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Stomatal distribution in selected loranthaceae members and its significance on parasitism

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ABSTRACT

Mistletoes are specialized flowering adapted for parasitic life. The hemiparasitic plants belonging to loranthaceae have haustorial connection between the host and the parasite which is the pathway for the movement of water and nutrient from the xylem sap of the host to the parasite. A gradient in water potential is essential for this which is provided by the stomata. The present study was undertaken to identify the variation in stomatal type, density and also stomatal index in six Loranthaceae members found in the state of Kerala. All the species studied were amphistomatous with polygonal epidermal cells and paracytic stomata. However stomatal density and stomatal index varied from one species to another. Stomatal index and stomatal distribution was found to be related with the ecological distribution of the species.

KEYWORDS

Hemiparasites;
Loranthaceae;
Stomatal index;
Stomatal distribution.

INTRODUCTION

Plants have developed several adaptive mechanisms for survival. Mistletoes are specialized flowering plants adapted to parasitic life on hosts. The state of Kerala with a humid tropical climate is the house of diverse mistletoe species belonging to the families Loranthaceae and Viscaceae. However the members of these two families seen in the state are mainly hemiparasites which depend only for water and inorganic nutrients from the host. They lack an active system of water and nutrient uptake and it is through haustorial connections they extract minerals and water from the host.

For the movement of xylem sap from the host to the parasite a gradient in water potential is essential. This is provided by the stomata which are the breathing holes. They are a pair of specialized guard cells that are found on the surface of aerial parts of higher plants which can open and close to control gaseous exchange between the plant and its environment. Their purpose is to act as portals for the entry of CO_2 into the leaf for photosynthesis and exit of water vapour which may be for evaporative cooling of the leaf.

In green leaves they occur either on both surfaces (amphistomatic) or on only one side, either the upper (epistomatic leaf) or more commonly on the lower side that is hypostomatic leaf[4].

Leaf cuticular study is becoming more important because taxonomists, drug industry workers, animal nutritionists, animal toxicologists, and police investigators have all found it useful in plant identification[1]

The present study was undertaken to identify the variation in stomatal type, density and also stomatal index in the various Loranthaceae members found in the state. Stomatal index is a reliable taxonomic character as it is independent of the changes in the epidermal cell size brought about by environmental factor[3]. While stomatal density and stomatal size determine the maximum leaf diffusive (stomatal) conductance of CO_2 (g_{cmax}) to sites of assimilation.

MATERIALS AND METHODS

Collection and preparation of epidermal peel

Fresh specimens of *Macrosolen parasiticus, Taxillus cuneatus,Tolypanthus lagenifer Helicanthus elastica, Dendrophthoe trigona,*and *Dendrophthoe falcata* were collected from different parts of Kerala. Specimens were identified and confirmed with the Fisher collection maintained at the Tree Breeding Institute, Coimbatore. Leaf segments with an area of 1 cm^2 were cut from the specimens. As the cuticle was very thick the segments were boiled with 5% NaOH solution for 15 minutes. Upper and lower epidermis peels from the segments were washed in distilled water. Peelings were then stained in 1 % aqueous solution of safranin for about 3 minutes. Excess stain was rinsed off with water. The stained specimen was then mounted in glycerin for observations in an image analyzer.

The parameters studied were presence and absence of stomata on each epidermis, type of stomata, density, stomatal index and size of stomatal pore. The statistical evaluation of the stomata and epidermis included mean, standard deviation and standard error.

Determination of stomatal density and stomatal index

The stomatal density was determined as the number of stomata per square millimeter. The index was determined as the number of stomata per square millimeter divided by the number of stomata plus number of epidermal cells per square millimeter multipled by 100. The length and width of stomata were measured to determine the stomatal size.

The statistical evaluation of the stomata included mean and standard deviation. Different parameters were observed in this study such as type of epidermal cell, presence or absence of stomata on each epidermis, type of stomata, density, stomatal index, and size of stomatal pore (average length & width).

RESULT AND CONCLUSION

Stomata type

The study indicated that all the species studied were amphistomatous. Indicating that stomata are distributed both on the upper and lower epidermis. The Epidermal cells of all the species were polygonal type with straight walls. The stomata were paracytic or rubiaceous type. In this the guard cells are accompanied with two subsidiary cells, the longitudinal axis of which is parallel to that of guard cells and aperture.

Stomata crucially permit plants to regulate transpiration water loss from leaves during the simultaneous uptake of CO_2 for photosynthesis. It has been reported that the parasite transpires at a higher rate than the host so as to ensure a gradient for the movement of minerals and water from the host to the parasite[2]. Generally the stomatal number was higher in the lower epidermis as compared to the upper epidermis. In amphistomatous plants the variation in the stomatal density between the lower and upper epidermis is related to the spatial orientation of the leaf with respect to horizon[5]. It has also been reported that the transpiration from the lower surface was always higher than that from the upper surface. The stomatal densities on both the surfaces were almost on par for *D.falcata* and *Tolypanthus*. While in *H.elastica* and *D.trigona* the variation between the upper and lower epidermis was very significant. The number in the lower epidermis is significantly higher as compared to the upper epidermis, indicating that the water loss from these species should be comparatively higher.

Stomatal density and stomatal index

Stomatal density and stomatal index varied from one species to another. The density of stomata of the lower epidermis was highest in *H. elastica* (0.036) and was lowest 0.009 in. Peter,1984 has reported that the difference in conductance to be related to stomatal densities.

Stomatal index indicates the proportion of stomata, relative to leaf surface. It is a reliable taxonamic character The stomata index of the upper epidermis was highest in *T. cuneatus* (0.193) and lowest in *H. elastica* (0.039). Average length of the stomatal pore of the lower and upper epidermis varied significantly in almost all the species while it was on par in *M.parasiticus*. Generally the stomata length was higher for the stomata of the lower epidermis. However in the case of *H. elastica* and *D. trigona*, the stomata of the upper epidermis had higher values. In both these species the density of stomata was higher in the lower epidermis than in the upper epidermis, indicating that there was more number of smaller sized stomata in the lower epidermis. Studies by Peter J. Franks and David J. Beerling[6]. Indicated that smaller stomata are capable of faster response times, enabling improved water-use efficiency and optimization of long-term carbon gain with respect to water loss. This can be a possible reason for the relative virulence of *H.elastica* which is the most virulent species of the plains. *D trigona* is also a very sturdy and large species found mostly in the high ranges the species is found to dominate the high branches of tall trees, as CO_2 concentration in the atmosphere is found to reduce with height a more efficient mechanism is essential for better fixation.

TABLE 1 : Stomatal index of loranthaceae members

Sl No	Species	Surface	Stomatal index
1	*D.falcata*	lower	15.52±3.63
		upper	14.34±1.52
2	*D. trigona*	lower	18.99±3.86
		upper	11.03±2.44
3	*H. elastica*	lower	21.53±5.35
		upper	4.52±0.50
4	*M. parasiticus*	lower	21.33±7.28
		upper	18.45±2.71
5	*T. cuneatus*	lower	13.94±0.73
		upper	19.55±3.89
6	*Tolypanthus lagenifer*	lower	18.96± 6.30
		upper	13.24±4.36

TABLE 2 : Stomatal density of loranthaceae members

Sl No	Species	Surface	Stomatal density
1	*D.falcata*	lower	30.75±4.11
		upper	30.75±2.62
2	*D. trigona*	lower	20.25± 5.32
		upper	30.75± 2.63
3	*H. elastica*	lower	24.00± 2.16
		upper	22.25± 2.63
4	*M. parasiticus*	lower	15.5±1.29
		upper	19.00± 2.16
5	*T. cuneatus*	lower	28.75±1.50
		upper	18.00±0.82
6	*Tolypanthus lagenifer*	lower	20.25± 2.36
		upper	18.32±1.15

TABLE 3 : Stomatal length of loranthaceae members

Sl No	Species	Surface	Mean
1	*D.falcata*	lower	20.11±2.76
		upper	14.43±2.23
2	*D. trigona*	lower	23.22±2.11
		upper	27.49±2.32
3	*H. elastica*	lower	12.33±0.76
		upper	18.89±1.89
4	*M. parasiticus*	lower	22.76±2.27
		upper	22.91±5.20
5	*T. cuneatus*	lower	18.32±1.63
		upper	13.83±2.36
6	*Tolypanthus lagenifer*	lower	18.96±6.30
		upper	13.24±4.36

CONCLUSION

The stomata form crucial organs which regulate water loss and CO_2 availability to the plant. In the study all the members of Loranthaceae studied were amphistomatous with polygonal epidermal cells and paracyotic stomata. However, in the case of *H. elastica* and *D. trigona*, the higher stomatal index of the upper epidermis and the higher stomatal density of the lower epidermis seems to be an ecological adaptation for better water use efficiency and higher CO_2 capture accounting for their virulence in nature.

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