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Amanita austrostraminea (Agaricales, Amanitaceae), a variable species from southern Australia

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Abstract: *Amanita austrostraminea* D.A.Reid (*A. straminea* Cleland) has small fruiting bodies with yellow lamellae, ellipsoid to elongate spores and lacks clamp connections; it was described from South Australia. Another species with small fruiting bodies and yellow lamellae, *A. flaviphylla* O.K.Mill., has cylindrical spores and frequent clamp connections; it was described from Western Australia. Phylogenetic analysis of the nuclear ribosomal large subunit rRNA region, the nuclear ribosomal internal transcribed spacer region, β-tubulin, translation elongation factor 1-alpha and RNA polymerase II genes show that both these small species with yellow lamellae form a single, well supported clade. We synonymise *A. flaviphylla* with *A. austrostraminea* as a variable species from southern Australia which has ellipsoid to elongate to cylindrical spores and in which clamp connections may be present or absent. Sequences in GenBank from two collections from Hawaii and New Caledonia, named *A. austrostraminea* are not closely related to *A. austrostraminea* from southern Australia.

Keywords: Fungi, mushrooms, *Amanita*, Basidiomycota, Australia

Introduction

Amanita Pers. is a large, cosmopolitan genus of mushrooms which is well represented in Australia. They are ecologically important because the majority are believed to be mycorrhizal with woody plants. They are economically important because some have medicinal properties, some are traditional foods, whilst others are extremely poisonous (Cai *et al.* 2014; Wu *et al.* 2019). The genus is monophyletic (Cui *et al.* 2018), with agaricoid species defined by the field character of a membranous or friable universal veil, the microscopic characters of bilateral gill trama and acrophysalidic stipe trama, and the ontogenetic character of schizohymenial development (Bas 1969: 294).

The genus *Amanita* was recently revised by Cui *et al.* (2018) using a multi-molecular marker data set. They recognised three subgenera: *Amanita*, *Amanitina* (E.-J. Gilbert) E.-J.Gilbert, and *Lepidella* Beauseigneur, which can be separated by spore amyloidy and mycorrhizal or saprotrophic habit. Most Australian species have amyloid spores, are believed to be mycorrhizal, and are in subgenus *Amanitina*. This subgenus is divided into six sections: *Amidella* (E.-J.Gilbert) Konrad & Maubl., *Arenariae* Zhu L.Yang, Y.Y.Cui & Q.Cai, *Phalloideae* (Fr.) Quél., *Roanokenses* Singer ex Singer, *Strobiliformes* Singer ex Q.Cai, Zhu L.Yang & Y.Y.Cui and *Validae* (Fr.) Quél. These sections can be separated by the form of the pileus margin (appendiculate or non-appendiculate, striate or non-striate), whether there is a membranous volva at the stipe base, and presence or absence of clamp connections.

Most agaricoid amanitas have colourless spores and white or pale lamellae, however, there are several species where the gills are distinctly coloured. These include *A. brunneofolia* J.W.Jo, H.S.Kim, Y.N.Kwag & C.S.Kim and *A. ochroterrea* Gentilli ex Bas with brown lamellae, *A. carneiphylla* O.K.Mill., *A.roseolifolia* Y.Y.Cui, Q.Cai & Zhu L.Yang and *A. roseolamellata* A.E.Wood with pink lamellae, *A. ochrophylla* (Cooke & Massee) Cleland with cream to buff lamellae, *A. ochrophylloides* D.A.Reid with pale golden yellow lamellae, as well as *A. austroviridis* O.K.Mill. and *A. chlorophylla* A.E.Wood with green lamellae.

* Professor Elaine Davison was a highly regarded plant pathologist and mycologist. She was an inspiration to all scientists she engaged with, providing mentorship and sharing her knowledge and expertise even after retirement. Throughout her 50 plus years of teaching and research she contributed to 62 scientific publications, notably describing 11 new *Amanita* species found within Australia. The present paper, completed in the days before her death, is a fitting tribute to a most distinguished career.

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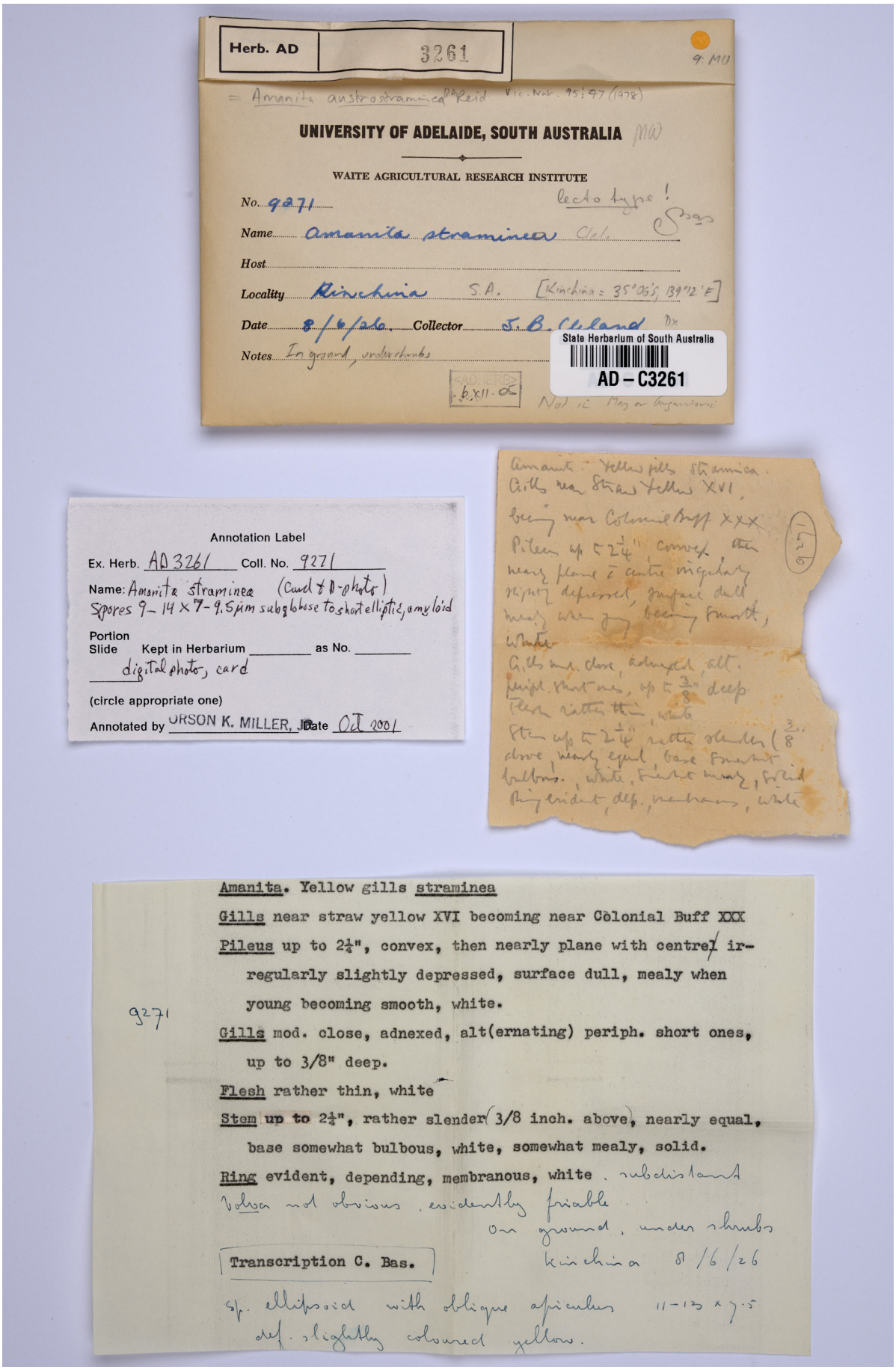
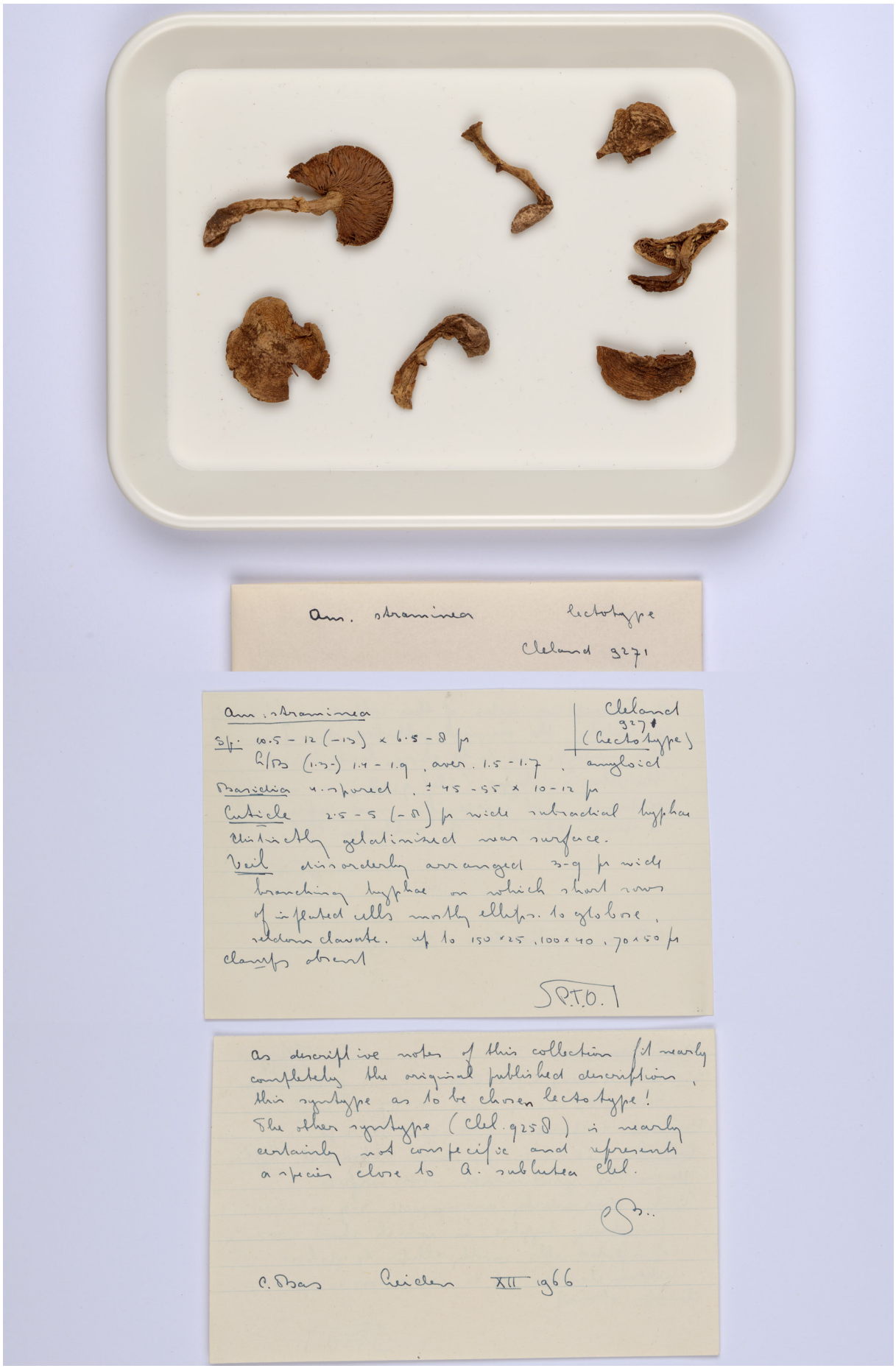


Fig. 1. Lectotype of ***Amanita austrostraminea*** (*J.B. Cleland 9258*; AD-C3261), with annotations by J.B. Cleland (1926), C. Bas (1966), D.A. Reid (1978) and O.K. Miller (2001). Imaged with permission from H. Vonow (AD) by J. Percy-Bower (PERTH).



Am. straminea lectotype
Cleland 3271

Am. straminea
Cleland 3271 (lectotype)
Sp: 10.5 - 12 (-13) x 6.5 - 8 µ
Q/Bs (1.3-) 1.4 - 1.9, aver. 1.5 - 1.7, amyloid
Basidia 4-spored, ± 45 - 55 x 10 - 12 µ
Cuticle 2.5 - 5 (-8) µ wide subradial hyphae
distinctly gelatinized near surface.
Veil disorderly arranged 3-9 µ wide
branching hyphae on which short rows
of inflated cells mostly elliptic to globose,
rebound clavate. up to 150 x 25, 100 x 40, 70 x 50 µ
clamps absent

SPTO. 1

As descriptive notes of this collection fit nearly
completely the original published descriptions,
this syntype as to be chosen lectotype!
The other syntype (Cleland 9258) is nearly
certainly not conspecific and represents
a species close to A. sublutea Cleland.

C. Bas Leiden XII 1966

Fig. 1. continued

Fig. 2. Isotype of ***Amanita flaviphylla*** (*O.K. Miller Jr. OKM 24002, H.H. Miller & N.L. Bougher*; PERTH07547676) with annotations by E.M. Davison. Image by J. Percy Bower (PERTH).

A species with yellow lamellae was described from Kinchina and Encounter Bay in South Australia (S.A.). in 1927 as *A. straminea* Cleland (Cleland 1927) (Fig. 1). Reid (1980) introduced the replacement name *A. austrostraminea* D.A.Reid, because he thought *A. straminea* Cleland was preoccupied by *A. straminea* Secr., but in fact, it is a homonym of the earlier *A. straminea* Lam. (and Secretan's name is invalid). A detailed description of *A. austrostraminea* was given by Bas (1969: 513–515, as *A. straminea*), indicating it has small fruiting bodies and ellipsoid to elongate amyloid spores, and that clamp connections are absent. Another species with small fruiting bodies, yellow lamellae and amyloid spores, *A. flaviphylla* O.K.Mill., was described from the south coast of Western Australia (W.A.) (Miller 1991) (Fig. 2). This species has cylindrical spores and frequent clamp connections. Thus, there are two species with yellow lamellae that can be separated by spore shape and presence or absence of clamp connections. Additional collecting in both S.A. and W.A. however, has shown that clamp connections may occasionally be present in collections with ellipsoid spores, or absent from collections with cylindrical spores (Tab. 1).

In this paper we determine the placement of these collections with yellow lamellae within subgenus *Amanitina* using the nuclear ribosomal large subunit rRNA (28S) region, because this is the only region available from GenBank for a significant number of type collections for species within subgenus *Amanitina*. We have used other gene regions used by Cui *et al.* (2018), β-tubulin, translation elongation factor 1-alpha (*tef1-α*) and RNA polymerase II (*rpb2*), to examine the relationship between selected species within section *Roanokenses*. We have assessed the variation between clones of the nuclear ribosomal internal transcribed spacer region (ITS) of the collections to see whether they form separate clades. On the basis of the molecular

Table 1. Spore dimensions and presence of clamp connections in collections of small Australian species with yellow lamellae. Biometric variables for spores follow Tulloss (2000), see methods.

Collection number	Sample size	L (µm)		W (µm)		Q		Shape	Clamp connections
		Mean	Range	Mean	Range	Mean	Range		
AD-C3261 (Lectotype)	20/1	11.2	(10–) 10.5–12	6.55	6-7 (–8)	1.71	(1.50–) 1.57–1.92	Elongate	-
AD-C3261 (Lectotype) (Bas 1969: 514)	30/4		10.5–12 (–13.5)		(6–) 6.5–8		1.4–1.9	Ellipsoid to elongate	-
AD-C03257	20/1	10.5	9-12	5.5	5–6	1.92	(1.50–) 1.67–2.4	Elongate to cylindrical	-
AD-C03257 (Bas 1969: 514)			9.5–12		5–6.5				-
AD-C03262	20/1	12.6	11–14	6.45	(5.5–) 6–7	1.96	1.71–2.17 (–2.36)	Elongate to cylindrical	-
AD282269	20/1	10.15	9–11	5.05	5–5.5	2.01	1.80–2.20	Elongate to cylindrical	-
AD282270	20/1	8.55	(7–) 7.5–10	5.75	5–6	1.49	(1.27–) 1.33–1.67	Ellipsoid to elongate	+
AD282272	20/1	11.8	(10–) 10.5–13 (–13.5)	5.3	5–6	2.21	(1.91–) 2.00–2.40	Cylindrical	+
All S.A. collections	**100/5/5**	**11.2**	**(9–) 9.5–13 (–14)**	**5.8**	**5–7 (–8)**	**1.96**	**(1.50–) 1.57–2.36 (–2.40)**	**Ellipsoid to cylindrical**	**+ or -**
PERTH02241722	20/1	11.5	(10–) 10.5–13	5.6	5–6	2.06	1.83–2.20 (–2.40)	Elongate to cylindrical	+
PERTH05031435	20/1	11.1	10–12 (–12.5)	5.15	4.5–5.5 (–6)	2.16	(1.82–) 1.83–2.40 (–2.44)	Elongate to cylindrical	+
PERTH05254892	20/1	10.7	10–11.5 (–12)	5.3	5–6	2.03	1.82–2.20	Elongate to cylindrical	+
PERTH05505925	20/1	12.0	11–13	5.4	(4.5–) 5–6	2.23	(1.92–) 2.00–2.40 (–2.44)	Cylindrical	+
PERTH07547676 (Isotype)	20/1	12.5	(11–) 11.5–13 (–13.5)	5.3	5–5.5	2.34	(2.00–) 2.18–2.60	Cylindrical	+
PERTH07574312	20/1	10.9	10–12	5.25	5–5.5 (–6)	2.08	2.00–2.20 (–2.40)	Cylindrical	+
PERTH07660235	20/1	11.6	(10.5–) 11–12.5	5.3	(4.5–) 5–5.5	2.20	(1.91–) 2.00–2.40 (–2.67)	Cylindrical	+
PERTH08105480, immature									
PERTH10000305, immature									+
PERTH10000291	100/5	10.1	(8–) 8.5–11.5 (–12)	5.6	5–6 (–6.5)	1.80	(1.45–) 1.58–2.00 (–2.18)	Elongate to cylindrical	-
PERTH10000313	20/1	9.8	8.5–11	6.8	6.5–7.5	1.45	(1.29–) 1.31–1.67	Ellipsoid to elongate	+
All W.A. collections	**260/13/9**	**10.8**	**(8–) 9–13 (–13.5)**	**5.6**	**(4.5–) 5–6.5 (–7.5)**	**1.97**	**(1.29–) 1.47–2.40 (–2.67)**	**Ellipsoid to cylindrical**	**+ or -**

evidence, we synonymise *A. flaviphylla* with *A. austrostraminea* and provide an updated description of its diagnostic features.

In GenBank there are currently four nucleotide sequences from two collections named *A. austrostraminea*. One of these collections is from Hawaii (voucher RET 553-7, http://www.tullabs.com/amanita/?Amanita%20austrostraminea), the other from New Caledonia (voucher 09.354). We have included these sequences in our phylogenies to determine whether *A. austrostraminea* is more widely distributed than originally thought, or whether these collections have been incorrectly assigned to this species.

Materials and methods

Phylogenetics. DNA extraction, amplification and cloning of the ITS and amplification of the β-tubulin, 28S, *tef1-α* and *rpb2* gene regions follows the methodology of Davison *et al.* (2013, 2017). PCR product was sent for dual direction sequencing using the commercial services of Australian Genome Research Facility (Perth node) using Big Dye® Terminator v3.1 Cycle Sequencing Kit in accordance with ABI protocols (Applied Biosystems, Foster City, California, USA).

The forward and reverse sequences were assembled with Geneious (version 12.2.6, https://www.geneious.com/; Kearse *et al.* 2012) using the Geneious Alignment option (settings set to automatically determine sequence direction, cost matrix 65% similarity, gap open penalty 12, gap extension penalty 3) to generate a single consensus sequence.

Additional 28S sequences from subgenus *Amanitina* that were used for placement of *Amanita austrostraminea* and *A. flaviphylla* within a section, together with ITS, β-tubulin, *tef1-α* and *rpb2* gene regions from named species from section *Roanokenses* identified as being somewhat similar through a Blastn search, were accessed from GenBank (https://www.ncbi.nlm.nih.gov/; accessed 19 Dec. 2025) (App. 1, 2).

Maximum likelihood phylogenetic trees were built using MEGA version 5.05 (Tamura *et al.* 2011) following alignment with MUSCLE (Edgar 2004). The best model for each dataset was selected using the Model Function. The Kimura 2-parameter model (Kimura 1980) with a gamma distribution rate was used to place the collections in subgenus *Amanitina* using the 28S gene region. This phylogenetic tree was rooted in *A. subglobosa* (subg. *Amanita* sect. *Amanita*). The Tamura 3-parameter model (Tamura 1992) with a gamma distribution rate was used for the ITS region. The Kimura 2-parameter model (Kimura 1980) with invariant sites was used for the *rpb2* and *tef1-α* gene regions, and with a gamma distribution rate for the β-tubulin gene region. The Tamura-Nei model (Tamura & Nei 1993) with a gamma distribution rate was used for concatenated 28S, *rpb2*, *tef1-α* and β-tubulin sequences. These phylogenetic trees were rooted in *A. djarilmari* (subg. *Amanitina* sect. *Phalloideae*).

The difference between cloned haplotypes of the ITS region were obtained from the Distance Matrix: % Identity of an alignment in Geneious and are presented as a contingency table (Tab. 2).

Taxonomy. The methodology for describing the macroscopic and microscopic characters largely follows Tulloss (2000). Colour names, for the colour of spores in deposit and other shades of white to cream (designated by the letters A–G), follow Royal Botanic Garden Edinburgh (1969), whilst other colour codes are from Kornerup and Wanscher (1983). In the descriptions of basidiospores (and basidia) the notation [x/y/z] denotes x basidiospores measured from y basidiomes from z collections. Biometric variables for spores follow Tulloss (2000), specimen = basidiome, i.e.

L = the average spore length computed for one specimen examined, **L'** = the average spore length computed for all spores measured, **W** = the average spore width computed for one specimen examined, **W'** = the average spore width computed for all spores measured, Q = the ratio of length / width for one spore, **Q** = the average value of Q computed for all

Table 2. Percentage difference in the internal transcribed spacer (ITS) region within and between collections of *Amanita austrostraminea* based on cloned sequences.

	No. clones	AD282269	AD282270	AD282272	PERTH 10000313	PERTH 05254892	PERTH 07574312	PERTH 10000291
AD282269	4	0.2–0.7						
AD282270	5	15.2–16.3	0.3–2.2					
AD282272	5	13.1–15.1	10.4–12.7	0.5–4.1				
PERTH 10000313	5	13.6–14.7	9.9–11.3	10.4–11.6	0.5–1.4			
PERTH 05254892	1	14.0–14.5	14.0–14.5	1.7–2.8	10.4–10.8			
PERTH 07574312	5	14.2–15.3	10.5–12.8	0.7–4.6	10.5–12.0	0.7–4.0	0.2–4.8	
PERTH 10000291	4	13.8–14.6	13.3–14.7	11.6–14.3	10.5–12.0	11.6–14.3	12.7–14.5	0.3–5.0

spores of one specimen examined, **Q'** = the average value of Q computed for all spores measured.

Tulloss (2000) also notes that spores

> should always be measured in lateral view with apiculus and both ends of the spore all in focus. When presenting a range of measurements of the form (a–) b–c (–d), the numbers have the following meanings: a = the smallest value encountered, b = the greatest measured value such that at least 95% of all spores measured yielded a number greater than or equal to b, c = the least measured value such that at least 95% of all spores measured yielded a number less than or equal to c, d = the largest value measured.

Results

Placement of small Australian species with yellow lamellae within subgenus *Amanitina*

28S is the only gene region available from GenBank for all the type species from the six sections within subgenus *Amanitina*. These, together with additional species, have been used to determine their affinities within the subgenus (App. 1). Phylogenetic analysis using the maximum likelihood method (811 base pair positions) shows the collections from southern Australia with yellow lamellae form a clade with good bootstrap support (BS 93), within section *Roanokenses* (Fig. 3). The spore dimensions and presence of clamp connections are given in Tab. 1. From here on they are referred to as *Amanita austrostraminea*.

The two *A. austrostraminea* sequences from GenBank (MK277513, OR545959) do not form a clade with the small Australian species with yellow lamellae. The collection from New Caledonia forms a poorly supported clade with the New Zealand species *A. australis* G.Stev. and the Australian species *A. cretaceaverruca* E.M.Davison & Giustiniano, while the position of the Hawaiian collection is unresolved (Fig. 3).

Comparison of ITS and other gene regions from S.A. and W.A. collections

ITS. The ITS region is between 569 and 615 base pairs long for the seven collections of *A. austrostraminea* from southern Australia for which ITS amplicons are

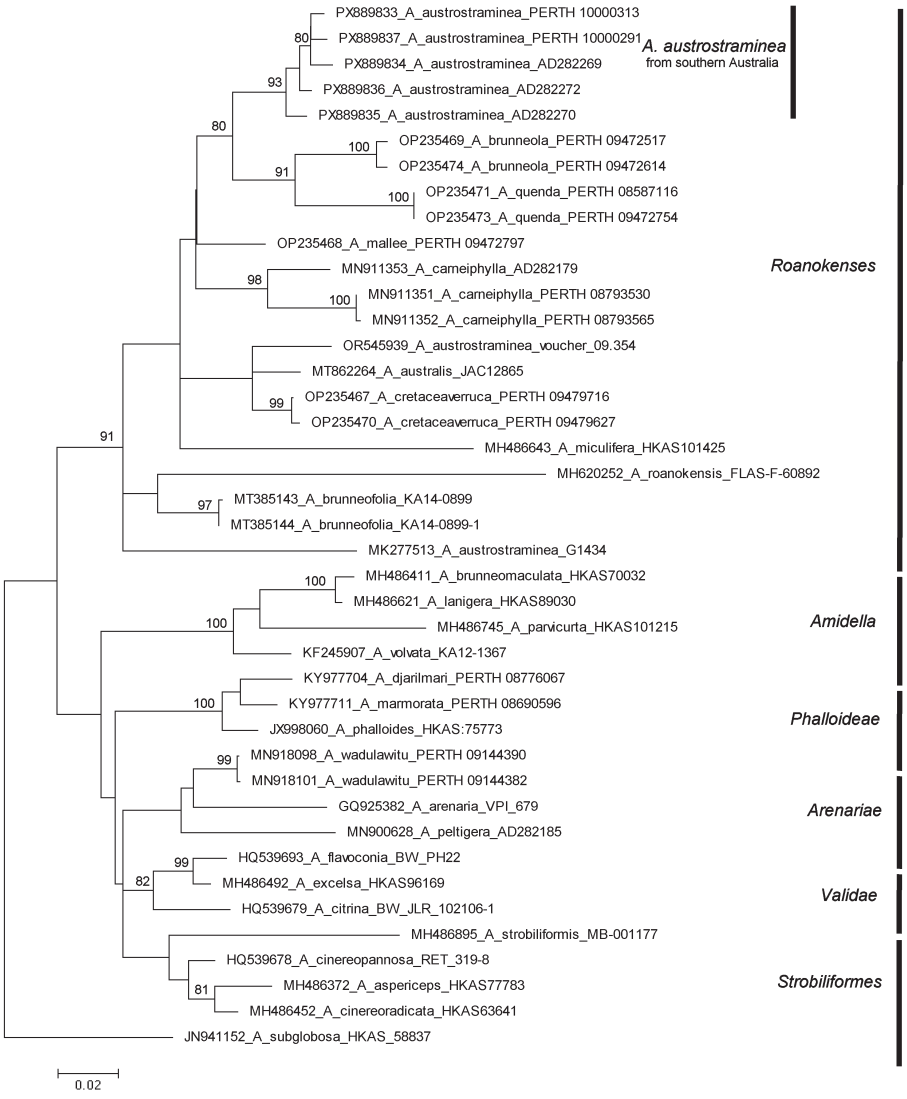


Fig. 3. Molecular phylogenetic analysis by the maximum likelihood method of 28S sequences from all sections in subgenus *Amanitina*. The tree is drawn to scale with branch lengths measures in the number of substitutions per site. It is rooted in *A. subglobosa* (subg. *Amanita* sect. *Amanita*). Each section is highlighted in black. All bootstrap values less than 80% have been deleted. In all phylogenies, samples from S.A. were accessioned in AD and samples from W.A. at PERTH.

available (App. 2). Within a collection the difference between clones is 0.2–5.0% (Tab. 2). Between collections the difference is up to 15.3%. (Other work has shown similar differences between haplotypes of the same species (Davison *et al.* 2025)). Phylogenetic analysis by the maximum likelihood method (550 base pair positions) shows that there are two subclades, one of which has good bootstrap support (BS 88) (Fig. 4). Collections from S.A. and W.A. fall within both clades.

Other gene regions. Additional gene regions (*rpb2*, *tef1-α* and β-tubulin) are available for some collections of *A. austrostraminea* (App. 2). Phylogenetic analysis by the maximum likelihood method shows that for the *rpb2* gene region (490 base pair positions), *A. austrostraminea* from southern Australia form a well-supported clade (BS 83); the sequence from the New Caledonia collection forms a clade with *A. australis* and *A. cretaceaverruca* (Fig. 5A). For the *tef1-α* gene region (468 base pair positions), *A. austrostraminea* from southern Australia forms a well-supported clade (BS 99), whilst the sequence from the New Caledonia collection forms a well-supported clade (BS 99) with *A. australis* and *A. cretaceaverruca* (Fig. 5B). The phylogenetic tree for the β-tubulin gene region (233 base pair positions), shows that *A. austrostraminea* from southern Australia form a well-supported clade (BS 89) (Fig. 5C). Concatenated sequences (2147 base pair positions) show a similar pattern, *A. austrostraminea* from southern Australia form a well-supported clade (BS 100) (Fig. 5D).

The collections of '*A. austrostraminea*' from Hawaii and New Caledonia appear to have been wrongly named.

Amended description of *Amanita austrostraminea*

Amanita austrostraminea D.A.Reid

Vict. Naturalist 95(2): 47 (1978), as "*austro-straminea*". — *Amanita straminea* Cleland, *Trans. Roy. Soc. South Australia* 51: 299 (1927) [MB278931], *nom illeg.*, *non* Lam., *Encycl.* 1(1): 106 (1783) [MB494920]. — *Aspidella straminea* E.-J.Gilbert in Bresadola, *Iconogr. Mycol. (Milan)* 27(1) [*Suppl.* I]: 79 (1940) [MB284333]. — **Type citation:** "On the ground under shrubs. S.A.–Kinchina, June 8, 1926; Encounter Bay". **Lectotype:** South Australia, Kinchina, 8 June 1926, *J.B. Cleland 9271* (AD-C3261! ex ADW), *fide* Bas, *Persoonia* 5: 514 (1969). **Remaining syntype:** South Australia, Encounter Bay, *s.dat.*, *J.B. Cleland 9258* (AD-C03257).

Mycobank number: MB308540.

Amanita flaviphylla O.K.Mill., *Canad. J. Bot.* 69(12): 2696 (1991) [MB358168]. — **Holotype:** Nut Road, Denmark [Walpole-Nornalup National Park (N.P.)], 21 June 1989, *O.K. Miller Jr. OKM 24002, H.H. Miller & N.L. Bougher* (VPI). **Isotype:** PERTH07547676.

Illustrations. Bas, *Persoonia* 5: 515, Figs. 294–296 (1969). Bougher & K.Syme, *Fungi of southern Australia* 166–167 (1998).

Diagnostic features. Very small to small fruiting bodies which have an ivory to yellowish white to dull yellow

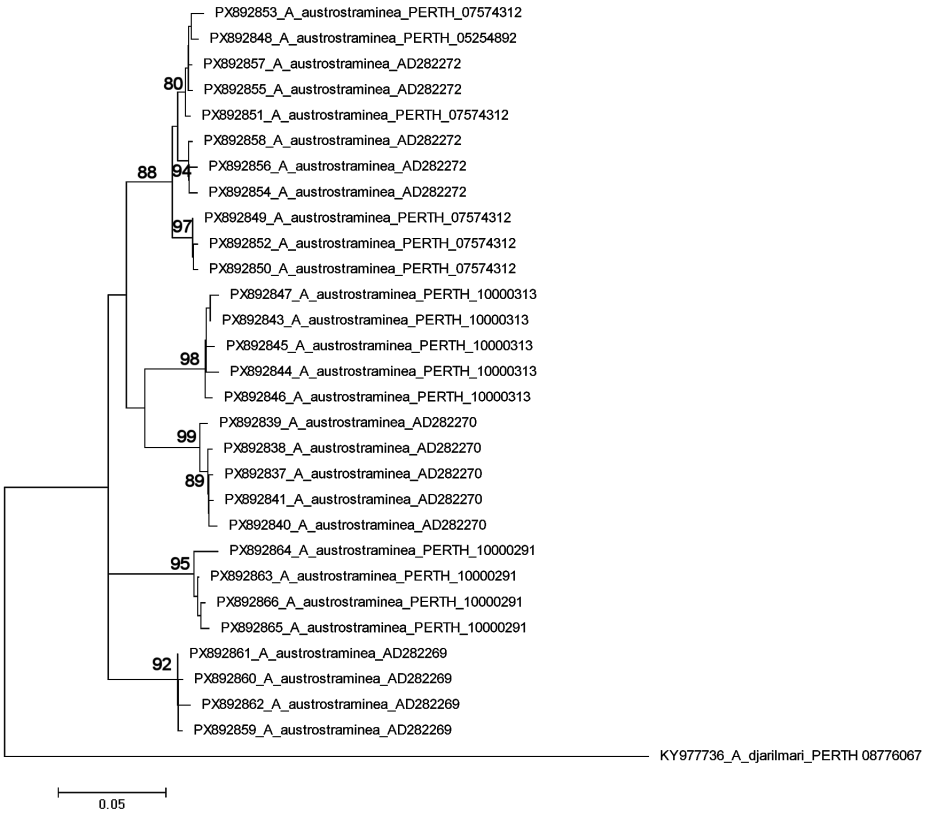
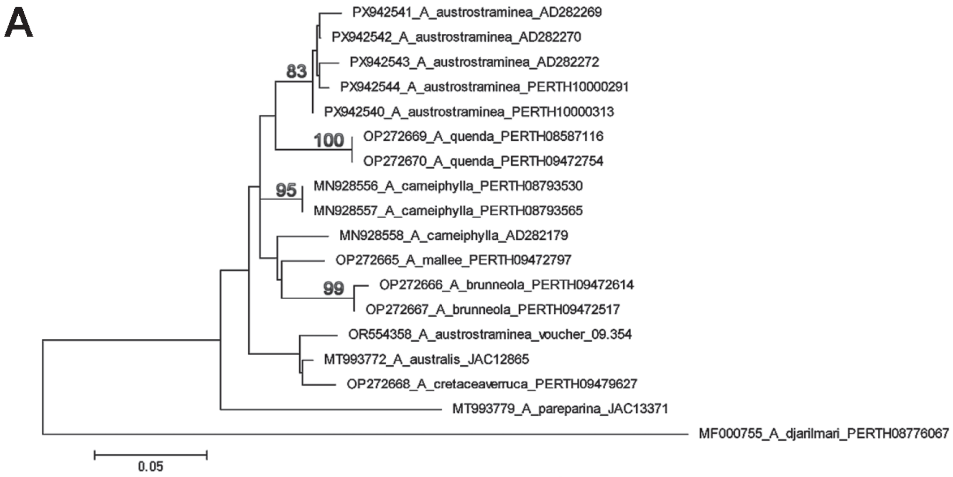
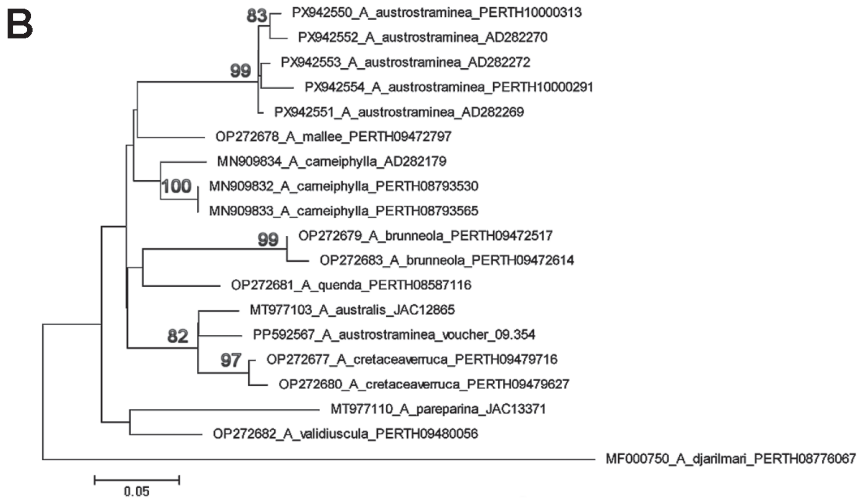
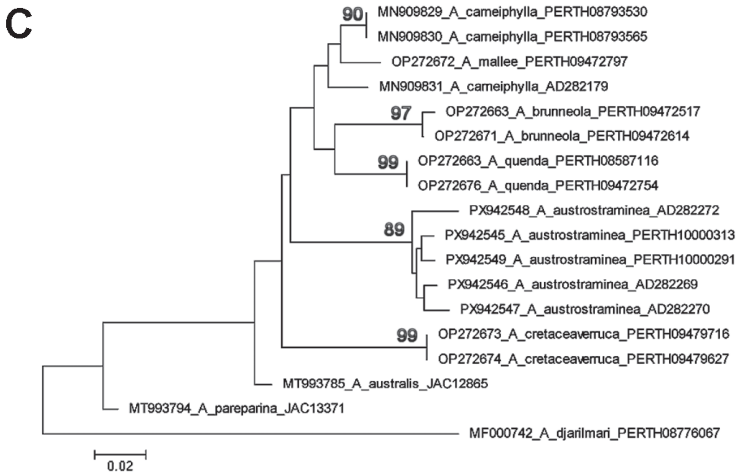


Fig. 4. Molecular phylogenetic analysis by the maximum likelihood method of ITS clones from *Amanita austrostraminea* from southern Australia. The tree is drawn to scale with branch lengths measures in the number of substitutions per site. It is rooted in *A. djarilmari*. All bootstrap values less than 80% have been deleted.







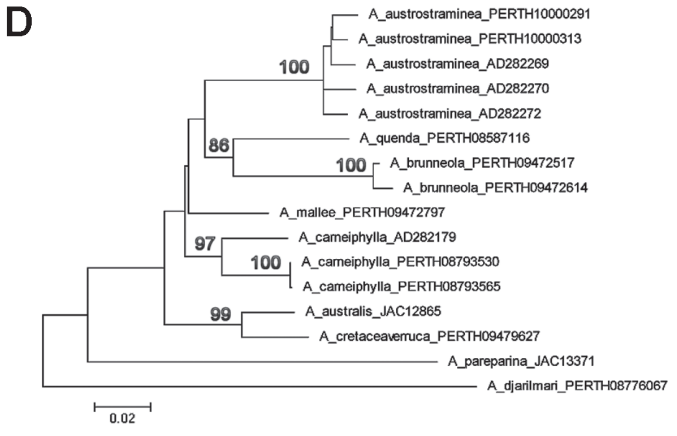


Fig. 5. Molecular phylogenetic by the maximum likelihood method of *Amanita austrostraminea* collections from S.A. and W.A. **A** *rpb2* gene region; **B** *tef1-α* gene region; **C** β-tubulin gene region; **D** Concatenated sequences of 28S, β-tubulin, *tef1-α*, *rpb2* gene regions. The trees are drawn to scale with branch lengths measures in the number of substitutions per site. They are rooted in *Amanita djarilmari*. All bootstrap values less than 80% have been deleted.

Fig. 6. *Amanita austrostraminea*. *E.M. & P.J.N. Davison, EMD 73-2021* (PERTH10000291). Photo: E.M. Davison.

to greyish yellow to light grey pileus. The universal veil is thin, forming concolorous floccose patches. The lamellae are initially ivory, becoming cream to pale ochraceous to straw to lemon yellow to luteous. The stipe is ivory to cream to yellowish cream to light yellow with a similar coloured superior, membranous partial veil. The bulb is globose or ovoid, sometimes with floccose remains of the universal veil at the top. The flesh is white or cream or yellow. There is no distinctive smell. The spores are amyloid, ellipsoid to elongate to cylindrical. Clamp connections are present or absent. **Figs. 6, 7.**

Other specimens examined

SOUTH AUSTRALIA. **Kangaroo Island:** Church Road, opposite Walsh Track, 8.7 km from Karatta, 25 July 2014, *J.F. Haska JHAR 588* (AD282269); Church Road, 8.37 km N Karatta, 28 July 2015, *J.F. Haska JHAR 676* (AD282270); Kelly Hill Conservation Park, S of Karatta, South Coast Rd, 25 Aug. 2017, *J.F. Haska JHAR 918* (AD282272). **South-Eastern:** Meningie, Sep. 1956, *L.D. Williams 64* (AD-C03262).

WESTERN AUSTRALIA. South Sister Reserve [City of Albany], 3 Oct. 1993, *E.M. Davison s.n.* [*EMD 4-2019*] (PERTH05031435); Whicher Block, Shire of Busselton, 6 June 2019, *E.M. & P.J.N. Davison EMD 22-2019* (PERTH10000305); Dryandra forest, Shire of Cuballing, 18 May 2016, *E.M. & P.J.N. Davison EMD 31-2016* (PERTH10000313); Blue Rock, Jarrahdale, Shire of Serpentine Jarrahdale, 19 July 2021, *E.M. & P.J.N. Davison EMD 73-2021* (PERTH10000291); corner of Seaton Ross Rd and Corbalup Rd, near Manjimup [Shire of Bridgetown-Greenbushes], 28 May 1991, *O.K. & H.H. Miller, L. & M. Bailey OKM 24656* (PERTH02241722); Two Peoples Nature Reserve, Firebreak Gully track, past last barrier heading towards sea [City of Albany], 6 Aug. 1991, *K. Syme, V. Kermode & P. Davis KS 315/91* (PERTH5254892); Walpole-Nornalup N.P., corner of Nut Rd and Ficifolia Rd [Shire of Denmark], 5 Aug. 1992, *K. Syme KS 611/92*

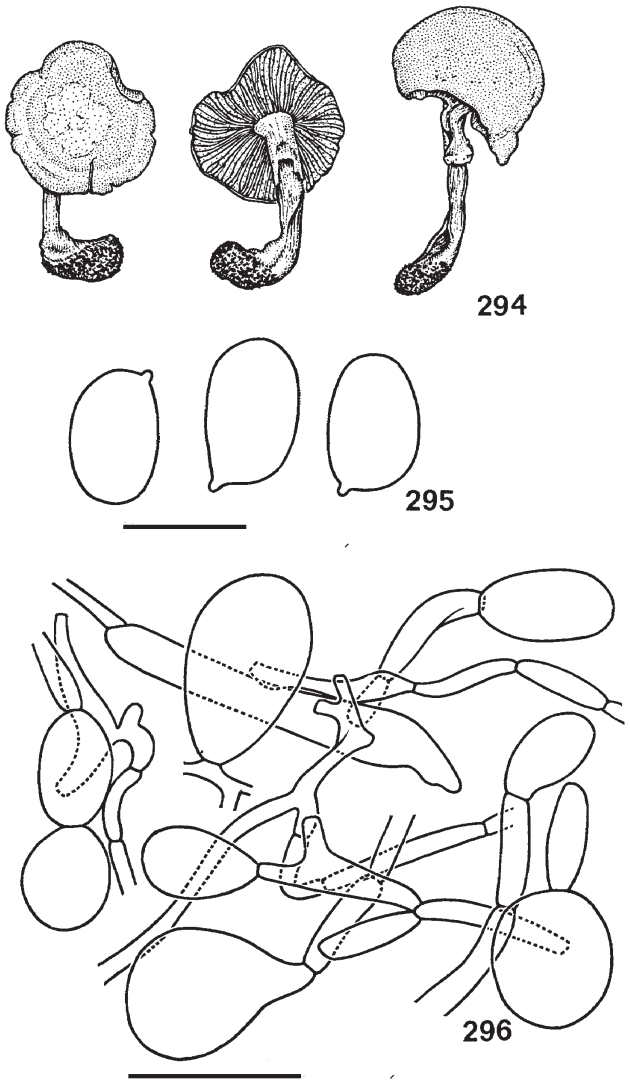


Fig. 7. *Amanita austrostraminea*, lectotype, modified from Bas (1969: 515; as *A. straminea*). **294** Dried fruiting bodies; **295** basidiospores; **296** crushed volval remnants from pileus. Scale bars = 10 µm (295), 50 µm (296). *J.B. Cleland 9271* (AD-C3261).

(PERTH5505925); Walpole-Nornalup N.P., corner Nut and Ficifolia roads [Shire of Denmark], 7 June 1992, *K. Syme & N.L. Bougher s.n.* [*E4780*] (PERTH07660235); Cape Knob Peninsula, Mt Remarkable, Bremer Bay [Shire of Jerramungup], 30 Aug. 2007, *K. Syme KS 2077* (PERTH08105480).

Discussion

Our examination of collections of *Amanita austrostraminea* from southern Australia shows its micro-anatomy is more variable than envisaged by Bas (1969) or Miller (1991). Our sequencing shows that these collections form a single clade with no geographic separation between collections from S.A. or W.A. Similarly, presence or absence or clamp connections and spore shape show no geographic separation (Tab. 1):

We conclude that *A. austrostraminea* is a single, variable species.

There appear to be at least two more species with yellow lamellae in the Pacific region, as illustrated by sequences from collections RET 553-7 from Hawaii and 09.354 from New Caledonia (App. 1). These collections require further investigation.

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Appendix 1. GenBank numbers for nuLSU sequences, including type species, from the different sections of *Amanita* subgenus *Amanitina*. Sequences in bold have been generated for this work.

Section	*Amanita* sp.	Voucher number	Location	Collector	Date	28S
Amidella	*A. volvata* (Peck) Lloyd	KA12-1367	Gyeongbuk, Korea		6 Sep. 2012	KF245907
	A. brunneomaculata Zhu L. Yang, Y.Y. Cui & Q. Ca	HKAS70032	Yunnan, China	Qing Cai	29 July 2011	MH486411
	A. lanigera Y.Y. Cui, Q. Cai & Zhu L. Yang	HKAS89030	Yunnan, China	Gang Wu	9 July 2014	MH486621
	A. parvicurta Y.Y. Cui, Q. Cai & Zhu L. Yang	HKAS101215	Yunnan, China	Zhu L. Yang	30 Aug. 2017	MH486745
Arenariae	*A. arenaria* (O.K. Mill. & E. Horak) Justo	VPI679 (Holotype)	City of Albany, W.A.	O.K. Miller	22 June 1989	GQ925382
	A. wadulawitu McGurk, E.M.Davison & E.L.J.Watkin	PERTH 09144404	City of Melville, W.A.	E.M. & P.J.N. Davison	26 Apr. 2015	MN918100
	A. peltigera D.A.Reid	AD282185	Kangaroo Island, S.A.	J.F. Haska	16 May 2015	MN900628
	A. wadulawitu	PERTH 09144382	Shire of Esperance, W.A.	K.J. Knight	29 Mar. 2018	MN918101
Phalloideae	*A. phalloides* (Vaill. ex Fr.) Link	HKAS75773	China			JX998060
	A. djarilmari E.M. Davison	PERTH 08776067	Shire of Cuballing, W.A	E.M. & P.J.N. Davison	18 Apr. 2016	KY977704
	A. marmorata Cleland & E.-J.Gilbert	PERTH 08690596	Shire of Denmark, W.A.	K. Syme	8 May 2014	KY977711
Roanokenses	*A. roanokensis* Coker	FLAS-F-60892	Florida, USA	R. Healy, B. Kaminsky, D. Borland, N. Kraisitudomsook	14 June 2017	MH620252
	A. australis G.Stev.	JAC12865				MT862264
	A. austrostraminea	09.354	New Caledonia			OR545939
	A. austrostraminea	RET 553-7	Hawaii, USA			MK277513
	A. brunneofolia J.W.Jo, H.S.Kim, Kwag & ChangS.Kim	KA-0899	South Korea		29 Aug. 2019	MT385143
	A. brunneofolia	KA-0899-1	South Korea		30 Aug. 2019	MT385144
	A. brunneola E.M.Davison & Giustiniano	PERTH 09472517	City of Melville, W.A.	E.M. & P.J.N. Davison	14 June 2020	OP235469
	A. brunneola	PERTH 09472614	City of Cockburn, W.A.	E.M. & P.J.N. Davison	30 May 2010	OP235474
	A. carneiphylla O.K.Mill.	PERTH 08793530	City of Melville, W.A.	E.M. & P.J.N. Davison	8 May 2016	MN911351

Appendix 1. continued

Section	*Amanita* sp.	Voucher number	Location	Collector	Date	28S
	A. carneiphylla	PERTH 08793565	Shire of Cuballing, W.A.	E.M. & P.J.N. Davison	18 May 2016	MN911352
	A. carneiphylla	AD282179	Kangaroo Island, S.A.	J.F. Haska	7 May 2016	MN911353
	A. cretaceaverruca E.M.Davison & Giustiniano	PERTH 09479716	City of Melville, W.A.	E.M. & P.J.N. Davison	3 July 2011	OP235467
	A. cretaceaverruca	PERTH 09479627	Shire of Manjimup, W.A.	E.M. & P.J.N. Davison	2 June 2013	OP235470
	A. mallee E.M.Davison, Giustiniano & M.D.Barrett	PERTH 09472797	Shire of Coolgardie, W.A.	M.D. Barrett	13 Dec. 2013	OP235468
	A. miculifera Bas & Hatan	HKAS 101425				MH486643
	A. quenda E.M.Davison	PERTH 08587116	City of Melville, W.A.	E.M. & P.J.N. Davison	27 July 2011	OP235471
	A. quenda	PERTH 09472754	City of Melville, W.A.	E.M. & P.J.N. Davison	8 Aug. 2012	OP235473
Strobiliformes	*A. strobiliformis* (Paulet ex Vittad.) Bertill.	MB-001177	Germany			MH486895
	A. aspericeps Y.Y. Cui, Q. Cai & Zhu L. Yang	HKAS77783	Guangdong, China	Fang Li	13 Sep. 2012	MH486372
	A. cinereopannosa Bas	RET 318-8	Maine, USA			HQ539678
	A. cinereoradicata Y.Y. Cui, Q. Cai & Zhu L. Yang	HKAS63641	Yunnan, China	Jiao Qin	10 Jul 2010	MH486452
Validae	*A. excelsa* (Fr.) Bertill.	HKAS96169	Austria			MH486492
	A. citrina Pers.	BW JLR 102106-1	New Jersey, USA			HQ539679
	A. flavoconia G.F. Atk.	BW_PH22	Massachusetts, USA			HQ539693
Amanita	*A. subglobosa* Zhu L. Yang (outgroup)	HKAS58837	China	Q. Cai	29 Aug. 2009	JN941152
	A. austrostraminea	AD282269	Kangaroo Island, S.A.	J.F. Haska	25 July 2014	**PX889834**
	A. austrostraminea	AD282270	Kangaroo Island, S.A.	J.F. Haska	28 July 2015	**PX889835**
	A. austrostraminea	AD282272	Kangaroo Island, S.A.	J.F. Haska	25 Aug. 2017	**PX889836**
	A. austrostraminea	PERTH 10000313	Shire of Cuballing, W.A.	E.M. & P.J.N. Davison	18 May 2016	**PX889833**
	A. austrostraminea	PERTH 10000291	Shire of Serpentine-Jarrahdale, W.A.	E.M. & P.J.N. Davison	19 July 2021	**PX889837**

Appendix 2. GenBank numbers for ITS clones, β-tubulin, *tef1-α* and *rpb2* gene regions for small species with yellow lamellae from S.A. and W.A. and other species from section *Roanokenses*. Sequences in bold have been generated for this work.

***Amanita* sp.**	**Voucher number**	**Location**	**Collector**	**Date**	**GenBank numbers**			
					ITS	**β-tubulin**	***tef1-α***	***rpb2***
A. australis	JAC12865					MT993785	MT977103	MT993772
A. austrostraminea	AD282269	Kangaroo Island, S.A.	J.F. Haska	25 July 2014	**PX892859–PX892862**	PX942546	PX942551	PX942541
A. austrostraminea	AD282270	Kangaroo Island, S.A.	J.F. Haska	28 July 2015	**PX892837–PX892841**	PX942547	PX942552	PX942542
A. austrostraminea	AD282272	Kangaroo Island, S.A.	J.F. Haska	25 Aug. 2017	**PX892854–PX892858**	PX942548	PX942553	PX942543
A. austrostraminea	PERTH 05254892	City of Albany, W.A.	K. Syme, V. Kermode & P. Davis	6 Aug. 1991	**PX892848**			
A. austrostraminea	PERTH 07574312	City of Albany, W.A.	K. Syme	20 Aug. 2006	**PX892849–PX892853**			
A. austrostraminea	PERTH 10000313	Shire of Cuballing, W.A.	E.M. & P.J.N. Davison	18 May 2016	**PX892843–PX892847**	PX942545	PX942550	PX942540
A. austrostraminea	PERTH 10000291	Shire of Serpentine-Jarrahdale, W.A.	E.M. & P.J.N. Davison	19 July 2021	**PX892863–PX892866**	PX942549	PX942554	PX942544
A. austrostraminea	09.354	New Caledonia					PP592567	OR554358
A. brunneola	PERTH 09472614	City of Cockburn, W.A.	E.M. & P.J.N. Davison	30 May 2010		OP272671	OP272683	OP272666
A. brunneola	PERTH 09472517	City of Melville, W.A.	E.M. & P.J.N. Davison	14 June 2020		OP272663	OP272679	OP272667
A. carneiphylla	PERTH 08793530	City of Melville, W.A.	E.M. & P.J.N. Davison	8 May 2016		MN909829	MN909832	MN928556
A. carneiphylla	PERTH 08793565	Shire of Cuballing, W.A.	E.M. & P.J.N. Davison	18 May 2016		MN909830	MN909833	MN928557
A. carneiphylla	AD282179	Kangaroo Island, S.A.	J.F. Haska	7 May 2016		MN909831	MN909834	MN928558
A. cretaceaverruca	PERTH 09479716	City of Melville, W.A.	E.M. & P.J.N. Davison	3 July 2011		OP272673	OP272677	
A. cretaceaverruca	PERTH 09479627	Shire of Manjimup, W.A.	E.M. & P.J.N. Davison	2 June 2013		OP272674	OP272680	OP272668
A. mallee	PERTH 09472797	Shire of Coolgardie, W.A.	M.D. Barrett	13 Dec. 2013		OP272670	OP272678	OP272665
A. quenda	PERTH 08587116	City of Melville, W.A.	E.M. & P.J.N. Davison	27 July 2011		OP272663	OP272681	OP272669
A. quenda	PERTH 09472754	City of Melville, W.A.	E.M. & P.J.N. Davison	8 Aug. 2012		OP272676		OP272670
A. pareparina	JAC13371					MT993794	MT977110	MT993779
A. validiscula	PERTH 09480056	Shire of Cuballing, W.A.	E.M. & P.J.N. Davison	19 May 2016			OP272682	
A. djarilmari (outgroup)	PERTH 08776067	Shire of Cuballing, W.A.	E.M. & P.J.N. Davison	18 Apr. 2016	MF000750	MF000742		MF000755