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ROOST DIVERSITY AND HABITAT SELECTION OF *PTEROPUS MEDIUS (GIGANTEUS*) IN CHANDRAPUR DIST., (M.S.), INDIA.

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Abstract
The present research delivers substantial information regarding the distribution and roost tree features of the Indian flying fox *(Pteropus medius (giganteus)* in the Chandrapur district of Maharashtra, India. Monthly field surveys were carried out across twenty-seven designated roosting sites in various localities of the Chandrapur district, each showcasing unique environmental characteristics. A total of 4,341 individuals were recorded over the course of the year, with all roosting sites utilized consistently throughout the year. The investigation revealed 42 roost trees across 07 species, with *Magnifiers indica* (n = 14) and Ficus (n = 15) being the most commonly utilized. The characteristics of roost trees, such as height and canopy cover, showed a positive correlation with bat abundance, suggesting a preference for larger trees that offer greater safety and adequate room for huge colonies. Bats may opt to roost close to bodies of water, as evidenced by the considerable positive association that was established between colony size and the distance to the closest body of water. Even the distances to fruit orchards, agricultural fields, and human populations were positively correlated with colony size. Large tree conservation is crucial since the study identifies the best roosting locations for *Pteropus medius (giganteus)* in the region.

Keywords: *Pteropus medius (giganteus)*, Chandrapur district, colony size, roost tree, roost selection, and conservation.

Introduction:

Bats account for more than 20% of the entire mammal species. They are found on every continent, except for the Arctic, Antarctica, and certain oceanic islands (Gunnel et al., 2017). Order Chiroptera is the second most widespread classification of mammals. Most bats exist mainly on insects or fruits (Li et al., 2018). Bats are very important for the pollination of plants, dispersal of seeds, and pest control. There exist more than 1,455 different species of bats worldwide (Simmons and Cirranello, 2022). Megachiroptran bats are placed in the genera *Acerodon* and *Pteropus* of the Pteropodidae family (Tsang, 2020). These family members are found in different geographical areas and are highly adaptable to different environmental circumstances. *Pteropus medius (giganteus)* is common in countries of the Indian subcontinent, also in Myanmar and China (Elangovan et al., 2018). Roosting areas are key habitats for population survival, offspring growth, social contact, and breeding functions. Roosting tree selection is of utmost importance for *Pteropus medius (giganteus),* as these entities mostly inhabit such areas throughout their lives (Kerth et al., 2003). *Pteropus medius (giganteus)* is a very social species, often aggregating in huge colonies with numbers in the range of hundreds to thousands (Tsang, 2020). They show a preference for a wide range of habitats for roosting, such as rural and city areas, near farmland, water bodies, and paths (Tsang, 2020; Kumar & Elangovan, 2019). Further*, Pteropus medius (giganteus)* chooses big trees like *Mangifera indica, Eucalyptus sp., Tamarindus indica, Ficus religiosa,* and *Ficus benghalensis* for roosting (Vendan, 2003). This species requires the denser canopies of high, stable trees where they are protected from predators and extreme weather situations (Kingston et al., 2023). Roosts for

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Print version ISSN 0e70 0765
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Pteropus medius (giganteus) are normally situated near water bodies such as ponds, lakes, canals, or rivers, which help meet their water needs and enhance tree growth. *Pteropus medius (giganteus)* makes use of its roosts for grooming, vocal communication, and spatial position (Myint, 2023). These are very faithful to their roosting areas and converge on the same places every year. *Pteropus medius (giganteus)* feeds on fruits hence becoming important contributors to processes of pollination. Urban areas very often offer a lot of food and space for roosting, hence the formation of great colonies in metropolitan areas. However, being close to human inhabitants can instill conflicts, hence the need for careful administration and conservation practice in a bid to save such favorable species (Heldbjerg et al., 2023). Anthropogenic events such as widespread deforestation in association with urban growth, water shortages in food, route formation, building works, habitat destruction and subdivision, perturbations, and hunting methods leave a huge effect on the population of *Pteropus medius (giganteus)* (Chakraborty & Chakraborty, 2021). A clear understanding regarding the ecological needs and roosting habits of *Pteropus medius (giganteus)* is necessary for their effective conservation.

Material and Methods:

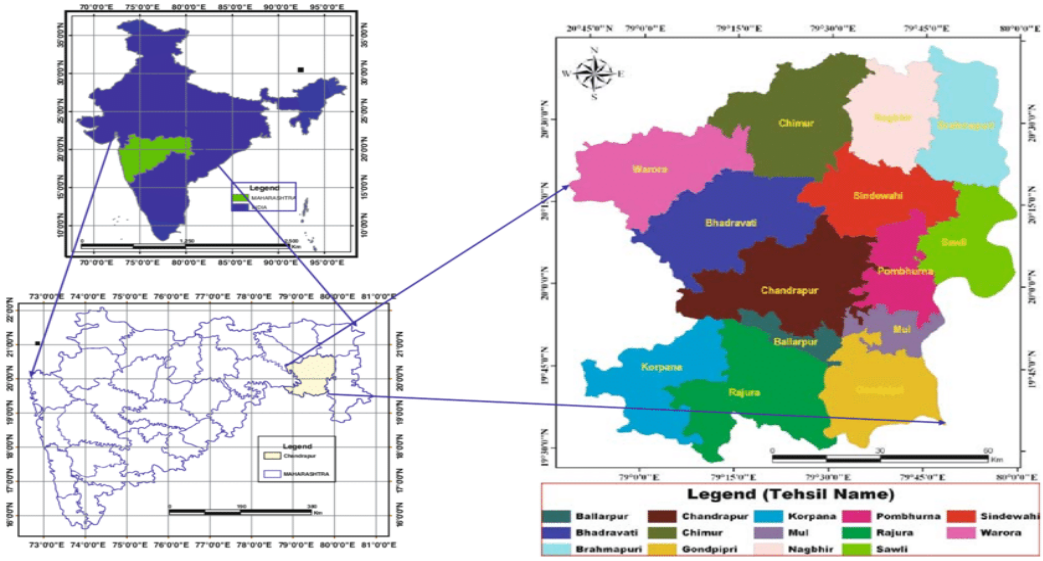

Fig. 1. Map of Chandrapur district, Maharashtra,

Bulletin of Pure and Applied Sciences
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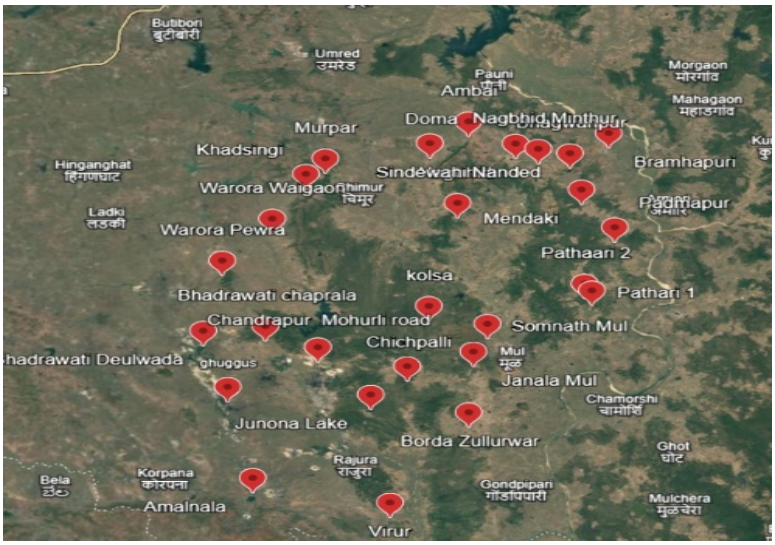

Fig 2. Locations of roosting sites *Pteropus medius (giganteus)* in Chandrapur dist.

The location of Chandrapur district is in the eastern limits of Maharashtra state, along with Gadchiroli district within the eastern section of the Vidarbha region. Geographically, it is situated between latitudes 19.30' N and 20.45' N and at a longitude of 78.46' E. To the north, it borders Bhandara and Nagpur districts, while Wardha and Yavatmal districts lie to the west. Gadchiroli district is to the east, and the southern boundary is shared with the districts of Komaram Bheem and Adilabad in Telangana. The district has a tropical hot climate, with temperatures fluctuating throughout the year. Two main seasons dominate the region: a very hot summer and a relatively cool winter. Its monsoon follows subsequent to the summer, until late September, where the southwest monsoon brings heavy rainfall. December is known to be the coldest of months with mean high temperatures of 28.2°C and lows of 11.6°C. Coldest temperatures recorded were 3°C in the northern parts and 8°C in the southern areas. May, being the peak of summer, maximum temperatures in many instances are higher than 43°C with a minimum of 28° to 29°C. Both the primary and secondary data for the present study were collected in each of the four administrative blocks (Bramhapuri, Chandrapur-Warora, Rajura, and Mul-Gondpipari) of Chandrapur in the Maharashtra state.

Data collection:

From January 2023 to December 2023, comprehensive field studies and surveys were conducted in the Chandrapur district to identify the Pteropus medius (giganteus) roosting sites. Initially, data were gathered through direct interactions and verbal inquiries with local residents, along with collecting information from nearby villages. Each roost site was revisited to gather details about the characteristics of the roosts and the sizes of the *Pteropus medius (giganteus)* colonies. Bat populations at each site were estimated using the direct roost count method (Kunz et al. 2009), utilizing field binoculars (Olympus 10 x 50 S) for observation and a Nikon 5300D DSLR and Canon SX-70 HS Bridge camera for photography. The geographical locations of the roosting sites were recorded with an eTrex Vista HCx handheld GPS device. Just before dawn, measurements of girth, diameter at breast height (DBH), and tree height were taken. A tape measure was used to record the tree's girth (g), and DBH was calculated by dividing the circumference by π. Additional habitat features of the roost trees, such as the distance to water sources and human settlements, were also noted. A map was created to illustrate the locations of *Pteropus medius (giganteus)* roosts within the study area.

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Print version ISSN 0e70 0765
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Statistical analysis

Height, circumference, and DBH of the roost trees were taken into account and noted. Pearson correlation analysis was performed in order to observe the association of those factors on the abundance of bats and impact of temperature and humidity on the site of roosting (Devi & Kumar, 2024). Similarly, the impact of dependent variables like the distance of the location of roosting from the closest human settlement, water source, and farming activity in particular related to fruit farming, on colony size was tested through a multiple regression (Kumar and Elangovan, 2019).

Result:

During the research investigation, a comprehensive total of 42 colonies, encompassing 4143 individual specimens, were meticulously recorded within the Chandrapur district of Maharashtra, India. The pertinent details regarding the location, geographic coordinates, proximity to the nearest aquatic bodies, quantity of roosting trees, colony dimensions, and the ecological characteristics of the roosting sites are delineated in Table 1. The study reveals that 42 roost trees comprising seven species of six genera preferred by *Pteropus medius (giganteus)* as roosting trees, as illustrated in Fig. 1. *Pteropus medius (giganteus)* exhibited a marked preference for wide-canopy arboreal structures (constituting 80.952% of the trees), including species such as *Ficus benghalensis, Ficus religiosa, Mangifera indica, Tamarindus indica,* and *Azadirachta indica*, while occupying narrow-canopy trees to a significantly lesser extent (19.04% of the trees), exemplified by *Terminalia arjuna* and *Eucalyptus sp*. Among the 27 identified locations, nine colonies were situated in immediate proximity to the water source, while the remaining 18 sites of *Pteropus medius (giganteus)* roosts displayed an intermediate distance from the aquatic source. Within the study area, *Pteropus medius (giganteus)* was observed utilizing both solitary and dispersed roosting patterns. Amongst all roosts, *Pteropus medius (giganteus)* predominantly favored solitary roost trees, whereas in seven instances, roosts were located on multiple aggregated roost trees, with a pronounced prevalence of *Mangifera indica* and *Eucalyptus sp.* in these locales. The colonies exhibited considerable variability in size, ranging from 39 to 328 individuals, with an average colony size approximating 161 bats. Height of the roost trees ranged from 12.82 m in Azadirachta indica through 33.1 m in Eucalyptus sp. to a mean of 25.72 m. Diameter at breast height (DBH) ranged between 33.8 cm for Eucalyptus sp. and 152.5 cm for *Ficus religiosa*. The findings from the Pearson correlation analysis revealed very significant positive correlation between the number of bats and the structural attributes of the trees they roost in. *Pteropus medius (giganteus*) was found to have a positive relationship with taller trees (Fig. 2). A similar trend was observed with dbh, as larger dbh was often chosen by *Pteropus medius (giganteus)* across most locations (Fig. 3). Close to 56% of the roosts were near water bodies, with 29% directly situated on the banks of these water sources, while the rest were nearby farming and forest areas. A significant positive relationship was observed between the circumference of the roost trees and the colony size (Fig.4). The adaptability of *Pteropus medius (giganteus)* to both rural and urban ecosystems is particularly noteworthy. Notwithstanding this adaptability, their coexistence with human settlements has precipitated escalating conflicts, encompassing persecution, tree removal, and habitat encroachment, driven by concerns regarding potential disease transmission, which may adversely affect the viability of the colonies (Fig. 5).

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Print version ISSN 0e70 0765
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Table .1 Distribution, GPS location, colony size (n), and preferred roost trees of *Pteropus giganteus (medius)* in Chandrapur districts of Maharashtra, India.

Tehsil	Colony Location	Latitude	Longitude	Colony Size	Roost Tree Species
Bhadrawati	Bhadrawati Deulwada	20°05'19"N	79°03'58"E	245	*Ficus religiosa*
Bhadrawati	Bhadrawati Chaprala	20°06'07"N	79°11'22"E	42	*Mangifera indica*
Bramhapuri	Bramhapuri Padmapur	20°21'53"N	79°52'41"E	316	*Mangifera indica*
Bramhapuri	Bramhapuri Men.daki	20°27'48"N	79°48'44"E	252	*Terminalia arjuna*
Bramhapuri	Bramhapuri town Bramhapuri	20°36'43"N	79°51'55"E	80	*Ficus religiosa*
Bramhapuri	Bhagwanpur	20°33'31"N	79°47'22"E	328	*Mangifera indica*
Chandrapur	Ghuggus	19°56'28"N	79°06'55"E	246	*Eucalyptus sp.*
Chandrapur	Mohurli road	20°02'49"N	79°17'36"E	69	*Eucalyptus sp.*
Chandrapur	Junona lake	19°55'22"N	79°23'55"E	105	*Ficus benghalensis*
Chandrapur	Chichpalli	19°59'53"N	79°28'13"E	184	*Eucalyptus sp.*
Chimur	Chimur Ambai	20°38'30"N	79°35'18"E	71	*Tamarindus indica*
Chimur	Chimur Doma	20°35'04"N	79°30'44"E	45	*Ficus religiosa*
Chimur	Chimur Murpar	20°32'37"N	79°18'20"E	73	*Azadirachta indica*
Chimur	Chimur Khadsangi	20°30'09"N	79°16'01"E	148	*Mangifera indica*
Mul	Mul Janala	20°02'13"N	79°36'02"E	187	*Ficus religiosa*
Mul	Mul Somnath	20°06'37"N	79°37'41"E	240	*Mangifera indica*
Nagbhid	Nagbhid Minthur	20°34'13"N	79°43'35"E	172	*Tamarindus indica*
Nagbhid	Nagbhid town	20°35'02"N	79°40'54"E	57	*Ficus religiosa*
Pombhurna	Borda Zullurwar	19°52'38"N	79°35'30"E	109	*Ficus benghalensis*
Rajura	Virur Rajura	19°38'20"N	79°26'14"E	153	*Tamarindus indica*
Rajura	Amalanala Reservoir	19°42'06"N	79°09'58"E	318	*Mangifera indica*
Saoli	Saoli Pathari 1	20°11'55"N	79°50'00"E	110	*Ficus religiosa*
Saoli	Saoli Pathari 2	20°12'59"N	79°49'09"E	153	*Ficus religiosa*
Sindewahi	Sindewahi Nanded	20°25'40"N	79°34'04"E	254	*Mangifera indica*
Sindewahi	Sindwahi Kolsa	20°09'23"N	79°30'45"E	273	*Ficus benghalensis*
Warora	Warora Pewra	20°16'25"N	79°06'10"E	39	*Ficus religiosa*
Warora	Warora Waigaon	20°23'05"N	79°12'04"E	72	*Ficus religiosa*

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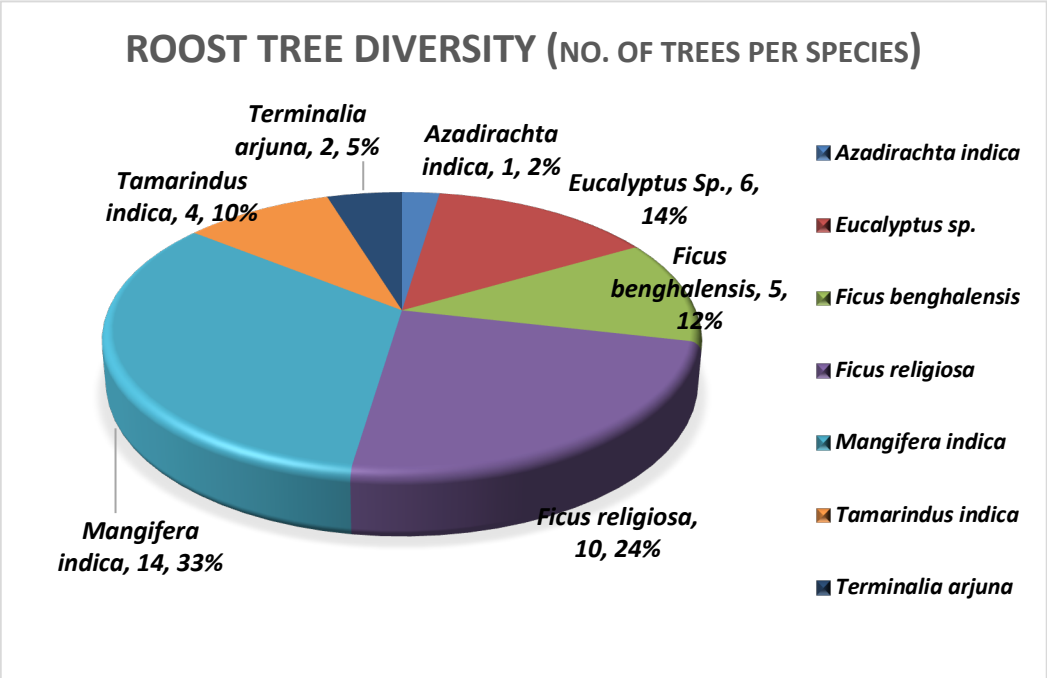

Fig.1- Roosting variation of Pteropus medius in Chandrapur district.

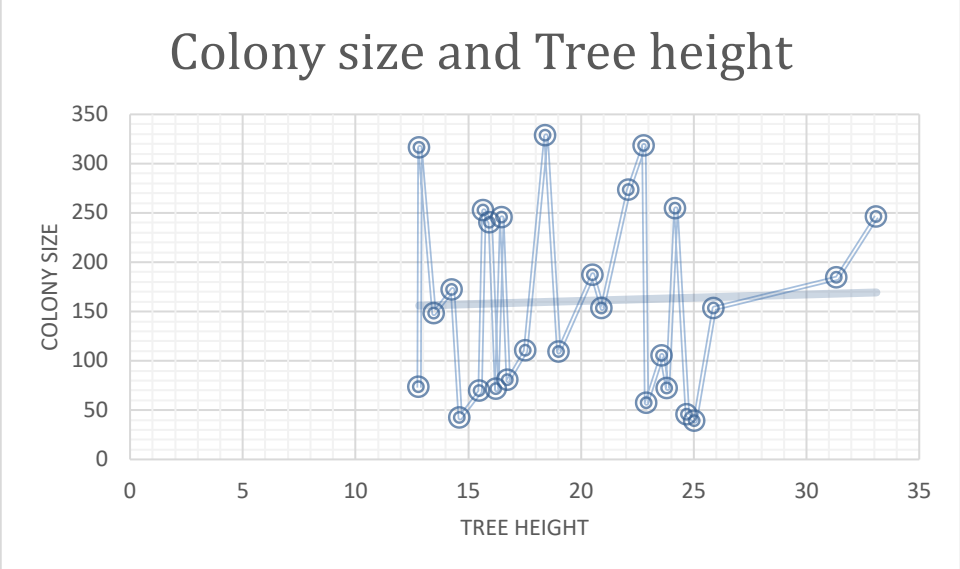

Fig. 2 - Abundance of Pteropus medius relative to tree height

Bulletin of Pure and Applied Sciences
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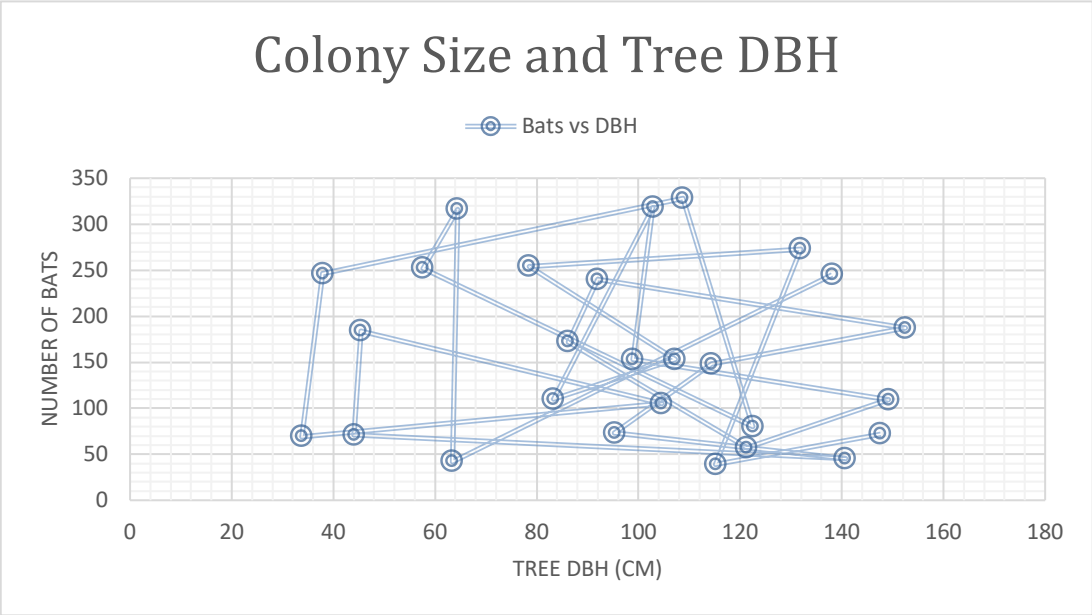

Fig.3 – Colony Size of Pteropus medius with reference to tree DBH

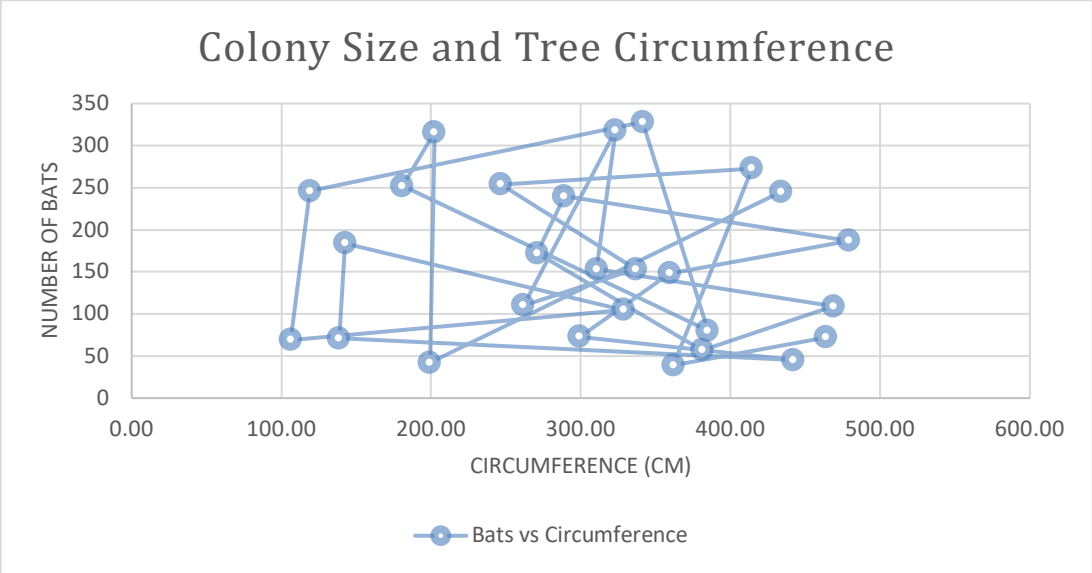

Fig.4 – Colony Size of Pteropus medius with reference to tree Circumference.

Bulletin of Pure and Applied Sciences
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Online version ISSN 2320 3188

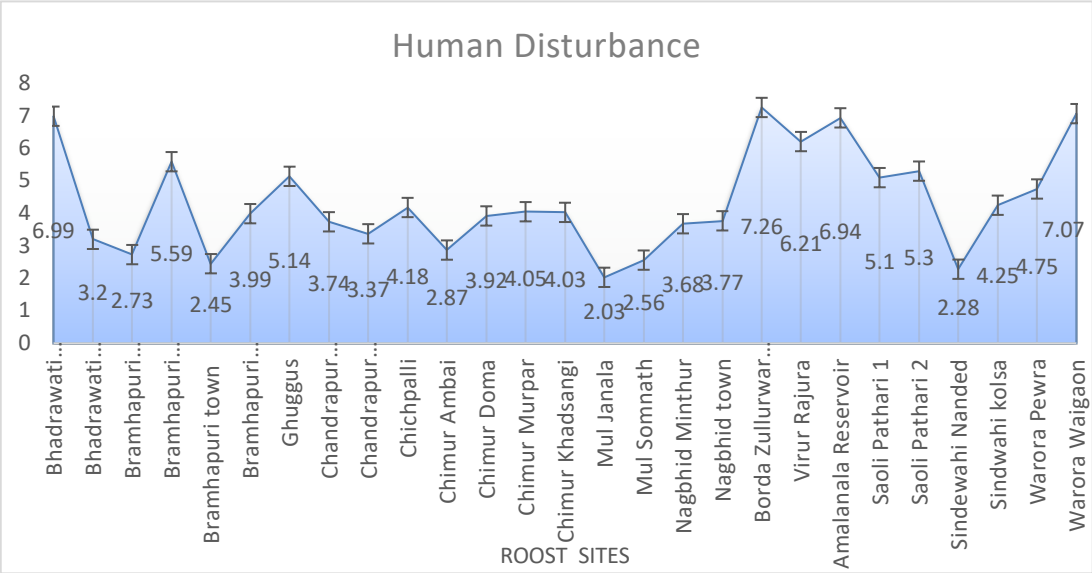

Fig. 5 – Human disturbance index on colony size and viability in Chandrapur dist.

Discussion:

The study identified a total of 42 roosting trees across 27 sites within the Chandrapur district. The selection of roosts by *Pteropus medius (giganteus)* was influenced by structural properties of the trees like size of the canopy cover and diameter at breast height (DBH). Colony size was related to the number of roost trees and grove size in the study site. The positive relationship between colony size and grove size indicates the choice of Pteropus medius (giganteus) for big groves, which may provide additional safety for their existence and breeding (Granek 2002, Gulraiz et al. 2015). Albeit high variation in the canopy cover, height, and DBH of the roost trees, our study reveals that these variables play a key role in understanding the colony size of Pteropus medius (giganteus). The data of the current study confirm earlier studies suggesting bats use big trees as preferred habitat (Vyas & Upadhyay, 2014; Elangovan & Kumar, 2015). In this study, seven different tree species selected by *Pteropus medius (giganteus)* were identified, demonstrating its ability to thrive in various habitats. These records are consistent with previous studies in India regarding Pteropus medius (giganteus) roosting on various tree species (Chakravarthy & Yeshwanth 2008; Bhatnagar & Salvi 2011; Timalsina & Ghimire 2011; Dey et al. 2013; Ali 2014; Manandhar et al. 2018; Mishra et al. 2020; Madala et al. 2022). Similar research spotted 22 species of trees for roosting across 20 districts in Uttar Pradesh (Kumar & Elangovan, 2019). This underscores the importance of preserving larger groves to provide roosting habitats for large bat colonies. The findings strongly indicate that *Pteropus medius (giganteus)* in the Chandrapur district exhibits a preference for specific roosting trees, particularly large-canopied, mature arboreal species such as *Mangifera indica, Ficus religiosa*, and *Ficus benghalensis*. The tree species identified align with earlier research in peninsular India (Kunz & Lumsden, 2003; Tiwari et al., 2019), which suggested that fruit bats favor fig and mango trees due to their evergreen foliage, abundant food sources, and extensive canopy cover. The proximity of most roosts to water sources is supported by South Asian data, which indicates that water availability is a primary factor in bats' roost selection (Molur et al., 2021). Riparian vegetation not only provides food sources but also offers microclimatic conditions that mitigate heat stress, which is vital for day-roosting bats in tropical regions. *Pteropus medius (giganteus)* demonstrates a high degree of synanthropy,

Print version ISSN 0e70 0765
Online version ISSN 2320 3188

roosting in various human-impacted habitats such as temples, village forests, and roadside cultivation sites, even amidst significant human disturbance. This finding supports previous studies (Mickleburgh, Hutson, & Racey, 2002; Mahmood-ul-Hassan et al., 2010), which concluded that fruit bats can persist in anthropogenically modified environments where roosting trees are adequately preserved. However, colonies in forest habitats with low disturbance levels were generally larger, suggesting that sites with reduced disturbance may be more conducive to supporting large bat populations. The reliance on a limited range of tree species indicates potential vulnerability to habitat loss and degradation, particularly in the rapid decline of large old-growth trees due to urbanization and agriculture in central India (Singaravelan & Marimuthu, 2004). Therefore, the conservation of roost trees, especially culturally significant fig trees and mango groves, is essential for the continued survival of *Pteropus medius (giganteus)* populations in the district. Overall, the research highlights that the roost selection behavior of *Pteropus medius (giganteus)* is governed by a combination of tree structure, proximity to water sources, and human tolerance. The study highlights the need for conservation strategies that are based on community involvement, fostering a deeper understanding of the ecological roles fruit bats play in seed dispersal and pollination to safeguard essential roosting habitats. These findings are consistent with previous records.

Conclusion:

In summary, the findings of the current study uncover that roost preference of *Pteropus medius (giganteus)* at Chandrapur is influenced by tree size, arrangement of canopy structure, water proximity, and by tolerance of human disturbance. Despite the fact that the species has demonstrated its potential to adjust and tolerate disturbed human-influence landscapes, its specificity in dependence on a restricted pool of culturally and environmentally significant tree species renders it at risk of modifications in its environment. Hence, its conservation has to integrate ecological imperatives, cultural significance, and proactive role by the immediate people to ensure the longevity of this ecologically significant central Indian bat species..

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