

EPIDERMAL STRUCTURE OF STOMATA AND TRICHOMES OF *VACHELLIA TORTILIS* (FORSSK.) GALASSO AND BANFI

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Abstract

Leaves of *Vachellia tortilis* were collected along the national road (N1) in Limpopo province, South Africa. Variations in the epidermal structure of stomata and presence of trichomes amongst *V. tortilis* in nine different stations selected along the study site were investigated. In this study leaves of *V. tortilis* were found to be hypostomatic. The epidermal cell revealed a polygonal structure only. Anticlinal walls were either straight or curved. Trichomes recorded showed a non-glandular unicellular conical shape. Stomata types observed were paracytic and anisocytic with single subsidiary cell. In comparison the frequency of epidermal cells was higher than that of guard cells. Stomatal index and frequencies of stomata and epidermal cells were also recorded and compared.

Keywords: Epidermal structure; Stomata; Anticlinal walls; *Vachellia tortilis*.

Introduction

Vachellia genus is the second largest in the family of Fabaceae with more than 1350 species (Maslin, 2003). The majority of the species of this genus are indigenous to South Africa and neighbouring countries. *Vachellia tortilis* is one of the dominant species in Botlokwa area of South Africa with an amazing growth pattern as distributed from the Tropic of Capricorn to the tropical and sub-tropical regions. Leaf epidermal structures such as stomata, trichomes and other characters are useful features of importance in anatomy (Ahmad *et al.*, 2009).

Leaf epidermal features can provide efficient tools for separating and linking in some cases at least the higher level of a taxonomic hierarchy (Hameed *et al.*, 2008). According to Roth-Nebesick *et al.* (2001) their properties are expected to associate to their functional aspects as in the case of leaf venation. Liakopoulos *et al.* (2006), argue that polyphenols in trichomes enable them to provide a protection that is effective against harmful UV-B. It also protects the leaves against levels of visible radiation that are high. Most of the phenolic compounds like flavonoids present in lamina and trichomes may provide an extra protective trait to the leaves.

This investigation was undertaken with the aim of determining the differences in anatomical characters such as epidermal features of stomata and trichomes. Its main objective was to establish if there were any differences in the cells of *Vachellia tortilis* from the Tropic of Capricorn, tropical region as well as the sub-tropical region of Limpopo province. A study of this nature is of importance because analysis of shape and arrangement of epidermal cells as well as other foliar structures like trichomes made provision of new findings in solving phylogenetic and taxonomic problems (Alvarez *et al.*, 2009). The structure of stomatal complexes and the differences in shapes and arrangement of their subsidiary cells may assist in understanding the growth habit of *Vachellia tortilis* as influenced by environmental conditions as influenced by environmental conditions.

Materials and Methods

Study area: The study was carried out along the N1 national road of South Africa as it stretches between

Polokwane and Louis Trichardt towns of Limpopo province. Botlokwa area, which is almost at the middle of the two towns, is located at about 60 km towards north of Polokwane town, where the N1 road comes to a column marking the position of the Tropic of Capricorn at 23°26'16" S in the Limpopo Province of South Africa. The Tropic of Capricorn is one of the most significant features of our country, because it separates sub-tropical and tropical areas of South Africa.

South of the Tropic of Capricorn, Papkuil, Rita, Machaka and Mphakane are in the sub-tropical regions; while towards the north of Capricorn Plaza, Lalapanzi, Adam's Apple and Louis Trichardt fall under the tropical region. Therefore, the morpho-anatomical research data were recorded on either side of the Tropic of Capricorn, at the distance of 10 to 40 kilometres in to the tropical and sub-tropical regions at the interval of 10 kilometres. The reason for using the 10 to 40 kilometres distance was because after 50 km on either side the Tropic of Capricorn *Vachellia karroo* was observed to be dominating while *Vachellia tortilis* was observed to be disappearing.

Procedures: Epidermal peels were obtained by carefully crushing leaves with glycerine in a pestle and mortar. The leaflets were too small to obtain the epidermal peels by hand peeling method. The peels were then stained by Delafield's haematoxylin and mounted using glycerine. Mean values of thirty observations per station were taken to calculate the epidermal frequency, stomatal frequency and index, as well as the size of stomata in micrometres (μm). The prepared slides were observed using light microscope [(40x) AxioImager A2 Carl Zeiss microscope] where the length and breadth of stomata including guard cells were measured. All observations were supported by micrographs.

Results

Epidermis: The leaves of *V. tortilis* are hypostomatic, and the stomata were distributed all over the abaxial and adaxial, except on the veins. The epidermal cells were polygonal (Fig. 1A-F) and the anticlinal wall vary from straight (Fig. 1E) to curved (Fig. 1B-D and F). There were no crystals observed in this particular study.

Trichomes: Observations with light microscope revealed the presence of only one type of trichomes. Non-glandular unicellular conical trichomes are abundant and completely obscure the epidermal surface of the leaf (Fig. 1F & G).

Stomata: Paracytic, anisocytic, and stomata with unitary subsidiary cells were the stomatal types that were observed in all the locations. Paracytic stomata were flanked by two lateral and parallel subsidiary cell (Fig. 1A & E), whereas anisocytic stomata were surrounded by three cells; of which one is clearly smaller when compared with the other two (Fig. 1F). Stomata with single subsidiary were also present (Fig. 1B). Stomata with single guard cell and no guard cells were observed (Fig. 1C & D). The stomatal index (Table 1) decreased from Adam's apple and increased at Lalapanzi and decreased and increased by 34.

Discussion

Anatomical studies revealed no differences in size and shape of stomata, and presence of trichomes in different locations. The plant specimens collected from all the study areas exhibit similar kind of stomatal types and anticlinal walls. The importance of stomatal character in taxonomy varied in different group of plants (Gill *et al.*, 1982). The presence of paracytic stomata has been known to be the characteristic and most dominant in the subfamily of Mimosoideae especially in the former *Acacia* genus (Shah *et al.*, 1972).

The leaves were amphistomatic whereas stomata observed in this investigation were paracytic and anisocytic. This was supported by Gindel (1969), when he concluded that *Vachellia tortilis*, *Balanites aegyptiaca* and *Vachellia spirocarpa* had stomata on both side of the leaf blades and they were xerophytic plants growing naturally under extremely harsh ecological conditions in deserts where the water tables were far from the roots zonation. It appeared that soil water content deficiency and arid conditions might result in modification of morphological features resulting in an increase of stomatal density per unit area. This phenomenon in most instances might be accompanied by the decrease in length of stomata (Gindel, 1969).

Stebbins & Krush (1961) described the geographic distribution of plants with three types of stomatal complex showing a regular progression. In orders with no subsidiaries cell appeared to be predominantly temperate and orders with two subsidiaries are of halophytes or hydrophytes and tropical or southern hemisphere families. Finally, the group with many subsidiary cells also appeared to be consisting almost entirely of tropical or predominantly tropical families.

The stomatal distribution and anatomy appeared to be similar to the description of Solereder (1908). They were mainly distributed on the abaxial leaf surface. To some certain degree of comparison, with other families with the same order, the distribution of the stomata appeared to be proportional to the size of the pinnules. The observation appeared to be the taxonomic character, which were used in the systematic anatomy to differentiate between the genera of the Mimoseae. In contrast to the habitat variation, the distribution of the stomata was not affected by the habitat. Furthermore, the study revealed the general diagnosis which was reported by Solereder (1908), that the occurrence of two subsidiary cells, which were parallel to the pore, was also the noticeable characteristics of the stomata of the *Vachellia tortilis* which were sampled from the different sites. Hence, the characteristics pattern of the guard cell arrangement in relation to the subsidiary cell is considered to be important taxonomic value as an anatomical approach to systematic because they are less affected by the environmental factors. Hence this character was in the literature where anatomical tool was applied to different ranks of taxonomic classification (Chowdhury, 1959).

In conclusion the present investigation has recorded the shortest plants of *Vachellia tortilis* along the Tropic of Capricorn. As far as epidermal anatomy is concerned there are variations in the stomatal index and epidermal frequency. When the stomatal index and epidermal frequency increased, the stomatal size and epidermal cells decreased, whereas length of guard and epidermal cell was more or less the same. There were also no changes in the shape and structure of trichomes.

Table 1. The frequency and index of stomata in mm⁻², size of guard and epidermal cell (µm) and epidermal frequency and nature of anticlinal walls in *Vachellia tortilis*.

Location	Index	Frequency mm ⁻²	Stomata size of guard cells in µm		Frequency mm ⁻²	Epidermis size of epidermal cell in µm		Anticlinal walls
			L ₁	W		L ₁	W	
Papkuil	53	7	21	7	6	35	19	st,c
Rita	39	5	20	7	7	26	16	st,c
Machaka	33	4	22	8	7	27	17	st,c
Mphakane	33	4	20	7	8	24	15	st,c
Tropic of Capricorn	31	3	25	9	6	40	21	st,c
Capricorn Plaza	26	3	23	8	8	21	14	st,c
Lalapanzi	32	4	21	8	8	19	14	st,c
Adam's Apple	29	3	21	7	8	23	14	st,c
Louis Trichardt	34	4	22	8	7	30	18	st,c

L₁ = length; w = width; c = curve; st = straight

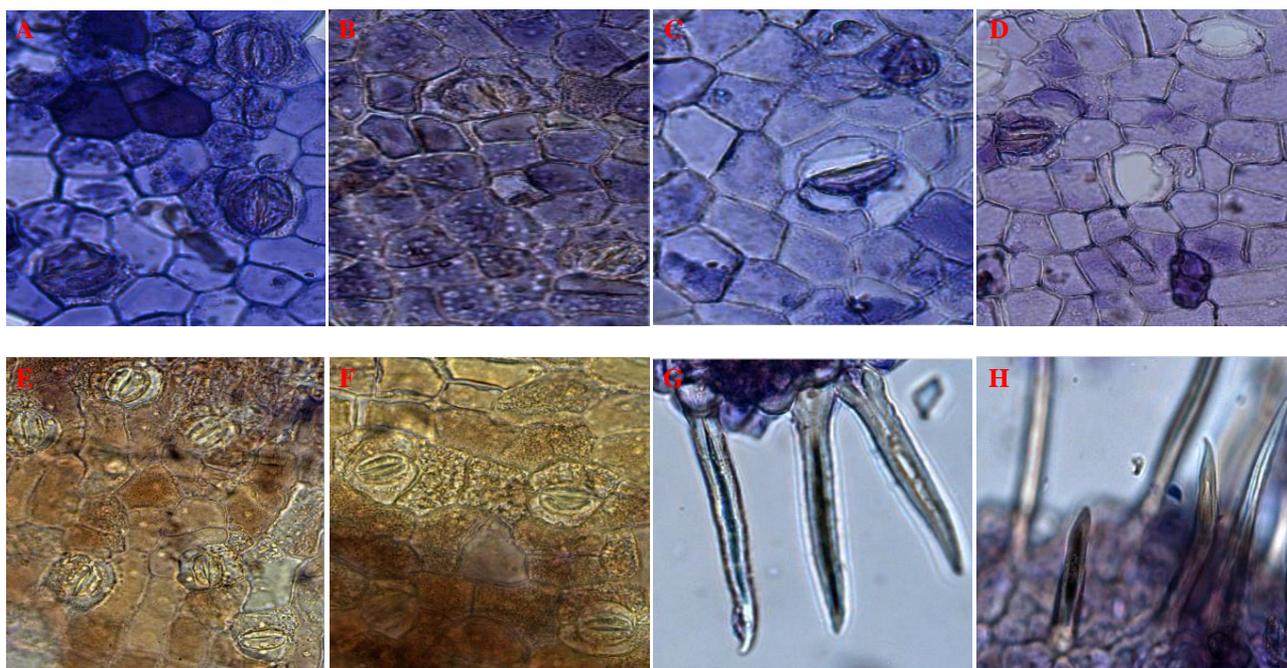


Fig. 1. Stomata and tracheid of *Vachellia tortilis*.

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