

## Leaf Anatomy of *Parkia clappertoniana* Keay (Mimosaceae)

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### ABSTRACT

The bipinnate-compound leaf of *Parkia clappertoniana* has prominent, long petiole with a pulvinal base. The pulvinus has wood, periderm, lenticels and extensive cortical layer. Its vascular bundles are elongated with alternating rays. The vascular bundles of the petiole, rachis and veins are oval, with conspicuous bundle caps. Stomatal complex is predominantly paracytic with occasional occurrence of anomocytic stomata near the mid-rib. The oval stomata have conspicuous stomatal ledges. Trichomes are unicellular, acicular and restricted to the rachis, petiole and pinnule mid-ribs and margin. Ecological and taxonomic significance of features is discussed.

### INTRODUCTION

*Parkia clappertoniana* is an economically important tree species, which produces edible seeds used as food condiment in many parts of Nigeria. The yellow pulp of the pod is rich in carbohydrate (Purseglove, 1968). The plant has been a subject of study with respect to its morphology (Hutchinson and Dalziel, 1958), the microbiology of its seeds (Odunfa, 1981) and the physiology of seed germination (Etejere *et al.*, 1982). However, knowledge about its anatomy is scanty in the literature, hence the present paper attempts to elucidate this aspect of its biology. The leaf being the major seat of energy transformation within the plant, thus duly attracts primary attention in respect of its anatomical structure.

The study is also intended to stimulate further research on the plant with an ultimate goal of improving crop productivity and industrial applicability of the vegetative parts of the plant.

### MATERIALS AND METHODS

Fresh leaf materials were collected from trees of *Parkia clappertoniana* Keay growing within the campus of University of Ilorin, Nigeria. Frozen sections 15  $\mu$ m thick, were cut on a Reichert sledge microtome, with a freezing stage. Sections were stained in 1% aqueous safranin and mounted in glycerine jelly. Leaf cuticles were isolated with 20% chromium

trioxide at 27°C for 16h., and stained in Sudan IV (Alvin and Boulter, 1974).

Observations were recorded on an Olympus-Vanox research microscope with camera attachment. Epi-illumination photography was done on a Carl Zeiss Tessovar Photomacrographic Zoom System.

## RESULTS

The leaf in *Parkia clappertoniana* is bipinnate-compound with prominent rachis, rachillae, pinnae, pinnules, a long petiole and a conspicuous pulvinus (Fig. 1). The pulvinus is about 0.8 cm in diameter and 1.5 cm long. Its surface is wrinkled or undulating and covered by epidermis with thick cuticle, which is interrupted in several places by periderm formations and elliptical lenticels (Figs. 2-4). In longisection, the lenticels consisting of numerous cork cells are usually rectangular, while they are usually of triangular shape in transection (Figs. 3 and 4). Beneath the epidermis is a layer of small cork cells followed by a layer of larger, isodiametric cortex and secondary cortex cells, which form the main bulk of the outer part of the pulvinus. Above the epidermis or cuticle is a thin, densely staining layer, which is interpreted as an extracuticular wax layer (Figs. 2-4).

The vascular tissue consists of a ring of contiguous, elongated vascular bundles, with some intervening ray parenchyma cells (Figs. 5 and 6). External to the phloem is the bundle cap, consisting of thick-walled phloem fibres (Fig. 5). Large pores or secondary vessels are observable with the xylem tissue of the bundle. At the centre of the pulvinus is the medullary tissue of tanniferous as well as starchy cells (Fig. 6). The petiole, rachis and rachillae have a similar set of components or structure to the pulvinus, with the exception of the periderm formation, occurrence of lenticels and the shape of the vascular bundles.

Unlike the pulvinus, they are covered with epidermis bearing unicellular trichomes especially on the grooved adaxial surface (Fig. 7). Beneath the epidermis is the cortex, followed by a ring of 4-5 oval vascular bundles which enclose a central core of medulla (Fig. 7). A small vascular bundle of similar size to that in the rachilla usually subtends the main vascular tissue on the adaxial side of the rachis or petiole (Fig. 7). The vascular bundles are collateral and open, with adjacent bundle caps of phloem fibres (Fig. 7). There are large secondary xylem vessels in the bundles (Figs. 8-10).

The lamina of the pinnules has an upper layer of large epidermal cells followed by 1 or 2 tiers of tightly-packed, densely-staining palisade mesophyll cells (Fig. 11). The spongy mesophyll cells are also tightly-packed but faintly-staining, with rather inconspicuous intercellular spaces, particularly farther away from the substomatal cavity. The lower epidermal cells are also prominent and rhomboidal (Fig. 11). The margin of the pinnule is not differentiated into palisade and spongy mesophyll tissue. It consists of a small group of parenchymatous cells an overlying layer of smaller epidermal cells, with undulating outer surface

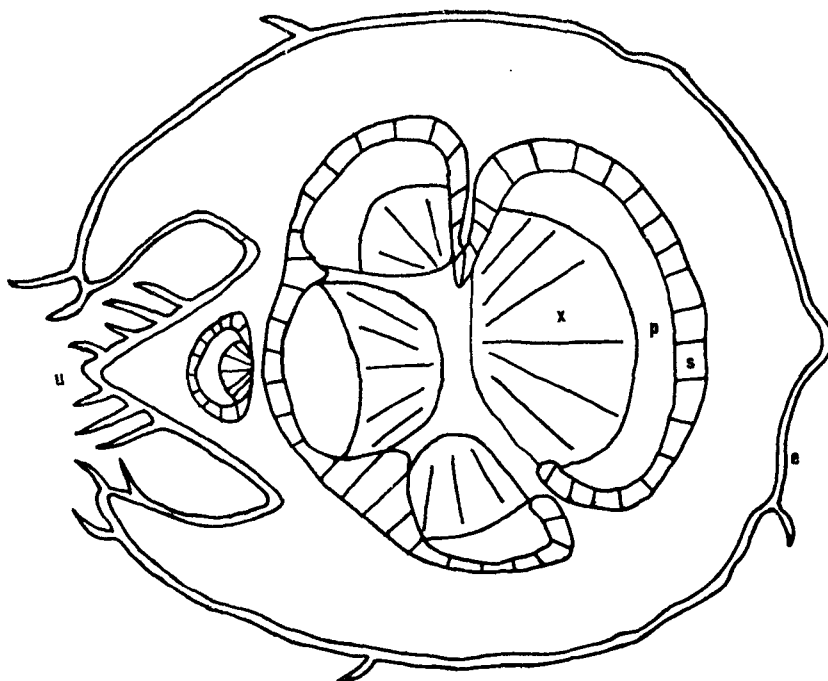


Fig. 7. T.S. Rachis, showing the grooved abaxial surface (u), epidermis (e) with trichomes, and a ring of oval, collateral vascular bundles, consisting of xylem (x), phloem (p) and sclerenchyma (s).  $\times 20$ .

(Fig. 12).

Stomata are found only on the abaxial surface of the pinnules. They are oval and not sunken, having 2 lateral subsidiary cells whose long axes run parallel to those of the guard cells, giving the paracytic type of stomatal complex (Figs. 13-15). However, near the mid-rib, some anomocytic stomata can be found. Similarly, cuticular striations radiating from the guard cells are observable on the subsidiary cells. The stomata have prominent outer and inner stomatal ledges or lips (Fig. 13). Trichomes on the pinnule lamina are restricted to the mid-ribs and margin, particularly near the base of the leaflet, adjacent to the rachis. The trichomes, like those on the rachis, are unicellular, acicular and thick-walled with narrow lumina (Figs. 14, 16 and 17). The trichome base is multicellular consisting of 4-5 small, radially arranged cells (Figs. 14, 16 and 17).

## DISCUSSION

*Parkia clappertoniana* is a perennial that grows in savanna environment, where temperature is high, relative humidity and precipitation are relatively low. The hypostomatic nature of the leaf as well as occurrence of trichomes along the rachis and pinnule margin are features that can reduce water loss via transpiration by way of the trichomes reducing

the velocity of air movement in between the pinnules. Furthermore, the lenticels on the pulvinus can accentuate gaseous exchange necessary for photosynthesis and respiration in the plant. These features can ensure viable, large-scale cultivation of the plant, especially in dry regions.

Other features of note in the plant include the stomatal complex, stomatal ledges, trichome type and distribution, sclerenchyma and secondary xylem. These characters have been found to have useful, diagnostic and taxonomic application in various plant families (Metcalf and Chalk, 1979; Cutler, 1979; Dilcher, 1974; Oladele, 1983). It would be of interest to know the significance of these features in a taxonomic study of the family. Similarly, the pulvinus is a feature found in most members of the family Mimosaceae e.g., *Mimosa*, *Albizzia*, where it is believed to be concerned with the movement of leaflets during nastic or nyctinastic response to tactile and light stimuli (Esau, 1977). Although the pulvinus in *Parkia clappertoniana* is prominent, the leaf does not exhibit nastic or nyctinastic responses, hence its function other than mechanical, is a subject that deserves elucidation.

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### EXPLANATION OF FIGURES

- Fig. 1. Bipinnate-compound leaves, with long and prominent petioles and pulvini.  $\times 0.25$ .
- Fig. 2. L.S. Pulvinus, showing wrinkled surface, epidermis with prominent cuticle, subjacent cork cells and rhomboidal secondary cortex cells. Note also the darkly-staining, extracuticular layer (arrow-head)  $\times 90$ .
- Fig. 3. L.S. Lenticel on the pulvinal base. Note the ruptured epidermis, the cork cells and isodiametric cortical cells.  $\times 90$ .
- Fig. 4. T.S. Lenticel, showing triangular shape cortical cells are rhomboidal.  $\times 90$ .
- Fig. 5. T.S. Pulvinus. Bundle caps of phloem fibres are seen between the cortex (upper half) and vascular bundles (lower one-third)  $\times 90$ .
- Fig. 6. T.S. Pulvinus, showing radially-arranged contiguous vascular bundles around a central core of medullary cells, some of which are darkly-stained due to tannin content. Note ray parenchyma between vascular bundles.  $\times 90$ .
- Fig. 8. L.S. Pulvinus, showing ray parenchyma cells (arrow-head), xylem and cortex.  $\times 90$ .
- Fig. 9. T.S. Oval, collateral and open vascular bundle, with prominent bundle cap of fibres. Also note large metaxylem vessels.  $\times 90$ .
- Fig. 10. L.S. Rachis, showing pitted reticulate xylem vessels.  $\times 250$ .
- Fig. 11. T.S. Pinnule. Upper and lower epidermal cells are rhomboidal. Note the compact arrangement of the palisade and spongy mesophyll cells.  $\times 250$ .
- Fig. 12. T.S. Leaf margin. Note isodiametric cells, smaller size of the epidermal cells and the undulating surface for the margin.  $\times 500$ .
- Fig. 13. T.S. Stoma, showing the prominent inner and outer stomatal ledges, subsidiary cells and substomatal cavity.  $\times 500$ .
- Fig. 14. Surface view of paracytic stomatal complex and trichomes. Stomata are oval, and flanked by 2 subsidiary cells. Note the multicellular base of the unicellular, acicular trichomes. Smaller epidermal cells of the margin are to the right.  $\times 250$ .
- Fig. 15. Surface view of paracytic stomatal complex with 2 lateral subsidiary cells, with long axes parallel to the guard cells.  $\times 500$ .
- Fig. 16. Surface view of unicellular trichome showing thick wall, narrow lumen and pointed end.  $\times 500$ .
- Fig. 17. T.S. Pinnule margin, showing the smaller size of the trichome base cells, thick wall and narrow lumen of trichome.  $\times 90$ .

