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A comprehensive checklist of fungal species associated with *Shorea robusta* (Sal tree) in South Asia: taxonomic diversity and ecological insights

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Abstract

In this literature-derived report, we present an updated checklist of fungal species associated with *Shorea robusta*. This compilation encompasses information regarding the habitats and locations where fungi have been identified on the sal tree, and integrates original taxonomic descriptions when available. In aggregate, 79 fungal species from 16 nations have been documented on the sal tree. The associated fungi can be classified into three primary groups: (i) Ascomycota: Spanning 10 orders, 12 families, and 13 genera, this group comprises 18 identified species and an additional 3 species yet to be precisely identified. (ii) Anamorphic-Hyphomycetes: This group includes 08 orders, 6 families, and 19 genera, encompassing 23 identified species and 2 species whose identification remains pending. (iii) Basidiomycota: Covering 5 orders, 11 families, and 26 genera, there are 39 discerned species and 3 species with undetermined taxonomy. From the data analyzed, a predominant proportion of the fungal species have been detected on the sal tree's leaves, bark, branches, and decaying wood. Notably, the leaves manifest the highest fungal association. This checklist serves as a foundational resource for gauging the diversity of fungal species on the sal tree within the South Asian region.

Keywords – Ascomycota – Basidiomycota – Checklist – Fungi – Hyphomycetes – South Asia

Introduction

Forests play a pivotal role as a primary reservoir of biodiversity, underpinning human survival, economic prosperity, and the stability and functionality of ecosystems. The *Shorea robusta*, colloquially known as the sal tree, is indigenous to the Indian subcontinent, specifically encompassing regions like Nepal, Bhutan, Bangladesh, and Sri Lanka (Soni et al. 2011). This species, part of the Dipterocarpaceae family, predominantly populates tropical dry deciduous

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forests, sharing these habitats with teak (*Tectona grandis*), *Acacia catechu*, and *Syzygium cumini*. A notable feature of sal forests is their distinctive flora, largely characterized by the overwhelming dominance of tree species.

Regrettably, due to relentless logging and habitat degradation, populations of *Shorea robusta* are dwindling in select areas (Hore & Uniyal 2008, Tripathi & Singh 2009, Das et al. 2020). These circumstances have precipitated conservation endeavors to safeguard this invaluable species. The sal tree captivates the attention of ecologists and researchers, given its intrinsic role in forest ecosystems, biodiversity, and as an indicator of anthropogenic influences on pristine habitats.

Forests, particularly those anchored by species like *S. robusta*, are ecologically invaluable. They shelter a myriad of wildlife, ranging from mammals to fungi, thereby augmenting regional biodiversity (Choeyklin et al. 2011). In this ecological tapestry, the *Shorea robusta* has symbiotic relationships with a diverse array of fungi critical for processes like nutrient recycling and plant vitality. The exact fungal communities partnering with *S. robusta* can be influenced by myriad factors, including geography, edaphic conditions, and other environmental dynamics.

Although several fungal checklists emphasizing specific hosts, nations, or fungal subsets exist - such as the ones concerning fungi on cabbage plants in New Zealand (*Cordyline* spp.) or rust fungi in Turkey (Bahcecioglu & Kabaktepe 2012, Ariyawansa et al. 2015) – a holistic checklist detailing fungi linked with *Shorea robusta* remains elusive. The Systematic Mycology and Microbiology Laboratory (SMML) database reveals 79 fungus-host dyads related to sal (Farr & Rossman 2021). accessible via https://nt.ars-grin.gov/fungaldatabases/). Predominantly, *Shorea robusta* is associated with Ascomycota fungi, which can manifest as endophytes, pathogens, or saprobes (Farr & Rossman 2021). A subset of Basidiomycota, often implicated in sal basal stem rot and ectomycorrhizal symbiosis, is also documented (Farr & Rossman 2021, Tarafder et al. 2018, 2022).

The intention behind formulating this checklist is to consolidate extant knowledge about fungal species affiliated with *Shorea robusta*. Such a curated list would not only stimulate future fungal research but also lay the foundation for a comprehensive database detailing fungi associated with sal trees.

Materials & Methods

This checklist is meticulously curated from both recent academic publications and reputable online databases. A significant reference point for this list was the USDA database, available at https://nt.ars-grin.gov/fungaldatabases/fungushost/fungushost.cfm, with the most recent access on 15–11–2023. To ensure the utmost systematic precision, accuracy in nomenclature, and the usage of current names, we referred to two globally recognized fungal databases: Index Fungorum, available at http://indexfungorum.org and MycoBank, accessible at https://www.mycobank.org. Both databases were last consulted on 06 November 2023.

For ease of reference, the taxa – encompassing phylum, class, order, family, genera, and species – are organized in an alphabetical order.

Results

The checklist detailing fungal associations with *Shorea robusta* has been meticulously assembled utilizing data from the United States National Fungus Collections Fungus-Host Database (Farr & Rossman 2021, Piepenbring 2006). This is further augmented by scholarly articles from both books and peer-reviewed journals. Within the checklist, information encompasses fungal species names, their associated substrate, and the specific locations where fungi have been detected on the sal tree. The nomenclature used for these fungal species is corroborated by the most recent data from Index Fungorum (2023) available at https://www.indexfungorum.org/Names/Names.asp. The taxonomy is based on the classification by Wijayawardene et al. (2020).

From the combined data sourced from the U.S. National Fungus Collections Fungus-Host Database (Farr & Rossman 2021) and pertinent literature, the comprehensive checklist presents 80 species identified at the genus level. These species are distributed among 40 genera, 32 families, and 22 orders, spanning across three fungal phyla:

1. **Basidiomycota**: Housing 40 species, this phylum is further categorized into 5 orders, 11 families, and 27 genera (Table 3). The dominant genera include *Phellinus* (23%), *Ganoderma* (10%), and *Lenzites* (5%) as illustrated in Fig. 1A. The families predominantly observed are Hymenochaetaceae (54%), Polyporaceae (18%), and Phomitopsidaceae (12%) as shown in Fig. 2A. The orders with the most representations are Hymenochaetales (64%), Polyporales (26%), and Agaricales (5%) - depicted in Fig. 3A.

2. **Ascomycota**: This phylum includes 18 species grouped into 13 genera, 11 families, and 10 orders (Table 1). Prominent genera within this group are *Lembosia* (17%), *Xylaria* (12%), and *Morenoella* (11%), as delineated in Fig. 1B. The most represented families include Asterinaceae (39%), Xylariaceae (29%), and Nectriaceae (6%), shown in Fig. 2B. The major orders are Asterinales (44%), Coronophorales (11%), and Xylariales (6%), as illustrated in Fig. 3B.

3. **Anamorphic Fungi**: Encompassing 23 species, these are divided into 18 genera, 10 families, and 8 orders (Table 2). The most prevalent genera are *Fusarium* (13%), *Cylindrocladium* (9%), *Pseudocercospora* (9%), and *Zasmidium* (6%) as depicted in Fig. 1C. The major families are Mycosphaerellaceae (47%) and Nectriaceae (26%) as displayed in Fig. 2C. The predominant orders include Hypocreales (35%), Mycosphaereles (26%), and Eurotiales (9%), represented in Fig. 3C.

The most reported species on plant parts were dead hardwoods (40%), leaves (27%), rotten trunk (14%), and base of living tree (7%) (Fig 4). Fig. 5 depicts the distribution frequency of ascomycota, anamorphic fungi and basidiomycota associated with sal trees. The largest reports were from India 45, Philippines 16, and Indonesia 9 taxa. This holistic checklist not only presents a granular insight into the fungal biodiversity associated with *Shorea robusta*, but also serves as a valuable resource for subsequent research and conservation efforts.

Discussion

According to our findings, the most abundant species on *Shorea robusta* trees are Basidiomycota and Ascomycota. Over fifty percent of the taxa are isolated from leaves and the base of the living tree. Fungi are critical in the breakdown of leaf litter as they can swiftly decompose lignin and other refractory components, impacting decomposition in terrestrial ecosystems (Tripathi & Singh 2009, Fedorenko 2019, Fabrini & Wartchow 2020). The foregoing overviews clearly demonstrate that the taxon of different fungi determines their prospective ability to break down litter. Meanwhile, the origins or substrates of fungal species may have an impact on their breakdown ability (Nizamani et al. 2023).

To deepen our understanding of ecological relationships, it’s crucial to explore the co-evolutionary dynamics between the *Shorea robusta* tree, a sal tree predominantly found in south Asian forests, and dominant fungal families such as Hymenochaetaceae. This symbiosis may extend beyond mere mutual benefits; it could lead to specialized interactions that have evolved over time to significantly influence the survival, growth, and health of both the tree and the fungi. For instance, the fungi may offer the tree protection against pathogens while gaining essential nutrients for their own growth (Smith & Read 2010). Furthermore, examining such relationships may also offer insights into broader ecological questions. It can serve as a gateway for future research endeavors focused on understanding how specific fungi contribute to the overall health and resilience of trees. The implications of this could be far-reaching, potentially informing forest management strategies aimed at promoting sustainable ecosystems (Hooper et al. 2005).

The checklist presented provides an exhaustive and contemporary summary of fungi associated with *Shorea robusta*, a species of tree primarily found in South Asian forests. The data has been meticulously compiled from multiple sources, notably the USDA Database, which can be accessed online, as well as from scholarly monographs and books. The taxa enumerated in this checklist are systematically categorized into varying levels of taxonomic hierarchy, including 23 orders, 29 families, 58 genera, and 80 identified species. Additionally, there are 8 species that remain unidentified at this time. The research findings also delve into the spatial distribution of these fungi on different parts of the *Shorea robusta* tree. According to the data, the leaves host 27% of the total identified fungi species, while the base of the living tree accommodates 14%.

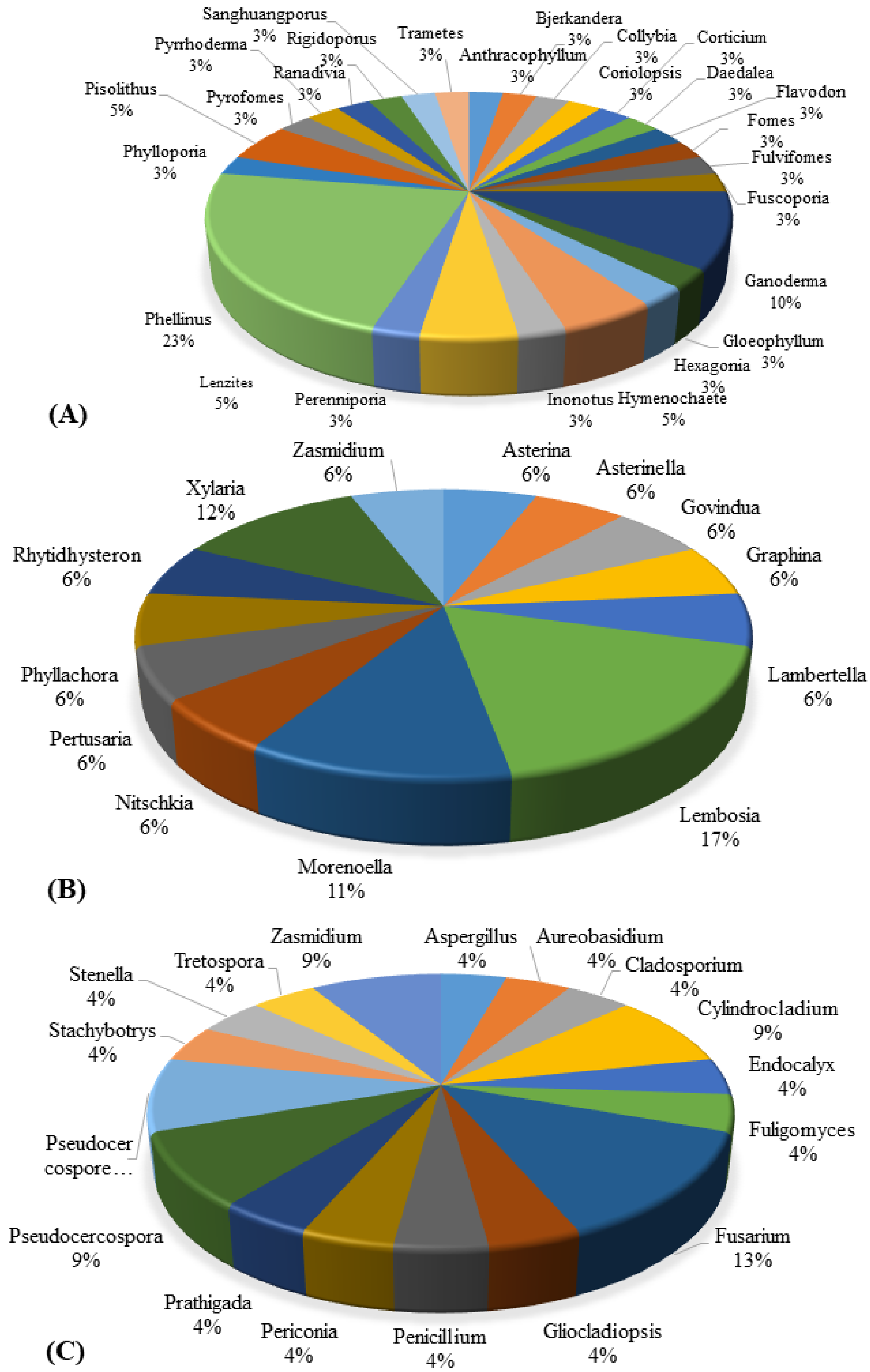

Fig. 1 – The percentage frequency of genera of Basidiomycota, Ascomycota, Anamorphic fungi associated with the sal tree. Pie chart showing the frequency percentage occurrence. A Basidiomycota. B Ascomycota. C Anamorph.

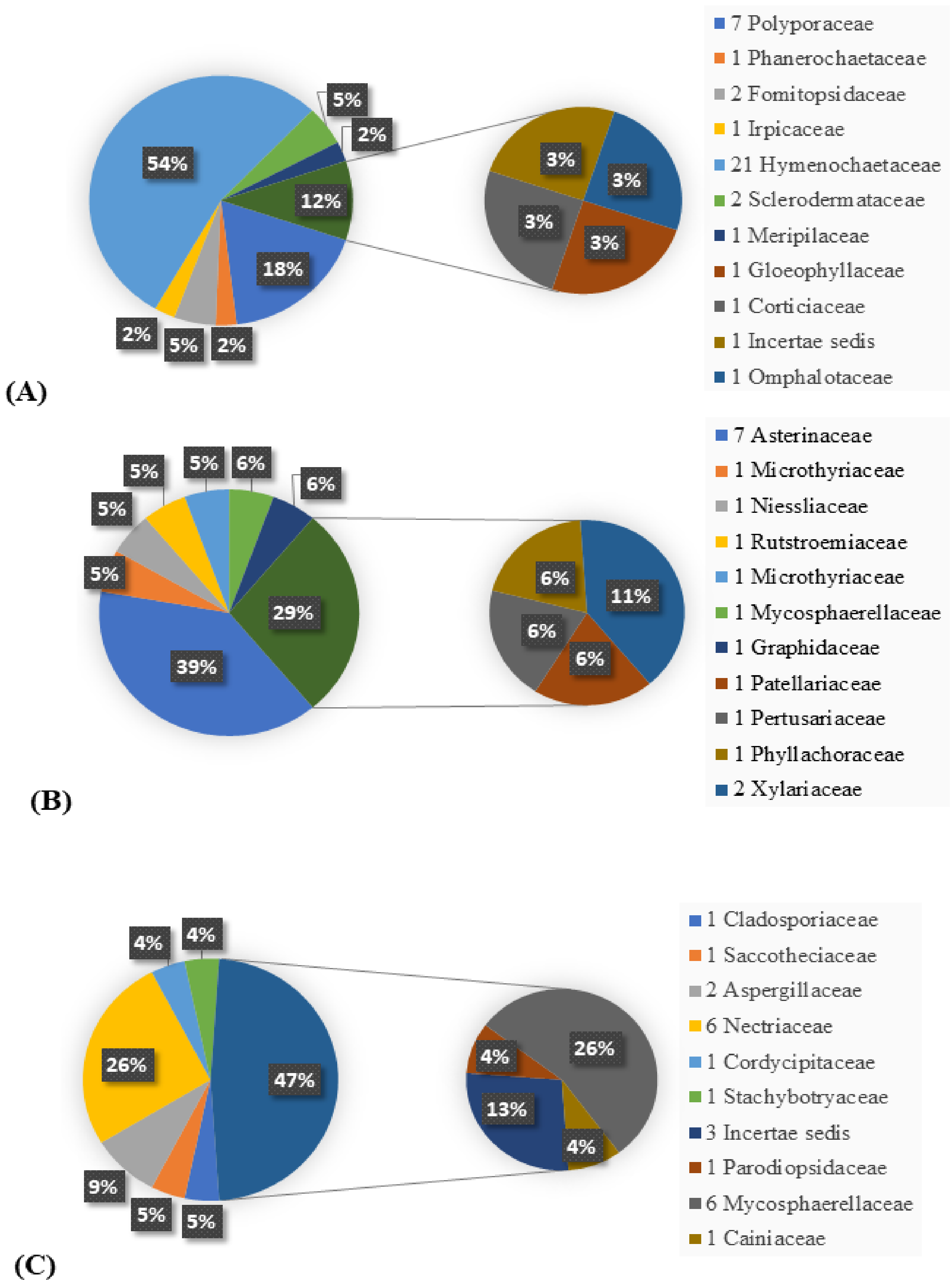

Fig. 2 – The percentage frequency of families of Basidiomycota, Ascomycota, Anamorphic fungi associated with the sal tree. Pie chart showing the frequency percentage occurrence. A Basidiomycota. B Ascomycota. C Anamorph.

Table 1 List of Ascomycota on *Shorea robusta*.

Genus	Family	Order	Host Substratum	Country	Reference
Asterina pemphidioides	Asterinaceae	Asterinales	Leaves	India	Patel et al. (1997), Teodoro (1937)
Asterina pluripora	Asterinaceae	Asterinales	Living leaves	India	Spaulding (1961), Hosagoudar & Abraham (2000)
Asterinella luzonensis	Microthyriaceae	Asterinales	Leaves	Philippines	Teodoro (1937), Spaulding (1961)
Govindua shoreae	Microthyriaceae	Microthyriales	Leaves	India	Wu et al. (2011)
Graphina sp.	Graphidaceae	Ostropales	Fallen Bark	Brunei Darussalam	Peregrine & Ahmad (1982)
Lambertella buchwaldii	Rutstroemiaceae	Helotiales	Twigs and petioles of leaves	India	Tewari & Singh (1972)
Lembosia bakeri	Asterinaceae	Asterinales	Leaves	Philippines	Teodoro (1937)
Lembosia shoreae	Asterinaceae	Asterinales	Leaves	India	Soni et al. (2011)
Lembosia xyliae	Asterinaceae	Asterinales	Leaves	Thailand	Hyde et al. (2019)
Morenoella bakeri	Asterinaceae	Asterinales	Leaves	Philippines	Teodoro (1937)
Morenoella euopla	Asterinaceae	Asterinales	Living leaves	Malayasia	Lui (1977)
Nitschkia floridana	Nitschkiaceae	Coronophorales	Dead Bark	India	Patel et al. 1997
Pertusaria sp.	Pertusariaceae	Pertusariales	Leaves	Brunei Darussalam	Peregrine & Ahmad (1982)
Phyllachora sp.	Phyllachoraceae	Phyllachorales	Leaves	Myanmar	Thaung (2008)
Rhytidhysteron rufulum	Patellariaceae	Patellariales	Fallen Bark	India	Rajak & Pandey (1985)
Xylaria corniformis	Xylariaceae	Xylariales	Decaying wood	Philippines	Teodoro (1937)
Xylaria polymorpha	Xylariaceae	Xylariales	Decaying wood	India	Spaulding (1961)
Zasmidium shoreicola	Mycosphaerellaceae	Mycosphaerellales	Leaves	India	Kamal (2010)

Table 2 List of Anamorphic Fungi on *Shorea robusta*.

Genus	Family	Order	Host Substratum	Country	Reference
Aspergillus niger	Aspergillaceae	Eurotiales	Leaves	India	Richardson (1990)
Aureobasidium pullulans	Saccotheciaceae	Dothideales	Leaves	Florida, Oregon	Schmidt & French (1976)
Cladosporium tenuissimum	Cladosporiaceae	Capnodiales	Leaves	Laos	Bensch et al. (2010, 2012)
Cylindrocladium scoparium	Nectriaceae	Hypocreales	Dead bark	Malaysia	Richardson (1990)
Cylindrocladium sp.	Nectriaceae	Hypocreales	Leaves	Malay Peninsula	Richardson (1990)
Endocalyx amarkantakensis	Cainiaceae	Xylariales	Dead wood	India	Patel et al. (2000–2001)
Fuligomyces indicus	Incertae sedis	Incertae sedis	Leaves	India	Khan et al. (1993)
Fusarium oxysporum	Nectriaceae	Hypocreales	Leaf litter	Indonesia	Tunarsih et al. (2015)
Fusarium solani	Nectriaceae	Hypocreales	Leaf litter	Indonesia	Tunarsih et al. (2015)
Fusarium sp.	Nectriaceae	Hypocreales	Leaf litter	Indonesia, Malay Peninsula	Richardson (1990), Tunarsih et al. (2015)
Gliocladiopsis tenuis	Nectriaceae	Hypocreales	Leaf litter	India	Crous (2002)
Lecanicillium saksenae	Cordycipitaceae	Hypocreales	Leaf litter	Indonesia	Sukarno et al. (2009)

Table 2 Continued.

Genus	Family	Order	Host Substratum	Country	Reference
Penicillium sp.	Aspergillaceae	Eurotiales	Leaves	Malay Peninsula	Richardson (1990)
Periconia shyamala	Incertae sedis	Pleosporales	Leaves	India	Kobayashi & Guzman (1988)
Prathigada shoreae	Mycosphaerellaceae	Mycosphaerellales	Leaves	India	Kamal (2010)
Pseudocercospora shoreae-robustae	Mycosphaerellaceae	Mycosphaerellales	Leaves	India	Kamal (2010)
Pseudocercosporella shoreae	Mycosphaerellaceae	Mycosphaerellales	Leaves	India	Rai & Kamal (1993)
Spiropes shoreae	Incertae sedis	Incertae sedis	Leaves	India	Ellis (1971)
Stachybotrys mangiferae	Stachybotryaceae	Hypocreales	Dead twigs	India	Misra & Srivastava (1982)
Stenella shoreae	Teratosphaeriaceae	Mycosphaerellales	Leaves	India	Khan et al. (1995)
Tretospora shoreae	Incertae sedis	Incertae sedis	Leaves	India	Khan et al. (1993)
Zasmidium shoreae	Teratosphaeriaceae	Mycosphaerellales	Leaves	India	Kamal (2010)
Zasmidium shoreicola	Teratosphaeriaceae	Mycosphaerellales	Leaves	India	Kamal (2010)

Table 3 List of Basidiomycota on *Shorea robusta*.

Genus	Family	Order	Host Substratum	Country	Reference
Anthracophyllum nigritum	Omphalotaceae	Agaricales	Fallen twigs	India, Philippines	Senthilarasu & Kumaresan (2016), Teodoro (1937)
Bjerkandera adusta	Phanerochaetaceae	Polyporales	Rotten trunk	India	Sharma (2012)
Collybia sp.	Omphalotaceae	Agaricales	Fallen twigs	Malay Peninsula	Thompson & Johnston (1953)
Coriolopsis badia	Polyporaceae	Polyporales	Dead hardwoods	Philippines, Brunei Darussalam	Peregrine & Ahmad (1982)
Corticium sp.	Corticiaceae	Corticiales	Decaying logs	Philippines	Teodoro (1937), Sarbhoy & Agarwal (1990)
Daedalea sulcata	Fomitopsidaceae	Polyporales	Rotting hardwood stump	Sri Lanka, India	Sharma (2012)
Flavodon flavus	Irpicaceae	Polyporales	Dead branches	North America, India	Sharma (2012)
Fomes fullageri	Polyporaceae	Polyporales	Rotten trunk	Philippines	Teodoro (1937)
Fulvifomes imbricatus	Hymenochaetaceae	Hymenochaetales	Living logs	Thailand	Zhou (2015)
Fuscoporia senex	Hymenochaetaceae	Hymenochaetales	Fallen wood	Iran, China, Taiwan, Japan, Vietnam, Korea, Philippines	Teodoro (1937), Zhou (2015)
Ganoderma applanatum	Polyporaceae	Polyporales	Dead logs	India, Philippines	Teodoro (1937), Sarbhoy & Agarwal (1990), Spaulding (1961)

Table 3 Continued.

Genus	Family	Order	Host Substratum	Country	Reference
Ganoderma applanatum var. philippinense	Polyporaceae	Polyporales	Rotten trunk	India, Peninsular Malaysia, Borneo, Java, Philippines	Teodoro (1937)
Ganoderma australe	Polyporaceae	Polyporales	Rotten stump	India, Philippines	Teodoro (1937), Reinking (1921), Sharma (2012), Spaulding (1961),
Ganoderma lucidum	Polyporaceae	Polyporales	Roots and trunks	India	Sarbhoy & Agarwal (1990), Sharma (2012), Spaulding (1961)
Gloeophyllum striatum	Gloeophyllaceae	Gloeophyllales	Decaying logs	Philippines	Teodoro (1937), Reinking (1921)
Hexagonia albida	Polyporaceae	Polyporales	Dead hardwoods	Philippines	Teodoro (1937)
Hymenochaete microcycla	Hymenochaetaceae	Hymenochaetales	Rotting trunk	India	Sarbhoy & Agarwal (1990)
Hymenochaete rubiginosa	Hymenochaetaceae	Hymenochaetales	Rotting stump	India	Sharma (2012)
Lenzites albidus	Polyporaceae	Polyporales	Rotting trunk	India	Sharma (2012)
Lenzites striatus	Polyporaceae	Polyporales	Rotting trunk	India	Sharma (2012)
Perenniporia xantha	Polyporaceae	Polyporales	Bark of decaying twig	French Guiana	Boom & Mori (1982)
Phellinus badius	Hymenochaetaceae	Hymenochaetales	Base of living tree	India	Sharma (2012)
Phellinus caryophylli	Hymenochaetaceae	Hymenochaetales	Dead trunk	India	Sharma (2012)
Phellinus fastuosus	Hymenochaetaceae	Hymenochaetales	Base of a living tree	India	Sharma (2012)
Phellinus gilvus	Hymenochaetaceae	Hymenochaetales	Hardwood trunk	India	Sharma (2012)
Phellinus rimosus	Hymenochaetaceae	Hymenochaetales	Base of living tree	India	Sharma (2012)
Phellinus robiniae	Hymenochaetaceae	Hymenochaetales	Base of living tree	Massachusetts, New York, New Jersey, Ohio, West Virginia, Virginia, Alabama, India	Sharma (2012)
Phellinus setulosus	Hymenochaetaceae	Hymenochaetales	Dead hardwoods	India	Sharma (2012)
Phylloporia ribis	Hymenochaetaceae	Hymenochaetales	Base of a living tree	India	Sharma (2012)
Pisolithus aurantioscabrosus	Sclerodermataceae	Hymenochaetales	Under living tree	Peninsular Malaysia	Watling et al. (1995)
Pisolithus sp.	Sclerodermataceae	Hymenochaetales	Living logs	New Caledonia, Japan	Hosaka (2009)
Pyrofomes tricolor	Polyporaceae	Polyporales	Living trunk	Philippines, India	Sharma (2012)
Pyrrhoderma lamaoense	Hymenochaetaceae	Hymenochaetales	Decayed wood	Philippines	Teodoro (1937)
Ranadivia stereoides	Fomitopsidaceae	Hymenochaetales	Dead trunk	India	Lindner et al. (2011)
Rigidoporus microporus	Meripilaceae	Hymenochaetales	Living hardwoods	India	Sharma (2012)
Sanghuangporus baumii	Hymenochaetaceae	Hymenochaetales	Base of living tree	India	Sharma (2012)
Trametes hirsute	Polyporaceae	Polyporales	Rotting hardwood stump	India	Sarbhoy & Agarwal (1990)

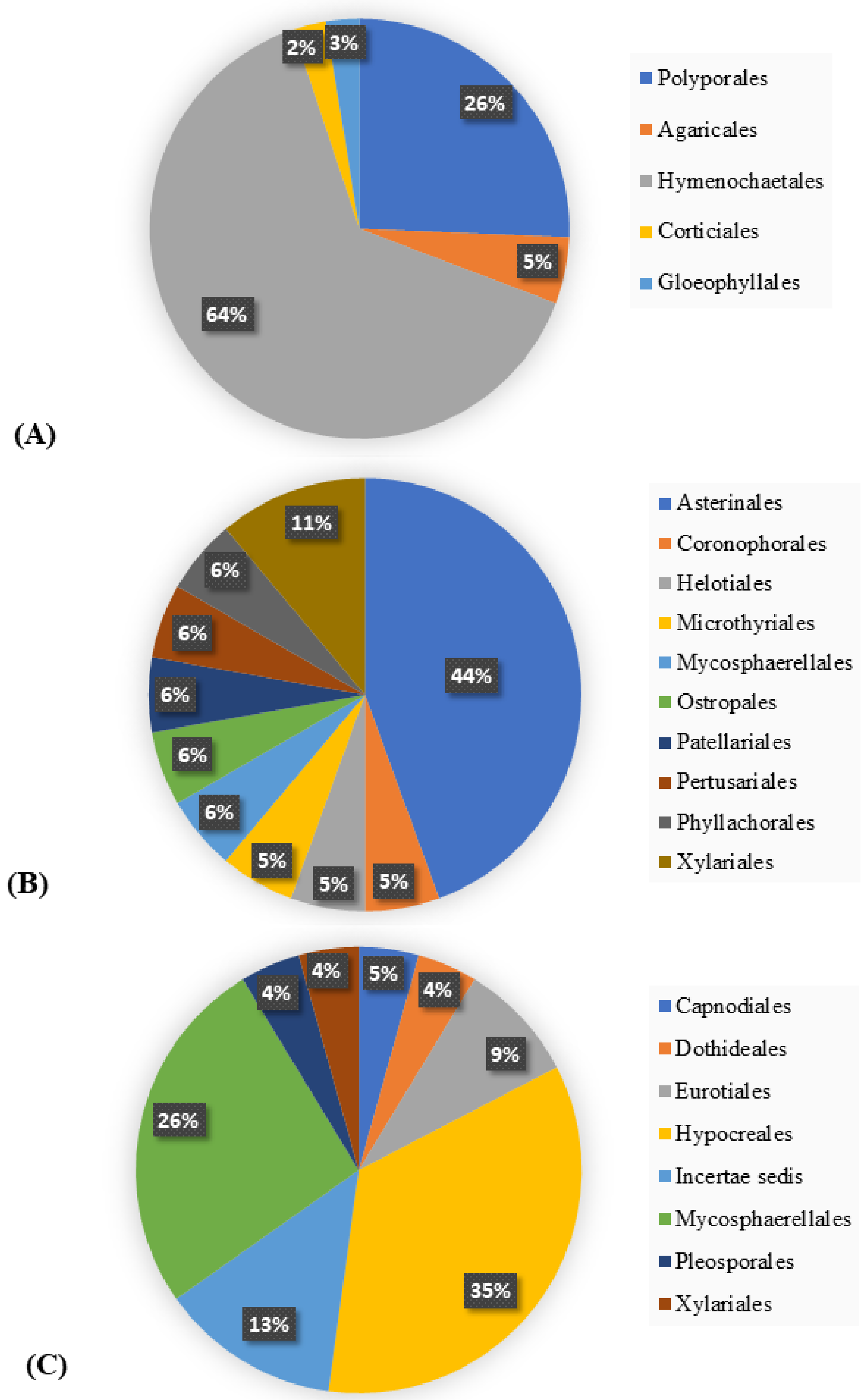

Fig. 3 – The percentage frequency of order of Basidiomycota, Ascomycota, Anamorphic fungi associated with the sal tree. Pie chart showing the frequency percentage occurrence. A Basidiomycota. B Ascomycota. C Anamorph.

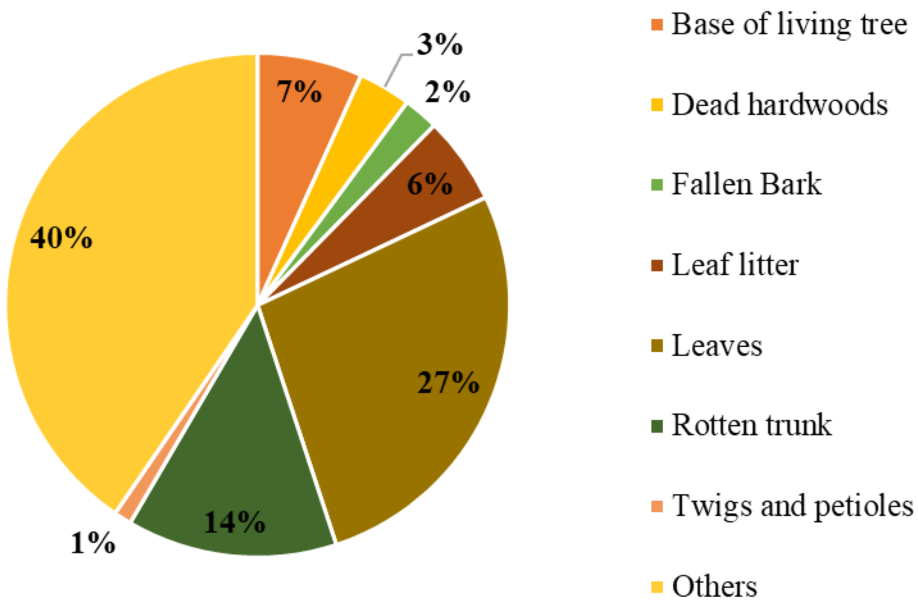

Fig. 4 – Pie chart showing the frequency percentage of species associated from different plant parts of the *Shorea robusta* tree.

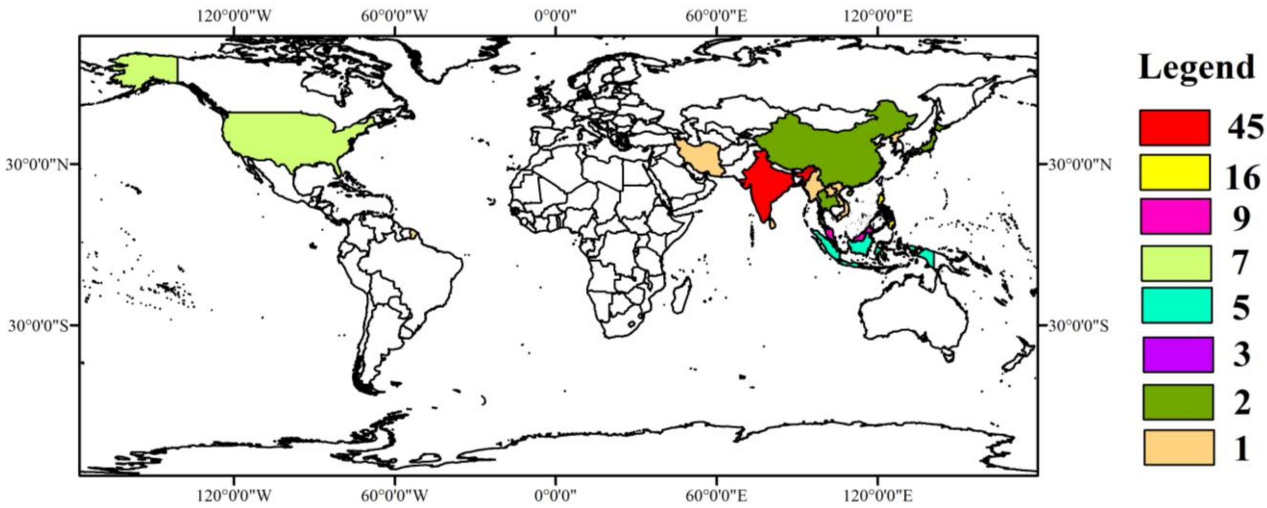

Fig. 5 – The number of species isolated belonging to Basidiomycota, Ascomycota and Anamorphic fungi associated with *Shorea robusta* trees from different countries.

Interestingly, fallen bark accounts for 7% of the fungi species. These specifics offer a granular understanding of how fungi interact with different parts of the tree, which can be invaluable for both ecological studies and practical applications, such as disease management in forestry (Piasai & Manoch 2009a, b).

It is particularly striking that within the Basidiomycota division, the Hymenochaetaceae family stands out as the most expansive and universally distributed, featuring an impressive 15 genera and 25 species. This family's prevalence suggests its critical role in shaping the ecology around the *Shorea robusta* trees and could hint at specialized symbiotic relationships that are yet to be explored (Smith & Read 2010). Following Hymenochaetaceae, the Polyporaceae family also emerges as a significant contributor, with its representation comprising 7 genera and 10 species. These families might play different roles in nutrient cycling, decomposing wood, or even in protecting the trees from certain pathogens (Gilbert & Sousa 2002). Worthy of mention are also the families Omphalotaceae and Gloeophyllaceae, each represented by a single genus and species. Though less numerous, their unique presence may offer insights into specialized roles they play in the ecosystem, whether it be in nutrient absorption, mutualistic relationships, or other ecological functions (Baldrian 2017).

The preeminence of the Hymenochaetaceae family in association with *Shorea robusta* is not just a numerical curiosity; it holds broader ecological implications that warrant closer examination. This family's dominance may imply a range of ecological functions and services that they provide, both to the *Shorea robusta* trees and to the ecosystem at large. For example, members of the Hymenochaetaceae family could serve as a crucial food source for certain decomposers like detritivorous insects, thereby fueling the nutrient cycle (Shivas et al. 2007, Crowther et al. 2015). Alternatively, these fungi might also engage in mutualistic relationships with other organisms, including plants and animals, thereby facilitating complex ecological networks (Kiers et al. 2011). Moreover, it is imperative to bring the discussion to the contemporary context of climate change. Shifts in temperature, humidity, and other climatic factors can potentially alter the distribution and prevalence of these fungi. Such changes could have ripple effects on ecosystem functions, such as nutrient cycling, soil structure, and even the health and distribution of *Shorea robusta* itself (Allen et al. 2003).

The checklist serves as a cornerstone resource for a diverse group of experts, including mycologists, ecologists, and conservationists, who are keen on understanding and preserving the rich fungal biodiversity associated with *Shorea robusta*. The checklist's utility extends far beyond academic interest; it could potentially inform critical conservation initiatives. Evaluating the conservation status of the fungi on the list becomes paramount, especially in the context of an ever-changing environment (Paguirigan et al. 2020). Are any of these fungi endangered, threatened, or vulnerable? The extinction or diminution of specific fungal species could have cascading impacts on the *Shorea robusta* ecosystems. These fungi may play key roles in nutrient cycling, plant health, and the stability of food webs, among other things (Heilmann–Clausen et al. 2015, Rathnayaka & Jayawardena 2019). Understanding the conservation status could not only help in the protection of these fungi but could also offer insights into the overall health and resilience of the *Shorea robusta* ecosystems they inhabit. Additionally, information about endangered or threatened fungal species could guide future conservation policies, and even inform land management decisions that favor the preservation of these critical ecological components (Waldrop et al. 2006).

Conclusion

The intricate fungal associations with *Shorea robusta* underscore the vast biodiversity and ecological interactions underpinning global forest ecosystems. The compiled checklist, curated from reputable sources such as the USDA database and scholarly literature, offers an invaluable resource highlighting the intricate taxonomy and distribution of fungi affiliated with this tree. With Hymenochaetaceae emerging as the predominant family in this symbiotic relationship, the data brings to the forefront the significance of certain fungal families in sustaining and influencing the health and biodiversity of *Shorea robusta*. Such insights not only augment our understanding of forest ecology but also pave the way for informed conservation and research initiatives. As we move forward, it's crucial that these checklists are updated on a regular basis to account for the dynamics of forest ecosystems changing over time and the dynamic field of fungal biodiversity.

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