ Jelly fungi such as *Tremella fuciformis* are popular in Asian soups.

Tremella fuciformis

Checklist of features

HABITAT	In native forests. Parasitic on the mycelium of other fungi.
HOST	The fungus *Annulohypoxylon* (the host fungus is not usually visible directly under the *Tremella*).
SUBSTRATE	On dead wood, often on large fallen tree trunks.
HABIT	Solitary or gregarious.
SPOROPHORE	Highly variable in form but usually lettuce-like or seaweed-like, less often blob-like, with a narrow point of attachment at the base. To 10 cm diameter, to 5 cm tall, convoluted, with few to numerous lobes, the margin of which can be entire or wavy or with block-like teeth, translucent to semi-translucent to opaque white, becoming yellowish when old surface moist, smooth and shiny.
FLESH	Texture firm, jelly-like or rubbery, whole sporophore shrinking radically when dried, becoming pale yellow, reconstituting when wetted again.
ODOUR	Indistinct.
PHENOLOGY	Mostly appears in late autumn, winter and early spring.

Sporophores of this species are longer-lived than those of most other fungi. Therefore, take care to collect fresh sporophores that have not been sitting around for too long. Older sporophores tend to become less translucent and less plump, and may develop yellow tints near the point of attachment.


Sporophores highly variable, typically convoluted with many lobes.


Sometimes with few lobes.


May be densely folded.


Semi-translucent to opaque.


Always grows on wood.


Older sporophore yellowing with age.

Name

Tremella derives from the Latin *tremulus* meaning shaking or trembling. In *Species Plantarum* (1753) Linnaeus placed the genus *Tremella* among the algae and included in it a hodgepodge of species including rust fungi, lichens and cyanobacteria. In 1794, Persoon published a new arrangement of the fungi, in which he took up the name *Tremella* in the sense that it is used today, for species of fungi including *Tremella mesenterica*. *Tremella fuciformis* was described in 1856 by Berkeley from a collection made by the English botanical explorer Richard Spruce at Panuré on the Rio Uaupés in the Amazon basin. The epithet *fuciformis* refers to the resemblance of the sporophores to *Fucus*, a type of seaweed.

Distribution

Tremella is a myco-parasite, growing on diverse fungi including other jelly fungi, polypores and lichens. Some species of *Tremella* form readily visible sporophores but others grow microscopically inside sporophores of their host. *Tremella encephala* incorporates hyphae of the host *Stereum* inside its sporophore as a dense internal nodule. Other *Tremella* do not have any obvious connection to the host. When *Tremella* appears on wood, as does *T. fuciformis*, they are likely to be parasitising host hyphae deep in the substrate. *Tremella fuciformis* parasitises species of *Annulohypoxylon* (formerly placed in *Hypoxylon*) including *A. archeri* and *A. stygium*. *Annulohypoxylon* is a pyrenomycete (named for the charcoal-like appearance) that forms a thin, black crust on dead wood. Under a hand lens, this crust can be seen to be composed of tiny spheres, each with an opening at the top.

Tremella fuciformis is found throughout South America, except for the far south. It is commonly reported from Central America and North America, particularly in the eastern half. Scattered records exist from Africa and East and South-east Asia. It is common throughout New Zealand. This distribution seems widespread for a fungus that grows as a parasite of another fungus. Parasitic fungi often grow with one or a few host species and their distribution is consequently limited by that of the host. It is possible that the name *T. fuciformis* is being used for multiple species of similar appearance, or that the species has spread from a more restricted distribution. Alternatively, it may have a wide host range. In Australia, occurrences are mostly in native forest and therefore *T. fuciformis* is considered a native species.

In Australia, it is found in the eastern half of the continent from South Australia to far north Queensland. In South Australia, it occurs in the higher rainfall regions of the state in the Adelaide area, the Fleurieu Peninsula, the western end of Kangaroo Island and the far-south-east. In Tasmania, it is widespread, apart from the west coast and the Midlands. In Victoria, it is widespread in the south of the state, extending to subalpine areas. In New South Wales it occurs in scattered locations as far inland as the Tumut area, including the Australian Capital Territory. In Queensland, there are records from the far south-east and also along the coast in scattered locations, as far north as the Cape Yorke Peninsula. The few reports from Western Australia need confirmation, especially due to possible confusion with old and faded sporophores of *T. mesenterica* group.

Yeasts

In contrast to the usual growth of fungi as filamentous hyphae, yeasts form rounded cells that divide by budding. In some fungi, including *Tremella*, a yeast phase is part of a life cycle that also includes production of hypha. In other fungi, only a yeast form is produced. Yeasts occur in a variety of groups of fungi and are among the most useful and most harmful of fungi as far as humans are concerned. On the one hand, yeasts in *Saccharomyces* are widely used for brewing and baking; on the other hand, some yeasts in *Candida* and *Cryptococcus* are pathogenic to humans. In *Tremella*, the yeast phase occurs when spores produced by the normal sexual process bud to form numerous spherical cells, which are presumed to act as dispersal propagules. How the dispersal of sexual spores in nature contrasts with that of yeast cells is not yet understood for *Tremella*.

Classification

Fungi with gelatinous flesh such as *Tremella* are colloquially referred to as jelly fungi. Differences in the structure of the basidium, the microscopic organ that produces sexual spores, are used in the classification of jelly fungi. One of the characteristics of *Tremella* is that basidia have interior, vertical cross-walls that result in the top view of basidia being cross-shaped, like a hot cross bun. In other jelly fungi, such as *Auricularia*, horizontal cross-walls divide basidia into compartments, like the floors of a high-rise building. In *Calocera* and *Heterotextus* basidia are in the shape of a tuning fork, with two long arms. The jelly fungus most similar in appearance to *Tremella* is *Exidia*, which has similar cross-walls in basidia, but differs by the sausage-shaped spores, in contrast to the spherical or ellipsoid spores of *Tremella*.

Identity

The morphological features of *Tremella fuciformis* as reported from Australia match well to those of the species as understood from around the globe. As yet, no DNA sequences have been obtained from Australian collections.

Australian species

Australian species of the genus *Tremella* have not been comprehensively reviewed. Most species reported from Australia were originally described from elsewhere, and further examination is required to clarify if the names of these species are being correctly applied. In addition to *T. fuciformis*, species of *Tremella* reported from Australia with readily visible sporophores include *T. encephala* (= *Naematelia*, with pale pink to pinkish brown sporophores; see lookalikes below), *T. globispora* (small, white blob-like sporophores) and the *T. mesenterica* group (including *T. aurantia*, with bright yellow to orange sporophores; see lookalikes, below). In contrast, *T. stevensiana* forms tiny (to 0.5 mm diameter) wart-like sporophores on the surface of the lichen *Usnea*. The genus *Phaeotremella* is similar in appearance to *Tremella*, forming convoluted sporophores. Species in the *P. foliacea* group (including *P. fimbriata* and *P. frondosa*) form dark brown sporophores.

Lookalike species

These lookalike species are unlikely to be poisonous but are not considered edible. Being familiar with these species as well as with *Tremella fuciformis* will increase the confidence with which you can identify the targetted edible species.

Tremella mesenterica group sporophores are yellow.

Tremella mesenterica group (yellow brain)

Includes *Tremella aurantia*.

Features to note:

- Sporophores share almost all features with *T. fuciformis*, the most obvious difference being the golden yellow to orange colour, drying dark orange, but may be paler or even colourless when old and waterlogged.
- *Tremella mesenterica* parasitises *Peniophora* and *T. aurantia* parasitises *Stereum*.

Tremella encephala forms compact sporophores on conifer wood.

Tremella encephala (pine-tree brain)

(Synonym: *Naematelia encephala*)

Features to note:

- Solitary or in clusters, parasitising the bracket fungus *Stereum sanguinolentum* growing on conifer wood, possibly also parasitising other *Stereum* species.
- Sporophores typically smaller (to 3 cm diameter), compact, less lobed and more tightly convoluted than *T. fuciformis*.
- Colour off-white becoming pale pink to pinkish brown.
- Flesh with a hard, whitish fibrous central core (evident when cut) consisting of hyphae from the parasite host.

Exidia glandulosa with darker papillae.

Exidia glandulosa (witches' butter)

Most American authors use the vernacular name witches' butter for *Tremella mesenterica,* but most British authors use the name witches' butter for *Exidia glandulosa*. This regional variation in vernacular names underlines the value of scientific names in communicating about fungi around the globe.

Features to note:

- Sporophores commence as translucent blister-like blobs, soon becoming cushion-like to irregularly lobed or tightly convoluted, usually with multiple sporophores coalescing to form rows or irregular masses.
- Colour dirty cream then greyish brown, dark grey or black.
- Surface minutely roughened with darker papillae (small bumps – use hand lens).
- Flesh firmer in texture than *Tremella*, drying to a thin hard, grey to black crust.

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Lycoperdon pratense

(Synonym: *Vascellum pratense*)
common puffball
field puffball
meadow puffball

The easily recognisable *Lycoperdon pratense* often appears on lawns and in gardens. Puffballs have long been popular as edible fungi in the USA and are becoming better known in Australia. They should only be eaten when young, firm and fleshy throughout. At this stage, they can be confused with the button stage of mushrooms. Making a cross-section is the best way to ensure you have not found the button stage of a toxic mushroom such as *Amanita phalloides*. When mature, puffballs such as *L. pratense* produce a mass of powdery spores that is released in puffs through the opening as raindrops fall on the outer layer.

◄ Species other than *Homo sapiens* enjoy eating puffballs.

Lycoperdon pratense

Checklist of features

HABITAT	Usually in grassy areas, in human-modified environments including track edges, road verges, paddocks, lawns, parks, sports fields and golf courses. Saprotrophic.
SUBSTRATE	On the ground.
HABIT	Solitary or in widely scattered groups, sometimes in rings.
SPOROPHORE	Diameter 1.5–6.5 cm tall, 2–6 cm broad. Eventually forming an upper spore-containing section and a lower, sterile (spore-less) section. Overall, subglobose then typically broader above and ovoid to pear shaped or 'lightbulb-shaped', often flattened above. Below with a short, squat, stipe-like base 1–2 cm long and to 3 cm diameter, approximately half the width of upper section.
PERIDIUM	Peridium (skin) of two layers, the outer (exoperidium) initially downy or with irregular scattering of minute spines or granules, disappearing with age, exposing the inner (endoperidium) that is smooth becoming slightly wrinkled and shiny.
STOMA	Stoma (opening) initially a small central apical pore that widens (to 4 cm diameter), often becoming angular, to leave a bowl-shaped or urn-like 'husk' attached to the sterile base.
FLESH	Sterile, stipe-like base with small chambers that is separated from gleba by a membranous diaphragm (as seen in cross-section or in old sporophores once spores have weathered away).
GLEBA	Gleba (spore mass) forms within the upper section of the sporophore. Initially soft, fleshy and pure white, becoming powdery and darkening, from light brown, through pale yellow to olive brown or dark brown when fully mature.
ODOUR	Mushroomy but not distinct. Taste similar.
PHENOLOGY	Appears throughout the year, but in contrast to the profiled agaric species, most often in spring and early summer.

Often in groups, darkening with age.

Sporophore lightbulb shaped.

Outer peridium of scattered, minute spines.

Inner peridium smooth once outer peridium spines disappear with age.

Flesh pure white when young.

Sterile base with small cavities.

Formation of small central apical stoma.

Angular shape of developing stoma.

Powdery brown pore mass escapes through stoma.

Name

Puffballs make no sound on releasing spores and nor is their odour unpleasant, yet the derivations of their names are often scatological. French botanist Joseph de Tournefort introduced the genus name *Lycoperdon* in *Institutiones rei Herbariæ*, published in 1700. Tournefort indicated that the name derived from Ancient Greek *lukos* wolf and *perdo* to break wind. He also provided a French vernacular name *vesse du loup* – a silent yet malodorous fart. The allied genus *Bovista* was coined by Persoon in his 1794 article about fungal classification. The name *Bovista* derives from the German word *bovist* from *wohen* vixen and *fist* a silent fart. The species *Lycoperdon pratense* was also named by Persoon in his 1794 article. The epithet *pratense* means growing in meadows.

Distribution

The natural distribution of *Lycoperdon pratense* is the temperate regions of the Northern Hemisphere where it is particularly common across Europe. In Australia, it is an exotic species, always growing in disturbed sites. *Lycoperdon pratense* is a saprotroph and can form fairy rings in lawns. Unlike *Marasmius oreades*, where there are often concentric zones of lush grass growth contrasting with bare ground in the one ring, fairy rings formed by *L. pratense* show only lush growth.

Lycoperdon pratense is the one of the least recorded species profiled in this book. However, it is possibly overlooked or under-recorded. In south-west Western Australia it is known from a few coastal sites from Perth to Esperance. In eastern Australia, it occurs from Adelaide in South Australia to Mackay in Queensland, including in Tasmania, Victoria and the Australian Capital Territory. There are a few records from far inland such as from south-western New South Wales and Alice Springs in the Northern Territory. It is commonly reported from central Victoria but otherwise records are scattered.

Classification

Lycoperdon pratense was formerly separated in the genus *Vascellum* due to the presence of an obvious diaphragm separating the gleba from the sterile base. However, analysis of DNA sequences does not support this separation.

A puffball and a mushroom seem like chalk and cheese. The first has spores forming a powdery mass at maturity; the second has lamellae on which spores are formed in a thin layer, the hymenium. For centuries, puffballs and mushrooms were classified as separate groups within the fungal kingdom. With the availability of DNA sequences from a wide range of fungi, unexpected evolutionary relationships have been revealed. None is more surprising than the close relationship between puffballs such as *Lycoperdon* and mushrooms such as *Agaricus*. Indeed, these two genera belong in the same family, the Agaricaceae, as do the mushrooms *Chlorophyllum*, *Coprinus* and *Lepiota* and the stalked puffball *Podaxis*.

The function of the fungal sporophore is to produce spores and facilitate their dispersal. In a mushroom, spores fall down from the lamellae and are caught by air currents. In puffballs, raindrops hit the papery outer surface and cause the characteristic puff of spores. Each of these sporophore morphotypes has evolved independently on several occasions. This suggests that both mushrooms and puffballs are effective ways of building a sporophore, but what are the relative merits of the different forms? The puffball morphotype appears to have an advantage in drier regions, because puffballs such as *Battarrea*, *Tulostoma* and *Podaxis* are more diverse and more common in arid Australia than mushrooms. In drier climates, suitable conditions for growth may be brief. The sporophores of puffballs are long-lived and can persist until subsequent rain events enhance spore dispersal at a time conducive to spore germination. However, suitability to aridity is not the only advantage of the puffball, as they also grow in the wettest of environments, such as rainforests. Understanding how the varied forms and colours of fungal sporophores relate to their environment remains one of the intriguing challenges of fungal biology.

Identity

All characters of Australian occurrences of *Lycoperdon pratense* match those of the species as known from the Northern Hemisphere. DNA sequences have not yet been generated from Australian collections.

Australian species

There are around half a dozen species of *Lycoperdon* in Australia all with scurfy to spiny outer surface when young. They mostly grow on the ground but *L. purpurascens* (= *Morganella*) grows on wood. Species other than *L. pratense* all lack an obvious diaphragm. Some have beautiful patterns on the exterior when young, such as shown by *L. perlatum*, one of the vernacular names of which is gem-studded puffball. *Apioperdon pyriforme* (= *Lycoperdon*) grows on wood, especially in wet forests, and is pestle-shaped. *Bovista* lacks the chambered basal portion or the chambers are minute. *Calvatia* has a smooth outer surface and sporophores are often relatively large as in *C. gigantea* (= *Langermannia*). *Mycenastrum corium* is relatively large and has a thick outer layer.

Lookalike species

Some field guides state that all puffballs are edible and hence differentiating among them is not important. However, while this might apply elsewhere, it is not necessarily the case in Australia. In particular, the toxic earthballs have the overall appearance of puffballs, differing principally by the thicker outer layer. Furthermore, puffballs can be confused with the button stage of poisonous fungi such as amanitas. Therefore, we recommend you become familiar with the features necessary to accurately identify *Lycoperdon pratense*. Note also that all puffballs should be avoided once the spore mass turns powdery.

A cross-section is the best way to ensure you have not found the button stage of a mushroom, stinkhorn or earthball. A young *L. pratense* in cross-section has a homogenous, white interior. In young *Amanita muscaria* and *A. phalloides* (and other agarics) the developing pileus, lamellae and stipe are visible, in their immature form. In addition, young *Amanita* usually have an enlarged bulbous base. *Scleroderma* and *Ileodictyon* also have characteristic features in cross-section.

Amanita muscaria button stage.

Amanita muscaria button stage cross-section.

Amanita muscaria (fly agaric) button stage

See full species profile in Chapter 8.

The button stage of *A. muscaria* can be confused with young puffballs.

Features to note:

- Grows with exotic conifers (commonly *Pinus radiata*) and exotic deciduous trees (especially *Betula* and *Quercus*) and the native Australian southern beech (*Nothofagus*)
- Cross-section reveals developing agaric form with miniature pileus, lamellae and distinctly bulbous stipe base; pileus often showing as a thin yellow or red line of tissue beneath the outer veil.

Amanita phalloides button stage.

Amanita phalloides button stage cross-section.

Amanita phalloides (deathcap) button stage

See full species profile in Chapter 8.

The button stage of *A. phalloides* can be confused with young puffballs.

Features to note:

- Grows under or near exotic *Quercus* (oak), commonly *Q. robur* in Australia.
- Cross-section reveals developing agaric form with miniature pileus, lamellae and distinctly enlarged bulbous base of stipe, all enclosed within white outer universal veil.

Scleroderma (earthballs)

Features to note:

- Mycorrhizal with tree genera most often *Eucalyptus*.
- Peridium pale brown or often yellow, rough or scaly and often areolate (cracked like dried mud).
- Young sporophore solid with firm, rubbery texture.
- Cross-section reveals thick peridium and interior pale spore-producing tissue that darkens to purplish brown (often appearing marbled) then becomes powdery at maturity (*L. pratense* is softer in texture with a thinner peridium and the spore mass is olive brown at maturity).
- Peridium flesh may stain reddish when cut.
- Often the base has extensive tufts of rhizomorphs.
- At maturity, peridium tears and splits open in irregular star-like pattern which enlarges as it starts to disintegrate.

Scleroderma (earthball).

Scleroderma cross-section showing purplish brown spore mass.

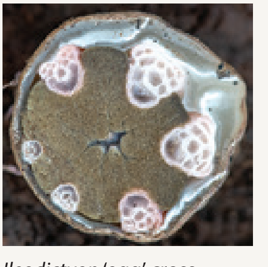
Ileodictyon (cage fungi)

The unopened 'egg' stage of stinkhorns such as *Ileodictyon* can be confused with young puffballs. Mature specimens have a distinctive cage-like structure.

Features to note:

- The initial stage is a whitish 'egg' to 3 cm diameter, rubbery in texture, attached to white 'cords'.
- A cross-section shows developing olive brown spore mass, within which are miniature arms that will form the mature cage structure.
- Mature sporophore is polygon-shaped with mesh-like arms covered with foul-smelling, slimy spore mass.

Ileodictyon 'egg' stage.



Ileodictyon 'egg' cross-section showing developing arms of the cage.

Emerging knowledge

Further to the profiled edible species, we regularly hear about people eating other foraged wild fungi in Australia, mostly with no ill effect. We refer to these other species as having 'emerging knowledge' because information is largely anecdotal and their identification, occurrence and/or edibility is not yet firmly established. A species cannot be unambiguously defined as 'edible' until many people have eaten it with no ill effects. Hence the importance of contributing knowledge about edibility and toxicity based on your experience, such as by lodging vouchers in reference collections. We briefly discuss some 'emerging' species in the same morphogroup sequence used in Chapter 4. The onus is on the reader to research these species further, including toxic lookalike species.

Oysters

The genus *Pleurotus* contains several widely cultivated species such as the oyster mushroom (*Pleurotus ostreatus*). In Australia there are several native species, including *P. australis* and *P. purpureo-olivaceus* in southern Australia and *P. djamor* in northern Australia. Cultivated strains of oyster mushroom might also have escaped to the natural environment. Great care should be taken if consuming wild *Pleurotus* to distinguish them from the toxic and common *Omphalotus nidiformis* (ghost fungus). Where recipes in the following chapter include oyster mushrooms, we recommend using cultivated varieties.

Chanterelles

Chanterelles (*Cantharellus*) have an international reputation as a prized edible group, particularly in Scandinavia. Among their more distinctive characteristics is the strongly decurrent 'skin folds' rather than lamellae. In Australia, chanterelles were first identified as the Northern Hemisphere *Cantharellus cibarius* (golden chanterelle) but the local species, of which there are at least several, are different. One species found in southern Australia is *C. concinnus* (Australian chanterelle). Further species, yet to be described, are known from the south and particularly the tropical north of the continent. Chanterelles in Australia do not produce sporophores with the great abundance of the European *C. cibarius* and hence have not received as much attention as other edible fungi. Both John Cleland and Jim Willis (pioneering Australian mycologists) mention eating a local *Cantharellus* that they incorrectly identified as *C. cibarius* and chanterelles are also mentioned on various Australian websites about edible fungi. Chanterelles are often described as having an apricot-like or fruity odour and sweet flavour.

Boletes

Numerous types of boletes grow in Australia, but their edibility is largely unknown. There are several accounts of Indigenous Australians consuming boletes, but the species are not able to be identified. A fatality in Queensland has been attributed to consumption of a bolete (see *Rubinoboletus*, p. 79). Many edible boletes grow in the Northern Hemisphere, but also a few toxic species, especially in the genera *Neoboletus* and *Rubroboletus*. Neither genus is reported from Australia. *Boletus edulis* (penny bun) is a well known and sought-after edible bolete of the Northern Hemisphere. It has recently been found in Australia, in association with exotic *Quercus* in South Australia and Victoria. Identification of at least one of the Australian occurrences has been confirmed by DNA sequencing. *Phlebopus marginatus* (giant bolete) forms large sporophores (pileus to 60 cm in diameter) that appear in grassy areas near native trees. *Boletus edulis* is superficially similar but has a reticulate stipe surface and grows with exotic trees. *Phlebopus marginatus* is mentioned in several online sources as edible, but is also known to cause gastrointestinal symptoms, usually after consumption of large quantities that perhaps were not fully cooked. Confusingly, in east Asia, a mushroom also called *P. marginatus* is both collected from the wild and cultivated. Other species in the genus in Africa are collected for food, but have been found to contain toxins, although at low levels. Further research is needed to establish how many species of *Phlebopus* exist in Australia and to determine their relationship to the Asian species.

Beefsteak fungus

Fistulina hepatica (beefsteak fungus), as suggested by the species epithet, resembles a liver in shape, texture and colour. It is easy to identify by the overall appearance coupled with the underside composed of tightly packed tubes, like brush bristles. It grows on trees and stumps in temperate Australia as far north as southern Queensland. Despite being described as 'the celebrated beef-steak fungus' in a report of the Field Naturalists Club of Victoria in 1885, it is rarely recommended in European guides. Reports of an edible fungus known as *Numar* to the Nyungar people of south-west Australia are thought to refer to *F. hepatica*. It has a distinctive flavour, sometimes described as acidic, sour or like citrus. It is likely that *Fistulina* occurring in Australia is not the same as *F. hepatica* (*F. spiculifera* could be the more appropriate name and a new species *F. tasmanica* was described recently from Tasmania).

Native bread

Laccocephalum mylittae (native bread) produces a large, underground sclerotium, which is a dense mass of hyphae. When the sclerotium is cut in half, the exposed surface has a marbled appearance. Fire stimulates the production of an above-ground mushroom-like sporophore, with pores on the underside of the pileus. The sclerotium is edible and there are records of use by Aboriginal people of Tasmania and Victoria.

Beech oranges

Cyttaria (beech oranges) produce orange, dimpled sporophores on woody galls in spring. Beech oranges occur across the southern continents in association with the tree family Nothofagaceae. They are eaten in several countries in South America including Chile, where they are sold in markets. In Australia, there are three species, all growing on *Nothofagus* (southern beech) in cool temperate rainforests. *Cyttaria gunnii* is found in Tasmania and Victoria and *C. septentrionalis* occurs in northern New South Wales and far south-east Queensland. In Tasmania, *C. gunnii* is recorded as a favourite food of Aboriginal people. It is known by various names including *Narmmener* among the people of the north coast. Beech oranges have been identified as a potential bush food. However, harvesting is currently discouraged due to concerns about damage to rainforest remnants such as by the spread of the pathogen myrtle wilt.

Cantharellus concinnus (Australian chanterelle).

Pseudohydnum gelatinosum (toothed jelly).

Fistulina hepatica (beefsteak fungus).

Boletus edulis (penny bun).

Morels

Morchella (morels) are prized edibles found in natural and disturbed environments around the globe. The 'mulch morels' can appear in profusion in newly created mulched garden beds. The pileus forms a honeycomb-like mesh, supported on a stipe. In Australia, for many years, two species groups were reported: the *Morchella elata* group (also known as *M. conica*) with strong vertical ridges in the mesh and the *M. esculenta* group without strong vertical ridges. *Morchella* in Australia are typically found in dryer native bushland, but sometimes grow in parks and gardens in cities. They can also appear after fire.

In the last decade, there has been an explosion in the number of species recognised in the genus. Many species of similar appearance are now distinguished largely by their DNA sequences. In Australia, *Morchella australiana* has recently been described (equating to what was called *M. elata* at least in part). There are also reports of *M. eximia* (= *M. septimelata*), *M. galilaea* and *M. rufobrunnea*, all confirmed by DNA. It is not yet clear how many species exist in Australia and which are native and which are exotic. If foraging for morels, be aware of the uncommon but potentially toxic *Gyromitra tasmanica* (formerly known in Australia as *G. esculenta*), recognisable by its convoluted (not deeply ridged) pileus. The related *G. esculenta* of the Northern Hemisphere contains gyromitrin. If eaten raw, this compound is metabolised to the toxin monomethylhydrazine (which can result in multi-organ effects). There are also many reports of toxicity associated with eating raw or under-cooked morels. Some people even react adversely to cooked morels, particularly when large quantities are consumed (see p. 68, 'Morel neurologic syndrome'). Additionally, gastrointestinal symptoms are occasionally reported, including after consumption of Australian morels.

Other edible fungi

Several other fungi have been mentioned as edible in the Australian context. *Pleurotus tuber-regium*, sometimes placed in *Lentinus*, produces sporophores from a large sclerotium that forms in rotting wood. *Macrolepiota dolichaula* is reported by some Australian sources as edible, but there are also reports of toxicity (see p. 77). The *Oudemansiella gigaspora* group (rooting shank) is a complex of several species of austral rooting shanks, formerly referred to as the Northern Hemisphere *O. radicata* (and sometimes placed in *Hymenopellis* or *Xerula*). *Pseudohydnum gelatinosum* is a cosmopolitan jelly fungus that is used most commonly in Asian cuisine. The sporophore of *Hericium coralloides* forms a mass of downward hanging spines, arising from wood, commonly *Nothofagus*. Various exotic species of *Rhizopogon* form rubbery truffle-like, hypogeal sporophores in association with *Pinus*. *Auricularia* (wood ears) such as *A. cornea* are found along the east and north coasts and elsewhere in tropical regions.

As with any fungi, always assume a species is toxic unless definitively known to be edible.

Cultivated fungi

Mushrooms have been cultivated for centuries. Popular species such as *Auricularia auricula-judae* (jelly ear), *Flammulina velutipes* (velvet shank), *Lentinula edodes* (shiitake) and

Volvariella volvacea (paddy straw mushroom) have been cultivated by the Chinese since at least 600 AD. The ubiquitous and most commonly produced species, *Agaricus bisporus* (known by various commercial names including button mushroom, Swiss brown, portobello, baby bella and snowy white) was first cultivated in the dank Parisian subterrains by the French in the 1600s. France led the world in mushroom production up until the Second World War when the USA became the dominant producer. Today, advanced and highly mechanised mushroom cultivation techniques have enabled large-scale mushroom production. China produces over 85% of mushrooms worldwide, employing more than 35 million people.

Cultivated mushrooms were first imported to Australia as canned produce from Canada and Europe. The industry was established in Victoria in the 1920s and in the disused railway tunnels of Circular Key in Sydney in the 1930s. During the Second World War, the Australian canned food industry rapidly expanded and by the 1970s most mushrooms that were consumed were canned. Mushroom production and consumption continue to grow in Australia and fresh mushrooms are mostly consumed today. Greater awareness of health benefits, the introduction of the 'Australian Mushrooms' brand and opportunities for the public to partake in mushroom farm tours have all contributed to their rise in popularity. Additionally, mushroom protein is a significant contributor to the rapidly expanding range of meat substitutes, including mushroom-based burgers, complete with bleeding beetroot juice.

For those who prefer not to forage, commercially produced mushrooms provide a safe alternative. While *A. bisporus* dominates the commercial mushroom market, production is expanding to include 'gourmet' species such as *Flammulina velutipes*, *Hericium erinaceus* (lion's mane), *Lentinula edodes*, *Lyophyllum shimeji* (hon-shimeji), *Pleurotus eryngii* (king oyster) and *P. ostreatus* (oyster mushroom). Cultivated fungi available in Australia are often imported. Check that packaged fungi are in good condition or support the local industry by seeking out Australian-grown brands. Most cultivated fungi are available fresh, but some such as *Auricularia auricula-judae* are mostly supplied dried. Some cultivated fungi (e.g. *Pleurotus ostreatus*) are available in kit form. Kits not only create a supply of fresh mushrooms for consumption but are a great way for children to learn how sporophores grow from mycelia.

Almost all commercial production involves saprotrophic fungi as they are easier to cultivate than mycorrhizal fungi. Although *Pinus radiata* plantations in Australia offer the potential for commercial production of edible mycorrhizal species such as *Lactarius deliciosus*, research (conducted in New Zealand) is only in its infancy. The stand-out exception is *Tuber melanosporum* (Périgord black truffle). This European species has increased in popularity in Australia with truffle farms (truffières) first appearing in Tasmania and Western Australia in the 1990s and now spreading to other regions of temperate Australia to include over 160 commercial growers. Cultivation of *T. melanosporum* involves using innoculated *Quercus robur* (English oak) and *Corylus avellana* (hazel) seedlings. To maximise the chance of production, climatic conditions are chosen to resemble the regions of Europe where the species naturally occurs and soil is modified to increase alkalinity.

Agaricus bisporus (Swiss brown).

Pleurotus ostreatus (oyster mushroom).

Lentinula edodes (shiitake).

Tuber melanosporum (Périgord black truffle).

Chapter 10

Fungi in the kitchen and on the table

Mushrooms are tantalising. In Australia and the developed world more generally, the flavour of mushrooms usually prevails over nutrition, with few people foraging for subsistence. Much of the pleasure is derived from the activity itself. Culinary satisfaction is intensified by the quality of 'gatheredness' – or how one's enjoyment of the harvest is enhanced by the foraging experience as a whole. Experienced foragers seek particular fungus species that are known for their distinctive characteristic flavours and textures. Furthermore, the great variety of fungus shapes and colours lend tremendous visual appeal and contrast to a dish. Innovative chefs in Australia are opening our eyes, indeed our palates, to enticing new fungal flavours and cuisines.

This chapter prises us from the forest and heads to the kitchen to consider the various ways to prepare, preserve and cook different sorts of fungi. The recipe section showcases the great versatility of edible fungi and the many ways they can be used in a suite of different dishes. We faced the difficult task of selecting only 29 recipes. In doing this we have tried to represent both traditional and modern approaches, as well as simple and more elaborate techniques to bring out the best of a range of edible species. Australia has always been a multicultural nation and the recipes reflect that diversity along with new tastes and techniques brought in from elsewhere. There are also those that might be considered characteristically Australian, cooked accordingly out bush in a camp oven. Many recipes offer the possibility to substitute alternative species, while some are especially designed to highlight the flavours of one favourite. Some recipes incorporate easily obtainable commercial species or dried fungi, in case you had an unlucky day foraging. We hope you enjoy discovering new and interesting flavours and culinary delights in the following pages.

Whatever your approach to cooking edible fungi, ensure that they are at their freshest to experience their characteristic flavours and textures. The flavours of fungi, although particular, are often subtle and delicate. Different species need different treatment in the

◄ Sliced blewits ready for cooking.

kitchen, to both highlight those particularities and retain their nuances. Given that fungi-beyond-the-button-mushroom have not typically been in many Australians' culinary repertoire, cooking with them is also about experimentation and imagination, adjustment and refinement.

Keep in mind that edibility and palatability are not the same thing. Some fungi such as *Boletus edulis* (penny bun) and *Cantharellus* (chanterelles) are internationally recognised for their flavour and palatability. Then there is a whole suite of other fungi where opinions about their palatability (and even their edibility) varies wildly, depending on individual tastes, familiarity and cultural traditions. In fact, species preference is often more strongly connected to culture and tradition than species distribution (availability). What is certain is that the foraging fraternity is full of paradoxes, with wild picked mushrooms being symbolic of both poverty and affluence. Fungi, whether edible or not, have always inspired extremes of attitudes.

Although this book is mostly about wild mushrooming, cultivated species provide the benefit of availability and certainty about identity. Wild-foraged species can be substituted for commercial species in many of the recipes. Remember that when trying a new species for the first time, consume only small quantities. Even well-known edible species can cause unusual reactions in some people. If symptoms are experienced after consuming mushrooms, you need to be able to isolate the culprit, hence do not mix different species when trying a new one. Most important of all, be absolutely sure of your identifications.

Whether you found your mushrooms while foraging or at the farmers' market, what are you going to do with them? To enjoy their inherent flavours and textures at their best, the following section provides some basic techniques for treating, preparing and cooking with mushrooms.

Storage and preparation

Mushrooms are short-lived and deteriorate quickly after harvesting. Whether wild-picked or cultivated, fresh fungi should always be eaten as soon as possible, as most lose some of their flavour the moment they are picked. If you do not intend to eat them immediately, store them in a cool place (between 2°C and 5°C and with an optimum humidity of 85–90%) where they can 'breathe' (not in plastic). Consume them within a couple of days.

Opinions vary about the best way to clean mushrooms, but careful harvesting should remove the need for much cleaning. Get into the habit of gently removing mushrooms from their substrate and brushing or picking off any debris there in the field. Fungi such as ceps are particularly popular with species other than *Homo sapiens*. You might need to coax out a few persistent inhabitants and trim the mushrooms with a knife to remove any gnawed parts. They should then only require careful inspection before cooking to remove any last remaining debris with a brush or damp cloth. Many chefs suggest using as little water as possible, while ensuring they are sufficiently clean. Some mushrooms such as *Morchella* (morels) often retain dirt and debris and might need to be thoroughly rinsed in a colander unless you are partial to eating grit. If you clean them with cold water under a running tap, most mushrooms will absorb little water. Wash them whole, not chopped, to minimise water

Lepista nuda (blewit).

Lactarius deliciosus (saffron milk cap).

Coprinus comatus (lawyer's wig).

Boletus edulis (penny bun).

Macrolepiota clelandii (Australian parasol).

Suillus granulatus (weeping bolete).

Agaricus campestris (field mushroom).

Hydnum crocidens group (echidna fungus).

absorption. Mushroom cell walls are made of chitin and do not absorb as much water as commonly believed. Moreover, given most mushrooms already have a high water content they are not able to absorb much more. If you allow them to soak for a prolonged period, they will absorb some water, but it is likely to only be a couple of per cent of their total weight. Excess water can be evaporated by patting them dry, whizzing them in a salad spinner or by drying them quickly in a hot pan. If you wash your mushrooms, do it right before cooking, as storing washed mushrooms will affect their texture and reduce their shelf life. Ultimately, it is about common sense. As with every other foodstuff we put in our mouths, if your mushrooms are dirty, wash them.

Generally speaking, it is not necessary to peel mushrooms (especially cultivated ones) although some people react to the slimy covering of some species of *Suillus*. If this is the case, peel off the slimy layer. Australian chef and restaurateur Stephanie Alexander agrees that it is not necessary to peel mushrooms but adds that it can help with the absorption of flavours such as olive oil. Some people prefer to discard particular parts of wild fungi, for example the tubes of boletes or the spines of *Hydnum* (wood hedgehog and echidna fungus). This is usually due to aesthetics, custom or concern about bitterness or texture. The edible species in this book can be eaten in their entirety. However, sometimes the stipes of some species (such as *Marasmius oreades*, fairy ring mushroom) can be dry or tough, in which case you might choose to discard them. Alternatively, keep them to make a flavoursome stock.

Preserving mushrooms – drying, freezing and pickling

Part of the pleasure of eating fungi is their limited seasonality. However, for those who cannot live without mushrooms between seasons, various possibilities exist for preserving them. Moreover, in some recipes, dried mushrooms are used in preference to fresh mushrooms because of their intensified flavour. Dried mushrooms added to fresh cultivated mushrooms such as button mushrooms give a richer and deeper flavour to a dish. Likewise, pickled mushrooms offer concentrated flavour and the distinctive seasoned character of pickling ingredients such as oils and vinegars.

Drying

Mushrooms are easy to dry and many are quick to rehydrate again for cooking. Only ever preserve good quality mushrooms that are unbruised and free of decay and inhabitants. You can dry them in various ways. For example, in many European countries, ceps are sliced and threaded on a string, then hung in front of a fire in great festoons. However, if you do not have a fire, or a piece of string, you can dry them by a sunny window or in an oven or dehydrator. With ceps and other fleshy mushrooms, slice them thinly into evenly sized pieces and place on a surface such a rack or tray lined with baking paper. Small mushrooms such as *Marasmius oreades* can be dried whole. Put them in an oven on low heat (65°C) for an hour, then turn them over and leave for another hour. Let them cool before checking that they are crispy dry. If not, return to the oven and periodically check for dryness. Completely dry mushrooms will snap rather than bend. A sunny windowsill free of flies or a dry and airy room work equally well, but will take longer, up to several days. Or you can dry them on the dashboard of your car, so long as you are not in the habit of hard cornering. Remember that you are *drying* them, not cooking them. Good circulation of air is more important than heat in the drying process.

Once thoroughly dried, store them in clean, dry, well sealing jars and label and date. They should last for a good 12 months. To rehydrate, soak them in warm water for at least 20 minutes. The left-over water makes good stock. You can also pulverise dried mushrooms and use them as stock powder.

Some mushrooms dry better than others and it is worth experimenting for yourself. From the fungi included in this book, *Agaricus, Boletus*, *Cantharellus*, *Lentinula*, *Morchella* and *Suillus* are generally suitable for drying.

Freezing

Some people freeze mushrooms raw with the hope of retaining texture. However, given their high water content, the freezing process usually robs some of the texture (firmness and bite), although the flavour is retained. One option to maximise texture is to cook them by either sautéing (frying), steaming, microwaving or blanching. Choose high quality, undamaged mushrooms. Young, small mushrooms can be sautéed whole and larger ones more than 3–4 cm in pileus diameter should be diced or sliced first. To sauté, heat mushrooms in a pan with oil or butter on high heat for 4 or 5 minutes until most of the liquid has evaporated. Allow to cool and then divide into portions and freeze in small airtight containers or bags. Make sure they are well sealed to prevent freezer burn. Label and date and use within six months.

Mushrooms can also be blanched before freezing, especially if they are destined for a soup recipe. To blanch mushrooms, place in a pot of boiling water (unsalted) for 1–2 minutes. Remove and drain in a colander, then plunge into cold water. Remove and once they are cool to touch and dry, place in container and freeze. Stephanie Alexander suggests this method especially for morels to reduce their fragility and bulk

Frozen mushrooms can be used in the same way as fresh mushrooms and added directly to most recipes without thawing.

Pickling

The pickling process preserves mushrooms and kills most bacteria by lowering the pH using acid (e.g. vinegar), or by anaerobic fermentation using brine. It basically involves removing water from the mushrooms, boiling them in vinegar to retain their appearance and texture, then submerging or ‘sealing’ them in oil. Pickled mushrooms make a delicious antipasto, side dish or can enhance a salad. Small, firm-fleshed mushrooms work best as they retain their shape and consistency. Herbs, garlic and black peppercorns make tasty additions if used sparingly to enhance rather than overwhelm the inherent mushroom flavour. Use small jars as they need to be consumed within a few days of opening.

To pickle mushrooms in their own juices:

- Clean and slice or keep whole if small.
- Bring a large pot of salted water to boil.

- Add juice of 2–3 lemons.
- Place in pot and boil for 2–3 minutes.
- Drain and pack tightly in sterilised jars.

To pickle mushrooms in oil:

- Clean and slice or keep whole if small.
- Sprinkle with salt and stand aside for 60 minutes, then pat dry.
- Heat oil in pan and fry mushrooms quickly to remove some of their liquid.
- Pack tightly in sterilised jars.
- Add your choice of peppercorns, herbs and garlic and cover with olive oil.

Also see the pickling recipe on p. 297.

Cooking mushrooms – frying, roasting and grilling

People are rarely indifferent to mushrooms. Many revere them while others are repulsed. Some claim they are slimy, textureless or tasteless, but this is usually because they are either not fresh or not prepared properly. Mushrooms are versatile but different mushrooms need particular treatment in the kitchen. Some combine well with other species and there are those best cooked on their own to retain their distinctive flavours and textures. Some are delicate in flavour and structure, others more robust. There are mushrooms that add flavour to a meal (e.g. ceps and truffles). Others need to be enhanced to bring out their flavours. For example, cultivated species such as button, oyster and shiitake mushrooms are mildly flavoured and it is the challenge of the cook to highlight their character. Some fungi, such as jelly fungi, add texture rather than flavour. Then there are those that are dramatically changed by the cooking process. For example, some mushrooms that are chewy when raw can become silky or meat-like in texture when cooked. A few tips for cooking mushrooms are outlined below.

Frying (sautéing)

A heavy-based pan is best for frying mushrooms to retain heat. Also use a pan with the largest possible surface area as you want every part of the mushroom to contact the pan so they can brown.

Basic steps for frying mushrooms:

- Slice mushrooms into a uniform size.
- Heat good quality butter or oil in a pan on high (Italian chef Antonio Carluccio recommended a mixture of both to prevent butter turning brown). A generous quantity will intensify the mushrooms' flavour.
- Add a single layer of mushrooms without overcrowding. If overcrowded they release too much water and are likely to steam instead of fry (steaming is more often the result of over-crowding rather than them having retained water by washing). Heat on high to sear rather than poach. Do not stir.
- Use your ears and listen to your mushrooms cooking. As moisture is released from the mushrooms and comes into contact with the fat, it sizzles and evaporates. Keep

Pseudohydnum gelatinosum (toothed jelly) being rinsed under running water.

Thinly sliced *Boletus edulis* (penny bun) drying on rack.

Lactarius deliciosus (saffron milkcap) pickling.

Sautéeing *Morchella* (morel).

the heat on high. As soon as the sizzling stops, watch carefully so that they brown nicely but do not burn, then flip and fry the other side.

- Remove from heat and season to taste. Be sparing. Do not obscure the flavour of the mushrooms by over-seasoning. You might like to deglaze with a good slosh of cognac, wine or sherry before removing from heat.

Roasting (baking)

While frying is a popular way to cook mushrooms, roasting brings out their natural sweetness and intensifies flavour. To roast:

- Preheat oven to 200°C.
- Place mushrooms in a shallow baking dish, brush lightly with oil and season to taste.
- Bake in oven for 20 minutes, stirring occasionally. Drain excess liquid if necessary and continue roasting until browned.
- If using fresh garlic or herbs, add once the mushrooms are ~80% cooked to save from scorching.

Grilling

Grilling is preferable for larger mushrooms like parasols, milkcaps, field mushrooms or cultivated portobello.

- Lightly brush with oil then season with salt and pepper.
- Grill ~10 cm from heat source for 5 minutes on each side, brushing with oil if necessary, to prevent them from drying out.

Nutritional value

The nutritional value of mushrooms is sometimes exaggerated. However, as British mycologist David Moore notes, 'fungi make a wholesome food, being nutritious with twice the protein of most fresh vegetables, a good source of fibre, and rich in minerals, essential amino acids and vitamins including B2, niacin and B12, few calories (26 in 100 g fresh weight) and little fat, and no cholesterol'. While mushrooms contain only limited amounts of vitamin B12, they are one of the few non-animal fresh food sources, making them ideal for vegans. They are also a source of other B complex vitamins including riboflavin and pantothenic acid and non-fortified vitamin D. Additionally, mushrooms provide minerals including iron, copper, selenium, potassium and phosphorus that are vital to body functions such as red blood cell production. Fresh mushrooms contain amino acids with antioxidant properties (*in vitro*) including glutathione and ergothioneine. Although these are also found in animals, plants and bacteria, fungi such as ceps and oysters contain the highest levels. Hence, in addition to their own flavours, mushrooms enhance the flavours of other foods with which they are cooked. While fungi provide these nutritional benefits, most people eat mushrooms simply to enjoy their tastes and textures.

Keep in mind that although fungi contain valuable health-giving compounds, they can also contain detrimental compounds absorbed directly from the environment, such as heavy metals and other toxins. Only collect from uncontaminated environments away from busy roads or areas where chemicals have been used such as parks, gardens and golf courses.

Recipe selection

The following recipes were contributed by people who forage for fungi in the field: chefs and cooks, farmers and gardeners and others including a mushroom-wielding diesel mechanic. The recipes form a medley that comes together through a shared passion for mushrooms, rather than a highly refined culinary selection. You might not be surprised that many contributors considered mushrooms were best simply cooked in butter and served on toast. And what better way to enjoy them than in the forest, straight from the pan on the fire. Hence, we include a recipe. At the other end of the spectrum, some contributors honoured the slow and considered approach of their forebears, spending hours preparing their fungal fare. Several recipes have been served for years in award-winning restaurants. We have edited them for consistency but have tried to retain contributors' individual voices and approaches. Some are well rehearsed, others more experimental and adventurous. On a technical note, all metric measures are Australian standard measures. Oven temperatures are for non-fan-forced ovens unless specified.

A reminder for chefs

Chefs cannot only awaken our palates to a new 'myco-cuisine' but can also advocate fungal conservation and reinforce sustainable foraging. As discussed in previous chapters, foraging is controversial and Australian foragers can guide the practice of foraging to minimise the environmental and social issues that have arisen elsewhere. The International Society for Fungal Conservation reminds journalists and chefs (especially celebrity chefs) that potential environmental and social impacts of foraging are likely to be magnified by any accompanying publicity. Mindful foraging is the basis of a safe and sustainable Australian approach.

Recipes

◀ Mixed mushrooms frying in the pan.

Mushroom pâté

Jan Waddington, Waddingtons at Kergunyah

This is something I have been making for probably 30 years. Our children loved it on toast or fresh chappatis when they came home from school. It's great on garlic croutes with a glass of wine or on crackers as part of a platter. I first started making it in autumn when we had an excess of field mushrooms in the paddocks and then when it became a family favourite, I often had to buy mushrooms to be able to make it at other times of the year.

6
SERVES
ENTREE / PLATTER

PREPARATION TIME
10
MINUTES

COOKING TIME
10
MINUTES

4 golden shallots or 2 small red onions, chopped
4 garlic cloves, chopped
2 tbsp olive oil
1 tbsp of butter
4 cups mushrooms (field mushrooms or Swiss browns), roughly chopped
1 tbsp thyme, chopped
2 tbsp red wine vinegar
salt and pepper to taste
1 tbsp Italian parsley, chopped
150 ml sour cream
extra melted butter for the top of the containers

Over medium heat, sauté shallots or onions and garlic in olive oil and butter until soft.

Add mushrooms, thyme and red wine vinegar, salt and pepper and cook on medium heat until mushrooms are soft.

Once mushrooms have absorbed liquid, place a lid over the container and turn heat to low. Cook an extra 10 minutes checking that the mushrooms are not drying out.

Cool slightly, then add to a food processor with parsley and sour cream and process until smooth. It does not need to be really smooth. Season to taste.

Place in smaller containers and pour over melted butter to seal the top.

This will keep for a week in a covered container in the fridge.

Serve at room temperature with croutes, crusty bread or crackers.

◄ Freshly foraged field mushrooms.

Spicy skewered mushrooms

Renee Ludekens, Pendower House

Mushrooms … what isn't there to love about them? As a vegetarian I adore mushrooms and this dish is a great starter or main, served with broccoli, flaked almonds and rice. Small wild-foraged field mushrooms are great as they hold their juiciness while being cooked. Commercially available button mushrooms work well too. Being on a skewer they are manageable as finger food and won't end up in your lap!

The heat from the chilies combined with the coconut cream makes them mini flavour explosions. A dish that can be made in advance is perfect for me, but if I run out of time for marinating, I throw them in the oven immediately and they are delicious. However, allowing them an hour or so to absorb the spices gives a richer flavour.

6
SERVES
AS A STARTER

PREPARATION AND COOKING TIME
45
MINUTES

MARINATING TIME
60
MINUTES
(OPTIONAL)

1–2 fresh red chillies (finger length ones), deseeded and finely chopped
4 small garlic cloves, finely chopped
salt
2 tbsp fresh ginger, peeled and finely grated
juice from ½ a medium lemon
3 tbsp Greek yoghurt
5 tbsp of coconut cream
1 tsp ground cinnamon
1 heaped tsp ground cumin
1 tsp ground coriander
1 tsp ground turmeric
1 heaped tsp sweet paprika
25 small field mushrooms or cultivated button mushrooms or Swiss browns
fresh coriander for garnish
skewers

Mix chillies and garlic together with pinch of salt in a bowl. Add ginger, lemon juice, yoghurt, coconut cream, cinnamon, cumin, coriander, turmeric and sweet paprika.

If the mixture seems a little lumpy, give it a quick blast with a stick blender. Pour the mixture into a rectangular baking dish.

Thread mushrooms onto skewers and place in baking dish, ensuring mushrooms are well coated with sauce. Cover and place in fridge to marinate for 1–2 hours.

Place each skewer containing mushrooms and coating under griller for 10 minutes and turn as they brown. Alternatively place in oven at 200°C and let cook for 15 minutes.

Sprinkle with chopped coriander leaves and serve immediately.

Here's a tip: put skewers in water before using them so they won't burn while under griller.

◄ Sizzling spicy skewered mushrooms straight out of the oven.

Wild mushroom soup

Gary Thomas, Spade to Blade Catering

Our foraged finds for this soup included saffron milkcaps, field mushrooms, blewits and slippery jacks. Echidna fungi, parasols, oysters or fairy ring mushrooms would also work well. A slippery jack or two popped in the stock gives this recipe a bit of extra body, as bones would do in a meat base.

6
SERVES

PREPARATION AND COOKING TIME
60
MINUTES

Stock

1 cup nasturtium leaves and flowers
1 large leek (green part)
1 cup slippery jacks, chopped
1 large apple
6 cups water

Soup

6 cups vegetable stock
100 g butter
100 ml olive oil
2 shallots, peeled and diced
1 cup leek, white part only, cleaned and sliced thinly
2 cups carrot, grated
1 kg wild mushrooms, sliced
pinch fresh mace
3 cups potato, peeled and chopped
1 cup parsley, chopped
1 tbsp sour cream or kefir cheese, to serve

To make vegetable stock: simmer together all ingredients for 30 minutes. Strain and retain liquid stock.

Melt butter with oil in a heavy-bottomed pot over a moderate flame. Add shallots, leek and carrot and sauté gently until soft.

Add mushrooms and mace. Mix well.

Add potato and reserved stock. Bring to the boil then simmer gently for 45 minutes. Puree.

Stir through parsley. Serve with a dollop of sour cream or kefir cheese.

◄ Wild mushroom soup.

Sundowner stuffed mushrooms with rocket and toasted pine nuts

Sally-Ann Hardy, forager

Auntie Lorraine introduced me to this delicious appetiser, or sundowner as she called it. It's dead easy and always a hit at any party or gathering – even among diehard meat eaters. Savoury and substantial, these little mouthfuls of deliciousness capture the unique earthiness of mushrooms. In this recipe I used Swiss browns, but you could easily substitute them with wild-picked field mushrooms or small young saffron milkcaps.

Try to find panko – Japanese fried breadcrumbs – as they lend a lovely texture to this dish. Serve warm, among good friends, with a nice bottle of plonk.

6
SERVES
AS A STARTER

PREPARATION TIME
20
MINUTES

COOKING TIME
20
MINUTES

splash of olive oil
small red onion, finely diced
3 cloves garlic, crushed
½ cup walnuts, toasted and finely chopped
3 medium-sized tomatoes, finely chopped
2 cups rocket, finely chopped (or spinach or kale)
⅓ cup breadcrumbs
½ cup parsley, finely chopped
1 tbsp balsamic vinegar
coarsely ground salt and black pepper
30 small Swiss brown mushrooms, cleaned with stems removed
2 tbsp pine nuts, toasted

Preheat oven to 180°C.

Heat oil in a frypan over medium heat, add onion and garlic and cook, stirring frequently for 6 or 7 minutes, until translucent and fragrant.

Reduce the heat to medium-low and add walnuts and tomatoes and sauté for another 4 or 5 minutes.

Add rocket, breadcrumbs and two thirds of the parsley. Stir to combine. Turn off the heat.

Add vinegar. Season with salt and pepper to taste.

Arrange mushrooms upside down on a lightly oiled baking tray. Fill each mushroom cavity with about a teaspoon of the filling, pressing down firmly. Sprinkle each mushroom with a few pine nuts.

Bake for 15–20 minutes, or until mushrooms are tender.

Remove from oven and allow to cool for 5 minutes. Garnish with remaining parsley. Serve warm.

◄ Stuffed mushrooms make an ideal appetiser.

Echidna fungus vol-au-vents

Alison Pouliot

This is a fun starter that takes me back to my childhood, when vol-au-vent sounded rather sophisticated to my young Australian ear. On the other hand, the French name for this mushroom *pied-de-mouton*, meaning sheep's foot, is more perplexing. Perhaps 'echidnas in holes' is a more apt Australian name for this recipe.

The spines on the underside of the echidna fungus (*Hydnum crocidens* group) give it a unique appearance and texture, less familiar in Australia than in Europe, where wood hedgehog mushrooms (*Hydnum repandum*) are readily available at produce markets. It has a reputation for its mild yet sweet, nutty flavour and firm, crunchy texture. The flavour is often likened to that of chanterelles, but to me they taste uniquely of echidna fungus. The trick with these mushrooms is to harvest them carefully to prevent dirt getting caught in the spines.

As another suggestion, try making a caramelised onion tart with these mushrooms. They pickle well too.

6
SERVES
AS A STARTER

PREPARATION TIME
20
MINUTES

COOKING TIME
5
MINUTES

- 2 tbsp butter
- 1 small brown onion, finely chopped
- 1 large garlic clove, finely chopped
- 2 tsp plain flour
- 300 g echidna fungi, brushed clean and chopped finely
- 1 cup cream
- black pepper freshly ground, to taste
- pinch of salt
- 24 small vol-au-vent pastry cases
- fresh thyme, chopped finely with a few sprigs kept aside as a garnish

Preheat oven to 180°C.

Melt butter in pan, sauté onion and garlic lightly without browning.

Add chopped mushrooms and gently stir for 4 or 5 minutes.

Slowly stir in flour continuously for a minute or two. Add cream and salt and pepper to taste.

Heat vol-au-vents in oven for a few minutes.

Remove vol-au-vents and fill with the warm mixture.

Garnish with fresh sprigs of thyme.

Serve immediately.

◄ Echidna fungus vol-au-vents with sprigs of fresh thyme.

Sunday mushroom omelette

Hazel Hamilton, wine maker

Apparently, the French invented the omelette, then the Brits went silly and made it too cheesy, but thankfully the Aussies nailed it!

Making omelettes is hugely satisfying. They are quick, easy to make and versatile in that you can swap fillings around to cater for different tastes. Mushroom omelettes are our favourite, especially for an autumn Sunday brunch on the verandah, as the vines are changing colour. All sorts of mushrooms work so long as they don't release too much water.

You can always elaborate on this simple recipe with extra herbs or nutmeg or whatever you like. Just don't overbeat the eggs, and don't cook it too long, or you'll be able to bounce it like a rubber ball.

2
SERVES

PREPARATION AND COOKING TIME
20
MINUTES

2 tbsp butter
1 shallot, minced
1 garlic clove, crushed
4 medium-sized field mushrooms, sliced (or a dozen small chanterelles left whole)
4 large free-range eggs, whisked a little (don't overdo it!)
⅔ cup grated Gruyère cheese
⅓ cup parsley, chopped
salt and pepper to taste

Heat a heavy based frying pan with butter until sizzling, then swirl around a bit to coat the bottom and sides.

Sauté shallot and garlic for 2–3 minutes.

Add mushrooms and cook gently for ~3–4 minutes.

Add eggs and cook on medium heat for 3–4 minutes. Stir in the middle vigorously for 5–10 seconds with a rubber spatula so it scrambles, but the edges stay intact.

Add cheese and cook on medium heat for 4–5 minutes, being careful not to burn the underside.

Ease gently around the edge of the omelettete with a spatula and fold in half. Cover pan with plate and remove from heat.

Let it stand for a minute before serving, then slide onto a warmed plate. Sprinkle with parsley and season with salt and pepper.

◄ Omelette with field mushrooms and chanterelles.

Tarte mit Schopftintlingen (Inkcap tartelettes)

Barbara Thüler, mushroom inspector

Inkcap is an apt vernacular name for this mushroom. Fortunately, it also has a life before it lives up to its inky name. However, it is just a short one, so don't dally in preparing this mushroom. In just a day or so, its blossom-white gills turn pink, then grey, then finally strangely black. What was once a mushroom rapidly turns itself inside out into an unsightly mush. However, if it turns to ink before you can cook it, then use the ink to write yourself a reminder as to where to find it next time!

This dish is perfect either as an appetiser or together with salad as a main course. Other soft-textured fungi can be substituted, but inkcaps have a particularly delicate flavour.

4
SERVES
AS A STARTER

PREPARATION AND COOKING TIME
45
MINUTES

250 g small inkcaps, stems removed
2 tbsp butter
2 spring onions, finely chopped
3 cloves garlic, finely chopped
3 tbsp of cognac
500 g thin shortcrust pastry (either commercial pastry or make your own)
1 handful of pitted black olives, cut into fine wheels
small bunch of parsley, chopped finely
250 ml crème fraîche
250 g of small cherry tomatoes, halved
salt and black pepper

Pre-heat oven to 220°C.

Cut inkcaps into pieces (about four pieces per mushroom) and set aside.

Heat butter in a large frying pan. Gently sauté spring onions and garlic until translucent.

Add mushrooms and sauté vigorously for a minute or two. Deglaze with cognac and allow liquid to evaporate a little. Set aside.

To make tartelette shells: use a small bowl or cookie cutter to cut out circles from the dough. Moisten the edges of the dough with a little water and fold it at regular intervals with two fingers so that the edges are raised.

To finish the filling: fold olives and parsley into mushroom mixture together with crème fraîche.

Spread a thin layer of the mixture into the dough circles. Put cherry tomatoes on top. Season with salt and pepper.

Bake in oven on the second lowest rung for 15–18 minutes, until golden brown.

Remove and allow to cool slightly before serving.

◄ Lawyer's wigs (an inkcap) with stipes removed, ready for cooking.

Pizza with porcini, goat cheese and burnt butter sage

Valérie Chételat, photographer and outdoor guide

Italian cuisine has always been my favourite, especially porcini risotto and pizza. Although the classic pizza is based around tomatoes and mozzarella, Aussies tend to break custom and whack anything on top! In reality, this recipe is probably much more adventurously Australian than traditionally Italian.

While porcini have a particular flavour, other types of boletes such as young slippery jacks could also be substituted. Or you could also use commercial mushrooms such as Swiss browns.

Porcini are robust and keep several days in the fridge but get them on that pizza as soon as they're picked to experience their superb flavour at its best.

2
SERVES

DOUGH PREPARATION TIME
10
MINUTES

DOUGH RISING TIME
1-2
HOURS

CHOPPING INGREDIENTS AND ASSEMBLY TIME
15
MINUTES

COOKING TIME
15-20
MINUTES

Pizza dough

300 g of sieved white (bakers) plain flour (for a lighter textured pizza base, use Italian Tipo '00' flour).
15 g fresh yeast
a good pinch of salt
25 ml extra virgin olive oil
250 ml lukewarm water
(alternatively, use a pre-made pizza base)

Topping

extra virgin olive oil
2 cloves garlic, chopped finely
2 medium-sized freshly foraged porcini, cleaned and sliced finely (2–3 mm)
3 tbsp butter
20 leaves fresh sage
100 g mild goat cheese (or sheep or cow cheese if you prefer)
freshly ground black pepper

If you've got an adobe wood fired oven fire it up well ahead of time, otherwise preheat oven to 200°C.

To make pizza dough: mix together flour, yeast and salt in a large bowl and make a well in the middle. Combine olive oil and water and gradually mix into the dry ingredients with a fork to form a soft sticky dough. As it starts to come together, use your flour-dusted hands to work in the remainder of the flour.

Turn dough onto a floured surface and knead for 7–8 minutes until smooth and elastic. Transfer to a clean floured bowl, cover with a damp tea-towel and leave to rise for 1–2 hours in a warm place, until dough has doubled in size.

To prepare topping: fry garlic in hot oil (leaving half a tbsp to brush dough) without browning. Add ceps carefully so as to retain whole pieces and sauté for 3–4 minutes.

Melt butter in a heavy-bottomed frypan over medium-high heat. Once melted, add sage leaves, gently stir until they become crisp, being careful not to burn them. Remove pan from heat and set aside.

Cut goat cheese into pieces about the same size as the ceps.

To assemble: roll out dough on a piece of floured parchment, kneading a little bit more to push out any air. Brush with olive oil and top with mushrooms, garlic and cheese and cook in oven for 10–12 minutes or until dough is golden brown and the cheese has melted a little. Remove from oven, top with fried sage leaves and drizzle with a little of brown butter. Season with pepper and serve immediately.

◄ This recipe is supposed to serve two … if you're prepared to share!

Barbecued saffron milkcaps with olive oil, lemon and herbs

Fofi Christou, Fofi's Feasts

The saffron milkcap is one of my favourite wild mushrooms due to its firm and meaty texture but also because it holds for me fond childhood memories.

Growing up in a Greek Cypriot family in the Western Suburbs of Melbourne, mushroom hunting was a treat to look forward to every autumn. We would leave early in the morning with the extended family to beat the crowds of other Greeks and Italians, to forage for pine mushrooms in the mountain ranges on the outskirts of western Melbourne.

My memories are as vivid as ever of my dad and uncles lighting a fire, placing their portable grill pad over it with a layer of pine mushrooms, drizzling olive oil, seasoning them with salt and pepper and finishing them off with a generous squeeze of lemon. I can still

smell the earthy aroma and taste that smoky flavour of those delicious barbequed mushrooms dancing in a pool of that age-old Greek olive oil and lemon juice elixir.

My family brought this mushroom foraging tradition from the island of Cyprus, where saffron milkcaps are found in abundance in the pine forests. These mushrooms are highly esteemed among local delicacies and are usually cooked on charcoal, marinated with olive oil and lemon or bitter orange or fried with onions and red wine. This recipe also works well with field mushrooms or cultivated portobello mushrooms.

6
SERVES

PREPARATION TIME
10
MINUTES

GRILLING TIME
20
MINUTES
(DEPENDING ON MUSHROOM SIZE)

6 large (or 12–15 small) saffron milkcaps, cleaned and stems removed
⅓ cup olive oil
sea salt (a pinch or so for each mushroom)
6 sprigs thyme
1 garlic clove, minced (optional)
ground pepper
juice of 1 lemon (2 tbsp)
⅓ cup flat leaf parsley (finely chopped)

Light a fire with charcoal or wood. Wait until fire has subsided and hot red coals remain. Place a grill over the fire. Alternatively fire up the barbeque or heat a lightly greased cast iron grill. You can also use a barbeque or grill on the stove rather than an open fire.

Brush mushroom gills lightly with some of the olive oil and place on hot grill with gills facing downwards, for ~10 minutes until slightly charred. While mushrooms are cooking also brush their upper sides lightly with oil.

Once gills are slightly charred, turn mushrooms over and sprinkle with sea salt and a sprig of thyme, and garlic if desired. Cook for a further 10–15 minutes or until mushrooms accumulate their juices in the cap.

Drizzle mushrooms with olive oil and lemon juice in that order, leave for a few minutes to warm and then remove from the grill and put onto a platter.

Finishing off by drizzling a little more olive oil and lemon juice and sprinkle freshly chopped parsley.

◀ Mushroom juices accumulating nicely in grilling saffron milkcaps.

Wood ear and sesame salad

Jan Waddington, Waddingtons at Kergunyah

I discovered this salad while travelling in Yunnan, China. It seemed to be popular in country areas where there was an abundance of fresh wood ear fungus being collected in the forest. I also saw it being prepared in Hong Kong from dried wood ears. It is delicious served as a side salad to other dishes. Ours was served with crispy deep-fried fish, fermented tofu and corn and water spinach with ginger and garlic. The white brain (*Tremella fuciformis*) would probably also work well in this recipe.

6
SERVES
AS A SIDE DISH

PREPARATION TIME
10
MINUTES

COOKING TIME
15
MINUTES

4 cups of fresh (or rehydrated) wood ear fungus
4 cloves garlic, finely chopped
1 large red chilli (remove seeds if you do not like it too hot), finely chopped
1 continental cucumber, seeds removed and sliced
1 large red capsicum, chopped
3 tbsp spring onion, chopped
2 tbsp coriander, chopped
2 tbsp black vinegar
1 tbsp light soy sauce
1 heaped tsp sugar
2 tsp sesame oil
1 tbsp sesame seeds, freshly roasted
salt and white pepper to taste

Cook fungus in boiling salted water for 4 minutes.

Rinse with cold water and place in a colander or salad spinner to drain well.

Mix all ingredients except roasted sesame seeds and fungus together and stir until sugar is dissolved.

Add fungus and toss together.

Refrigerate for at least 30 minutes before serving.

Scatter toasted sesame seeds over the top before serving.

◄ Wood ears lend a wonderful crunchy texture to this salad.

Roasted kipfler spuds with oyster mushrooms and rosemary

Reg Kennedy, farmer

Kipfler potatoes are succulent, almost nutty and have a creamy texture. Because of their high starch content, they don't fall apart. They're perfect in combination with oyster mushrooms. Oyster mushrooms have a subtle but delicate flavour. They are easy to grow and are therefore cultivated all over the world. They also look beautiful. I grew my own, but you can find them in farmers' markets and most supermarkets these days. You could also use wild mushrooms if you know what you're picking. This dish also makes a nice side with a roast.

6
SERVES

PREPARATION TIME
15
MINUTES

COOKING TIME
25
MINUTES

500 g organic kipfler potatoes (or other small new season fingerling potatoes)
2 tbsp virgin olive oil
salt, to taste
a couple of sprigs of rosemary, finely chop some and leave the rest whole
2 tbsp salted butter
2 garlic cloves, finely chopped
300 g oyster mushrooms (4 cups), trimmed to remove any tough stems
black pepper, freshly cracked

Preheat oven to 180°C.

Wash and pat dry potatoes. Put in large roasting pan and drizzle with half the olive oil. Sprinkle with salt and some rosemary. Shake the pan a little to coat potatoes. Place in oven and roast for 20–25 minutes.

Heat butter and remaining oil in a large frying pan on medium heat. Add garlic and sauté for 30 seconds, then add mushrooms along with a generous pinch of salt. Sauté on medium-high heat for a further 3–4 minutes, gently stirring, until mushrooms are lightly browned and tender to the bite.

Remove potatoes from oven and add mushrooms. Gently stir to mix mushrooms with potatoes. Return to oven and bake for 10 minutes. Stir and continue baking until potatoes are browned, soft and tender.

Season with pepper and add whole sprigs of rosemary as a garnish.

Remove from oven and let stand for a couple of minutes before serving.

◄ Roasted kipfler spuds with oyster mushrooms and rosemary.

Drover's egg and mushroom pie

Pete Munro, diesel mechanic

The old boy spent most of his life in the saddle, droving big mobs of cattle along the Murray–Darling. Sometimes as a little tacker he'd let me go with him. At night he'd cook up his egg and mushroom pie in a camp oven. I've no idea where he got the mushies from. Or the eggs. It was like he pulled 'em out of the air or something. He didn't use a recipe or nothin' so I'm guessin' a bit. I cook up his pie sometimes with field mushies that grow in the paddocks, down along the creek, on our property. I've added the parsley, but he would've said I was getting a bit too fancy.

2
SERVES
(OR ONE HUNGRY DROVER)

PREPARATION TIME
20
MINUTES

COOKING TIME
30
MINUTES

3 large eggs, beaten
1 ½ cups milk
½ cup self-raising flour
3 large field mushrooms, sliced
½ cup grated tasty cheese
1 large brown onion, finely diced
salt and pepper to taste
oil or butter for greasing the pie dish
½ cup fresh parsley, chopped

First dig a hole and build a fire in it ahead of time. Allow fire to die back to form a good coal bed. You'll probably need to open a cold beer to help pass the time.

Beat eggs and combine with milk and flour. Mix well.

Add mushrooms, cheese and onion and stir through. Season with salt and pepper.

Pour mixture into a greased pie dish. Place dish on a trivet inside camp oven. Then place camp oven in the hole with coals underneath. Pile coals up around the sides and some on the lid, so that it cooks evenly.

Depending on the heat of the coals, it will take between 20–30 minutes to cook. Remove when 'set' and golden brown. Throw parsley on top. You can also cook it in the oven and save muckin' around (bake at 170°C for 30 minutes).

◄ Drover's egg and mushroom pie.

Caramelised wood hedgehogs with aubergine on lemon risotto

Barbara Thüler, mushroom inspector

Mushrooming in Australia is different to that in my home country of Switzerland, where long traditions are passed between generations. My parents were raised during the Second World War and wild mushrooms were a staple 'meat substitute' for less affluent families. The collective gathering, then the feasting on the bounty – which always tasted different depending on which fungi we found – is an unforgettable childhood memory.

The wood hedgehog is a favourite. In German language we call it Semmelstoppelpilz; 'stoppel' meaning 'stubble', referring to the spines on the underside. When rubbed, the spines break off, making it easy to identify. As children, we were allowed to forage alone for this species.

Wild mushrooms provide unique and delicate flavours in today's kitchen. In this recipe, the caramelising gives the mushrooms a full and round taste (and removes bitterness from any older mushrooms). Although I am a mushroom inspector in Switzerland, the edibility of Australian fungi is little known. I am taking my time and starting with just a few edible species. This recipe is for the European wood hedgehog but also works with the Australian echidna fungus.

4
SERVES

PREPARATION AND COOKING TIME
40
MINUTES

1 aubergine (eggplant), cut into small cubes (1 cm × 1 cm)
1 tbsp salt
7 tbsp olive oil
200 g risotto rice (e.g. Arborio)
1 small onion, chopped
2 cloves garlic, chopped
200 ml white wine
500 ml vegetable stock
12 small cherry tomatoes
1 tbsp butter for frying
1 tbsp sugar
300–400 g young wood hedgehog fungi
2 tbsp of Mascarpone cheese
40 g cup Parmesan cheese, grated
juice and zest from half an organic lemon
handful of fresh basil leaves
black pepper

Sprinkle aubergine cubes with salt and stand aside for 20 minutes while preparing the rest of the recipe.

Heat 3 tbsp oil on high, add rice and sauté until it has a glassy appearance. Add chopped onion and garlic. Deglaze with white wine. Add vegetable stock a ladleful at a time, stirring constantly. Cook until al dente.

Pat aubergine cubes dry with a tea towel, then sauté in 4 tbsp hot olive oil until they brown a little and become soft (~10 minutes). Add cherry tomatoes, season with pepper and keep warm.

To caramelise wood hedgehogs: heat butter in a frying pan, add sugar and allow to lightly caramelise, stirring to avoid burning. Add wood hedgehogs and sauté for ~10 minutes.

Add cooked rice mix, Mascarpone, Parmesan, lemon zest and juice and fold in gently. Season to taste. Arrange slightly liquid risotto on a plate surrounded by aubergine cubes. Garnish with basil. Place mushrooms and cherry tomatoes on top and serve.

◀ Wood hedgehogs being prepared for the pan.

Setas con Oloroso (Mushrooms in sherry)

Richard Cornish, food writer

I was working on the Movida Solera book with Frank Camorra from Movida. We were in Restaurante Las Camaches on the old Cordoba-Malaga highway in the wine-producing town of Montilla, famous for its oloroso and Pedro Ximenez. Deep in the heart of this labyrinthine dining establishment is one of the original rooms, one wall lined with bottles, the other with barrels. Here we were served this dish with several of these wines (they are similar to sherry but cannot be called that as they are not made in the Sherry region of Spain). These wines are made with a lot of yeast contact and when the yeast dies it releases its amino acids which add mouthfeel to the wines. These amino acids also stimulate the tastebuds that sense deliciousness. Mushrooms are full of similar amino acids hence their deliciousness. When you add the two together it compounds that sense (the Japanese call it umami). Mushrooms form a large part of the Spanish diet and while this dish calls for oyster mushrooms feel free to substitute any edible fungi you have at hand.

4
SERVES

PREPARATION TIME
20
MINUTES

COOKING TIME
15
MINUTES

500 g (8 cups) oyster mushrooms
3 rashers streaky bacon
70 g (5 tbsp) butter
2 cloves garlic, quartered
sea salt to taste
cracked black pepper
70 ml (⅓ cup) Oloroso sherry
1 tbsp parsley, chopped

Tear some of the larger mushrooms in half with your hands.

Slice bacon into lardoons (strips), ~1 cm × 2.5 cm.

In a large frying pan, melt butter over medium heat and add bacon and garlic. Cook for a few minutes until lightly browned.

Increase heat to medium high and add mushrooms. Season with salt and pepper. Cook for 5–6 minutes or until mushrooms are lightly browned.

Deglaze pan with Oloroso sherry, then turn up heat to high and let sherry sizzle away until it evaporates.

Sprinkle with parsley and serve.

◄ Oyster mushrooms.

Forest cooked mushrooms on sourdough bread

Florian Hofinger, Mt Franklin Organics

Mushrooms have wonderful flavours and the best way to bring them out is to keep the recipe simple. This is a favourite recipe from my childhood days in the Austrian Alps. As a kid I'd go mushrooming with my dad and brother. We'd collect chanterelles, make a fire in the forest and eat them right there with big hunks of sourdough bread. In Australia, chanterelles are harder to come by, but other wild mushrooms such as saffron milk caps or field mushrooms work well too.

Of course, they taste much better eaten in the forest.

2
SERVES

PREPARATION AND COOKING TIME
20
MINUTES

100 g butter
1 clove garlic, chopped
300 g wild mushrooms, cleaned and chopped or left whole if small
parsley, roughly chopped
salt and pepper
½ cup dry white wine
big loaf of sourdough bread

Make a little fire. Once you've got a good coal bed, put frypan on top.

When hot, add butter and chopped garlic. Stir so it doesn't brown. Cook for a few minutes.

Throw in mushrooms and parsley. Cook for 5 or 6 minutes, until they are soft. You need to test them as it is hard to estimate an exact time as it depends on the heat of your fire.

Season to taste with pepper and salt and a good splash of white wine. Reduce a little.

Use thick slices of bread to scoop out mushrooms and mop up juices. And don't waste the rest of the wine! Drink the remainder to wash them down.

◀ Mushrooms on the fire.

Parasol mushroom parmigiana

Fofi Christou, Fofi's Feasts

Although I have had the European parasol mushroom in Italy and have cooked it myself many times with friends and family with the addition of lemon rind, polenta, almond meal and some garnishes, the origin of this recipe can only be credited to Antonio Carluccio.

The parasol mushroom can grow so large that one cap can feed two or three people as an entrée or be a meal in itself for one. In Carluccio's words, 'The cap and the thick but tender gills underneath form a round, flat and substantial whole, just asking to be dipped in beaten egg and breadcrumbs, then shallow fried until golden. The finished result – an Italian idea – looks like an omelettete and can easily cover your plate.'

Parasol mushrooms are keenly sought-after in Europe because they are readily recognisable, common and versatile in the kitchen. Different cultures have their own preparation techniques but sautéing them in butter is a popular favourite. The Australian parasol doesn't grow as big but also tastes fantastic. Large flat field mushrooms could be used as a substitute but the flavour won't be as delicate as the parasol.

4
SERVES
(MAIN)

PREPARATION AND COOKING TIME
30
MINUTES

4 parasol mushroom caps, each ~15 cm in diameter, cleaned
3 eggs
4 tbsp parsley, finely chopped (3 tbsp for breadcrumb mixture and 1 tbsp for garnish)
4 tbsp Parmesan cheese, freshly grated
sea salt and pepper to taste
½ cup of fresh white breadcrumbs
½ cup coarse polenta
¼ cup of almond meal
zest of 1 lemon
a mix of olive oil and rice bran oil (or other neutral oil, e.g. vegetable oil) for shallow frying
4 tbsp crème fraîche
2 tbsp of pomegranate seeds
a few parsley sprigs or 12 mint leaves

Beat eggs and mix in 3 tbsp of parsley, Parmesan and some salt and pepper. Set aside.

Combine breadcrumbs, polenta, almond meal, zest and a pinch of salt and pepper in a shallow but wide bowl.

Dip parasol caps in egg mixture first and then into breadcrumb mixture, making sure the whole of the cap is covered. Place on a plate lined with non-stick paper. Chill to allow the coating to 'set'.

Heat oil and gently immerse mushrooms, one at a time. Fry each cap over a moderate heat until golden on both sides.

Drain on absorbent paper, then transfer to plates. Add a dollop of crème fraîche and sprinkle with pomegranate seeds and parsley or mint leaves.

◀ A young parasol pileus sits atop parasol mushroom parmigiana.

Blewit and duck gizzard ragoût

Simon Rickard, gardener

Blewits' floral-dried apricot aroma stands up surprisingly well to the stronger flavours in this dish. The silky-meaty texture of the blewits contrasts with the slightly crunchy texture of gizzards.

Blewits are in season at the same time of year I slaughter my ducks. I invented this recipe as a response to having these two rather exotic ingredients on hand and being a little afraid to try either of them. By mincing them both finely until they were indistinguishable from one another, I thought I could trick myself into eating them. As luck would have it, each maintained its identity within the ragout, and both turned out to be absolutely delicious. I now eagerly await the few short weeks of the year when I can make this dish for myself.

Birds do not have a stomach in the way mammals do. They have a muscular organ called a 'gizzard', in their body cavity, used for grinding up their food. Because gizzards are muscle meat rather than organ tissue, they are a great gateway to approaching offal for the first time. Although duck gizzards are unfamiliar in Anglo culture, they are staples of French and Chinese cuisine. Every French supermarket sells them vacuum packed, for making the classic salade de gésiers de canard confits. If you think you don't like gizzards, try making this dish!

Any silky-textured mushroom can work well in this dish, although you will miss out on the unique, fruity flavour of the blewit. Young field mushrooms would work adequately, crunchy saffron milkcaps less so.

2
SERVES
(MAIN)

PREPARATION AND COOKING TIME
20-25
MINUTES

10–12 blewits (~8 cm diameter)
4 duck gizzards or 6 chicken gizzards
4 cloves garlic, chopped
2 sprigs fresh thyme
¼ cup dry sherry
2 tbsp extra virgin olive oil
salt and pepper to taste
½ cup flatleaf parsley, chopped

Brush mushrooms to clean them, discard stipes. Mince mushrooms as finely as possible.

Remove and discard membranes from gizzards. Mince gizzards as finely as possible.

Heat oil in a frypan, fry garlic for a few seconds.

Add mushrooms and thyme. Fry for 5 minutes until mushrooms are cooked through.

Add gizzards and fry until cooked and liquid has evaporated.

Add sherry, bring to boil and reduce liquid.

Season with salt and pepper.

Stir through flatleaf parsley and turn off heat. Serve with a drizzle of fresh olive oil on pasta or buttered toast.

◄ Blewit and duck gizzard ragout ready to eat.

Mushroom tortellini with garlic, sage and lemon butter sauce

Marina Pribaz, artist and cook

This dish pays homage to my Italian heritage – in particular to my mamma's delicious slow Sunday lunches that were made with such love and attention. Pasta is one of my favourite foods and tortellini – little morsels of deliciousness encased in pasta – is my favourite. This recipe can be made with commercial or wild mushrooms. It is a little involved but making pasta from scratch is such a pleasurable relaxing activity.

6-8
SERVES

PREPARATION AND COOKING TIME
3
HOURS

Pasta

400 g 00 flour (bakers or hard flour), sifted
4 eggs, beaten
1 tbsp olive oil
pinch of salt

Filling

70 g unsalted butter
1 tbsp olive oil
1 red onion (2 cups), diced
1 long red chilli, finely chopped
1 tbsp fresh marjoram leaves, finely chopped
400 g Swiss brown mushrooms, finely chopped
100 g king oyster mushrooms, finely chopped
50 g enokitake mushrooms, finely chopped
12 fairy ring mushrooms, stems removed
1 tbsp preserved lemon, finely chopped
50 g parmigiano reggiano cheese, finely grated
90 g soft goat cheese
2 tbsp almond meal
2 tbsp panko breadcrumbs
½ cup Italian flat parsley leaves

Garlic lemon sauce

180 g unsalted butter
4–6 large garlic cloves, thickly sliced in 5–7 slices each
2 cups sage leaves
lemon zest from one lemon
½ cup fresh lemon juice
salt and pepper
1 cup fresh Italian parsley leaves, to garnish (optional)

To make pasta: process flour, eggs, oil and salt in food processor until it comes together in a ball. Lightly knead with a sprinkle of flour and pop in cling wrap and set aside at room temperature for at least an hour.

To make filling: melt butter and oil in a heavy base frying pan. Add onion and chilli and sauté gently for 5 minutes.

Add marjoram leaves and mushrooms. Cook until mushrooms start to brown and some of the liquid from the mushrooms evaporates. Add lemon, cheeses, almond meal and breadcrumbs. Cook for a few minutes. Add parsley. Set aside to cool. Process mixture in food processor until finely processed (just a few seconds).

To assemble and cook tortellini: use a pasta machine at the finest setting to roll out pasta dough a little at a time. Place the first sheet of pasta on a wooden breadboard and cut circles with a cookie cutter. Fill one half of pasta disc with ½ teaspoon of filling. Brush edges of disc with water, fold in half, seal edges together and wrap the two ends around your finger to create a tortellini shape. Place the tortellini on a floured tea towel and continue until all the tortellini are made.

Boil a large quantity of water in a large saucepan. Add large pinch of salt. Drop tortellini in boiling water 10–15 at a time. Wait till they float to the surface (ca 3–4 minutes). Scoop out with a round slotted spoon and place in a bowl. Add a bit of oil or butter to stop tortellini from sticking to each other. Continue until all the tortellini are cooked.

To make sauce: melt butter with garlic in frypan over gentle heat for 5 minutes. Add sage leaves. Sauté over gentle heat for 5 minutes until sage leaves turn a darker green and start to crisp. Add the lemon zest and lemon juice. Add salt and pepper to taste. Heat through. Add tortellini to sauce and toss through. Serve with parsley if desired.

◄ Freshly made mushroom tortellini ready for the pot.

Sri Lankan mushroom curry

Indeera Wimalasuriya

In my motherland of Sri Lanka, mushrooms are commonly referred to as *hathu* or *bimmal*; *bim* meaning the earth and *mal* meaning flower in the Sinhalese language. As a child, I accompanied my father on his early morning walks in my hometown Galle. We would pick *hathu* on our way home and my mother then prepared a delicious *hathu* curry. We always enjoyed this hearty dish with freshly baked bread from our local bakery for breakfast before heading off to school.

Hathu has special meaning to me and my family, and I seem to have passed my love for them to my own children. This curry is great served on rice with a papadam on the side and a fresh green salad.

4
SERVES

PREPARATION TIME
1
HOUR

COOKING TIME
30
MINUTES

3 tsp coriander seeds
2 tsp cumin seeds
2 tbsp rice bran oil
2 sprigs fresh Sri Lankan curry leaves (*karapincha*)
1 large brown onion, chopped
3 cm long piece of fresh ginger, crushed in mortar and pestle
6 garlic cloves, sliced finely
½ tsp turmeric powder
2 tsp dried chilli flakes, or to taste
3 large fresh shiitake, coarsely chopped
50 g king oyster (1 cup), coarsely chopped
50 g oyster mushroom (1 cup), coarsely chopped
200 g enokitake (4 cups)
1 tsp salt (or adjust to taste)
100 ml coconut milk (½ cup)
200 g button mushrooms (4 cups)
10 small wood ears
4 small red fresh chillis, sliced (or adjust to taste)
2 medium green chillis, sliced (or adjust to taste)

In a small frying pan, dry roast coriander seeds on low heat for 1 minute until light brown, making sure not to burn. Turn heat off. Add cumin seeds. Stir. Transfer to mortar and pestle and crush into powder.

In a wok, heat oil and add curry leaves. Stir for 10 seconds, then add onions, stir and allow to brown (3–4 minutes).

Add ginger, stirring for 2 minutes. Add garlic, stirring for 2 minutes. Add turmeric, stirring for 1 minute. Add cumin and coriander mix to wok along with chilli flakes.

Add shiitake, king oyster, oyster and enokitake and stir to cook for ~3–4 minutes or until mushrooms are soft.

Add salt and coconut milk. Mix through for 1 minute. Add button mushrooms, wood ears, red and green chillis. Toss through quickly, no more than a minute. Turn off heat.

Serve on basmati rice with green salad and a papadam on the side.

◀ This vegan mushroom curry incorporates a variety of wild and farmed mushrooms.

Pasticcio di funghi ovali (Mushroom bread and butter pudding)

Bernadette Hince, gardener and cook

The cultivated portobello was used in this recipe. A variety of wild-foraged mushrooms could be substituted, especially firm-fleshed ones such as blewits or saffron milkcaps.

This recipe comes from one of 11 or 12 ring-binder folders on my cooking bookshelves. Since I was a teenager, I have been collecting recipes and pasting them into these books. Once, the recipe clippings were sparsely glued in, and I used to tear them out if I cooked one and was not impressed with the result. If that happens now, I find it more satisfying to write detailed disgusted comments on the pages instead.

I can look at many of the individual recipes in these folders and remember where they came from, but with my handwritten pasticcio recipe, I have no idea. All I know is that this dish was part of a substantial family meal of Italian food celebrating my mother's birthday 30 years ago.

6
SERVES

PREPARATION TIME
45
MINUTES

BAKING TIME
1½
HOURS

2 tbsp butter
1 tbsp olive oil
2 cloves garlic, chopped
1 kg mushrooms, sliced
4 eggs, beaten
1 cup grated Parmesan
¼ cup chopped parsley
salt and pepper
1 ½–2 cups chicken or vegetable stock
good wholemeal bread, crusts cut off, thickly sliced and generously buttered (day old bread works well)
a ceramic or ovenproof pudding bowl (that holds ~8 cups)

Fry garlic slowly in butter and oil until fragrant. Add mushrooms and fry on medium to high heat for ~10 minutes or until they are cooked through.

Remove from heat and cool for 10 minutes before adding eggs, Parmesan and parsley. Season well with salt and pepper.

Line an ovenproof pudding basin (or an oval dish – hence *ovali*) carefully with bread, buttered side out, so that the slices stick to the dish. Arrange slices to make as good a fit as possible, a sort of inverted igloo-shell of bread so that it all fits together well.

Pour in half of the mushroom mix. Put one thickness of buttered bread on top of the mushroom layer, and repeat with remaining mushroom mix and bread, ending with a layer where the bread is buttered side up. Any bread scraps can be used to form the 'lid' of the bowl.

Pour the stock gently over the top of the dish and let it stand for 30 minutes, so that the bread absorbs some of the liquid. Bake at 180°C for ~90 minutes, until it is golden brown and puffed up. It will not be spoilt by sitting it in the turned off oven for up to half an hour.

Serve straight from the dish, with a green salad. If you are feeling brave and the pudding seems sufficiently unified, you can turn it out onto a deep dish. It looks comforting. For extra pizzazz, you could try putting a few bay leaves at the base under the bread before you cook it.

◄ This flavoursome dish is comforting in both appearance and flavour.

Oven roasted shiitake and prawns

Duc Nguyen, pop-up restaurateur

Shiitake is both food and medicine in Asia. It has been cultivated for thousands of years. This healthy and delicious dish cooks in one roasting pan, which means less washing-up afterwards. To speed it up even more, buy prawns that are already deveined. Aussie prawns are the best in the world. I like fresh shiitake, but you can also use dried ones soaked in hot water for half an hour. Cook it fast but eat it slow; with your grandmother. It's good served with fresh green Asian salad.

2
SERVES

PREPARATION AND COOKING TIME
30
MINUTES

250 g uncooked prawns
3 tbsp canola oil
12 fresh chives, finely chopped
3 tbsp fresh coriander, finely chopped
¼ large red chilli, finely chopped
2 garlic cloves, finely chopped
1 tbsp rice vinegar
1 tsp dark brown sugar
3 tsp fresh ginger, grated
pinch of sea salt
1 tsp sesame oil
2 tbsp sesame seeds
150 g fresh shiitake mushrooms

Preheat oven to 200°C.

Peel and de-vein prawns (if not bought peeled/de-veined) and set aside.

Combine all other ingredients except mushrooms in a bowl.

Place the baking sheet on a large baking tray. Place mushrooms upside down on baking sheet. Spoon some mixture on top of each mushroom. Place tray on the top shelf of the oven.

Bake for 7–8 minutes, then strew prawns in among mushrooms. Bake for a further 3–4 minutes until prawns turn pink.

Remove from oven and serve immediately.

◄ Eat this dish with your grandmother!

Parmentier de canard aux Marasmes d'Oréades (Duck parmentier with fairy ring mushrooms)

Brett Foulis, landscape designer

While on exchange in France as a teenager, my host family introduced me to mushrooming in the fields and oak forests near their home. Fairy ring mushrooms (*marasmes des Oréades* in French) or *girolles* (chanterelles) were the most sought after and usually quickly fried in the pan with a knob of butter and crushed garlic and served with hunks of fresh baguette and butter.

***Confit de canard* is duck meat cooked and preserved in duck fat, usually canned. It's a rich and hearty treat often brought out for mid-winter dinners or quick après ski nosh-ups pulled from the chalet larder. The delicate texture and flavour of the fairy ring mushrooms works beautifully with this comfort food combination of pureed potato and slow cooked duck. Some of the duck fat which is melted off in the reheating of the preserved meat is kept and used to fry the mushrooms, adding intensity to the flavour. The celeriac cooked in with the potato helps to lighten the texture of the potato puree and add a nutty flavour.**

Australians seem to have overlooked this mushroom, perhaps because it's small and indistinct, but don't be fooled by its appearance as it has superb flavour.

4
SERVES

PREPARATION AND COOKING TIME
60
MINUTES

400 g potatoes, peeled
400 g celeriac, cut into large cubes
crème fraîche
50 g butter
ground nutmeg
200 g fairy ring mushrooms, stipes removed
4 preserved duck leg and thighs
salt and pepper
flat Italian parsley, chopped

Steam whole potatoes with celeriac for 20 minutes until tender.

Mash vegetables using a mouli, whisk or masher. Add crème fraîche and butter in small cubes. Season with salt and nutmeg. Keep warm.

In a pan, heat preserved duck legs on medium heat. Once heated, remove from the stove. Remove skin and bones. Keep only the flesh. Shred and keep warm.

Empty pan of excess fat, add mushrooms and fry on medium to high heat for 2–3 minutes. Season with salt and pepper and toss through a handful of chopped parsley.

Assemble into stacks in a circle on each plate, starting with the shredded duck, then the mashed potatoes and finally the sautéed mushrooms. Serve immediately.

◄ Fairy ring mushrooms with stipes removed.

Stockman's silverbeet and mushroom frittata

Claire O'Callaghan, jillaroo

I worked as a jillaroo on a heap of stations in the outback. Sometimes I'd cook this up for the fellas for tea and even though it doesn't have meat, they'd woof it down like there was no tomorrow. I reckon they didn't know what they were eating half the time, I could have told them it was anything. We all worked hard and we loved our tucker. They'd lick the plate clean at the end. That's blokes for ya.

This is a creamy hearty meal and although it's pretty unlikely, if there's any left over, heat it up for brekky the next day. It's a dead easy dish, you can whip it together in a flash.

Funnily enough you don't seem to see as many mushies these days. Or perhaps I'm just not looking hard enough.

4
SERVES

PREPARATION TIME
15
MINUTES

COOKING TIME
45
MINUTES

2 tbsp butter
1 large brown onion, sliced
2 garlic cloves, chopped finely
400 g field mushrooms
1 bunch silverbeet, washed and chopped roughly
4 eggs
300 ml thickened cream
½ cup Feta cheese, crumbled
½ cup Parmesan cheese, grated
½ tsp nutmeg
black pepper and salt
a few chives, chopped

Preheat oven to 180°C. Heat butter in large heavy bottomed pan on moderate heat and sauté onion for 3 minutes. Add garlic and sauté for another 3 minutes.

Add mushrooms and sauté for 2–3 minutes until soft.

Add silverbeet. Cover with lid and cook for 2–3 minutes or until just wilted.

Remove from heat, cool and drain off excess moisture. Transfer into large baking dish (6 cup) and spread evenly across the bottom.

Whisk eggs and cream together. Stir through Feta and grated Parmesan. Season with nutmeg, pepper and salt. Pour mixture over silverbeet mixture and mix gently with a fork.

Bake for 40–45 minutes or until nicely browned and set.

Allow to cool before slicing. Sprinkle with chopped chives. Serve with a big green salad and fresh bread.

◀ This simple mushroom frittata can be whipped together in a flash.

Butter sautéed ceps on Ricotta ravioli

Barbara Thüler, mushroom inspector

The cep – my darling! Where I grew up in Switzerland, these mushrooms were seldom found – not because they were rare, but because other foragers got in first. Good mushrooming spots were (and still are) closely guarded secrets. Any ceps that were not immediately eaten were dried and kept as precious treasure for a delicious cep risotto in winter. If we met other foragers in the forest, we would briefly greet each other, then take a good long look in their basket. If words were exchanged, one of two strategies were used: either we'd be overly modest and suggest, 'It isn't worth looking here' or we'd boast 'I have already picked all the mushrooms here'.

In between my visits to Australia, I hear that ceps have been found Downunder. I'm curious to see how the Australian cep situation will unfold, or whether the greedy Europeans will take first pick!

To bring out the exquisite nutty aroma of ceps, I fry them in butter until they are golden yellow, almost crispy. But don't overdo it. To honour them a little more, I put them on a Ricotta ravioli. The perfect match, a wonderful couple.

4
SERVES

PREPARATION AND COOKING TIME
40
MINUTES

- zest and juice of half an organic orange
- 300 g Ricotta
- 1 egg yolk
- 80 g grated Parmesan
- ¼ tsp salt
- a little black pepper
- 2 fresh pasta sheets (available in Italian delis or see recipe on p. 277)
- 1 egg white
- 5 tbsp butter
- 300 g fresh ceps, trimmed and cleaned
- a little parsley for garnish, finely chopped

Combine lemon juice, zest, Ricotta, egg yolk and Parmesan cheese. Season with salt and pepper.

Spread out a sheet of pastry dough and cut in half. Brush one half with egg white. Using the back of a knife, score the pastry so you have 3 rows in each direction and 9 squares. Place a teaspoon of Ricotta in the middle of each square.

Lay the second half of the pastry dough over the first half that has the filling. Press the pastry together around the filling. Cut ravioli by slicing between the 'pockets' of filling to yield individual filled squares. Make sure the edges of each piece are well sealed by pressing together with fingers or tines of a fork, so the filling doesn't escape when boiled.

Place ravioli on a floured kitchen towel. Follow the same procedure with second sheet of pastry.

Cut ceps into thin slices and fry until golden brown. While they are frying, place each ravioli portion, one at a time in boiling salted water for ~5 minutes, then remove with a slotted spoon.

Carefully place fried ceps over the hot ravioli. Garnish with parsley and serve immediately.

◄ The cep is among the most delicately flavoured of all wild mushrooms.

Gratin de morilles et d'asperges (Gratin of morels and asparagus)

Valérie Chételat, photographer and outdoor guide

This recipe is a French favourite, but I can imagine it might just take off in Australia too. It works well with either fresh or dried morels. However, if you're using fresh morels, keep in mind that they contain a mild toxin and must be cooked for 10–15 to neutralise it. They also contain millipedes … urghhh. Morels are rich and filling and you only need a few for a tasty meal.

The Australian morels seem to like the sandy soils of a friend's property in the granite country on the edge of the Grampians in Western Victoria. It's a treat to visit in springtime and enjoy this special delicacy.

4
SERVES
AS A STARTER

PREPARATION TIME
20
MINUTES

COOKING TIME
20
MINUTES

12 morels, cleaned
10 green asparagus spears (finger width)
2 tbsp butter
1 cup thickened cream
1 egg yolk
20 g Gruyère or other aged cheese
20 g Parmesan
pinch of nutmeg
freshly ground black pepper to taste
salt
4 sprigs of thyme

If using fresh morels, brush them with a dry pastry brush to remove any grit or wipe them with a damp cloth. If using dried morels, they should already be clean. Rehydrate dried morels by placing them in a bowl of hot water for 15 minutes. Drain and gently squeeze out excess water (you might like to save this as a stock for cooking rice etc.).

Rinse asparagus and snap off any hard ends. Place in pot of boiling salted water for 2–3 minutes. Remove asparagus with a slotted spoon and place in a bowl full of ice water for 3–4 minutes to stop the cooking process and help them retain their colour. Drain and set aside.

Melt butter in a non-stick frying pan and simmer morels over low heat for 3–4 minutes (or 10–15 minutes for fresh morels).

Preheat griller.

Mix cream, egg yolk, cheese, nutmeg. Season with salt and pepper.

Arrange morels and asparagus in a 20 × 20 cm (or equivalent) ovenproof gratin dish (or 4 individual ramekins). Carefully spoon over the cream mixture. Garnish with thyme sprigs.

Place under griller for 8–10 minutes until top is golden brown and liquid is almost set.

Serve immediately.

◄ Morels, asparagus and cheese make for a rich and delicate gratin.

Silky Mapo slippery jacks

Cameron Russell, forager

I have a really soft spot for slippery jacks. They were the first mushroom I became confident in picking. Although slippery jacks have a texture that does not always sit well within Western tastes, they slip in well with a Sichuan style of cookery. I love the Mapo tofu as a dish and slippery jacks just lend themselves to these flavours and textures.

Slippery jacks are also great dried and give a flavour boost to dishes such as pasta, soups, sauces and anywhere you need an umami kick. When preparing slippery jacks, wipe them with a damp cloth rather than wash them. I peel the skin off the cap as some people react to it, experiencing stomach upsets. Some people also remove the tubes, but I leave them intact.

I hope you love this dish as much as I do.

4
SERVES

PREPARATION TIME
10
MINUTES

COOKING TIME
15
MINUTES

200 ml vegetable oil (¾ cup)
25 g fresh hot red chilli, stems removed, roughly chopped
12 g dried red chilli peppers (1 tbsp)
5 g green Sichuan peppercorns (½ tsp)
250 g slippery jacks, wiped clean, skin removed, sliced (little finger thickness)
150 g chicken thigh, deboned and roughly diced
5 g garlic, finely chopped
5 g ginger, finely chopped (1 tsp)
200 ml water or chicken stock (¾ cup)
5 g corn starch
1 spring onion, finely sliced (3 tbsp)

Place the wok or pan on stove and add half the oil. Heat on medium until hot but not smoking.

Add fresh chili, dried chili and green Sichuan peppercorns and fry for 1 minute, being careful not to burn. Pour into a small bowl and put aside.

Place pan back on stove, add some more oil. Heat until hot but not smoking. Slide in slippery jacks and chicken and fry until chicken is almost cooked. Add garlic and ginger and cook for 2 minutes, stirring so as not to burn. Add 150 ml of stock and cook on medium heat for ~5 minutes to reduce the liquid slightly.

In a bowl, mix corn starch with 50 ml of chicken stock and stir until it forms a smooth paste. Add paste to pan, reduce heat slightly and stir well to stop it forming lumps. Allow to cook. If too thick, add a little more stock. If too thin add a little more starch paste.

Add chilli and green Sichuan peppercorns.

Allow to sit for 2 minutes, then pour into serving bowls. Sprinkle spring onions on top.

Serve with rice or noodles.

◄ Freshly foraged slippery jacks.

Truffle and vanilla panna cotta

Helene Bell, Corunnun Truffles

Truffles mature from late June to early August in Victoria. Our dog Riley finds them, but we need to make sure only the ripe ones are unearthed. Mature truffles should be firm with a sweet aroma. Internally the fine white veins should be well defined against the black space that holds its spores. A truffle with pale grey flesh and little aroma is immature.

Truffles are sweetest in the first week but can keep for 2–3 weeks. Store them in a well-sealed jar, wrapped in a paper towel changed daily to keep it dry. Truffle is well matched with simple foods such as eggs, cheese, cream, Parmesan cheese and potatoes, absorbing the truffle aroma when stored with them. The truffle is best added to dishes just after they are cooked as the warmth brings out the truffle aroma, but too hot and it will vaporise.

Robyn Barrand's Cucina Colac Cookery School provided the inspiration for this recipe after a wonderful day of cooking with truffles.

6
SERVES

PREPARATION TIME
60
MINUTES
(PLUS OVERNIGHT REFRIGERATION)

1 cup (250 ml) cold water
4 leaves gold-strength gelatine
80 g caster sugar
500 ml full cream milk
250 ml cream
½ tsp vanilla bean paste
15 g fresh black truffle, shaved then chopped into thin strips
spun sugar or Persian fairy floss and micro mint leaves (or whole mint leaves), for decoration

Place water and gelatine into a small bowl and leave until leaves have softened. Set aside.

Place sugar, milk, cream and vanilla bean paste in a small heavy-based saucepan and heat gently, stirring with a wooden spoon until sugar has dissolved.

Take off heat and allow to cool to 35°C before adding truffle (any hotter and you risk losing the volatile truffle aroma).

Gently squeeze water out of gelatine leaves and add them to warm milk, cream and truffle mixture. Stir gently to completely dissolve gelatine.

Stir mixture to ensure truffle is evenly distributed, then pour into parfait bowls or wine glasses. Cover with cling film and refrigerate overnight to allow truffle aroma to permeate the panna cotta.

Leaving panna cotta in the bowl, decorate it with spun sugar or Persian fairy floss and mint leaves.

◄ A freshly unearthed Périgord black truffle.

Pickled saffron milkcaps

Millie Ross, gardener

I am relatively new to mushroom hunting, hence the confidence-building saffron milkcap is a firm favourite. They are robust, filling and relatively easy to find. While I do enjoy them fresh-cooked in the forest, one of my favourite tasks of the season is preserving a day's haul to last the whole year. The largest tattered mushrooms are dehydrated, perfect for stock and stews once tidied up a bit, while the prettiest little pilei are pickled! I use this basic brine to preserve any excess veggies, and I'm sure it would work with almost any firm-fleshed mushroom.

I seldom use a recipe, so quantities are a bit of a guess. You may want to adjust a little to taste. Once bottled I always pasteurise my pickles in a water bath, but more sugar and salt will also increase the preservation and therefore shelf life. Mine keep for a year or more and are beaut on a cheese board or toasted cheesy sandwich.

3-4
JARS

PREPARATION AND COOKING TIME
20
MINUTES

PROCESSING IN HOT WATER BATH
30
MINUTES

1 cup vinegar
1 cup water
2 hot chillies
2 cloves garlic, sliced
6 small sprigs thyme
1 bay leaf
1 tsp sugar
pinch of salt (1 tsp)
pepper to taste
1 kg saffron milkcaps
sterilised jars and lids
750 ml olive oil

It is a good idea to start your pickling brine before cleaning mushrooms, as they bruise when handled.

In a non-reactive saucepan, combine all ingredients, except mushrooms and olive oil. Slowly bring to the boil.

Clean mushrooms using a damp cloth, checking for insects and debris. Slice.

Add mushrooms to pickling brine and allow to simmer for a few minutes. Remove from heat and allow to cool for 2–3 minutes.

Using a slotted spoon, fill jars almost to the brim with mushrooms. Cover completely with hot brine.

Use a sterile knife to move mushies in the jar and release any air bubbles. Fill to the brim with olive oil.

Seal and place in a water bath for 30 minutes, then allow to cool overnight.

Store in a cool, dark place.

◄ Pickled saffron milkcaps.

Risotto with burnt grated golf ball

Alison Pouliot

Fungi come in many shapes and sizes and truffles in particular, appear as little round lumps, sometimes slightly poking through the soil surface. While walking through the bush looking for fungi, I've often bent down to look at what I thought was a fungus, only to discover it was a cocoon, gall, stone, scat, spider egg case, seed pod or other round unidentifiable object, but not a fungus. I've collected these various items over the years and use them for a little quiz in my fungus workshops, each laid out in a row, with the question 'Which of these are fungi?'.

I was about to start a workshop in the Mallee, when an over-excited participant burst through the door with something in her outstretched hand. Catching her breath, she exclaimed how she'd found a Périgord black truffle (*Tuber melanosporum*), one of the most sought after and valuable fungus species in the world. She then asked me how much money she could ask for it on eBay.

I looked at the round black lump in her hand, which on first inspection, resembled a Périgord black truffle. But something wasn't quite right. I asked where she found it. She looked at me suspiciously, then waved her hand vaguely and said, 'Oh out there in the bush'.

I picked it up, smelt it, squeezed it, scratched it and then witnessed her crushing disappointment when I suggested it wasn't a truffle. I asked if by chance she'd found it anywhere near the local golf course, alongside of which had been a recent fire. To her chagrin, what she had found was not a truffle, but the burnt inside of a golf ball. It was burnt black and the plastic had bubbled up into little knobs, giving it a superficial likeness to a truffle. We both burst laughing and she said, 'Oh well I guess I should put this into your quiz' and she popped it on the table among the other round fungus-like lumps.

At the end of the day, I asked participants if they knew which of the items in the quiz were fungi. I then glanced down, only to notice that the burnt golf ball had disappeared. It seems someone else had also mistaken it for a Périgord black truffle … and snaffled it.

That evening, as the autumn light faded and a gentle rain set in, I imagined the eager anticipation of the snaffler, tucked up at home, fire in the hearth, perhaps a nice glass of red already poured, as they attempted to grate a burnt golf ball into their perfectly cooked white wine risotto …

2
SERVES

PREPARATION AND COOKING TIME
45
MINUTES

1 tbsp virgin olive oil
1 tbsp butter
medium-sized brown onion, finely chopped
1 cup Arborio rice
1 cup good dry white wine
2 cups vegetable stock (with a bit more in reserve)
½ cup freshly grated Parmesan cheese and a bit more for garnish
freshly ground black pepper to taste
1 Périgord black truffle (check carefully it's not a burnt golf ball …)

Place stock in a medium saucepan and heat to a simmer. Reduce heat and keep warm.

Heat olive oil and butter over medium-high heat in a heavy-based frying pan. Add onion, reduce heat to medium, and cook for 3–4 minutes until translucent, stirring often.

Add rice and stir with a wooden spoon to coat grains with oil. Allow to cook 3–4 minutes, stirring frequently so it absorbs butter, until opaque. Add a pinch of salt. Increase heat, add wine, stir and bring to boil. Turn down heat.

Add stock, a ladle at a time, and cook, stirring frequently until almost absorbed. Keep stirring and adding stock for 17–20 minutes, until rice is tender but still al dente and sauce is creamy in consistency.

Add Parmesan and stir until combined. Taste and season with salt as desired.

Remove from heat and spoon rice onto individual plates and shave truffle on top along with freshly ground pepper to taste.

◀ The inner texture of this truffle reveals that it is definitely not a golf ball.

Glossary

adnate – with lamellae attached broadly to the stipe.
adnexed – with lamellae attached narrowly to the stipe.
agaric – fungus with lamellae on underside of pileus.
amatoxin – group of cell and organ destroying toxins that can be lethal even in small doses, produced by some *Amanita*, *Galerina* and *Lepiota* among other genera.
anastomosing – forming cross-connections between lamellae.
annulus – ring or collar of tissue on stipe left by breaking of partial veil as mushroom matures.
arbuscular mycorrhiza – mycorrhiza in which fungal hyphae penetrate cell walls in the roots of the partner plant (formerly referred to as endomycorrhiza).
Ascomycota – fungi that produce spores in sac-like asci.
ascus (pl. asci) – microscopic flask-like structure containing sexual spores of Ascomycota.
austral – southern (in context of species distribution).
autodigestion – self-digestion.
basidia – microscopic club-shaped structures that produce sexual spores of Basidiomycota.
Basidiomycota – fungi that produce spores on basidia.
binomial – the combination of a generic name and a specific epithet in the name of an organism, such as *Agaricus campestris*.
bioluminescent – glowing as a result of a biological process.
biomass – the total quantity or weight of organisms in a given area or volume.
bolete – fleshy mushroom with tubes on underside of pileus.
button – young stage of a mushroom before pileus has matured and opened.
caespitose – growth form where sporophores grow in dense clumps with their stipes fused or clustered together at the base, e.g. *Armillaria luteobubalina*.
cellulose – major constituent of wood and plant cell walls that gives rigidity and support.
chitin – primary structural compound of fungi (and some arthropods) that gives hardness.
conifer (adj. coniferous) – a woody plant, usually a tree, that produces cones, such as a pine-tree.
coprine – mycotoxin first isolated from *Coprinopsis atramentaria*.
cortina – a type of partial veil consisting of delicate cobweb-like fibres (e.g. *Cortinarius*).
cryptic species – species that are similar in appearance but differ in subtle characters (often their DNA sequences).
cytotoxic – toxic to living cells.
decurrent – (of lamellae) running down the stipe.
deliquescent – liquefying at maturity (e.g. inkcaps).
ectomycorrhiza – mycorrhiza with hyphae that do not penetrate plant cells.
enzyme – protein that catalyses (speeds up) chemical reactions in living organisms.
exotic – not native, introduced from elsewhere.
farinaceous – (odour) floury or mealy (like poultry feed).
fibrillose – with fibrils (fibres), usually flat to the surface.
foetid – (odour) foul, unpleasant, rancid or rotten.
forager – (in context of this book) a person who seeks wild edible fungi as food.
forayer – (in context of this book) a person who seeks fungi mostly for scientific interest.
fungarium (pl. fungaria) – a reference collection of fungi.
genus (pl. genera) – a group of closely related species.

gill – see lamella.
gleba – spore mass that develops inside sporophores such as puffballs.
globose – in the shape of a sphere.
gluten – clear gel-like layer on surfaces of some fungi.
glutinous – covered with gluten, slimy.
gyromitrin – a toxin and carcinogen that causes neurological and gastrointestinal effects.
heterotroph – organisms that obtain energy (nutrition) from organic compounds.
hygrophanous – watery or translucent when moist and opaque and differently coloured when dry; usually in reference to a mushroom pileus.
hymenium (pl. hymenia) – spore-bearing surface of fungi that covers, for example lamellae or spines or lines pores.
hypha (pl. hyphae) – filament of fungus mycelium.
hypogeous – underground.
ibotenic acid – a powerful neurotoxin found in *Amanita*.
in vitro – occuring outside of a living organism in artificial conditions (e.g. a test tube).
lamella (pl. lamellae) (also called gill) – vertical plate on underside of pileus on which the spore-bearing layer is formed.
latex – milky liquid exuded by some fungi (e.g. *Lactarius*).
lignin – complex polymer that along with cellulose gives plants structure, strength and rigidity.
margin – area adjacent to the edge of pileus.
membranous – thin, like a membrane or skin-like.
morphology – form and structure.
muscarine – a deadly alkaloid found in *Clitocybe*, *Entoloma*, *Inocybe* and *Mycena* and in trace amounts in other genera.
muscimol – a narcotic and hallucinogenic alkaloid found in *Amanita muscaria* and other fungi.
mycelium (pl. mycelia) – see the information box on p. 3.
mycology – the scientific study of fungi.
mycorrhiza – the mutualistic symbiotic association between a fungus and the roots of a plant.
neurotoxin – a toxin that alters the structure or function of the nervous system.
notched – (of lamellae) abruptly adnexed, as though a small wedge-shaped piece of tissue had been removed at junction with stipe.
pallid – pale.
partial veil – inner veil of tissue that joins stipe and pileus edge in some mushrooms when immature, often breaking to leave a ring (annulus) or ring-zone on stipe and/or remnants on pileus margin.
pathogen – disease-causing agent.
peridium – outer enveloping layer of fungi such as puffballs.
phenol – chemical compound, found, for example, in *Agaricus xanthodermus*.
phenology – the timing of a biological event, such as the appearance of sporophores.
pileus – (also called cap) upper section of a mushroom that bears the fertile surface underneath.
plane – (in reference to pileus) flattened.
pores – mouths of tubes in boletes and polypores.
pruinose – powdery or finely granular.
ring-zone – remnants of partial veil on stipe (e.g. *Cortinarius*).
saprotroph (also saprophyte or saprobe) – organism that gains nutrients from dead organic material.
specific epithet – the second part of the binomial name of a particular organism.
spore – basic reproductive unit of a fungus, usually a single cell (also produced by some bacteria, bryophytes, ferns and slime moulds).

sporophore – (also fruiting body, sporing body, sporocarp) spore-bearing structure.
stipe – stem or stalk-like structure supporting pileus of most mushrooms.
stoma – the opening through which the spores of puffballs escape
striate – having radiating lines on pileus, usually more prominent near margin.
substrate – substance or material in which a fungus grows and from which it obtains nutrients.
symbiosis – an intimate relationship between two or more different organisms (the symbionts).
synonym – another name for the same species (usually a later name for the same organism or an alternative generic placement).
tawny – between yellow brown and rust brown, approximately the colour of a lion.
taxon (pl. taxa) – a taxonomic unit (e.g. genus) of any rank within a taxonomic system.
toadstool – see the information box on p. 3.
tomentose – with fine hairs on the surface.
toxin – a poison produced by a living organism.
umbilicate – pileus with a dip in the centre of the upper surface.
umbo – rounded protuberance or boss at the centre of a pileus.
umbonate – pileus furnished with an umbo.
veil – protective membrane that encloses developing hymenium of some fungi.
viscid – sticky but not glutinous (slimy) (stickiness can be felt after wetting the specimen).
volva – remains of universal veil at the base of stipe in some mushrooms, usually in the form of a sac, collar, or series of concentric rings or scales (especially in *Amanita*).

Further reading and resources

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Australian Fungi ANBG, <http://www.anbg.gov.au/fungi/>

Fungi in Australia downloadable e-book, <http://www.fncv.org.au/fungi-in-australia/>

FunKey, <https://www.rbg.vic.gov.au/science/projects/mycology/interactive-tools-for-identifying-fungi>

IUCN Red List of Threatened Species, <https://www.iucnredlist.org/search?query=fungi>

Fungus interest groups and recording schemes

Field Naturalists Club of Victoria Fungi Group, <http://www.fncv.org.au/fungi-group/>

Fungal Studies Group, South Australia, <http://www.fnssa.org.au>

Fungal Network of New Zealand, <https://www.funnz.org.nz/>

Fungimap, Australian fungus mapping scheme, <https://www.fungimap.org.au/>

iNaturalist, <https://www.inaturalist.org/>

Queensland Mycological Society, <qldfungi.org.au/>

Sydney Fungal Studies Group, <http://www.sydneyfungalstudies.org.au/>

WA Naturalists Fungi Group, <https://www.wanaturalists.org.au/branches-groups/fungi/>

Professional organisations

Australasian Mycological Society, <https://www.australasianmycologicalsociety.com/>

Australasian Plant Pathology Society, <https://www.appsnet.org/>

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Pages for detailed profiles of species are indicated in bold. Synonyms in recent use are cross-referenced to the currently accepted name. Vernacular names are included as the whole phrase – therefore see 'horse mushroom', rather than 'mushroom, horse'.