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Hair morphology in Three Local Solanaceous Taxa

Research Article

Ganguly S* and Das S

Graduate Student, Department of Botany, Ranaghat College, Ranaghat, Nadia,West Bengal, India

***Corresponding author:** Sudarshan Ganguly, Department of Botany, Ranaghat College, Ranaghat, Nadia, West Bengal, India. E-mail Id: sudarshanganguly2001@gmail.com

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Abstract

Hairs or indumentum are the unicellular or multicellular outgrowth of epidermal cells, commonly observed on plant surface including leaves, stems, fruits and different parts of flower. Single linear row or several rows of cells constitute multicellular hairs. It holds significant role in plant taxonomy, physiology, ecology, anatomy, systematic and stress response study. The family Solanaceae with large number of genera exhibited diverse types of hair or trichome or indumentums. With an objective to study hair design pattern in Solanaceae, three locally available plants were selected and epidermal hair morphology were investigated. Following proper methodology in cleaning, peeling and observation, both vegetative and reproductive parts were prepared on glass slides. Plant parts like leaves, stems and floral parts were observed. Fairly widespread diversity were observed between three different plants and between parts of same plant. The hair styles ranged from glandular to non-glandular, unicellur, bicellular to multicellular, branched to un-branched and other variations stellate, stinging, strigose, hirsute, hispid types etc. which were found to be stable in different replicates. The similarities and dissimilarities among taxa regarding hair morphology can be used as a reference point for future systematic studies in the family Solanaceae.

Keywords: Hair Design; Morphological Investigation; Vegetative and Reproductive Parts; Solanaceae

Introduction

The Solanaceae Juss. commonly known as Potato family, is a large angiosperm family consisting a large number of genera (~3500 species) throughout the world, mostly shrubs or herbs rarely lianes, distributed mainly in the tropical and temperate regions [1,2]. In India, this family is represented by 88 species, belonging to 15 families. Most of the species are either wild or cultivated throughout India and are chiefly found in Himalayan range, Southern and Eastern India [3]. Commercial taxa like potato (*Solanum tuberosum* L.), egg plant (*Solanum melongena*), tomato (*Solanum lycopersicum* L.), chilies (*Capsicum annum* L.), tobacco (*Nicotiana tabacum* L.) and Datura (*Datura stramonium* L.) are cultivated throughout India as commercial purposes. *Solanum verbascifolium* L. a small Solanaceous tree that is native to southern North America and northern South America is also observed in India. Many members of the family are used as medicinal plants. Belladonna is a homeopathic medicine from *Atropa belladonna* L., is used as treatment of spasmodic cough and bronchitis and helpful on respiratory problems. Similarly, *Withania somnifera* L. or 'Aswagandha' is used as a stimulant, tonic and treatment of sleep disorder [2,4,5].

Surfaces of various plant organs display impressive variation in the origin, size, shape, location, and distribution of epidermal projections [6]. Notable among these are the plant hairs: Unicellular or multicellular appendages (hair-like structures) originating from epidermal cells of various plant parts including leaves, stems and flowers [7], and projecting out wards [6]. Plant hairs are distributed almost universally in the plant kingdom and exhibit dramatic variation in their morphology and density on plant surface. The use of morphological and leaf epidermal features has been found to be of immense interest in taxonomic research [8,9].

Plant hairs can be classified into glandular (presence of glandular head) and non-glandular (absence of glandular head) [6]. Taxa of family Solanaceae exhibited wide spread variation in surface hair morphology [6,10]. Both glandular and non- glandular hairs are found which can be classified into unicellular and multicellular

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hair. Non-glandular unicellular hairs were found as multicellular which can be further classified into branched and unbranched. Non-glandular multicellular branched hairs are four types – stellate, peltate, Candelabra, T- shaped and non-glandular multicellular unbranched hairs are three types-, uniseriate, biseriate, multiseriate [9-11].

Increased attention has been paid regarding roles of plant epidermal morphology in taxonomic evaluations and responsiveness of plants to biotic as well as abiotic stressors. Considering the importance, present study has been undertaken to document the epidermal hair morphology in different vegetative and reproductive parts of three common members of Solanaceae. It can provide a reference point for future study on hair types and its use in determining systematic position and ranking of Solanaceous members in Angiosperm.

Materials and Methods

The present investigation was done on three plants belonging to the family Solanaceae.

Study Area

Present study was conducted in the month of February-March 2023. Plants materials were collected from Santipur, Nadia, West Bengal, India. The plants were the most abundant in the present study area (Figure 1).

Methodology

The collected plant samples were carefully cleaned (not with water, just dust free) and each part (stem, leaf, flower, and fruit) of every plant were observed under compound light microscope (10x). Both adaxial (dorsal) and abaxial (ventral) side of fresh leaf samples (n =5 per side per sample) were used. For the microscopic investigation the stems of collected plants were cut in transverse section (T.S). Stems and leaf surface were peeled whenever necessary. The mechanical scratching method was followed for obtaining the peels. Epidermal peelings were taken from both the upper and lower surfaces of the fresh leaves, using a sharp razor blade. The peelings were then washed in distilled water and the peelings were then mounted in 50% glycerine, sealed using wax and observed under Microscope. Chemical pre-treatment was not done in any case and staining was avoided to prevent any damage or alteration of the hair types/style. Each of the three specimen parts were studied in three different plants of same species. Photographs of each sample were taken in triplicate and suitable one was selected. Hair type identification was done following Reo (1971) and hand book of terminology of plant indumentum [13].

Results

In the present study, epidermal characters of three members of Solanaceae were analysed. Both vegetative and reproductive organs are considered. Among the vegetative characters, hair styles of dorsal and ventral leaf surface and stem surface were studied. The reproductive parts included surface hairs of floral parts like sepals, petals, anther lobes, filaments, ovary and fruits. The nature of hair types of the three members of Solanaceae are given in the (Table 1).

Solanum torvum Sw.

Characteristics stellate, non-glandular hairs present on stem surface. Leafepidermis is characterized by presence of large number of noticeable strong stellate hairs with 8 projections on both adaxial and abaxial surfaces, with lesser number of hairs on the dorsal side than that in the abaxial surface (Figure.2a-d). On both dorsal and ventral side of sepals, stellate hairs at high density were found interspersed with small glandular hairs. Lower numbers of hairs are present on petal surfaces. Hairs were multiple and stellate on ovary wall but are small and glandular on stigmatic surfaces (Figure.2 e-i).

Nicotiana plumbaginifoia Viv.

Unbranched glandular hairs showing sparse distribution are found present on adaxial surface of leaves and stems (Figure 3 a-f). The hairs are multicellular on stem surface.

Brugmansia suaveolens (Humb. And Bonpl. Ex Willd.) Sweet

Leaf upper epidermis was covered by bicellular finger hair while lower epidermis was covered by multicellular finger hair (Figure3 g-i). Hairs are non-glandular, un-branched with broad base and pointed curved apex (strigose type). On stem surfaces, multicellular, finger-like hairs with pointed tips are also found (Figure 3 j).

Discussion

Implementation of epidermal hair morphology or indumentum in plant taxonomy and systematics has become a growing trend to solve taxonomic problems in at genus and species level.Being very distinctive, easily noticeable and variable, the hair styles can be correlated with other taxonomic features of the taxa under investigation[14,15]. Hair styles have been considered as one of the most dependable genetic traits in angiosperm family Solanaceae[4,16-18].

In the present investigation, different hair structures were observed under light microscope in three different taxa belonging to the family Solanaceae. Stellate hairs occurred in leaves and stems of *S. torvum as* also observed in previous studies [9,18]. Hair styles are diverse in these three species ranging from glandular to non-glandular to stellate with different morphology in plant parts, as partially covered in an earlier study on leaf surface of *S. melongena* [19]. Leaf epidermis in *S. torvum* is characterized by presence of large number of noticeable strong stellate hairs with 8 arms on both adaxial and abaxial surfaces, with lesser number of hairs on the dorsal side than that in the abaxial surface. This is in accordance with earlier works on *S. torvum* leaves in which Kumar et al. (2017) [20] reported variation in number of arms in stellate hairs of *Solanum* spp. In another study, large-sized stellate trichome in *S. torvum* was present in the lower epidermis but the upper epidermis reportedly showed small stellate hairs [9]. In the present investigation, on both dorsal and ventral side of sepals, dense stellate non-glandular hairs were found intermixed with small glandular hairs. Lower numbers of hairs are present on petal surfaces. Hairs were multiple and stellate on ovary wall but are small and glandular on stigmatic surfaces. The thick mat provided by stellate hairs in the present study may be correlated with ecological and protective adaptation of Solanaceous members. Sampaio et al. (2014) [5] observed great diversity of stellate trichomes, mainly porrect-stellate and multiangulate, and peltatetrichomes in *S. swartzianum*

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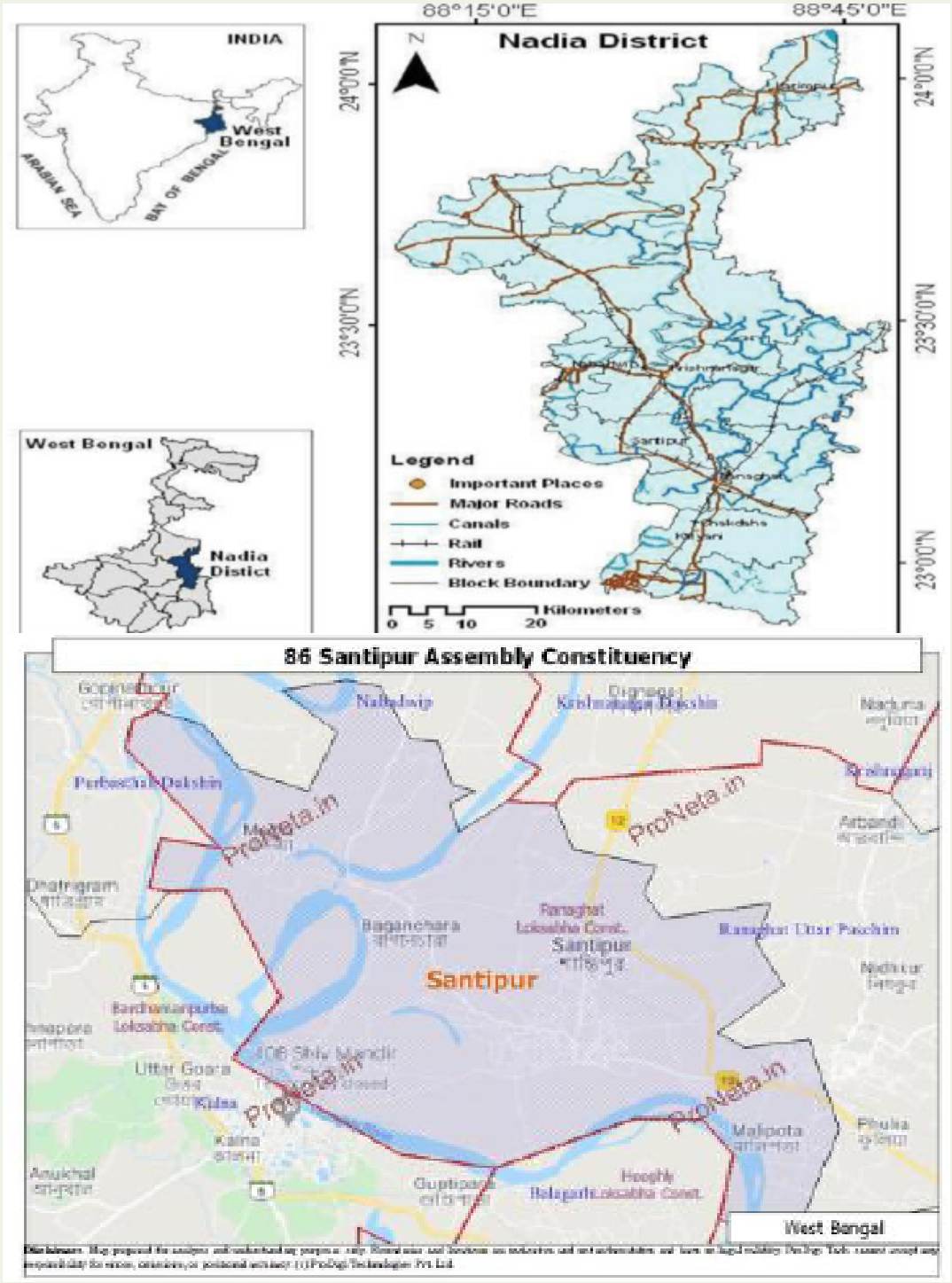

Figure 1: Study area.

• Plant materials

A mixture of two wild and one domesticated species of genus Solanum were included in the present study. The selected plants are-

(i) *Solanum torvum* Sw.

(ii) *Nicotiana plumbaginifoia* Viv.

(iii) *Brugmansia suaveolens* (Humb. & Bonpl. Ex Willd.) Sweet

Selected plant specimens were identified with the help of Herbarium available at Department of Botany, Ranaghat College and author citation was done with www.ipni.org.

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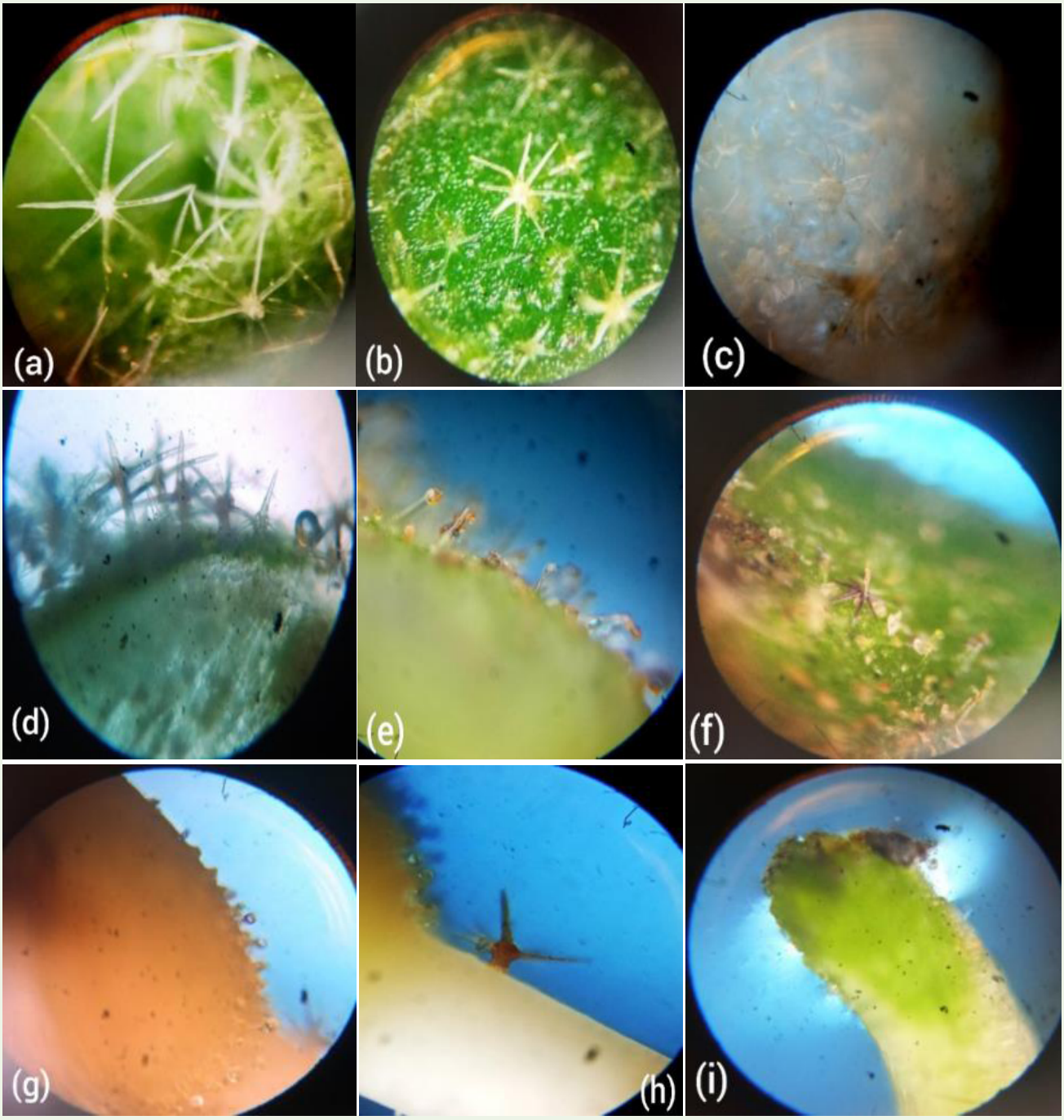

Figure 2: *S. torvum* surface hair types; (a) adaxial, (b) abaxial surface of leaf, (c) petal, (d) stem, (e) glandular hairs on sepals, (f) mixed glandular and stellate hair on sepals, (g) short glandular hair on ovary, (h) stalked stellate hair with 4 arms, (i) short glandular hair on stigma (10x).

Table 1: Outline of Solanaceous hair types in the present study.

Sl. No.	Name of the studied taxa	Plant part/s	Major hair types observed
1.	*Solanum torvum* Sw.	Stems, leaves, floral parts	Stellate, Small glandular hair.
2.	*Nicotiana plumbaginifolia* Viv.	Stems, leaves, floral parts	Stellate, Small glandular hair.
3.	*Brugmansia suaveolens* (Humb. & Bonpl. Ex Willd.) Sweet	Stems, leaves, floral parts	Bicellular and multicellular finger hair, strigose, large glandular hair.

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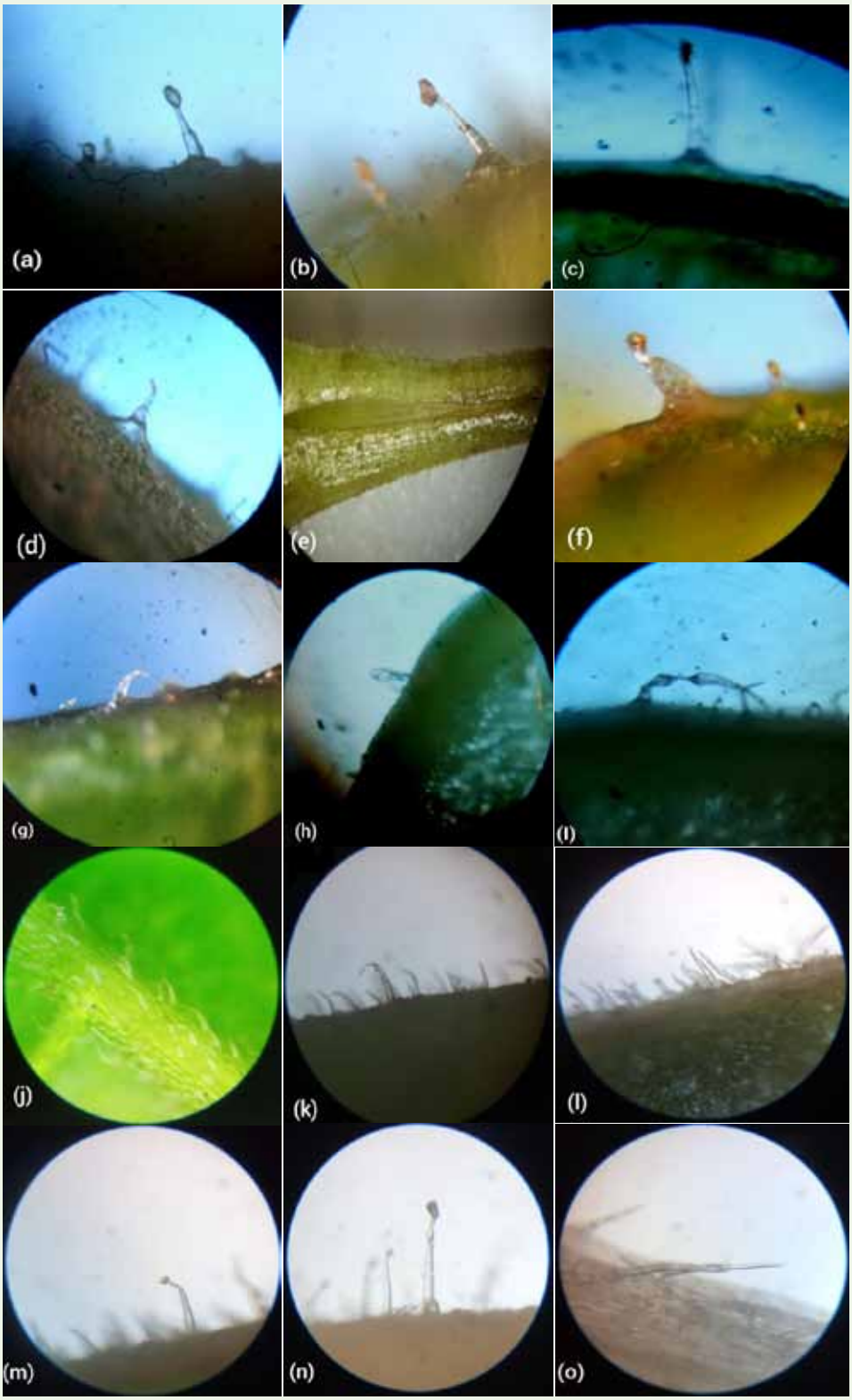

Figure 3: *Nicotiana plumbaginifolia*: (a) multicellular long glandularhairs on adaxial leaf surface, (b) on abaxial surface, (c) on stem, (d) non-glandular scabrous hair on stem small pilose like hairs on sepals, (f) glandular hairs on anther filament; (10x) *Brugmensia* sp: Hair style on (g, h, i, j) leaf adaxial and abaxial surface, (k) Stemshair;(l) sepal abaxial surface; (m,n,o) petal abaxial and adaxial surface;(10x).

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at Atlantic forest. Along with other leaf epidermal characters, the study showed diversity of trichomes exhibiting four types: glandular, nonglandular, stellate, and dendritic. Nonglandular trichomes were found in the leaves of *Hyoscyamus* species, as found in the present *S. torvum*, *Brugmensia* sp. But the pattern and intermixing with other types of hairs on a particular plant parts are unique in the present study which assumes significance for the future work.

The distinct stellate hairs in the present investigation also exhibited glandular types which were found in the sepals and stigma of *S. torvum* and also in sepals, anther filament, fruit surface and adaxial surface of leaves and stems of *N. plumbaginifolia*. The glandular hairs are multicellular in most of the cases and were considered characteristics features of *Solanum* sp [20]. Lower frequency of glandular hair compared to non-glandular unbranched as well as dendroid-stelliform hairs was reported earlier in *Physalis* sp. of Solanaceae [15]. Four types of trichomes (glandular, non-glandular dendritic, non-glandular bicellular and non-glandular multicellular) was reported, found in *Withania somnifera* [21], which in agreement with the present study indicating occurrence of intraspecific variation in epidermal hair styles in Solanaceous taxa.

A different type of hair pattern was observed in *Brugmansia suaveolens* where upper epidermis of leaves was covered by bicellular finger hair but lower epidermis was covered by multicellular finger hair. Similar results were obtained earlier [9]. On stem surfaces, multicellular, finger-like hairs with pointed tips are also found. Present result supports earlier studies where multicellular finger hairs were the major trichome type in Solanaceous members with the exception of *Capsicum* sp. showing bicellular finger hair [9]. Absence of glandular hairs/trichomes was also reported in leaves of Egyptian collection of *S. nigrum* [22]. Besides, non-glandular and scabrous types of hairs were also screened in species of *Solanum* and *Nicotiana*. Many non-glandular hair or trichome types exhibit xeromorphic nature and prevent apoplastic water leakage [23]. Quite contrastingly, glandular trichomes may not cause physical damage as it is pliable but can release toxic chemicals to intoxicate herbivores [24,25]. Glas et al. (2012) [26] 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

Future Prospects

Variety of hairs or trichomes can be considered as a measure of evolutionary progress of the plant species. In plant science hair style is a genetically-controlled morphology of plants. In the present study, diverse types of hair styles were revealed; unicellular, bicellular, multicellular, un-branched, branched, glandular, non-glandular, scabrous, sessile, stalked, strigose and stellate types with non-glandular types in higher frequency as compared to glandular one. 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. Seithe and Sullivan (1990) [15] stressed the importance non-glandular stellate-dendritic hair in taxonomic assemblage and grouping of solanaceous members like *Physalis*. An evolutionary trend from unbranched to branched, glandular to non glandular, non stalked /sessile to stalked, and few to many branches has been proposed [27]. Among the hair styles, stellate, 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. Use of advanced genomic analysis and breeding tools on hair structure of Solanaceae may give further information of biological significance of hair pattern studied in the present Solanaceous taxa.

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References

1. Lawrence GHM (1951). Taxonomy of Vascular Plants. The Macmillan Company, New York Pp: 333-438.
2. Judd WS, Christopher S, Campbell, Elizabeth A, Kellogg, et al. (2002) Plant Systematic. A Phylogenetic Approach. Sinauer Associates, Inc. Publishers, Sunderland, Massachusetts U.S.A, 53.
3. Bhattacharya K, Hait G, Ghosh KA (2007) A Text book of Botany. New Central Bock Agency (P) Ltd, 2.
4. Harisha CR, Jani S (2013) Pharmacognostical study on trichomes of Solanaceae and its significance. UJP 2: 100-104.
5. Sampaio VS, Araújo ND, Agra MF (2014) Characters of leaf epidermis in Solanum (clade Breather) species from Atlantic Forest of Northeastern Brazil. South African Journal of Botany, 94: 108-113.
6. Werker E (2000) Trichome diversity and development. Advances in Botanical Research, 31: 1-35.
7. Oksanen J, BlanchetFG, Friendly M, Kindt R,LegendreP, et al. (2018)Vegan: Community Ecology Package. R Package Version 2: 5-1.
8. Mbagwu FN, Edeoga HO (2006) Observations on the vegetative and floral morphology of some Vigna species (Leguminosae-Papilionoideae). Pakistan J. Biol. Sci 9: 1754-1758.
9. Sumitha VR, Thankappan S (2018) Epidermal studies on ten members of Solanaceae. Journal of Advances in Biological Science 5: 45-56.
10. Ganguly S, Das S (2023) Hair styles in four local collection of Solanaceae: A morphological study. International Journal of Botany Studies 8: 40-45.
11. Mbagwu FN, Nwachukwu CU and Okoro OO(2007). Comparative Leaf Epidermal Studies on *Solanum macrocarpon* and Solanumnigrum. Nat. Sci 5: 1-4.
12. Roe KE (1971) Terminology of hairs in the genus Solanum. Taxon 20: 501-508.
13. Hewson HJ (1988) Plant Indumentum: A handbook of terminology. Bureau of Flora and Fauna, Canberra, Australia 9: 5-29.
14. Cutler DF (1969) Anatomy of the monocotyledons.Juncales Clarendon Press Oxford 4.
15. Seithe A, Sullivan J (1990) Hair morphology and systematics of Physalis (Solanaceae). Plant Systematics and Evolution 170: 193-204.

Citation: Ganguly S, Das S. Hair morphology in Three Local Solanaceous Taxa. J Plant Sci Res. 2024;11(2): 266

16. Bukenya ZR, Carasco JF (1994) Hair types, pollen and seed surfaces of Solanum macrocarpon complex and Solanumlinnaeanum (Solanaceae). Israel Journal of Plant Sciences 4: 41-50.

17. Das S and Ganguly S (2024). Hair morphology of Solaneceous family: A brief study. International Journal of Research and Analytical Reviews (IJRAR) 11: 764-772.

18. Adedeji O, Ajuwon OY, Babawale OO (2007) Foliar Epidermal Studies, Organographic Distribution and Taxonomic Importance of Trichomes in the Family Solanaceae. Int. J. Bot 3: 276-282.

19. Watts S, Kariyat R (2021) Morphological characterization of trichomes shows enormous variation in shape, density and dimensions across the leaves of 14 Solanum species. AoB Plants, 13: plab071.

20. Kumar Anil VS, Sunila AV, Murugan K (2017) Foliar trichomes and their systematic relevance in Solanum (Solanaceae) species from southern Western Ghats, Kerala. Rheedea, 27: 119-131.

21. Munien P, Naidoo Y, Naidoo G (2015) Micromorphology, histochemistry and ultrastructure of the foliar trichomes of Withania somnifera (L.) Dunal (Solanaceae). Planta , 242: 1107–1122.

22. Ragab OG, Gabr DG, Khafagi AAF (2022). Micromorphological characters of the leaf epidermis for identification of certain Solanoideae (Solanaceae). International Journal of Theoretical and Applied Research 1: 38-48.

23. Fahn A (1990) Epidermis. In: Plant Anatomy, Butterworth Heinemann Publ 4: 173-176.

24. Kariyat RR, Raya CE, Chavana J, Cantu J, Guzman G, (2019) Feeding on glandular and non-glandular leaf trichomes negatively affect growth and development in tobacco hornworm (Manducasexta) caterpillars. Arthropod-Plant Interactions, 13: 321–333.

25. Kaur I, Kariyat RR (2020) Eating barbed wire: direct and indirect defensive roles of non glandular trichomes. Plant, Cell & Environment, 43: 2015-2018.

26. Glas JJ, Schimmel BCJ, Alba JM, Escobar-Bravo R, Schuurink RC, et al. (2012). Plant Glandular Trichomes as Targets for Breeding or Engineering of Resistance to Herbivores. Int J Mol Sci 13: 17077-17103.

27. Lavania S (1990) Trichome morphology in Indian Solanum. J. Ind. Bot Soc 69: 143-148.

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