

Taxonomic notes on the Clathraceae (Phallales: Phallomycetidae) *sensu* Bottomley and a new key to the species in southern Africa

J.C. COETZEE*

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ABSTRACT

Bottomley's (1948) *Gasteromycetes of South Africa* is still widely used for identification purposes. However, as a result of developments since 1948, the work has become outdated in many respects. Entries in the Clathraceae are here updated and briefly commented upon and a species key to the twelve southern African representatives of the family is provided.

INTRODUCTION

The classic work on the Gasteromycetes of South Africa by Bottomley (1948), still widely used as a definitive reference for the region, is outdated, not only as an identification tool, but also as a measure of the diversity of the southern African gasteromycetous fungi (Coetzee *et al.* 1997). There is a need for an interim aid facilitating the more effective use of Bottomley (1948), and to that purpose a first contribution, dealing with the Geastraceae, Tulostomataceae, Nidulariaceae and Sphaerobolaceae *sensu* Bottomley (1948), appeared in this journal some time ago (Coetzee *et al.* 1997). The current paper constitutes the second instalment to be used in conjunction with Bottomley (1948). Although this contribution contains some personal taxonomic judgements, it does not proclaim to be a critical re-appraisal of the family concerned and primarily reflects the views and ideas expressed in the literature since 1948. It is presented also in the hope that it might kindle the necessary interest for further studies on this intriguing but taxonomically poorly understood group of macrofungi in southern Africa.

ANNOTATED LIST OF TAXA

As in Coetzee *et al.* (1997) the order of arrangement of taxon entries below follows Bottomley (1948), and the headings of the taxon names and author citations have been taken, unchanged, from the latter publication. The number in brackets following each heading refers to the relevant page number in Bottomley (1948). Suggested taxon names and/or corrections are supplied in bold. References to ICBN Articles and Recommendations pertain to the Vienna Code (McNeill *et al.* 2006). Author citations are abbreviated according to Brummitt & Powell (1992).

1. Phallales (509)

The order **Phallales** *E.Fisch.* originally included two families, the Phallaceae Corda (stinkhorns) and the Clathraceae Chevall. (cage fungi). Cunningham's (1931)

extension of the order to include also the Clautulaceae G.Cunn. has been widely accepted (Bottomley 1948; Zeller 1949; Dring 1973; Jülich 1981; Hawksworth *et al.* 1995; Mills *et al.* 1997; Kirk *et al.* 2001; May *et al.* 2003; Kirk *et al.* 2008) but Dring's (1973) incorporation of the order Hysterangiales into the Phallales, widely accepted initially (Fan *et al.* 1994; Hawksworth *et al.* 1995; Mills *et al.* 1997; Kirk *et al.* 2001), is not considered appropriate anymore (Hosaka *et al.* 2007; Kirk *et al.* 2008).

Several recent authors such as Kasuya (2007), Leite *et al.* (2007) and Cortez *et al.* (2008) have adopted the classification of Kirk *et al.* (2001) who treated the entire gomphoid-phalloid clade—the monophyly of which was proposed by Hibbett & Thorn (2001) and supported by Binder & Hibbett (2002)—as the order Phallales. This lumpers' approach forces the elimination of various monophyletic groups, including distinct and well-established families such as the Clathraceae, which then disappears into an expanded Phallaceae (Hosaka *et al.* 2007). The recent proposal by Hosaka *et al.* (2007) to treat the gomphoid-phalloid clade as a subclass (Phallomycetidae *K.Hosaka, Castellano & Spatafora*) comprising the four orders Geastrales *K.Hosaka & Castellano*, Hysterangiales *K.Hosaka & Castellano*, Gomphales *Jülich* and the Phallales, has been favourably received and has already been adopted in the new consensus classification of the kingdom Fungi proposed by the 'Assembling the Fungal Tree of Life' (AFTOL) Project (Hibbett *et al.* 2007) as well as the latest edition of the authoritative *Dictionary of the Fungi* (Kirk *et al.* 2008).

1.1. Clathraceae *Ed. Fischer* (521)

The correct author citation for this family, which was the subject of a revision and monograph by Dring (1980), is **Clathraceae** *Chevall.* Dring's (1980) classification of the family has been adopted almost without question by most subsequent workers, but the more traditional generic delimitations as retained in Miller & Miller (1988), and Pegler & Gomez (1994) might perhaps not be devoid of merit altogether.

Kirk *et al.* (2001) incorporated the Clathraceae into the Phallaceae but in a recent study of the molecular phylogenetics of the gomphoid-phalloid fungi, Hosaka *et al.* (2007) regarded the Clathraceae as a monophyletic group worthy of recognition at family level. Despite

* Department of Horticultural Sciences, Cape Peninsula University of Technology, P.O. Box 1906, 7535 Bellville.
E-mail: coetzeej@cput.ac.za.
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their acceptance of the new classification of the Phallomycetidae as proposed by Hosaka *et al.* (2007), Kirk *et al.* (2008), in the latest edition of the *Dictionary of the Fungi*, did not recognise the Clathraceae as an autonomous family, but incorporated all the clathraceous genera in the Phallaceae. The proposal by Hosaka *et al.* (2007), to treat the Lysuraceae Corda as a segregate family of the Clathraceae *sensu* Dring (1980), has also not found acceptance in Kirk *et al.* (2008).

1.1.1. *Linderiella* G.H. Cunningham (521)

Cunningham (1931) separated the genus *Linderia* G.Cunn. from *Clathrus* but later changed the name to *Linderiella* G.Cunn. because of the confusing similarity between *Linderia* and the earlier *Lindera* Thunb. (Cunningham 1942). Despite the persistent preference of *Linderia* over *Linderiella* by some authors (Dring 1973; Liu 1984; Miller & Miller 1988; May *et al.* 2003), Cunningham's name change was perfectly justified in terms of Example 6 of the current ICBN Art. 53.3 which unambiguously indicates that *Linderia* should be treated as a later homonym of *Lindera*. Dring's (1980) re-incorporation of *Linderiella* into *Clathrus* has found general acceptance (Hawksworth *et al.* 1995; Mora & Garza 1997; Kirk *et al.* 2001; May *et al.* 2003; Calonge *et al.* 2005; Kirk *et al.* 2008) but Miller & Miller (1988) and Pegler & Gomez (1994) preferred to retain *Linderiella* as a separate genus. Should that, for whatever reason, be the correct approach, Dring (1980) is of the opinion that not *Linderiella*, but *Colonnaria* Raff., as proposed by Fischer (1933) and as applied by Santesson (1943), Zeller (1949) and Gómez (1974), would be the correct generic name to use.

1.1.1.1. *Linderiella columnata* (Bosc.) G.H. Cunningham (521)

Bottomley (1948) based this entry on a single record only, namely the type collection of *Laternea angolensis* Welw. & Curr. from Angola which, according to Dring (1980) is neither a *Laternea* Turpin nor a *Linderiella*, but a *Blumenavia* Möller. The correct name and author citation for this species is ***Blumenavia angolensis*** (Welw. & Curr.) Dring. The alleged record from the Drakensberg Mountains of South Africa (Dring 1980) is incorrect. The material in question did not come from the Drakensberg, but from Drachenberg near Amani in the East Usambara Mountains, Tanzania (Eichelbaum 1907).

1.1.2. *Anthurus* Kalchbrenner and MacOwan (522)

Most recent authors have accepted Dring's (1980) relegation of the genus *Anthurus* Kalchbr. & MacOwan to synonymy under *Clathrus* (Mornand 1993; Van der Westhuizen & Eicker 1994; Hawksworth *et al.* 1995; Kirk *et al.* 2001; May *et al.* 2003; Tkalčec *et al.* 2005; Kirk *et al.* 2008). Miller & Miller's (1988) and Pegler & Gomez's (1994) preference to retain *Anthurus* as an autonomous genus might not be devoid of merit, however, and a molecular investigation of the *Anthurus-Clathrus* relationship should provide instructive insight in this regard.

1.1.2.1. *Anthurus Archeri* (Berkeley) Ed. Fischer (522)

If treated as a *Clathrus*, the correct name and author citation for this fungus would be ***Clathrus archeri*** (Berk.) Dring. In the genus *Anthurus*, however, the correct name is ***Anthurus archeri*** (Berk.) E.Fisch.

1.1.3. *Lysurus* Fries (523)

A number of authors, including Greuter *et al.* (1993) in NCU3, have used Fr.: Fr. as the author citation for this genus described by Fries (1823). That, however, is the result of a misunderstanding of the sanctioning principle as contained in Articles 13.1 d. and 15 of the current ICBN. Fries's *Systema mycologicum*, volumes 1–3 (1821, 1822, 1823, 1829, 1832), including his *Elenchus fungorum* (1828) are sanctioning works for the 'Fungi caeteri', but not for the 'Gasteromycetes'. Gams (1984) clearly and unambiguously explained the situation as follows: 'names of Gasteromycetes etc. not sanctioned by Persoon but listed by Fries have not been sanctioned'. The use of the sanctioning notation is thus inappropriate for this genus and the correct citation would merely be ***Lysurus* Fr.**

According to Hosaka *et al.* (2007), *Lysurus* is more closely allied to the Phallaceae than the Clathraceae and they therefore resurrected the long ignored Lysuraceae Corda to accommodate this genus. As already mentioned, this approach has not been adopted in Kirk *et al.* (2008).

1.1.3.1. *Lysurus Gardneri* Berkeley (524)

As indicated also by Dring (1980), the inclusion of *Lysurus gardneri* Berk. in Bottomley (1948) seems to have been based on a misidentification. Plate 22 in Bottomley (1948) clearly does not depict *L. gardneri*, but ***Lysurus cruciatus*** (Lepr. & Mont.) Henn., of which *Anthurus woodii* MacOwan in Kalchbr. and *Lysurus woodii* (MacOwan) Lloyd from KwaZulu-Natal are synonyms (Dring 1980). Dring's (1980) claim that *L. gardneri* occurs in South Africa requires verification.

1.1.4. *Aseroe* La Billardiere ex Fries (526)

The correct spelling and author citation is ***Aseroë*** Labill. (note the diaeresis). Four species—*Aseroë floriformis* Baseia & Calonge, *A. coccinea* Imazeki & Yoshimi ex T.Kasuya, *A. arachnoidea* E.Fisch. and *A. rubra* Labill.—are currently accepted in the genus (Kasuya 2007), of which only *A. rubra* is known to occur in southern Africa.

1.1.4.1. *Aseroe rubra* La Billardiere ex Fries (526)

Bottomley (1948) regarded the occurrence of this species in South Africa as 'rather doubtful' and speculated that the single record from Cape Town might actually have been based on a misidentified *Clathrus archeri* (as *Anthurus archeri*) specimen at Kew. This suspicion was later corroborated by Demoulin & Dring (1975) and Dring (1980). Subsequent to Bottomley (1948), the occurrence of *Aseroë rubra* in South Africa has, however, been confirmed by various authors (Talbot 1958; Swart 1959; Jacot-Guillarmod 1959; Demoulin & Dring

1975; Dring 1980; Van der Westhuizen & Eicker 1994; Howell 2006; Gryzenhout 2007). *A. rubra* is known also from Swaziland (Demoulin & Dring 1975), but not the Karoo as indicated in Gryzenhout (2007). The collection (PREM41980) referred to by Gryzenhout, did not come from Richmond in the Karoo, but from Richmond in KwaZulu-Natal (Jacot-Guillarmod 1959). Due to the change in the starting point for the nomenclature of the non-fossil fungi in 1981 (Korf 1983), the correct author citation for this species is *Aseroë rubra* Labill.

1.1.5. *Clathrus Micheli* ex Persoon (527)

In accordance with the changes to the ICBN enacted in 1981 (Korf 1983), the appropriate author citation, indicating also the sanctioned status of this name, should be ***Clathrus P. Micheli* ex L. : Pers.** or merely ***Clathrus L. : Pers.*** as provided for by Article 46.6 of the current ICBN. As explained by Korf (1996), the ‘: Pers.’ notation may also be omitted in non-taxonomic papers.

1.1.5.1. *Clathrus cibarius* (Tulasne) Ed. Fischer (528)

According to Dring (1980) this species should be placed in the genus ***Ileodictyon* Tul.** as ***Ileodictyon cibarium* Tul.** in Raoul (1844).

1.1.5.2. *Clathrus gracilis* (Berkeley) Schlechtendal (529)

According to Dring (1980), this species should be placed in the genus ***Ileodictyon*** as ***Ileodictyon gracile* Berk.**

1.1.5.3. *Clathrus* sp. (529)

Although Dring (1980) suggested that the material mentioned in Bottomley (1948) might be akin to *Clathrus crispus* Turpin, it also bears some resemblance to *Clathrus preussii* (Henn.) Henn. While it is safe to say that Bottomley’s fungus is not conspecific with either *C. crispus* or *C. preussii*, its true identity remains unresolved and requires further investigation.

1.1.6. *Clathrella Fischer* (530)

Fischer’s (1898) separation of ***Clathrella* E. Fisch.** from *Clathrus* does not seem to have found much acceptance and important authors such as Zeller (1949), Dring (1973, 1980), Miller & Miller (1988), Pegler & Gomez (1994), Hawksworth *et al.* (1995) and Kirk *et al.* (2001, 2008) have not accepted *Clathrella* as an autonomous genus.

1.1.6.1. *Clathrella Baumii* (P. Henn.) Ed. Fischer (531)

According to Dring (1980) the correct name and author citation for this fungus is ***Clathrus baumii* Henn.** The type specimen from Angola (Dring 1980) represents the only known record of this species from southern Africa (Bottomley 1948; Dring 1980).

1.1.6.2. *Clathrella* cfr. *pseudocancellata* Ed. Fischer (531)

Although Dennis in Dring (1980) tentatively accepted Bottomley’s (1948) doubtful identification—but as ***Clathrus pseudocancellatus* (E. Fisch.) Lloyd**—this determination is quite uncertain and requires verification.

1.1.7. *Kalchbrennera Berkeley* (532)

Dring’s (1980) emendation of the genus *Lysurus* to embrace all the stipitate clathraceous genera, resulting in the relegation of *Kalchbrennera* to synonymy under *Lysurus*, has been widely accepted (Hawksworth *et al.* 1995; Kirk *et al.* 2001; Kirk *et al.* 2008). A few authors, however, have continued to treat ***Kalchbrennera* Berk.** as an autonomous genus (Levin *et al.* 1985; Miller & Miller 1988; Pegler & Gomez 1994).

1.1.7.1. *Kalchbrennera corallocephala* (Welwitsch et Currey) Kalchbrenner (532)

If one accepts Dring’s (1980) concept of the genus *Lysurus*, the correct name for this fungus would be ***Lysurus corallocephalus* Welw. & Curr.**, but if treated as a *Kalchbrennera*, the name ***Kalchbrennera corallocephala* (Welw. & Curr.) Kalchbr.** is correct.

REVISED KEY TO SPECIES OF CLATHRACEAE IN SOUTHERN AFRICA

Apart from the species discussed above, the twelve Clathraceae species known to occur in southern Africa also include *Clathrus transvaalensis* Eicker & D.A.Reid (Eicker & Reid 1990; Van der Westhuizen & Eicker 1994) from Gauteng and *Clathrus* cf. *crispus*, not previously reported from the African continent and included here as an unconfirmed first record based on recent photographic evidence only.

Bottomley (1948) provided a key to the genera of the Clathraceae but no species key. A key to species is presented here, based partly on my own observations but relying heavily also on the descriptions in Bottomley (1948), Dring (1980), Eicker & Reid (1990) and Van der Westhuizen & Eicker (1994). A useful glossary of terms is contained in Bottomley (1948).

1a Receptacle with bright red arms radiating sideways in a stellate fashion:

2a Receptacle stellate with 5–11 apically bifurcating arms arising from a ± horizontally flattened disk at apex of a reasonably prominent stipe; gleba restricted to upper surface of disc and bases of arms, apices of arms devoid of gleba 1. *Aseroë rubra* Labill.

2b Receptacle composed of 4–8 rugulose arms tapering to pointed tips, initially joined apically but separating as receptacle matures, spreading out sideways resembling arms of an octopus; outer surface of arms pale pink, distinctly furrowed longitudinally; gleba occurring along entire lengths of blood-red inner surfaces of arms 2. *Clathrus archeri* (Berk.) Dring [= *Anthurus archeri* (Berk.) E. Fisch.]

1b Receptacle not with stellate arms but composed of apically fused columns or hollow latticed structure or stipitate with gleba borne apically on specialized glebiferous structures:

3a Receptacle not stipitate, composed of 3–5 apically fused white columns, each up to 10 mm wide; gleba restricted to two rows of ragged glebiferous wings extending entire length of inner angles on each side of each column 3. *Blumenavia angolensis* (Welw. & Curr.) Dring

- 3b Receptacle distinctly stipitate or consisting of hollow spherical to ovoid latticed (clathrate) structure:
- 4a Receptacle distinctly stipitate, not divided into separate columns; gleba borne apically on specialized glebiferous structures:
- 5a Receptacle terminating apically in hollow, dome-shaped, red, latticed structure composed of transversely rugulose arms bearing simple or forked, erect appendages at intersections of arms; gleba occurring on all surfaces of clathroid apical part and appendages 4. *Lysurus corallocephalus* Welw. & Curr. [= *Kalchbrennera corallocephala* (Welw. & Curr.) Kalchbr.]
- 5b Receptacle terminating apically in 4–7 vertical columns, inner, convex surface of each covered by gleba which does not extend to smooth, white, orange or red, concave outer surfaces 5. *Lysurus cruciatus* (Lepr. & Mont.) Henn.
- 4b Receptacle not stipitate but clathrate, consisting of hollow, spherical to ovoid, latticed ball:
- 6a Receptacle hollow, spherical, latticed structure lacking dorsiventral differentiation, becoming detached from rest of basidiocarp at maturity:
- 7a Receptacle globose, white, translucent; arms marked with creases due to concertina-like folding in egg, not thickened at intersections; gleba distributed uniformly on insides of arms; odour of camembert cheese 6. *Ileodictyon cibarium* Tul.
- 7b Receptacle globose, white; arms relatively smooth, not creased as in previous species, considerably wider at intersections; gleba covering entire inner surface of arms; odour sweet-sour, not foul 7. *Ileodictyon gracile* Berk.
- 6b Receptacle distinctly clathroid with clearly defined apical and basal parts:
- 8a Receptacle red or orange:
- 9a Receptacle bright red; arms large in relation to openings, creating appearance of perforated ball rather than a mesh; openings roundish, not polygonal, surrounded by distinct border (corona) clearly distinguishable from rest of arm; spores 3.8–4.2 × 1.8–2.2 µm 8. *Clathrus* cf. *crispus* Turpin
- 9b Receptacle red; openings between arms not bordered by a corona:
- 10a Receptacle reddish orange; arms round to rounded triangular, transversely rugulose on outside, more strongly so on the inside, openings polygonal; gleba borne on inner surfaces of arms, mostly on wart-like cushions at intersections; spores 4–5 × 2–4 µm 9. *Clathrus* cf. *pseudocancellatus* (E.Fisch.) Lloyd
- 10b Mature receptacle red at apex, salmon buff at base; outer surface of arms longitudinally grooved, inner surface transversely rugulose, margins expanded into projecting points giving arms a fringed appearance; gleba evenly distributed on inner surface of all but basal arms; spores 3.5–5.1 × 1.6–2.2 µm 10. *Clathrus* sp.
- 8b Receptacle yellow to salmon-coloured, yellowish brown, pale ochraceous, pinkish brown or white:
- 11a Receptacle yellow to salmon-coloured, otherwise as described under 10a with spores up to 4 µm wide 9. *Clathrus* cf. *pseudocancellatus* (E.Fisch.) Lloyd
- 11b Spore width not exceeding 2.2 µm:
- 12a Receptacle white to bright yellow to yellowish brown or pale ochraceous; outer surface of arms distinctively flat, gleba borne on wart-like bulges at arm intersections; odour very foetid; spores 4.0–5.4 × 1.5–2.2 µm 11. *Clathrus baumii* Henn.
- 12b Receptacle consisting of up to eight stout, erect, columns, white to yellowish or cream-coloured below, darkening upwards to pale pinkish brown, supporting a pinkish brown or salmon-coloured clathroid mesh; gleba borne on unique glebiferous organs mostly located at junctions of arms but also elsewhere, consisting of cushion-like swellings with clathroid meshes, apically bearing lobed processes; odour fruity, of granadilla and pineapple; spores 4.0–4.5 × 1.5 µm 12. *Clathrus transvaalensis* Eicker & D.A.Reid

Note: *Clathrus crispus* has hitherto been known from the West Indies and the Americas (North, South and Central) only, and confirmation of its occurrence in South Africa would significantly expand its distribution range. South African record:

GAUTENG—2528 (Pretoria): Pretoria, Magalieskruin, in humus-rich soil beneath mango (*Mangifera indica*) tree, 29 January 2009, (–CA), Hannes van der Merwe s.n. (PRUM4484, photographs only).

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