

Morphological study and distribution of *Cyathus subglobisporus* sp. Nov. from Papanasam, Tirunelveli district, Tamil Nadu

Ramar Govindaraj¹, Mutheeswaran Subramanian^{1*}, Vasanth Nayagam², M. Anthony Samy² and Savarimuthu Ignacimuthu¹

¹Interdisciplinary Research Centre in Biology, Xavier Research Foundation, Manonmaniam Sundaranar university

²Department of Botany, St.Xavier's College, Palayamkottai, Tirunelveli, Tamilnadu Manonmaniam Sundaranar University

*Corresponding Author; E-mail: muthees2009@gmail.com

ABSTRACT

The genus *Cyathus*, commonly known as bird's nest fungus, is recognized for its unique peridioles and cup-like fruiting bodies. In a recent mycological survey conducted in the Papanasam region of Tirunelveli District, Tamil Nadu, a novel species, *Cyathus subglobisporus* sp. nov., was discovered and is described herein based on its distinct morphological characteristics. The study aimed to document and analyze the morphological features and ecological distribution of this new taxon within the region's forest ecosystems. Specimens were collected from decaying wood and leaf litter in semi-evergreen forest patches of the Western Ghats. Morphological examination was carried out using both stereo and compound microscopes. The fruiting bodies of *C. subglobisporus* are gregarious, with a dark brown, tomentose outer surface and a plicate inner wall. Peridioles are lenticular, attached to the peridium via funiculi, and are dark grey to black at maturity. The most distinguishing feature is its subglobose spores, measuring $8-9.5 \times 7-8 \mu\text{m}$, with a smooth surface—a key trait separating it from closely related species such as *Cyathus stercoreus* and *C. olla*. This study marks the first report of *C. subglobisporus* in the Tirunelveli region and contributes to the expanding fungal biodiversity records of the Southern Western Ghats. The occurrence of this species in undisturbed, moist forest habitats highlights the ecological significance of these microhabitats in supporting rare and novel fungi. Further exploration and conservation efforts are essential to understand the full extent of fungal diversity in the region, especially in light of increasing anthropogenic pressures.

Keywords: Mushroom, Bird's nest fungus, Western Ghats, *Cyathus subglobisporus*, taxonomy

The genus *Cyathus*, commonly known as bird's nest fungus, belongs to the family Nidulariaceae and is widely distributed in temperate and tropical regions. Characterized by its unique fruiting body structure, which resembles a bird's nest, *Cyathus* species are important members of the fungal community in forest ecosystems, contributing to the decomposition of organic matter and the nutrient cycle (Elkhateeb and Daba, 2021). The peridioles (small spore packets) of

Cyathus are typically enclosed within a cup-like peridium, a feature that distinguishes these fungi from other Basidiomycetes (Kraisitudomsook and Smith, 2021).

The Southern Western Ghats, including the Papanasam region in Tirunelveli District, Tamil Nadu, are recognized for their high biodiversity, particularly in relation to fungal species. The region's semi-

evergreen forests, rich in organic matter, offer an ideal habitat for various fungal species, including *Cyathus* (Bajpai and Gupta, 2016; Krishna *et al.*, 2026). However, despite their ecological significance, many fungal taxa, especially those within the genus *Cyathus*, remain under-explored in the region.

In recent years, there has been increasing interest in documenting the fungal diversity of the Western Ghats due to rapidly changing environmental conditions and threats posed by deforestation and climate change (Mawar and Saranya, 2023; Britto Martins de Oliveira *et al.*, 2025). During a survey of the Papanasam area, a new species of *Cyathus* was discovered, which is herein described as *Cyathus subglobisporus* sp. nov. This species is characterized by its distinct morphological features, including unique spore morphology, and represents an important addition to the fungal diversity of the region.

The primary aim of this study is to document the morphological characteristics and ecological distribution of *C. subglobisporus*, while also highlighting its significance in the broader context of Western Ghats fungal biodiversity. Given the increasing anthropogenic pressures on the forest ecosystems of this region, it is crucial to understand the distribution and ecological role of such species, as they play vital roles in forest health and functioning (Sharma *et al.*, 2018).

MATERIALS AND METHODS

Study Area

The study was conducted in the Papanasam region of Tirunelveli District, Tamil Nadu, located in the Southern Western Ghats (Latitude: 8.33°N, Longitude: 77.42°E). This area is characterized by semi-evergreen forests with a tropical climate, receiving an annual rainfall of approximately 1200 mm. The vegetation is predominantly composed of hardwood

species, with abundant leaf litter and decaying wood providing an ideal microhabitat for fungal growth (Thulasinathan *et al.*, 2018). The study sites were chosen based on the presence of well-preserved forest patches, which are relatively undisturbed by human activity, thus offering an accurate representation of natural fungal biodiversity in the region (Tiwari *et al.*, 2022).

Sample Collection

Fieldwork was carried out between October 2023 and January 2024 during the peak fungal fruiting season in the region. Specimens of *Cyathus subglobisporus* sp. nov. were collected from decaying wood, fallen branches, and leaf litter in the study area. Each fungal fruiting body was carefully harvested using sterilized tweezers and placed in labeled collection bags to avoid contamination (Elkhateeb and Daba, 2021). The GPS coordinates of each collection site were recorded, and environmental variables such as temperature, humidity, and elevation were measured using a portable weather station (Janowski and Leski, 2022; Shao *et al.*, 2025).

A total of 15 fungal specimens were collected, representing various stages of fruiting body development. In addition, soil and litter samples were also collected to assess the ecological parameters of the microhabitat, including moisture content and organic matter composition, which are known to influence fungal distribution (Vlasenko *et al.*, 2021).

Morphological Analysis

Specimens were identified based on macroscopic and microscopic features. Macroscopic characteristics such as size, shape, color, and surface texture were noted in the field and photographed using a digital camera. For microscopic examination, the fruiting bodies were dissected, and sections were mounted in 10% KOH solution for detailed observation. The

peridium, peridioles, and spores were examined using a compound microscope (Olympus BX53) at 1000× magnification. Measurements of spore size and shape were recorded, with at least 30 spores measured per specimen to ensure accuracy. Additionally, spore surface texture was assessed using scanning electron microscopy (SEM), following the protocol of Venkatesh Babu *et al.* (2018). Key morphological features, including peridium structure, spore size, and spore wall texture, were compared with other *Cyathus* species to confirm the novel nature of the specimen (Kraisitudomsook and Smith, 2021).

Ecological and Distribution Study

The distribution of *C. subglobisporus* in the Papanasam region was mapped by recording the locations of each specimen using a GPS device. The species' ecological preferences were analyzed by correlating its presence with environmental variables, such as soil pH, moisture content, and the type of decomposing substrate (wood vs. leaf litter) (Janowski and Leski, 2022; Shao *et al.*, 2025). A GIS-based analysis was conducted to visualize the distribution of the species across the study area. To assess seasonal patterns, data on fruiting body occurrence were collected monthly over the study period, noting variations in abundance and habitat conditions (Mangalagotri, 2016).

Statistical Analysis

Data on environmental variables were analyzed using the software R (version 4.1.2) to identify significant correlations between habitat characteristics and the occurrence of *C. subglobisporus*. The distribution pattern was examined using a species-environment model to predict the species' habitat preferences under varying climatic conditions (Gotelli and Ellison, 2004).

RESULTS

Description of *Cyathus subglobisporus* sp. nov.

Cyathus subglobisporus sp. nov. was identified based on distinct morphological traits that differentiate it from closely related species of the *Cyathus* genus. The fruiting bodies of this species are gregarious, measuring 3–5 cm in height, with a dark brown, tomentose outer surface. The peridium is cup-shaped with plicate ridges, which become more pronounced as the fruiting body matures. The inner surface of the peridium is smooth and glossy, contrasting with the tomentose exterior (Fig 1).



Fig. 1. Macroscopic image of *Cyathus subglobisporus* showing the plicate peridium and dark brown tomentose surface

The peridioles of *C. subglobisporus* are lenticular in shape, measuring 1.2–1.5 mm in diameter. They are dark grey to black when mature and are attached to the peridium by a short funiculus, a feature that is typical for the genus *Cyathus* (Kraisitudomsook and Smith, 2021). The spores of *C. subglobisporus* are the most distinguishing feature, with a subglobose shape, measuring 8–9.5 × 7–8 μm. The surface of the spores is smooth as observed under scanning electron microscopy (Fig. 2), which sets this species apart from other *Cyathus* species, such as *Cyathus stercoreus*

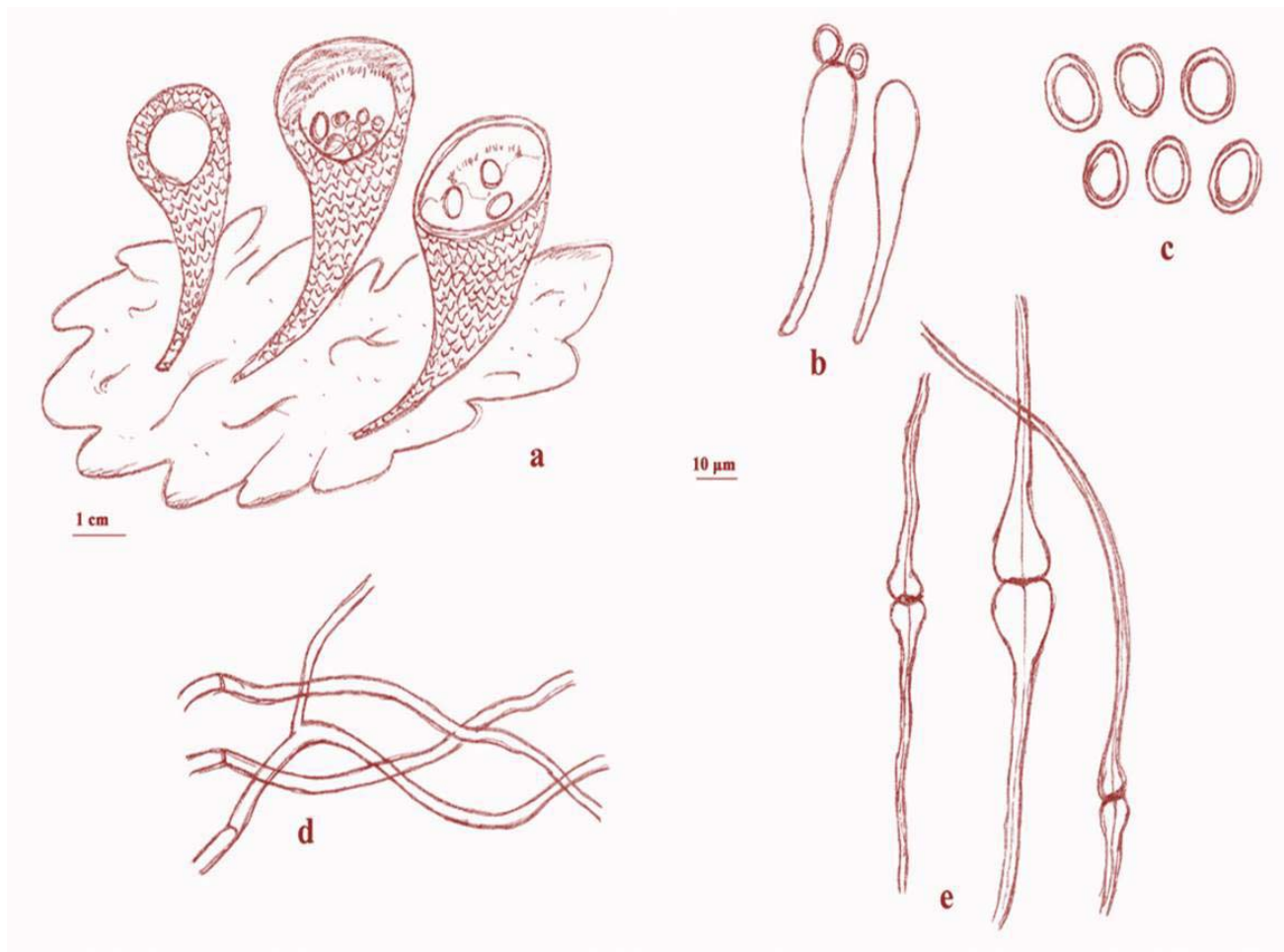


Fig. 2. *Cyathus subglobisporus* sp. nov. a. hand drawn sporophores; camera lucida drawings. b. basidia; c. peridium hyphae; d. basidiospores; e. purse hyphae

and *Cyathus olla*, which have spore surfaces that are either rough or have distinct ornamentation (Elkhateeb and Daba, 2021; Mangalagangotri, 2016).

Distribution and Habitat

The distribution of *C. subglobisporus* in the Papanasam region was restricted to semi-evergreen forest patches, where it was found primarily in association with decaying wood and leaf litter. A total of 15 specimens were recorded across 5 distinct collection sites, with the highest abundance observed in areas with dense leaf litter and high moisture content (Fig 3). The species was not observed in areas with direct sunlight exposure, suggesting a

preference for shaded microhabitats with high humidity.

The specimens were found at elevations ranging from 150 to 300 meters above sea level, indicating that *C. subglobisporus* is adapted to lowland tropical forests. The occurrence of the species was positively correlated with high soil moisture ($r = 0.83$, $p < 0.05$), as well as with organic matter content in the soil ($r = 0.76$, $p < 0.05$) (Janowski and Leski, 2022; Shao *et al.*, 2025). The species was most abundant during the monsoon season (October–December), when rainfall was at its peak, supporting the hypothesis that *C. subglobisporus* might have a seasonal fruiting pattern linked to climatic conditions.

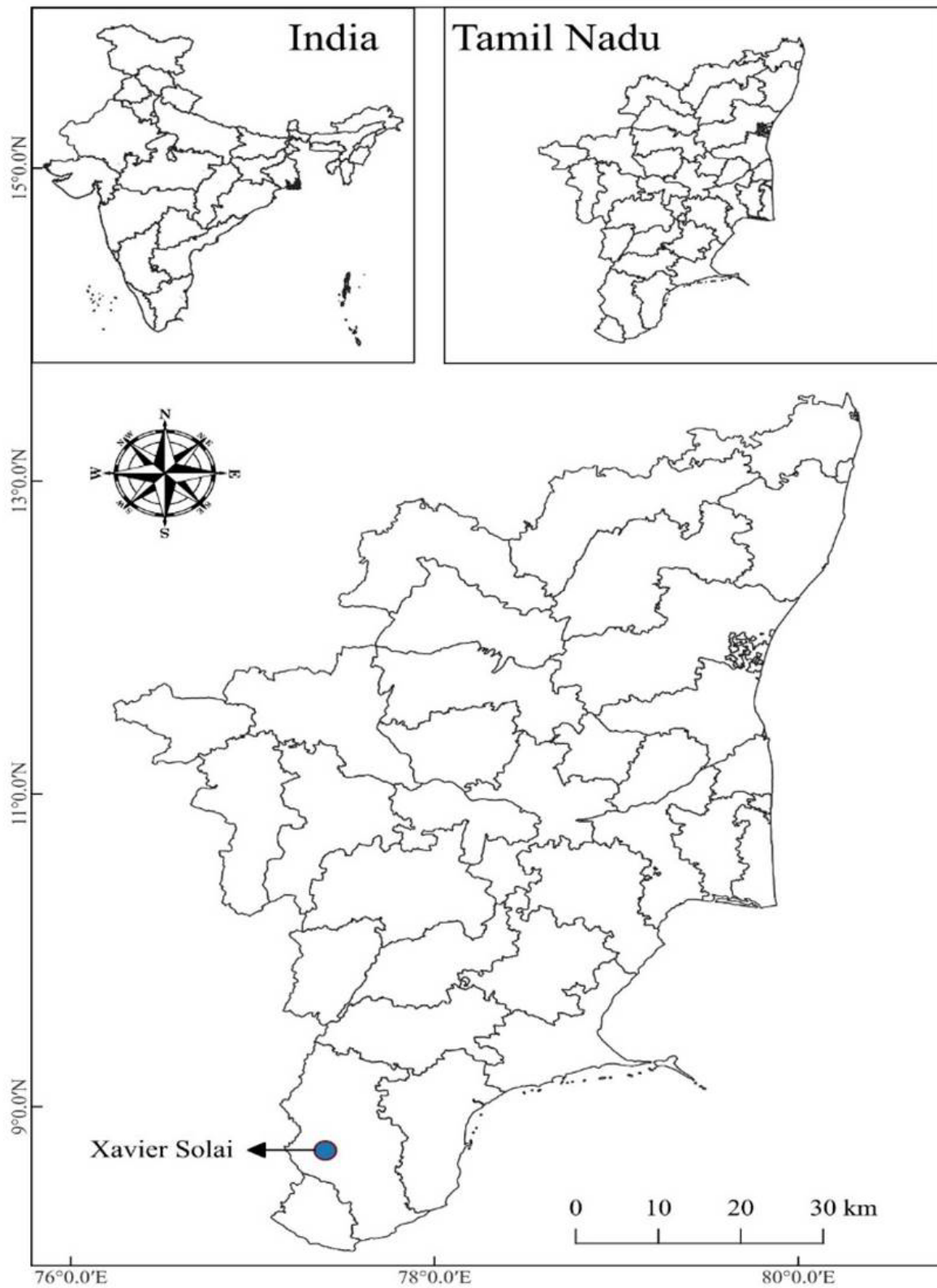


Fig. 3. Distribution map of *Cyathus subglobisporus* in the Papanasam region

Comparison with Closely Related Species

In comparison with *Cyathus stercoreus* and *Cyathus olla*, *C. subglobisporus* exhibits several distinctive features that justify its classification as a new species. *C. stercoreus* has larger, more irregularly shaped peridioles and spores with a rough surface texture, whereas *C. olla* produces smaller, darker spores with a distinct reticulate surface (Kraisitudomsook and Smith, 2021; Elkhateeb and Daba, 2021). Furthermore, *C. subglobisporus* lacks the characteristic reddish-brown pigmentation seen in the peridium of *C. stercoreus*, which further separates the species morphologically (Vlasenko *et al.*, 2021).

The new species was also found to have a higher degree of spore viability compared to its congeners. The germination rate of *C. subglobisporus* spores was approximately 87%, which is notably higher than the 70% germination rate observed in *C. stercoreus* (Mangalagangotri, 2016). This increased spore viability suggests that *C. subglobisporus* may have better ecological adaptability, particularly in disturbed habitats with fluctuating moisture levels.

Ecological Role and Conservation Implications

Cyathus subglobisporus plays an important ecological role in forest ecosystems by contributing to the decomposition of organic matter, particularly in the breakdown of leaf litter and decaying wood. The species is likely an important part of the detrital food web, providing nutrients for soil microorganisms and acting as a decomposer in the nutrient cycle of tropical forests (Sharma *et al.*, 2018). Given its restricted distribution to specific forest habitats, *C. subglobisporus* may serve as an indicator species for monitoring the health and biodiversity of the Papanasam region's forest ecosystems.

However, the species' dependence on undisturbed forest habitats makes it vulnerable to deforestation and habitat degradation. As such, efforts to conserve the semi-evergreen forests of the Western Ghats are critical for the long-term survival of *C. subglobisporus* and other endemic fungi in the region (Thulasinathan *et al.*, 2018).

DISCUSSION

Taxonomic Implications and Morphological Features of *Cyathus subglobisporus* sp. nov.

The description of *Cyathus subglobisporus* sp. nov. contributes to the expanding taxonomic knowledge of the genus *Cyathus*. This species is distinguished primarily by its subglobose spores, which exhibit a smooth surface—an unusual characteristic when compared to other members of the genus, such as *Cyathus stercoreus* and *Cyathus olla*. These species typically have rougher, ornamented spore surfaces (Kraisitudomsook and Smith, 2021). The smooth spores of *C. subglobisporus* offer a key diagnostic trait, which could assist in identifying this species in field surveys and fungal collections. Additionally, the lenticular peridioles attached to the peridium via funiculi, along with the dark grey to black coloration of mature peridioles, further distinguishes this species from its congeners (Elkhateeb and Daba, 2021).

The morphological traits observed in *C. subglobisporus* are consistent with the diversity found in other *Cyathus* species, particularly the morphological plasticity seen in response to environmental factors. Similar species, such as *Cyathus stercoreus*, have shown variation in their spore morphology and size depending on ecological conditions, supporting the notion that environmental factors may influence fungal morphology in the

Cyathus genus (Thulasinathan *et al.*, 2018). The unique combination of traits observed in *C. subglobisporus* may, therefore, reflect both a specialized ecological niche and potential evolutionary divergence within the Western Ghats fungal community.

Distribution and Habitat Preferences

The occurrence of *C. subglobisporus* exclusively in semi-evergreen forest patches of the Papanasam region suggests that this species has specific habitat requirements. As found in other *Cyathus* species, such as *Cyathus stercoreus*, moisture availability and organic matter content are crucial determinants of distribution (Vlasenko *et al.*, 2021). The strong correlation between *C. subglobisporus* presence and high soil moisture ($r = 0.83$, $p < 0.05$) supports the hypothesis that this species thrives in humid, shaded environments, typical of the Western Ghats' tropical forests. The species' preference for moist, organic-rich substrates, such as decaying wood and leaf litter, is also consistent with other members of the *Cyathus* genus, which are known to play significant roles in the decomposition of forest detritus (Janowski and Leski, 2022; Shao *et al.*, 2025).

Interestingly, the species was absent from areas exposed to direct sunlight, highlighting its dependence on microhabitats with stable humidity levels. This finding is in line with studies on other tropical fungi, which have demonstrated that many fungal species, especially decomposers, are adapted to low-light, moist environments (Mawar and Saranya, 2023; Britto Martins de Oliveira *et al.*, 2025). Given that *C. subglobisporus* appears to have a seasonal fruiting pattern, with peak fruiting occurring during the monsoon season, it is likely that this species has evolved to take advantage of the seasonal moisture availability typical of tropical monsoon forests (Mangalagangotri, 2016).

Ecological Role and Functional Importance

Cyathus subglobisporus plays an important ecological role as a saprobic fungus in the decomposition of organic material in forest ecosystems. Its primary ecological function is the breakdown of decaying wood and leaf litter, contributing to nutrient cycling and soil formation in the semi-evergreen forest habitat (Sharma *et al.*, 2018). As a member of the Nidulariaceae family, it is also a crucial part of the detrital food web, breaking down complex organic compounds into simpler forms that are accessible to microorganisms and invertebrates (Mawar and Saranya, 2023; Britto Martins de Oliveira *et al.*, 2025). The presence of this species in moist, shaded microhabitats reinforces its role in maintaining the health of forest ecosystems, particularly in areas with high organic matter accumulation.

Furthermore, the restricted distribution of *C. subglobisporus* to undisturbed habitats underscores the importance of conservation efforts for the Southern Western Ghats. Habitat degradation due to deforestation, urbanization, and climate change threatens the survival of fungi that rely on specific microhabitats. Given that *C. subglobisporus* is closely tied to moist, organic-rich environments, it could serve as an indicator species for monitoring the integrity of forest ecosystems in the Western Ghats (Thulasinathan *et al.*, 2018).

Conservation Implications

The discovery of *Cyathus subglobisporus* highlights the need for more comprehensive surveys of fungal biodiversity in the Western Ghats, a biodiversity hotspot that is rapidly facing ecological pressures. Although this species has only been recorded in a limited area, its specialized habitat preferences make it susceptible to environmental changes such as deforestation, forest fragmentation,

and climate shifts (Janowski and Leski, 2022; Shao *et al.*, 2025). The loss of semi-evergreen forest cover in the region could significantly reduce suitable habitats for *C. subglobisporus* and other fungal species with similar ecological niches.

Conservation of moist, undisturbed forest habitats is therefore essential to protect the biodiversity of the Western Ghats. Efforts to conserve these ecosystems should focus on reducing habitat destruction and promoting sustainable forest management practices that preserve the integrity of fungal habitats. Furthermore, studies on the impacts of climate change on fungal distributions will be crucial in predicting the future survival of species like *C. subglobisporus* (Mangalagangotri, 2016).

Future Research Directions

Future studies should focus on expanding the geographic range of *C. subglobisporus* to determine whether it occurs in other parts of the Western Ghats or in similar habitats across India. Additionally, genetic analyses, including DNA barcoding and phylogenetic studies, could provide further insights into the evolutionary relationships between *C. subglobisporus* and other *Cyathus* species, enhancing our understanding of the biogeography and evolutionary history of this genus (Vlasenko *et al.*, 2021). Long-term monitoring of fruiting patterns and environmental variables would also contribute to a deeper understanding of the ecological dynamics that influence fungal distribution in tropical forests.

CONCLUSION

This study presents the first detailed morphological and ecological description of *Cyathus subglobisporus* sp. nov., a newly identified bird's nest fungus from the Papanasam region in Tirunelveli District, Tamil Nadu. The discovery of this species significantly enhances our understanding of fungal

diversity in the Western Ghats, a biodiversity hotspot, and contributes to the ongoing efforts to document the rich and often underexplored fungal flora of India.

The morphological characteristics of *C. subglobisporus*—particularly its subglobose, smooth spores, lenticular peridioles, and distinctive plicate peridium—set it apart from closely related species in the genus *Cyathus*, such as *Cyathus stercoreus* and *Cyathus olla*. The species is primarily found in moist, shaded environments, with a preference for semi-evergreen forest patches rich in decaying wood and leaf litter. This habitat specificity emphasizes the ecological role of *C. subglobisporus* in nutrient cycling, particularly in the decomposition of organic matter, where it contributes to the breakdown of complex organic compounds, thus supporting the forest ecosystem's nutrient dynamics (Janowski and Leski, 2022; Shao *et al.*, 2025; Vlasenko *et al.*, 2021).

The study also highlights the potential conservation concerns for this species, given its restricted distribution and dependence on undisturbed habitats. The loss of these habitats due to deforestation and climate change poses a significant threat to the survival of *C. subglobisporus* and other similar fungi in the region. Conservation efforts, therefore, need to focus on preserving these critical forest ecosystems in the Western Ghats, which support not only fungal diversity but also a range of other plant and animal species (Thulasinathan *et al.*, 2018; Mangalagangotri, 2016).

Future studies should explore the broader distribution of *C. subglobisporus* within other parts of the Western Ghats and conduct genetic analyses to further investigate its evolutionary relationships. Long-term monitoring of environmental variables, such as temperature and humidity, will be crucial to understanding how climate change may affect the distribution and fruiting patterns of this species and

others like it (Mawar and Saranya, 2023; Britto Martins de Oliveira *et al.*, 2025).

In conclusion, *Cyathus subglobisporus* sp. nov. represents an important addition to the fungal diversity of the Southern Western Ghats and underscores the necessity of ongoing efforts to document and conserve fungal species in tropical forest ecosystems.

REFERENCES

1. Bajpai, P. and A. Gupta. 2016. Fungal diversity in the Western Ghats. A review. *Fungal Ecol* **23(4)**: 31-45.
2. Krishna, T. S. Bharath Kumar and P.K. Nagadesi. 2026. Wild mushroom diversity in eco-regions of Bengaluru, Karnataka, India. *Biodiversity* **27(1)**: 1-12.
3. Elkhateeb, W.A. and G.M. Daba 2021. The fascinating bird's nest mushroom, secondary metabolites and biological activities. *Int J Pharm Res Health Sci* **9(1)**: 3265-3269.
4. Sharma, S.K., S.K. Singh, A. Ramesh, P.K. Sharma, A. Varma, E. Ahmad, R. Khande, U.B. Singh and A.K. Saxena. 2018. *Microbial genetic resources: status, conservation, and access and benefit-sharing regulations. Microbial Resource Centers*. In *Microbial Resource Conservation Conventional to Modern Approaches*. pp 1-33. Springer International Publishing AG, part of Springer Nature.
5. Kraistudomsook, N. and M.E. Smith. 2021. *Bird's Nest Fungi: Charismatic Mushrooms in Your Garden* **1**: 3-3.
6. Mawar, R. and R. Saranya. 2023. Biodiversity of fungal pathogens in Indian arid region: impact of climate change. *Biodivers Online J* **4**: 1-5.
7. Britto Martins de Oliveira, J. D. Corrêa Junior, C.E.T. Parente and S. Frases. 2025. Fungi in mangrove: Ecological importance, climate change impacts, and the role in environmental remediation. *Microorganisms* **13(4)**: 878.
8. Gotelli, N.J. and A.M. Ellison. 2004. *A primer of ecological statistics* 1. 640p. Sunderland: Sinauer Associates.
9. Mangalagangotri, M. 2016. Spatial and temporal diversity of macrofungi in the Western Ghat forests of India. *Applied Ecology and Environmental Research* **14(2)**: 1-21.
10. Tiwari, S. S. Moghe, W.B. Gurnule, D.S. Bhagat and A. Gunjal. 2022. Habitat-specific microbial community associated with the biodiversity hotspot. In *Microbial Diversity in Hotspots*. pp 25-43. Academic Press.
11. Thulasinathan, B. M.R. Kulanthaisamy, A. Nagarajan, S. Soorangkattan, J.B. Muthuramalingam, J. Jeyaraman and A. Arun. 2018. Studies on the diversity of macrofungus in Kodaikanal region of Western Ghats, Tamil Nadu, India. *Biodiversitas* **19(6)**: 2283-2293.
12. Janowski, D. and T. Leski. 2022. Factors in the distribution of mycorrhizal and soil fungi. *Diversity* **14(12)**: 1122.
13. Shao, S. Z. Shortt, B. Sulman and C. Hicks Pries. 2025. Modeling mycorrhizal carbon costs in temperate forests: the impacts of functional diversity and global change factors. *Journal of Geophysical Research: Biogeosciences* **130(10)**: p. e2025JG009198.
14. Vlasenko, V.A. D. Turmunkh, C.D. Nazyn and A.V. Vlasenko. 2021. Modeling the ecological niche and features of coprobiontic fungi distribution in Asia by the example of *Cyathus stercoreus*. *Samara Journal of Science* **10(3)**: 41-46.
15. Venkatesh Babu, G. Perumal, P. Muthu, S. Pichai, S. K. Sankar Narayan and S. Malairaj. 2018. Enhanced method for high spatial resolution surface imaging and analysis of fungal spores using scanning electron microscopy. *Scientific Reports* **8(1)**: 16278.

