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New Adaptive Feature in *Dolichandrone spathacea* (L.f.) K. Schum (Bignoniaceae)

The Dolichandrone spathacea (L. f.) Seem. is a species of Bignoniaceae. In a swampy environment, the plant displays morpho-physiological adaptations. The findings showed that salt glands are found in all aerial parts, including leaves, branches, and reproductive organs like flowers and seeds. It is regarded as a new adaptive characteristic in the species. The number of salt glands present in each portion, their size in the leaf, the amount of chloride present, and their osmotic potential value has all been used to evaluate the dispersion of these glands. One of the necessary modifications to survive in this habitat is the presence of salt glands. This is an adaptation that helps organisms thriving in salty environments with few freshwater supplies maintain a healthy salt balance.

Key words: *Dolichandrone spathacea*, Halophytes, Mangrove associated, Salt glands

Adaptations can be recognized as a character that is fit to environment and it help them to survive and reproduce in the habitat.

Introduction

The species of *Dolichandrone spathacea* (L.f.) K. Schum. belongs to family Bignoniaceae. It is mostly found beside mangroves and related plants along the mangrove coast. Regarding its ecological standing in coastal habitats, there is some controversy. According to some writers (Duke *et al*., 2012; Nayak and Andrade, 2013; Ragvan *et al*., 2014), it is a mangrove species, but other authors (Bhosale, 2013 and Mohanan, 2013) refer to it as a mangrove associate. It has been stated several criteria to classify the species as mangrove or associate, according to Kathiresan *et al*. (2013). They contend that a key factor in this kind of differentiation is the quantity of adjustments. The presence of salt glands is one such adaptation.

Many plant species in nature exhibit the existence of salt glands. One cannot, however, assume that they are all functional. It calls for a thorough investigation of salt glands, particularly with regard to their form, density, and capacity for salt secretion. With the exception of salt glands, Seibert (1948) characterised the other types of glands found in Bignoniaceae family members. It has been noted that salt glands occur in this family very frequently. Salt glands are not only present in *D. spathacea*, but they also function and aid the species' ability to tolerate salt. Due to the importance of salt glands as one of *D. spathacea* most significant morpho-physiological adaptations, an effort has been made to examine them in the current piece of work.

Material and Method

The leaves of *Dollichandrone spathacea* were collected from coastal village Khavane in Vengurla Tahsil of Sindhudurga District of Maharashtra, India (N15^0 55,278' E 073^{0}34,442'). Mature leaves were processed for SEM to assess the structure of salt glands. With the help of

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double staining technique, the salt glands present in leaf epidermis were studied in cross sectional view. In order to find out whether the salt glands are functional or not, the leaves were washed with distilled water and assessed for secreted chlorides method (Grasshoff *et al.*, 1983). The density of salt glands per unit area in leaves was studied. Both lower and upper surface of leaves were studied for structural details of salt glands. Collected data is statistically analyzed for standard deviation. The osmotic potential of leaves was estimated by Electrical conductivity meter by using following formula.

$$\text{Osmotic Potential} = -\frac{0.36\text{XEC at 25 C x DF}}{0.987}$$

Where,

0.36 = Constant

EC = Electric conductivity m mhos/cm at 25^0 C

Df = Dilution = $\frac{\text{25 (volume)}}{\text{Moisture content}}$

0.987 = Factor for conversion of atmospheric pressure to bar

Result and Discussion

The occurrence of salt glands in *Dolichandrone spathacea*, various plant parts were analyzed microscopically. The results are depicted in Table 1, except stem and root, all the parts are covered by salt glands. Interestingly, the density is very high onspathe *i.e.* specialized calyx. Structurally, all salt glands are same but differ in size. The distribution of glands clearly indicates that they are present on all parts exposed to outer environment. Mature and old stem do not show salt glands. In this case, they may probably replace by lenticels. Because, the stem growth in mature is also normally suspended by high salt concentrations (Acosta-Motos *et al*., 2017). There is no presence of salt glands on seeds. Almost all floral parts are covered by salt glands. Spathe water which is present inside the spathe in bud conditions shows the presence of chlorides. It indicates that the salt glands on floral parts are functional. It also indicates that the spathe water is of physiological in origin. The average number of salt glands in leaf of *D. spathacea* is depicted in Table 2.

In order to find out dimensions and total number of salt glands from both the epidermis, young mature and senescent leaves are selected. The result of the same is shown in Table 3. From the table, it is clear that irrespective of these stages, salt glands on upper surface are wide. The size increases from young stage to senescent stages on both the epidermal layers. The increasing of Na+ accumulation in salt glands can enhance the salt tolerance (Yuan *et al*., 2016). In case of all three stages, the density of salt glands is more or less same on upper and lower surface. Interestingly, the number of salt glands is increasing from young to senescent stage. It indicates that ontogenically salt glands are formed as per the requirement in life span of leaves.

To distinguish whether the salt glands are functional or not, the leaf washings were taken and analyzed for occurrence of chlorides and result is shown in Table 4. The chlorides in leaf washing show comparatively the higher amount in mature leaf. Though, young leaf shows more leaf area of salt glands than senescent leaf, the amount of chloride is less. The predominant form of the halogen element chlorine in soils is the chloride (Cl) anion. Cl has long been viewed as a harmful anion rather than a plant nutrient, particularly in the agronomic environment. The function of Cl as an essential micronutrient and its toxicity under salt stress circumstances are two extreme situations that is dealt with in the role and consequences of Cl in higher plants (Colmenero-Flores *et al*., 2019). Comparatively, its density is found to be higher in mature leaf and it can be correlated with higher amount chloride on the surface. But, density of salt glands is the highest in senescent leaves which do not show the highest chlorides in leaf washings. This indicates that the senescent leaf shows very little physiological activity regarding salt secretion. The young leaf shows less amount of chloride but the mature leaves appear to be more significant.

Table 1 : Approximate number of salt glands on various parts of *Dolichandrone spathacea.*

Plant part	Presence of salt glands	Overall frequency
Leaf Petiole	Present	++
Leaf Rachis	Present	++
Young stem	Present	++
Mature stem	Absent	-
Old stem	Absent	-
Root	Absent	-
Spathe (Calyx) Inner surface	Present	++++
Spathe (Calyx) Outer surface	Present	++
Corolla Inner Surface	Present	+
Corolla outer Surface	Present	++
Ovary	Present	+
Young Pod	Present	++
Mature Pod	Present	+++
Seeds	Absent	-
Pedicel of Flower	Present	+
Style	Present	+
Filament of Stamen	Present	+

-Absent, +Rare, ++Occasional, +++Frequent, ++++Abundant

Table 2 : Average number of salt glands in leaf of *Dolichandrone spathacea* (number/1mm^2)

Leaf	Epidermis	Average/Mean no.
Young	Upper	4.33±0.57
	Lower	5.00±1.00
Mature	Upper	7.66±0.57
	Lower	9.67±1.50
Senescent	Upper	15.33±1.57
	Lower	18.66±1.52

Values indicate average of 10 readings and ± indicate standard deviation.

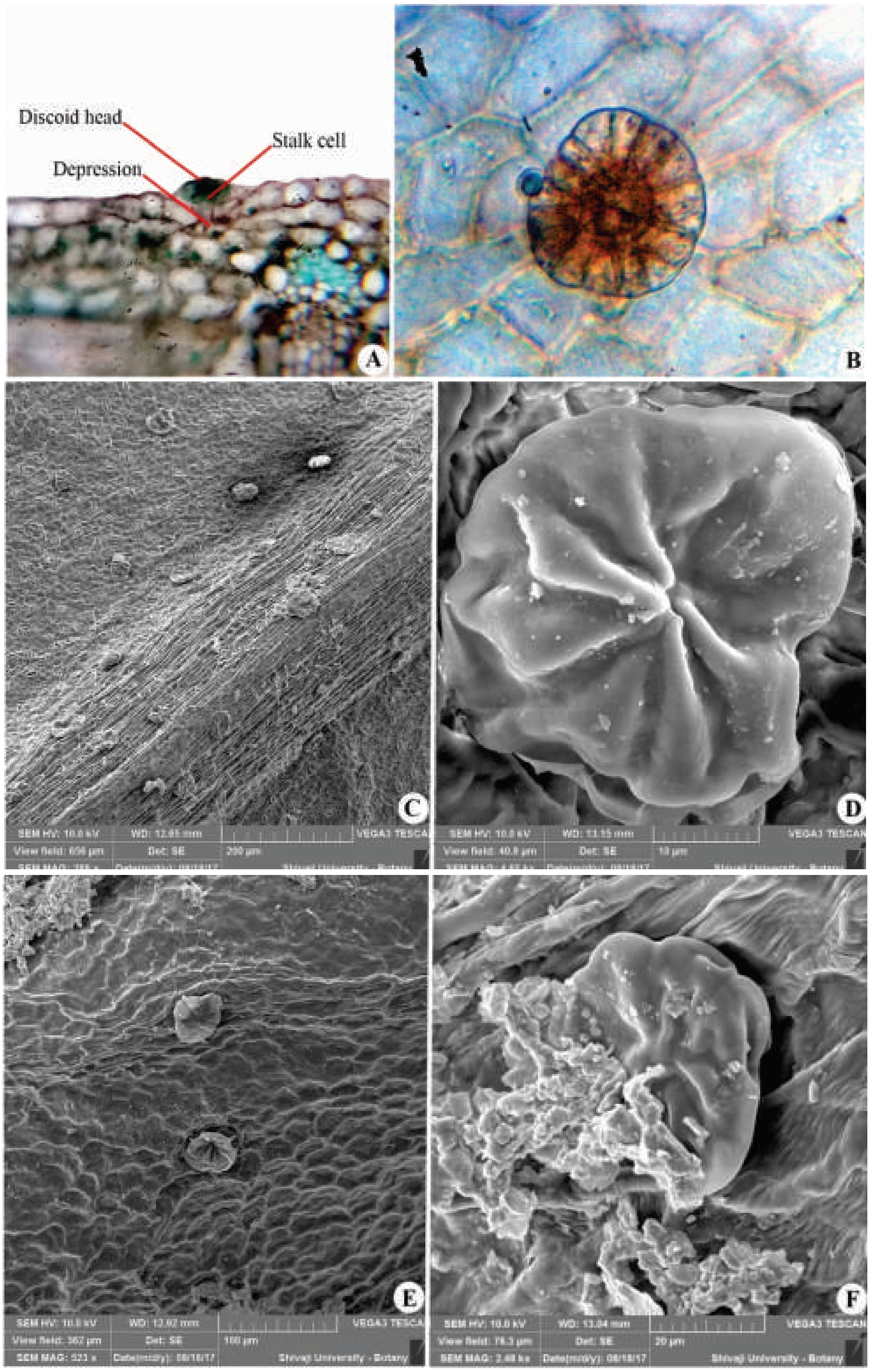

Fig. 1 : Light Microscopic images of salt glands: **A**. T.S. of salt gland, **B**. Surface view of salt gland; Scanning Electron Microscopic images of salt gland: **C**. Surface view of lower epidermis showing salt glands, **D**. Magnified salt gland on lower surface, **E**. Surface view of upper epidermis showing salt gland, **F**. Magnified salt gland on upper epidermis.

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Table 3 : Details of salt glands with respect to dimensions and total number present in the entire leaf.

Leaf	Dimensions (µm)		Total no. of glands present at both the surfaces in the entire leaf
	Upper surface	Lower surface	
Young Leaf	48.41±1.35	45.93±1.71	55,971
Mature leaf	49.77±1.30	47.39±2.37	1,44,788
Senescent leaf	55.49±1.45	51.05±2.03	1,77,825

Values indicate average of 10 readings and ± indicate standard deviation.

Table 4: Amount of Chloride present in leaf washings.

Leaf	Leaf area	Chloride content in mg	Chloride/cm^2 leaf area
Young	62.18	58.38±1.12 mg	0.905±0.05 mg
Mature	67.50	135.942±2.09 mg	2.01 mg±0.09
Senescent	55.02	72.224±0.83 mg	1.31 mg±0.70

In order to confirm structure of salt glands young, mature and senescent leaves were screened using SEM (Fig. 1), it is clear that the salt glands of *D. spathacea* are well organized and secretary structures. From the sectional view, it is clear that the salt glands are situated in small depression of the epidermal layer. Eventually the bladder cells may rupture, depositing salt on the epidermal surface (Dassanayake and Larkin, 2017). According to Mullen (1931) the salt gland is composed of short stalk cells and discoidal head which are divided into number of cells by vertical walls. The surface view of salt glands with 450 x magnification indicates that in *D. spathacea,* the discoidal head is made up of many elongated cells. In surface view, they appear to be sixteen in number. The SEM studies support the structure but it appears that there are eight cells with unequally thickened walls. The salt gland appears to be a cup like structure in which central stalk cell appear as cavity. Cells of discoidal head are protrudes above the epidermal cells. The secreted salt in the form of crystals is seen on lower as well as upper epidermis. It also appears that the glands are not superficial but present in the shallow cavity in the epidermis. Actually, salt secretion is temporal or kinetic activity of the plant. It is very difficult to study the rate of excretion. Here, an attempt has been made to detect presence of salt on the surface of young, mature and senescent leaves. The secreted salt is comparatively more in case of mature leaf. It is the lowest at young stage and medium at senescent stage. In scanning electron microscopic analysis of the leaf samples, salt crystals are seen on lower as well as upper epidermis. It clearly indicates that the species fall under secretary category in salt regulation mechanism of mangroves.

Osmotic potential is mainly due to the presence of various ions and organic solutes. The mangrove and halophytes have got capacity of osmotic adjustments which is important in absorption and translocation of water and minerals and this is considered as adaptive feature (Rahman *et al*., 2021). The magnitudes of water potential indicate chemical potential in the cells. It is important in understanding transport of water and solutes within plants. The osmotic potential of pure water is zero while that of water in the cells is less than zero. The driving force for transport of chemical substances like salt dissolved in water is related with magnitude of osmotic potential in cells. Here transport is from zero to negative or from less negative to more negative values of osmotic potential. From the table, it is clear that in *D. spathacea* also, the transport of water along with salt is from less negative to more negative magnitudes of osmotic potential *i.e.* from -7.32 young leaf to -8.66 mature leaf to -8.90 senescent leaf. Based on these values, it is clear that the direction of transport of water along with salt is from young to mature and to senescent leaf. The osmotic potential values of plant leaves are as mentioned in Table 5.

Table 5: Osmotic potential

Leaf	
Young	-7.32 bars
Mature	-8.66 bars
Senescent	-8.90 bars

Values indicate average of 5 readings.

Conclusion

According to the current study, salt glands are a new adaptive characteristic present in *Dolichandrone spathacea* plant sections. Chlorides can be seen in the spathe water that is contained within the spathe in bud. It suggests that the salt glands on floral components are active as well. The salt glands are evidently located in a tiny depression in the epidermal layer from the sectional view. It appears that the cuticle does not deposit salt gland. The SEM study confirms the structure, although eight cells with unequally thickened walls are seen. The salt gland resembles a cup-shaped structure, with a cavity formed by the centre stalk cell. On both the lower and upper epidermis, salt secretions appear as crystals. The species appears to belong under the secretary category.

_डोलिचेंड्रोन स्पैथेसिया_ (एल.एफ.) के. शुम (बिग्नोनियासीई) में नई अनुकूली सुविधा

कमलाकर एच. पाटिल, सुनीता वी. तोरो, महेश वी. गोखले और सिदानंद वी. कंभार

सारांश

डोलिचेंड्रोन स्पैथेसिया (एल.एफ.) देखें। बिग्नोनियासी की एक प्रजाति है। दलदली वातावरण में, पौधा रूपात्मक-शारीरिक अनुकूलन प्रदर्शित करता है। निष्कर्षों से पता चला कि नमक ग्रंथियाँ पत्तियों, शाखाओं और फूलों और बीजों जैसे प्रजनन अंगों सहित सभी हवाई भागों में पाई जाती हैं। इसे प्रजातियों में एक नई अनुकूली विशेषता के रूप में माना जाता है। प्रत्येक भाग में मौजूद नमक ग्रंथियों की संख्या, पत्ती में उनका आकार, मौजूद क्लोराइड की मात्र और उनके आसमाटिक संभावित मूल्य सभी का उपयोग इन ग्रंथियों के फैलाव का मूल्यांकन करने के लिए किया गया है। इस आवास में जीवित रहने के लिए आवश्यक संशोधनों में से एक नमक ग्रंथियों की उपस्थिति है। यह एक अनुकूलन है जो कुछ ताजे पानी की आपूर्ति के साथ नमकीन वातावरण में पनपने वाले जीवों को स्वस्थ नमक संतुलन बनाए रखने में मदद करता है।

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