

## RESEARCH ARTICLE

# Foliar fungal pathogens of the tree species

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## Abstract

Tree species are predominantly found throughout our surrounding environment. They hold significant economic and ecological importance for us. However, it is noticeable that most research focuses on commercial crops, aiming to enhance their production by mitigating the adverse effects of pathogens. In contrast, naturally growing trees receive less attention than commercially cultivated crops. Similar to crops, trees also face adverse conditions due to surrounding pathogens. As a result, they compromise their healthy growth and survivability rates. In the present study, we encountered several infected tree species, observed the symptoms of the infected species, and collected samples to identify and document the fungal pathogens.

Key Words: Arunachal Pradesh; Assam; Fungi; Host; Parasite; Symptom

## 1. Introduction

Fungal pathogens are microorganisms belonging to the kingdom Fungi, a diverse group that encompasses a vast array of species with varying lifestyles and modes of interaction with trees. Some fungi establish mutualistic relationships with trees, forming mycorrhizal associations that enhance nutrient uptake and contribute to overall tree health. However, others exploit weaknesses in tree defenses, penetrating their host's tissues and causing diseases that can range from mild aesthetic issues to severe mortality events. This intricate dance between trees and fungal pathogens underscores the dynamic interplay between biotic factors in ecosystems. The susceptibility of tree species to fungal pathogens is influenced by a myriad of factors, including genetic predisposition, environmental conditions, and the presence of other stressors. As human activities continue to alter landscapes and climates, the balance between tree health and fungal pathogen proliferation becomes increasingly delicate. Introducing a comprehensive exploration into the realm of tree health and the delicate balance between nature's flora and the challenges posed by pathogens, we delve into the subject of "Foliar fungal Pathogens of Some Local Trees." In this study, we embark on a journey to unravel the intricate interactions between local trees and the pathogens that can detrimentally affect their foliage. By examining these relationships, we aim to deepen our understanding of the ecological dynamics that shape our natural landscapes and to offer insights into potential strategies for mitigating the impact of these foliar pathogens. Through careful analysis and investigation, this exploration seeks to shed light on the complex web of interactions between trees and their microbial adversaries, fostering a greater appreciation for the fragility and resilience of our local ecosystems.

## 2. Materials and methods

Infected leaves of various tree species were collected in separate sterile paper bags between the months of January and April 2023 from local areas, namely Jorhat, Assam, and Doimukh, Arunachal Pradesh (sub-tropical). The date of collection, collector's name, and location were carefully documented, alongside the local names of the trees. Disease symptoms were meticulously observed and recorded. Following the collection, the samples were air-dried at room temperature, and herbaria were prepared using properly dried leaves. For microscopic observations, the leaves were examined under a stereo microscope, and a few slides were prepared for

compound microscopic observation. Cotton blue, 10% glycerol, and 5% lactophenol were employed for the preparation of these slides. Additionally, the morphological appearance of pathogens on the leaves was observed, and compound microscopic characters were studied using a compound microscope. Taxonomical characteristics were documented, complemented by supporting photographs.

## 3. Result and discussion

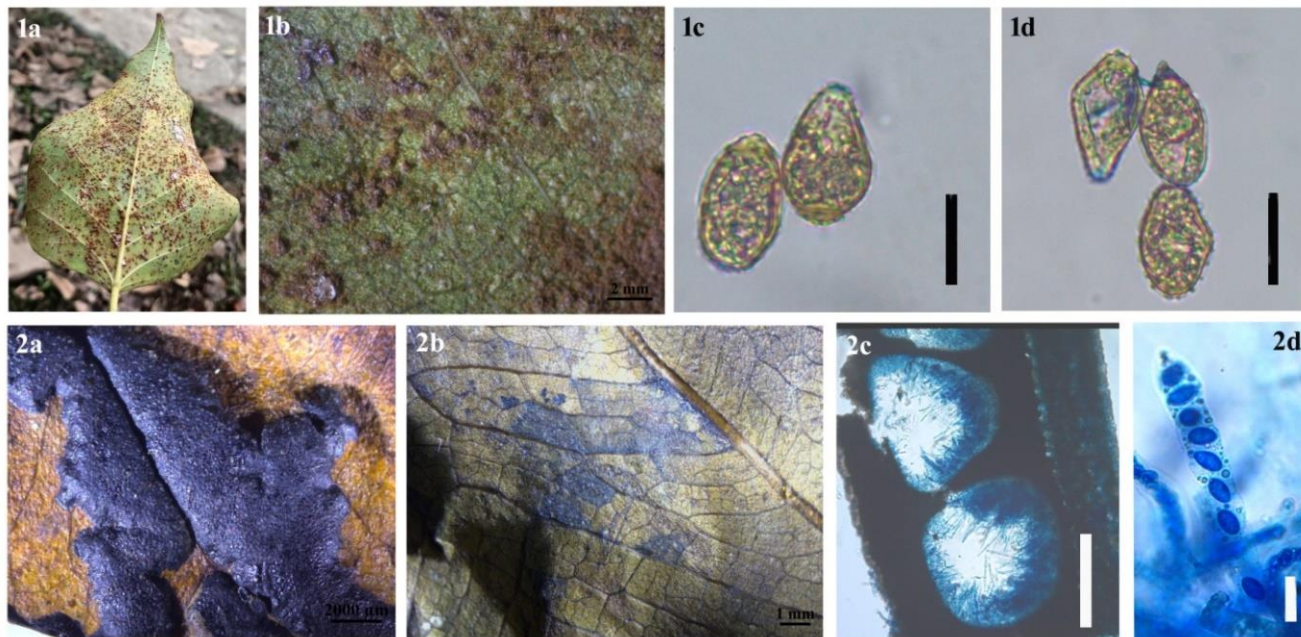
**Host:** *Ficus religiosa* L. (Moraceae)

Location: Jorhat, Assam

**Pathogen:** *Cerotelium fici* (Castagne) Arthur (1917), Phakopsoraceae, Uredinales, Urediniomycetes, Basidiomycota. Figure 1(a-d)**Disease Symptoms on leaf:** Angular leaf spots on adaxial surfaces and numerous orange rust pustules on the abaxial surface of the host were observed. Pustules typically pale reddish-brown to reddish-brown in colour. Almost all infected leaves abscised prematurely leaving bare branches.**Microscopic characters:** Urediniospores usually hypophyllous on leaves and fruits, mostly scattered or sometimes tending to be grouped around edge of a leaf. Spore granules are yellowish to faintly orange. Urediniospores are globose or obovoid, sparsely echinulate, spore walls pale. Urediniospores are and vary in size and. Spermogonia and aecia not found.**Host:** *Ficus religiosa* L. (Moraceae)

Location: Doimukh, Arunachal Pradesh

**Disease symptoms on leaf:** Early symptoms of tar spot start to develop on leaves in early summer, but often go unnoticed as they are fairly inconspicuous. It is not until mid to late summer that the darker coloration of the spots shows up. The development of the tar spot varies by the species of pathogen. One species produces tiny black spots that later coalesce into larger black spots that may be 1/3 to 1/2 inch in diameter. These spots will eventually be slightly raised. Another species of the pathogen causes dark spots may be an inch or more in diameter. Spots are effused- pulvinate type. These spots are usually more prominently raised and have a textured surface. Late in the season, tar spot may cause some leaves to drop early.



**Figure 1.** *Cerotelium fici*. a, Symptom on lower surface of the leaf. b, Enlarged view of the symptom. c,d, Urediniospores. Scale bars: c,d, 20  $\mu$ m. **Figure 2.** *Rhytisma* sp. a, Tar spot on the upper surface of the leaf. b, Tar spot on the lower surface of the leaf. c, Ascomata d, Asci with ascospores. Scale bars: c,d, 20  $\mu$ m.

**Microscopic characters:** A microscopic sign of the pathogen is the stroma, mats of hyphae found in the lesions. These lesions can cause senescence of leaves. Ascospores, hyaline in colour and clustered with long paraphyses. Young ascospores are oval and matured ascospores are spherical in shape.

**Identified pathogen:** *Rhytisma* sp. (1819), Rhytismataceae, Rhytismatales, Leotiomyces, Ascomycota. [Figure 2\(a-d\)](#)

**Host:** *Pongamia pinnata* (L.) Panigrahi (Fabaceae)

Location: Jorhat, Assam

**Disease symptoms on leaf:** Black chlorotic spots observed on the upper surface of the leaf, and a huge number of teliospores were scattered on the lower surface of the leaf in irregular patches. The spore mass brown-black in colour.

**Microscopic characters:** Telia erumpent, Teliospores many celled, almost globose and bear hair-like structure on the wall. Spores are light brown in colour.

**Identified pathogen:** *Ravenelia hobsonii* Cooke (1880), Raveneliaceae, Pucciniales, Pucciniomycetes, Basidiomycota. It occurs primarily in subtropical and tropical climate and widespread in distribution. The rust *Ravenelia hobsonii* was originally described by Cooke from East India and Ceylon (Dietel, 1906). [Figure 3\(a-d\)](#)

**Host:** *Pongamia pinnata* (L.) Panigrahi (Fabaceae)

Location: Doimukh, Arunachal Pradesh

**Disease symptoms on leaf:** Pathogen causing leaf spots, shape and size variable, subcircular to irregular, sometimes diffuse, or confluent and larger, sometimes large leaf segments or almost entire leaves discoloured, yellowish green, ochraceous to brownish, reddish brown, later becoming dark brown to blackish brown by the development of abundant sporodochia. Light brown patches observed on the upper surface.

**Microscopic characters:** Conidiophores densely fasciculate, very numerous, arising from stromata, septate below or conidiophores reduced to conidiogenous cells, unbranched, straight to slightly sinuous, pale brown, wall thin. Conidiogenous cells integrated, terminal, cylindrical. Conidia formed singly, broad ellipsoid, ovoid, sub-cylindrical or obclavate, apices obtuse, bases truncate, 0–1(–2) septa, wall pale, hyaline.

**Identified pathogen:** *Pedrocrousiella pongamiae* (Syd. & P. Syd.) Rajeshkumar, U. Braun & J.Z. Groenew. (2021)

(Mycosphaerellaceae, Cosphaerellales, Dothideomycetes, Ascomycota). [Figure 4\(a-b\)](#)

**Host:** *Terminalia arjuna* (Roxb.) Weight & Arn. (Combretaceae)

Location: Doimukh, Arunachal Pradesh

**Disease symptoms on leaf:** Brown irregular chlorotic spots present on the upper leaf surface and spots smaller to larger in size. Masses of spores present on the lower surface of the leaf.

**Microscopic characters:** Spores are golden- yellow in color and globose to ovate in shape.

**Identified pathogen:** *Elsinoe terminaliae* (Bitanc.) X.L. Fan & Crous (2017), Elsinoaceae, Myriangiales, Dothideomycetes, Ascomycota. [Figure 5\(a-b\)](#)

**Host:** *Syzygium jambos* (L.) Alston (Myrtaceae)

Location: Doimukh, Arunachal Pradesh

**Disease symptoms on leaf:** The first symptoms are chlorotic specks which become, after a few days, pustules containing uredia producing yellow masses of spores. Pustules can coalesce and parts of the plant can be completely covered with pustules. After about 2-3 weeks, pustules dry and become necrotic. The disease can cause deformation of leaves, heavy defoliation of branches, dieback, stunted growth and even death.

**Microscopic characters:** Urediospores are spherical, smooth wall and yellow in color.

**Identified pathogen:** *Austropuccinia psidii* (G. Winter) Beenken (2017) (Sphaerophragmiaceae, Urediniaceae, Pucciniales, Pucciniomycetes, Basidiomycota). [Figure 6 \(a-d\)](#)

**Host:** *Psidium guajava* L. (Myrtaceae)

Location: Jorhat, Assam

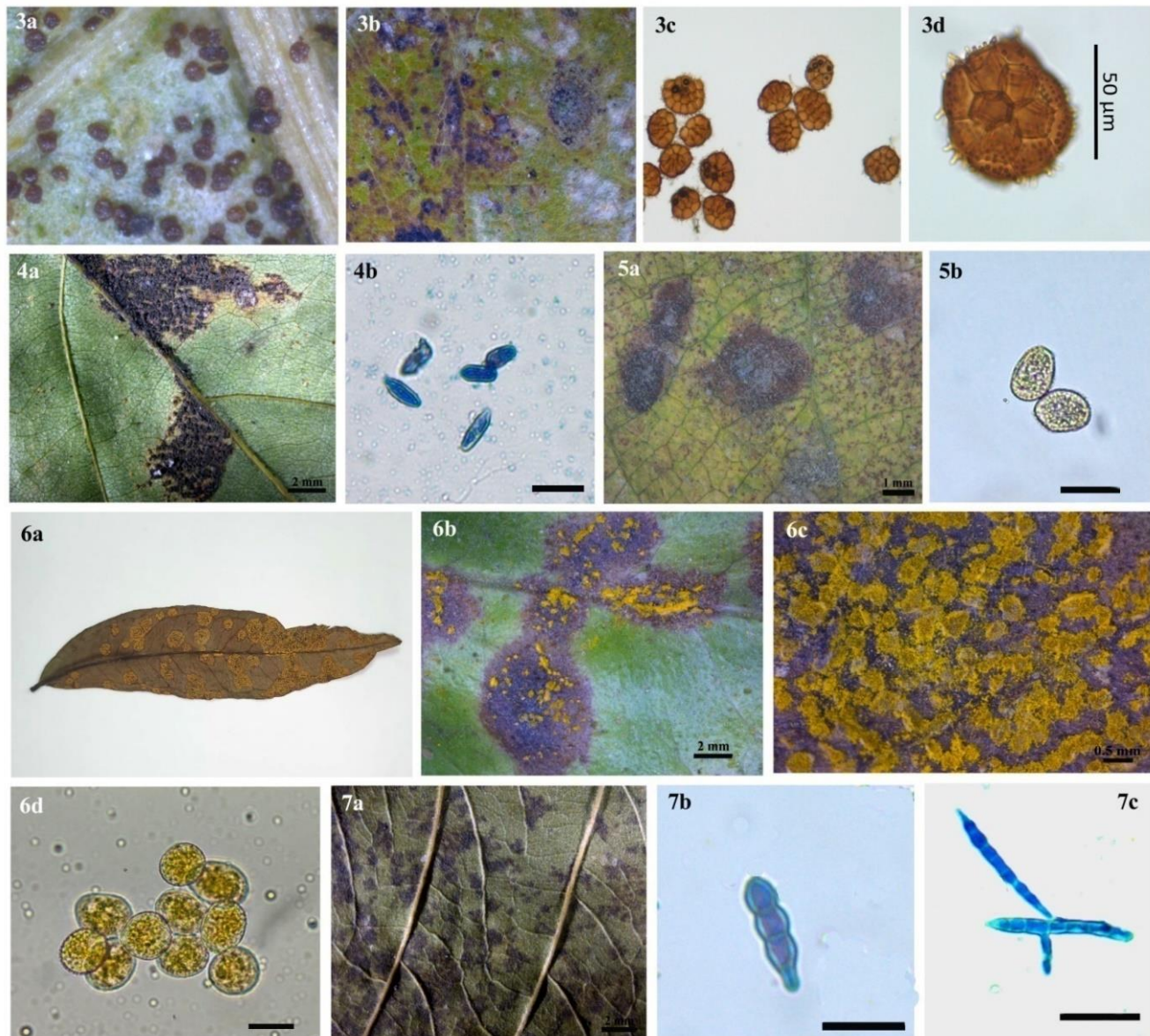
**Disease symptoms on leaf:** Purple-black spots present on the leaf. Spots are scattered, distinct, irregular and smaller to larger in size.

**Microscopic character:** Superficial hyphae is present which is septate, branched, sub-hyaline, smooth-walled. Conidia are medium, hyaline, elongated, obclavate, usually straight to slightly curved, and rounded at the apex. Conidia have septa (range 1 to 8).

**Pathogen:** *Passalora* sp. (1849) (Mycosphaerellaceae, Capnodiales, Dothideomycetes, Ascomycota). [Figure 7 \(a-c\)](#)

**Host:** *Artocarpus altilis* (Parkinson) Fosberg (Moraceae)





**Figure 3. *Ravenelia hobsonii*.** a, Symptom on lower surface of the leaf. b, Symptom on upper surface of the leaf. c, d, Teliospores. **Figure 4. *Pedrocrousiella pongamiae*.** a, Symptoms on the lower surface of the leaf. b, Conidia. Scale bar: b, 20  $\mu$ m. **Figure 5. *Elsinoe terminaliae*.** a, Symptoms on the upper surface of the leaf. b, Spores. Scale bar: b, 20  $\mu$ m. **Figure 6. *Austropuccinia psidii*.** a, Infected leaf. b, Symptoms on the upper surface of the leaf. c, Enlarged view of the symptom. d, Urediospores. Scale bar: d, 20  $\mu$ m. **Figure 7. *Passalora* sp.** a, Enlarge view of the symptom. b, c, different conidia. Scale bars: b, c, 20  $\mu$ m.

Location: Doimukh, Arunachal Pradesh

**Disease symptoms on leaf:** Burning like spots present on the leaf. Irregular to subcircular in shape and dark brown to black in colour. This disease cause leaf to turn yellow and senescence of the leaf.

**Microscopic characters:** 1. Conidia pale golden in colour, fusiform, thick walled, transversely septate with 3 septa. 2. Conidia elongated, hyaline, transversely septate with 5-7 septa and many celled with tapering end.

**Identified pathogen:** 1. *Corynespora cassicola* (Berk. & M.A. Curtis) C.T. Wei (1950) (Corynesporascaceae, Pleosporales, Dothideomycetes, Ascomycota). Figure 8 (a,b,c). 2. *Passalora* sp. (1849) (Mycosphaerellaceae, Capnodiales, Dothideomycetes, Ascomycota). Figure 8 (a,b,d)

**Host: *Alnus glutinosa* (L.) Gaertn. (Betulaceae)**

Location: Doimukh, Arunachal Pradesh

**Disease symptoms on leaf:** Dark brown leaf spots were present on the leaf. Small yellow pustules (uredinia) occur on lower surface

of the leaf. Masses of white colour hyphae like structure also present on the spots.

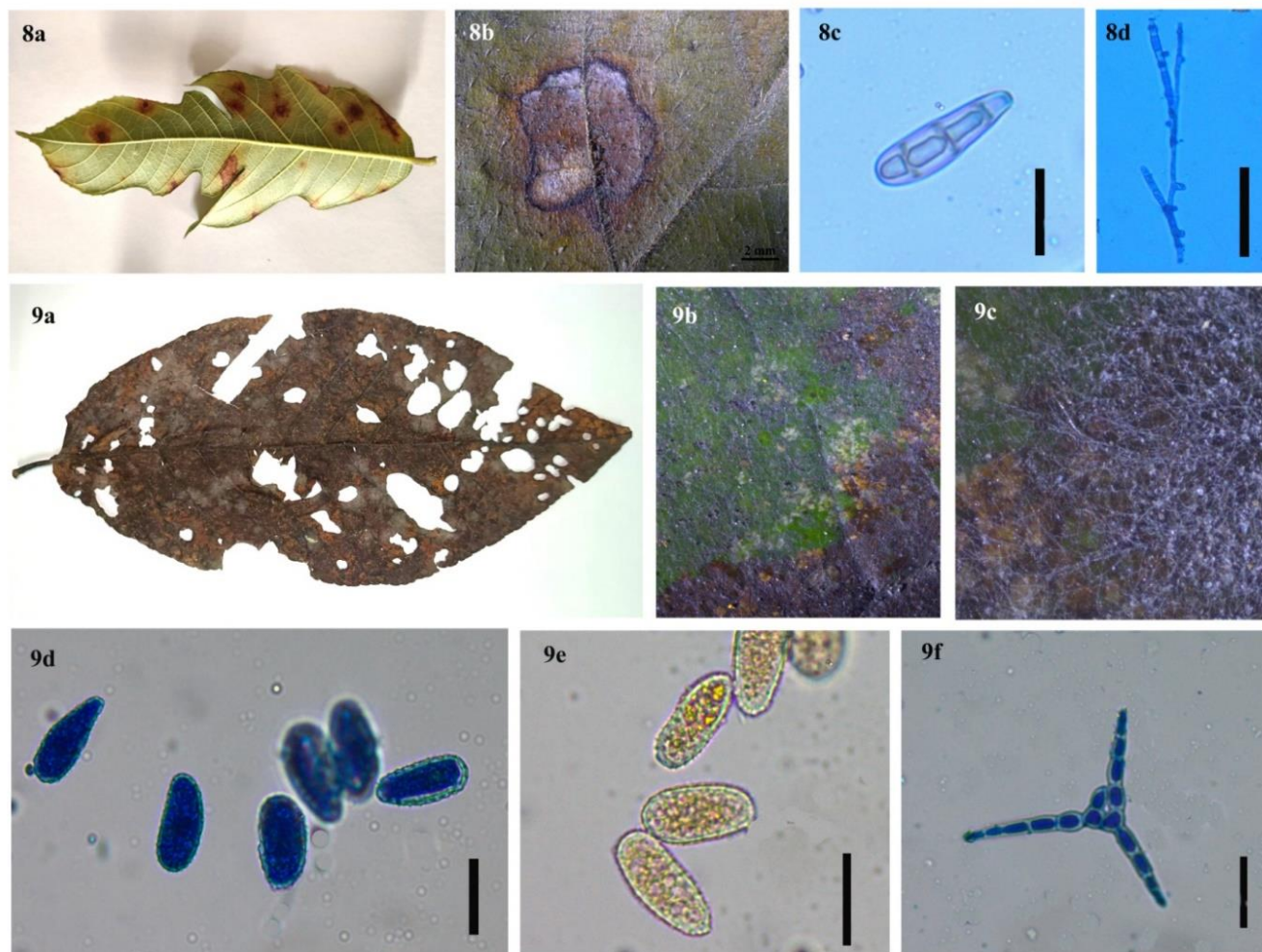
**Microscopic characters:** 1. Urediospores 22-38 x 9-15  $\mu$ m, ellipsoidal or clavate, the wall hyaline and it has uniformly echinulated. Spores are light golden in colour. 2. Conidia are star shaped, hyaline, arms 3-6 septate, arms cells slightly constricted at the septa and tapered at the end, branches are produced from the main axis. Occasionally conidia have four branches with a short branch arising from the cell near the main axis.

**Identified pathogen:** 1. *Melampsorium alni* (Thüm.) Diel (1900), (Pucciniastraceae, Puccinales, Pucciniomycetes, Basidiomycota). Figure 9 (a,b,c); 2. *Triposporium* sp. (1837) (Asteriaceae, Eurotiales, Eurotiomycetes, Ascomycota). Figure 9(a,b,d)

**Host: *Cassia fistula* L. (Fabaceae)**

Location: Doimukh, Arunachal Pradesh





**Figure 8.** *Corynespora cassiicola*. a, infected leaf. b, Enlarge view of the infected spot. c, Conidia. Scale bar: c, 20  $\mu$ m.; **Figure 8.** *Passalora* sp. a, infected leaf b, Enlarge view of the infected spot. c, Conidia. Scale bar: d, 20  $\mu$ m.; **Figure 9.** *Melampsorium alni*. a, infected leaf. b,c, Enlarge view of the symptoms. d,e, spores. Scale bars: d,e, 20  $\mu$ m.; **Figure 9.** *Triposporium* sp. a, Infected leaf. b,c, Enlarge view of the symptoms. f, spores. Scale bar: f, 20  $\mu$ m.

**Disease symptoms on the leaf:** Black tar-like appearance on the adaxial side of the leaf, over infected area appear as if burnt.

**Microscopic character:** Conidia Y-shaped, hyaline, 2-3 septate arms with slightly constricted at the septa and tapered at the end, three of the branches are produced from the main axis. Occasionally conidia have 4 branches arising from the cell near the main axis.

**Identified pathogen:** *Triposporium elegans* Corda (1837) (Asterinaceae, Capnodiales, Dothideomycetes, Ascomycota) [Figure 10 \(a-c\)](#)

**Host:** *Mangifera indica* L. (Anacardiaceae)

Location: Doimukh, Arunachal Pradesh

**Disease symptoms on the leaf:** Light brown with black margin spots on both sides of the leaf, small-large, mainly infects the veins and veinlets.

**Microscopic character:** Conidia-septate, smooth walled, grows in group.

Identified pathogen: *Cytosphaera Mangifera* Died (1916) (Mycosphaerellaceae, Capnodiales, Dothideomycetes, Ascomycota). [Figure 11 \(a-c\)](#)

**Host:** *Tectona grandis* L.f. (Lamiaceae)

Location: Doimukh, Arunachal Pradesh

**Disease symptoms on leaf:** Small regular and irregular brown to grey necrotic areas that cover the upper side of the leaf surface. Lower surface contains numerous rust pustules.

**Microscopic characters:** Uredospore were produced singly in a short pedicel, sub-globose or ellipsoid in shape, mostly hyaline, pale brown, echinulate.

**Identified pathogen:** *Olivea tectonae* (T.S Ramakr & K.Ramakr.) J.L. Mulder (1973), (Chaconiaceae, Pucciniales, Pucciniomycetes, Basidiomycota). [Figure 12 \(a-c\)](#)

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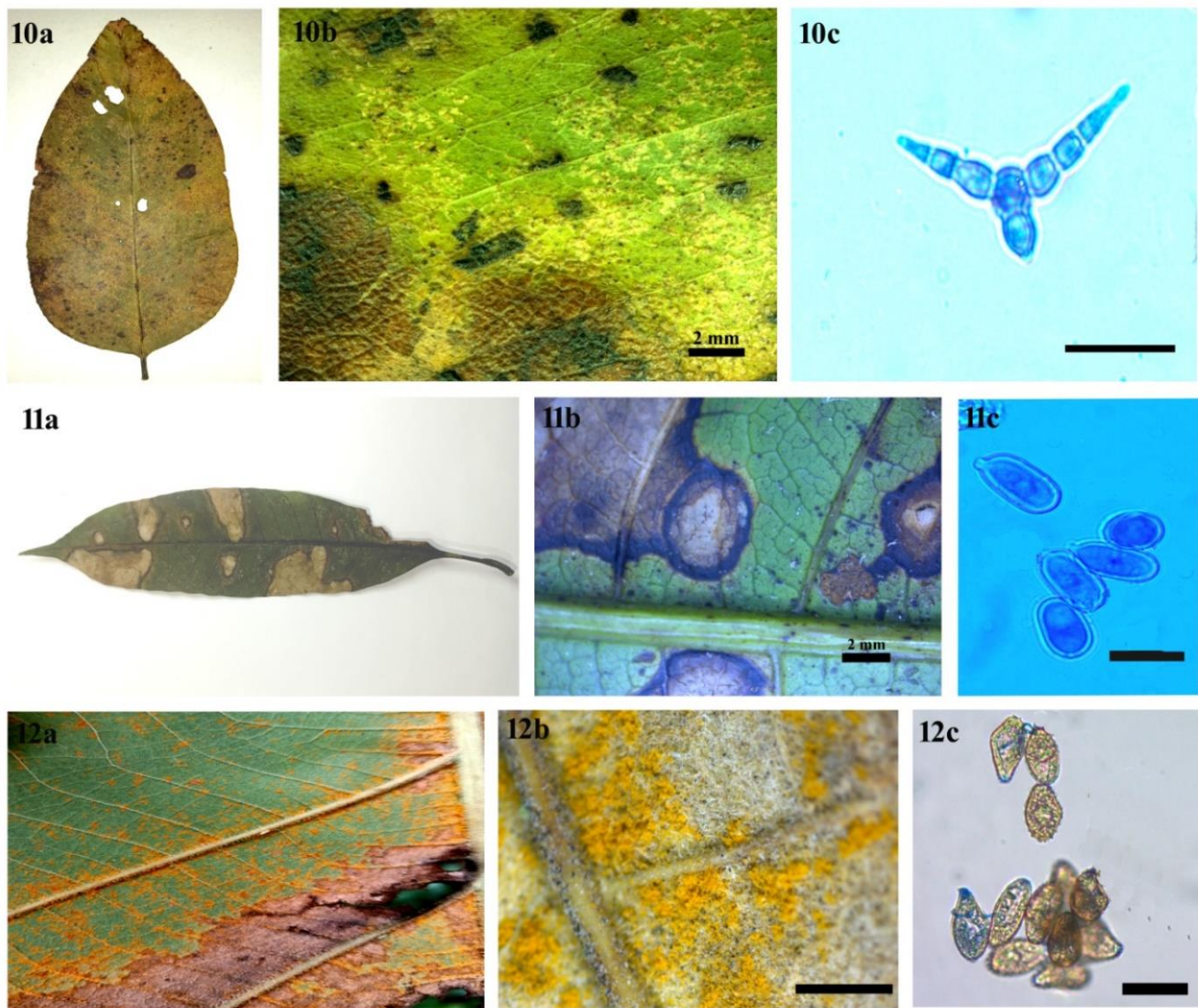
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#### Authors' contributions

RKS: Original concept, final draft of manuscript. GD: Scientific approach, data contribution, manuscript writing; UB & OP: Data generation and experiment, field work.

#### Declaration of conflict of interest

Authors declare that there is no conflict of interest.



**Figure 10.** *Triposporium elegans*. a, Infected leaf. b, Enlarge view of the symptoms. c, conidiophores. Scale bar: c, 20  $\mu$ m.; **Figure 11.** *Cytosphaera Mangifera*. a, Infected leaf b, Enlarge view of the symptoms. c, Spores. Scale bar: c, 20  $\mu$ m.; **Figure 12.** *Olivea tectonae*. a, enlarged view of infected leaf b, Enlarge view of the symptoms. c, Spores. Scale bars: b, 1mm, c, 20  $\mu$ m.

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