A checklist of the non-gilled fleshy fungi (*Basidiomycota*) of Kerala State, India

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Abstract — Kerala is a geographically unique state in India with more than half of its area encompassed within the Western Ghats hill ranges. The peculiar physiographic, edaphic and climatic conditions that prevail in Kerala contribute to a rich biological diversity. A literature-based checklist of the non-gilled, fleshy basidiomycetes of Kerala is presented herein. The list includes 81 species (*Agaricomycetes, Dacrymycetes*, and *Tremellomycetes*) that have been documented and published from the region thus far, excluding polypores. The listed species belong to 39 genera in 18 families placed in 11 orders. *Boletus* and *Lycoperdon* are the genera represented by the most species.

Key words —boletes, jelly fungi, macrofungi, mycobiota, tropical fungi

Introduction

Kerala State is situated in the southwestern tip of the Indian peninsula with area coordinates 8°18′–12°48′N 74°52′–77°22′E (Mohanan 2011). The state occupies an area of about 39,000 km^2 and is flanked by the Arabian sea of the Indian Ocean on the west and the Western Ghats hill ranges on the east (Balasubramanian 2017). The tropical climate of Kerala is maritime and monsoonal (Farook et al. 2013). Southwest (June-August) and northeast (October-December) monsoons are the two principal rainy seasons during the year, and these provide alternating dry and wet climatic conditions in Kerala. The annual rainfall is around 3000 mm (Adarsh et al. 2018). The average monthly temperature from December to February is 22–33 °C and 24–39 °C during the other months (Nair 2011). The major forest types of Kerala are evergreen, semi-evergreen, moist deciduous, dry deciduous, and the Shola-grassland complex (Champion and Seth 1968). The tropical rainforest is the natural climax vegetation (Nair 2011). Kerala is rich in its biodiversity owing to the peculiar physiographic, edaphic and climatic conditions (Mohanan 2011). A high proportion of endemic species characterizes the biota of Kerala (Nair 2011). About 5094 flowering plants belonging to 1537 genera are found in Kerala (Sasidharan 2012), 344 of which are endemic to Kerala (Reddy et al. 2007) and 1709 to Peninsular India (Arisdason & Lakshminarasimhan 2014).

Published records on the mycobiota of Kerala reveal a rich species diversity (Florence 2004, Mohanan 2011, Farook et al. 2013). A literature survey indicates that serious systematic studies on the macromycetes of Kerala began only in the later part of the twentieth century. Since then, the number of species discoveries has been steadily increasing. It is interesting to note that the number of macromycetes documented in this short span of time is more than 850 species. Farook et al. (2013) compiled a checklist of 616 species of gilled mushrooms recorded from Kerala. This exhaustive checklist included several novelties that were independently published from Kerala. Although macrofungi that produced poroid hymenium were outside the scope of that work, some polypores with gilled hymenium were also considered. Recently, Adarsh et al. (2018) published a checklist of polypores of Kerala that contained 148 species. This list included both the fleshy and non-fleshy polyporoid taxa. However, the above checklists exclude all the other macromycetes that produce non-gilled fleshy basidiomata. Species records of the non-gilled fleshy fungi that have been documented from Kerala thus far have not been compiled. Such

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records remain scattered in the literature. This is an impediment to monographic studies on the different groups of these fungi in Kerala. Hence, we compile and present herein a literature-based checklist of non-gilled, fleshy basidiomycetes (*Agaricomycetes, Dacrymycetes,* and *Tremellomycetes*) so far reported from Kerala.

Materials & methods

This checklist was prepared based on published accounts of non-gilled fleshy fungi from Kerala (Fig. 1). Only records of all basidiomycetes that produce more or less fleshy basidiomata, without true lamellae (gills) were considered. This included basidiomata that were clavarioid, gasteroid, jelly-like, and boletoid with tubular hymenia. Poroid fungi currently included in the *Polyporales* (according to the concept of Justo et al. 2017) were excluded. All taxonomic names, author citations, synonyms listed, and the systematic positions indicated in this checklist are as given in the Index Fungorum (http://www.indexfungorum.org/names/names.asp; accessed on 10/12/2018). Commas separate independent publications that report a species. Replaced synonyms are provided in brackets exactly as how they were used in the references cited. New species, which were invalidly published in the referred works are not included. Taxa that are identified only to the genus level are also excluded from the checklist. Genera and species are listed in alphabetical order according to Kirk et al. (2008).

Results & Discussion

This checklist includes 81 species of non-gilled fleshy fungi belonging to 39 genera, which are placed in 11 orders (*Agaricales, Auriculariales, Boletales, Cantharellales, Geastrales, Gomphales, Phallales, Sebacinales, and Thelephorales*) of the *Agaricomycetes*, one order (*Dacrymycetales*) of the *Dacrymycetes,* and one order (*Tremellales*) of the *Tremellomycetes*. In this checklist, *Agaricomycetes* is represented by the highest number of non-gilled fungi, followed by the *Dacrymycetes* and *Tremellomycetes*. In the *Agaricomycetes*, the family *Boletaceae* has the highest number of species (16), followed by the *Clavariaceae* (10), *Agaricaceae* (9), *Phallaceae* (7), *Ramariaceae* and *Sclerodermataceae* (6 each), *Geastraceae* (5), *Auriculariaceae* and *Suillaceae* (3 each), *Boletinellaceae*, *Clavulinaceae* and *Gomphaceae* (2 each). The families *Hydnaceae*, *Sebacinaceae*, *Gyroporaceae,* and *Thelephoraceae* are represented by one species each. *Lycoperdon* and *Boletus* are the genera represented by the most species in the class *Agaricomycetes*, having seven species each. The class *Dacrymycetes* includes four species belonging to two genera and the class *Tremellomycetes* includes two species belonging to two genera.

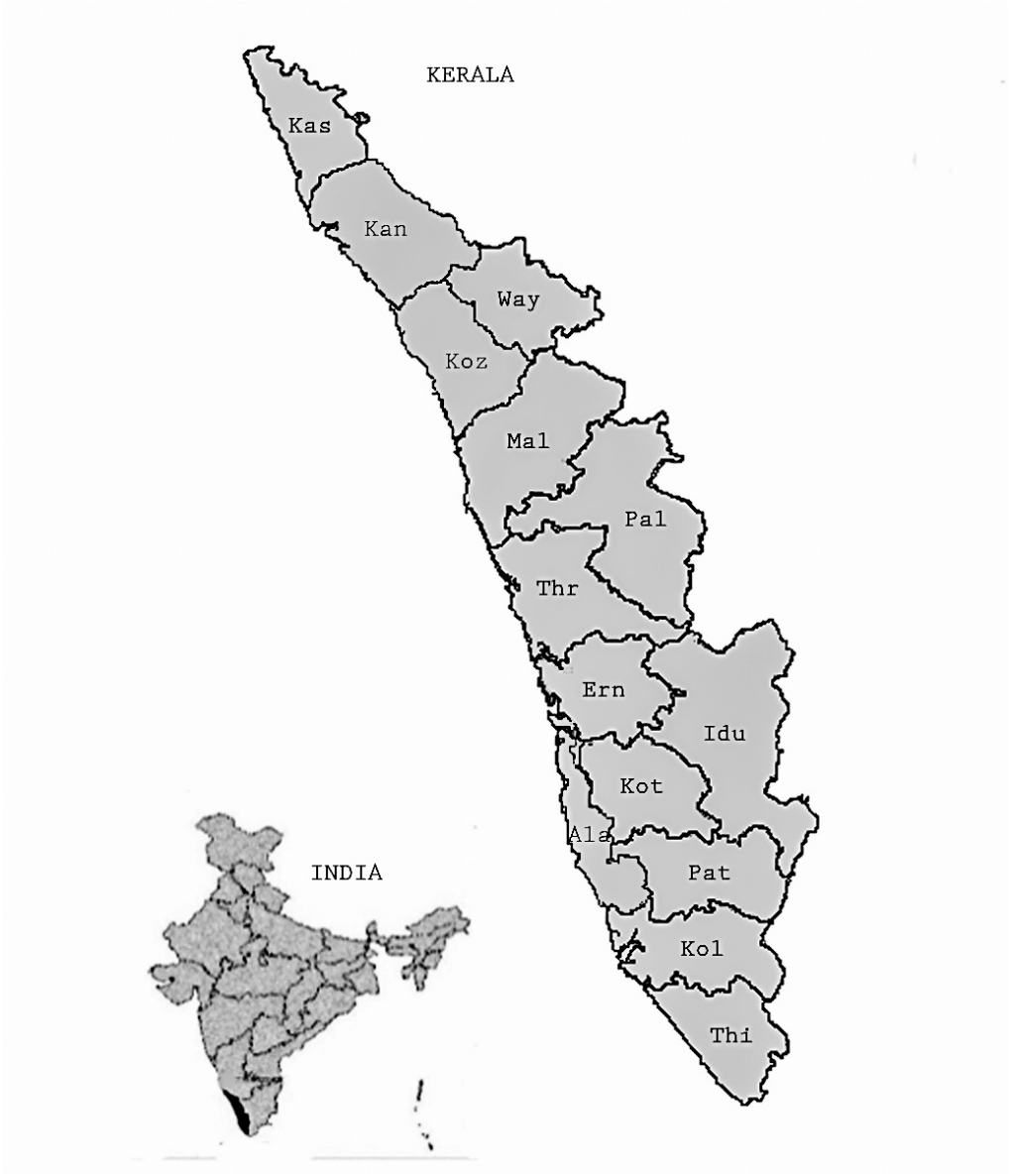

Figure 1. Outline map of Kerala State, India. Abbreviations refer to the districts of the State.

Species of non-gilled fleshy fungi (*Basidiomycota*) reported from Kerala

DISTRICTS: Ala = Alappuzha, Ern = Ernakulam, Idu = Idukki, Kan = Kannur, Koz = Kozhikode, Kol = Kollam, Kot = Kottayam, Kas = Kasaragod, Mal = Malappuram, Pat = Pathanamthitta, Pal = Palakkad, Thr = Thrissur, Thi = Thiruvananthapuarm, Way = Wayanad

AGARICOMYCETES

Agaricales

Agaricaceae

Apioperdon pyriforme (Schaeff.) Vizzini

Way — Mohanan (2011, as *Lycoperdon pyriforme* Schaeff.)

Bovistella utriformis (Bull.) Demoulin & Rebriev

Mal — Mohanan (2011, as *Lycoperdon utriforme* Bull.)

Cyathus striatus (Huds.) Willd.
Ern, Thr, Way — Mohanan (2011)
Lycoperdon decipiens Durieu & Mont.
Ern — Mohanan (2011)
Lycoperdon echinatum Pers.
Idu — Mohanan (2011)
Lycoperdon excipuliforme (Scop.) Pers.
Mal, Thr — Mohanan (2011)
Lycoperdon lividum Pers.
Idu — Mohanan (2011)
Lycoperdon nigrescens Pers.
Idu— Mohanan (2011, as *Lycoperdon nigrescens* Wahlenb.)
Lycoperdon perlatum Pers.
Idu — Mohanan (2011)

Clavariaceae

Clavaria versatilis (Quel.) Sacc. & Trotter
Mal — Mohanan (2011, as *Ramaria versatilis* Quél.)
Clavaria zollingeri Lév.
Way — Mohanan (2011)
Clavulinopsis aurantiocinnabarina (Schwein.) Corner
Pal, Thr — Mohanan (2011)
Clavulinopsis corniculata (Schaeff.) Corner
Thi — Mohanan (2011)
Clavulinopsis fusiformis (Sowerby) Corner
Kan, Thi — Mohanan (2011)
Clavulinopsis laeticolor (Berk. & M.A. Curtis) R.H. Petersen
Thr — Mohanan (2011)
Clavulinopsis luteoalba (Rea) Corner
Kan — Mohanan (2011)
Ramariopsis kunzei (Fr.) Corner
Way — Mohanan (2011)
Ramariopsis pulchella (Boud.) Corner
Way — Mohanan (2011)
Ramariopsis subtilis (Pers.) R.H. Petersen
Thr — Mohanan ((2011, as *Clavulinopsis dichotoma* (Godey) Corner)

Auriculariales

Auriculariaceae

Auricularia cornea Ehrenb.
Thr, Mal, Idu — Mohanan (2011, as *Auricularia auricula-judae* (Bull.) Quel.))
Auricularia mesenterica (Dicks.) Pers.
Thr, Mal — Mohanan (2011)
Auricularia nigricans (Sw.) Birkebak, Looney & Sanchez-Garcia
Thr, Mal — Mohanan (2011), Florence (2004, as *Auricularia polytricha* (Mont.) Sacc.)

Boletales

Boletaceae

Austroboletus gracilis (Peck) Wolfe
Thr, Mal — Mohanan (2011, as *Austroboletus gracilis* var. *laevipes* (Peck) Wolfe)
Boletellus ananas (M.A. Curtis) Murrill
Thi — Pradeep & Vrinda (2010a), Vrinda & Pradeep (2014)
Boletus alutaceus Morgan
Way — Mohanan (2011, as *Boletus alutaceus* var. *sublutaceus* T.N. Lakh. & Sagar)
Boletus edulis Bull.
Way, Mal — Mohanan (2011, as *Boletus edulis* subsp. *clavipes* (Peck) Singer)
Boletus hongoi T.N. Lakh. & Sagar
Way, Mal — Mohanan (2011)
Boletus huronensis A.H. Sm. & Thiers
Ern — Mohanan (2011)

Boletus pallidus Frost
Mal — Mohanan (2011)
Boletus patriciae A.H. Sm. & Thiers
Mal — Mohanan (2011)
Boletus reticulatus Schaeff.
Way, Thi, Mal — Mohanan (2011)
Leccinum scabrum (Bull.) Gray
Way, Thi — Mohanan (2011)
Rubinoboletus caespitosus T.H. Li & Watling
Mal — Mohanan (2011)
Strobilomyces annulatus Corner
Way, Pal — Mohanan (2011)
Strobilomyces strobilaceus (Scop.) Berk.
Thi, Way, Kol — Pradeep & Vrinda (2010a), Mohanan (2011), Vrinda & Pradeep (2014, as *Strobilomyces floccopus* (Fr.) Karsten)
Strobilomyces mollis Corner
Way, Pal — Mohanan (2011)
Tylopilus alboater (Schwein.) Murrill
Way — Mohanan (2011)
Xerocomellus chrysenteron (Bull.) Šutara
Thi — Pradeep & Vrinda (2010a, as *Boletus chrysenteron* Fries.), Vrinda & Pradeep (2014, as *Boletus chrysenteron* Fries.)

Boletinellaceae
Boletinellus merulioides (Schwein.) Murrill
Thi — Mohanan (2011)
Phlebopus portentosus (Berk. & Broome) Boedijn
Thr — Mohanan (2011), Pradeep & Vrinda (2010b), Vrinda & Pradeep (2014)

Gyroporaceae
Gyroporus castaneus (Bull.) Quél.
Ern, Way — Mohanan (2011)

Sclerodermataceae
Pisolithus albus (Cooke & Massee) Priest
Mal, Thr, Kol — Mohanan (2011)
Scleroderma areolatum Ehrenb.
Idu — Mohanan (2011)
Scleroderma bovista Fr.
Way, Mal, Idu — Mohanan (2011)
Scleroderma citrinum Pers.
Mal, Ern, Thr — Mohanan (2003, as *Scleroderma geaster*), Florence (2004), Mohanan (2011)
Scleroderma polyrhizum (J.F. Gmel.) Pers.
Idu, Way — Mohanan (2011)
Scleroderma verrucosum (Bull.) Pers.
Idu, Mal, Way — Florence & Yesodharan (2000), Mohanan (2003), Florence (2004), Mohanan (2011)

Suillaceae
Suillus brevipes (Peck) Kuntze
Idu — Mohanan (2011)
Suillus placidus (Bonord.) Singer
Way, Ern — Mohanan (2011)
Suillus tomentosus Singer
Mal — Mohanan (2011)

Cantharellales

Clavulinaceae
Clavulina coralloides (L.) J. Schröt.
Thi— Mohanan (2011)
Clavulina rugosa (Bull.) J. Schröt.
Thi — Mohanan (2011)

Hydnaceae
Hydnum repandum L.
Tsr — Mohanan (2011, as *Hydnum rufescens* Pers.)

Geastrales

Geastraceae

Geastrum elegans Vittad.
Mal — Mohanan (2011)
Geastrum quadrifidum DC. ex Pers.
Mal — Mohanan (2011)
Geastrum rufescens Pers.
Way — Mohanan (2011)
Geastrum saccatum Fr.
Way — Mohanan (2011)
Geastrum triplex Jungh.
Thi — Mohanan (2011)

Gomphales

Gomphaceae

Gomphus clavatus (Pers.) Gray
Way — Mohanan (2011)
Phaeoclavulina cokeri (R.H. Petersen) Giachini
Mal — Mohanan (2011, as *Ramaria cokeri* R.H. Petersen)

Ramariaceae

Ramaria apiculata (Fr.) Donk
Thi — Mohanan (2011)
Ramaria eumorpha (P. Karst.) Corner
Mal — Mohanan (2011)
Ramaria flava (Schaeff.) Quél.
Mal — Mohanan (2011)
Ramaria formosa (Pers.) Quél.
Mal — Mohanan (2011)
Ramaria gracilis (Pers.) Quél.
Thr — Mohanan (2011)
Ramaria pallida (Schaeff.) Ricken
Thr — Mohanan (2011)

Phallales

Phallaceae

Aseroe rubra Labill.
Idu — Mohanan (2011, as *Aseroe rubra* var. *zeylanica* (Berk.) E. Fisch.)
Clathrus archeri (Berk.) Dring
Idu — Mohanan (2011)
Colus pusillus (Berk.) Reichert
Mal, Thr — Florence (2004), Mohanan (2011)
Ileodictyon gracile Berk.
Kan, Thr — Mohanan (2011)
Mutinus caninus (Huds.) Fr.
Idu — Mohanan (2011)
Phallus cinnabarinus (W.S. Lee) Kreisel
Mal, Pal, Thr — Mohanan (2011, as *Dictyophora cinnabarina* W.S. Lee)
Phallus indusiatus Vent.
Mal, Thr — Mohanan (2011)

Sebacinales

Sebacinaceae

Sebacina sparassoidea (Lloyd) P. Roberts
Thr, Mal — Mohanan (2011, as *Tremella reticulata* (Berk.) Farl.)

Thelephorales

Thelephoraceae

Thelephora terrestris Ehrh.
[Locality unknown] — Mohanan (2003), Florence (2004)

DACRYMYCETES

Dacrymycetales

Dacrymycetaceae

Calocera viscosa (Pers.) Fr.
Ern, Thi — Mohanan (2011)

Calocera cornea (Batsch) Fr.
Ern — Mohanan (2011), Florence and Yesodaran (2000), Florence (2004)

Dacryopinax elegans (Berk. & M.A. Curtis) G.W. Martin
Idu — Mohanan (2011)

Dacryopinax spathularia (Schwein.) G.W. Martin
Way — Mohanan (2011)

TREMELLOMYCETES

Tremellales

Tremellaceae

Phaeotremella foliacea (Pers.) Wedin, J.C. Zamora & Millanes
Thr, Pal — Mohanan (2011, as *Tremella foliacea* Per.)

Tremella mesenterica Retz.
Mal, Ern — Mohanan (2011, as *Tremella mesenterica* Schaeff.)

The earliest published record of a non-gilled, fleshy basidiomycete from Kerala seems to date back only to the year 1965 (Rehill & Bakshi 1965). Species records since then, as listed herein, highlight the diversity of these fungi in Kerala. It is highly possible that a remarkable number of species are yet to be discovered from the region, warranting more exploratory studies. Also, critical revisionary studies based on the deposited specimens of the recorded species are needed to confirm the taxonomic identities and existence of these species in Kerala.

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