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# *Coprinopsis stangliana* – a recently introduced fungus expanding in urban bushlands of the Perth region of Western Australia

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## Abstract

Bougher, N.L. *Coprinopsis stangliana* – a recently introduced fungus expanding in urban bushlands of the Perth region of Western Australia. *Nuytsia* 16(1): 3–10 (2006). Successively for the past ten years a distinctive, large fungus superficially resembling the northern hemisphere Magpie Fungus *Coprinopsis picacea* syn. *Coprinus picaceus* has been observed for the first time in Western Australia (WA). The fungus is a member of the section *Coprinus* subsection *Alachuani.* Based on morphological and habitat attributes, the WA fungus is considered in this paper to be affiliated with *Coprinopsis stangliana* syn. *Coprinus stanglianus. C. stangliana* is known from calcareous soil, limestone, and chalk in Europe and Turkey, but has not been confirmed in Australia. In WA, *C. stangliana* generally has larger fruit bodies than reported for this species elsewhere. The fungus produces abundant fruit bodies in highly disturbed patches within numerous urban bushlands of the Perth region. The apparent recent establishment of such a conspicuous fungus, and observations of its fruiting patterns over successive years suggest that it is rapidly spreading following a relatively recent introduction into the Perth region.

## Introduction

The genus *Coprinus* Pers. consists of dark-spored fungi generally referred to as ink caps, as many of the species autodeliquesce (self-digest) into a black liquid as they mature. Over 745 names have been applied to *Coprinus* (Index Fungorum 2006), representing at least 350 species (Kirk *et al*., 2001). Over 50 of the species have been recorded in Australia (May *et al*. 2005), and 15 in Western Australia (WA) (Hilton 1982, 1988). Recent phylogenetic analyses of molecular sequences have indicated that *Coprinus* is not monophyletic (Redhead *et al*. 2001). The type species of *Coprinus* – *C. comatus* and a few related species remain as *Coprinus* aligned with the Agaricaceae. The vast majority of other species formerly considered *Coprinus* have been allocated by Redhead *et al*. (2001) to genera aligned with the Psathyrellaceae - *Coprinopsis* P. Karst., *Parasola* Redhead, Vilgalys & Hopple, and *Coprinellus* P. Karst. These genera are not accepted universally (e.g. Kirk *et al.* 2001; May *et al*. 2005). The present author accepts the genera after taking into account congruence of some long-recognized morphological attributes with the molecular phylogeny (as discussed by Redhead *et al*. 2001).

During the past 10 years the author and colleagues have observed a large, distinctive species of *Coprinopsis* in highly disturbed patches within numerous urban bushlands in the Perth region over successive years. The fungus has not been seen in WA before this time (K. Griffiths, R.N. Hilton, E. McCrum pers. comm.). This paper examines the identity of this fungus. The fungus has the stature

of the northern hemisphere Magpie Fungus – *Coprinopsis picacea* (Bull.: Fr.) Redhead, Vilgalys & Moncalvo [*Coprinus picaceus* (Bull. : Fr.) Gray], but is considered in this paper to be more closely affiliated with *Coprinopsis stangliana* (Enderle, Bender & Gröger) Redhead, Vilgalys & Moncalvo [*Coprinus stanglianus* Enderle, Bender & Gröger].

*Coprinopsis picacea* is aptly named the Magpie Fungus because of its dark cap neatly adorned with thick white patches of veil. It occurs widely throughout temperate regions of the world, particularly on calcareous soils. It is not an abundant fungus in the northern hemisphere - variously considered as "found only occasionally" (Dickinson and Lucas 1979), "rare" (Breitenbach and Kränzlin 1995), "widespread but local" (Orton and Watling (1979), or "found it only once, but not uncommon in southern California" (Arora 1986). Records of the Magpie Fungus in Australia are scant. May *et al*., (2005) list the only records as Hennings (1898) and Dickinson & Lucas (1979). Both are not likely to be first-hand reports. The reports may stem from *Coprinus picaceus* sensu Cooke (Cooke 1892) which is a misidentification of *Coprinus gigasporus* Massee from Brisbane, Queensland (Massee 1896; May *et al*. 2004). *C. gigasporus* has very large spores: 28–30 × 14–16 µm (Massee 1896). McAlpine (1895) also listed *C. picaceus* sensu Cooke in his Systematic Arrangement of Australian Fungi.

*Coprinopsis stangliana* is generally considered to be a smaller fungus than *C. picacea.* In the Netherlands *C. stangliana* is known as "kleine spechtinktzwam" while *C. picacea* is known as "spechtinktzwam". *Coprinopsis stangliana* is also distinguished from *C. picacea* by having spores under 10 µm wide. *C. stangliana* is reported to be a rare but widespread species in Europe found on calcareous soil or chalky loam (Bender & Enderle 1988, Uljé and Noordeloos 1997). *C. stangliana* was recognized and published for the first time in Britain only recently by Henrici and Laessøe (1993) who found it in troops in a calcareous grassland. It is also known in Mediterranean Turkey (Kaya 2001). *C. stangliana* has not been reported in Australia.

## Methods

Fresh fruit bodies collected from the field were described, and then air-dried for later examination. Hand sections for microscopic observations were mounted in 3% KOH and in 1% Congo Red. Microscopic characters were drawn with a Nikon drawing tube system. Spore measurements include the hilar appendix.

## Taxonomic description

**Coprinopsis stangliana** (Enderle, Bender & Gröger) Redhead, Vilgalys & Moncalvo, *Taxon* 50: 231 (2001). *Type:* near Bissengen, Baden-Württemburg, Germany, 29 May 1986, *M. Enderle & G.J. Krieglsteiner s.n.* (*holo:* M). *Basionym*: *Coprinus stanglianus* Enderle, Bender & Gröger, *in* Bender & Enderle, *Zeitschrift für Mykologie* 54: 57–64 (1988).

*Pileus* 45–60 mm tall × 45–50 mm wide when unexpanded, conical in button stage, elevating upon rapidly elongating stipe before expanding to conico-campanulate up to 100–125 mm diam. Finally deliquescent with highly reduced, dissected and distorted portions of pileus weeping and dripping from the apex of the white stipe which remains upstanding at this stage. Margin thin, becoming ragged and deeply split with age. Button entirely white to cream with pale brown tinges (see data about the veil,

below). Surface of unexpanded pileus on elongated stipe grey except yellow-brown at apex, darkening from margin inwards, finally dark grey to black when old. Surface dry and felty at first (button) becoming moist-greasy, finally wet and dripping, finely radially grooved from margin to centre. Context white. *Veil* felty, contiguous, entirely enveloping unexpanded fruit bodies at first then soon breaking up into two forms as the pileus expands: (a) Thick, plaque-like, densely matted, white to cream blocks up to 5 mm wide. Some plaques especially near the pileus centre with pale brown tinges due to a thin membranous surface layer; (b) Underneath and in between the plaques the veil is appressed, loosely matted, fibrillose, white, much thinner in profile than the plaques, and not as densely matted as the plaques in surface view. *Lamellae* to 10 mm broad, free, becoming distant from stipe, crowded, pale cream at first, soon becoming bluish-grey then black and moist, finally deliquescent. Edges whitish-grey, glistening under lens. *Stipe* 100–200 mm in length, 10–20 mm broad, cylindrical to slightly narrowing towards apex, with swollen to angular base up to 30 mm broad, without volva, hollow, white except for spore-stained zones and brown colouration at extreme base due to scant velar remains, dry, finely felty (not conspicuous after handling). Fragile, easily broken if bent, and easily separated from pileus. Context white. *Basal mycelium* dull white, thin and/or thick rhizomorphs (up to 1.5 mm broad) loosely binding a clod of rich, organic, decomposed litter and woody material. *Macrochemical test* 15% KOH no reaction on pileus or stipe surface and context. *Odour* not distinctive. *Taste* mild. *Spore print* black. *Basidiospores* 10.5–14 (14.5) × (7.7) 8–10 (10.5) µm (n = 180), side view mean 12.1 × 8.4 µm, mean L/B ratio 1.45 (n = 90), face view mean 12.1 × 8.9 µm (n = 90), mean L/B ratio 1.34. Greyish-brown when immature becoming dark brown then black when mature in 3% KOH or water. Ellipsoid or broadly ovoid, slightly amygdaliform in side view, smooth, thin-walled. Germ pore central, barely truncate to broadly truncate (strongly evident in some immature spores). *Basidia* 25–36 × 10–12 µm, clavate to cylindric, pedicellate with cylindric neck 3–4 µm broad, sterigmata up to 5 µm in length, 4-spored, collapsing, clamped at base. Spaced apart by swollen, vesiculose, thin-walled pavement cells up to 20 µm broad. *Lamellae trama* parallel, smooth-walled, hyphae 1.5–3 µm broad. *Subhymenium* hyphae similar to trama. *Pleurocystidia* 90–120 (175) × 25–50 µm, utriform, broadly lageniform, ventricose, largest cystidia often cylindrical with obtuse apex, all abruptly tapering near base to narrow septum, hyaline, smooth-walled, scattered singly, collapsing, clamped at base. *Cheilocystidia* 50–120 (175) × 22–45 µm, clavate with narrow neck 6–10 µm broad, broadly lageniform, hyaline, smooth-walled, sometimes with mucilaginous material adhering near apex, hyaline, crowded in young hymenium, collapsing, clamped at base. *Pileipellis* tightly-packed, parallel hyaline hyphae 2–9 µm broad, septa constricted, with clamp connections. *Pileus trama* similar hyphae merging with the pileipellis, inflated up to 30 µm broad. Scattered oily or glassy, sinuous hyphae up to 6 µm broad present. *Veil elements* interwoven, thin-walled hyphae 4–15 (20) µm broad. Mostly smooth-walled but some with minute encrustations. Some hyphae rarely branched, other types highly branched or with some short diverticulate projections or branches. *Clamp connections* present on most septa. (Figures 1, 2)

*Specimens examined.* Kings Park, Perth, in sand among weeds next to sand track north off Lovekin Drive near DNA tower broadwalk under *Allocasuarina fraseriana,* 2 June 1997, *N. Bougher & M. Bougher s.n.* (PERTH 07240562, formerly CSIRO E5834); Kings Park, Perth, in litter next to track under tuart (*Eucalyptus gomphocephala*), 13 June 1999, *N. Bougher & M. Bougher s.n.* (PERTH 07240570, formerly CSIRO E6058); Bold Park, Perth, 31° 56' 34.5" S 116° 46' 48.1" E, among weeds in tuart (*Eucalyptus gomphocephala*) open woodland south of Reabold Hill (near peg 3586), 4 July 1999, *N. Bougher & R. Wills s.n.* (PERTH 07240694, formerly CSIRO E6190); Yanchep National Park, Perth, 31° 33' 10.3" S 115° 41' 01.7" E, in organic humus at side of track among weeds in tuart (*Eucalyptus gomphocephala*) open woodland, limestone outcrops in vicinity, 15 June 2004, *N. Bougher & R. Hart s.n.* (PERTH 07240589, formerly CSIRO E8013); Star Swamp, Perth, 31° 50' 59" S 115° 45' 29" E, amid weeds near side of track in *Eucalyptus marginata* and *C. calophylla* woodland, 19 May 2005, *N. Bougher s.n.* (PERTH 07240708, formerly CSIRO E8174); Mindarie Bushland, Long Beach Promenade, Mindarie, Perth, amid weeds near side of limestone track in *Eucalyptus gomphocephala* open woodland, 19 June 2005, *N. Bougher &*

*J. Weaver s.n.* (PERTH 07240716, formerly CSIRO E8219); Rockingham Lakes Regional Park, Lake Cooloongup, South Cooloongup, Perth, 32° 17' 44.2" S 115° 46' 36.5" E, in litter under *Eucalyptus gomphocephala*, 21 June 2005, *N. Bougher & P. Davison s.n.* (PERTH 07240597, formerly CSIRO E8225); Warwick Open Space (near corner Warwick Rd and Lloyd Drive), Warwick, Perth, in mulch in the Warwick Leisure Centre carpark, near a patch of remnant *Corymbia calophylla* woodland, 26 June 2005, *K. Clarke & M. Brundrett s.n.* (PERTH 07240724 , formerly CSIRO E8239).

*Distribution and Habitat*. *Coprinopsis stangliana* has been confirmed only from the Perth region in Western Australia, but it or similar fungi may occur in other parts of Australia, e.g. a smaller-spored fungus labeled *Coprinus 'albosquamosus*' from South Australia (P. Catcheside, pers. comm.), and a fungus recently photographed as "*Coprinus picaceus* group" in East Gippsland, Victoria by K. Thiele**.** In WA this fungus produces conspicuous fruit bodies emerging well above the soil or litter, singly or in troops often clustered within small, discrete patches. It can be recognized by its large size and tall,


Figure 1. A – *Coprinopsis stangliana* (PERTH 07240589), Yanchep National Park. Note the thick veil enveloping the button stage, and irregular, mainly thin patches of veil on the mature fruit bodies; B – C: *Coprinopsis stangliana* (PERTH 07240694), Bold Regional Park. Note the weedy habitat, fallen leaves of tuart (*Eucalyptus gomphocephala*), and a native fringed lily (*Thysanotus*): B – immature fruit bodies; C – matured fruit bodies from same patch as shown in B; D – *Coprinopsis stangliana* (PERTH 07240597), Warwick Open Space. Note in these specimens the veil persists as thick, well-formed, quite uniform plaque-like patches that extend over much of the pileus.

hollow white stem, white veil patches on the grey, finely-grooved pileus, and the presence of at least some dull white rhizomorphs emerging from the swollen stem base and binding the humus. In dry conditions the veil persists as thick, well-formed, quite uniform plaque-like patches that extend over much of the pileus (Figure 1D). In wetter or moist conditions the plaques may be scarce on mature specimens (Figures 1A, B). Only zones of thin, appressed veil may then persist, especially near the pileus margin. The tall white stipe of older fruit bodies is topped with ragged, black, weeping remains of the pileus (Figure 1C).

*C. stangliana* produces abundant fruit bodies in many urban bushlands throughout the Perth region, particularly in tuart (*Eucalyptus gomphocephala*) or *Banksia*-dominated woodlands. The fungus has been observed almost exclusively in highly disturbed patches within the bushlands such as heavily weeded areas, aside of tracks in organic humus among weeds, or on recently piled earth. Up to 20 or more fruit bodies often cluster around the immediate vicinity of these sites but rarely beyond. This fungus often produces successive crops of fruit bodies over a sustained period during the main local fungal fruiting season (May – August).

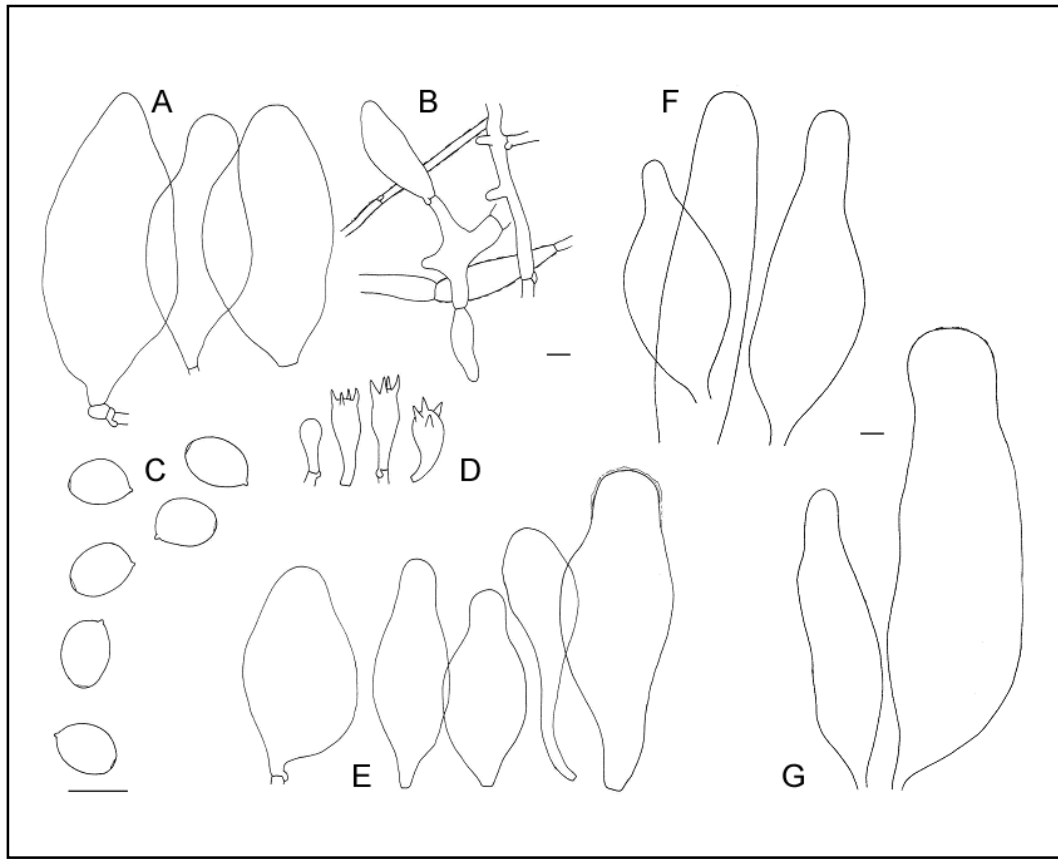


Figure 2. A–G: micromorphology of *Coprinopsis stangliana* (A–E all from PERTH 07240694): A – pleurocystidia; B – veil elements from the pileus of a mature fruit body; C – spores; D – basidia; E – cheilocystidia; F – pleurocystidia (PERTH 07240570); G – pleurocystidia (PERTH 07240589). Scale bars = 10 µm (longer bar for spores only).

*Affinities*. The hyphal pileipellis structure of this fungus aligns it with the genus *Coprinopsis* as defined by Redhead *et al*. (2001). Currently 12 species of *Coprinus* sensu lato reported in Australia are assignable to *Coprinopsis* (May *et al.* 2005). Of these species, the WA fungus described in this paper is closest to *C. picacea* but differs from that species in several significant attributes:

(a) All examined collections of the WA fungus have spores entirely or predominantly 10 µm or less broad. The possession of spores greater than 10 µm broad is the major character which distinguishes *C. picacea* from almost all other *Coprinus* species of section *Coprinus* subsection *Alachuani* (fungi with loosely attached veil composed of branched, diverticulate hyphae, Uljé and Noordeloos 1997).

(b) The veil of WA *Coprinopsis* does not form a neat pattern of uniform-sized and concentrically arranged thick scales characteristic of *C. picacea* (as usually illustrated as typical e.g. Dickinson and Lucas 1979; Breitenbach and Kränzlin 1995).

(c) The surface of the unexpanded cap of WA specimens is not as dark grey to black as is illustrated as typical of *C. picacea*.

(d) *C. picacea* reportedly has a "strong" odour (Orton and Watling 1979), described as "gas-like or like creosote" (Breitenbach and Kränzlin 1995), or "like that of mothballs, a hot grass pile, or burnt hair or rank" (Arora 1986). The WA fungus does not have a distinctive odour.

(e) Cystidia of the WA fungus (see Figure 2) are similar in size to those of *C. picacea* but are more predominantly lageniform and many have a prominent apical extension. The cystidia of *C. picacea* are variously described and illustrated as clavate-ventricose, utriform, ellipsoid, conical, cylindric, cylindric-vesiculose or fusiform (e.g. Orton and Watling 1979, Uljé and Noordeloos 1997, Breitenbach and Kränzlin 1995). Lageniform cystidia are not mentioned or illustrated for *C. picacea*, except by Orton and Watling (1979) for cheilocystidia which they describe as "cylindric or vesiculose to narrowly lageniform, 60–80 × 20–30µm".

Two other macroscopically similar species of the section *Coprinus* subsection *Alachuani,* but with spores less than 10 um broad, are *C. kimurae* (Hongo & Aoki) Redhead, Vilgalys & Moncalvo and *C. stangliana*. *C. kimurae* occurs on material such as straw, rotting coconut matting, cotton textiles, and differs from the WA specimens by having subglobose spores. *C. stangliana* has similar macroscopic and microscopic morphology to the WA fungus. For example, cystidia with an apical extension such as are abundant in the WA fungus match those illustrated by Bender & Enderle 1988, and Uljé and Noordeloos 1997 for *C. stangliana*. Ecological preference for basic soils may also point to a similarity between the WA fungus and *C. stangliana*. Like *C. picacea, C. stangliana* also occurs predominantly on calcareous soil, limestone and chalk (Uljé and Noordeloos 1997). The WA fungus appears to be particularly abundant in tuart (*Eucalyptus gomphocephala*) communities. Tuart is endemic to the Swan Coastal Plain and predominantly occurs on aeolian sands derived from underlying limestone (Keighery *et al*. 2002). *C. stangliana* recently has been reported in a Mediterranean climatic region (in Turkey, Kaya 2001). It may be expected to occur in other Mediterranean regions of the world, such as south-western Australia.

Several attributes differentiate the WA fungus from the current concept of *C. stangliana*. Members of *Coprinopsis* subsection *Alachuani* such as *C. picacea* and *C. stangliana* exhibit a capacity for high variability in size. The WA fungus also varies in size but its pileus (45–60 × 45–50 mm) is larger than the size range variously reported for *C. stangliana*, e.g. 15–40 × 10–25 mm (Uljé and Noordeloos 1997), up to 33 (45) × 30 (40) mm (Bender & Enderle 1988), 20–40 × 45 mm (Henrici and Laessøe 1993). Also the stipe of this fungus (100–200 × 10–20 mm) is larger than reported for *C. stangliana*, e.g. stipe up to 70 (120) mm long × 6 mm wide (Bender & Enderle 1988), up to 120 mm tall (Uljé and Noordeloos 1997), 40–120 × 10 mm (Henrici and Laessøe 1993). The spores of the WA *Coprinopsis*, 10.5–14 (14.5) × (7.7) 8–

10 (10.5) µm, overlap with, but extend beyond, the upper size ranges reported previously for *C. stangliana*. The spores of *C. stangliana* have been reported to be (8.6) 9.5–11.3 (12.5) × (6) 6.5–7.5 (8.5) µm (Bender & Enderle 1988), 8.6–12.6 × 6.1–8.9 µm (Uljé and Noordeloos 1997), 10–12.5 × 6.5–8.5 µm (Henrici and Laessøe 1993). Clarification of the relationships between the WA fungus, herein assigned as a robust form of *C. stangliana*, and other members of the section *Coprinus* subsection *Alachuani* will be undertaken in a molecular phylogenetic study.

## Recent introduction

It is surprising that this conspicuous fungus affiliated with *C. stangliana* previously has not been reported in Western Australia, or indeed Australia. Henrici and Laessøe (1993) expressed similar surprise upon the recent discovery for the first time of *C. stangliana* in Britain. Recent discovery in WA of *C. stangliana* would be less surprising if this fungus was either inconspicuous, or rare. However, it is distinctive, large, and occurs in troops observed in many bushlands of the Perth region over the past 10 years. This includes in well-studied bushlands such as Kings Park where intensive botanical and student mycological excursions have been undertaken annually since the early twentieth century. It is unlikely, though not impossible that this fungus simply had been overlooked in the bushlands (and elsewhere) before 10 years ago.

Aside from the absence of sightings until recently, several observations suggest that *C. stangliana* is rapidly spreading following a relatively recent introduction into the Perth region. The fungus produces a massive spore load, often heavily self-printing on the stem and blackening the surrounding litter, in restricted discrete highly disturbed patches within bushlands. Abundant insects observed in association with deliquescing fruit bodies may aid spore dispersal. In at least some cases observed over many successive years, the fruit bodies of this fungus have spread rapidly outwards from initially small foci. This is the case with an occurrence at Bold Regional Park observed over 6 successive annual fruiting seasons. Initially, during the first year of observation, scattered fruit bodies were confined to a patch of approximately 3 $m^2$. The area with fruit bodies expanded outwards by 3–5 metres each subsequent season. Climatic conditions varied and affected fruiting to different extents in different seasons, but during most seasons the fruit bodies occurred near the perimeter as well as scattered throughout the occupied area.

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