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Structure and development of extrafloral nectaries and trichomes in *Macaranga peltata* (Roxb.) Muell. Arg. (*Euphorbiaceae*)

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Abstract

The extrafloral nectaries (30-50) are found on the upper surface of the lamina in *Macaranga peltata*. Glandular trichomes are restricted to the lower surface while eglandular trichomes are observed on all vegetative and reproductive organs. Nectaries originate from a group of initials and trichomes from a single epidermal cell. Stalkless extrafloral nectaries comprise a 2 to 3 layer secretory zone and 1 to 2 layer sub-secretory zone. The structure of the glandular and eglandular is described. Small black ants are seen visiting the nectary and sucking nectar. The probable functions of nectaries and trichomes are discussed.

Key words: extrafloral nectaries, trichomes, Macaranga peltata, ontogeny, structure, function

INTRODUCTION

Macaranga peltata (Roxb.) Muell. Arg. is a large tree occurring in the Western ghats of India (Gamble 1956). Metcalfe and Chalk (1957) reported the presence of extrafloral nectaries in the lamina and inhabitance of ants in the stem in this genera. Matthew (1983) pointed out the presence of secretory structures as one of the major feature of taxonomic value. However, the development, structure and micromorphology of the foliar secretory structures of *Macaranga peltata* are yet to be investigated. The present paper reports the ontogeny, structure and functions of the foliar secretory structures of *Macaranga peltata*.

MATERIAL AND METHODS

Shoot apices having different developmental stages of nectaries and trichomes were collected from Kerala forests, Erumely range and fixed in F. A. A. (Johansen 1940). After dehydration and embedding in Merck wax (52-54°C) sections were cut at 4-6 μm on an AO Spencers rotary microtome and stained with tannic acid-ferric chloride followed by safranin 0 and fast green FCF (Sass 1952). Photomicrographs we were taken using a Carl-Zeiss bright field/epifluorescence microscope. The dehydrated materials having trichomes and nectaries were cut, mounted on a stub, coated with gold-palladium and observed under a Cambridge-Stereoscan S_4-10 electron microscope and photographed with Orwo NP55 film. Continuous field observations were carried out to check the behaviour of ant visitors.

OBSERVATIONS

OCCURENCE

The extrafloral nectaries of *Macaranga peltata* occur on the upper side of the leaf very near to the margin varying in number from 30 to 50. The nectaries occurring on the anterior side of the lamina are situated close to each other outside the loop formed by the joining of super adjacent secondary veins. The extreme tip of the leaf is narrow and about 2.5-3.75 cm in lenght possessing at least a dozen nectaries arranged on either side of the mid-rib. Some of the nectaries occurring on the posterior side of the leaf lamina are seen on the primary veins just below the point of divergence into secondary, and on secondary veins about 2.5 cm away from the margin (Fig. 1A). The leaf margin nectaries are round in shape and those occurring on the veins are somewhat elliptical (Fig. 1B). All nectaries appear to the naked eye as light pink spots on the lamina.

The glandular trichomes are stalked structures present on the lower side of the lamina and are invisible to the naked eye (Fig. 1C). They possess a globular head in younger stages while it becomes flat at maturity. The non-glandular trichomes are distributed on both sides of the leaf, on veins, bracts, stipules, petiole, pedicel, young shoot apices, calyx and fruit wall. The young leaves are densely covered with only non-glandular trichomes on the upper side and both types on the lower side (Fig. 1D).

DEVELOPMENT

A group of cells derived from both epidermal and sub-epidermal layers from the upper side of the lamina function as nectary initials (Fig. 2E). The nectary meristem shows deeper staining than other cells. The sub-epidermal

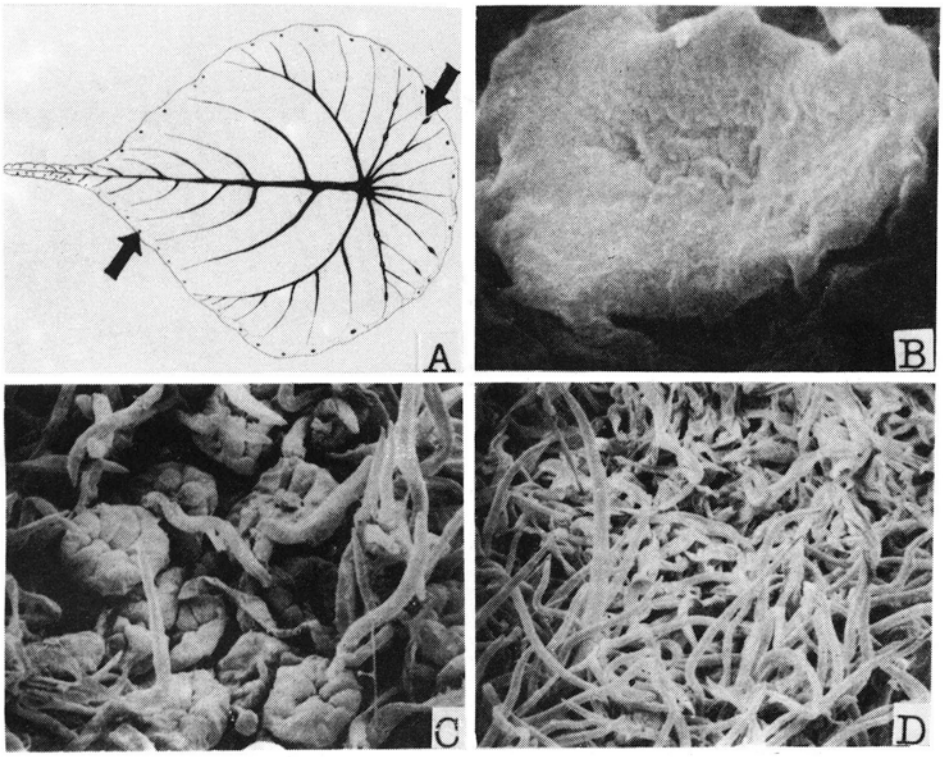
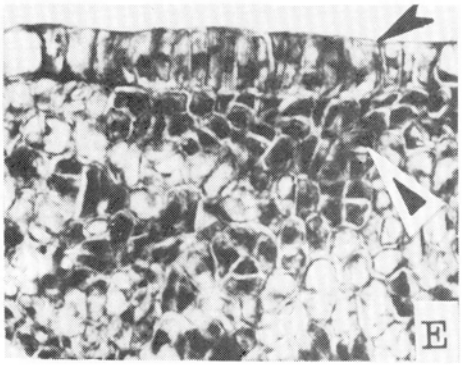


Fig. 1. Morphology of leaf surface. A — Diagram of leaf showing the distribution of extrafloral nectaries, × 0.25. B — SEM photomicrograph of extrafloral nectary (note the absence of stoma and pores), × 500. C — SEM photograph of leaf lower surface showing glandular and non-glandular trichomes, × 500. D — SEM photograph of leaf upper surface showing non-glandular trichomes, × 500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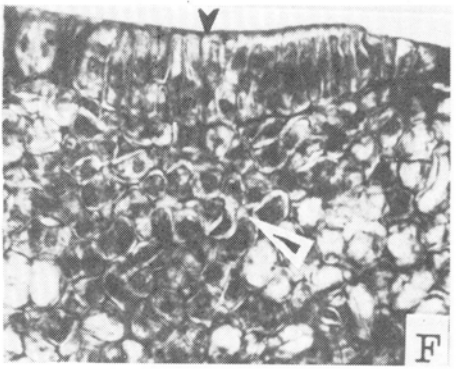
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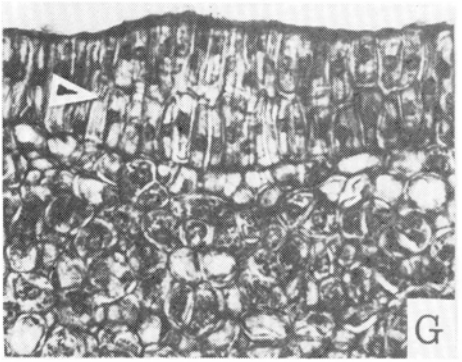
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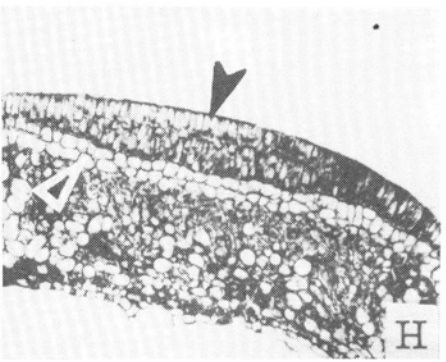
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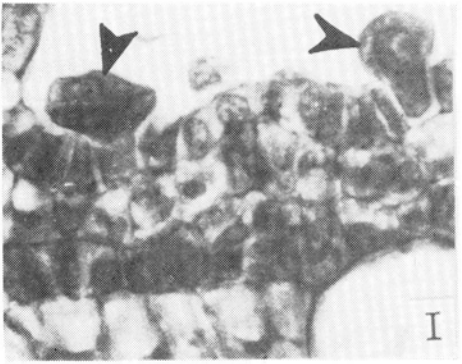
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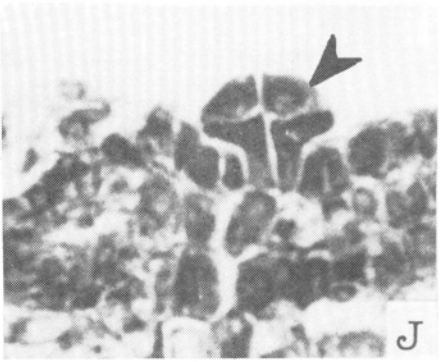
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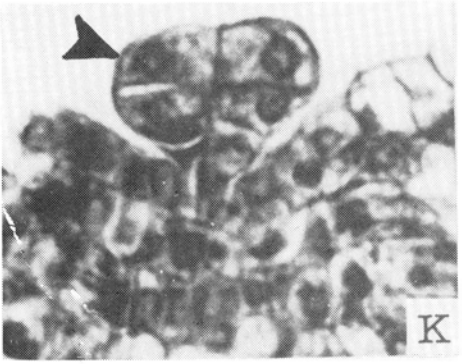
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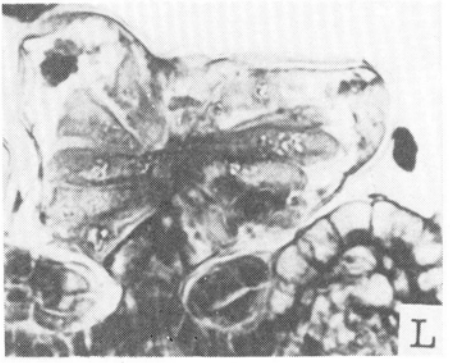
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cells divide in all planes (Fig. 2F). The epidermal initials during their first phase divide only anticlinally. After attaining half maturity these cells undergo periclinal divisions also (Fig. 2G). Active cell divisions in both layers take place and the epidermal cells undergo one more periclinal division.

The glandular trichome develops from a single trichome initial on the lower surface of the leaf, with large size, dense cytoplasm and prominent nuclei. The initial divides first periclinally into an outer cell and basal cell (Fig. 2I). In the case of non-glandular trichomes the outer cell simply elongates completing its development. In grandular trichomes, the outer cell and basal cell undergo one anticlinal division while the outer cell undergoes periclinal divisions also (Fig. 2J). After 2-3 anticlinal and periclinal divisions, the uppermost cells undergo transverse elongation (Fig. 2K). Trichomes develop even before extrafloral nectaries.

STRUCTURE

A mature nectary is a stalkless, structure seen embedded in the lamina. The nectary can be divided into a secretory zone and a sub-secretory zone. The secretory zone is composed of 2 to 3 layers of radially elongated parenchyma cells with dense cytoplasmic contents and prominent nucleus. The cuticle covers the secretory zone which does not have any pores or stomata. The sub-secretory zone consists of 1 to 2 layers of polygonal parenchyma cells. During secretory stages the uppermost cells of the sub-secretory layers undergo complete vacuolization. Direct vascular supply to the nectary is not observed (Fig. 2H).

The glandular trichomes are with a bulbous head at the young stage and the head become flat at old stages (Fig. 2L). The stalk is bicelled. The uppermost layer of cells are highly elongated. The uniseriate trichome is found either filled with some content or highly vacuolated.

FUNCTIONS

The secretary starts secreting when the leaf completes about half of its maturity. The cuticle breaks to eliminate the secretory product which comes out during morning hours in very small amounts. Small black ants were seen wandering on the leaf lamina and sucking nectar from it. No established ant colonies were observed in the tree.

Plate II

Fig. 2. Developmental stages of extrafloral nectaries and glandular trichomes. E – Extrafloral nectary initials (at arrows), × 100. F – Division of epidermal and sub-epidermal cells (at arrows), × 100. G – Periclinal division of epidermal cells (at arrow), × 60. H – Extrafloral nectary at secretory stage showing secretory layer (at black arrow), sub-secretory layer (at white arrow), × 15. I – Trichome initials and first division of an initial (at arrows), × 260. J – Trichome initial showing second division (at arrow), × 260. K – Half matured glandular trichome L. S., × 180. L – L. S. of a mature glandular trichome, × 70

DISCUSSION

The extrafloral nectaries in *Macaranga peltata* are seen only in leaf lamina and not in any other foliage parts as in *Ricinus* of the same tribe *Acalypheae* (Reed 1923). The development of extrafloral nectaries is quite similar to other *Euphorbiaceae* genera (Dave and Patel 1979, Aufrescht 1981, Annigeri and Rudramuniyappa 1984) but the stalkless foliar nectaries with 2-3 layers of secretory zone are rarely observed in *Euphorbiaceae*. These small dispersed nectaries can be considered an advanced type (Elias and Newcombe 1979, Subramanian and Inamdar 1986). The invitation of ants by extrafloral nectaries and plant guarding by ants is reported by several authors (Koptur 1979, Beckman and Stucky 1981). But in the present study, ants visiting the extrafloral nectaries do not play a prominent role as plant guards because their visits occur only during the secretory phase when the leaf is already half matured.

The occurrence of various types of trichomes has been reported in *Euphorbiaceae* (Metcalfe and Chalk 1957). But the glandular trichomes are of rare occurrence. The distribution of glandular trichomes is highly specific while the non-glandular types are commonly seen.

In *Macaranga peltata* the young shoot apices show a thick pubescence of both glandular and non-glandular trichomes. The protective role of plant pubescence has been established beyond doubt by many authors (Levin 1973, Johnson 1975). In our opinion, the leaf pubescence by dimorphic trichomes overshadows the extrafloral nectaries in protecting very young leaves because the nectar-induced and visits occur only at half mature stages of a leaf.

Acknowledgments

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Budowa i rozwój pozakwiatowych miodników i włosków u Macaranga peltata (Roxb.) Muell. Arg. (Euphorbiaceae)

Streszczenie

Na górnej powierzchni blaszki liściowej u *Macaranga peltata* znaleziono pozakwiatowe miodniki (30-50). Włoski gruczołowe występowały jedynie na dolnej powierzchni, podczas gdy włoski bezgruczołowe obserwowano na wszystkich wegetatywnych i generatywnych organach. Miodniki rozwijają się z grupy komórek inicjalnych, natomiast włoski z pojedynczej komórki epidermalnej. Bezogonkowe pozakwiatowe miodniki składają się z 2-3 warstwowej strefy wydzielniczej oraz z 1-2 warstwowej strefy subwydzielniczej. Opisano budowę włosków gruczołowych i bezgruczołowych. Widziano małe czarne mrówki odwiedzające miodniki i wysysające nektar. Przedyskutowano przypuszczalną rolę tych miodników i włosków.