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Red Cup Fungi *(Sarcoscypha coccinea spp.)* in Goygol National Park (Azerbaijan): Distribution, Morphology and Ecological Roles

Jamur Cangkir Merah *(Sarcoscypha coccinea spp.)* di Taman Nasional Goygol (Azerbaijan): Distribusi, Morfologi dan Peran Ekologi

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ABSTRACT

The genus (*Sarcoscypha coccinea spp.*), commonly known as Red Cup Fungi, is represented by ecologically significant saprotrophic species that contribute to wood decomposition and nutrient cycling in forest ecosystems. This study documents, for the first time, the presence of *Sarcoscypha coccinea spp.* in Goygol National Park, located in the Little Caucasus region of Azerbaijan, and provides a synthesis of its distribution, morphology, and ecological functions in a mountain forest environment. The primary objective of the research is to characterize the species occurrence within the park, evaluate its habitat preferences, and highlight its potential role as an indicator organism for forest ecosystem integrity. Field surveys were conducted in March 2024 within the humid montane forest belt between Aggol and Goygol. The specimens were found at 40.4051° N, 46.3315° E and 1,540–1,620 m above sea level on decaying hardwood substrates, particularly on fallen trunks and stumps of *Fagus orientalis* and *Carpinus betulus*. The study area is characterized by a cold, humid mountain climate with 600–900 mm of annual precipitation and brown forest soils rich in organic matter. The species occurred in mesic, shaded microhabitats with stable moisture levels, typically along streamside forest corridors. Morphological examination confirmed the species as *S. coccinea spp.*, distinguished by its bright scarlet apothecia, cup-shaped hymenial surface, and ellipsoid ascospores with two *Conspicuous guttules*. Ecologically, it accelerates lignocellulosic degradation, enhances soil organic matter formation, and supports microhabitat diversity in montane forest ecosystems. Its occurrence in Goygol National Park reflects both the conservation value of the region and the relatively undisturbed saproxylic habitats that persist within it. This study underscores the need for future molecular phylogenetic analysis and systematic documentation of fungal diversity in Azerbaijan's protected areas.

Keywords: Ecosystem resilience, Forest microhabitats, Nutrient cycling, Habitat specificity

ABSTRAK

Genus (*Sarcoscypha coccinea* spp.), yang umumnya dikenal sebagai Jamur Cangkir Merah, terdiri dari spesies saprotrof yang secara ekologis penting dan berperan dalam dekomposisi kayu serta siklus nutrisi di ekosistem hutan. Penelitian ini mendokumentasikan, untuk pertama kalinya, keberadaan Sarcoscypha coccinea spp. di Taman Nasional Goygol, yang terletak di wilayah Little Caucasus di Azerbaijan, serta menyajikan sintesis mengenai distribusi, morfologi, dan fungsi ekologisnya dalam lingkungan hutan pegunungan. Tujuan utama penelitian ini adalah untuk mengkarakterisasi keberadaan spesies di dalam taman nasional, mengevaluasi preferensi habitatnya, dan menyoroti perannya sebagai organisme indikator untuk integritas ekosistem hutan. Survei lapangan dilakukan pada Maret 2024 di sabuk hutan pegunungan lembab antara Aggol dan Goygol. Spesimen ditemukan pada koordinat 40.4051° LU, 46,3315° B dan ketinggian 1.540–1.620 m di atas permukaan laut pada substrat kayu keras yang membusuk, terutama pada batang dan tunggul pohon *Fagus orientalis* dan *Carpinus betulus* yang tumbang. Kawasan studi memiliki iklim pegunungan yang dingin dan lembap dengan curah hujan tahunan 600–900 mm serta tanah hutan coklat yang kaya akan bahan organik. Spesies ini ditemukan di mikrohabitat mesik dan teduh dengan tingkat kelembapan yang stabil, umumnya di sepanjang koridor hutan tepi sungai. Pemeriksaan morfologis mengonfirmasi spesies ini sebagai *S. coccinea spp*., yang dibedakan oleh apotecia berwarna merah cerah, permukaan himenial berbentuk cawan, dan spora askoid elips dengan dua guttula yang mencolok. Secara ekologi, spesies ini mempercepat degradasi lignoselulosa, meningkatkan pembentukan bahan organik tanah, dan

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mendukung keragaman mikrohabitat di ekosistem hutan pegunungan. Kehadirannya di Taman Nasional Goygol mencerminkan nilai konservasi wilayah tersebut serta habitat saproksilik yang relatif tidak terganggu yang masih bertahan di dalamnya. Studi ini menekankan perlunya analisis filogenetik molekuler dan dokumentasi sistematis keanekaragaman jamur di kawasan lindung Azerbaijan di masa mendatang.

Kata Kunci: Ketahanan ekosistem, Mikrohabitat hutan, Siklus nutrisi, Spesifisitas habitat

INTRODUCTION

Sarcoscypha coccinea spp., commonly known as the Red Cup Fungus (Alborzi et al., 2018; Achigsoz et al., 2015; Brockerhoff et al., 2017), is a saprotrophic ascomycete that plays a pivotal role in the decomposition of lignocellulosic materials within temperate forest ecosystems. Characterized by its striking scarlet, cup-shaped fruiting bodies, this species is widely distributed across Europe, North America, and parts of Asia, thriving in moist, shaded environments where it colonizes decaying hardwoods, particularly those of the beech *(Fagus orientalis)* and hornbeam *(Carpinus betulus)* families Ecologically, *S. coccinea* contributes significantly to nutrient cycling and soil formation by facilitating the breakdown of complex organic matter. Its fruiting bodies, which can emit an audible "puffing" sound during spore discharge, are typically found on buried or decaying wood, often in clusters. Such a notable study has not been realized in the territory of the National Park, like other fungi determined here by the local scientists. The fungi were found in the territory of the National Park occasionally (Figure 1).

In early spring in Group

Figure 1. Red Cup Fungi *(S.coccinea spp.)*
Photos: Fuad Guliyev (vice director of Goygol National Park)

Figure 1 presents *S. coccinea's* natural appearance and distribution in early spring. However, comprehensive ecological, morphological, and also biogeographical (Buckley, 2011; Butarbutar et al., 2013; Meteoblue Climate, 2025) data remain scarce, highlighting the need for further investigation into its distribution and ecological roles within the region. This study aims to fill this knowledge gap by documenting the occurrence of *S. coccinea* in Goygol National Park, Azerbaijan. Through detailed morphological analysis and ecological assessment, we seek to elucidate the species' habitat preferences, distribution patterns, and functional contributions to forest ecosystem dynamics. The findings will provide valuable insights into the biodiversity of Azerbaijan's protected areas and inform future conservation and ecological research initiatives.

Identify the preferred habitats and microclimates of *Sarcoscypha c.* in Goygol National Park; Understand its role in wood decomposition and nutrient cycling within forest ecosystems; Provide baseline data to support fungal biodiversity monitoring and conservation efforts in Azerbaijan. The species exhibits a preference for stable, mesic microhabitats, indicating its sensitivity to environmental conditions and potential as a bioindicator of forest ecosystem health. Despite its ecological importance, research on *S. coccinea* in Azerbaijan has been limited.

MATERIALS AND METHODS

From an ecological point of view, I am fascinated by the intricate roles' fungi play in forest ecosystems. Among these, the Red Cup Fungi (Edwin et al., 2017; Harbi et al., 2018; Kamaludin et al., 2020) *(S. coccinea spp.)* stand out for their vivid scarlet fruiting bodies and ecological importance. In Goygol National Park, a pristine forested area in Azerbaijan, these fungi occupy a unique ecological niche, colonizing decaying hardwood and contributing to nutrient recycling. During my field surveys, I observed the fungi primarily in shaded, moist microhabitats, often on fallen branches and twigs. The early spring emergence of their bright red apothecia signals

active decomposition and the renewal of forest nutrients. Morphologically, these fungi exhibit cup-shaped fruiting bodies with smooth inner surfaces and minute, oblong ascospores, which are crucial for accurate species identification. Ecologically (Nugroho et al., 2018; Rahma et al., 2020; Reinhart et al., 2020), these species are vital saprobes. By breaking down lignin-rich wood, they accelerate nutrient turnover and enhance soil fertility. Their conspicuous coloration may also facilitate spore dispersal through invertebrate interactions, linking fungi to broader ecosystem processes. Understanding its distribution, morphology, and ecological roles in the National Park not only fills a gap in Azerbaijan's mycological records but also provides baseline data for biodiversity monitoring and conservation.

As a researcher, documenting these fungi enriches our knowledge of forest ecosystem dynamics and highlights the need to protect these delicate yet essential organisms in their natural habitats. Field surveys were conducted in Goygol National Park, Azerbaijan, during the fruiting season of the fungi species, from early spring to late spring, when environmental conditions favor fungal emergence. Systematic transect walks were performed across representative forest habitats, including mixed deciduous and riparian woodlands, to assess the occurrence and distribution. Sampling sites were selected based on microhabitat variability (Roy, 2021; Sihite, 2018; Sisriany et al., 2020), such as canopy cover, moisture level, and the presence of decaying hardwood substrates. At each site, all visible fruiting bodies were recorded, photographed in situ, and their GPS coordinates noted. Small portions of the fungi were carefully collected for morphological analysis in the laboratory, ensuring minimal disturbance to the surrounding ecosystem. Environmental parameters, including soil moisture, pH, litter depth, and surrounding vegetation composition, were documented at each sampling point to evaluate its ecological preferences in early spring. Collected specimens were preserved using standard herbarium techniques for further morphological characterization and taxonomic identification. This approach provides a comprehensive dataset to link its distribution patterns with specific microhabitat conditions within the park.

Morphological characterization (Mammadova, 2024; 2023; 2013) of *S. coccinea* specimens collected from Goygol National Park was performed using standardized mycological methodologies to ensure taxonomic precision and reproducibility.

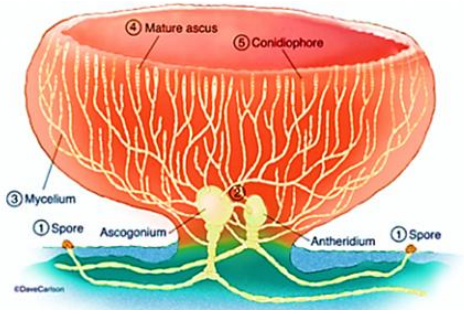

Figure 1. General Morphological Structure (Red Fungsi, 2025)

Macroscopic traits, including apothecial diameter, cup morphology, coloration of the hymenium and exterior surface, margin configuration, and substrate attachment, were systematically recorded in situ immediately upon collection. Colorimetric (Mammadova, 2022; 2013; 2012) data were standardized according to the Methuen Handbook of Colour to minimize subjective bias. In addition, ambient temperature and light intensity were noted at each collection site to understand their influence on pigmentation and cup development. Photographs were taken under natural light to capture the authentic texture and color details of each specimen.

Figure 3. Red Cup Fungi (*Sarcoscypha coccinea spp.*) around the Goygol *(*lake*)*
Photos: Fuad Guliyev (vice director of Goygol National Park)

As seen in Figure 3, the fungi grow on the trees, especially. For microscopic evaluation, representative sections of the hymenium, excipulum, and spores were prepared using a microtome and hand-sectioning techniques.

The Cup of the fungi *(Sarcoscypha coccinea spp.)*

Red Cup Fungi

Figure 4. Real size of cup fungi
Photos: Fuad Guliyev (vice director of Goygol National Park)

All morphological parameters were systematically compared with published descriptions of Sarcoscypha coccinea species to confirm identification and assess phenotypic plasticity in response to the specific microclimatic and substrate conditions of Goygol National Park. This integrative morphological assessment provides a scientifically rigorous foundation for understanding species diversity, ecological adaptation, and potential conservation priorities for *S. coccinea* in the Caucasus region. Observations were conducted under a compound light microscope at magnifications ranging from 100× to 1000×. Quantitative measurements included spore dimensions, ornamentation, wall thickness, and asci and paraphyses morphology, with at least 30 spores analyzed per specimen to achieve statistical robustness. Photomicrographs were captured, and detailed schematic illustrations were produced to document morphological variation.

Ecological Assessment

The ecological assessment of *S. coccinea* in Goygol National Park focused on understanding the species' habitat preferences, substrate associations, and functional role within forest ecosystems. Field data collected during systematic surveys included microhabitat characteristics such as soil moisture, pH, litter depth (Mammadova, 2025a; 2025b; 2025c), canopy cover, and the presence of decaying hardwood substrates. These parameters were analyzed to determine the environmental conditions that favor the establishment and fruiting of Sarcoscypha coccinea. Observations indicated a strong preference for well-decayed hardwood, particularly fallen branches of deciduous trees, suggesting a saprotrophic lifestyle essential for lignocellulosic decomposition. Spatial distribution patterns were assessed using georeferenced occurrence data, revealing clustering in moist, shaded microsites with stable microclimatic conditions.

Additionally, the contribution of *S. coccinea* to nutrient cycling was inferred from its role in wood decomposition, facilitating the release of carbon and essential minerals back into the soil. The ecological assessment also considered potential interactions with other fungi, invertebrates, and microbial communities, highlighting *S. coccinea* as an integral component of forest detrital networks. By linking occurrence patterns with environmental variables, this assessment provides baseline data for monitoring fungal biodiversity, evaluating ecosystem health, and informing conservation strategies within Goygol National Park. Data collected from field surveys and laboratory examinations were rigorously processed to uncover patterns in the distribution, habitat utilization, and morphological traits of *S. coccinea spp.* in Goygol National Park. The locations of all observed specimens were analyzed in relation to environmental factors to determine conditions that favor the species' occurrence.

Morphological characteristics (Mammadova et al., 2025; Mammadova, 2025d; Red Cup, 2025), such as spore size, shape, and apothecial dimensions, were measured and statistically assessed to understand variability within and between populations. Descriptive statistics were generated, and multivariate techniques such as principal component analysis (PCA) were applied to explore associations between morphological features and environmental variables. Environmental parameters such as soil moisture, pH, litter depth, canopy density, and type of woody substrate were examined using correlation and regression analyses to identify key factors influencing *S. coccinea spp.* abundance. Graphical representations, including scatterplots, boxplots, and heatmaps, were used to reveal patterns and facilitate comparisons across different microhabitats.

This comprehensive analytical approach integrates morphological and ecological information, providing a solid basis for understanding the ecological niche, functional role, and conservation significance of *S. coccinea spp.* in temperate forest ecosystems of the Caucasus.

RESULT AND DISCUSSION

Field surveys in Goygol National Park revealed that *S. coccinea spp.* exhibits distinct habitat preferences and ecological roles. The species was predominantly found on decaying hardwood in shaded, moisture-retentive microhabitats. The distribution, substrate, and fruiting patterns were closely linked to soil properties, climate, litter depth, and canopy cover. Morphological examination confirmed the species identity, with consistent cup-shaped apothecia and ellipsoid ascospores. Observations revealed that decaying logs with active *S. coccinea* colonization exhibited higher local soil organic content compared to uncolonized substrates.

Table 1. Environmental and morphological parameters of *S. coccinea spp.* in Goygol National Park

Parameter Category	Parameters	Observed Range / Mean±SD	Notes
Soil Properties	Soil moisture (%)	35 – 55 / 44 ± 6	Higher moisture favored fruiting
	Soil pH	5.6 – 6.8 / 6.2 ± 0.4	Slightly acidic, suitable for decomposition
	Organic matter content(%)	6 – 12 / 9 ± 2	Correlated with saprotrophic activity
Climate Parameters	Air temperature (°C)	10 – 18 / 14 ± 2	Spring fruiting season
	Relative humidity (%)	75 – 90 / 83 ± 5	Moist environments promote apothecia formation
	Annual precipitation (mm)	600 – 900	Mesic montane climate
Forest Floor / Litter	Litter depth (cm)	5 – 12 / 8 ± 2	Deeper litter supports fungal establishment
	Canopy cover (%)	70 – 95 / 82 ± 7	Shaded microhabitats favored
	Substrate type	Beech *(F. orientalis)*, Hornbeam *(C. betulus)*	Fallen branches and logs
Morphological Traits	Apothecia diameter (mm)	15 – 40	Bright scarlet, cup-shaped
	Inner surface texture	Smooth	Glossy, characteristic of the species
	Spore shape	Ellipsoid, 18 × 10 µm	Containing guttules
	Spore ornamentation	Smooth	Minimal variation across microhabitats

Morphological analysis confirmed the presence of *S. coccinea*, identifiable by bright scarlet, cup-shaped apothecia and ellipsoid ascospores containing guttules. Apothecia diameter ranged from 15 to 40 mm, with inner surfaces smooth and glossy. Spore dimensions averaged 18 × 10 µm, with slight variation between individual specimens (Figure 2).

Table 2. Morphological traits of *S.coccinea spp.* in Goygol National Park

Trait	Observed Range / Description	Notes
Apothecia diameter (mm)	15 – 40	Bright scarlet, cup-shaped
Inner surface texture	Smooth	Glossy, characteristic of the species
Spore shape	Ellipsoid, 18 × 10 µm	Containing guttules
Spore ornamentation	Smooth	Minimal variation across microhabitats
Color of apothecia	Scarlet-red	Uniform among observed specimens
Attachment to substrate	Sessile or short-stalked	Found on fallen branches and logs

Table 2 shows that *S. coccinea spp.* plays a significant role in wood decomposition and nutrient cycling. Its saprotrophic activity accelerates lignin and cellulose breakdown, releasing carbon and essential minerals back into the soil. These results confirm that *S. coccinea* contributes both structurally and functionally to the detrital network of montane forests, supporting objectives 1 and 2.

Morphological plasticity appeared minimal across different microhabitats, suggesting the species' adaptation to stable mesic conditions. These findings provide a basis for accurate taxonomic confirmation and highlight phenotypic consistency in natural populations. Furthermore, fruiting bodies' conspicuous coloration may enhance spore dispersal via invertebrate vectors, linking fungal presence to broader forest ecosystem dynamics. The documentation of *S. coccinea* in Goygol National Park provides baseline data essential for fungal biodiversity monitoring and conservation planning (Objective 3). Its occurrence indicates intact saproxylic habitats, which are often sensitive to anthropogenic disturbance. Preservation of shaded, moist microhabitats (Sandhyavitri et al., 2023; Wang, 2014) with decaying hardwood is crucial for sustaining this and other saprotrophic species. By linking species distribution to microclimatic and substrate parameters, this study establishes a framework for ongoing ecological monitoring in Azerbaijan's protected areas.

CONCLUSION

The results demonstrate that *S. coccinea* is highly selective regarding its habitat, favoring shaded, moisture-

retentive microsites with abundant decaying hardwood. These findings align with global studies of Red Cup Fungi, where mesic forest floors and stable microclimatic conditions are critical for. The species' ecological function as a decomposer underscores its importance in maintaining nutrient cycling and forest soil fertility. Additionally, documenting its presence in Azerbaijan fills a crucial gap in the country's mycological records, providing a foundation for future conservation efforts.

In conclusion, *S. coccinea* in Goygol National Park demonstrates distinct ecological preferences, significant saprotrophic activity, and serves as a bioindicator of undisturbed forest ecosystems. Conservation strategies should prioritize the protection of shaded, decaying-wood microhabitats to maintain fungal biodiversity and sustain ecosystem functions.

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