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First occurrence of *Trametes elegans* from Punjab and an Overview of genus *Trametes* from Pakistan

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ABSTRACT

Trametes elegans reported as a first locality record from Punjab province, Pakistan during this study. Based on morphological and anatomical characteristics, this species was identified as *T. elegans*. The distinguishing characters of this species were tomentose, irregularly to kidney shaped pileus that had concentric zones, partly poroid hymenial surface with semi-daedaloid pores, trimitic hyphal system, white spore print and basidiospores of 5.13–7.12 × 2.5–2.85 µm size. In this paper, the morphological and anatomical features of *Trametes elegans* has been described with the help of macrographs and micrographs and illustrations. Distribution map of *Trametes* species reported from different districts of Pakistan has been given. Morphological and anatomical features, host ranges and localities of all the reported *Trametes* species from Pakistan are also given in tables.

Keywords: Distribution, *Polyporaceae, Macrofungi*, Shalimar Garden Lahore, Trametes elegans, Wood rotting.

INTRODUCTION

Genus *Trametes* (Polyporaceae, Basidiomycota) is a group of wood-decaying fungi that has tetrapolar mating system. This genus is cosmopolitan and found in all type of forest ecosystems of tropical, boreal and temperate areas (Wahab et al., 2021; Zhang et al., 2024). Members of this genus are found in all major climatic zones and in all continents (Olou et al., 2020). The most common and widespread species of this genus is *Trametes versicolor* (turkey tails), found growing on angiosperms (*Quercus* Linn*, Populus* Linnaeus*, Malus* Mill*., Eucalyptus L 'Hér. Betula* L., and *Acer* Linn*.)*, and on conifers like *Abies* Mill., *Cupressus* L*., Larix* Mill. and *Pinus* L. (Bernicchia, 2005; Wahab et al., 2021).

Due to the morphological similarities, species of *Trametes* are difficult to identify (Wahab et al., 2021). The most distinguishing features of *Trametes* species are pileate basidioma, dimitic to trimitic hyphal system, a poroid hymenophore, hymenium usually without true hymenial cystidia, hyaline,

usually cylindrical, non-amyloid, non-dextrinoid, smooth and thin-walled basidiospores that do not react in Melzer's reagent and cause white-rot to the woods (Olou et al., 2020; Wahab et al., 2021).

The genus *Trametes* was first officially described by Fries in 1835 on the basis of *Trametes suaveolens* (L.) Fr. as a type species, but this group has inferred in diverse ways that resulted in diverse numbers of species ascribed to the genus (Olou et al., 2020). The concept of *Trametes* was re-delimited by recent phylogenetic analyses (Justo and Hibbett, 2011; Olou et al., 2020).

According to Ryvarden (1991), on the basis of hyphal types, there are 11 groups in the family Polyporaceae and there are 16 genera of fungi with trimitic hyphal systems with white rotting habit in *Trametes* gruop such as *Trametes*, *Trichaptum, Pycnoporus, Mollicarpus, Microporus, Megasporoporia, Lenzites, Hexagonia, Fomitella, Elmerina, Earliella, Datronia, Daedaleopsis, Cryptoporus, Coriolopsis* and *Cerrena* (Wahab et al., 2021).

In Pakistan, 13 *Trametes* species have been reported so far. These are: *T. cingulata* Berk, *T. corrugata* (Pers. Ex Fr.) Bres., *T. elegans* (Spreng.) Fr., *T. flavida* (Lev.) Zmitr., Wasser & Ezhov., *T. hispida* Bagl., *T. hirsuta* (Wulfen) Lloyd, *T. incana* Berk., *T. incerta* (Curr.) Cooke., *T. lactinea* (Berk.) Sacc., *T. roseola* Pat. and Har., *T. suaveolens* (L.) Fr., *T. Trogii* Berk. and *T. versicolor* (L.) Lloyd growing on wooden stumps and logs of angiosperms and gymnosperm trees.

This group causes the white rot to the decaying woody substrates (Olou et al., 2020). Lignicolous fungal species like *T. versicolor*, (the Turkey tail) and *T. gibbosa*, (the Lumpy bracket) cause white-rot and are found growing on trees like oak, plums, fir or pine trees (Janjusevic et al., 2017; Puia et al., 2018). In many cultures, this genus has medicinal and ethno-mycological importance (Cui et al., 2011; Veena and Pandey, 2012; Ueitele et al., 2017; Olou et al., 2020) and a few species have also been used in cancer research (Zmitrovich et al., 2012; Cruz et al., 2016; Blagodatski et al., 2018., Olou et al., 2020). In China, despite of the fact that this group has inedible species but because of several biological activities, it has been used as folk medicine (Kamiyama et al., 2013; Janjusevic et al., 2017; Puia et al., 2018).

According to Puia et al. (2018), biological activities of *Trametes* like anti-inflammatory, antioxidant (Kamiyama et al., 2013), anticancer (Standish et al., 2008; Cruz et al., 2016), immune-enhancing (Li et al., 2011) anti-diabetic (Shokrzadeh et al., 2017), antimicrobial (Ozgor et al., 2016), prebiotic (Cruz et al., 2016; Zhuo-Teng et al., 2013), antiviral (Teplyakova et al., 2012; Kamiyama et al., 2013; Cruz et al., 2016), AChE inhibitory activities (Janjusevic et al., 2017) have been reported.

Regardless of the importance of wood decomposition, and medicinal properties, still limited taxonomic and phylogenetic information available about *Trametes* species (Carlson et al., 2014; Olou et al., 2020; Torres-Farradá et al., 2024). This study aims to expand the existing knowledge of *Trametes elegans* in Pakistan, refine current taxonomic records, and document this species as newly recorded from Lahore, which is reported for the first time in Pakistan through this research.

MATERIALS AND METHODS

One species of *Trametes*, was collected during rainy seasons of 2021. The site for this collection was Shalimar Garden, district Lahore, Punjab, Pakistan, due to its humid environment, diverse hardwood trees, and minimal disturbance—ideal for wood-decay fungi. Sample was taken from fresh, mature basidiocarps on hardwood stumps to ensure accurate identification and quality material. At the sampling site, the specimen was collected after photography and tagged with specific codes. Some morphological description in addition to the details of location, date and host tree was as prepared on-site. After drying, samples were placed in a zip locked bags along with the tags.

Macroscopic Analysis:

Macroscopic characteristics of fruiting body such as length, width, shape, color, texture, surface, margins

of stipe and pileus, hymenial surface of basidiocarp, taste and odor were analyzed.

Slide preparation and Micrometry:

Slides of the specimen were prepared for microscopic analysis. For this purpose, small pieces of the dried specimen were soaked separately for 5 minutes in alcohol and then were placed onto the glass slide. Two drops of 5% KOH was used as mounting media. Congo red was also used as a stain. The fine section of mushrooms was finely teased and covered with cover slip and observed under light microscope.

For microscopic analysis, the length and width, shape, and quotient value and range of basidiospores, basidiole and width range of skeletal hyphae were taken into account. The illustrations were made by observing hymenial section. Identification of the species was done on the basis of morphological and anatomical features.

RESULTS

Trametes elegans (Spreng.) Fr., Epicr. syst. mycol. (Upsaliae): 492 (1838) [1836-1838]

Macroscopic Characterization:

Basidiocarp; 7.2–7.4 cm × 11.8–14.4 cm, annual to perennial, solitary and attached laterally or centrally, semicircular, flexible and corky when fresh and solid rigid when dry, thick. **Pileus;** very finely tomentose, irregularly kidney-shaped or bracket shaped, aplanate, convex, flattened, uneven near the point of attachment, upper surface smooth, concentric zones present, white to grey, glabrous, white when young turns dark at maturity, slightly thick and bright white margins. **Stipe;** absent. **Hymenial surface ribs;** present, very variable, partly poroid, white to pale cream in color. **Pores**; round to angular, semi-daedaloid, 2 mm deep, 1-3 per mm and 1 mm wide. **Context;** white to pale cream, thick near the base, 0.1-0.5 cm.

Tube layer; 0.2-1.0 cm thick, woody hard when dried. White spore print. **Rhizomorphs;** absent. **Habitat;** on fallen logs or stumps. **Habit;** solitary or gregarious. **Microscopic Characterization:**

Basidiospores; 5.13–7.12 × 2.5–2.85 µm in size, Q = 1.8-2.3, avgQ = 2.02, symmetrical, smooth, thin-walled, round, smooth, hyaline to light green, single layered, germ pore absent.

Figure 1: Morphology of *Trametes elegans* **(**FA-15)**. A-B.** Basidiomata. **C.** Hymenium. **D.** Closer view of hymenium showing ribs. **Scale bars for A&D=** 2.0 cm. **B=** 1.6 cm. **C=** 4.4 cm.

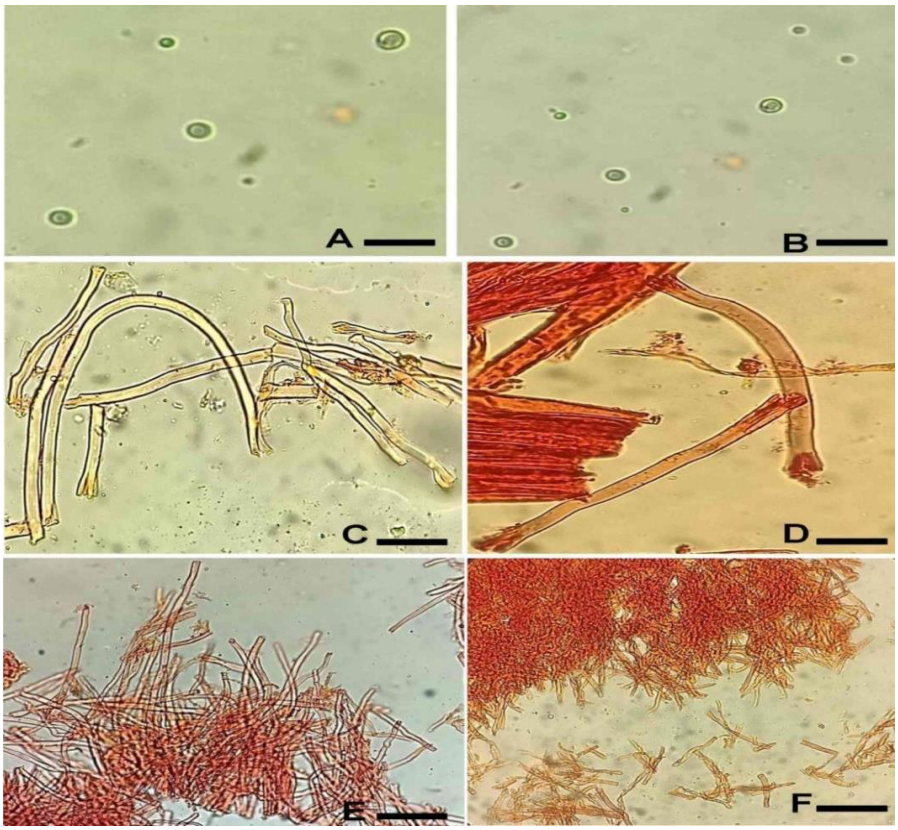

Figure 2: Light micrographs of microscopic features of *Trametes elegans* **(**FA-15)**. A-B.** Basidiospores. **C-D.** Pileus hyphae. **E-F.** Hymenium hyphae. **Scale bars for A=** 20.5 µm. **B=** 30.5 µm. **C&D=** 0.2 µm. **E=** 0.3 µm. **F=** 1 µm.

Table 1: Macroscopic Characterization of different species of genus *Trametes* reported from Pakistan

Sr. no.	Taxa	Macroscopic Characterization								Source
		Pileus								
		Width (cm)	Shape	Color	Texture	Concentric Zones	Margins	Diameter (cm)	Length (mm)	
1	***T. cingulata***	1.5-8	fan shaped or semi-circular with a flat to slightly convex upper surface	red brown	hard corky and rigid on drying	concentrically zonate	acute, undulating or lobed	0.1-1.3(-2)	1-3	(Fidalgo and Fidalgo, 1966)
2	***T. corrugata***	2- 10	wavy or corrugated	whitish to light greyish	hard corky and rigid on drying	concentrically zonate	acute, undulate or lobed	0.1-1.3(-2)	1-2.9	(Fidalgo and Fidalgo, 1966)
3	***T. elegans***	7.2-7.4	irregularly kidney shaped or bracket shaped	white to grey	flexible and corky when fresh and solid rigid when dry	concentrically zonate	irregular or wavy	0.1 - 0.5	0.2-1	current study
4	***T. flavida***	3	semicircular to flabelliform	white, creamy, pale ochraceous to clayey	coriaceous when fresh, flexible when dry	concentrically zonate	sharp, entire	0.7	8- 10	(Ranadive, 2014)
5	***T. gibbosa***	8–15	semicircular	white at first, then cream to ochraceous or discolored, pale brown sometimes	tough and coriaceous	azonate	sharp	3	1-5	(Wahab et al., 2021)

6	***T. hirsuta***	1.5-6	fan- shaped or semicircular with a flat to slightly convex upper surface	Gray	coriaceous when fresh	concentrically zonate	tomentose	1-4	3	(Wahab et al., 2021)
7	***T. incana***	10	semicircular and dimidiate	pale cinnamon to ochraceous, when young with a pinkish tint, becoming darker with age	coriaceous to woody hard when dry	concentrically zonate	undulating or wavy	0.6	15	(Lindner et al., 2011)
8	***T. incerta***	5	semicircular to dimidiate	white to creamy, also bears shades of light brown or grey	hard and firm	concentrically zonate	acute, entire	0.1	5–10	(Gibertoni et al ., 2011)
9	***T. lactinea***	2–10	semicircular	white to creamy, turning ochraceous	hard corky	azonate	obtuse	0.5–2	1–10	(Vlasak and Kout, 2011; Kim et al., 2021)
10	***T. roseola***	8	elongated to semicircular	white-grayish to pale ochraceous buff, later darker buff or more pale dirty brown	soft corky when fresh, drying to tough and corky	concentrically zonate	Obtuse	0.1- 2	1-3	(Santra and Nandi, 1977)
11	***T. suaveolens***	1-10	semicircular in outline, pilei plane or slightly convex	whitish-creamy to grayish-browm	very tough flesh	concentrically zonate	obtuse or bolster-like to acute	0.7	10 - 15	(Zmitrovich, 2016)
12	***T. trogii***	1.5-2	semicircular or fan shape d	cream-buff to ochraceous-buff	tough-corky	concentrically zonate	Sharp	0.2-0.4	9-10	(Suliaman et al., 2017)
13	***T. versicolor***	3-7	fan-shaped	multicolored with yellowish, orangish, grayish, bluish, and blackish,	leathery	concentrically zonate	wavy or undulation	0.25- 0.4	0.05-0.1	(Gautamm, 2013; Razaq and Shahzad, 2016)

Table 2: Macroscopic Characterization of different species of genus *Trametes* reported from Pakistan

Sr. no.	Taxa	Microscopic Characterization								Source
		Basidiospores		Hyphal system	Generative Hyphae Diameter (µm)	Skeletal hyphae Diameter (µm)	Binding Hyphae Diameter (µm)	Basidia Size (µm)	Cystidia Size (µm)	
		Size (µm)	Shape							
1	***T. cingulata***	9-11 × 3-4	cylindric to elliptic	trimitic	1.5-4.5 (-5)	2.5-3.5	1-2	13.5-17.5 × 4-6	not seen	(Fidalgo and Fidalgo, 1966)
2	***T. corrugata***	9-11 × 3-4	cylindric to elliptic	trimitic	1.5-4.5 (-5	2.5-3.5	1-2	13.5-17.5 × 4-6	not seen	(Fidalgo and Fidalgo, 1966)
3	***T. elegans***	5.13–7.12 × 2.5–2.85	round	trimitic	1.0-3.2	3.2-6.0	1.5-3.5	8.0-7.5 × 11.0-14.0	not seen	current study
4	***T. flavida***	6-7 × 3.3.3	cylindrical	trimitic	1.5	9.7	3.3	not seen	absent	(Ranadive, 2014)
5	***T. gibbosa***	4- 5 × 2-2.5	cylindrical to oblong ellipsoid	trimitic	2-4	13-19 × 4-5	4-9	14-18 × 3-5	not seen	(Wahab et al., 2021)
6	***T. hirsuta***	6-9 × 2-2.5	cylindric	trimitic	2.5-2.9	3-3.9	2-4	15-22 × 5-7	Not seen	(Wahab et al., 2021)
7	***T. incana***	5.5-6 × 3-3.5	broadly ellipsoid	trimitic	2-3.5	2.5-6	2-5	not seen	not seen	(Lindner et al., 2011)
8	***T. incerta***	4.0–5.1(–	ellipsoid	trimitic	2-3	4-5	2–2.5	not seen	13–27 × 5–7	(Gibertoni et al .,

		5.5) × (2.0–)2.1–3.0(–3.1)								2011)
9	***T. lactinea***	5–7 × 2.5–3.2	oblong-ellipsoid to cylindrical	trimitic	1–3	4–6	1–5	12–16 × 5–7	not seen	(Vlasak and Kout, 2011; Kim et al., 2021)
10	***T. roseola***	8-10.5 × 3-4	cylindric	dimitic	1-4	2-4	_	12-20 × 4-6	not seen	(Santra and Nandi, 1977)
11	***T. suaveolens***	(8–12 × 4–4.5	allantoid (sausage-shaped)	dimitic	3–5.5	2.5–8.5	__	20–30 × 5–7.5	not seen	(Zmitrovich, 2016)
12	***T. trogii***	10-12 × 2-4	cylindric	trimitic	2-4	4-6	2-3.5	18-23 × 6-7.5	not seen	(Suliaman et al., 2017)
13	***T. versicolor***	1.5-3 × 5-6	cylindrical	trimitic	1.5 - 2.5	3.0 - 4.0	1.5 - 2.0	18–20 × 3–4.5	not seen	(Gautamm, 2013; Razaq and Shahzad, 2016)

Hyphal system; trimitic. **Generative hyphae;** hyaline, 1.0-3.2 µm thick, thin-walled with clamp connections. **Skeletal hyphae;** thick-walled to filled, hyaline, 3.2-6.0 µm thick, dominating, yellow to golden, unbranched. **Binding hyphae;** hyaline to pale-yellow, filled, 1.5-3.5 µm, sparsely branched. **Cap hyphae;** 1–2 µm, broad, branched, aseptate, thick, hyaline in KOH. **Hymenium hyphae**; 1 µm, highly interwoven, aseptate, branched, thin-walled, hyaline in KOH. **Basidia;** with 4 sterigmata, 8.0-7.5 × 11.0-14.0 µm, spherical. **Cystidia;** not observed.

Analyzed Sample:

PAKISTAN: Punjab province, Lahore district, Shalimar Garden, 217 m a. s. l., solitary, on tree, 10th October, 2021, Fizza Ahmed, FA-15.

Literature reviewed for species identification:

Description of the illustrated taxon (FA-15) was consistent with worldwide published descriptions of *Trametes elegans* provided by Justo and Hibbett (2011), Li and He (2011), Adeyelu et al. (2017) and Olou et al. (2020).

DISCUSSION

Genus *Trametes* of family Polyporaceae cause white-rot to the woods. The distinguishing characters of genus are poroid hymenophore, trimitic hyphal system and smooth, thin-walled basidiospores which give negative result in Melzer's reagent. A detailed comparison of reported species of genus *Trametes* from Pakistan has been provided in Table 1 & 2. Moreover, an overview of localities and host association of species of genus *Trametes* from Pakistan is listed in Table 3. A thorough map for the distribution of different species of genus *Trametes* recorded from different districts of Punjab, Pakistan is also given in Figure 4.

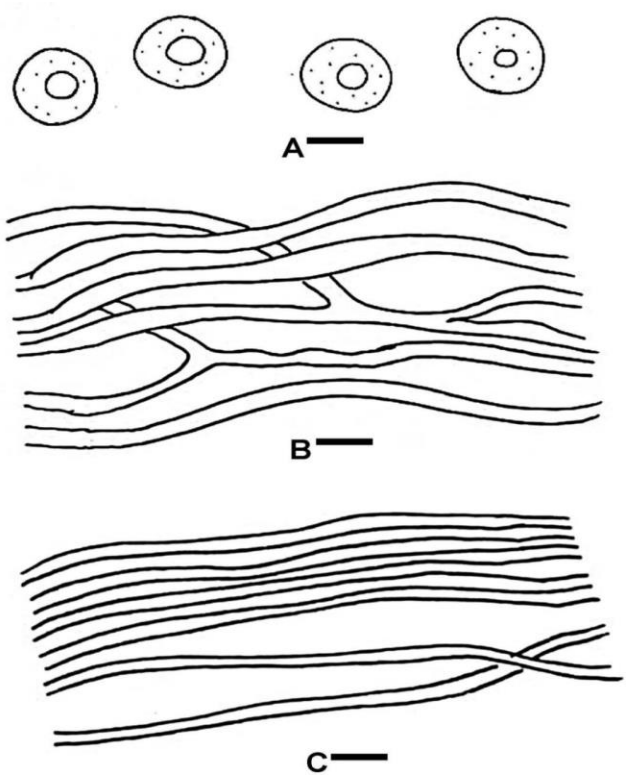

Figure 3: Illustrations of microscopic features of *Trametes elegans* **(**FA-15**). A.** Basidiospores. **B.** Pileus hyphae. **C.** Hymenium hyphae. **Scale bars for A=** 3.5 µm. **B=** 0.25 µm. **C=** 0.16 µm.

Habitat: T. elegans has the ability to grow not only in soil but also on the synthetic media in the temperature of about 25-35 °C (Sagar et al., 2020). Furthermore, they live in the hardwood forests and on leaf litter and rotting wood in tropical forests (Kanakasundar, 2023; Zhang et al., 2024).

T. elegans is present in the hardwood forest as an

endophytic fungus (Pinruan et al., 2010; Kanakasundar 2023). This species of *Trametes* is involved in the breakdown of the lignin non-specifically, extracellularly and non-hydrolytically. In the forest ecosystems this species is involved in recycling of carbon (Lara et al., 2003; Osano et al., 2004).

Skin damage caused by free radicals can be protected by antioxidant agents taken from the extract from *T. elegans* (Awala and Oyetayo, 2015) but the extracts of this species presented intermediate antioxidant activity as compared to other antioxidant rich macro-fungi i.e. *Auricularia polytricha, Auricularia auricularjudae* and *Ganoderma lucidum* (Singh and Tripathi, 2018; Irankhahi et al., 2024).

In this study, *Trametes* sp. has been collected from Shalamar Garden, Lahore. When thoroughly investigated based on macroscopic and microscopic characters, specimen was identified as *T. elegans* which is a first report of this taxon from district Lahore and Punjab province. However, it has already been reported from Malakand division of KP province (Wahab et al., 2021). This species is characterized by irregularly kidney-shaped very finely tomentose pileus with concentric zones, basidiospores 5.13–7.12 × 2.5–2.85 µm in size, round, and a trimitic hyphal system. *T. elegans* is closely related to *T. lactinea* but both these species are differentiated on the basis of sizes of spores and basidia. The spores are larger in *T. lactinea* (usually > 6 µm × 3 µm) and smaller in *T. elegans* (< 6 µm × 2.5 µm). Unlike to *T. lactinea,* the size of basidia in case of *T. elegans* is also smaller 8–13 × 4–6 µm.

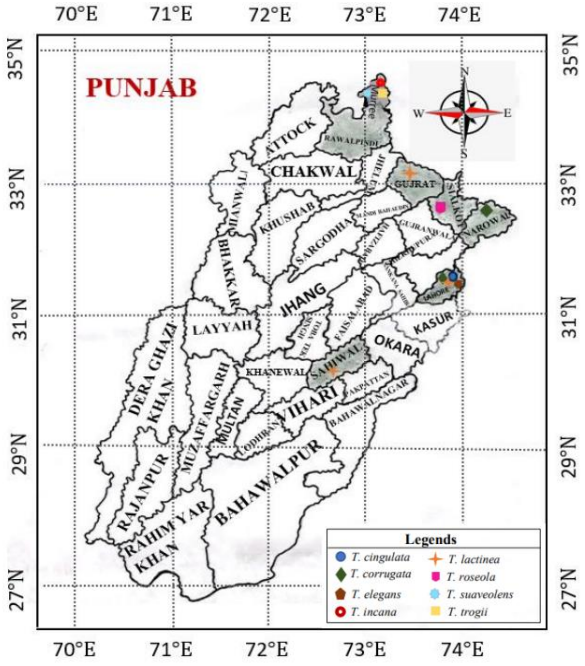

Figure 4: Distribution of different species of genus *Trametes* recorded from different districts of Punjab, Pakistan.

Table 3: Localities and Host Association Overview of genus *Trametes* from Pakistan

Sr. no.	Species Name	Authority	Locality	Host Plant	Source
1.	*T. cingulata*	Berk.	Changa Manga Reserve Forest, district Kasur	On logs of *Morus alba* and *Dalbergia sisso* Roxb.	(Ahmad et al., 1997)
2.	*T. corrugata*	(Pers.) Bres.	Changa Manga Reserve Forest, district Kasur & Zafarwal, district Narowal	On logs and stumps of *Dalbergia sisson* Roxb, and *Morus alba*	(Ahmad et al., 1997)
3.	*T. elegans*	(Spreng.) Fr.	Malakand division, Khyber Pakhtunkhawa. Lahore, Punjab,	On dead deciduous wood of all kinds	(Ahmad et al., 1997; Wahab et al., 2021)
4.	*T. flavida*	(Lev) Zmitr., Wasser &Ezhov	Desan forest, Swat	On decaying wood.	(Ahmad et al., 1997)
5.	*T. gibbosa*	(Pers.) Fr.	Malakand division, Khyber Pakhtunkhawa	On *Olea ferruginea* twigs	(Wahab et al., 2021)
6.	*T. hirsuta*	(Wulfen) Lloyd	Malakand division, Khyber Pakhtunkhawa	On trunks of *Broussonetia papyrifera*	(Wahab et al., 2021)
7.	*T. incana*	Berk.	Murree, district Rawalpindi	On trunks of dead trees	(Ahmad et al., 1997)
8.	*T. incerta*	(Curr.) Cooke	Azad Kashmir	On logs of *Quercus dilatata* and *Shorea robusta*	(Ahmad et al., 1997)
9.	*T. lactinea*	(Berk.) Sacc.	Changa Manga Reserve Forest, district Kasur; Chichawatni Reserved Forest, district Sahiwal & district Gujrat	on logs of *Dalbergia sissoo, Morus alba* and *Quercus incana*	(Ahmad et al., 1997)
10.	*T. roseola*	Pat. & Har.	District Sialkot	On logs of *Acacia arabica*	(Ahmad et al., 1997)
11.	*T. suaveolens*	(L.) Fr.	Ghora gali (Murree)	On dead wood	(Ahmad et al., 1997)
12.	*T. trogii*	Berk.	Murree, districts Rawalpindi & Malakand division, Khyber Pakhtunkhawa	On dead poplar	(Ahmad et al., 1997; Wahab et al., 2021)
13.	*T. versicolor*	(L.) Lloyd	Gilgit-Baltistan	On rotten wood	(Razaq et al., 2014)

The pileus surface in *T. elegans* is glabrous but in *T. lactinea*, it is never glabrous and quit variable. In case of *T. elegans*, the reaction with KOH is moderate that result in hyphal swelling without shrinkage due to rapid hyphal movements but in *T. lactinea*, the skeletal hyphae much feebler or less arresting. As the basidiocarp develops, pores of *T. lactinea* also develop from round, thick-walled and white to angular, relatively thin-walled and brownish but never labyrinthine however in case of *T. elegans,* the pores are bit elongated or labyrinthine at best in portion of the fruit body when poroid but mostly they are lamellate (Vlasak and Kout, 2011).

Another closely related species to *T. elegans* is *T. gibbosa* but *T. elegans* is concentrically zonate while *T. gibbosa* is azonate and there is a slight difference in the length of spores, *T. elegans* has 5.13–7.12 × 2.5–2.85 µm and *T. gibbosa* has 4- 5 × 2-2.5 spore sizes with the shapes of round and cylindrical to oblong ellipsoid respectively. (Ahmad et al., 1997; Wahab et al., 2021).

Conclusion

To conclude, morphology and anatomy of basidiocarps, host plant and size of basidiospores were key features for the confirmation of *Trametes elegans.* Lahore is reported as a new locality for this wood rotting fungus. The illustrations, micro-plates and colored photographs of micro-plates described *T. elegans* entirely. All the *Trametes* species reported from Pakistan have been compared with our taxon; some briefs about the host plants have been given in the tables along with the distribution map describing the different localities of *Trametes* species in Pakistan.

Conflict of Interest

The authors declare that they have no conflict of interest.

Acknowledgements

Ethical Statement

Not Applicable

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