



OVERVIEW OF RESEARCH OF MUSHROOMS IN SRI LANKA

PANORÁMICA DE LA INVESTIGACIÓN DE HONGOS EN SRI LANKA

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SUMMARY

According to recent estimates the mycota of Sri Lanka is highly diverse, yet it has been relatively little studied and remains poorly understood. Sri Lanka may contain up to 25,000 species of fungi, of which only a little more than 2000 are presently known, and this estimate does not take into account the large number of exotics introduced along with food, plantation, and ornamental plants. Mycological research in Sri Lanka has been limited to certain parts of the country, and the available information is widely dispersed, difficult to access, and plagued by synonymy. Commercially cultivable mushrooms were first introduced to Sri Lanka in 1985, and today both endemic and non-native species are cultivated. This paper addresses the current status of Sri Lankan mushroom research, and suggests measures which are needed to support the future development of Sri Lankan mycology.

Index words: Biodiversity, edible mushrooms, macrofungi, medicinal mushrooms.

RESUMEN

Según estimaciones recientes la micota de Sri Lanka es muy diversa, pero ha sido relativamente poco estudiada y sigue siendo mal entendida. Sri Lanka puede contener hasta 25,000 especies de hongos, de las cuales sólo se conocen actualmente algo más de 2000, y esta estimación no tiene en cuenta el gran número de materiales exóticos introducidos junto con los alimentos, las plantaciones y las plantas ornamentales. La investigación micológica en Sri Lanka se ha limitado a ciertas partes del país, y la información disponible está muy dispersa, de difícil acceso y plagada de sinónimos. Los hongos comercialmente cultivables se introdujeron por primera vez en Sri Lanka en 1985 y actualmente se cultivan tanto especies endémicas como no nativas. Este artículo aborda el estado actual de la investigación de hongos de Sri Lanka, y sugiere medidas que son necesarias para apoyar el desarrollo futuro de la micología de Sri Lanka.

Palabras clave: Biodiversidad, hongos comestibles, macrohongos, hongos medicinales.

INTRODUCTION

Tropical and subtropical regions are potentially the richest source of new fungal species and Sri Lanka, though small in area, is no exception. This is due in part to the close juxtaposition of areas which differ widely in altitude and rainfall. Relatively few studies have been carried out on

Sri Lankan mycota, and the information available is widely scattered. Arriving at an accurate estimate of Sri Lankan fungi is further complicated by inconsistencies in synonyms used and duplicated entries across different studies. The works of D. N. Pegler and T. Petch together with a large collection of original illustrations of Agarics are deposited in the library at the Royal Botanical gardens, Peradeniya, but very few publications of a later date are seen. Pegler and Petch's macrofungi collections, moreover, are deposited at Kew. This lack of original collections and types complicates the identification of synonymies amongst macrofungi, as it is both costly and time-consuming to borrow herbarium specimens from Kew. Collections of soil and plant pathogenic fungi in Sri Lanka and the relevant literature are more complete and up to date because of their obvious economic importance.

The earliest Sri Lankan fungi to be recorded were *Peziza ceylonische* and *P. lembosa* described in Houttuyn (1783). The number of described species had risen to over 2,000 in about 640 genera, due to the efforts of Berkeley and Broome (1870, 1871, 1873), Petch (1908a, 1908b, 1910, 1913, 1915a, 1915b, 1916a, 1916b, 1916c, 1917a, 1917b, 1919, 1922, 1923, 1924a, 1924b, 1924c, 1924d, 1925, 1926a, 1926b, 1927, 1928, 1945, 1947), and Petch and Bisby (1950).

Various handbooks (Man and Biosphere, or MAB) on fungi parasitic on plants, associated with insects, or found in soil were published in the 1970s and 1980s, such as Coomaraswamy (1979a, 1979b), Coomaraswamy and De Fonseka (1981), and Coomaraswamy and Kumarasingham (1988). Also, the comprehensive book *Agaric Flora of Sri Lanka* was published by D. N. Pegler in 1986. The majority of references to Sri Lankan fungi, however, are still scattered across journals, University publications, research institutions, reports, proceedings and theses. A list of fungal plant pathogens and host names, prepared by S. Sivanathan (unpublished) is currently being updated.

Certain fungal groups have been researched more thoroughly than others, because of their prominence (macrofungi), or practical importance (phytopathogens and mycorrhizae). In Sri Lanka only 130 Myxomycota (earlier in Kingdom fungi and now in Protozoa) species in 30 genera have been recorded (Petch and Bisby, 1950) and thereafter there are no records in the published literature. Seventy-two species of mostly soil-inhabiting Zygomycota have been recorded in 17 genera, and 252 mostly entomo- or phytopathogens species of Ascomycetes have also been recorded.

Records of species in the order Uredinales include *Uredo* (58 species), *Puccinia* (41 species), *Aecidium* (20 species), *Uromyces* (19 species), *Ravenelia* (8 species), *Phragmidium* (4 species), *Melampsora* (4 species), *Coleosporium* (3 species), *Diorchidium* (3 species), *Pucciniastrum* (2 species), *Hemileia* (1 species), *Blastopota* (1 species), *Ceratolium* (1 species), *Cystospora* (1 species) and *Scopella* (1 species), making a total of 167 species (Berkeley and Broome, 1870-1877; Petch; 1908-1947; Petch and Bisby, 1950). In the 'Aphyllphorales' (Polyporales in modern molecular phylogeny based classification), 342 species in 51 genera have been recorded. The dominant genera are *Polyporus* (57 species), *Fomes/Rigidoporus* (32 species), *Poria* (23 species), *Stereum* (26 species) and *Trametes* (no number given). In Gasteromycetes (now known as gasteroid fungi) 75 species in 37 genera have been recorded, the dominant genera being *Geastrum* (9 species) and *Cyathus* (4 species). In Ustilaginales, 25 species belonging to 7 genera have been recorded; in Exobasidiales 2 species belonging to a single genus have been recorded, and in Agaricales 513 species belonging to 50 genera have been recorded, making a grand total of 1125 species in 162 genera for Sri Lanka (Berkeley and Broome, 1870-1877; Petch, 1908-1947; Petch and Bisby; 1950).

The best known fungal group in Sri Lanka is the larger Basidiomycetes, with records of 513 species of Agaricus in 50 genera such as *Marasmius* 53 spp., *Psalliotia* (*Agaricus*) 35 spp., *Hygrophorus* 27 spp., *Lentinus* 14 spp. and *Pleurotus* 12 spp. (Petch and Bisby, 1950; Coomaraswamy, 1979a, 1979b; Coomaraswamy and De Fonseka, 1981; Coomaraswamy and Kumarasingham, 1988). The Herbarium of Horticultural Crop Research and Development Institute (HORDI), Gannoruwa, Peradeniya has a collection of 412 paintings of agarics by W. de Alwis (1842-1916), a Sri Lankan artist and entomologist, which are now available in digital form.

RESEARCH ON MACROFUNGI

Very few studies have been carried out on the taxonomy and phylogeny of macrofungi in Sri Lanka over the

past two decades, while Houttuyn (1783), Berkeley and Broome (1870-1877), Petch (1905-1925), Petch and Bisby (1950), Coomaraswamy (1979a, 1979b), Pegler (1986) and Coomaraswamy and Kumarasingham (1988) have done lot of work on macrofungi based only on morphological characteristics. More than 500 Agaricoid genera collected by G. Gardner, who was the Superintendent of the Royal Botanic Gardens, Peradeniya during 1844-1849, have been described or recorded by M. J. Berkeley. Gardner was helped by G. H. K. Thwaites, and over 1200 dried specimens were sent to M. J. Berkeley at Kew, for identification.

Four hundred and three agaric species were reported by Berkeley and Broome, of which 305 were described as new species and provided with type collections (Berkeley and Broome; 1870, 1871, 1873). A few years after Berkeley and Broome's publications, Cesati (1879) described several agaric species based on O. Beccari's collections in 1865. F. V. Höehnel rediscovered some of Berkeley and Broome's specimens during his visit to Sri Lanka in 1907 (Höehnel, 1908, 1909, 1914). T. Petch, the appointed Mycologist at Peradeniya Royal Botanic Gardens, collected many mushrooms on the island and several of his accounts were published during 1905-1925.

Recent publications on agarics involve the genera *Lepiota* (Pegler, 1972) and *Inocybe* (synonym: *Asterosporina*) (Horak, 1979, 1980), and the family *Entolomataceae* (Pegler, 1977; Horak, 1980). *Lentinus giganteus* Berk. was recently moved to *Pleurotus* based on Thai and Sri Lankan collections (Karunarathna *et al.*, 2011), and *Agaricus hanthanaensis* Karun. & K.D. Hyde from Kandy district in the central Province of Sri Lanka was described as a new species (Liu *et al.*, 2015). Li *et al.* (2016) reported *Clarkeinda trachodes* (Berk.) Singer, *Lilloa* based on both morphological characteristics and molecular phylogenetic analysis after Berkeley (1847) first described it. In addition, one coprophilous fungus (*Panaeolus sphinctrinus* (Fr) Quél.) and one grassland species (*P. foenisecii* (Pers.) J. Schröt.) were described from Sri Lankan dry zone forest reserves based on morphological characteristics and DNA sequences (Ediriweera *et al.* 2015).

More recently, Tipbromma *et al.* (2017) reported *Boletellus emodensis* (Berk.) Singer, *Favolaschia auriscalpium* (Mont.) Henn., *F. manipularis* (Berk.) Teng, *Lentinus sajorajaju* (Fr.) Fr., *Leucocoprinus cretaceus* (Bull.) Locq., *Russula* cf. *virescens* (Schaeff.) Fr. and *Tremella fuciformis* Berk. as new records to Sri Lanka with the support of morphological characteristics and DNA data, while *Lentinus squarrosulus* Mont. and *L. velutinus* Fr. were reported with the support of DNA data, following previous reports by Pegler (1983). *Boletellus emodensis*, *L. sajorajaju*, *L. squarrosulus*, *R. virescens* and *T. fuciformis* are edible mushrooms

which grow wild in Sri Lanka, but most Sri Lankans are not aware that they are safe to eat.

MUSHROOM CULTIVATION IN SRI LANKA

Commercial mushroom cultivation was first introduced to Sri Lanka by the United Nations Development Programme (UNDP) in 1985. Spawn laboratories and mushroom houses for spawn production and mushroom cultivation were established by the Sri Lanka Export Development Board (Rajapakse, 2014). Subsequently, research and development activities connected to mushroom cultivation have been led by the Department of Agriculture as the state institution responsible for food crop production. The most popular cultivated species across the country in terms of production and consumption is *Pleurotus ostreatus* (Jacq.) P. Kumm., followed by *P. cystidiosus* O. K. Mill. and *P. eous* (Berk.) Sacc.

Even though the necessary technology for the cultivation of *P. eryngii* (D. C.) Quél. has been comprehensively developed by researchers (Anon, 2009), this has been restricted to the mid- and up country of Sri Lanka. *Volvariella* spp. (paddy straw mushroom) production is usually carried out outdoors in Sri Lanka (Rajapakse, 2014). The protocol for cultivation of button mushrooms in Sri Lanka [*Agaricus bisporus* (J. E. Lange) Imbach] was developed by Wijesinghe *et al.* (2000). Cultivation of milky mushroom (*Calocybe indica* Purkay. & A. Chandra) and black ear mushrooms (*Auricularia* spp.) were first introduced to the country by Udugama and Wickramarathna (1991).

Ganoderma lucidum (Curtis) P. Karst. cultivation was refined by Rajapakse *et al.* (2010), while Bandaranayake *et al.* (2012) first reported cultivation technology and methods for domesticated *G. lucidum*. Methods for the successful artificial cultivation of the Sri Lankan endemic mushroom *Pleurotus giganteus* (Berk.) Karunaratna & K.D. Hyde (Udugama and Wickramarathna, 1995) have been developed using sawdust. Recently, Namalee *et al.* (2016) published the commercial cultivation potential of *P. giganteus*, using locally adaptation of sawdust-based compost media under ambient tropical conditions - a method normally used for oyster mushroom cultivation (Figure 1).

CONCLUSION AND RECOMMENDATIONS

The proper identification of mushrooms, plant pathogenic fungi, and other fungi is an important part of Sri Lankan fungi research. Although several edible and medicinal mushrooms are found in Sri Lanka, most people are afraid to exploit this resource due to a widespread lack of mushroom knowledge. High school and university students, farmers and other local communities in Sri Lanka should

be educated through workshops, conferences and guide books on how to safely make use of edible and medicinal mushrooms. If managed properly, the collection and cultivation of edible and medicinal mushrooms can provide a significant boost to rural incomes and nutrition.

Sri Lanka needs both a national fungi herbarium and culture collection, and a strong network of local fungi research groups. It is also vital to have a focal point for mycological activities within the national herbarium capable of managing the identification of all local fungi. Collaboration with other fungi research groups around the world is also vital in order for Sri Lankan scientists to stay abreast of new techniques and discoveries in fungi research. Sri Lankan mycologists should also be recognized for their hard work and persistence in developing this often neglected area of mycology.

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Figure 1. Edible mushrooms recorded in Tipbromma et al. (2017) A) *Lentinus squarrosulus*. B) *Russula* cf. *virescens*. C) *Tremella fuciformis*- D) *Lentinus sajor-caju*. E) *Boletellus emodensis*.

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