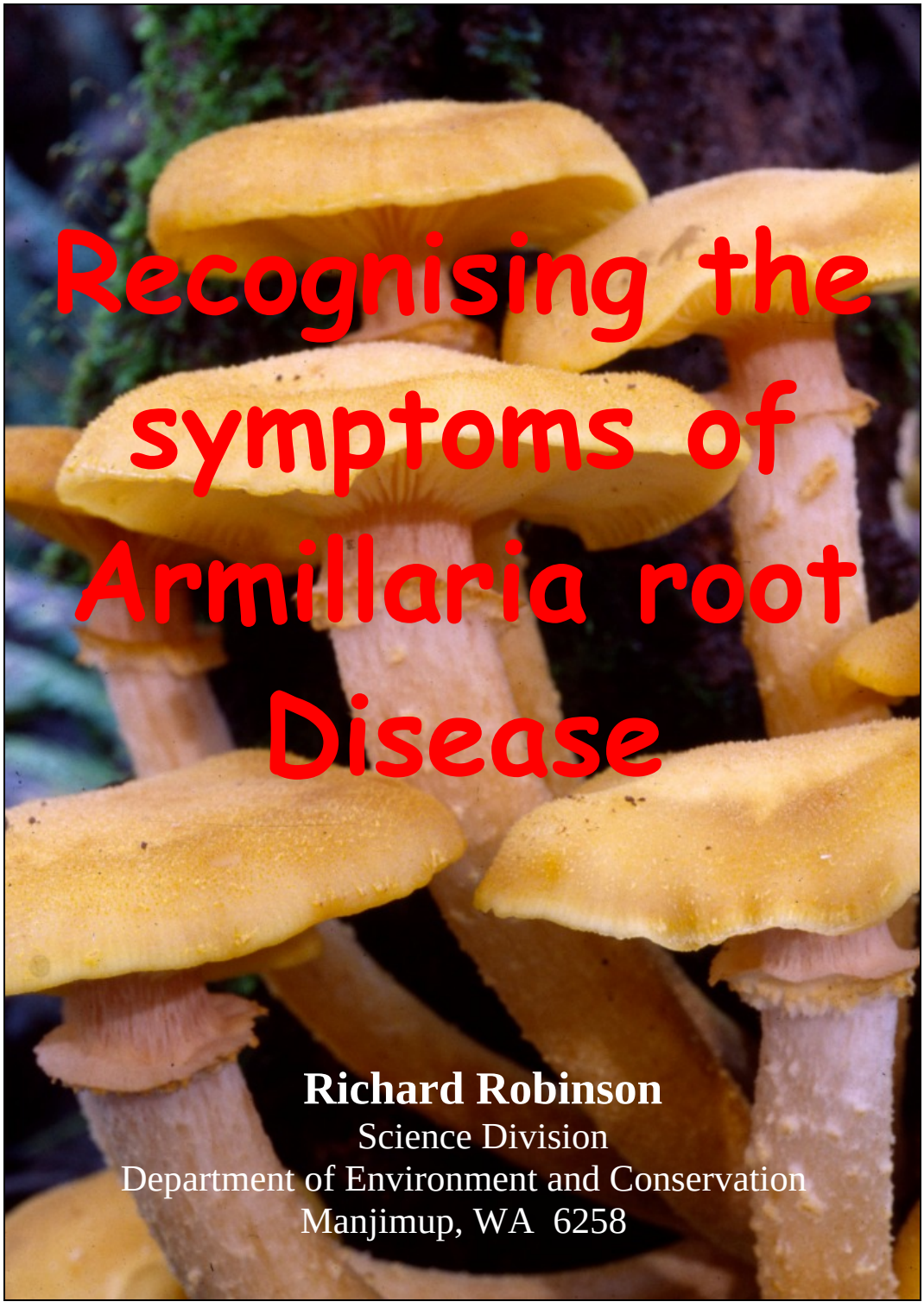

Recognising the symptoms of Armillaria root Disease

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Introduction

Armillaria luteobubalina Watling & Kile, the Australian honey fungus, is a widespread, endemic pathogen of native forest, woodland and coastal shrub communities in the southwest of Western Australia. It is the causal agent of Armillaria root disease (ARD) and is associated with deaths of karri (*Eucalyptus diversicolor* F. Muell.), wandoo (*E. wandoo* Blakely) and jarrah (*E. marginata* Donn ex. Sm.), *Banksia* spp. in coastal woodlands as well as exotic eucalypts planted on mine-sites and in plantations.

In Australia there are 6 known species of *Armillaria*. *Armillaria luteobubalina* is the only species known to occur in Western Australia. In healthy undisturbed environments Armillaria root disease is generally not the primary cause of death in forest or woodland trees but more usually it kills trees weakened by competition, age-related decline or environmental stress and disturbance. In disturbed or intensely managed environments, however, *A. luteobubalina* can become a particularly aggressive pathogen. The list of susceptible hosts is extensive and is likely to include all native shrub and tree species as well as all introduced species.

Above: *Armillaria* disease centre in 80 year old karri forest at Big Brook

Armillaria luteobubalina infects the roots of living trees, spreads towards the root collar below the bark and eventually kills the tree when it girdles the root collar. Seedlings and saplings are most susceptible to infection, however, healthy vigorous trees older than about 20 years have some resistance and develop callus tissue at the margin of lesions. Callus reactions result in the formation of inverted V-shaped scars at the base of infected stems. Infection spreads to neighbouring healthy trees by root-to-root contact. Factors

such as drought or fire may cause stress which will lead to infection in otherwise healthy trees.

The life cycle of the fungus consists of a parasitic phase during which the host is infected and killed followed by a saprophytic phase during which the root system and stump of the dead host is used as a food base. In this manner *Armillaria luteobubalina* has the ability to persist in an infected root system for decades during which surrounding regrowth may also be susceptible to infection.

Detecting *Armillaria luteobubalina* Infection

Symptoms of ARD may include crown deterioration (including chlorosis of foliage), inverted V-shaped scars (Λ), bark fissuring and/or kino exudation at the base of the stem, the presence of white mycelial fans below the bark at the base of the stem, fruit bodies (mushrooms) of *A. luteobubalina* at or in closer proximity of the root collar or a wet stringy white rot in the wood of the roots or at the root collar which may contain thin black zone lines or plates. *A. luteobubalina* rarely produces rhizomorphs (black boot-lace-type organs) in the field, but sometimes rhizomorphs may be seen on the surface of the bark of infected roots or at the root collar. However, they are readily produced when the fungus is isolated and grown on artificial media in the lab.

Young trees and shrubs may die suddenly with their crowns intact and growth often unaffected until immediately prior to death. In older trees bark fissuring and kino exudation at or immediately above the root collar are common symptoms of *Armillaria* infection. Older trees may also undergo gradual crown deterioration, although sudden crown wilt may occur suddenly. Root infection is generally followed by the development of large inverted V-shaped scars at the base of the stem. Infection results in root and butt rot and trees are susceptible to wind throw (especially after thinning in regrowth karri). Infected roots have a characteristic white rot and white fan-like sheets of mycelium under the bark.

In coastal habitats, large disease centres may develop. They are characterised by a high number of dead shrubs surrounded by chlorotic or dying shrubs and plants. The disease can be recognised by removing dead shrubs and looking for sheets of mycelium under the bark of dead roots or around the root collar of dead plants.

Summary – characteristic symptoms of ARD

- Λ-shaped scar at base of tree
- Clusters of fruit bodies at or near base of infected trees and shrubs
- White mycelial fans below the bark
- Wet, stringy yellow-white rot in roots and base of tree

Recognising the fruit bodies of *Armillaria luteobubalina*.

Fruit bodies may also be referred to as basidiomes, basidiocarps, sporocarps or simply mushrooms. *A. luteobubalina* fruit bodies are a "typical" mushroom, consisting of cap, gills and stem. They are generally short-lived and are produced in clusters at the base of infected trees, or sometimes on the stem up to 3 metres above the ground, in mid-late autumn to early winter.

Cap: May range from 4-10 cm diam. and is firm and fleshy. Initially the cap is convex and becomes flat as it expands. The colour may vary but is generally lemon-yellow to honey-brown. The central disc of the cap is covered in small brown-black squamules (scales) which become sparse towards the margin. The squamules give the cap surface a rough texture. The flesh is white and has a lingering bitter taste.

Stem: 4-10 (may be up to 15) cm long and 1-2 cm in diam., attached at the centre of the cap. It is solid, generally thickened towards the base and has a persistent **annulus** (ring) attached just below the gills. Below the annulus the stem is distinctly floccose (covered in coarse scales). The colour ranges from a light pinkish-brown near the apex to dark brown at the base. The flesh of the stem is white and generally stringy.

Gills: Are white to pallid when young and become cream-brown or pink-brown with age. They are fleshy and pliable and attached to the stem near the apex. The gills are crowded and of uneven length. The **spore print** is cream to white. A dusting of white spores is often seen on the cap surface of the fruit bodies in the bottom of a cluster.

Summary – characteristic features of *Armillaria* fruit bodies

- Fruit bodies often develop in clusters
- Lemon-yellow to honey-brown cap
    - small black squamules cover the central disc
    - cap surface feels rough (like cats tongue)
- Persistent ring around stem
- Floccose (shaggy) stem immediately below the ring
- Cream-white gills changing to pink-brown with age
    - White spores - often seen on the cap surface of the fruit bodies in the bottom of a cluster
- Flesh has a bitter taste

Armillaria luteobubalina

Watling & Kile

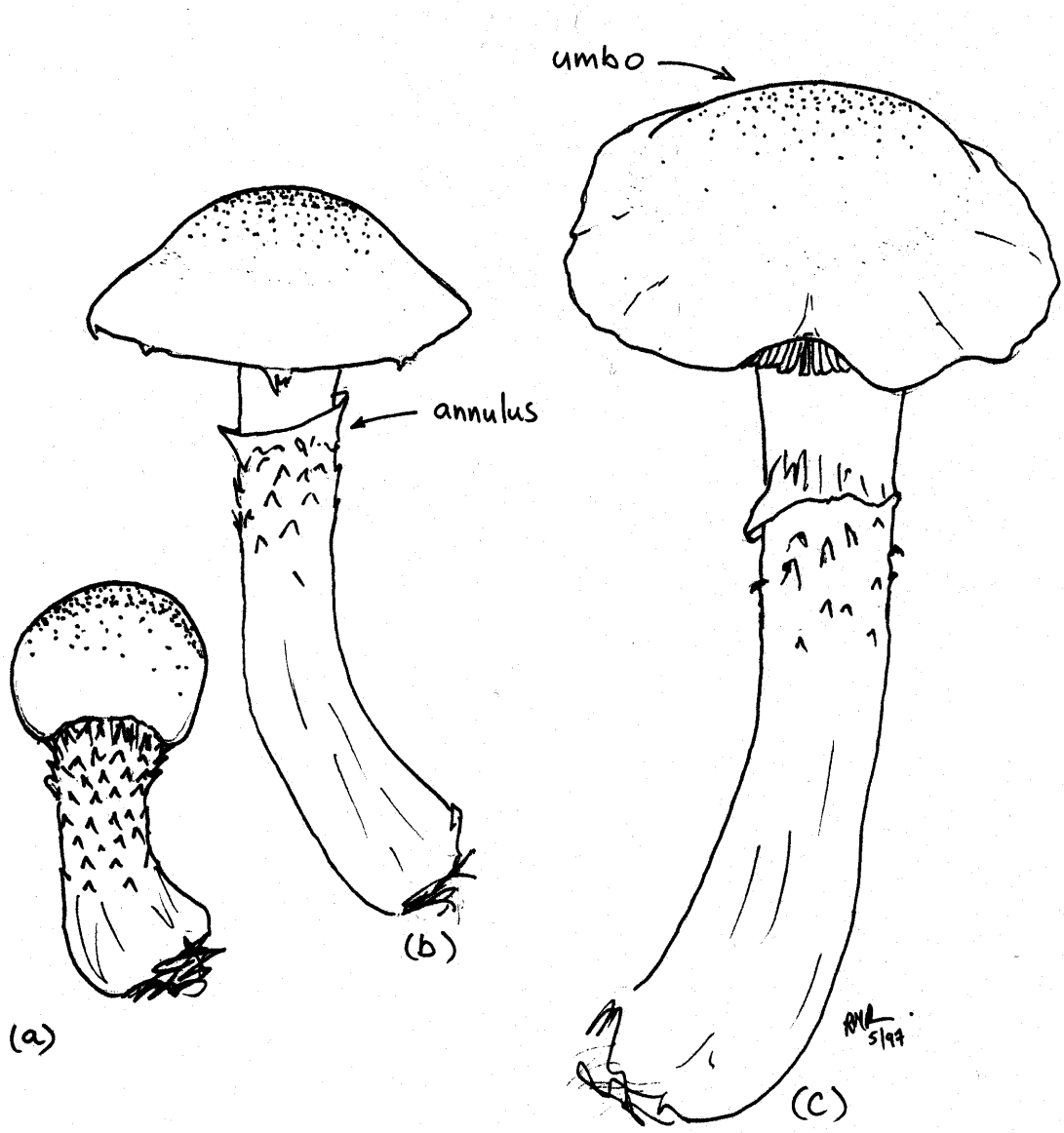

Fig 1. The development of *Armillaria luteobubalina* fruit bodies. In the "button" stage (a) the cap is not yet detached from the annulus, and the stem is distinctly floccose. Small black squamules (scales) cover the centre of the cap. As the cap expands (b) the margin may have remnants of the annulus attached and a distinct annulus can be seen attached to the stem. The stem is floccose (covered in coarse scales) below the annulus only. When mature (c) the cap is flat, but may have a distinct "shield-like" swelling (umbo) in the centre and a wavy (sometimes upturned) margin. The small black squamules persist on the umbo, but may be washed off with age.

Armillaria root disease – Symptoms

Above: A cluster of *Armillaria luteobubalina* fruit bodies

Above: Black scales on the top of *Armillaria luteobubalina* caps

Left: Clusters of fruit bodies are found either on the ground or at the base of infected trees and shrubs in the autumn.

Below: Huge clusters of fruit bodies can also develop on infected stumps

Top left: Scar at base of 25-year-old karri regrowth tree caused by infection from the stump in the foreground.

Top right: A close-up of an infection scar in the bark of 25-year-old karri regrowth tree.

Left: Callus surrounding an *Armillaria*-caused scar on the stem of 25-year-old karri regrowth tree.

NB. *Armillaria* scars are distinguished from fire scars by being open at the base – due to infection spreading from roots.

Left: Stringy white rot in the sapwood at the base of an infected karri. The rot is typically very wet and "mushy" in the winter and dry and "crackly" in the summer.

Below: Sheets of white mycelial "fans" under the bark of an infected root.

Above: Typical rot and scar formation on the surface of a karri stump infected with *Armillaria luteobubalina* (Photo: M. Stukely)

Above: Typical white rot and zone lines in infected wood

Armillaria root disease in coastal communities

Above: ARD in urban coastal dune community at Scarborough Beach, Perth

Above: ARD in *Banksia speciosa* population in Stokes Inlet NP (photo: C. Hooper)

Characteristics of *Armillaria* in culture

Armillaria luteobubalina is readily isolated from infected wood and grown on sterile malt extract agar. Cultures will develop in about 10 days. The resulting mycelial mat will initially be white and fluffy. Within about 2 weeks it may produce black rhizomorphs that extend into the growing media. The white fluffy colony continues to develop around the rhizomorphs. As the cultures mature they develop a brown crust.

Above: *Armillaria* culture isolated from infected karri roots showing rhizomorph development and brown crust.

Above: *Armillaria* culture viewed from below

Further reading

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