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Structure and Function of the Anther Gland in *Prosopis juliflora (Leguminosae, Mimosoideae):* A Histochemical Analysis

By

Bharti CHAUDHRY and M. R. VIJAYARAGHAVAN*)

With 2 Figures

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Summary

CHAUDHRY B. & VIJAYARAGHAVAN M. R. 1992. Structure and function of the anther gland in *Prosopis juliflora (Leguminosae, Mimosoideae):* A Histochemical Analysis. – Phyton (Horn, Austria) 31 (2): 1–7, 2 figures. – English with German summary.

The anther gland in Prosopis juliflora (SW.) DC. lies above the anther locules as an appendage of the anther connective. The gland consists of a narrow, multicellular-stalk and a wide, multicellular, globose head of secretory cells. In an active gland, the secretory cells lyse and through degeneration of the protoplasts release a protein-carbohydrate exudate which passes through cuticular openings to the exterior of the gland. The heterogenous exudate that envelops the gland surface, serves as a food source and attracts foraging insects.

*) B. CHAUDHRY, Prof. Dr. M.R. VIJAYARAGHAVAN, Department of Botany, University of Delhi, Delhi 110 007, India.

Zusammenfassung

CHAUDHRY B. & VIJAYARAGHAVAN M. R. 1992. Struktur und Funktion der Antherendrüse bei *Prosopis juliflora (Leguminosae, Mimosoideae):* Eine histochemische Analyse. – Phyton (Horn, Austria) 31 (2): 1–7, 2 Abbildungen. – Englisch mit deutscher Zusammenfassung.

Die Antherendrüse bei *Prosopis juliflora* (SW.) DC. liegt über den Antherenlokuli als Anhang des Konnektivs. Die Drüse besteht aus einem schmalen, mehrzelligen Stiel und einem großen, mehrzelligen runden Köpfchen aus Drüsenzellen. Während der aktiven Phase lösen sich die sekretorischen Zellen auf und durch die Degeneration der Protoplasten entsteht ein protein-kohlenhydrathältiges Exudat, welches durch Öffnungen in der Cuticula nach außen gelangt. Das verschiedenartig zusammengesetzte Exudat umhüllt die Drüsenoberfläche, und lockt als Nahrungsquelle futtersuchende Insekten an.

1. Introduction

Glands are highly specialized cells whose function is to discharge substances to the exterior (exotropic) or into special intercellular cavities (endotropic). They are structurally complex, and this morphological complexity is augmented by cytological and physiological peculiarities of glands. Secretory glands are widespread in angiosperms but anther glands are rare, and are reported in *Myrtaceae* (BEARDSELL & al. 1989) and *Violaceae* (FAHN 1979). In *Prosopis juliflora* (present work), each anther is surmounted by a gland whose structure and function is poorly understood. This plant produces abundant flowers and pollen and secretes copious amounts of nectar. Many potential pollen vectors, particularly insects and bees, thus, forage the inflorescences.

The present communication is an attempt to examine the structure of the anther gland, the nature of the secreted material, and to see whether the exudate, in addition to pollen and nectar, is a potential source of food for the foraging insects.

2. Material and methods

Buds at different developmental stages and mature anthers with the glands were fixed in 10% aqueous acrolein, dehydrated in the butanol series and infiltered in pure glycol methacrylate. The material was embedded in monomer mixture (glycol methacrylate : Azobis : polyethylene glycol 400; FEDER & O'BRIEN 1968). The sections were cut at 2 μm using glass knives. Insoluble polysaccharides were localized with periodic acid Schiff's reagent (FEDER & O'BRIEN 1968) and total proteins with Coomassie brilliant blue (FISHER 1968).

The tissue, for scanning electron microscopy, was fixed in formalin : acetic acid : alcohol (5:5:90 v/v) for 24 hr; dehydrated in an ascending acetone series, critical point dried, coated with gold and observed in a Philips 501 B SEM.

3. Observations

In *Prosopis juliflora,* the anther gland lies above the anther locules as an appendage of the anther connective (Figs 1 A; 2 A, D). At the earliest stage

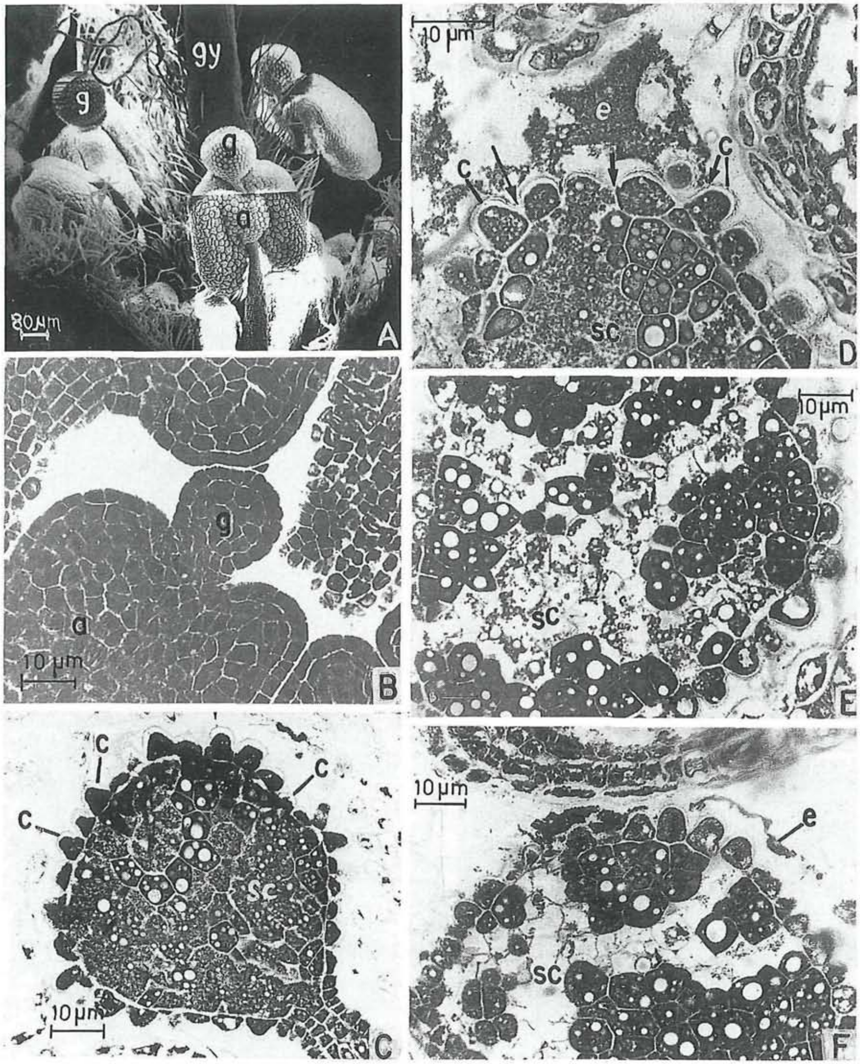

Fig. 1. Anther gland in *Prosopis juliflora.* A, Scanning electron micrograph; B–F Light micrographs (stained with Coomassie blue). A: A mature floral bud split open to show the anthers surmounted by glands. B: Longisection of floral bud at an early developmental stage of the anther gland. C: Longisection of the mature anther gland with well stained secretory cells rich in proteinaceous inclusions. D–F: Same, to show progressive lysis of secretory cells whose contents and lysate are protein rich. In D the overlying cuticle shows openings at the sites of common walls between secretory cells (arrows) through which the exudate is forced out. In E and F the lysed cells are noteworthy. (a = anther, c = cuticle, e = exudate, g = gland; gy = gynoecium, sc = secretory cells).

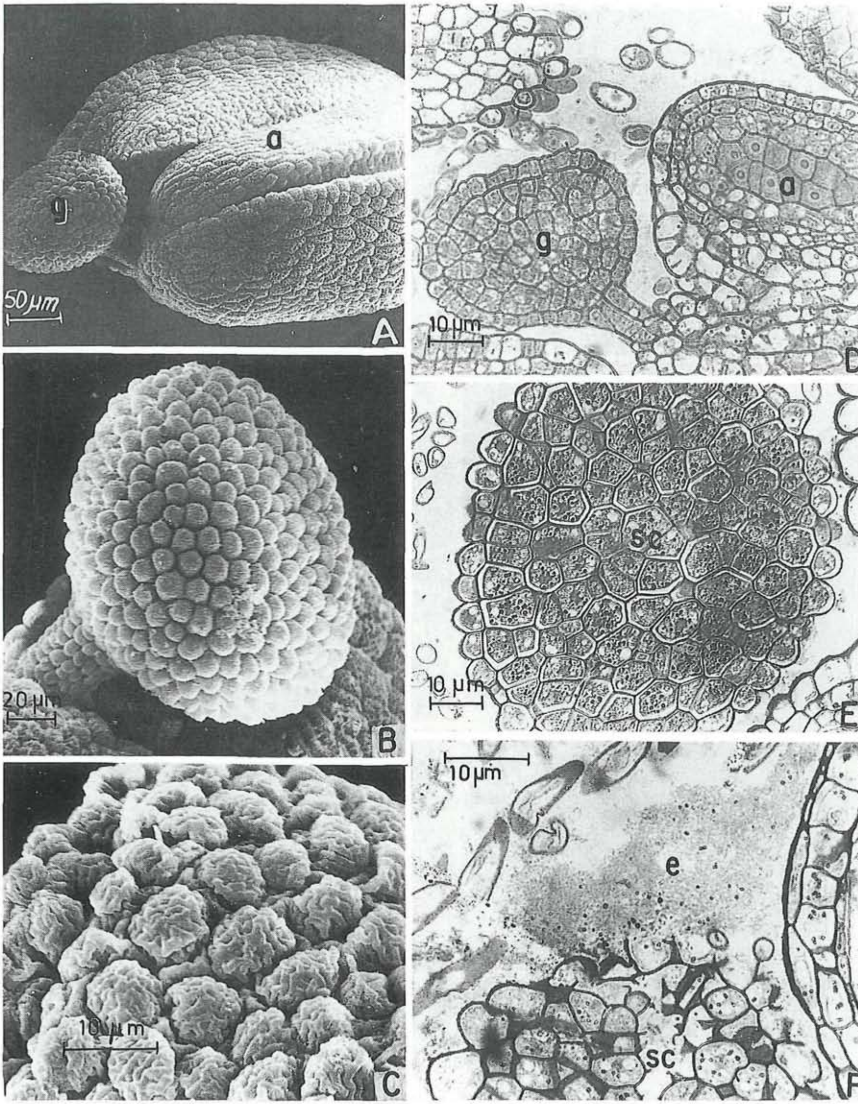

Fig. 2. Anther gland in *Prosopis juliflora*. A–C Scanning electron micrographs; D–F Light micrographs (stained with Periodic acid Schiff's reagent). A: A tetrasporangiate anther with mature gland, prior to secretion. B: Anther gland from above enlarged. C: The gland head cells show rugulate pattern. D: Longisection of young anther gland at the sporogenous stage of the anther. E: Longisection of mature anther gland prior to secretion with well stained secretory cells rich in polysaccharide intracellular secretion. F: Same, showing lysis of secretory cells whose contents and exudate stain positively for polysaccharides. (a = anther, e = exudate, g = gland, sc = secretory cells).

examined, the anther gland contains a homogenous mass of cells bounded by a single layer of distinct rectangular epidermal cells (Fig. 1 B). Both the anther gland and anther are intensely stained for total proteins (Fig. 1 B). With further development, the gland gets differentiated into a long, narrow multicellular stalk that supports a wide, multicellular globose head (Fig. 2 D). In a young and immature gland, the cells are devoid of polysaccharide grains and stain poorly with PAS (Fig. 2 D). In a mature gland, the secretory cells become densely cytoplasmic and are gorged both with proteins (Fig. 1 C) and polysaccharides (Fig. 2 E). The epidermal cells of the gland become round and a thin cuticle veeners the epidermis (Fig. 1 C, D). The surface view of the gland head cells show a rugulate pattern (Fig. 2 B, C). Histochemical tests reveal that the material initially enclosed in the storage vesicles of the anther gland, later accumulate on the surface. The secretory cells protoplast lyse (Fig. 1 D–F) and the exudate stains positively for both proteins (Fig. 1 D, F) and polysaccharides (Fig. 2 F). When secretory pressure becomes maximum, the exudate is forced through the cuticular openings, that are characteristically present at the sites of common walls between secretory cells (Fig. 1 D arrows).

4. Discussion

Glands that secrete hydrophilic substances are generally situated superficially (often as hairs or emergences) and thus communicate with the exterior. Schnepf (1974), depending on the specific substance exuded, classified such glands as digestive (secreting enzymes), nectaries (secreting sugars), salt glands (exuding sodium chloride), hydathodes (secreting water) and mucilage glands (secreting carbohydrates). In many plants, the stipules and the developing leaves also bear glandular trichomes which secrete sticky substances composed of either lipophilic compounds or polysaccharide exudate or both (Fahn 1979).

In *Prosopis juliflora (Leguminosae, Mimosoideae),* the aggregation of exudate on the surface of the mature anther gland suggests for the globose head cells a secretory function. This exudate is a protein-carbohydrate complex. Interestingly, the placental papillae of *Aptenia cordifolia* (*Aizoaceae;* Kristen 1976) and secretory trichomes on leaves and stems of *Pharbitis nil* (*Convolvulaceae;* Unzelman & Healey 1974) secrete a substance that has both polysaccharide and protein. The protein-carbohydrate complex in *Prosopis juliflora* is eliminated through the disintegration of the secretory cells (holocrine secretion) and eventually passes out through the cuticular pores. In placental papillae of *A. cordifolia,* Golgi vesicles export carbohydrate mucilage by exocytosis, but the protein-carbohydrate mucilage, of the storage vesicles, is eliminated through protoplasts lysis (Kristen 1976). In many glands, the secretion either remains in the subcuticular space, except for volatile components, or exuded through rupture of the cuticle. Pores are common in the glandular hairs cuticle of *Drosophyllum* (SCHNEPF 1963); the mucilage secretory hairs of *Rumex maximus* and *Rheum rhabarbarum* (SCHNEPF 1968); the trichome hydathodes of *Cicer arietinum* (SCHNEPF 1965), and salt glands of *Limonium vulgare* (ZIEGLER & LÜTTGE 1966).

The exudate plays an important role, especially in the interaction between plants and animals. The anther gland in *Thryptomene calycina (Myrtaceae)* contains a hydrophobic material which stains positively for lipids and probably also contains phenolic compounds (BEARDSELL & al. 1989). This material secreted through the gland-pore mixes well with pollen grains and acts as a food source for the insects. Many members of *Scrophulariaceae, Malpighiaceae* and *Orchidaceae* secrete fatty oils from special "glands" called elaiophors, and the oil is collected by *Centris* bees (VOGEL 1969).

In *Prosopis juliflora* (present work) the protein-carbohydrate complex also serves as a food source and ensures the visits of a wide range of foraging insects. A wide variety of *Hemiptera* particularly, *Oxyrhachis tarandus* and a number of winged thrips *(Thysanoptera)* are commonly found on the inflorescences, feeding on the anther gland and other floral parts. The insects once attracted and during gnawing on the gland surface, are dusted with pollen. They, thus, serve as inadvertent pollen vectors during visit from inflorescence to inflorescence and plant to plant. These exudates fulfil different functions depending on the plant species, organ or tissue in which the secretion occurs (SCHNEPF 1974). The role of plant exudate besides serving as reserve food, is well known in water retention, as lubricants of the growing roots tips, as adhesive in seed dispersal and in capture of insects by carnivorous plants. The secretion, in anther gland of *Prosopis juliflora* when exuded, binds the pollen grains together, acts as food source and facilitates pollen dispersal by foraging insects. This phenomena may significantly affect the flower-visiting behaviour of potential pollinators.

Acknowledgements

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Recensiones

POPOVSKÝ Jiří & PFIESTER Lois Ann 1990. *Dinophyceae (Dinoflagellida).* – In: PASCHER A./ETTL H., GERLOFF J., HEYNIG H. & MOLLENHAUER D., Süßwasserflora von Mitteleuropa, 6.–8°, 272 Seiten, 256 Abbildungen; Kunststoffeinband. – Gustav Fischer Verlag Jena, Gustav Fischer Verlag Stuttgart. – DM 110,–, für Bezieher des Gesamtwerkes DM 98,–. – ISBN 3-334-00247-0.

Genau die Hälfte der 26 Bände (inkl. Teilbände gezählt) der Neubearbeitung von PASCHERS Süßwasserflora ist seit 1978 bereits erschienen. Zuletzt wurde in Phyton 29 (2): 301 (1989) Vol. 10, *Chlorophyta* II, besprochen.

Nach dem Vorwort folgt auf p. 8–9 ein revidierter Bestimmungsschlüssel für die Klassen der Algen. 66 Seiten allgemeiner Teil geben eine Übersicht über den Bau der Dinophyceen-Zelle; z. B. werden Anordnung und Terminologie der Platten des Panzers durch zahlreiche Schemata dargestellt; Geißeln, Dinokaryon etc. werden behandelt. Mit Ausnahme von *Noctiluca* sollen alle Dinophyeen – entgegen älteren Meinungen – Haplonten sein. Dann folgen Abschnitte über die in dieser Klasse erreichten Organisationsstufen (monadal, rhizopodial. coccal), über sexuelle und asexuelle Reproduktion, Dauerstadien, Lebenszyklen (mit Schemata) und anderes, sowie zuletzt über Sammel- und Präparationsmethoden sowie über die Klassifikation. Literaturhinweise im Text sind leider spärlich.

Der spezielle Teil ist eine Kompilation aller bekannten Süßwasser Dinophyceen (12 Familien, 23 Gattungen) und enthält in der üblichen Weise Bestimmungsschlüssel, Beschreibungen und zahlreiche Abildungen.

Der Band wird sicher wesetnliche Arbeitsgrundlagen für das Bestimmen und die weitere Erforschung der Dinophyceen für weite Teile unserer Erde werden.

H. TEPPNER