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A study of stomatal distribution and trichome characteristics of some taxa of family Moraceae in Nashik region, (Maharashtra)

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Abstract
The genus *Ficus* (Family: Moraceae) includes several species with ethnobotanical and ecological importance. The present study investigates and compares the foliar anatomical characteristics of *Ficus carica, Ficus religiosa,* and *Ficus benghalensis*, focusing on the stomatal morphology, stomatal distribution in upper and lower epidermis, and trichome types. Leaf samples were subjected to microscopic analysis for identification of stomatal index, stomatal size, trichome density and epidermal structure. Results revealed that *Ficus carica* exhibited amphistomatic leaves with abundant stomata, while *Ficus religiosa* presented mostly hypostomatic leaves with anisocytic stomata. *Ficus benghalensis* leaves were found to be amphistomatic with unicellular and multicellular non-glandular trichomes. The study concludes that foliar anatomy serves as a useful diagnostic parameter in species identification and has ecological significance such as drought tolerance and adaptation.

Keywords: Ficus, Moraceae, foliar, anatomy, stomatal, trichome

Introduction

The genus *Ficus* (Family: Moraceae) comprises more than 800 species widely distributed in tropical and subtropical regions. These plants are highly valued due to their medicinal, ecological, cultural, and economic significance. Foliar anatomical characteristics such as stomatal types, distribution, and epidermal trichomes are reliable taxonomic markers in plant systematics and physiology. Stomata regulate gas exchange and transpiration, and their morphology reflects ecological adaptation. Trichome may provide mechanical protection, reduce transpiration, or assist in herbivory resistance. Comparing foliar features among three *Ficus* species provides insights into their ecological strategies and taxonomic variation.

Materials and Methodology

a. Materials

Sample Collection

Fresh and healthy leaves of *Ficus carica*, *Ficus religiosa*, and *Ficus benghalensis* were collected from different localities within the Nashik region (Maharashtra, India). Leaf samples were collected in the morning from mature plants. These three species are identified and authenticated from Botanical Survey of India, Pune (M.S.).

Ficus carica

Ficus religiosa

Ficus benghalensis

b. Methodology

Epidermal peels from both the adaxial and abaxial surfaces were obtained using the standard peeling method. In species where peeling was difficult, leaf samples were treated with 5–10% nitric acid or warm water to soften tissues, followed by gentle scraping using a fine brush or forceps. The peels were thoroughly washed with distilled water. Take epidermal peel or clear leaf using 5–10% nitric acid [5] (Ramasubbu, R. (2010). or warm to soften tissues. And then add 1–2 drops of Safranin stain, Keep for 1–2 minutes in the diluted safranin stain and wash with water. Mount in glycerin. Observe under microscope.

Microscopic Observation

Microscopy was performed using a compound light microscope. The following parameters were studied:

- Stomatal distribution (upper & lower surface)
- Stomatal type and size
- Stomatal index
- Trichome type and density

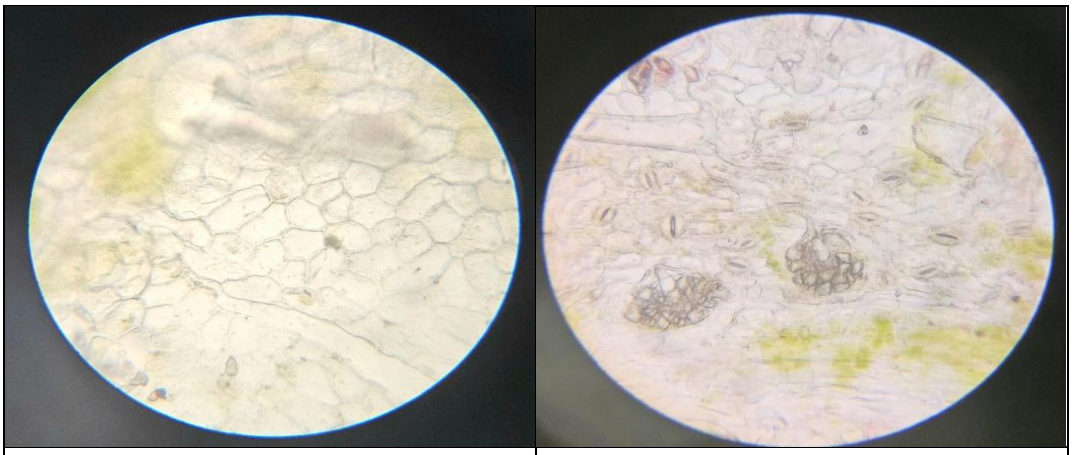
Quantitative Analysis

The stomatal index (SI) was calculated using the formula:

$$SI = \frac{\text{No. of stomata}}{\text{No. of stomata} + \text{No. of epidermal cells}} \times 100,$$

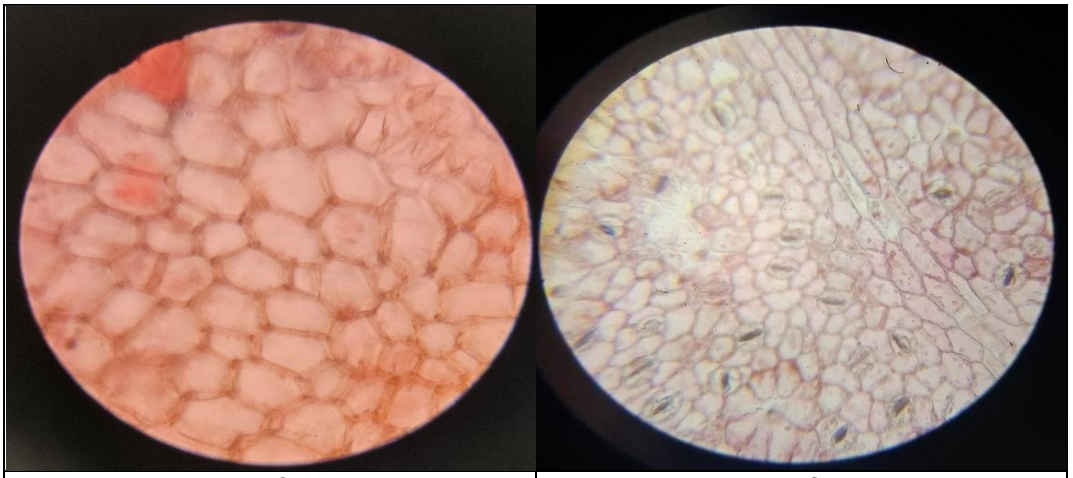
which expresses the proportion of stomata relative to the total epidermal cell count. (Salisbury, E. J. (1927) [1], Kumar, S., & Bhatia, H. (2016) [9], Kaushal, N., & Singh, A. (2018).

Observation



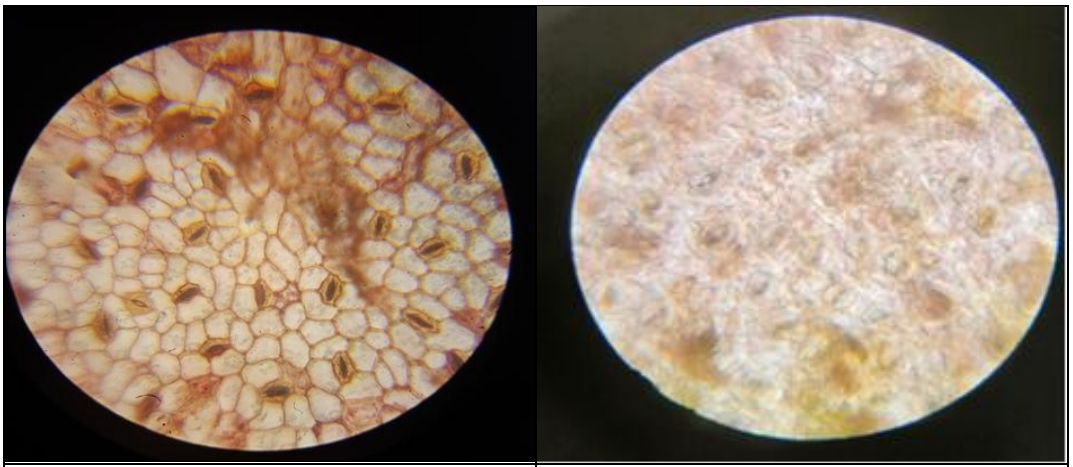
Ficus carica Adaxial Surface of stomata	*Ficus carica* Abaxial Surface of stomata

Fig 1:



Ficus religiosa Adaxial Surface of stomata	*Ficus religiosa* Abaxial Surface of stomata

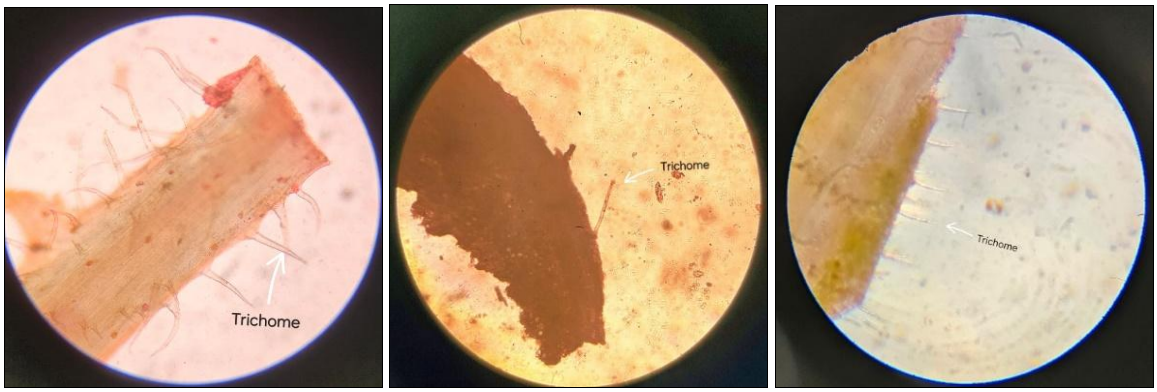
Fig 2:



Ficus benghalensis Adaxial Surface of stomata	*Ficus benghalensis* Abaxial Surface of stomata

Fig 3:

Trichome characteristics



Ficus carica *Ficus religiosa* *Ficus benghalensis*

Fig 4:

Macroscopic Observation

Species	Leaf Surface	Texture	Margin
F. carica	Rough	Soft	Entire
F. religiosa	Smooth	Thin	Entire
F. benghalensis	Thick	Leathery texture that can feel soft, smooth	Entire

Microscopic Observations
Stomatal Distribution and Type

Species	Upper Epidermis	Lower Epidermis	Stomatal Type
F. carica	Absent	Present	Anomocytic
F. religiosa	Absent	Present	Paracytic
F. benghalensis	Present	Present	Anomocytic

Stomatal Density

Species	Upper	Lower
F. carica	0	35–40 mm²
F. religiosa	0	30–35 mm²
F. benghalensis	18–22 mm²	25–30 mm²

Trichome Characteristics

Species	Trichome Type
F. carica	Non-glandular, unicellular
F. religiosa	Glandular unicellular
F. benghalensis	Multicellular non-glandular, abundant

Discussion

The comparative anatomical study reveals significant variation among the three *Ficus* species: -

In *Ficus carica* leaf surface is rough, leaf texture is soft and margin is entire as compare to in *Ficus benghalensis* leaf surface is think and texture is Leathery texture that can feel soft, smooth and leaf margin also entire. (In Fig No.01&03) *Ficus carica* and *Ficus benghalensis* the stomata style is Anomocytic. i.e., both these are amphistomatic, indicating adaptation to high sunlight exposure. In Ficus carica in which trichome is Non-glandular and unicellur as compare to in ficus benghalensis the trichomeis non-glandular and multicellur. In (In Fig No.02) *Ficus religiosa* leaf surface is smooth, leaf texture is thin and margin is entire. The stomata are present only lower surface and stomata style is Anisocytic. i.e. *Ficus religiosa* is hypostomatic, which is usually a water-conserving adaptation. The trichome is unicellular. Stomatal types provide taxonomic distinction of these three species of family Moraceae: - In Fig No.04 *F. carica* and *F. benghalensis is* Anomocytic stomatal type. *F. religiosa* in which paracytic stomatal type. These differences highlight the ecological adaptability of each species and support the value of foliar anatomy in plant taxonomy.

Result

The comparative foliar anatomy of *Ficus carica*, *Ficus religiosa*, and *Ficus benghalensis* revealed notable species-specific variations in stomatal distribution and trichome characteristics. *F. carica* exhibited a higher stomatal density on the abaxial surface with predominantly anomocytic stomata, while *F. religiosa* showed moderate stomatal density with a mixture of paracytic types. *F. benghalensis* displayed the lowest stomatal density but possessed well-developed non-glandular trichomes, contributing to increased leaf surface protection. Trichome density was highest in *F. benghalensis*, moderate in *F. carica*, and least in *F. religiosa*. These differences reflect distinct adaptive strategies related to microclimatic conditions and stress tolerance.

Conclusion

The study concludes that foliar anatomical traits such as stomatal distribution and trichome morphology vary significantly among *Ficus carica*, *Ficus religiosa*, and *Ficus benghalensis*, indicating species-specific ecological adaptations. The high stomatal density in *F. carica* suggests efficient gas exchange under moderate environmental stress, whereas the dense trichome covering in *F. benghalensis* reflects enhanced protection against desiccation and herbivory. *F. religiosa* demonstrates intermediate traits, representing a balanced adaptive strategy. Overall, the comparative analysis highlights the functional importance of foliar anatomy in supporting the survival and ecological versatility of Ficus species.

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