



***Exosporium gymnemae* sp. nov. from India**

Singh PN*, Baghela A, Singh SK and Maurya DK

National Fungal Culture Collection of India, Biodiversity and Palaeobiology Group, Agharkar Research Institute, Gopal Ganesh Agarkar Road, Pune, India 411004

Singh PN, Baghela A, Singh SK, Maurya DK 2015 – *Exosporium gymnemae* sp. nov. from India. *Mycosphere* 6(5), 508–514, Doi 10.5943/mycosphere/6/5/1

Abstract

A new species, *Exosporium gymnemae* is proposed as a saprobe associated with dead stems of *Gymnema sylvestre*. It has distinct morphological characters, especially the conidiophores which form large, compact, blackish brown synnemata with glazed surface and cylindrical to obclavate conidia with dark bands at the septa. A literature-based checklist of *Exosporium* species together with their respective hosts and geographic locations is also provided.

Keywords – microfungi – Pezizomycotina – taxonomy – Western Ghats.

Introduction

The Western Ghats comprise mountain ranges in southwestern India that are rich in evergreen rainforests. They are recognized as biodiversity hotspots by virtue of their rich flora and fauna, including endemic species. Our studies on fungal diversity have led to the identification of several novel fungi from this region (Karandikar & Singh 2010, Rajeshkumar et al. 2012, Senthilarasu & Singh 2013, Sharma & Singh 2013, Singh et al. 2009, 2010, 2012). During exploration of fungal diversity in the sacred grooves of Mulshi forest of Western Ghats region of Maharashtra (November 2011), several microfungi were collected for taxonomic study. An interesting effuse, hairy, compact, and glazed fruiting structure around dead stem of *Gymnema sylvestre* was encountered. This taxon turned out to be a compact synnematus species bearing cylindrical to obclavate conidia with distinct septation pattern and variable in size. Based on its distinct features, the fungus is described as a new species of *Exosporium* Link.

Exosporium is a hyphomycetous genus with saprobic (Ellis 1961, Zhao 2012) and endophytic or phytopathogenic (Ramakrishnan 1957, Braun & Nakashima 2014) life styles, and is widely distributed. Kirk et al. (2008) considered there to be about 19 valid species of *Exosporium* (typified by *Exosporium tiliae*). Since then, a further five species have been added to the genus, viz., *E. livistonae* (Crous & Summerell 2011), *E. machili* (Zhao & Zhao 2012), *E. husanum* (Zhao 2012), *E. petersii* (Braun 2014) and *E. miyakei* (Braun & Nakashima 2014). Table 1 depicts details of validly described species, in the genus.

Materials & Methods

Isolates and morphology

After collection from type locality, specimens were brought to the laboratory in separate paper bags. A trinocular Nikon stereo microscope (Model SMZ-1500 with Digi-CAM, Japan) was

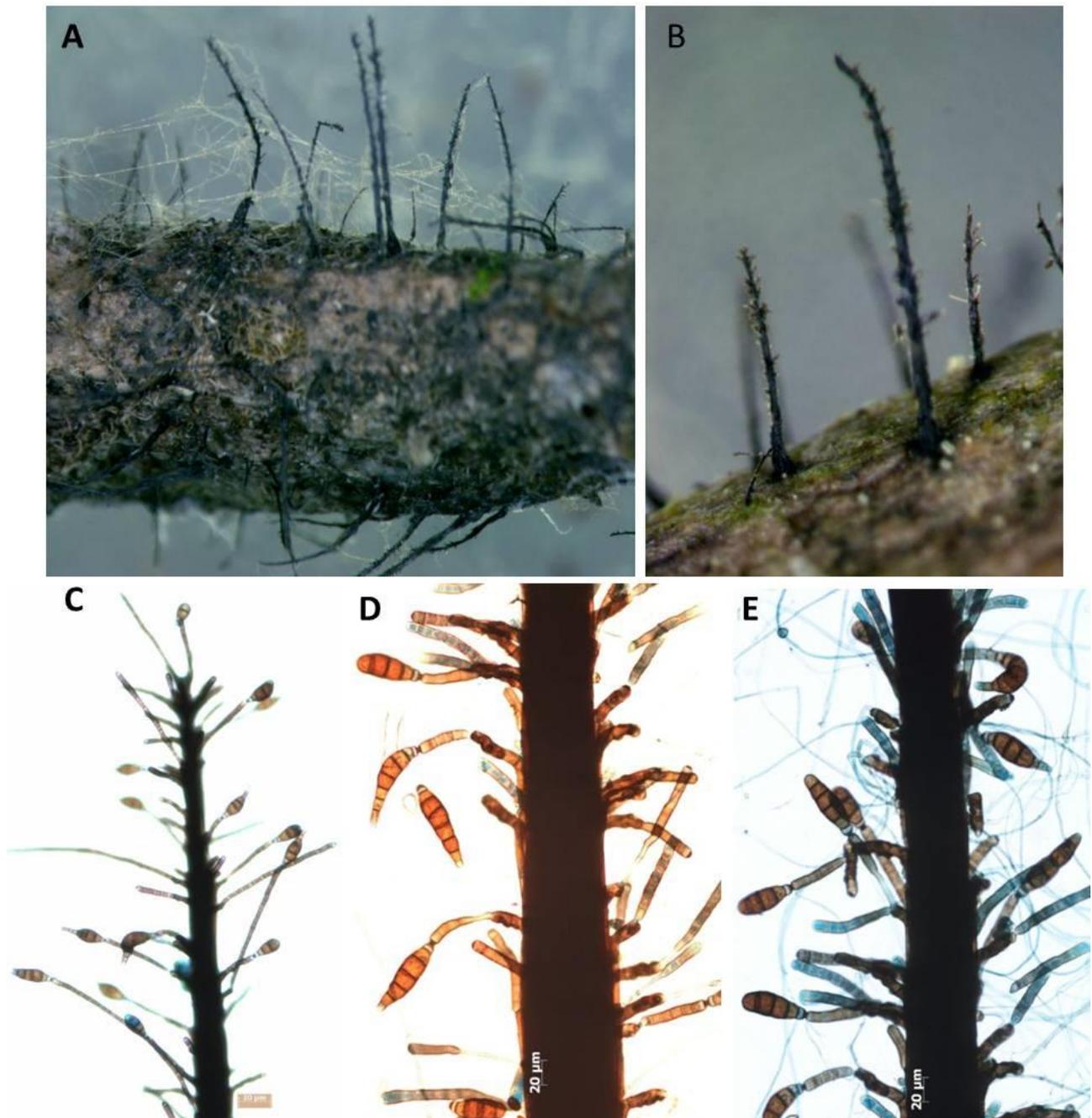


Fig. 1 – *Exosporium gymnemae* AMH 9666, A: Synnemata on substrate, B: Enlarged view of erect synnemata arising from substrate (dead stem), C–E: Conidia attached to conidiophores, and dark glazed synnemata. – Bars C=10 µm; D, E=20 µm.

used to study features of the fungus on stem surface and for taking photomicrographs. A scrape was taken from growing colonies and mounted in lactic acid cotton blue and examined using an AXIO-10 Carl Zeiss microscope. Microphotographs were taken of various morphological structures. The holotype specimen is deposited in Ajrekar Mycological Herbarium (AMH), MACS’ Agharkar Research Institute, Pune, India with the accession number AMH 9666. The present taxon was compared to the closely related synnematous species of *Exosporium*.

Attempts to culture the species on artificial media, such as potato dextrose agar and potato carrot agar (Tuite 1969) were unsuccessful.

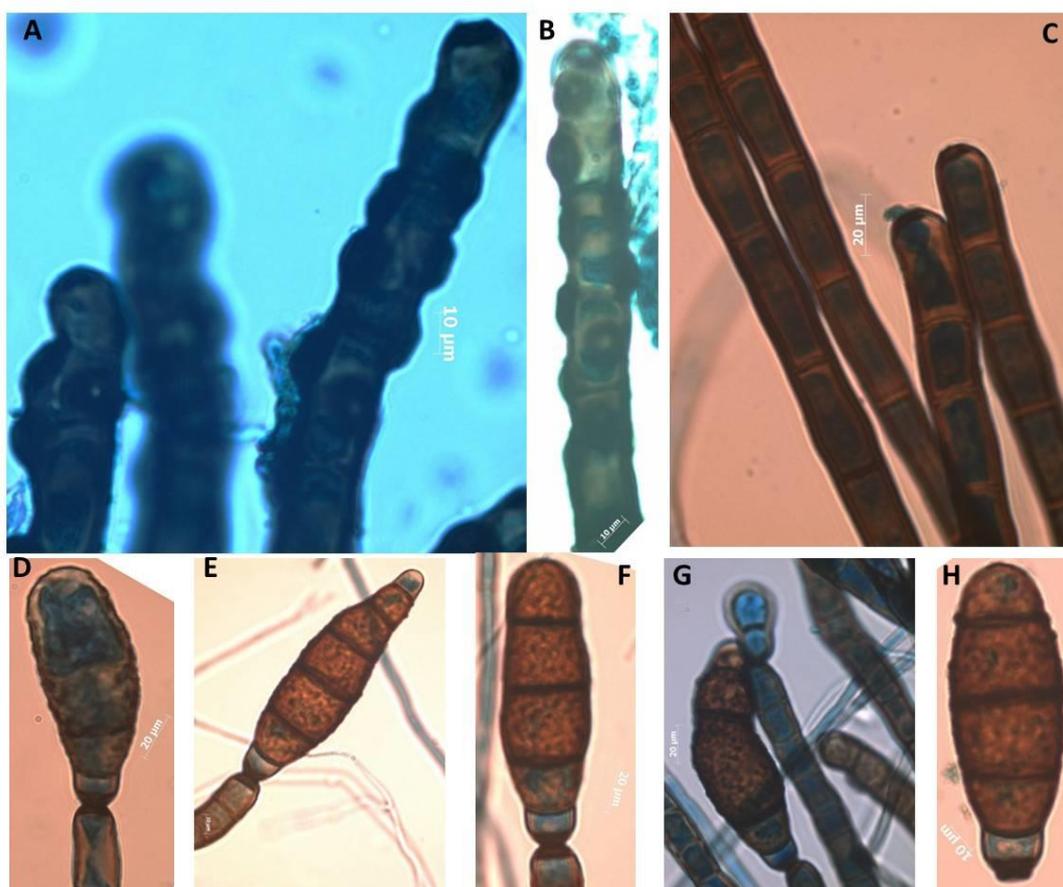


Fig. 2 – *Exosporium gymnema* sp. nov. A–B: Polytretic conidiogenous cells with prominent circular scars, C: Conidiophores with terminal conidiogenous cells, D–G: Conidia attached to conidiophores, H: Echinulate conidium with truncate base. – Bars A–C=10 µm; C=20 µm; D=20 µm; E=10 µm; F, G=20 µm; H=10 µm.

Results

Taxonomic description

Exosporium gymnema PN Singh, S.K Singh, sp. nov.

Figs 1–2

Mycobank MB 812842

Type – on dead stem of *Gymnema sylvestre* R.Br. (Apocynaceae), Sacred Groove (18° 50' N; 73° 50' E) Mulshi, Distirct Pune, Maharashtra, India, 7 November 2011, coll. P.N. Singh, AMH 9666 (holotype), PNS-ARI 11 (isotype).

Etymology – Latin, gymnema refers to a generic name of host '*Gymnema*'.

Colonies on dead stem punctiform, hairy, brown to black, elongated growing all around the stem surface. Stromata immersed in the substratum, cells compact, pseudoparachymatous, dark brown. Conidiophores arising from cells of stromata, unbranched, flexuous, septate, dark brown to golden brown, 12.5 µm wide at the widest part, closely adpressed forming synnemata, erect, black, glazed surface, wider near the base, 2200–3000 × 50–100 µm. Conidiogenous cells integrated, terminal to lateral or intercalary, sympodial proliferation, smooth-walled, olivaceous brown, rarely denticulate, cicatrized, scars prominent (up to 14) forming circular ring, up to 6 µm diam., in front view visible as central pore. Conidia acropleurogenous, solitary, straight to slightly curved, clavato-cylindric to obclavate, echinulate, thick-walled, pale to dark brown, basal and apical cells sometimes paler or subhyaline, euseptate (2–15 septa), constricted at septa, septation pattern variable (sigmoid, lanceolate and flat band like), base truncate with thick, dark brown scar, apex obtuse to broadly rounded, some conidia with short beak, 21–157 × 16–41.5 µm.

Discussion

There are four other species of *Exosporium* that produce synnemata: *E. monanthotaxis* (Pirozynski 1972), *E. ramosum* (Ellis 1971), *E. assamicum* (Agnihotrudu 1966) and *E. petersii* (Braun 2014). However, *E. gymnemae* has the largest, glazed, highly compact synnemata, and widest (16–41.5 µm), clavato-cylindric to obclavate conidia which are rough walled/echinulate and euseptate. The sigmoid, lanciolate and flat band like septation pattern in new species is also distinct from other species in the genus. Based on these salient features, this taxon is distinct from others in the genus.

Exosporium gymnemae is compared with non-synnematous species of Indian origin. It differs from *E. coonoorensis* (Subramanian 1956) in having shorter and wider conidia. The conidia of *E. gymnemae* are significantly longer and wider than those of *E. bryophylli* (Ramakrishnan 1957), *E. fici* (Payak & Thirumalachar 1957) and *E. ochroleucas* (Munjaj & Kulshreshtha 1966). *Exosporium lycopersici* (Khan & Sullia 1981), another species described earlier from India, needs to be re-classified as illustrations in the original paper suggest that it is probably a chain forming species of *Corynespora* (Table 2).

Table 1 Hosts and distribution of *Exosporium* species.

Species	Hosts	Country/Region	References
<i>E. acrocomiae</i>	<i>Acrocomia media</i> (leaves)	Puerto Rico	Chupp ex Stevenson (1975)
<i>E. ampullaceum</i>	<i>Funtumia</i> sp., <i>Rauwolfia</i> sp., <i>Theobroma</i> sp. (dead twigs and branches)	Sri Lanka, Ghana, Sierra Leone, India	Ellis (1961)
<i>Ex. assamicum</i>	<i>Albizia chinensis</i> (dead branch)	India (Assam)	Agnihotrudu (1966)
<i>Ex. bryophylli</i>	<i>Bryophyllum calycinum</i> (leaves)	India (Kerala)	Ramakrishnan (1957)
<i>Ex. catenulatum</i>	<i>Gymnanthes illicida</i> (dead twigs)	Cuba	Ellis (1976)
<i>Ex. cinnamomi</i>	<i>Cinnamomum zeylanicum</i> (leaves)	India (Coorg, Mysore)	Muthappa (1966)
<i>Ex. coonoorensis</i>	<i>Eugenia</i> sp. (twigs)	India (Coonor, Madras)	Subramanian (1956)
<i>Ex. extensum</i>	<i>Erythrina</i> sp. (dead branch)	Sri Lanka	Ellis (1961)
<i>Ex. fici</i>	<i>Ficus benghalensis</i> (leaves)	India (Maharashtra)	Payak & Thirumalachar (1957)
<i>Ex. husanum</i>	Unidentified (dead twigs)	China (Yunnan)	Zhao (2012)
<i>Ex. indicum</i>	<i>Michelia nilgirica</i> (dead twigs)	India (Madras)	Tilak (1966)
<i>Ex. lavistonae</i>	<i>Lavistona benthami</i> (leaves)	Australia	Crous & Summerell (2011)
<i>Ex. leptoderridicola</i>	<i>Leptoderris fasciculata</i> (dead twigs)	Sierra Leone	Ellis (1961)
<i>Ex. lycopersici</i>	<i>Lycopersicon esculentum</i> (fruits)	India (Bangalore, Karnataka)	Khan & Sullia (1981)
<i>Ex. machili</i>	<i>Machilus</i> sp. (leaves)	China (Yunnan)	Zhao & Zhao (2012)
<i>Ex. mexicanum</i>	<i>Erythrina</i> sp., <i>Mascagnia</i> , <i>Smilax</i> , <i>Uveria</i> (dead stems and branches)	India, Sri Lanka, Mexico, New Guinea, Philippines, Sierra Leone, USA	Ellis (1963)
<i>Ex. miyakei</i>	<i>Smilax glauca</i> (leaves)	USA (South Carolina)	Braun & Nakashima (2014)
<i>Ex. monanthotaxis</i>	<i>Monanthotaxis</i> sp. (dead twigs)	Tanzania, India (Salmalia,), Puerto Rico, Venezuela	Pirozynski (1972)
<i>Ex. natrassii</i>	<i>Croton macrostachys</i> (dead branches)	Kenya	Ellis (1961)
<i>Ex. occidentale</i>	<i>Cornus</i> sp. (dead branches)	Canada (Manitoba, Saskatchewan)	Sutton (1973)
<i>Ex. ochroleucum</i>	Dead branch	India (Hamirpur, Punjab)	Munjaj & Kulshreshtha (1966)

Species	Hosts	Country/Region	References
<i>Ex. petersii</i>	<i>Smilax nipponica</i> (leaves)	Japan	Braun (2014)
<i>Ex. pterocarp</i>	<i>Pterocarpus indicus</i> (leaves)	Malaysia	Ellis (1961)
<i>Ex. ramosum</i>	<i>Pinus</i> sp. (dead needles)	USA	Ellis (1976)
<i>Ex. stilbaceum</i>	<i>Elaes</i> sp. (leaves)	Congo, Ghana, Sudan, Zambia, Sierra, Leone	Ellis (1961)
<i>Ex. tamarindi</i>	<i>Tamarindus indicus</i> (leaves)	Godavari, Andhra Pradesh, India	Sydow & Sydow (1913)
<i>Ex. tiliae</i>	<i>Tilia</i> sp. (branches and twigs)	Europe	Link (1809)
<i>E. wisteriae</i>	Dead branch of <i>Wisteria</i> <i>sinensis</i>	Romania	Sandu (1968)

Table 2 Comparison of morphotaxonomic features of *Exosporium gymnemae* sp. nov. with synnematos, and non synnematos species of Indian origin.

<i>Exosporium</i> spp.	Synnemata	Conidiophores	Conidia
<i>E. assamicum</i>	Up to 1-mm long, 250 µm wide.	Fasciculate, unbranched, slightly darker at the apex, scars conspicuous.	Cylindrical to obclavate, 15–distoseptate, 140–190 × 24–36 µm.
<i>E. bryophilli</i>	Absent	In cluster, erumpent, unbranched, dark brown, 140–285 × 4–6 µm. Scars conspicuous.	Fusiform or clavate, 3 euseptate, 28–25 × 8–10 µm.
<i>E. coonoorensis</i>	Absent	In cluster, unbranched, darker at base, paler above, 770 µm long, 12 µm thick; scars thickened and darkend.	Obclavate, 10–20 euseptate, 90–200 × 22–33 µm.
<i>E. cinnamomi</i>	Absent	Fasciculate, unbranched, dark brown, 200–720 × 4.5–5.6 µm. Scars thickened.	Obclavate, 3– distoseptate, 26–60.8 × 8.5–11 µm.
<i>E. fici</i>	Absent	Arising in sporochia, unbranched, densely compacted, brownish black, 17–32 × 5–7 µm.	Obclavate to cylindrical, 3–5 euseptate, 23–92 × 3.5–7 µm.
<i>E. indicum</i>	Absent	Fasciculate, brown to dark brown, 180–260 × 9.3–15 µm. Scars thickened.	Obclavate, 3–8 distoseptate, 90–130 × 9.3–19 µm.
<i>E. lycopersici</i>	Absent	Fasciculate, dark brown, thick walled, 218.5–425.5 × 9–11.5 µm.	Obclavate, fusiform to cylindrical, straight or variously curved, solitary or catenate, 2–11 distoseptate, 35–160 × 7.5–17.5 µm.
<i>E. monanthotaxis</i>	1–1.5 mm long 50–150 µm wide	Conidiophores 3–4 µm wide near base, 8–10 µm wide at apex. Scars prominent.	Obovoid to obclavate, 4–7 distoseptate, 40–70 × 15–17 µm.
<i>E. ochroleucum</i>	Absent	Fasciculate, unbranched, brown to dark brown, 100–380 × 10–12 µm. Scars thickened.	Obclavate, 7–10 distoseptate, 36–100 × 8–14 µm.
<i>E. petersii</i>	Present	Loose to dense fasciculate 2–25 in group, coremioid, rarely branched, 30–250 × 3–6 µm. Conidiogenous cells occasionally percurrent, enteroblastic. Scars slightly thickened.	Obclavate, alternarioid, with very long pale beak in some conidia, small conidia broadly fusiform, 2–11 distoseptate, 20–130 × 4–8 µm.
<i>E. ramosum</i>	Present	Caespitose, branched towards apex, brown or dark brown, 400 µm long, 6–9 µm wide; scars 1–4, conspicuous and dark.	Fusiform to obclavate, 3–5 euseptate, 28–38 × 8–11 µm.
<i>E. tamarindi</i>	Absent	Arising in sporochia, fasciculate, aseptate, fuliginous, 4–6 µm wide.	Vermiform, obtuse at the ends, 3–10 euseptate, 18–45 × 4–6.5 µm.
<i>E. gymnemae</i>	2200–3000 × 50–100 µm.	Flexuous, septate, dark brown to golden brown, 12.5 µm wide at the widest part.	Clavate to obclavate, 2–15 euseptate, 21–157 × 16–41.5 µm.

Acknowledgment

We are grateful to The Director, MACS-Agharkar Research Institute for providing the necessary facilities to carry out the research.

References

- Agnihotrudu V. 1966 – Notes on fungi from-East India XXI. Two dematiaceous hyphomycetes from India. The Journal of The Indian Botanical Society 44, 398–401.
- Braun U, Crous PW, Nakashima C. 2014 – Cercosporoid fungi (Mycosphaerellaceae) 2. Species on monocots (Acoraceae to Xyridaceae, excluding Poaceae). IMA Fungus 5, 203–390.
- Chup C, Stevenson. 1975 – Contrib. Read Herb. 23, 516.
- Crous PW, Summerell BA. 2011 – *Exosporium livistonae* Crous & Summerell, sp. nov. Persoonia 27, 145.
- Ellis MB. 1961 – Dematiaceous Hyphomycetes III. Mycological Papers 82, 1–55.
- Ellis MB. 1971 – Dematiaceous Hyphomycetes. Commonwealth Mycological Institute, Kew, UK.
- Ellis MB. 1976 – More Dematiaceous Hyphomycetes. Commonwealth Mycological Institute, Kew, UK.
- Karandikar KG, Singh SK. 2010 – *Lylea indica*: a new hyphomycete species from India. Mycotaxon 112, 257–260.
- Khan KR, Sullia SB. 1981 – A new market disease of tomato caused by *Exosporium lycopersici* sp. nov. Indian Journal of Mycology and Plant Pathology 11, 122–123.
- Kirk PM, Cannon PF, Minter DW, Stalpers JA. 2008 – Dictionary of the Fungi 10th edition. CAB International, Wallingford, UK.
- Link HF. 1809 – Observationes in Ordines Plantarum naturales. Dissertatio I. Magazin Gesellschaft Naturforschender Freunde, Berlin 3, 10.
- Munjial RL, Kulshreshtha DD. 1966 – Some dematiaceous hyphomycetes from India IV *Exosporium* species. Indian Phytopathology 19, 290–293.
- Muthappa BN. 1966 – A new species of *Exosporium* on *Cinnamomum zeylanicum* L. From India. Sydowia 19, 146–147.
- Payak MM, Thirumalachar MJ. 1956 – Notes on some fungi collected on Bombay state (India). Sydowia 10, 30–40.
- Pirozynski KA. 1972 – Microfungi of Tanzania. I. Miscellaneous fungi on oil palm. II. New hyphomycetes. Mycological Papers 129, 1–65.
- Rajeshkumar KC, Kajale SC, Sutar SA, Singh SK. 2012 – *Ellisemia karadkensis* sp. nov. from southern Western Ghats, India. Mycotaxon 121, 181–186.
- Ramakrishnan T.S. 1957 – Notes on some fungi from South India. VI Proc. Indian Acad. Sci., Pl. Sci. section B 46, 149–154.
- Sandu-Ville et al. 1968 – Revue Mycol, (Paris), 33, 78.
- Senthilarasu G, Singh SK. 2013 – A new species of *Stropharia* from Western Ghats, India. Mycotaxon 123, 213–220.
- Sharma R, Singh SK. 2013 – A new species of *Gymnoascus* with verruculose ascospores. IMA Fungus 4, 177–186.
- Singh SK, Yadav LS, Singh PN, Hepat R. 2009 – A new species of *Gonatophragmium* from Western Ghats, India. Mycotaxon 110, 183–187.
- Singh SK, Yadav LS, Singh PN, Sharma R, Rajeshkumar KC. 2010 – A new record of *Gliocephalotrichum simplex* from India. Mycotaxon 114, 163–169.
- Singh SK, Yadav LS, Singh PN, Sharma R, Mukherjee G. 2012 – Additions to *Gliocephalotrichum* species (anamorphic Hypocreales) from fruit litters of the medicinal plants *Terminalia chebula* in the Western Ghats, India. Mycoscience 53, 391–395.
- Subramanian CV. 1956 – Notes on fungi from north east India XXI. Two dematiaceous hyphomycetes from Assam. The Journal of the Indian Botanical Society 35, 53–91.

- Sutton BC. 1973 – Hyphomycetes from Manitoba and Saskatchewan, Canada. *Mycological Papers* 132, 1–143.
- Sydow P, Sydow H. 1913 – Beiträge zur Kenntnis der Pilzflora des Südlichen Ostindiens, I. *Annales Mycologici* 11, 326–330.
- Tilak ST. 1966 – Notes on Indian fungi I. *Mycopathologia et Mycologia Applicata* 30, 353–356.
- Tuite J. 1969 – Plant pathological methods: fungi and bacteria. Burgess Publishing Company, Minneapolis.
- Zhao GC. 2012 – Higher microfungi from forests of Yunnan Province Book: 1–572.
- Zhao GC, Zhao RL. 2012 – Higher microfungi from forests of Yunnan Province Book: 1–572.