Sheathnema indicum gen. et sp. nov. a new sooty mold fungus from northern Western Ghats, India

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Abstract: A new genus and species Sheathnema indicum was collected from the leaves and other aerial parts of Pandanus tectorius Sol. ex Park. from the forest areas of Sawantwadi Taluka, Sindhudurg District, Maharashtra. Morphologically this new genus is a synnematous fungus and can be easily differentiated from similar genera such as, Spiropes, Dematophora, Tharoopama, Phaeoisariopsis, Graphium, Leptographium and various other synematous forms in having a dark brown infertile sheath completely covering the synemata at the young stage and partially covering the fruiting body at the mature stage. Besides this it can also be differentiated from other allied genera in having 2–3 septate hyaline to sub hyaline conidia. A description, illustrations and comparison with other allied taxa are presented hereafter.

Keywords: Ascomycetes, new genus, morphotaxonomy, Sheath, sooty mold, Synemata.

The forests, micro habitats and tropical warm humid climate that prevail in the Western Ghats support many rare and new forms of fungi. During January 2012, surveys were conducted to explore the microbial diversity in the natural forests of Sawantwadi, situated at an altitude of 690m in southern Maharashtra, which resulted in the collection of a rare fungi subsequently determined to be a new genus. The present study describes and illustrates this unusual interesting sooty mold fungus collected from the Sawantwadi Taluka of Maharashtra.

Material and Methods

Surface scraping of the aerial parts bearing the sooty mold fungus was taken and mounted in lactophenol
cotton blue mixture for microscopic examination. For micrometric measurements slides were observed under a Nikon compound microscope (Model Nikon Eclipse 50i). For morphotaxonomic studies and photomicrographs the Nikon microscope attached with a digital camera Nikon DS-Fi1 were used. The type specimen (Holotype) was accessioned and has been deposited in Ajrekar Mycological Herbarium (AMH) Pune, India for further reference. An isotype has been deposited at the Botanical Survey of India, Pune for further reference. Morphotaxonomic comparisons were made with allied taxa. Descriptions and nomenclatural details were deposited at MycoBank <www.mycobank.org>.

**Sheathnema Dubey & Moonambeth gen. nov.**
(Fungi: Ascomycetes: Sheathnema)
(Images 1–13)

Colony epiphyllous, dense, velvety, hyphae straight to effuse, dark blackish-brown, tufted, with large, black synematous like fruiting body occurring in association with meliolales fungi. Stroma none, setae and hyphopodia absent. Synemata dark brown, erect and curved at the apex appearing just like a boomerang and completely remains covered by a dark brown, infertile sheath at the young stage. On maturity, the upper half portion of synemata bearing conidiophores and conidia slowly splay out and finally spreads widely in the form of a brush leaving the dark brown sheath aside. Consequently, long dark brown synemata bearing a single, long dark brown, continuous infertile sheath casing lower half stalk forming portion of fruiting body and exposing the upper half fertile wide part bearing conidiophores and conidia are visible. Stalk is composed of numerous pale, olivaceous brown, unbranched or rarely branched parallel hyphae which progressively become free and diverge from main stalk to form the conidiophores. Conidiophores are pale brown, becoming hyaline towards the tip, macronematous, mononematous, unbranched, rarely branched in lower portion of hyphae, repeatedly having geniculations, diverging at various angles, straight, bend and curved. Conidiogenous cells polyblastic, integrated terminal or discrete, determinate, sympoidal, geniculate, smooth. Conidia acroporepleurogenous, single or in groups of 4–5, long, hyaline to subhyaline, mostly with three septa, clavate to sub-clavate, rounded at the apex, tapered to the base, smooth.

**Sheathnema indicum sp. nov.**
Dubey & Moonambeth
(urn:lsid:indexfungorum.org:names: 810081)
(Images 1–13)

**Material examined**
B.S.I. (W.C.) 200140, AMH 9599 (Holotype), BSI 132411 (Isotype), 21.i.2012, on aerial parts of *Panadanus tectorius* Sol. ex Park. Family Pandanaceae 16.00°N & 73.75°E, elevation 111.86m, Sawantwadi Taluka, Sindhudurg District, Maharashtra, India, coll. Rashmi Dubey.

Colonies dark brown, aggregated with large, black synematous fungi; sheath covers the synemata at the young stage and is up to 470µm long, 6.6–8.5 µm wide near the base and 2.5–4.0 µm wide near the apex. At the mature stage the upper part of synemata bearing conidiophores and conidia slowly splay out leaving
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The sheath running aside and measures about 60–90 x 36–79 µm, while the lower portion of synemata with sheath forms stalk. Sheath sterile, up to 470µm long, 7–9 µm wide at the base and 2–3 µm wide at the apex, dark blackish-brown and becomes hyaline at the tip. Stalk 73.6–90.50 x 4.75–6.5 µm, having numerous pale, olivaceous brown, unbranched parallel hyphae covered with a sheath; conidiophores 35.81 x 69.55–36.4 x 86.64 µm in upper part of synemata, with a sheath running one side. Conidia hyaline to sub hyaline, 3-septate clavate to subclavate, rounded at the apex, tapered to the base, smooth 9.02–12.25 x 2.5–3.20 µm.

**Etymology:** The genus name has been proposed on the basis of the presence of sheath on synematous form and species name is proposed on the name country from where it is reported.

**Teleomorph:** Unknown/ not observed.

**Known distribution:** Found in the natural forest of the northern Western Ghats.

**DISCUSSION AND CONCLUSION**

Considering the synematal structure *Sheathnema* can be classified under family *Stillbelaceae* (Fr.) 1821, which accommodate certain synnematous fungus like *Spiropes* (Ciferri, 1955), *Dematophora* (Hartig, 1883), *Tharoopama* (Subram., 1956), *Annelophragmia* (Subram., 1963), *Leptographium* (Lagerb. & Melin, 1927), *Graphium* (Corda, 1837), *Stilbum* (Tode, 1790), *Phaeoisariopsis* (Ferraris, 1909), *Arthrobotryum* (Cesati, 1854) and many more forms. However, according to the latest classification of Fungi the family *Stillbelaceae* has been merged with *Ascomycotina* (Kirk et al. 2008). After accomplishment of comprehensive studies (Seifert 1985) it was realized that the present fungus bears a unique identity in having a sheath completely covering the synemata at a young stage and partially at a mature
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Images 8–9. Mature synemata (X200)

Images 10–11. Conidia and conidiophores (X1000)

However, the proposed genus shows some resemblance in other morpho-taxonomic characteristics with a few synematous forms. It resembles certain other synematous forms like *Spiropes*, *Pheaeoisariopsis*, *Arthrobotryum*, *Phragmocephala* (Mason & Hughes, 1951), *Endophragmia* (Duvernoy & Maire 1920) etc., in having phragmospores. Colonies of *Spiropes* also occur in association with meliolaral fungi, but it differs from *Sheathnema* in its conidiogenous cells which are with prominent scars and is cicatrized, and the conidia are also solitary, subhyaline to dark brown, whereas conidiogenous cells of *Sheathnema* are smooth and conidia are solitary or in groups and is clavate to subclavate. *Pheaoisariopsis* differs from *Sheathnema* in possessing cicatized scars on conidiogenous cells and having stromata, on the contrary the conidiogenous cells of *Sheathnema* are smooth and stromata are totally absent. *Arthrobotryum* also has phragmospores but it differs from *Sheathnema* in having scattered synemata and the conidiogenous cells are percurrent with upto seven annelations, whereas synemata of *Sheathnema* has hyphae which are closely ad pressed along their length and splay out like a brush at the apex leaving the sheath aside and more over the conidiogenous cells are determinate in it. In *Endophragmia* the overall morphology resembles *Sheathnema* besides sheath but the conidia are 1–5 septate frequently with dark black bands at the septa. *Sheathnema* differs from the synematous forms like *Prathoda* (Subram, 1956) and *Trochospora* (Moore, 1955) which have scoleospores and helicospores respectively, whereas the proposed genus has phragmospores. *Sheathnema* also possesses determinate conidiogenous cell which separates it from other synematous fungi like *Graphium* (Corda, 1837) *Leptographium* (Lagerberg et al. 1927), *Doratomyces* (Corda, 1829) which have per current conidiogenous cells. In synematous fungi like *Spiropes*, *Tharoopama*, *Dendrographium* (Massee, 1892), *Phaeoisaria* (Hohnel, 1909) and *Pheaeoisariopsis* the conidiophores are macronematous, synematous, individual threads are closely adressed along their length and splays out the apex as well as the conidiogenous cells are polyblastic, integrated and determinate, conidia are hyaline to pale olivaceous brown and smooth. The overall morphology of the above mentioned genera coincides with the morphological characteristics of *Sheathnema* except...
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**Table 1. Comparison of Sheathnema gen. nov. with other related genera.**

<table>
<thead>
<tr>
<th>Genus</th>
<th>Fruiting body</th>
<th>Sheath covering fruiting body</th>
<th>Conidiophores</th>
<th>Conidiogenous cells</th>
<th>Conidia</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spiropes</td>
<td>Synematous or sometimes the conidiophores are in loose fascicles.</td>
<td>Absent</td>
<td>Unbranched</td>
<td>Polyblastic, cisticulated, scars numerous and prominent.</td>
<td>Solitary, dry; mostly obclavate, fusiform or oblong, smooth or verruculose, 1–9 transverse septate.</td>
<td>Ciferri (1955)</td>
</tr>
<tr>
<td>Dermatophora</td>
<td>Synematous</td>
<td>Absent</td>
<td>Simple branching, with geniculations.</td>
<td>Polyblastic, denticulate with short minute collar at each geniculations</td>
<td>One celled, ellipsoidal or obvoid, colourless to pale olivaceous brown, 0–septate, smooth, solitary, acropleurogenous.</td>
<td>Hartig. (1883)</td>
</tr>
<tr>
<td>Tharoopama</td>
<td>Synematous</td>
<td>Absent</td>
<td>Verticillate branching with geniculations.</td>
<td>Polyblastic and smooth.</td>
<td>Three or more septate, solitary, olivaceous brown or brown, smooth or verruculose, acropleurogenous.</td>
<td>Subram. (1956)</td>
</tr>
<tr>
<td>Phaeoisariopsis</td>
<td>Synematous</td>
<td>Absent</td>
<td>Unbranched</td>
<td>Polyblastic, cisticulated, scars thin.</td>
<td>Mostly three septate, hyaline, solitary or in groups, clavate to subclavate, rounded at the apex and narrow at base acropleurogenous.</td>
<td>Ferraris. (1909)</td>
</tr>
<tr>
<td>Sheathnema gen. nov.</td>
<td>Synematous</td>
<td>Synemata completely covered with a dark brown sheath in young stage and partially covered in a mature stage.</td>
<td>Unbranched or sometimes rarely branched, with repeated geniculations.</td>
<td>Polyblastic and smooth.</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

the sheath and conidial structure. The characteristics of the geniculated conidiophores of Tharoopama and Dermatophora are also present in Sheathnema. But detailed studies reveal that in Dermatophora, the conidiogenous cells are denticulate with a short minute collar at each geniculation and more over the conidia are amerospores, ellipsoidal and ovoid, whereas in the proposed genus the conidiogenous cells are smooth and integrated along with the geniculated conidiophores and the conidia are hyaline broadly clavate to subclavate, three septate and the fruiting body is covered with a sheath. In addition to this Tharoopama also bear a resemblance with Sheathnema in having geniculations in conidiophores, but differs from it in having repeated branching in conidiophores. Phaeoisariopsis resembles Sheathnema in having unbranched or simple branching conidiophores and three septate conidia, but differs from Sheathnema in having cisticlated scars on conidiophores as mentioned earlier. In Morisographium Morelet the conidiogenous zone in synemata is conspicuously concave and the synema is dark with falcate, 1–3 septate conidia. In Virgatospora Finley the conidia are more than three septate and green in mass; similarly in Pseudographiella Corda, the conidia are more than three septate but are yellow or orange in mass, while Ciferrixyphium Batista & Maia is a sooty mold fungus and the synema is dark with 3–10 septate conidia, equally Phialoarthrobotyum Mats is a saprophytic genus with three or more septate conidia. Besides having phragmospores all the above mentioned genera totally differ from Sheathnema as the proposed genera is unique in having a sheath on synemata.

Thus, the above discussion noticeably postulates that with the exclusion of sheath, Sheathnema to some extent comes closer to Spiropes, Tharoopama, Dermatophora and Phaeoisariopsis in overall morphology of synemata, but Sheathnema still differs from this genera as revealed in Table 1. No synematal genus has been reported to possess a sheath covering the synemata. The major differences in the morphological characteristics with related genera warrant this taxon to be assigned to a new genus. Hence, it is proposed to be placed as a new genus named Sheathnema with type species S. indicum.

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