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Hair style of Solanaceous plant: A morphological investigation

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ABSTRACT

Hairs are a covering of trichomes (fine hairs) covering plant surfaces including leaves, stems, fruits, sepals, petals and reproductive parts, and hold a significant position in plant taxonomy, physiology, stress response and fossil reconstruction study. To study the objective of hair morphology of Solanaceous plants, three local taxa - *Solanum lycopersicum* L., *Physalis minima* L., *Solanum diphyllum* L. were collected and epidermal hairs were investigated. Both vegetative and reproductive parts were prepared by following proper methodology including cleaning, peeling and observation under the light microscope. A total of ten different types of hairs have been documented in the tree taxa. The hairs can be classified as pointed gland, glandular hair, unicellular hair, unicellular stinging hair, multicellular stinging hair, multicellular finger hair, strigose, hirsute, hispid, and short conical hair. The similarities and dissimilarities of hair types among taxa can be used as a reference point for future systematic and stress response studies in the family Solanaceae.

KEYWORDS: Hair morphology, Plant parts, Solanaceae

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INTRODUCTION

Hairs are distributed almost universally in the plant kingdom and exhibit dramatic variation and alteration in their morphology and density (Ganguly & Das, 2023). The plant surface exhibits spectacular variation in the size, shape, location and origin of epidermal projections (Werker, 2000). Most important and well-studied plant hairs are unicellular or multicellular appendages (hair-like structures) of various plant parts (Oksanen *et al.*, 2018) and originated outwards (Werker, 2000).

Solanaceae is an angiosperm family of flowering plants comprising about 147 genera with 3000-4000 species (Lawrence, 1951; Judd *et al.*, 2002). Economically and commercially important plants belong to this angiosperm family. Indeed, Solanaceae is one of the most valuable and variable families among vegetable crops in terms of the number of species that have been domesticated and its wide variety of uses (Mueller *et al.*, 2005; Das & Ganguly, 2024).

Members belonging to the family Solanaceae display wide variation in their hair types which play important roles in taxonomic evaluations and responsiveness of plants to abiotic as well as biotic stress (Ganguly & Das, 2024). Considering the importance of epidermal hair in taxonomic research and stress biology of plants, endeavour has been made in the present investigation to characterize hair morphology on different parts of three local Solanaceous members. A perusal of the literature cites various scanty information regarding the morphology of surface hair in the three local Solanaceous members. The present endeavor has therefore been taken with objectives to describe the hair types in *Solanum lycopersicum* L., *Physalis minima* L., and *Solanum diphyllum* L. The outcome of the study may help determine the similarity and dissimilarity of hair types among the taxa and to deduce the importance of plant's epidermal hair in taxonomy and other biological and molecular study.

MATERIALS AND METHODS

Study Area

The present study was conducted in the month of February-July 2024. Plant materials were collected from Santipur, Nadia, West Bengal, India. Among the three plants two plants were the most available and one (*Solanum diphyllum* L.) was found very restricted in distribution in the present study area (Figure 1).

Plant Materials

Two wilds and one cultivated species of genus *Solanum* (3 species in total) were included in the present study (Figure 2).

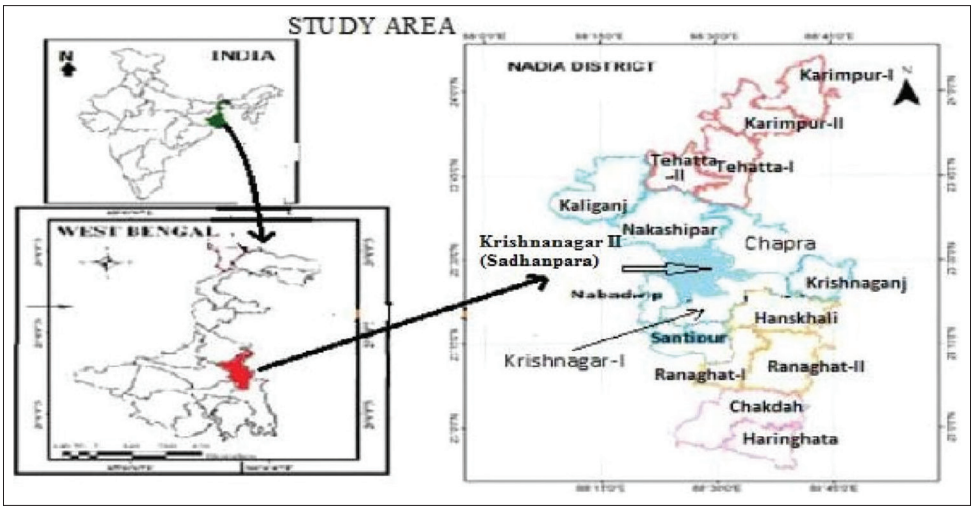

Figure 1: Study area

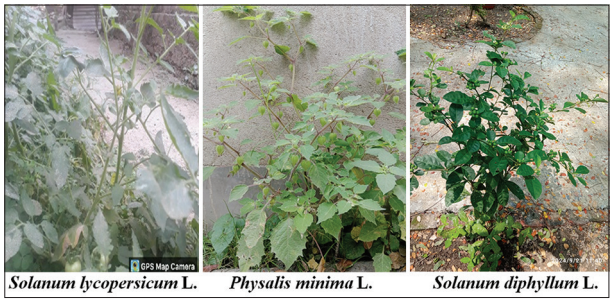

Figure 2: Photographs of selected plants in study areas

The selected plants were
i) *Solanum lycopersicum* L.
ii) *Physalis minima* L.
iii) *Solanum diphyllum* L.

Plants were identified with the help of resources available at the Department of Botany, Ranaghat College and author citation was done with online resources using www.ipni.org.

Methodology

Collected plant samples were carefully cleaned (not with water, just dust free) and each (stem, leaf, flower and fruit) of the three selected plants was observed under the light microscope (10x). Both dorsal (adaxial) and ventral (abaxial) sides of fresh leaf Samples (n=5 per slide per sample) were used. For the microscopic observation, the stems of collected plants were cut in transverse sections (T.S) and peeled stem and leaf surfaces whenever necessary. Sharp razor blades were used for peeling both the upper and lower surfaces of fresh leaves. The peelings were then washed in distilled water (pH=7) and the washed material was then mounted in 50% glycerin, wax-sealed and observed under light microscope. Each part of the three taxa was studied. Photographs of each sample were taken in triplicate with the digital camera and a suitable one was selected. Identification of hair type was done following Roe (1971) and hand book of terminology of plant indumentum (Hewson, 1988).

RESULTS

Epidermal characters of three members of Solanaceae were analysed in the present study. The nature of epidermal hairs analysed in the three members of Solanaceae is detailed below and presented in Table 1.

Solanum lycopersicum L.

The stem surface manifested at least three types of hairs, namely long stinging hairs, short glandular hairs and dense hirsute hairs (Figure 3a-d). Multicellular finger hairs were present on both sides of the leaves. This hairstyle was found intermixed with strigose non glandular types of hairs and attenuated glandular hairs with minute tips as well as glandular hairs with globular heads on the leaf surface (Figure 3e, f). All hairs were unbranched. Among floral members sepals and styles exhibited distinct stinging hairs (Figure 3g, h).

Physalis minima L.

Multicellular stinging hairs were present on the stem surface (Figure 3i, j) while unicellular stinging hairs were observed with pointed glands on the leaf margin (Figure 3k). This hairstyle was found on the ventral and dorsal sides of sepals also (Figure 3l, m). The ventral and dorsal side of the petal manifested three types of hair- multicellular stinging hair, finger like hair, and glandular hair (Figure 3n, o). All hairs were unbranched. The filament exhibited large stinging hairs bending (Figure 3p).

Solanum diphyllum L.

Glands with pointed tip were noticed on the stem surface as well as ventral and dorsal sides of both large and small leaves (Figure 4a-e). Short conical hair was also exhibited on the stem surface (Figure 4b). The glands were found intermixed showing unicellular hairs on the ventral and dorsal sides of both sepals and petals (Figure 4 f-i). All hairs were unicellular and unbranched. The hairs were densely located on the tip portion

Table 1: Overview of Solanaceous hair types in the present study

S. No.	Name of the studied plants	Plant part/s	Major hair types
1	*Solanum lycopersicum L.*	Stem, leaves, floral parts	Multicellular finger, strigose, attenuted glandular hair, long stinging, hirsute, hispid.
2	*Physalis minima L.*	Stem, leaves, floral parts	Unicellularand multicellular stinging hair, glandular hair, bend stinging hair.
3	*Solanum diphyllum L.*	Stem, leaves, floral parts	Short conical hair, pointed gland, unicellular hair.

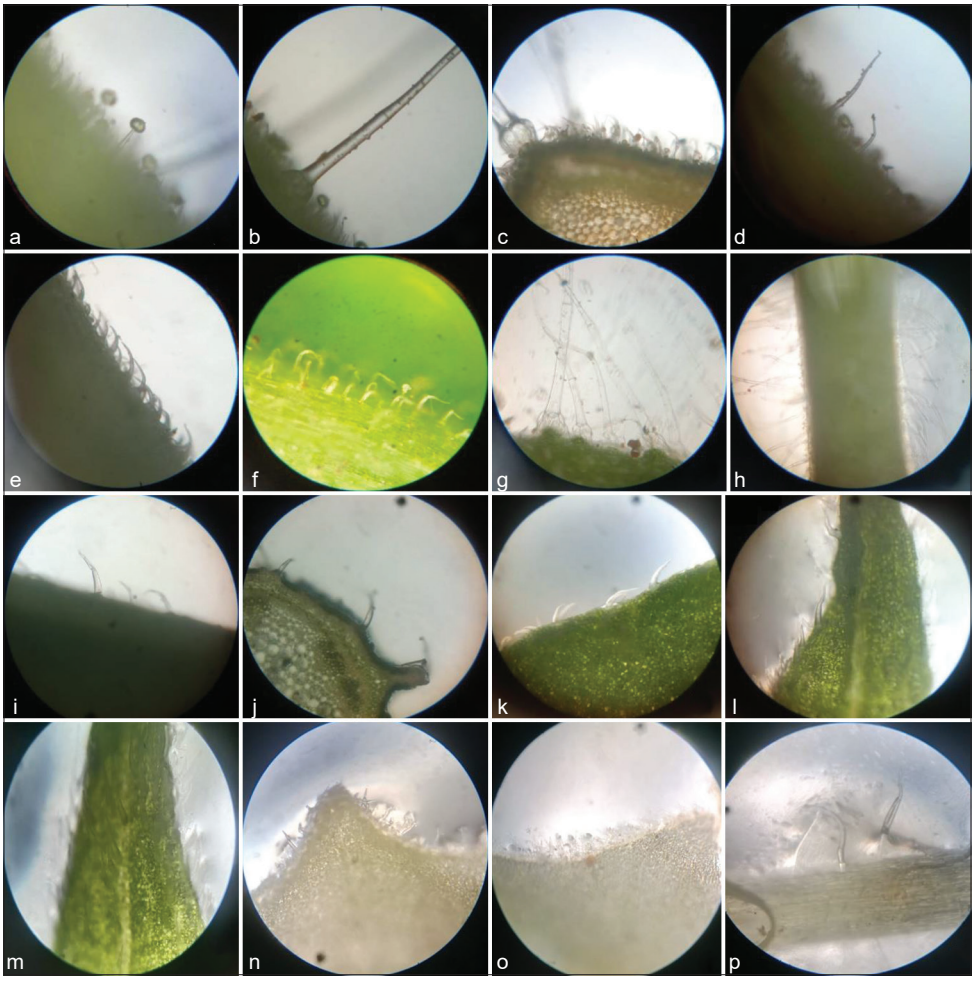

Figure 3: *Solanum lycopersicum* L. surface hair types; a) multicellular glandular hairs on stem, b, d) stinging hairs intermixed with glandular hairs, c) T.S of stem, e, f) ventral and dorsal side of leaf, g) stinging hairs on sepal, h) style (10x). *Physalis minima* L. surface hair types; i) stinging hairs on stem, j) T.S of stem, k) leaf margin, l, m) ventral and dorsal side of sepal, n, o) multicellular stinging hair intermixed with glandular hairs on ventral and dorsal side of petal and p) large bend stinging hairs on filament (10x)

of both sepals and petals and then gradually decreases to the lower surface.

DISCUSSION

The use of epidermal hair morphology or indumentation has become a growing tend to solve not only taxonomic problems but to help in fossil reconstruction also. Based on similar anatomical features like a large capitate gland on the surface of dispersed stems (*Lyginopteris*), leaves (*Sphenopteris*) and cupulateovule (*Lygenostoma*) the fossils were reconstructed (Oliver & Scott, 1904). Hairstyles have been considered as one of the most dependable genetic traits (Bukenya & Carasco, 1994; Adedeji *et al.*, 2007; Harisha & Jani, 2013). In plant physiology epidermal hairstyles play important roles. Pant hormones Jasmonic acid (JA), Salicylic acid (SA) and Gibberellic acids (GAs) reportedly help to increase trichome production of leaves on damage sites and protect plants from attack by insect or herbivores (Traw & Bergelson, 2003).

In the present morphological investigation, different hair styles were tracked under light microscope in three local taxa belonging

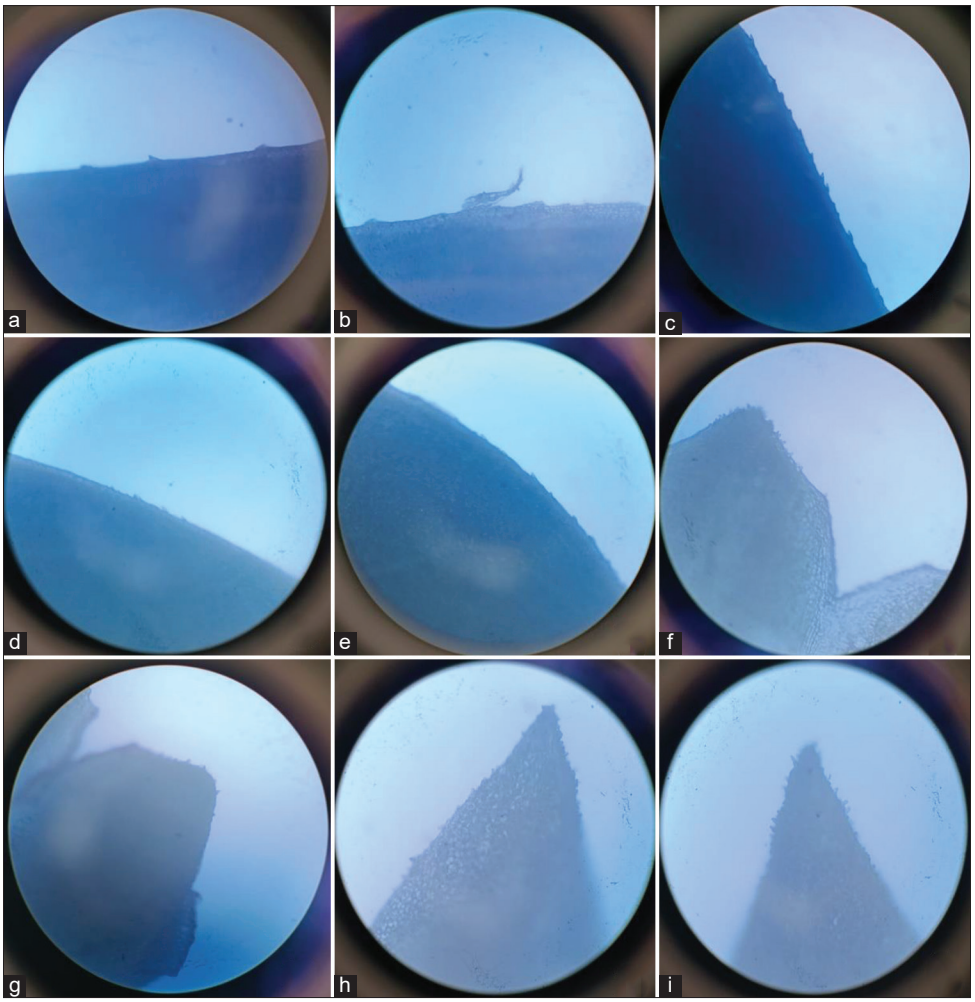

Figure 4: *Solanum diphyllum* L. surface hair types; a) pointed glands on stem, b) short conical hair, c) pointed gland on large leaf, d) ventral side of small leaf, e) dorsal side of small leaf, f, g) unicellular hair intermixed with pointed gland on ventral and dorsal side of sepal, h and i) ventral and dorsal side of petal (10x, with filter).

to the family Solanaceae. Occurrences of stinging hairs were common in stem, and on both ventral and dorsal side of leaves and sepals of both *Solanum lycopersicum* L. and *Physalis minima* L. However, in case of reproductive parts stinging hairs were found only in the style of *S. lycopersicum* and filament of *P. minima*. Interestingly, in case of *S. diphyllum* a unique type of pointed glands were found on the surface of the stems, large and small leaves, and also on sepals and petals. On sepals, these pointed glands were intermixed with unicellular hairs which confirmed earlier observation (Sumitha & Thankappan, 2018). In the present study, short conical hairs were rarely found on stem of *S. diphyllum* while multicellular glandular hairs were occurred on stem surface of *S. lycopersicum*. The glandular hairs are multicellular in most of the cases and were considered characteristics features of *Solanum* sp (Anil Kumar *et al*., 2017). This is in sharp contrast to results obtained in *P. minima* where glandular hairs were unicellular in the present study. *S. lycopersicum* exhibited comparatively large stinging hairs than *P. minima*. Lower frequency of glandular hair compared to non-glandular unbranched as well as dendroid-stelliform hairs was reported earlier in *Physalis* spp. (Seithe & Sullivan, 1990). Four types of trichomes (glandular, non-glandular dendritic, non-glandular bicellular and non-glandular multicellular) was reportedly found in medicinal plant *Withania somnifera* (Munien *et al*., 2015), which in accordance with the present study indicating occurrence of intraspecific variation in epidermal hair styles in Solanaceous taxa. Other hair types like hispid, hirsute, strigose, and attenuated glandular hairs were also found on the surface of *S. lycopersicum*. In the latter case, attenuated glandular hairs with minute tips as well as glandular hairs with globular head both were observed intermixed with non-glandular hair on leaf surfaces which supports the earlier observation (Watts & Kariyat, 2021).

Recent studies also indicated that non-glandular hairs in the *Solanum* species prevent herbivory primarily by deterring herbivore movement, feeding and oviposition (Kaur & Kariyat, 2020). Quite contrastingly, glandular trichomes may not cause physical damage as it is pliable but can release toxic chemicals to intoxicate herbivores (Kariyat *et al*., 2019; Kaur & Kariyat, 2020). Glas *et al*. (2012) reviewed the metabolic diversity found especially within glandular trichomes of the Solanaceae, and of the genomic tools like targeted genetic engineering, available to manipulate their activities for increasing pest resistance in sustainable agriculture.

CONCLUSION AND FUTURE PROSPECTS

Variety of hairs or trichomes can be correlated as a measure of evolutionary progress of the species. The hair style is a genetically-controlled morphology in plants. In the present study, diverse types of hair styles were revealed; unicellular, bicellular, multicellular, glandular, non-glandular, hirsute, hispid, strigose and stinging types. Both glandular and non-glandular hairs were noticed in the three taxa and diversity of hair styles exists in number, distribution pattern, and structure of hairs in three species. Among the hair styles, stinging, non-glandular types were found in the members who did not show huge glandular types and vice-versa, indicating distinct hair types in Solanaceae. The similarities and dissimilarities among three taxa regarding epidermal hair characters can be used as a reference of future taxonomic grouping of taxa in Solanaceae. Furthermore, being an important stressor, hairs in Solanaceae can also act as referral source for further studies regarding hair-related traits and their relationships with biotic and abiotic stresses and also used as referral for fossils reconstructionas well as forensic study. Use of advanced genomic analysis and breeding tools on hair styles of Solanaceae may give further insight of biological significance of hair pattern studied in the present Solanaceous taxa.

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