

Three New Records from Karnataka State, India of Genus *Trentepohlia* Mart. (Ulvophyceae, Chlorophyta)

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ABSTRACT

Genus *Trentepohlia* is a subaerial green alga (Chlorophyta). The present study recorded 3 *Trentepohlia* species (*Trentepohlia odorata* (F. H. Wiggers) Wittrock, *Trentepohlia abietina* (Flotow ex Kützing) Hansgirg, and *Trentepohlia rigidula* (J. Müller) Hariot) for the first time from the 3 distinct regions (Belagavi, Dharwad and Haveri) of the 13 districts of North Karnataka, India during the survey conducted in the year 2022 – 2024. The *Trentepohlia* species were found as yellow, orange and red coloured patches on both natural (bark of tree stem) and artificial (electric poles, concrete cementing walls of buildings and water tanks) substrata. Based on Sampling sites and substrata *Trentepohlia* shows host specificity rather than the artificial substratum specificity. According to date of collection the winter season is more appropriate for growth of *Trentepohlia* as the physical factors as temperature, humidity and light intensity at the time of collection had pronounced effect on growth of *Trentepohlia*. Hence, these physical factors can be considered as critical key factors for the growth of *Trentepohlia*. Morphometric studies revealed various distinct characters like shape of cell, cell dimensions, branching pattern and structure of sporangia. Since meager research work has been done on *Trentepohlia*, this article throws more light on the addition to *Trentepohlia* in Karnataka. Hence, study of *Trentepohlia* species is first basic attempt made in Karnataka for further research.

Keywords: Subaerial algae, *Trentepohlia*, Physical factors, North Karnataka, Substrata, Morphometry.

Highlights:

- New records from Karnataka.
- The distinct microscopic photographs and Morphometric evaluation help in species level identification.
- Physical factors necessary for the growth of *Trentepohlia* species in the environment are mentioned in detail.
- Understanding the host specificity of Genus *Trentepohlia* in the environment.

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INTRODUCTION

Genus *Trentepohlia* is a subaerial green alga distributed widely in tropical, subtropical, and temperate environments (Liu *et al.*, 2012). These *Trentepohlia* are microchlorophytes and are characterized by a combination of morphological and ultrastructural characters unique among the green algae, they have a distinctive characteristic appearance i.e., macrochlorophytes as the species forms orange red or green colour with irregular vertical streaks velvety to touch on its substrata, (Kharkongor and Ramanujam, 2015) hence they are easily recognizable on different surfaces by their different colouration which is formed by the accumulation of beta carotene and hematochrome (Rindi *et al.*, 2008, Kharkongor and Ramanujam, 2015).

These *Trentepohlia* grow on natural substrata like bark of the tree stem and leaves and several types of artificial substrata like rocks, cementing walls and poles (Rindi *et al.*, 2005). *Trentepohlia* is a genus of green algae classified within the phylum Chlorophyta (Chen *et al.*, 2015), class Ulvophyceae, and order *Trentepohliales*, which comprises a single family, *Trentepohliaceae* (Rindi *et al.*, 2009).

Key characteristics are used for the identification of species and varieties within the Genus *Trentepohlia*. The characterization of vegetative cells includes their shape, size, and the presence of hair-like appendages (setae), the branching pattern of filaments, and the position and morphology of reproductive structures. These features are considered critical for accurate taxonomic classification within the genus (Liu *et al.*, 2012, Sanctuary and Saraphol, 2020).

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Compared to all other algal groups, subaerial eukaryotic microalgae are presently among the least understudied and less known (Lopez-Bautista *et al.*, 2007). These things are especially true for the tropical region's algae, as because these algae have not been studied in detail as those of temperate regions and till today, the survey of microalgae in tropical environments leads to the discovery of new species (Rindi and Bautista, 2007).

The study on these subaerial algae of the Genus *Trentepohlia* is meager and poorly known on biodiversity, taxonomy, physiology and other biological studies because the wrong understanding to other organisms and the identification at the species level may be very difficult, caused by variation of morphological and environmental features (Sanctuary and Saraphol, 2020). Microscopic characteristics can vary significantly between species, as certain species exhibit marked polymorphism (Rindi and Guiry, 2002).

The life history of *Trentepohlia* is the most challenging aspect of its biology which is least understood and most problematic. In the genus, *Trentepohlia*, two distinct types of reproductive structures have been identified: zoosporangia and gametangia. Zoosporangia, which possess a unique morphology characteristic of the order *Trentepohliales*, are responsible for producing motile spores and gametangia, on the other hand, give rise to gametes. These reproductive structures are typically found on separate individuals, indicating a clear separation of reproductive roles. The life history of *Trentepohlia* is marked by an isomorphic alternation of generations, meaning that the diploid sporophyte and the haploid gametophyte generations are morphologically similar. The diploid sporophytes produce Quadri flagellate meiospores through meiosis, which then develop into haploid gametophytes. These gametophytes, in turn, generate biflagellate gametes. Sexual reproduction occurs through isogamous fusion, where gametes of similar size and morphology unite to form a zygote. This mode of reproduction has been reported and confirmed in several investigations, notably by Thompson and Wujek, 1992. Despite over two centuries of research on *Trentepohlia*, the actual process of sexual fusion between gametes has been directly observed on only two documented occasions. This scarcity of observed gametic fusion has raised questions about the prevalence and significance of sexual reproduction in the life cycle of this genus. Nevertheless, multiple studies have reported that biflagellate gametes, though presumed to function in sexual reproduction, are capable of germinating independently to form new thalli without undergoing gametic fusion (Rindi and Guiry, 2002). These controversial reports create difficulties for some unusual characteristics of these algae and are unavoidable outcome of these species (Uyenco, 1965).

Species of *Trentepohlia* exhibit slow growth under culture conditions, and with the exception of a few isolated reports (Uyenco, 1965), they have been rarely studied in such environments. In the cultured material, there is no production of zoosporangia, which further complicates the understanding of the relationship between the formation of zoosporangia and gametangia. Efforts to clarify these reproductive dynamics are hindered by the absence of observable reproductive stages in laboratory conditions. Additionally, cytological studies have offered limited insight, as the chromosomes of *Trentepohlia* are extremely difficult to distinguish and examine due to their small size and the lack of information on this subject (Rindi *et al.*, 2005).

In some cases, rarely statistical treatments can be used to measure and analyze the range of variation, and morphometric characters (such as cell length and width) of *Trentepohlia* species as because the data obtained from cultured specimens have proven insufficient in advancing the understanding of this particular. Consequently, most investigations have relied on a very narrow range of culture conditions, limiting the potential to fully explore the biological and reproductive characteristics of *Trentepohlia* species. According to numerous studies, these algae exhibit extremely slow growth rates when maintained in artificial culture environments. Furthermore, they infrequently produce reproductive structures—particularly zoosporangia—which are critical for reliable species-level identification and taxonomic resolution. The absence of such diagnostic features in culture significantly hampers efforts to distinguish between

closely related taxa and to understand their life history patterns in detail (Uyenco, 1965; Rindi and Guiry, 2002).

The Genus *Trentepohlia* studies have been mainly focused in Europe, Central America, South America and some countries. Most subaerial algae newly introduced to science over the past two centuries have been documented in tropical zones, highlighting the biodiversity richness of these regions (Sanctuary and Saraphol, 2020). Therefore, the study of subaerial algae of Genus *Trentepohlia* species are the necessary preliminary data for the tropical, subtropical and temperate regions.

MATERIALS AND METHODS

Collection and Identification of *Trentepohlia* species

A survey of study area was carried out by Global Positioning System (GPS) locations. Collection of *Trentepohlia* species was done by scraping of subaerial algae from epiphytic (natural) substrata i.e. stem bark of trees and epilithic (artificial) substrata i.e. Electric poles, concrete cementing walls of buildings and water tanks with the help of knife, razor blade, spatula and scalpel in air tight zip lock sterile plastic bags (Satpati and Pal, 2016) from different sampling areas (Belagavi – 15°51' N 74°30' E, Dharwad – 15° 27' 30" N 75° 00' 30" E and Haveri – 14.8° N 75.4°E) of North Karnataka. The parameters like latitude, longitude, light intensity, temperature, and relative humidity of sampling sites were estimated. The photographs of the algae along with its habitat have been recorded. The collected algal samples were freeze-dried at –4°C (degree Celsius) and also preserved in 4% formalin in the laboratory (Satpati and Pal, 2016). The species were observed under light microscope, and the morphometric evaluation is carried by scaling of cell measurements using micrometry (Satpati and Pal, 2019). Identification of *Trentepohlia* species was carried out by using standard monographs and research articles (Cribb, 1970; Rindi and Guiry, 2002; Rindi *et al.*, 2005 and 2006; Rindi and Lopez-Bautista, 2007; Allali *et al.*, 2013; Satpati and Pal, 2016; Binoy *et al.*, 2019; Rindi *et al.*, 2008; Sanctuary and Saraphol, 2020) and data base (Algae Base). The deposition of herbarium of all the three species of Genus *Trentepohlia* in the form of permanent slides at Foundation for Revitalization of Local Health Traditions (FRLHT), Bengaluru, Karnataka with the accession number 6771 – *Trentepohlia odorata* (F. H. Wiggers) Wittrock Fionia, Denmark (1880), 6772 – *Trentepohlia abietina* (Flotow ex Kützing) Hansgirg, Hirschberg, Bavaria, Germany (1886), 6773 – *Trentepohlia rigidula* (J. Müller) Hariot, Queensland (1889).

RESULTS AND DISCUSSION

Physical factors

The physical factors play major role in the growth of *Trentepohlia* species, the study reveals that the regions where *Trentepohlia odorata* was collected had 6,280 to 11,200 lux of light intensity, 26.2 to 29°C temperature and 62 to 76% relative humidity. The regions of *Trentepohlia abietina* have 4,100 to 4,620 lux of light intensity, 24 to 25.5°C temperature and 79–to 84% relative humidity. The intensity of light was 3,500 to 8,700 lux, temperature 24 to 28°C and the humidity 62 to 84% in the regions of *Trentepohlia rigidula* (Table 1). The sampling

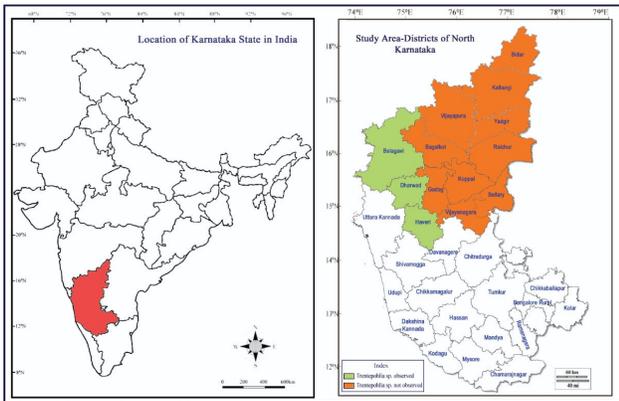


Fig. 1: Study Area

sites where the *Trentepohlia abietina* was obtained, which have less light intensity, less temperature and high relative humidity compared to the sampling sites from where the *Trentepohlia odorata* and *Trentepohlia rigidula* were obtained. Therefore, the growth of species depends on the environmental climatic conditions. Hence, the species were observed only in 3 regions (Belagavi, Dharwad and Haveri) of the 13 districts of North Karnataka and no species were observed at remaining regions namely, Bidar, Kalaburgi, Vijayapura, Bagalkote, Ballari, Vijayanagar, Gadag, Koppala, Raichur, and Yadagiri (Fig. 1), where the intensity of light and temperature were more and humidity was less.

This study also explains that, the species *Trentepohlia odorata* was observed from the month of August to March in the regions of Alnavar, and *Trentepohlia rigidula* was also observed

throughout the year in the regions of Katridaddi because of the rich vegetation of the forest maintaining approximately, 4000 to 8000 lux of light intensity, 24°C to 27°C of temperature, and 72% to 84% of relative humidity, as shown in Table 1. This shows that Table 1 explains consistency in the environmental factors, that favour the growth of *Trentepohlia* species, making the availability of the *Trentepohlia* species throughout the year.

According to previous studies, the Genus *Trentepohlia* is widely distributed in tropical, subtropical, and temperate environments (Abe *et al.*, 1999; Liu *et al.*, 2012; Satpati and Pal, 2016) and thrives on concrete substrates fully exposed to solar radiation. These algae are considered to possess significant physiological adaptations that enable survival under severe stress, like desiccation and thermal extremes (Abe, *et al.*, 1999). The luxuriant growth indicated by the colour of thallus varies seasonally, as during winter sampling it shows higher when compared to summer (Kharkongor and Ramanujam, 2015).

Collection and Morphometry

In the present study, the *Trentepohlia* species were found as orange, red and green patches on forms of both the Epiphytic (natural) and Epilithic (artificial) substrata, i.e., stem bark of trees, electric poles, concrete cementing walls of buildings and water tanks. The *T. odorata* were observed on both natural and artificial substrata, *Trentepohlia abietina* were observed only on natural substrata and *Trentepohlia rigidula* were observed on both natural and artificial substrata (Figs. 2, 3 and 4).

Trentepohlia odorata (F. H. Wiggers) Wittrock Fionia, Denmark (1880)

Thallus heterotrachous. Sometimes, erect and prostrate filaments are not clearly differentiated. The cells are cylindrical, in erect



Fig. 2: *Trentepohlia odorata* (a and b) Epiphytic Substrata (c - f) Epilithic Substrata



Fig. 3: *Trentepohlia abietina* (a - c) Epiphytic Substrata

filaments, 9.6 – 23.04 μm in length and 7.68 – 13.44 μm in width. The prostrate filament cells are subglobose to ellipsoidal in shape, with diameters ranging from 13.44 μm to 24.96 μm . Presumptive gametangia are nearly spherical to elliptic, lateral, terminal, or intercalary 13-15.36 μm in diameter. Sporangia, globose to subglobose, lateral/ terminal, sessile and stalked, 10.5–11.52 μm in diameter. The suffultory cell is straight or slightly curved, 11.52 μm long. Apical cells with pectic caps 15.36 μm in width and 19.2 μm in length. As shown in the Fig 5 and Table 2.

Trentepohlia abietina (Flotow ex Kutzing) Hansgirg, Hirschberg, Bavaria, Germany (1886)

Thallus heterotrichous and pseudoparenchymatous. The erect axis 126–198 μm long. The cells are cylindrical to barrel-shaped in the erect filaments, measuring approximately 3.84–7.68 μm in width and 15.36–16 μm in length. In contrast, the prostrate filaments have cylindrical, elliptical, or barrel-shaped cells and are slightly wider, ranging from 5.76–7.68 μm in width, with lengths similar to the erect cells at 15.36–16 μm . Presumptive gametangia globular or ovoid, 7.68 – 19.2 μm in diameter. Apical



a - Bark of tree stem of *Santalum* sp. of Santalaceae



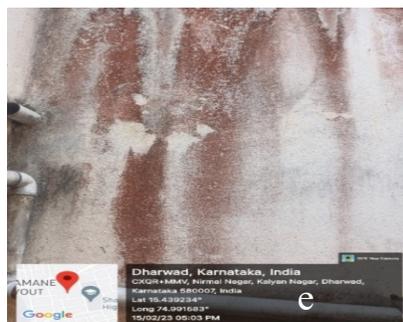
b - Bark of tree stem of *Mangifera indica* L. of Anacardiaceae



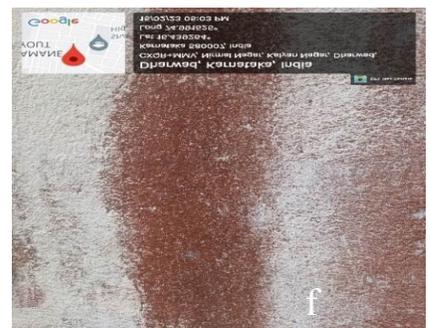
c - Bark of tree stem of *Thuja occidentalis* L. of Cupressaceae



d - Electric poles



e - Concrete cementing walls of buildings



f - Concrete cementing walls of buildings

Fig. 4: *Trentepohlia rigidula* (a - c) Epiphytic Substrata, (d - f) Epilithic Substrata

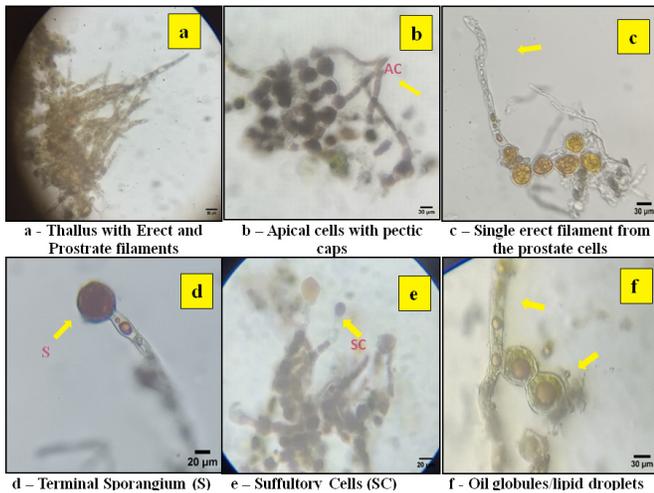


Fig 5: Microscopic structures of *Trentepohlia odorata* (F. H. Wiggers) Wittrock

cell with pectic cap 15.36 – 19.2 µm long and 7.68 µm wide. As shown in Fig 6 and Table 2.

***Trentepohlia rigidula* (J. Müller) Hariot, Queensland (1889)**

Thallus consists of uniseriate filaments, pseudoparenchymatous, consisting of a separation between dense prostrate and erect parts. The axis is up to 192 – 307.2 µm tall. The cells are elliptical, globular or oval in shape and ranges from 17.28 – 23.04 µm wide and 26.88 – 34.56 µm long. The apical cell is oval and ranges 17.28 – 23.04 µm in diameter. The sporangia are spherical in shape ranging 11.52 – 23.04 µm in diameter. The presumptive gametangia globular in shape 24.96 µm in diameter. As shown

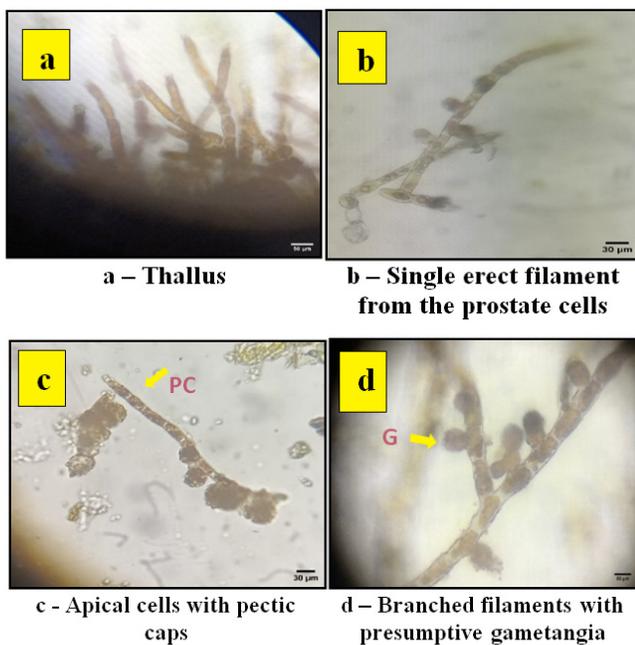


Fig. 6: Microscopic structures of *Trentepohlia abietina* (Flotow ex Kützing) Hansgirg

in Fig 7 and Table 2.

The present study has revealed the presence of *Trentepohlia* species in the samples collected from Karnataka by considering the distribution of species in various regions mentioned in previous studies like, presence of *Trentepohlia odorata*, in South-Eastern Queensland; Nilgiris, Kerala, India; Panama and Florida. Likewise, *Trentepohlia abietina* in Nilgiris, Kerala, India; Panama and Florida; Hawaiian Islands; French Guiana; Indian Sundarbans; Africa; Shillong; Nilgiris, Kerala, India; Panama and Florida; Bangladesh. Similarly, *Trentepohlia rigidula*, from Queensland, Gabon, Central Africa; West Bengal, and Southwestern ghats, India; Chiang Dao Wildlife Sanctuary and South-Eastern Queensland. and (Uyenco, 1965; Cribb, 1958; Krishnamurthy, 2000; Tiwari *et al.*, 2011; Rindi *et al.*, 2005, 2006 and 2008; Rindi and Bautista, 2008; Allali *et al.*, 2013; Satpati and Pal, 2015 and 2016; Binoy *et al.*, 2019; Sanctuary and Saraphol, 2020).

Trentepohlia odorata thallus is heterotrichous. Branched filaments, Cells cylindrical, in erect filament, 5-18 µm broad and 10-42 µm in length. Apical cell with pectose caps (Krishnamurthy, 2000; Tiwari *et al.*, 2011). The Cells are subglobose to ellipsoid in basal filaments and are usually sub-cylindric to cask-shaped in erect filaments, generally measures as long as broad, 17-25 x 14-24 µ. Basal filament cells have thin, smooth walls and erect filament cells have thicker walls 2-7 µ, and are often rough in texture with a shaggy or scaly appearance (Cribb, 1958). Presumptive gametangia nearly spherical to elliptic, lateral, terminal, or intercalary; zoosporangia similar in shape, 13 µm in diameter (Uyenco, 1965). Sporangia, globose to subglobose, lateral/ terminal, sessile and stalked, 10-30 µ diameter (Cribb, 1958; Krishnamurthy, 2000; Tiwari *et al.*, 2011). The *Trentepohlia odorata* have reported from the South-Eastern Queensland; Nilgiris, Kerala, India; Panama and Florida regions (Cribb, 1958; Uyenco, 1965; Krishnamurthy, 2000; Tiwari *et al.*, 2011).

Trentepohlia abietina Thallus heterotrichous, pseudo-parenchymatous (Krishnamurthy, 2000; Sanctuary and Saraphol, 2020). The thallus consisted of erect axes, originate from a relatively small prostrate base measuring between 195.45 - 600 µm tall (Rindi *et al.*, 2005, 2006, and 2008; Rindi

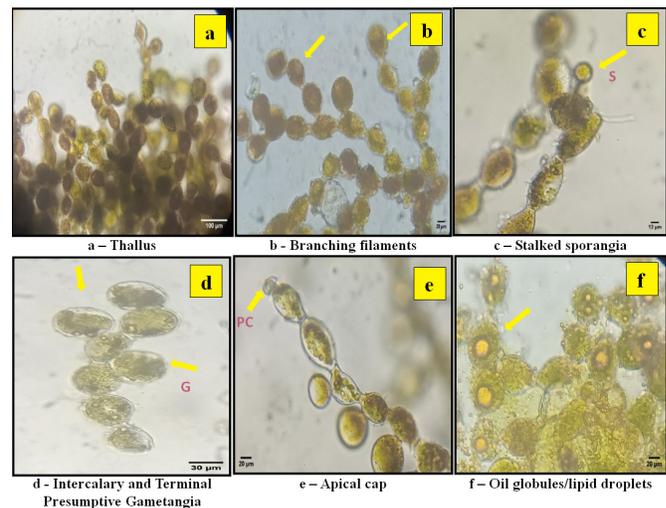


Fig. 7: Microscopic structures of *Trentepohlia rigidula*

Table 1: Sampling Sites and Physical Factors Recorded from the Regions of *Trentepohlia* species

Regions	Sampling Sites	Date of Collection	Substrata	Latitude	Longitude	Altitude (meter)	Light Intensity (lux)	Temperature (°C)	Relative Humidity (%)	Species
Dharwad	Railway Station	02/12/2022	Eucalyptus Tree Stem Bark	15.44438°	75.001456°	745.5	6400	28	63	<i>T. rigidula</i>
	University of Agricultural Sciences	02/12/2022 & 16/09/2024	Electric Poles	15.49154°	74.983209°	701.1	6700	26.4	74	<i>T. rigidula</i>
	Karnatak Science College Campus	13/12/2022	Santalum Tree Stem Bark	15.451674°	74.99708°	747.0	3500	24.8	69	<i>T. rigidula</i>
		12/09/2024	Coconut Tree Trunk	15.453226°	74.995684°	747.8	4750	28	62	<i>T. rigidula</i>
	Karnatak University Campus	16/11/2022	Eucalyptus Tree Stem Bark	15.43327°	74.984323°	757.7	6280	27.5	69	<i>T. rigidula</i>
		08/09/2023	Palm Tree Trunk	15.440816°	74.98647°	738.8	7000	28	69	<i>T. rigidula</i>
		08/09/2023	Cement Water Tank	15.433412°	74.984376°	757.3	6280	27.5	69	<i>T. odorata</i>
	Kalyan Nagar	27/03/2023	Acacia Tree Stem Bark	15.435092°	74.987935°	748.1	7250	25	71	<i>T. rigidula</i>
		15/02/2023	Cementing Wall	15.440236°	74.990716°	728.0	7820	26.2	76	<i>T. rigidula</i>
	Sadhanikeri	04/10/2023	Tuja Tree Stem Bark	15.462675°	74.987685°	720.1	4200	24.8	69	<i>T. rigidula</i>
	Sattur	07/11/2023	Gulmohar Tree Stem Bark	15.416948°	75.047629°	700.2	3750	24	72	<i>T. rigidula</i>
	Sanjivini Park	08/11/2023	Acacia Tree Stem Bark	15.412537°	75.057392°	708.9	3900	24.3	77	<i>T. rigidula</i>
		08/11/2023	Santalum Tree Stem Bark	15.412537°	75.057392°	708.9	3950	24.3	77	<i>T. rigidula</i>
	Neerasagar	07/11/2023	Mangifera Tree Stem Bark	15.314365°	74.999909°	538.0	5500	26	73	<i>T. rigidula</i>
Nayakanhulikatti	07/11/2023	Mangifera Tree Stem Bark	15.361054°	75.006063°	653.0	8700	27.2	61	<i>T. rigidula</i>	
Alnavar	27/10/2024 & 14/03/2025	Cement Water Tank	15.445989°	74.834812°	631.4	7820	26.2	76	<i>T. odorata</i>	
Belagavi	Jamboti	17/12/2023	Sweetania Tree Stem Bark	15.67876°	74.440289°	723.1	4750	24	84	<i>T. rigidula</i>
	Katridaddi	08/10/2023 & 27/10/2024	Acacia Tree Stem Bark	15.516195°	74.785015°	685.1	4764	25.5	84	<i>T. rigidula</i>
	Kulavalli	08/10/2023	Mangifera Tree Stem Bark	15.51872°	74.79533°	679.1	5168	25.5	82	<i>T. rigidula</i>
	Jamboti	17/12/2023	Eucalyptus Tree Stem Bark	15.699819°	74.386787°	777.6	4528	24	82	<i>T. abietina</i>
	Nagargali	8/10/2023	Tree	15.42178°	74.605045°	709.2	4620	24	79	<i>T. abietina</i>
	Ghataprabha	03/11/2023	Electric Poles	16.353964°	74.729415°	632.2	9866	28.2	62	<i>T. odorata</i>
		03/11/2023	Cementing Walls	16.353964°	74.729415°	632.2	9800	28.8	62	<i>T. odorata</i>
	Ghataprabha Bird Sanctuary Dhupadal	03/11/2023	Electric Poles	16.222647°	74.759051°	619.4	9250	27	62	<i>T. odorata</i>
	Raibag Forest	03/11/2023	Palm Tree Stem Bark	16.216603°	74.754636°	615.9	9250	27	63	<i>T. odorata</i>
		30/10/2023	Cementing Poles	16.465432°	74.752121°	594.8	11200	29	68	<i>T. odorata</i>
Haveri	Chikodi Residential apartment	02/11/2023	Electric Poles	16.451413°	74.607285°	609.0	9570	28	64	<i>T. odorata</i>
		02/11/2023	Cementing Walls	16.41419°	74.598806°	678.5	9570	27.8	67	<i>T. odorata</i>
	Haveri	15/10/2023	Acacia Tree Stem Bark	14.814969°	75.157606°	574.7	7200	27.5	64	<i>T. rigidula</i>
	Hanagal	15/10/2023	Eucalyptus Tree Stem Bark	14.700313°	75.099257°	593.5	4100	25.5	84	<i>T. abietina</i>
	Hanagal	15/10/2023	Eucalyptus Tree Stem Bark	14.700313°	75.099257°	593.5	4100	25.5	84	<i>T. odorata</i>

Table 2: Key Features of *Trentepohlia* species

Name of Species	Thallus	Cells (Shape and Size)	Prostrate Cells (Shape and Size)	Erect Cells (Shape and Size)	Branching of filaments	Sporangia (Shape and Size)	Gametangia (Shape and Size)	AC With PC	Suffultory Cells
<i>T. odorata</i>	Heterotrichous	-	Subglobose to ellipsoid 13.44 – 24.96 µm in diameter	Cylindrical W - 7.68 – 13.44 µm L - 9.6 – 23.04 µm	Present	Globose to subglobose, lateral /terminal/ intercalary 10.5 – 11.52 µm in diameter	lateral /terminal/ intercalary 13. – 15.36 µm in diameter	Present	Straight / slightly curved
<i>T. abietina</i>	Heterotrichous	-	Elliptical or cylindrical, or barrel-shaped, W - 5.76 – 7.68 µm L - 15.36 - 16 µm	Cylindrical or barrel-shaped W - 3.84 – 7.68 µm L - 15.36 - 16 µm	Not observed	Not observed	globular or ovoid 7.68 – 19.2 µm in diameter	Present	Not observed
<i>T. rigidula</i>	Uniseriate filaments	Globular/ elliptical W - 23.04 µm L - 26.88 µm	-	-	Present	Not observed	Spherical 23.04 µm in diameter	Not observed	Not observed

*W-Width; L-Length; AC- Apical Cell; PC-Pectic Cap.

and Bautista, 2008; Allali *et al.*, 2013; Binoy *et al.*, 2019; Sanctuary and Saraphol, 2020). Cell length 10-55 µm, Cell breadth 10-20 µm (Krishnamurthy, 2000; Satpati and Pal, 2013, 2015). The cells forming the erect axes are predominantly cylindrical, although variations in form occur, with some cells appearing swollen or barrel-shaped; their diameter generally falls within the range of 4 to 12 µm in diameter and 1–6 times as long as wide (Rindi *et al.*, 2005, 2006 and 2008; Rindi and Bautista, 2008; Tiwari *et al.*, 2011; Allali *et al.*, 2013; Sanctuary and Saraphol, 2020). Cells of the prostrate filaments are globular, elliptical or cylindrical, or barrel-shaped, 4–12 µm in diameter and 6–20 µm in length (Rindi *et al.*, 2005, 2006 and 2008; Binoy *et al.*, 2019; Sanctuary and Saraphol, 2020). Sporangia rare, cylindrical, diameter of sporangia 10-35 µm (Satpati and Pal, 2015). Apical cell 10 – 45 µm long and 10 – 25 µm broad without a cap (Krishnamurthy, 2000). Uyenco, 1965; Rindi *et al.*, 2005, 2006 and 2008; Rindi and Bautista, 2008; Allali *et al.*, 2013 stated that the presumptive gametangia are spherical or globular to ovoid in shape, measuring 10–25 µm in diameter. The Suffultory cell straight or slightly curved neck 12–14 µm wide, zoosporangia globular, 14–20 µm in diameter (Rindi *et al.*, 2005; Allali *et al.*, 2013). Apical cell with pectic cap (Rindi *et al.*, 2006 and 2008; Rindi and Bautista, 2008; Allali *et al.*, 2013; Binoy *et al.*, 2019). This *Trentepohlia abietina* have been reported from the regions of Hawaiian Islands; French Guiana; Chiang Dao Wildlife Sanctuary; Panama; Gabon, Central Africa; Southwestern Ghats, India; Indian Sundarbans; Africa; Shillong; Nilgiris, Kerala, India; Panama and Florida; Bangladesh (Uyenco, 1965; Krishnamurthy, 2000; Rindi *et al.*, 2005, 2006, and 2008; Rindi and Bautista, 2008; Allali *et al.*, 2013; Satpati and Pal, 2015; Binoy *et al.*, 2019; Sanctuary and Saraphol, 2020).

Trentepohlia rigidula thallus heterotrichous, pseudoparenchymatous (Sanctuary and Saraphol, 2020). Moniliform filaments (Cribb, 1970). Uniseriate filaments showed a prostrate and an erect portion (Satpati and Pal, 2016; Sanctuary and Saraphol, 2020). Erect axes 255.04 - 328.99 µm tall (Sanctuary and Saraphol, 2020). Cells are elliptical, barrel-shaped, globular, sub-globular or almost cylindrical, 10-33 µm wide (Cribb, 1970; Rindi *et al.*, 2008; Allali *et al.*, 2013; Satpati and Pal, 2016; Binoy *et al.*, 2019) and 12-60 µm in length or 1–3 times as long as wide. (Satpati and Pal, 2016; Allali *et al.*, 2013; Binoy *et al.*, 2019). Sporangium varied from globular, orbicular, or dome-shaped (Satpati and Pal, 2016; Binoy *et al.*, 2019) with a 15-30 µm diameter. (Satpati and Pal, 2016). The cells forming the prostrate region are typically globular, though some may appear sub-globular or barrel-shaped in form, measuring 12-15 µm wide, 12-18 µm long. Cells of the erect filaments were globular, sub-globular, barrel-shaped, 4.04-7.58 µm wide, 21.00-28.87 µm long. Apical cells with pectic cap. Septum is usually 5-10 times the diameter of the cell. Gametangia abundant, globular, ovoid or dome-shaped, 20-26 µm in diameter (Rindi *et al.*, 2008). The *Trentepohlia rigidula* was reported from the regions of West Bengal, India; Chiang Dao Wildlife Sanctuary; Panama; Gabon, Central Africa; Southwestern Ghats, India; Queensland (Cribb, 1970; Satpati and Pal, 2016; Allali *et al.*, 2013; Binoy *et al.*, 2019; Rindi *et al.*, 2008; Satpati and Pal, 2016; Sanctuary and Saraphol, 2020).

According to the present study and Rindi *et al.*, (2008) shows the presence of reproductive structures and stated as the Presumptive gametangia abundant, globular, ovoid or dome-

shaped, 20–26 µm in diameter (Rindi *et al.*, 2008). But in the study of Cribb (1970) and Sanctuary and Saraphol (2020) stated that reproductive structures, zoosporangia and gametangia were not observed.

CONCLUSION

The study of the Genus *Trentepohlia* species concludes that the first basic attempt helps to study the diversity of the Genus *Trentepohlia* in Karnataka. This study will be the best contribution to the terrestrial algae, as there is a lack of involvement of research on terrestrial algae. As such, there is no *Trentepohlia* species recorded till date, from the regions of Karnataka. The physical factors like; light intensity, temperature and relative humidity play major role and the detailed favourable conditions noted for the growth of *Trentepohlia* species of this study helps to conduct future research in different regions throughout the world.

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AUTHORS' CONTRIBUTIONS

Both the authors contributed equally

CONFLICT OF INTEREST

Authors declare no conflict of interest

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