



DIVERSITY AND DISTRIBUTION OF THE GENUS *SCHIFFNERULA* AND ITS SYNANAMORPHS IN INDIA

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ABSTRACT

The genus *Schiffnerula* represented by 96 species in India with the anamorphic genera: *Mitteriella* (1), *Questieriella* (11), *Sarcinella* (49) and the teleomorph *Schiffnerula* (35). All the taxa are listed with their host plants along with their localities. Distributional map is provided. These fungi represented in eleven states in southern, central and north-eastern states of India but Kerala and Karnataka hold more number of species because of their intensive collection. These may represent in other regions of India but are to be collected and studied.

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INTRODUCTION

Black mildews are abundant in the in the Western Ghats but occur in the Eastern Ghats and Deccan plateau. These are the leaf dwelling obligate parasites (Biotrophs) mostly infect leaves but also on stem, petiole and in some cases on fruits also. They appear a month or two after the monsoon but are scanty during summer and abundant during winter season. Taxonomically, black mildews or black colony forming parasitic fungi belong to several taxonomic groups, namely, Hyphomycetes (conidial fungi), Meliolales, the genus *Schiffnerula* and its anamorphic forms, Asterinales, Meliolinaceae, etc. The fungi with thyriothecium may belong to Asterinales (external mycelium with thyriothecia, which dehiscence stellately at the centre or vertically all along the length), Parmulariaceae (external mycelium absent) or Microthyriales (having ostiolate thyriothecium), Meliolales (having two-celled appressoria and unicellular phialides), *Schiffnerula* (like Asterinales but with unicellular appressoria, having different types of conidial forms), Hyphomycetes

(presence of conidia and conidiophores) and so on. *Schiffnerulaceae* fungi flourish well in the tropics and have extended their distribution to subtropical to temperate regions of the world. The connection between teleomorph and synanamorphs is well established (Hughes, 1987). The genus *Schiffnerula* includes four synanamorphs, namely, *Questieriella*, *Mitteriella*, *Digitosarcinella* and *Sarcinella*. These are characterized by black colonies formed on the leaf surface, mycelium septate, brown, superficial, appressoriolate; appressoria unicellular, formed laterally; thyriothecia orbicular, cells on the upper surface radiating, dissolve at the centre during maturity; asci globose, bitunicate, 8-spored; ascospores conglobate, brown, uniseptate, constricted at the septum. *Schiffnerulaceae* fungi represented by 96 species in India belonging to the anamorphs: *Mitteriella* (1), *Questieriella* (11), *Sarcinella* (49) and the teleomorph *Schiffnerula* (35). These are represented in eleven states in southern, central and north-eastern states of India but Kerala and Karnataka hold more number of species because of their intensive collection. They may represent in other regions of India but an intensive study is essential.

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MATERIALS AND METHODS

Infected plant parts were selected in the field, notes were made regarding the nature of colonies, infection pattern and its collection locality. For each collection, a separate field number was given and collected in individual collection polythene bags along with the host twig (preferably with the reproductive parts to facilitate the identity of the respective host). These infected plant parts were pressed neatly and dried in-between blotting papers. After ensuring their dryness, they were used for microscopic study.

Scrapes were taken directly from the infected host and mounted in 10% KOH solution. After 30 minutes KOH was replaced by Lactophenol. Both the mountants work well as clearing agents and make the septa visible for taking measurements. Nail polish technique (Hosagoudar and Kapoor, 1984) used for the preparation of permanent slides to study the structural and morphological characters of the fungi *in situ*.³ To study the entire colony in its natural condition, a drop of high quality natural coloured or well transparent nail polish, devoid of gilt, was applied to the selected colonies and carefully thinned with the help of a fine brush without

disturbing the colonies. When the nail polish on the colonies dried fully, a thin, colourless or slightly apple rose coloured “film or flip” was formed with the colonies firmly embedded in it. In case of soft host parts, a slight pressure on the opposite side of the leaves and just below the colonies lifts the flip up. In case of hard host parts, the flip was eased off from the edge with the help of a razor or scalpel. A drop of DPX was spread on a clean slide and the flip was spread properly on it. One or two more drops of DPX added on the flip and a clean cover glass was placed over it. Care was taken to avoid air bubbles. These slides were labelled and placed in a dust free chamber for 1-2 days for drying. These permanent slides were then used for further studies. For innate fungi, sections were made and stained in cotton blue. After the study of each collection, part of the material was retained in the Jawaharlal Nehru Topical Botanic Garden Travancore Herbarium (TBGT).

Taxonomy

Key to the genera

- Teleomorphsknown *Schiffnerula*
- Teleomorphsnotknown 2
- Conidia globose, sarciniform, brown to black *Sarcinella*
- Conidia not so. 3
- Conidia pale brown, falcate, 3-septate *Questieriella*
- Conidia straight, ellipsoidal, 0–4-septate *Mitteriella*

The genus *Digitosarcinella* is not represented in India

Fungus-host-locality

Sl.No	Name of fungus	Name of host	Distribution(State)
1.	<i>Mitteriella ziziphina</i>	<i>Ziziphus</i> sp. (Rhamnaceae)	Andaman Islands, Nabagram, Kalpong, Diglipur.
2.	<i>Questieriella ardisiae</i>	<i>Ardisia Solanaceae</i> (Myrsinaceae)	Kerala, Wayanad, Thenmala Karnataka, Kodagu, Hoddur
3.	<i>Questieriella grewiae</i>	<i>Grewia</i> sp. (Tilaceae)	Kerala, Idukki, near Munnar, Mannavan Shola
4.	<i>Questieriella malloti</i>	<i>Mallotus philippensis</i> (Euphorbiaceae)	Kerala, Wayanad, Banasuran mala
5.	<i>Questieriella ophiorrhizae</i>	<i>Ophiorrhiza</i> sp. (Rubiaceae),	Karnataka, Kodagu Madikeri, in the campus of Bharatiya Vidyabhavan Kodagu Vidyalaya
6.	<i>Questieriella passiflorae</i>	<i>Passiflora maculifolia</i> (Passifloraceae)	Kerala, Idukki, Mannavan Shola
7.	<i>Questieriella rhamni</i>	<i>Rhamnus wightii</i> (Rhamnaceae)	Tamil Nadu, Ooty, Mukurthi National Park
8.	<i>Questieriella sarcoccae</i>	<i>Sarcocca brevifolia</i> (Buxaceae); <i>S. coriacea</i>	Kerala, Idukki, Munnar, Gravel bank; Tamil Nadu, Kodaikanal, Kukkal Shola, Periyakanal
9.	<i>Questieriella strychni</i>	<i>Strychnos nuxvomica</i> (Strychnaceae)	Karnataka, South Canara, Kukke Subramanya; Kerala, Thiruvananthapuram, Karakulam, Eanikara; Kollam, Arippa
10.	<i>Questieriella tephrosiae</i>	<i>Tephrosia tinctoria</i> (Fabaceae)	Kerala, Wayanad, Chembra Peak
11.	<i>Questieriella toddaliae</i>	<i>Toddalia asiatica</i> ((Rutaceae); <i>T. asiatica</i> var. <i>floribunda</i>	Tamil Nadu, Kodaikanal, Mathikettan shoala & Samikanal
12.	<i>Questieriella zanthoxyli</i>	<i>Zanthoxylum khasianum</i> (Rutaceae); <i>Zanthoxylum</i> sp.	Karnataka, Kodagu, Bhagamandala; Meghalaya, Shillong, Lumshillong
13.	<i>Sarcinella allophyli</i>	<i>Allophylus cobbe</i> (Sapindaceae)	Karnataka, Kodagu, Madikeri, Jodupal
14.	<i>Sarcinella asiatica</i>	unknown host	Uttar Pradesh, North Gonda Forest division, Tulsipur
15.	<i>Sarcinella atalantiae</i>	<i>Atalantia</i> sp. (Rutaceae)	Kerala, Kottayam, Ponthanpuzha Researve Forest
16.	<i>Sarcinella bignoniacearum</i>	<i>Oroxylum indicum</i> (Bignoniaceae)	Uttar Pradesh, Nainital
17.	<i>Sarcinella bischofia</i>	<i>Bischofia javanica</i> (Euphorbiaceae)	Karnataka, Kodagu, Madikeri
18.	<i>Sarcinella caralliae</i>	<i>Carallia brachiata</i> (Rhizophoraceae)	Karnataka, Kaimada field, Hoddur, Kodagu
19.	<i>Sarcinella cassiae</i>	<i>Cassia tora</i> (Caesalpiniaceae); <i>C. occidentalis</i>	Karnataka, Belgaum; Uttarakhand, Kumaon, Bhimtal
20.	<i>Sarcinella cassiae-fistulae</i>	<i>Cassia fistula</i> (Caesalpiniaceae)	Kerala, Anchal, Kollam
21.	<i>Sarcinella castanopsidis</i>	<i>Castanopsis armata</i> (Fagaceae)	Meghalaya, Shillong, Lumshillong
22.	<i>Sarcinella chloroxyli</i>	<i>Chloroxylon swietenia</i> (Flindersiaceae)	Andhra Pradesh, Warangal, Kamaram forest, Pakhal Kothaguda Forest Range
23.	<i>Sarcinella cipadessae</i>	<i>Cipadessa baccifera</i> (Meliaceae)	Kerala, Thiruvananthapuram, Peppara Wildlife Sanctuary
24.	<i>Sarcinella colebrookiana</i>	<i>Colebrookia oppositifolia</i> (Lamiaceae)	Uttar Pradesh, Gorakhpur
25.	<i>Sarcinella dalbergiae</i>	<i>Dalbergia</i> sp. (Fabaceae)	Kerala, Wayanad, Banasuran mala
26.	<i>Sarcinella embeliae</i>	<i>Embelia tsjeriam-cottam</i> (Myrsinaceae)	Maharashtra, Satara
27.	<i>Sarcinella glycosmidis</i>	<i>Glycosmis pentaphylla</i> (Rutaceae)	Uttar Pradesh, Gorakhpur
28.	<i>Sarcinella gmelinae</i>	<i>Gmelina arborea</i> (Verbenaceae)	Kerala, Thirissur, Vazhachal,
29.	<i>Sarcinella gorakhpurensis</i>	<i>Diospyros melanoxylon</i> (Ebenaceae)	Madhya Pradesh, Jabalpur, Amarantak forest; Uttar Pradesh, Gorakhpur, Madhulia range
30.	<i>Sarcinella gymnosporiae</i>	<i>Gymnosporia rothiana</i> (Celastraceae)	Maharashtra, Pune, Simhagad
31.	<i>Sarcinella hardwickiae</i>	<i>Hardwickia binata</i> (Fabaceae)	Telangana, Warangal, Pasra forest, Etunagaram Wildlife Sanctuary
32.	<i>Sarcinella hippocrateae</i>	<i>Hippocratea arborea</i> (Hippocrateaceae); <i>Hippocratea</i> sp.	Uttar Pradesh; Karnataka, South Canara, Kukke Subramanya
33.	<i>Sarcinella hughesii</i>	<i>Nothopodytes foetida</i> (Icacinaceae); <i>Nothopodytes</i> sp.	Kerala, Wayanad, Padinharathara; Maharashtra, Mahabaleshwar
34.	<i>Sarcinella hugoniae</i>	<i>Hugonia mystax</i> (Linaceae)	Kerala, Malappuram
35.	<i>Sarcinella indica</i>	<i>Sapium insigne</i> (Euphorbiaceae)	Uttar Pradesh, Pithoragarh
36.	<i>Sarcinella indigoferae</i>	<i>Indigofera cassioides</i> (Fabaceae)	Telangana, Warangal, Jangalapally forest, Pakhal wild life sanctuary

37.	<i>Sarcinella jabalpurensis</i>	<i>Vitex negundo</i> (Verbenaceae)	Madhya Pradesh, Jabalpur, Bargi forest
38.	<i>Sarcinella jarwaensis</i>	<i>Terminalia chebula</i> (Combretaceae)	Uttar Pradesh, Gonda forest division, Jarwa
39.	<i>Sarcinella kamalii</i>	<i>Syzygium cumini</i> (Myrtaceae)	Karnataka, Sirsi
40.	<i>Sarcinella latifoliae</i>	<i>Ampelocissus latifolia</i> (Vitaceae)	Uttar Pradesh, Mandla
41.	<i>Sarcinella ligustri</i>	<i>Ligustrum perrotteti</i> (Oleaceae)	Maharashtra, Mahabaleshwar Wilson Point
42.	<i>Sarcinella limoniae</i>	<i>Limonia altissima</i> (Rutaceae)	Kerala, Thiruvananthapuram, Palode, TBGRI Campus
43.	<i>Sarcinella loranthacearum</i>	<i>Loranthus</i> sp. (Loranthaceae)	Kerala, Palakkad, Silent Valley National Park
44.	<i>Sarcinella lyoniae</i>	<i>Lyonia ovalifolia</i> (Ericaceae)	Meghalaya, Shillong, Mawphlang
45.	<i>Sarcinella nauradehiicola</i>	<i>Diospyros melanoxylon</i> (Ebenaceae)	Madhya Pradesh
46.	<i>Sarcinella odinae</i>	<i>Odina wodier</i> (Anacardiaceae)	Madhya Pradesh, Jabalpur, Kundam Road
47.	<i>Sarcinella oreocnidecola</i>	<i>Oreocnide integrifolia</i> (Urticaceae)	Kerala, Palghat, Silent Valley National Park, Sairandhri
48.	<i>Sarcinella oreophila</i>	<i>Carissa carandas</i> (Apocynaceae)	Kerala, Alappuzha, Chengannur, Karakkad
49.	<i>Sarcinella pogostemonis</i>	<i>Pogostemon benghalensis</i> (Lamiaceae)	Karnataka, Kodagu, Madikeri
50.	<i>Sarcinella pouzolziae</i>	<i>Pouzolzia</i> sp. (Urticaceae)	Karnataka, Kodagu, Madikeri, Nishane motta
51.	<i>Sarcinella prunicola</i>	<i>Prunus persica</i> (Rosaceae)	West Bengal, Darjeeling
52.	<i>Sarcinella quercina</i>	<i>Quercus dilatata</i> (Fagaceae)	Uttar Pradesh, Nainital
53.	<i>Sarcinella quesqualidis</i>	<i>Quisqualis indica</i> (Combretaceae)	Kerala, Thiruvananthapuram, Peppara Wildlife Sanctuary
54.	<i>Sarcinella raimundi</i>	<i>Solanum</i> sp. (Solanaceae)	Kerala, Ernakulam, Chalakudy, Chettikulam
55.	<i>Sarcinella securinegae</i>	<i>Securingea leucopyrus</i> (Euphorbiaceae)	Karnataka, Kodagu, Hoddur
56.	<i>Sarcinella shamboodarai</i>	<i>Elaeodendron glaucum</i> (Celastraceae); <i>Elaeodendron</i> sp.	Madhya Pradesh, Shadol Circle, Amarakantak (S.F.D.), Shambhoodhara; Maharashtra, Satara, Pateghar
57.	<i>Sarcinella tamarindi</i>	<i>Tamarindus indica</i> (Caesalpiniaceae)	Kerala, Wayanad, 16th mile Padinharathara
58.	<i>Sarcinella tandonii</i>	<i>Euonymus tingens</i>	Uttarakhand, Nainital
59.	<i>Sarcinella theae</i>	<i>Thea sinensis</i> (Theaceae)	Karnataka, South Canara, Kukke Subramanya
60.	<i>Sarcinella viticis</i>	<i>Vitex negundo</i> (Verbenaceae)	Uttar Pradesh, Mandla
61.	<i>Sarcinella wrightiae</i>	<i>Wrightia</i> sp. (Apocynaceae)	Kerala, Erumeli, Cheruvally
62.	<i>Schiffnerula actinodaphnes</i>	<i>Actinodaphne</i> (Lauraceae)	Kerala, Thiruvananthapuram, Palode
63.	<i>Schiffnerula aristolochiae</i>	<i>Aristolochia tagala</i> (Aristolochiaceae),	Karnataka, Devara kadu, Hoddur, Kodagu
64.	<i>Schiffnerula azadiractae</i>	<i>Azadiracta indica</i> (Meliaceae)	Kerala, Thiruvananthapuram, Kallara
65.	<i>Schiffnerula braunii</i>	<i>Morinda pubescence</i> (Rubiaceae)	Kerala, Thiruvananthapuram, Palode
66.	<i>Schiffnerula brideliae</i>	<i>Bridelia</i> sp. (Euphorbiaceae); <i>Bridelia macrantha</i>	Kerala, Wayanad, 16th mile, Padinharathara
67.	<i>Schiffnerula camelliae</i>	<i>Thea sinensis</i> (Theaceae)	Kerala, Thiruvananthapuram, Athirumala; Idukki, Munnar, Devikulam; Mattupetty; Palghat, Silent Valley National Park; Kottayam, Placherry; Wayanad, Periya
68.	<i>Schiffnerula canthii</i>	<i>Canthium</i> sp. (Rubiaceae)	Kerala, Thiruvananthapuram, Ponnudi
69.	<i>Schiffnerula cassiae</i>	<i>Bauhinia variegata</i> (Caesalpiniaceae)	Madhya Pradesh, Gwarighat
70.	<i>Schiffnerula catharanthi</i>	<i>Catharanthus roseus</i> (Apocynaceae)	Kerala, Thiruvananthapuram, Palode, Karimancode; Karnataka, Kodagu, Hakathur
71.	<i>Schiffnerula celastri</i>	<i>Celastrus paniculatus</i> Willd. (Celastraceae),	Kerala, Wayanad, Padinharathara; Munnar, Rajamala; Uttar Pradesh, Katarnia; Maharashtra, Pateghar; Karnataka, Kodagu, Madikeri hill top
72.	<i>Schiffnerula chukrasiae</i>	<i>Chukrasia</i> sp. (Meliaceae)	Andaman Islands, Central nursery, Lorogic Forest Camp, Middle Andaman
73.	<i>Schiffnerula cryptolepidis</i>	<i>Cryptolepis buehneri</i> (Periplocaceae)	Maharashtra, Panhala
74.	<i>Schiffnerula cryptostegiae</i>	<i>Cryptostegia</i> sp. (Asclepiadaceae)	Kerala, Thrissur, Vazhachal Forests
75.	<i>Schiffnerula dioscoriae</i>	<i>Dioscorea wallichii</i> (Dioscoreaceae)	Kerala, Malabar Wildlife Sanctuary, near Urakuzhy water falls
76.	<i>Schiffnerula ecliptae</i>	<i>Eclipta alba</i> (Asteraceae)	Kerala, Thiruvananthapuram, Palode
77.	<i>Schiffnerula fici</i>	<i>Ficus infectoria</i> (Moraceae)	Madhya Pradesh, Gwarghat, Jabalpur
78.	<i>Schiffnerula flacourtiiae</i>	<i>Flacourtia</i> sp. (Flacourtiaceae)	Kerala, Thiruvananthapuram, near Peppara dam, Peppara Wildlife Sanctuary
79.	<i>Schiffnerula girijae</i>	<i>Aegle marmelos</i> (Rutaceae)	Andaman Islands, North Andaman, Shibpur, Diglipur; South Andaman, Farrar gunj; North Andaman, Radhanagar, Diglipur, Kerala, Thiruvananthapuram, Palode, Karimancode
80.	<i>Schiffnerula glochidii</i>	<i>Glochidion</i> sp. (Euphorbiaceae)	Karnataka, Kodagu, Madikeri, Talacauvery, Bramahgiri; Kerala, Trissur, Vazhachal, Peringolkoothu Dam site
81.	<i>Schiffnerula hoddurensis</i>	<i>Vitex negundo</i> (Verbenaceae)	Karnataka, Hoddur, Kodagu,
82.	<i>Schiffnerula hughesii</i>	<i>Trema orientalis</i> (Ulmaceae)	Kerala, Thiruvananthapuram, Palode
83.	<i>Schiffnerula lagerstroemiae</i>	<i>Lagerstroemia microcarpa</i> (Lythraceae)	Kerala, Wayanad, 16th mile, Padinharathara
84.	<i>Schiffnerula meliosmatis</i>	<i>Meliosma simplicifolia</i> ssp. <i>pungens</i> (Sabiaceae)	Kerala, Thiruvananthapuram, Peppara Wildlife Sanctuary, Near Peppara Dam
85.	<i>Schiffnerula mirabilis</i>	<i>Passiflora foetida</i> (Passifloraceae); <i>Passiflora edulis</i>	Karnataka, Kodagu, Madikeri, Nishane motta; Kerala, Thiruvananthapuram, Kallara
86.	<i>Schiffnerula palodensis</i>	<i>Solanum</i> sp. (Solanaceae)	Kerala, Thiruvananthapuram, Palode, Chippanchira
87.	<i>Schiffnerula pulchra</i>	<i>Ligustrum</i> sp. (Oleaceae)	Karnataka, Kodagu, Madikeri, Nishanemotta
88.	<i>Schiffnerula ricini</i>	<i>Ricinus communis</i> (Euphorbiaceae)	Karnataka, Kodagu, Madikeri, Nishane motta; Kerala, Wayanad, Padinharathara, Puthusserikkadavu; Thrissur, Vazhachal, Poringalkuthu

89.	<i>Schiffnerula spilanathi</i>	<i>Spilanthes radicans</i> (Asteraceae)	Kerala, Wayanadu, Padinharathara
90.	<i>Schiffnerula tectonae</i>	<i>Tectona grandis</i> (Verbenaceae)	Karnataka, Jodupal; Kerala, Pathanamthitta, Placherry forest, Ranni; Thiruvananthapuram, Palode; Thrissur, Vazhachal, Pokalappara; Wayanadu, Puthuserrykadavu
91.	<i>Schiffnerula terminaliae</i>	<i>Terminalia catappa</i> (Combretaceae)	Kerala, Thiruvananthapuram, Karakulam, Eanikara; Pathanamthitta, Thiruvalla, Kuttapuzha; Kozhikode, Malabar Botanic Garden
92.	<i>Schiffnerula theissenii</i>	<i>Solanum</i> sp. (Solanaceae)	Maharashtra, Radhanagari
93.	<i>Schiffnerula triumfetticola</i>	<i>Triumfetta rotundifolia</i> (Tiliaceae)	Maharashtra, Ajara, Kolhapur
94.	<i>Schiffnerula vernoniae</i>	<i>Vernonia anthelmintica</i> (Asteraceae); <i>Vernonia peninsularis</i>	Kerala, Wayanad, Padinharathara; Idukki, Banasuran mala
95.	<i>Schiffnerula wedeliae</i>	<i>Wedelia chinensis</i> (Asteraceae)	Kerala, Thiruvananthapuram, Palode, TBGRI Campus,
96.	<i>Schiffnerula ziziphi</i>	<i>Ziziphus latifolia</i> (Rhamnaceae)	Uttar Pradesh, Maharajganj

DISCUSSION

The genus *Schiffnerula* and its synanamorphs represented in eleven states and a Union territory, namely, Andaman Islands has two species namely, *Mitteriella ziziphina* and *Schiffnerula chukrasiae*; Andhra Pradesh represents a single species, *Sarcinella chloroxyli*, Karnataka represents 23 species (*Questieriella* -4; *Sarcinella* -10 and *Schiffnerula* -9), Kerala represents 48 species (*Questieriella* -7; *Sarcinella* -16 and *Schiffnerula* -25), Madhya Pradesh represents 5-species of the genus *Sarcinella* and 2-species of the genus *Schiffnerula*; Maharashtra represents 8- species (*Sarcinella* -5 and *Schiffnerula* -3); Meghalaya represents 3- species (*Questieriella* -1 and *Sarcinella* -2); Tamil Nadu represents 3-species of *Questieriella*; Telangana represents 2- species of the synamorph genus *Sarcinella*; Uttar Pradesh represents 8-species (*Sarcinella* -6 and *Schiffnerula* -1); Uttarakhand and West Bengal represent *Sarcinella tandonii* and *Sarcinella prunicola*, respectively.

These fungi represented in southern, central and north-eastern states of India but Kerala and Karnataka hold more number of species because of their intensive collection. These may represent in other regions of India but are to be collected and studied.

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