Organographic distribution, structure and ontogeny of laticifers in *Plumeria alba* Linn.

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Abstract. The organographic distribution, structure and ontogeny of non-articulated laticifers are studied in *Plumeria alba*. The distribution of laticifer branches is studied in stem, pedicel, petiole, lamina, petal, stamen, ovary wall, style and stigma. Laticifer branches are observed in all except anther lobes and stigma. The wall of the laticifers is thicker than in the other cells and the cytoplasm contains many nuclei. Round starch grains were found in the neighbouring parenchyma cells, but starch grains are lacking in the laticifers. The laticifer branch can occur on either side of procambium of the shoot and these cells can easily be distinguished from other cells by larger size, prominent nuclei and denser cytoplasm. Laticifers grow intrusively along the intercellular spaces.

Keywords. *Plumeria alba*; laticifers; distribution; structure; ontogeny.

1. Introduction

Metcalfe (1967) reported the occurrence of non-articulated and articulated laticifers in 22 angiosperm families. These laticifers form a highly specialized internal secretory systems and they are known to synthesize economically and medicinally useful compounds. Hartig (1862) classified the laticifers into articulated and non-articulated. Mahlberg (1961, 1963) described the origin and development of non-articulated laticifers in the embryo of *Nerium oleander*. The present paper describes the ontogeny, structure and organographic distribution of non-articulated laticifers in *Plumeria alba*.

2. Materials and methods

Plant parts including shoot apices, young stem, petiole, pedicel, leaves and flower buds were collected from the adult plants growing in the university garden and fixed in FAA for customary methods of embedding, sectioning and mounting of histological sections (Johanson 1940). The 8–10 μm thick sections were stained with tannic acid, ferric chloride followed by safranin and fast green (Gurr 1953). Leaves and petals were cleared in 1:1 hydrogen peroxide and acetic acid, stained with oil red 'O' (Pearse 1968) and mounted in 50% glycerine. Some of the sections of paraffin embedded material were stained for fluorescent PAS type reaction (Pearse 1968) and viewed by a Carl Zeiss epi-fluorescence photomicroscope at 400–440 nm.

3. Observations

3.1 Origin and development of laticifers

The laticifers were detected on either side of the procambium in the shoot area. The tip of a laticifer branch can be distinguished from neighbouring cells by spherical
outline, larger size, prominent nucleus and denser cytoplasm (figure 1A). The development of the laticifers are faster than the ordinary parenchyma cells. The nuclei in the laticifers are reported to result from nuclear divisions (figure 1B) (Mahlberg 1959a; Mahlberg and Sabharwal 1966, 1967). During development laticifers elongate parallel to the procambium and send out branches (figures 1C, D). The tip of developing branch grows intrusively along intercellular spaces between parenchyma. The branch can penetrate into the pith where it is termed a pith branch, while those growing in the cortex are termed cortical laticifers. They grow along the longitudinal axis of the plant body and continue to produce branches that can develop laterally in the axis (figure 1D). This pattern of growth results in the formation of a branched elongated coenocytic laticiferous cell (figure 1E).

3.2 Structure

The laticifer system conforms to non-articulated branched type. Laticifers that occur on either side of the vascular cylinder and in pith of stem are found to be wide (53 μm) than those in the outer cortex (37.5 μm), while the width of the laticifers in pedicel and petiole are almost the same as in the pith region (52.5 μm). The wall of the laticifers are thicker than the neighbouring cells (figure 1F). They branch towards the inner pith and outer cortex. Branching may be of different types. It may be usually of 'H' or 'Y' type (figure 1D).

During the development of lamina, the laticifers from the stem cortex produce branches that penetrate into the leaf. Pith laticifers also develop additional branches and enter into the leaf primordia through leaf gaps. Laticifers that occur in lamina are more branched than in the stem. The branches of laticifers that occur in lamina are found to be along the vein (figure 2A). Their ending may be very slender and tapering (figure 2B). Laticifers in the petals also follow the vein and more or less are dichotomously branched in between the veins (figure 2C).

The laticifers may be polygonal or round with variable diameter in transection (figure 1F). However, the diameter of the lumen of a single laticifer is constant for a considerable length (figures 1C, D).

Small starch grains are found to occur in all the parenchyma cells but they are not observed in the laticifers (figure 2D). Cytoplasm and numerous nuclei were observed in the lumen of the laticifers of young parts (figure 1E). The nuclei are spindle shaped or round with prominent nucleoli. The size of the nucleus is almost the same in all laticifer branches.

3.3 Distribution of laticifers

Laticifers are distributed both in vegetative and reproductive parts except in anther lobes and stigma.

In stem and pedicel, laticifers occur in the cortex as well as in the pith either close to phloem or a few cells away from phloem (figure 2D). Cortical laticifers mainly occur in the inner cortex with branches extending towards the outer cortex up to the epidermis. In the pith laticifer branches are distributed evenly with increasing density close to the vasculature.

Petiolar laticifers are distributed around the vascular tissue close to phloem and
Distribution of laticifers in Plumeria alba

Figure 1. A-F. Origin and development of laticifers. A. Section from shoot apex showing laticifer initials on either side of procambium (× 208). B and C. Development of laticifers. Note the growth of the initials parallel to procambium and the divided nucleus (× 160, × 1184). D. Branching of laticifer in the pith (× 384). E. Laticifer in the shoot apex showing nuclei and cytoplasm (× 1216). F. Transection of laticifiers. Note the wall of the laticifers are thick (× 105-6).

(LL, Laticifer initial; PC, procambium; N, nucleus; L, laticifer).
Figure 2. A–F. Distribution of laticifers. A. Laticifers in the leaf. Note the branching of the vein follows the branching of laticifer (×105-6). B. Cleared leaf showing tapering end of the laticifers in the areoles (×128). C. Cleared petal showing branching of laticifers (×38-4). D. Fluorescent micrograph of stem. Laticifer occurs close to phloem. Note the starch grains in the neighbouring cells (×144). E. and F. Laticifer in the petiole present very near to phloem and in between vascular bundles (×38-4, ×53-7).

(L. Laticifer; XY, xylem; PH, phloem; St, starch).
ground tissue (figure 2E). Here, the laticifers also may be present between the vascular bundles (figure 2F). Laticifers are also observed in the glands present at the base of the petiole.

Laticifers in the lamina and petals are closely associated with phloem of the veins. Branching of the vein is accompanied by similar branching of laticifers (figure 2A). They may be distributed in the spongy parenchyma and the palisade tissue (figure 3A,C). Laticifers are observed just beneath the palisade tissue in lamina (figure 3C), sometimes branching in between the palisade cells with branches extending upto the epidermis (figure 3B). Petal laticifers extend throughout the entire ground tissue with branches upto the epidermis (figure 3D). Since the stamens are epipetalous, laticifers from the petal continue into the filament of the stamen, but not into the anther lobes. Laticifers are also observed in the ovary wall and style close to the vascular tissue but not in the stigma.

Figure 3. A–D. Distribution of laticifers. A and B. Paradermal section of leaf. A. Laticifer in the spongy parenchyma tissue (× 83-2). B. Branched laticifers present below the epidermis (× 115-2). C. Transection of leaf showing laticifer present below the palisade tissue (× 121-6). D. Longisection of petal showing laticifer reach upto the epidermis (× 201-6).
(L, Laticifer; Sp, spongy parenchyma; Pl, palisade tissue).
4. Discussion

Metcalfe (1967) and Mahlberg (1961, 1963) reported non-articulated branched laticifers in the family Apocynaceae. Mahlberg (1961) pointed that the laticifers arise from about 28 initials in the embryo, immediately below the embryonic shoot apex in *Nerium oleander*. According to Chaveaud (1891) and Schaffstein (1932) the non-articulated laticifers in *Urtica, Cannabis* and *Vinca* differentiate only in the shoot apex and not in the embryo. New laticifer initials were always produced during the growth of the shoot apex (Zander 1928). The present observations are in accordance with those of Chaveaud (1891), Schaffstein (1932) and Zander (1928). As reported by Mahlberg (1959b) development of laticifer initial is observed to be by intrusive growth. Starch grains of variable shapes were not observed here as reported by Mahlberg (1973, 1975) in the *Euphorbia* species.

The distribution of laticifers has been reported in *Euphorbia cotinifolia* (Scott 1889); *Cryptostegia* (Blaser 1945); *Euphorbia canariensis* (Garcia 1952); *Nerium oleander* (Mahlberg 1963) and *Euphorbia supina* (Rosowski 1968). Castells et al (1984) observed laticifers in all plant parts except anther lobes, stigmatic surface and nectaries of *Jatropha gossypifolia*. The present observations regarding the distribution of laticifers in *Plumeria alba* are in full conformity with those of Castells et al (1984).

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