

<https://botryosphaerales.org/>, an online platform for up-to-date classification and account of taxa of Botryosphaerales

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Abstract

Fungi are eukaryotes that inhabit various ecosystems worldwide and have a decomposing effect that other organisms cannot replace. Fungi are divided into two main groups depending on how their sexual spores are formed, viz. Ascomycota and Basidiomycota. The members of Botryosphaerales (Dothideomycetes, Ascomycota) are ubiquitous. They are pathogenic on a wide range of hosts, causing diverse diseases including dieback, canker, leaf spots and root rots and are also reported as saprobes and endophytes worldwide. As an important fungal group, of which most are plant pathogens, it is necessary to organize data and information on Botryosphaerales so that scientific literature can be used effectively. For this purpose, a new website, <https://botryosphaerales.org> is established to gather all published data together with updates on the present taxonomy of Botryosphaerales. The website consists of an easy-to-operate searching system and provides an up-to-date classification together with accounts of Botryosphaerales taxa, including colour illustrations, descriptions, notes and numbers of species in each genus, as well as their classification. Thus, readers will be able to obtain information on botryosphaeralean taxa through this platform.

Database URL: <https://botryosphaerales.org/>

Introduction

Botryosphaerales (Dothideomycetes) was established in 2006, to accommodate a single family, Botryosphaeriaceae (1). Nine families—Aplosporellaceae, Botryosphaeriaceae, Endomelanconiopsisaceae, Melanopsaceae, Phyllostictaceae, Planistromellaceae, Pseudofusicoccumaceae, Saccharataceae and Septorioideaceae—were accepted in Botryosphaerales by Wijayawardene *et al.* (2). However, based on morpho-molecular analyses and evolutionary divergence times, the number of families accepted in Botryosphaerales was reduced to six, namely Aplosporellaceae, Botryosphaeriaceae, Melanopsaceae, Phyllostictaceae, Planistromellaceae and Saccharataceae (3, 4). Endomelanconiopsisaceae and Pseudofusicoccumaceae were synonymized under Botryosphaeriaceae and Phyllostictaceae, respectively, while Septorioideaceae was synonymized under Saccharataceae (3). Members of Botryosphaerales are found worldwide, on many different host plants (5–17). They are endophytes, pathogens and saprobes and as opportunistic pathogens, they are of

considerable importance to agriculture, horticulture and forestry (18, 19). They cause severe diseases of economically important crops and plants leading to huge economic losses (20, 21). *Botryosphaeria*, *Diplodia*, *Dothiorella*, *Lasiodiplodia*, *Neofusicoccum* and *Phyllosticta* are the major pathogenic genera in Botryosphaerales. *Botryosphaeria dothidea*, *Diplodia seriata*, *Lasiodiplodia theobromae* and *Neofusicoccum parvum* are associated with grapevine dieback worldwide (27). *Diplodia seriata* has been reported as a pathogen on a wide range of hosts including eucalyptus, pine and stone fruits (22–26). *Phyllosticta citricarpa* and *P. citriasiana* cause freckle on banana and brown spots on pomelo, respectively (6, 9). One species can occur on several hosts in the same country, and pathogenicity of a species can vary from one region to another (19). This reflects the importance of gathering data on these fungal taxa to understand disease epidemiology.

Aplosporellaceae, Melanopsaceae and Planistromellaceae have immersed or semi-immersed multiloculate ascostromata,

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while those of Botryosphaeriaceae, Phyllostictaceae and Saccharataceae are uniloculate (3, 8, 28, 29). Asci are bitunicate, with a thick endotunica (3, 8, 28, 29). Ascospores are hyaline or pigmented, septate or aseptate, ellipsoid to ovoid.

Conidiomata are pycnidial, uni- to multilocular, frequently embedded in stromatic tissue. Conidiogenous cells are hyaline. Conidia are hyaline or pigmented, septate or aseptate, thin- or thick-walled (3, 8, 28–32).

Table 1. List of curators for *Botryosphaerales* webpage

Position	Name	Affiliation	Contact details
Head Curator	Alan J.L. Phillips	Microbiology and Biotechnology Laboratory Biosystems and Integrative Sciences Institute Faculty of Science, University of Lisbon Campo Grande, 1749-016 Lisbon, Portugal	alan.jl.phillips@gmail.com
Managing Curator	Na Wu	Center of Excellence in Fungal Research, School of Science, Mae Fah Luang University, 333 Moo 1 Muang District, Chiang Rai 57100, Thailand	wuna220@gmail.com
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botryosphaerales.org is a website dedicated to Botryosphaerales. The website focuses on providing an up-to-date account of Botryosphaerales with notes on orders, families and genera and species, keeping abreast of the current literature.

When using this website please cite:

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Highlights of Information

- Up-to-date account of Botryosphaerales
- Provide illustrations and plates of Botryosphaerales.

The website **botryosphaerales.org** is updated periodically

Recent Notes

[Economic and ecological significance of the families in Botryosphaerales](#)
[botryosphaerales.org Note 1](#)

Recent Genus

[Pileospora](#)
[Septorioides](#)
[Pileospora](#)

Recent Species

[Lasiodiplodia tropica](#)
[Lasiodiplodia microconidia](#)
[Lasiodiplodia brasiliensis](#)

Figure 1. The homepage of Botryosphaerales webpage.

All newly published data, which usually provide detailed descriptions and illustrations of new records, new species, new genera or new families, will be used to update the database. None of the papers generally link data from all

members of the order Botryosphaerales. Up until now, some websites involving specific groups of fungi have been established, such as <http://www.facesoffungi.org> (33), <https://onestopshopfungi.org> (34), <http://www.marinespecies.org>.

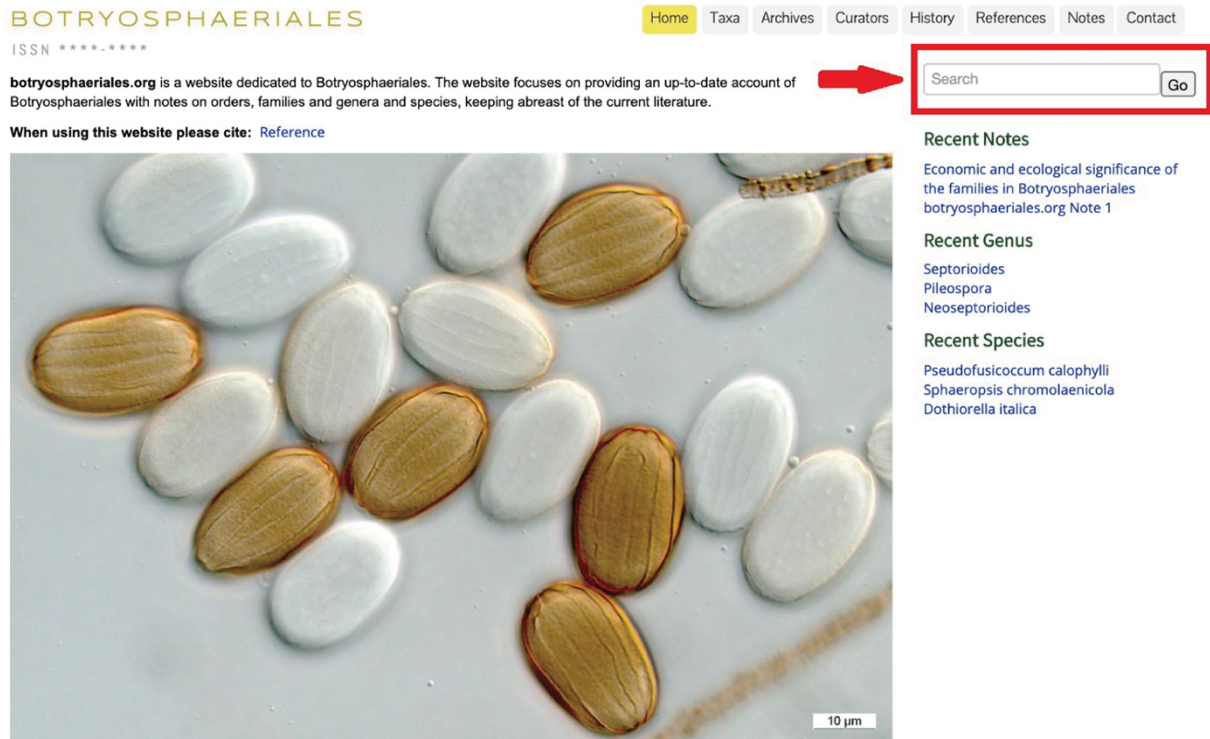


Figure 2. Red arrow indicates search tool to enter the taxon name.

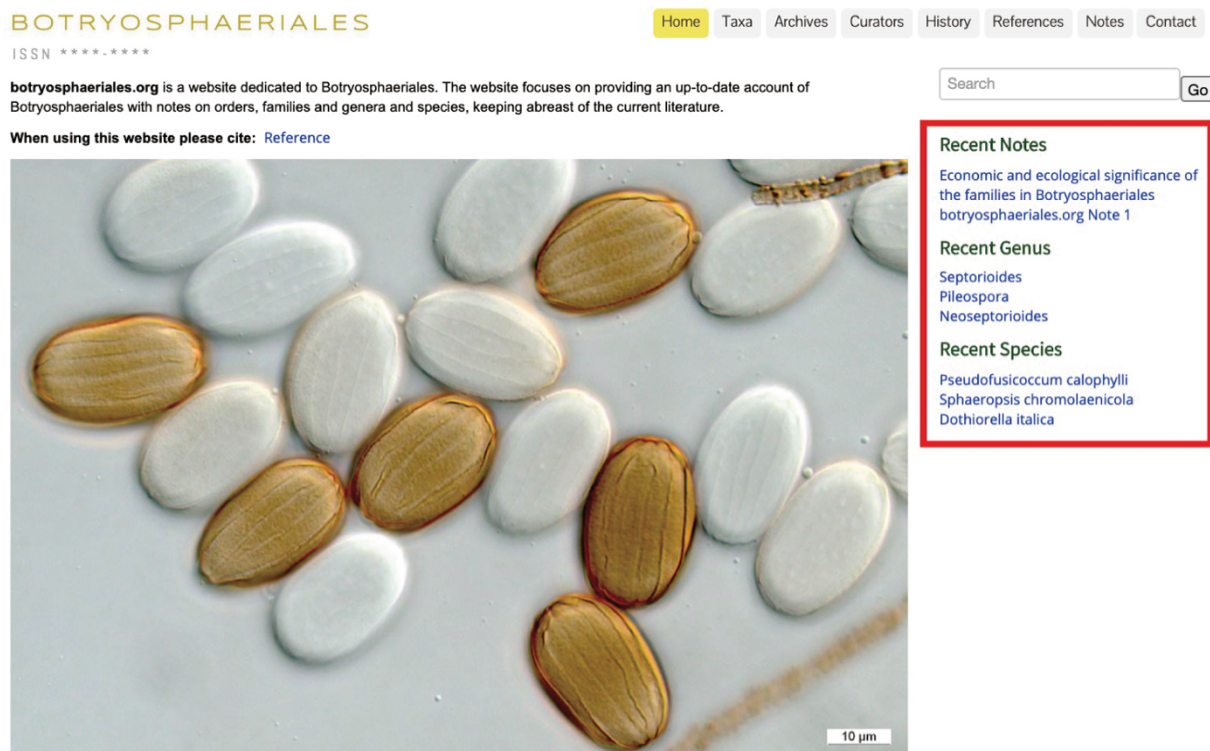


Figure 3. The recent notes, genus and species to enable easy access.

org (35), <https://fungalgenera.org> (36), <https://www.dothiomyces.org> (37) and <https://sordariomyces.org> (38). However, there is no database on Botryosphaerales. Therefore, in this paper, we provide a search method, designed to gather all the information about Botryosphaerales into one website.

The need for a Botryosphaerales database

Many Botryosphaerales species are associated with diseases in branches, leaves, fruits and seeds of aquatic and terrestrial plants (20, 31, 32, 39–43). In recent years, in-depth studies on Botryosphaerales have resulted in changes in the genus/family-level classification (2–4). Moreover, the number of publications and research works related to Botryosphaerales species are increasing all over the world (18, 20, 21, 44–48). With the increased number of studies on morphology, ecology and especially DNA-based phylogenetics, more and more new species are constantly being discovered. However, there are still many aspects needing clarification, such as naming new species from environmental samples, resolving the opportunistic pathogenic nature and how to define species boundaries in Botryosphaerales.

Currently over 2300 species have been described in Botryosphaerales in MycoBank based on morpho-molecular evidence (4). Most of the members of this order have

been scientifically documented. These publications on *Botryosphaerales* comprise various aspects such as taxonomy, morphology, pathogenicity or evolutionary studies. Information on Botryosphaerales taxa are scattered in over 1000 publications mainly as books and research papers. Hence, the intention of this website is to gather all data regarding taxa accepted in Botryosphaerales into a single entity that can be updated as new information becomes available.

The present website, <https://botryosphaerales.org/>, focuses on the Botryosphaerales with the following objectives: (i) gather all scattered data of accepted Botryosphaerales taxa into a single platform, (ii) provide notes on the recent changes in genera and species of Botryosphaerales with updated taxonomy and phylogeny and (iii) provide a list of all literature related to Botryosphaerales. Hence, this website will be the best platform to access information on the botryosphaeralean taxa easily with simple searches, thus reducing the time spent on searching for information.

The Botryosphaerales website

[Botryosphaerales.org](https://botryosphaerales.org/) is a website dedicated to Botryosphaerales taxa by providing an up-to-date account with descriptions, colour illustrations, culture characteristics, associated hosts, distribution and notes for order, families, genera

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Search Go

Taxa

Botryosphaerales (accepted species) – click on the species to go to the entry

Aplosporellaceae
Alanomyces
Alanomyces indica

Aplosporella
Aplosporella africana
Aplosporella artocarp
Aplosporella hesperidica
Aplosporella javeedii
Aplosporella longipes
Aplosporella ginkgonis
Aplosporella macropycnidia
Aplosporella papillata
Aplosporella prunicola
Aplosporella sophorae
Aplosporella thailandica
Aplosporella yalgorensis

Botryosphaeriaceae
Alanphillipsia
Alanphillipsia aloes
Alanphillipsia aloicola
Alanphillipsia aloeigena
Alanphillipsia aloetica
Alanphillipsia euphorbiae

Barriopsis
Barriopsis archontophoenicis
Barriopsis iraniana
Barriopsis stevensiana
Barriopsis tectonae

Botryobambusa
Botryobambusa fuscococcum

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[botryosphaerales.org Note 1](#)

Recent Genus
Septorioides
Pileospora
Neoseptorioides

Recent Species
Pseudofusicoccum calophylli
Sphaeropsis chromolaenicola
Dothiorella italica

Figure 4. The 'Taxa' view of the Botryosphaerales webpage.

and species. The website, <https://botryosphaerales.org> will be updated periodically, keeping abreast of current literature. It is convenient for all mycologists and pathologists who need information about the history and current classification status of botryosphaeralean taxa. The home page of the website has a mailbox so that mycologists, pathologists or anyone else who use this website can suggest ideas to improve it.

Construction

All fungi in the [Botryosphaerales.org](https://botryosphaerales.org) are listed according to the latest classification (3, 4, 49). Each entry includes the accepted binominal name, Index Fungorum number, Faces of Fungi number, MycoBank number, ex-type culture collection number, dry culture collection and herbarium number and GenBank accession numbers of available DNA sequences.

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Home Taxa

Botryosphaerales (accepted species) – click on the species to go to the entry

Altoporellaceae
Altoporellales
Altoporellales

Botryosphaeriaceae
Index Fungorum number: IF 80530; Facesoffungi number: FoF 00116, 279 species
Endophytic, pathogenic and saprobic on a wide range of hosts worldwide. Sexual morph: Ascomata uniloculate, solitary or clustered, becoming fully or partially erumpent with maturity, wall multi-layered, dark brown, infrequently embedded in stromatic tissues. Axi 8-spored, bitunicate, fissionate, with well-developed ocular chamber; thick endothecia, short pedicellate, clavate. Pseudoparaphyses intermixed with asci, hyaline, septate, frequently constricted at septa, hyphae-like, branched or not, deliquescent with maturity. Ascospores 2–3-seriate, ellipsoid to ovoid, hyaline or pigmented, smooth to verruculose, septate or not, mucoid sheaths mostly absent (phialoconidia of sexual characters can be seen in Phillips et al. 2013, 2019). Asexual morph: Coelomycetous. Conidiomata uni- or rarely multiloculate, pycnidial, infrequently embedded in stromatic tissue. Conidiophores mostly reduced to conidiogenous cells. Conidiogenous cells hyaline, phialidic, proliferating percurrently or internally giving rise to pericalthine thickenings, or proliferating percurrently forming annulations, without collarettes. Conidia hyaline or pigmented, aseptate or one or multi-septate, sometimes muriform, smooth or striate, thin- or thick-walled, without mucoid sheaths or appendages. Spermatozoa similar to conidiomata in anatomy. Spermatozoan cells ampulliform to lageniform or subcylindrical, hyaline smooth, phialidic. Spermata developing in conidiomata or spermatozoa, hyaline, smooth, granular, subcylindrical or dumbbell-shaped, with rounded ends. (Liu et al. 2012; Slippers et al. 2013; Phillips et al. 2013)

Type: *Botryosphaeria* Ces. & De Not.
Notes: *Botryosphaeriaceae* was introduced by Theissen and Sydow (1918b) for three genera, *Botryosphaeria*, *Phaeobotryon* and *Dibotryon*. Over decades of taxonomic revisions and updates based on morphology, the family has become increasingly complex. However, based on LSU sequence data Cruas et al. (2006a) revealed 10 lineages within *Botryosphaeriaceae*, which they considered to represent individual genera. Phillips et al. (2008) defined, introduced and reinstated a further five genera in *Botryosphaeriaceae*. *Altoporella* was shown to reside in *Botryosphaeriaceae* by Dunn et al. (2007). *Endomelanconiopsis* was assigned to this family by Rojas et al. (2008) while Phillips and Alves (2009) considered that *Melanopsis* is another genus in *Botryosphaeriaceae*. Two new genera (*Botryobambusa* Phook. et al. and *Copliniforma* Doolom et al.) were introduced by Liu et al. (2012). Phillips et al. (2013) resolved *Botryosphaeriaceae* into 17 genera and 110 species known from culture. Thereafter six new genera and 85 new species/species combinations have been introduced (Dissanayake et al. 2017). According to a recent study by Phillips et al. (2019) currently 22 genera are accepted in *Botryosphaeriaceae*. In earlier studies *Dothiorella* and *Spenceriaria* were regarded as two separate genera in the family (Phillips et al. 2008, 2013). However, Yang et al. (2016) synonymized *Spenceriaria* under *Dothiorella* Sacc. These two genera are morphologically distinguishable only in sexual morphs by the hyaline apiculi in *Spenceriaria*. So far, these characters are reported only in *S. viticola* but no other species in this genus have been observed with asexual morphs. Furthermore, phylogenetic distance is also small between these two genera. Therefore, it is accepted that *Spenceriaria* is a synonym of *Dothiorella*. *Phyllostictaceae* was re-instated for *Phyllosticta* (Wikee et al. 2013a). Another three families were introduced in *Botryosphaerales* by Slippers et al. (2013), namely *Saccharataceae* for *Saccharata*, *Altoporellaceae* for *Altoporella* and *Melanopsaceae* for *Melanops*. Nitschke ex Fiedt. Wyka and Brodes (2016) introduced *Septorioidaceae* for *Septorioides* Quaeqvl. et al. while Yang et al. (2017) raised *Endomelanconiopsis* and *Pseudofusicoccum* Mohali et al. to familial status as *Endomelanconiopsidaceae* and *Pseudofusicoccaceae* respectively. Taking into account morphology, phylogeny and evolutionary divergence times, Phillips et al. (2019) synonymised *Endomelanconiopsidaceae* with *Botryosphaeriaceae*, *Pseudofusicoccaceae* with *Phyllostictaceae*, and *Septorioidaceae* with *Saccharataceae*. In addition to that, genus *Pilgeriella* which fit within *Botryosphaeriaceae*, but do not have cultures or DNA (Wijayawardene et al. 2017a). Therefore, this genus was kept in incertae sedis in *Botryosphaerales*.

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Botryobambusa

Botryobambusa Phook., Jian K. Liu & K.D. Hyde, in Liu et al., Fungal Diversity 57(1): 166 (2012)
Index Fungorum number: IF 801313; Facesoffungi number: FoF 02408; – 2 morphological species (Species Fungorum 2020), 2 species with molecular data.
Type species: *Botryobambusa fusicoccum* Phook., Jian K. Liu & K.D. Hyde, in Liu et al., Fungal Diversity 57(1): 166 (2012).

Notes: *Botryobambusa* was introduced by Liu et al. (2012) with a single species with both sexual and asexual morphs. Phylogenetically this genus is clearly distinguished from *Botryosphaeria*. However, it is similar to *Botryosphaeria* except for smaller asci and ascospores that are surrounded by a mucilaginous sheath. Two species are accommodated in this genus (Dissanayake et al. 2017).

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Botryosphaerales » Botryosphaeriaceae » Botryobambusa
Botryobambusa fusicoccum
MycoBank: MB 870314

Etymology: Referring the asexual stage "Fusicoccum-like" Saprobi on dead bamboo. Ascostomata 103.5–152 µm high (including neck), 95–152 µm diam, dark brown to black, erumped under epidermis to erumpent, gregarious, visible as minute black dots or papilla on host tissue, multi-loculate. Locules individual globose to subglobose or latest corticoseous, vertical to the host surface, with a central ostiole. Neck 42–59 µm diam, 31–54 µm high, central papillate, periphysate. Peridium 12–20 µm wide, comprising several layers of cells, with relatively thick brown to black walls, arranged in bakera angulata, broader at the base. Pseudoparaphyses not observed. Ascii (40–55–65–82) × (14–17)–18 µm × 60 × 15.5 µm, n = 25, 8-spored, bitunicate, fissionate, clavate to cylindrical-ovoid, pedicel-like, apically rounded with well-developed ocular chamber (2.3 µm wide, n = 9). Ascospores (9–11)–(12–14) × 5–7 µm (n = 11.5 × 6 µm, n = 30), uniseriate at the base or imp. Uniseriate, hyaline, velvety, aseptate, ellipsoid to ovoid, usually wider in the apex, thick-walled, surrounded by distinctive structured mucilaginous sheath. Pycnidia formed on 16h on sterilized pine needles within 10 days) superficial or host surface, clustered in a stroma, multiloculate, globose to subglobose. Peridium comprising several layers of cells, lensura angulata, broader at the base, outer layers dark to dark brown and thick-walled, inner layers hyaline and thin-walled. Conidiogenous cells (9–10)–(14)–18 × 3–5 µm holoblastic, hyaline, cylindrical to ellipsoidal, smooth-walled. Conidia (21–22)–(24)–26 × 5–7 µm (n = 23.5 × 6 µm, n = 30), hyaline, aseptate, cylindrical to cylindrical-ovoid, thin-walled, with rough wall.

Culture characteristics: Colonies on PDA reaching 50 mm diam after 4 d at 25–30 °C, fast growing; circular, whitened in a few days, after one week becoming grey to green-black; flattened, fairly dense, surface smooth with crestate edge, filamentous, reverse grey to black, pigmented produced in mass.

Material examined: THAILAND, Lampang Province, Jao Non District, Mae Yang Forestry Plantation, on dead culms of *Bambusa sp.*, 19 August 2016. B. Phookamkam, RP0209 (MFU11–0178, holotype), ex-type living culture MFUCC11–0183, host, living culture MFUCC11–0657.

Fig 1. *Botryobambusa fusicoccum* (MFU11–0178, holotype) on dead culm of *Bambusa sp.* a Ascostomata on host substrate. b Section through multiloculate ascostomata. c Section through ascostomata showing emergence of cells. d Block with paraphyses. e–f Asci. g–h Ascospores. Scale bars: a) 500µm, b) = 200 µm, c = 20 µm, d–e = 50 µm, f–h = 10 µm, g–h = 5 µm.

Figure 5. Details of the genus *Botryobambusa*.

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Botryosphaerales Hierarchy

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- Melanopsaceae
- Phyllostictaceae
- Planistromellaceae
- Saccharataceae

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Septorioides
Pileospora
Neoseptorioides

Recent Species
Pseudofusicoccum calophylli
Sphaeropsis chromolaenicola
Dothiorella italica

Figure 6. Appearance of the 'Archives' section in Botryosphaerales webpage.

Figure 7. User-friendly interface of the 'Archives' section in Botryosphaerales webpage.

This website is handled and inspected regularly by the head curator, managing curator, senior curator and three other curators with expertise on botryosphaeralean taxonomy and phylogeny (Table 1).

Database interface and visualization

The website can be accessed at URL <https://botryosphaerales.org> and comprises eight main headings, i.e. Home, Taxa, Archives, Curators, History, References, Notes and Contact. The interface is user-friendly, and each section comprises the following information.

Home

The homepage briefly introduces the objectives of the website and has links to highlights of information. Colour photos of Botryosphaerales are displayed representing the key morphological features of this order (Figure 1). The relevant information can be accessed easily using the search box located at the right top corner (Figure 2). Beneath the search box, there is quick access to recent notes, recent genera and recent species. Clicking on these options opens the link in a new window (Figure 3).

Taxa

Under the 'Taxa' heading, the recent taxonomic classification as families, genera and species of Botryosphaerales is

provided (Figure 4). In addition, an updated phylogenetic tree for the order is given at the bottom. The search box at the top left corner will facilitate quick access to each entry on the website. Clicking a listed species name will direct to the full description and details in the archives section (Figure 5).

Archives

The 'Archives' is the main section containing all information on every entry in the website (Figure 6). It consists of six tabs representing each family in Botryosphaerales. Clicking on a particular family will automatically generate a dropdown list including all the genera belonging to the particular family (Figure 7). This can be further expanded into genus and species levels (Figure 7). By clicking the link for each species will open a new window containing all information on that species (Figure 8).

Curators

This section provides information about the curators who handle and update the website (Table 1; Figure 9).

History

This section provides a brief account of the classification of Botryosphaerales.

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Pseudofusicoccum calophylli

Pseudofusicoccum calophylli Jayasiri, E.B.G. Jones & K.D. Hyde, in Jayasiri, Hyde, Jones, McKenzie, Jeewon, Phillips, Bhat, Wanasinghe, Liu, Lu, Kang, Xu & Karunaratna, *Mycosphere* 10(1): 151 (2019)

Index Fungorum number: IF555584

Facesoffungi number: FoF05299

Holotype: MFLU 18–2153

Etymology: Referring to the host genus on which the fungus was collected, Calophyllum (Calophyllaceae)

Saprobic on Calophyllum inophyllum. **Asexual morph:** Undetermined. **Asexual morph:** Coelomycetous. *Conidiomata* 140–160 µm high × 133–197 µm diam. ($x = 144 \times 160 \mu\text{m}$; $n = 10$), semi-immersed, solitary, globose to subglobose, papillate, covered by host epidermal tissues, lack of ostiole. *Conidiomata wall* 30–50 µm wide ($x = 47 \mu\text{m}$; $n = 20$), outer pale brown textura angularis cell layers, inner hyaline textura angularis cell layer, embedded within plant tissues. *Conidiogenous cells* 10–14 × 3–5 µm ($x = 13 \times 4 \mu\text{m}$; $n = 20$), phialidic, ovate to cylindrical, smooth, hyaline. *Conidia* 14–17 × 4–5 µm ($x = 16 \times 4.5 \mu\text{m}$; $n = 30$), hyaline, ellipsoid, occasionally slightly bent or irregularly shaped, apices rounded, smooth with fine granular content, unicellular, thin-walled.

Culture characters: Conidia germinated on MEA within 24 hr. Germ tubes produced at one end or both ends of conidia. Colonies growing on MEA, reaching 35–40 mm diam. after 2 weeks at 18°C. Colonies fluffy, initially white to amber at the centre, olivaceous at the edges, becoming white to olivaceous with age.

Material examined: THAILAND, Krabi Province, Mueang Krabi District (8°2'27" N, 98°49'5" E), decaying fruit pericarp of Calophyllum inophyllum (Calophyllaceae), 31 August 2018, S.C. Jayasiri, C 346 (MFLU 18–2153, holotype; KUN-HKAS102429, isotype), ex-type living culture MFLUCC 17–2533, KUMCC 18–0282.

GenBank numbers: ITS: MK347764, tef1: MK340877, rpb2: MK434879, tub2: MK412885

Notes: *Pseudofusicoccum calophylli* clusters with two strains of *P. violaceum*. *Pseudofusicoccum violaceum* is characterized by bacilliform conidia with a mucilaginous sheath and larger spores compared to *P. calophylli* (33 × 9.5 vs. 16 × 4.5 µm) (Mehl et al. 2011). However, *Pseudofusicoccum calophylli* has bacilliform conidia in the immature stage but these later become irregular in shape, without a mucilaginous sheath (Fig. 129). A comparison of the ITS and tef1 nucleotides of these two strains reveals 5 (0.8%) and 5 (1.6%) nucleotide differences, which indicates that they are distinct taxa (Jeewon & Hyde 2016).

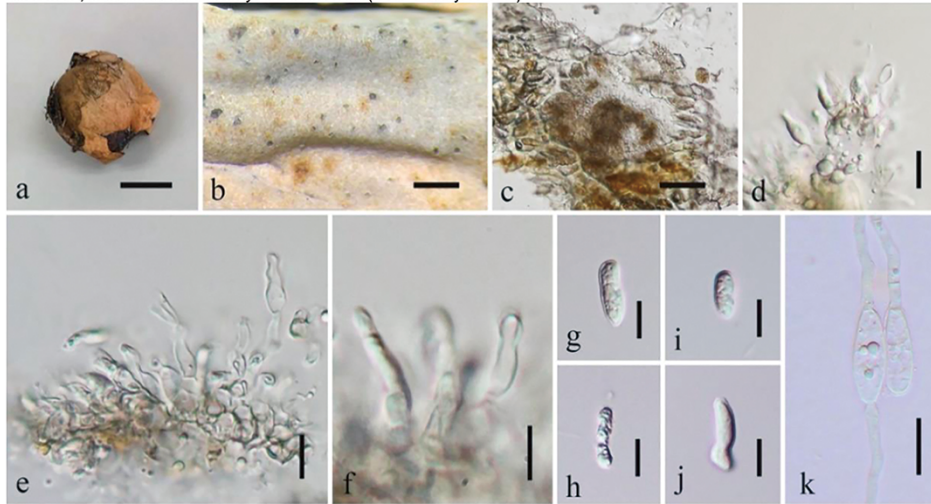


Figure 1. *Pseudofusicoccum calophylli* (MFLU 18–2153, holotype). a Host fruit. b Conidiomata on host surface. c Section through conidioma. d–f Conidiogenous cells. g–j Conidia. k Germinated conidia. Scale bars: a = 1 cm, b = 500 µm, c = 50 µm, d–k = 10 µm.

Figure 8. An entry with description, notes and plate (15).

References

A list of the citations used in the entries and history as well as other related information are provided under this heading.

Notes

Economic and ecological significance of families in Botryosphaeriales are given in this section. In addition, trends and current applications of the species of Botryosphaeriales will be added regularly to this section.

Contact

This section provides the contact details of the website and allows users to communicate any comments and suggestions.

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Recent Notes

Economic and ecological significance of the families in Botryosphaeriales
botryosphaeriales.org Note 1

Recent Genus

[Septorioides](#)
[Pileospora](#)
[Neoseptorioides](#)

Recent Species

[Pseudofusicoccum calophylli](#)
[Sphaeropsis chromolaenicola](#)
[Dothiorella italica](#)

Figure 9. Curators of the Botryosphaeriales webpage.

ecological restoration in high-phosphorus environment”
(Grant No: 31861143002).

Conflict of interest

None declared.

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