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Three new records for the Mycota of Türkiye: *Deconica micropora, Hebeloma incarnatulum,* and *Tephrocybe platypus*

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Türkiye Mikota'sı için üç yeni kayıt: *Deconica micropora, Hebeloma incarnatulum* ve *Tephrocybe platypus*

Abstract: The aim of this research is to contribute to the Mycota of Türkiye. In this context, a literature review was conducted to gather information about the structure of fungi, their habitats, collection and identification methods, as well as the mushroom species that have been found to date both throughout Türkiye and within the borders of Trabzon province. While theoretical research was ongoing, field studies were also organized. Mushroom collection activities were carried out during rainy seasons in forested and grassland areas within Trabzon province. The detected mushrooms were first assigned a collection number and photographed. The coordinates of the collection site, surrounding trees, and the main morphological features of the specimens were recorded in a field notebook. A few representative specimens reflecting all characteristics of the species were placed in paper bags and brought to the laboratory. After obtaining spore prints, the samples were dried in an electric dryer, kept in a deep freezer at -40°C for one week, and finally labeled to become fungarium material. Sections from the stipe, cap, and gills were taken and examined under a research microscope. The obtained data were compared with relevant literature to identify the fungi. As a result of comparing the findings with the List of Fungi of Turkey (Mycota of Türkiye), it was determined that three of the species were new records for the country. Specimens of these three species were subjected to more detailed macroscopic and microscopic studies at the Mycology Laboratory of Trabzon University, their cellular structures were photographed, and detailed descriptions were made. Dried samples from the study are preserved as evidence. For future researchers, it is recommended to investigate whether these new records are also distributed in other regions, to determine their biochemical structures, and to assess their potential for economic use.

Key words: Biodiversity, mycota, Trabzon, new records

Özet: Bu araştırmanın amacı Türkiye Mikotası'na katkı sağlayabilmektir. Bu kapsamda literatür taraması yapılarak mantarların yapısı, yetişme alanları, toplama ve teşhis etme yöntemleriyle günümüze dek Türkiye'de ve Trabzon il sınırları içerisinde yetişen mantar türleri hakkında bilgi edinilmiştir. Teorik araştırmalar devam ederken bir taraftan da arazi çalışmaları organize edilmiştir. Mantar toplama çalışmaları yağışlı mevsimlerle birlikte Trabzon il sınırları içerisinde, ormanlık ve çayırlık alanlarda gerçekleştirilmiştir. Saptanan mantarlara öncelikli olarak koleksiyon numarası verilmiş ve fotoğrafları çekilmiştir. Mantarların toplandığı koordinatlar, çevresindeki ağaçlar ve ana morfolojik özellikleri arazi defterine not edilmiştir. Türün tüm özelliklerini yansıtan birkaç örnek alınarak, kese kâğıtlarına konulmuş ve laboratuvara getirilmiştir. Spor izleri elde edildikten sonra örnekler elektrikli kurutucuda kurutulmuş, derin dondurucuda -40 ^{0}C da bir hafta tutulmuş ve nihayet etiketlenerek fungaryum materyali haline getirilmiştir. Sap, şapka ve lamellerinden kesitler alınmış ve araştırma mikroskobu altında inceleme yapılmıştır. Elde edilen veriler ilgili literatürle karşılaştırılarak mantarların teşhisi yapılmıştır. Bulguların Türkiye Mantarları Listesi (Türkiye Mikotası) ile karşılaştırılması sonucu 3 tanesinin Türkiye için yeni kayıt olduğu saptanmıştır. Bu 3 türe ait numuneler Trabzon Üniversitesi Mikoloji Laboratuvarında daha ayrıntılı makroskobik ve mikroskobik çalışmalara tabi tutulmuş, hücresel yapılarının fotoğrafları çekilmiş ve ayrıntılı betimlemeleri yapılmıştır. Çalışmaya ait kurutulmuş örnekler kanıt olarak saklanmaktadır. Bu konuda araştırma yapacaklara yeni kayıtların başka yörelerde de yayılış gösterip göstermediğinin ortaya çıkarılması, biyokimyasal yapılarının belirlenmesi ve ekonomik amaçlı kullanılabilme potansiyellerinin saptanması çalışmaları önerilebilir.

Anahtar Kelimeler: Biyoçeşitlilik, mikota, Trabzon, yeni kayıtlar

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1. Introduction

Biodiversity is one of the most significant assets of a country. Societies that can accurately identify and utilize their biodiversity can achieve substantial economic and scientific gains. The kingdom of fungi, along with other major living groups (bacteria, protists, plants, and animals), is among the key players in life on Earth. The structure commonly known as a fungus is, in fact, the fruiting body that emerges above ground or on decaying wood, while the actual body of the organism, resembling cotton threads, lies hidden in the soil or substrate. The identification of wild mushrooms in Türkiye, including their names, toxicity, and whether they have been previously collected, is critical for their economic utilization. Despite some public familiarity with certain mushrooms, cases of mushroom poisoning are still reported in the media annually.Without fungi, the decomposition of organic waste and dead matter would slow down, ecosystems would cease to function, and plants would struggle to grow as effectively. Historically, fungi have been used for various purposes, such as stopping bleeding, treating diseases, alleviating pain, enhancing the

flavor of food, and serving as direct sources of nourishment. Today, fungi are used for nutritional purposes, cancer research, immune system enhancement, cholesterol reduction, and as antiviral, antibacterial, and antifungal agents, as well as for liver protection and antidiabetic treatments (Audesirk et al., 2018; Sesli et al., 2020). In the 18th century, during the rise of modern scientific studies in Europe, numerous fungal species were described. Some of these studies included collections from Anatolia by European travelers. Notable foreign researchers include L. Rigler, who published 17 species in 1852; P. Tchihatcheff, who documented 33 species in 1860; and K. Fritsch, who described 4 species in 1899. Further contributions came from K. von Keissler (1930), M. Maire (56 species in 1904), and H.F. Handel-Mazzetti, who recorded 44 species from Bursa, Istanbul, Ordu, Samsun, and Trabzon in 1909. A. Pilát collected 170 species in the Ilgaz Mountains between 1932 and 1937. K. Lohwag conducted research in Istanbul and Ankara between 1957 and 1965. F. Kotlaba worked in the Amanos Mountains in 1976, while N. Öder conducted studies in Bolu, the Aegean, the Black Sea region, and Konya from 1972 to 1988. M. Öner also contributed through various studies in 1972. M. Selik focused on wood-decaying and parasitic fungi between 1962 and 1982, and R. Watling and N.M. Gregory identified 91 species of gilled fungi in 1977. These studies employed traditional methods, documenting the characteristics of fungal habitats, taking photographs, and comparing morphological features such as stem and cap with the literature. Color, size, and microscopic features like basidium, basidiospores, and cheilocystidia were crucial for identification. Thin sections from caps, stems, and gills were examined to reveal cellular structures. With the advent of high-quality microscopes and modern imaging methods in later years, knowledge about the fungi of Türkiye grew exponentially. By the end of 2020, studies were compiled and published in the book List of Fungi of Türkiye, supported by the Ali Nihat Gökyiğit Foundation. This publication introduced Turkish names alongside the Latin names of the fungi for the first time (Sesli and Denchev, 2014; Sesli et al., 2020). Despite all these efforts, the fungal biodiversity of Türkiye remains incompletely explored, necessitating further research. Recent studies, including those by Vizzini et al. (2015, 2016), Uzun et al. (2019), Acar et al. (2022), Akata et al. (2022), Berber et al. (2022), Demirak et al. (2022), Dizkırıcı et al. (2022), Kaşık et al. (2022), Kaygusuz (2022), Kaygusuz et al. (2022), Keleş et al. (2022), Uzun (2022, 2023), Acar and Dizkırıcı (2023), and Kaplan et al. (2023), Acar and Uzun (2024), Dalkıran et al. (2024) have identified new species and new records for both Türkiye and the world. The results and discussion sections of publications on this topic reveal that Türkiye's fungal diversity has yet to be fully uncovered, and there is a pressing need for new studies. Despite being one of the richest countries in biodiversity due to its geological structure and climate, the number of recorded fungi in Türkiye remains lower than anticipated. One major reason is the difficulty of collecting fungi. Unlike plants, fungi are not always visible in the field and decay quickly if not dried shortly after collection. The limited number of researchers in this field also restricts the number of studies conducted. Furthermore, the vast fungal biodiversity of Türkiye presents a challenge for completing these studies. The aim of this study is to identify fungi that have not yet been recorded in Türkiye, with the specific goal of discovering one or more new records.

2. Materials and Method

Relevant sources were reviewed and discussed, leading to the conclusion that conducting research on Türkiye's fungal diversity could yield intriguing findings. Consultations were held with experts at Trabzon University to gather information about fungi and exchange ideas on the research methodology. These experts provided insights into their ongoing projects, potential contributions, and recommended resources. Sources relevant to the topic were reviewed and discussed. The university was visited to discuss the research plan, examine various samples under a microscope, and measure the spores, cystidia, basidia, and hyphal structures. Field trips were conducted in 2023 across forests, shrubs, grasslands, and highlands within the borders of Trabzon Province, immediately following rainy weather, in line with the research schedule. Fifty-two fungal specimens believed to belong to different groups were collected during fieldwork. Photographs of basidiocarps were taken in the field, and key morphological features were noted. The nearest trees to each specimen were recorded, and a collection number was assigned to each sample. The surface characteristics (e.g., wet, sticky, or dry) and any color changes upon bruising were documented. Observations of cap surface texture (e.g., smooth, hairy, or scaly), stem color and shape, whether the stem was hollow, and its dimensions were recorded. Notes were taken on whether the stem base was bulbous, whether mycelium was present at the base, and the attachment, color, and density of the gills. A small garden trowel was used to collect a few basidiocarps, which were placed in paper bags and promptly transported to the laboratory. In the laboratory, the stem of one specimen was cut off, the cap was placed on paper, and spore prints were obtained after a few hours. Other specimens were dried in a fruit dryer, placed in plastic bags, and stored in a fungarium cabinet. Thin sections from the cap, stem, and gills were taken using a sharp razor under a binocular microscope. The sections were soaked in a 5% ammonia solution for a few minutes and examined under a research microscope. Microscopic structures of hyphae were analyzed from sections taken from the cap surface. The types of cystidia and hook formations were observed in the sections. The shapes of basidia were determined, and their dimensions were measured. Microscopic images of the structures were captured using an imaging system attached to the research microscope. Observations from the field, along with macroscopic and microscopic data for each sample, were compared with relevant literature. As a result of the identification of the samples using the works of Pacioni and Lincoff (1981), Phillips (1981), Arora (1986), Singer (1986), Breitenbach and Kränzlin (1984, 1986, 1991, 1995, 2000), Kränzlin (2005), McKenny (1987), Bas et al. (1999), Knudsen and Vesterholt (2008), Clémençon (2009), Sterry and Hughes (2009), Antonín et al. (2020), and Asan et al. (2022), *Deconica micropora* (Noordel. & Verduin) Noordel., *Hebeloma incarnatulum* A.H. Sm. and *Tephrocybe platypus* (Kühner) M.M. Moser were found to be absent in the existing List of Fungi of Türkiye. The identified species were also cross-referenced with the works of Allı et al. (2008), Uzun et al. (2017), Allı and Doğan (2019), Sesli et al. (2020), Çağli and Öztürk (2020), Kaya and Uzun (2020), Acar et al. (2022), Akata et al.

(2022a,b), Berber et al. (2022), Demirak et al. (2022), Dizkırıcı et al. (2022), Kaşık et al. (2022), Kaygusuz (2022), Kaygusuz et al. (2022), Uzun (2022, 2023), Uzun and Kaya (2022), Acar and Dizkırıcı (2023), and Kaplan et al. (2023) and clarified through discussions with relevant experts. Scientific names were assigned based on Kirk et al. (2008).

3. Results

As a result of this study, 3 species were determined for the first time as new records for Türkiye. Turkish names, primarily proposed to the Nezahat Gökyiğit Botanical Garden (Istanbul) and approved along with their scientific names, are as follows: Güdük gübreçanı = *Deconica micropora* (Noordel. & Verduin) Noordel., Çit turpkokan = *Hebeloma incarnatulum* A.H. Sm., Kız alacası = *Tephrocybe platypus* (Kühner) M.M. Moser. Detailed studies were conducted on the determined species, and the descriptions were provided.

3.1. *Deconica micropora* (Noordel. & Verduin) Noordel (Fig. 1):

The cap is 10–20 mm, hemispherical or convex, reddish-brown, and features a flat umbo. Its color changes as it dries. The edges are pleated or relatively straight, with membranous remnants and translucent striations. The gills are attached to the stipe without narrowing, sometimes descending onto it, sparse, and reddish-brown. The flesh has a slightly sweet taste and is odorless. The stipe measures 10–26 × 0.5–3 mm, is small, nearly cylindrical, wider at the base, yellowish or reddish-brown, and appears yellowish-red and powdery. Cheilocystidia are 14–26 × 4–7 µm and bottle-shaped. Basidia are 13–26 × 5–10 µm, clavate, 4-spored, and have clamps. Basidiospores are 5–8 × 4–5 µm, rounded, slightly angular, or almond-shaped.The cap skin is composed of smooth, parallel, cylindrical, clamped hyphae measuring 2–5 µm in thickness at the surface and elements measuring 45–110 × 5–21 µm in deeper layers.

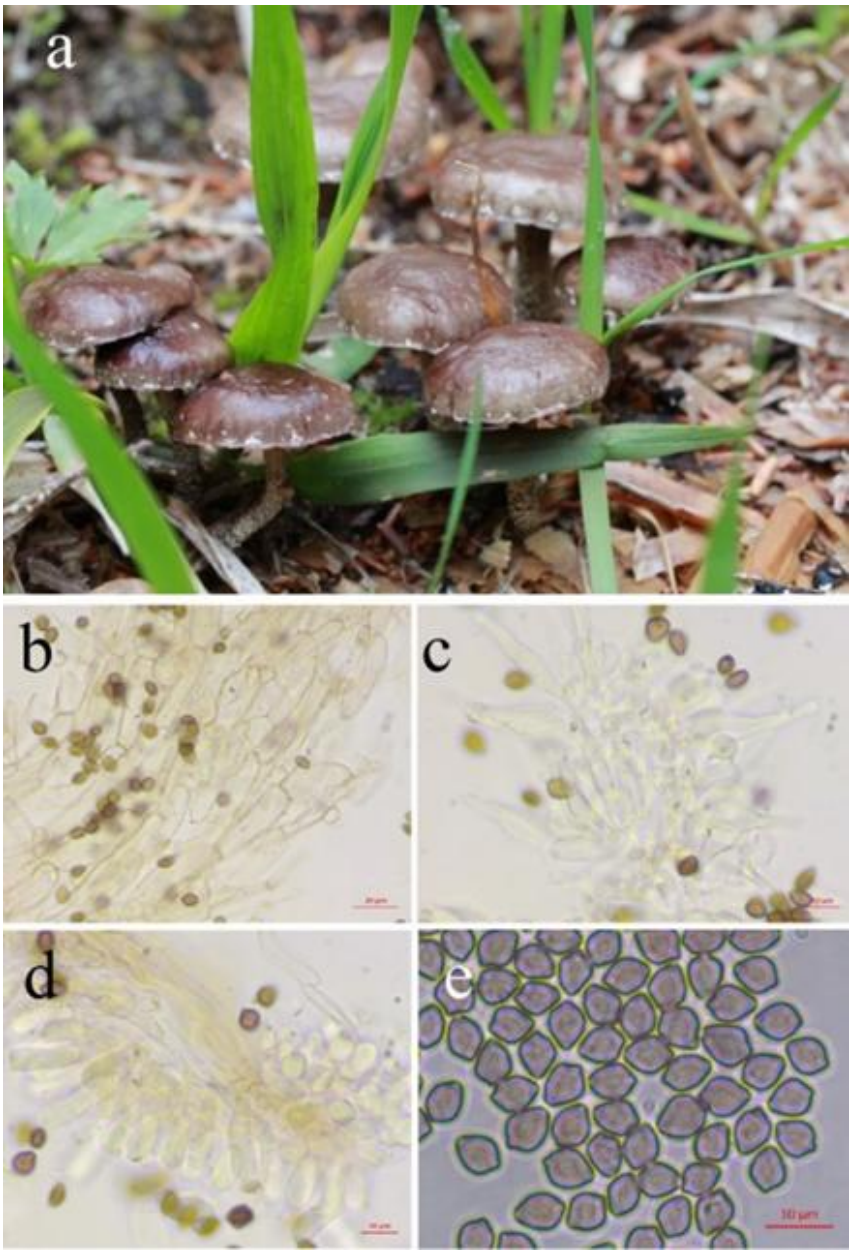

Figure 1. *Deconica micropora:* a. basidiocarps, b. cross-section of the cap cuticle, c. cheilocystidia, d. basidia, e. basidiospores.

3.2. *Hebeloma incarnatulum* A.H. Sm. (Fig. 2)

The cap measures 30–72 mm, is irregularly hemispherical, convex, or flat. It has a protruding umbo, is hygroscopic, sticky, pinkish or light brown when wet, and whitish when dry. The margins are wavy and sometimes uplifted. The gills are adnexed or broadly attached to the stem, closely spaced, pinkish, and pale brown. The flesh is firm, rubbery, whitish, radish-scented, and has a slightly sweet or bitter taste. The stem measures 45–120 × 5–10 mm, is cylindrical or club-shaped, whitish, becomes brownish toward the base when mature, slightly bulbous at the base, and covered with whitish scales. Cheilocystidia measure 25–133 × 2–11 µm, are cylindrical, club-shaped, or occasionally bottle-like. Basidia measure 22–36 × 6–10 µm, are somewhat cylindrical or club-shaped, and usually four-spored. Basidiospores measure 7–11 × 5–7 µm, are almond-shaped, yellowish-brown, and ornamented. The outer layer of the cap skin is 6–8 µm thick and composed of gelatinous hyphae, while the inner layer consists of short, elliptical cells 20–26 µm thick. It is found in coniferous forests, particularly among mosses in spruce forests, from summer to late autumn. It is inedible. Location: Trabzon, Maçka, Hocamezarı, under spruce trees. 09.09.2023. 40°40'46.66" N and 39°35'11.20" E, 1470 m. K: 14.) It grows in clusters on sandy soils, among plant debris, or mosses from summer to late autumn. It is inedible. Collected in Trabzon, Düzköy, Hırsafa Plateau. Found on sawdust at coordinates 40°53'37.03" N and 39°23'07.59" E, at an elevation of 1585 m, on 18 June 2023. Specimen number: K: 36.

3.3.*Tephrocybe platypus* (Kühner) M.M. Moser (Fig. 3)

The cap is hemispherical, convex or flattened, lighter in color during drying, and has a depressed center. It is a small mushroom, with the cap measuring approximately 10–28 mm. The surface is grayish-brown, cream, or beige, either smooth or slightly fibrous. The center is darker, the edges are translucent, wavy, sometimes lobed, and whitish. The gills are attached to the stalk, with a width corresponding to the stalk or slightly drooping, sparse or moderately

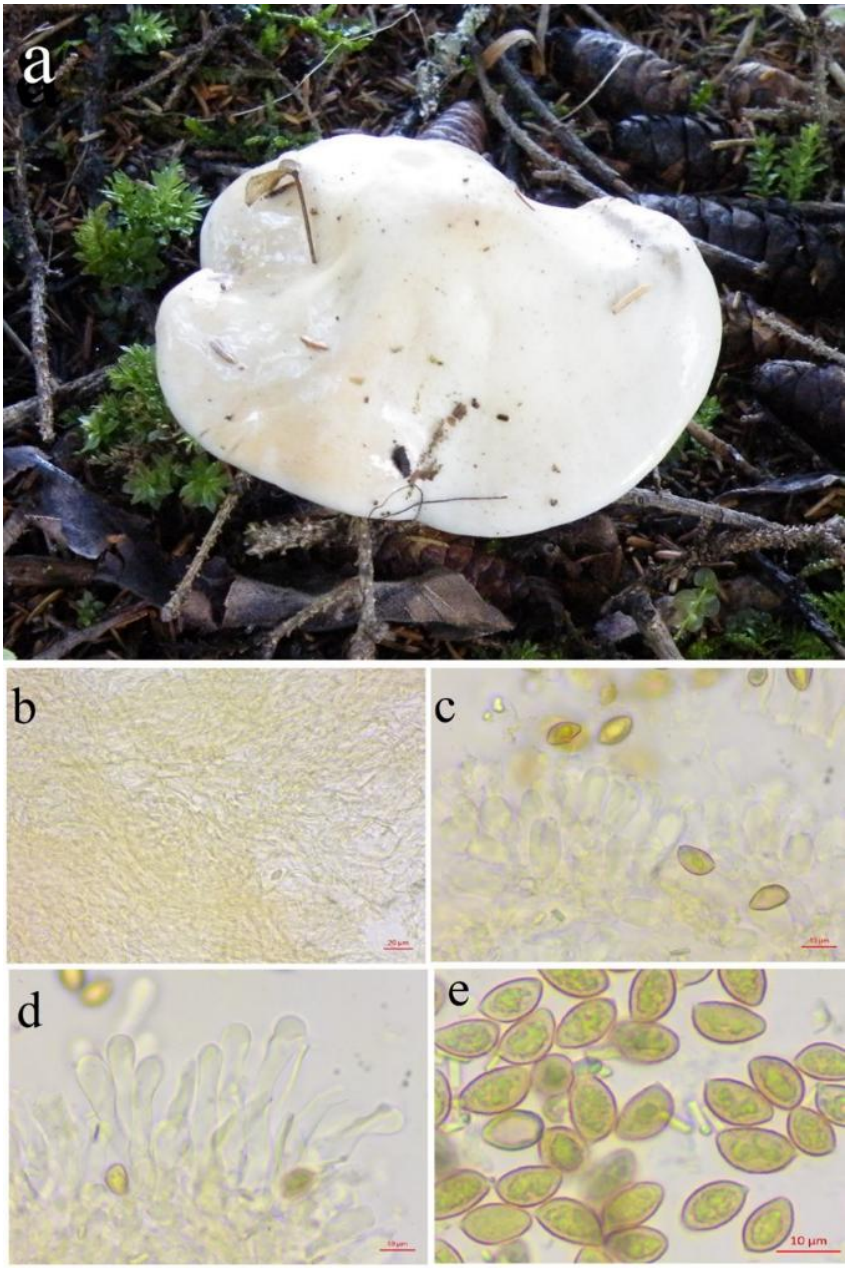

Figure 2. *Hebeloma incarnatulum*: a. basidiocarp, b. cross-section of the cap surface, c. basidia, d. cheilocystidia, e. basidiospores.

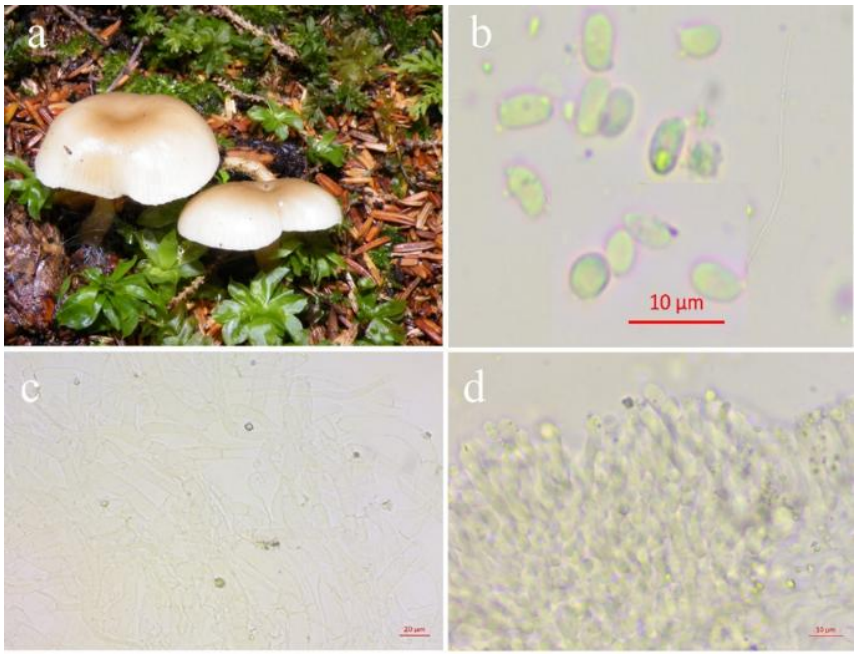

Figure 3. *Tephrocybe platypus*: a. basidiocarps, b. basidiospores, c. cap skin section, d. basidia.

frequent. The edges are smooth, whitish or grayish-beige. The flesh is thin, with a starch-like odor, slightly sweet, and grayish. The stalk is 10–42 × 3–6 mm, cylindrical, solid or hollow, tapering towards the base, generally flattened, and overall flexible. The surface is smooth, whitish or dirty white, grayish pale brown, and the upper part is dusted with whitish powder. Basidia are 20–32 × 4–6 µm, cylindrical or club-shaped, 2–4 spored, and hooked. Basidiospores are 4–7 × 3–5 µm, ellipsoid, translucent, smooth, and droplet-shaped. The cap tissue is composed of parallel and cross-arranged, 2–3 µm thick, hooked and cylindrical hyphae. It grows in areas with deciduous trees in almost any season, in mixed and humid forests, riverbeds, among mosses, grasses, and debris, spreading singly or in clusters. It is inedible. Found among mosses. Trabzon, Düzköy, Haçkalı Baba Plateau. 07.09.2023. 40°47'57.94" N and 39°26'10.15" E, 1870 m. K: 23.

4. Discussions

In this study, three macrofungi species, *Deconica micropora*, *Hebeloma incarnatulum*, *Tephrocybe platypus*, which are identified as new records for the Mycobiota of Türkiye within the scope of a high school student project were presented, achieving the proposed goal of the project. According to Tırpan et al. (2019) and Çağli and Öztürk (2020), the genus *Deconica* was represented by two species in Türkiye prior to this study. With the species *D. micropora* identified in this study, the number of species in this genus has increased to three. According to Sesli et al. (2020), Çağli and Öztürk (2020), Kaya and Uzun (2020), Acar et al. (2022), Akata et al. (2022), Berber et al. (2022), Demirak et al. (2022), Dizkırıcı et al. (2022), Kaşık et al. (2022), Kaygusuz (2022), Uzun (2022, 2023), Acar and Dizkırıcı (2023), and Kaplan et al. (2023), the genus *Hebeloma* was represented by 39 species in Türkiye before this study, and with the newly identified species *H. incarnatulum*, the number of species in the Turkish Mycota has increased to 40.

According to Huseyinov et al. (2001), Yağız et al. (2006), Sesli (2017, 2023), and Sesli et al. (2020), the genus *Tephrocybe* was represented by four species in Türkiye before this study, and with the species *T. platypus* identified in this study, the number has increased to five. Below are our recommendations for future research on similar topics: It can be investigated whether these newly recorded species from the Trabzon region are also found in other regions of Türkiye. The abundance levels of these species can be determined. The global distribution of these new records can be explored through literature research. The biochemical structures of these fungi can be elucidated from the dried samples we have or from newly collected materials. The enzyme and heavy metal contents can be determined. The economic potential of these fungi can be explored for possible uses.

Conflict of Interest

This study was produced from the project submitted to the high school student competition organized by TUBITAK in 2024. The researcher, who was the second person in the project, did not want to participate in the preparation process of this article and did not want to be an author in the article.

Authors' Contributions

The authors contributed equally.

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