

## THE MUCILAGE SECRETING HAIRS ON THE YOUNG FRONDS OF SOME LEPTOSPORANGIATE FERNS

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### INTRODUCTION

During a collecting trip to Thailand, as a member of the Thai-Dutch botanical expedition 1965/1966, I was struck by the excessive amount of mucilage sometimes present on the circinnate fronds of several leptosporangiate ferns. This was especially evident in representatives of the monotypic fern family *Plagiogyriaceae* and the Thelypteroid ferns.

The mucilage is secreted by a multitude of minute glandular hairs. In mature leaves the hairs are shrivelled and easily overlooked, or even have disappeared. Moreover, usually only herbarium specimens are available for investigation.

In *Plagiogyria*, these hairs, together with acrophores, were discovered by Mettenius (1858). After him Bower (1910) supplied short notes on the dense felt of hairs on the young fronds of some species. Kühn (1889), Goebel (1926), and Troll (1933) described glandular hairs from a few Thelypteroid ferns. Guttenberg (1935) studied the histology and cytology of acrophores and glandular hairs. He also gave suggestions about their function.

In recent years little attention has been paid to these ephemeral trichomes. Copeland for instance, who revised the genus *Plagiogyria* in 1928, wrote about the mucilage (1947) '... it has been reported to be secreted by hairs, which I have not seen.' On the young fronds of other ferns, e.g. *Pteris* and *Blechnum* species, glandular hairs can be found as well. Their presence, however, is often less marked, since the hairs are usually more loosely arranged or covered by scales.

As this kind of trichomes has but occasionally been described in detail, it seemed useful, from a taxonomist's point of view, to find out whether these hairs show sufficient differences in their characters to be of taxonomic interest.

### MATERIAL AND METHODS

Circinnate fronds, a few cm in length, were directly after cutting brought into an excess of the preservative FAPA (formaline 40 % : 5; glacial acetic acid: 2.5; propionic acid: 2.5; alcohol 50 % : 90). In this liquid the material can stay for months. Routine histological procedures were followed. Staining of sections was done with saffranine followed by fast green. Ruthenium red dissolved in lead-acetate, the vanilline-hydrochloric acid reagent of Lindt, and the reagent of Joachimowitz (for details of the reagents see Hegnauer, 1963, p. 17) were used to get some information about the chemical nature of the mucilage. Scrapings of the epidermis, washed in water and mounted in glycerine jelly were used for studies in toto.

The following species were investigated:

1. *Plagiogyria communis* Ching (*P. pycnophylla* Copel., p. p.) Thailand, Payap, summit region of Doi Inthanon, c. 2400 m: *Hennipman 3400*.

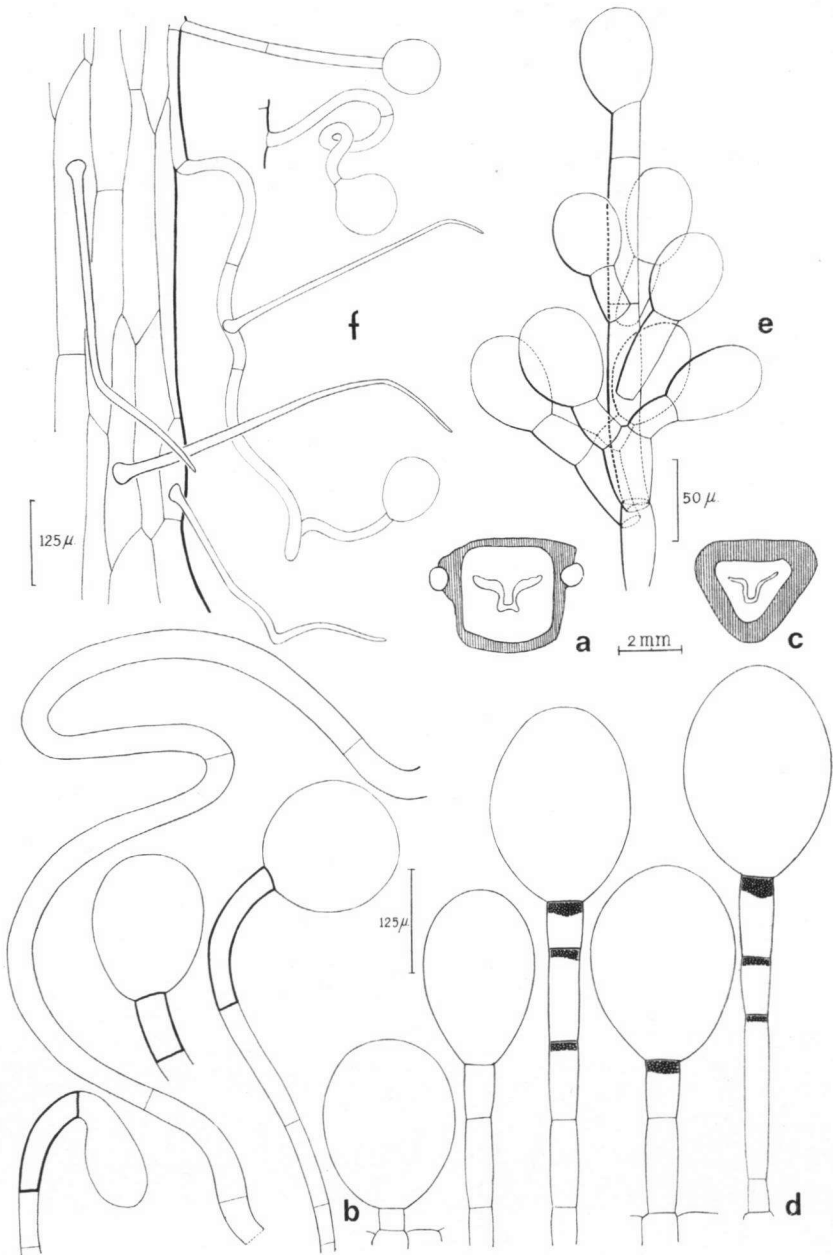


Fig. 1. *Plagiogyria communis* Ching. a. Cross-section through stipe of circinnate leaf, the shaded area comprises the glandular hairs; b. Id., some hairs in detail (Hennipman 3400). — *Plagiogyria tuberculata* Copel. var. *decrescens* C. Chr. c. As Fig. 1a; d. Id., as Fig. 1b (Vink 17081). — *Thelypteris xyloides* (Kunze) Ching. e. A glandular hair (Hennipman 3358). — *Cyclosorus* aff. *C. truncatus* (Poir.) Tardieu. f. Margin of scale with acicular and glandular hairs (Hennipman 3058).

2. *Plagiogyria tuberculata* Copel. var. *decrescens* C. Chr. New Guinea, Papua, Southern Highlands Dist., Mt. Kerewa, 3340 m: *Vink 17081*. As sectioning of the paraffine blocks proved to be difficult, sections made by hand and embedded in glycerine jelly were studied.

3. *Thelypteris (Pseudocyclosorus) xylodes* (Kunze) Ching. Thailand, Payap, near Sop Aep (98°35'E, 18°30'N), c. 750 m: *Hennipman 3358*; id., Pa Mon (98°30'E, 18°35'N), c. 1300 m: *Hennipman 3461*.

4. *Cyclosorus (Thelypteris) aff. C. truncatus* (Poir.) Tardieu. Thailand, Nakhon Sawan, Langsang National Park, SW. of Tak, c. 800 m: *Hennipman 3058*.

These species were growing in or near small rivulets or in marshy soil, either in primary forest or in secondary vegetation. Duplicates of these collections will be distributed by the Rijksherbarium to BKF, K, KYO, and various other herbaria.

## RESULTS

### 1. *Plagiogyria communis* Ching. — Fig. 1a—b. Photogr. 1—2.

Petiole of circinnate frond above the widened base, on cross-section about quadrangular, covered with a 250—500  $\mu$  thick, compact layer of mucilage-producing glandular hairs. Hairs uniseriate, unbranched, usually (strongly) curled, built up of a 1—7(—10)-celled stalk and an apical glandular cell. Stalk usually not longer than 0.5 mm, but sometimes measuring some mm. Stalk-cells 40—500 by 15—55  $\mu$ , thin-walled, colourless except the apical cell which is somewhat thicker and yellowish. Glandular cells obovoid to roundish, varying in diameter from 100—200(—400)  $\mu$ . Aerenphores cylindrical or irregularly shaped, in two rows lateral on the petiole and on the rhachis near the base of the pinnae, up to c. 2 mm wide, up to c. 4 mm high.

### 2. *Plagiogyria tuberculata* Copel. var. *decrescens* C. Chr. — Fig. 1c—d.

Petiole of circinnate frond on cross-section above the widened base triangular, covered with a 550—700  $\mu$  thick, compact layer of mucilage producing glandular hairs. Hairs uniseriate, unbranched, erect, consisting of a slender, 1—5 celled, up to 450  $\mu$  long stalk and an apical glandular cell. Individual stalk-cells up to 150 by 20—45  $\mu$ , 1—6 times longer than wide, thin-walled, yellowish, usually distally with dark brown contents. Glandular cells obovoid or ellipsoid, usually 125—300 by 75—200  $\mu$ , thin-walled. Aerenphores as in *P. communis*, but less striking through smaller size.

### 3. *Thelypteris xylodes* (Kunze) Ching. — Fig. 1e. Photogr. 3—4.

Petiole of circinnate frond densely covered with a 275—400  $\mu$  thick layer of glandular hairs. Hairs uniseriate, erect, much-branched, each branch ending in a glandular cell. Stalk-cells up to 100 by 35  $\mu$ , 1—6 times longer than wide, thin-walled, colourless. Glandular cells obovoid to round, 40—100 by 30—80  $\mu$ , thin-walled, colourless. Aerenphores linear, occurring as two lateral, longitudinal lines near the base of the petiole only, crowded with stomata.

Small excrescences on the stipe and abaxially near the base of the pinnae also present. Besides a short stalk, these structures have a branched xylem body originating from the leaf-trace adaxially, and aerenchymatic tissue terminally. Each xylem branch ends in what is obviously a hydathode.<sup>1</sup> Viewed from below these hydathodes are arranged together in a semi-circle (Fig. 2).

<sup>1</sup>) In a strict sense hydathodes are characterized by excreting the liquid through an opening in the epidermis. In this species such pores were not found, the xylem branches being covered with the epidermis throughout. In several other ferns, for instance *Polypodium vulgare* L., the hydathodes are also covered with an epidermis. Sadebeck (1902, p. 67) named these 'water-grooves' ('Wassergruben') and defined them as hydathodes without 'pores' ('Hydathoden ohne Wasserspalten').

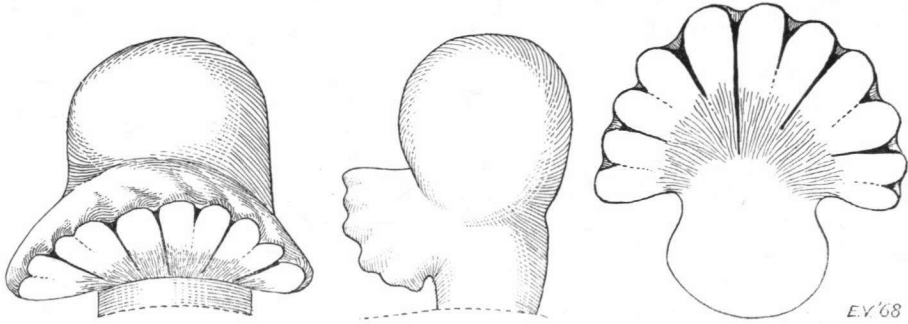


Fig. 2. *Thelypteris xylodes* (Kunze) Ching. Excrescence of petiole (Hennipman 3461).

In a very young stage of the frond the glandular hairs are hidden under numerous rather large scales which arise mainly from the lateral and adaxial sides of the rachis. The margin of the scales usually carries (un)branched glandular hairs similar to those described above. The scales lack the unicellular, needle-like hairs that are often present in *Thelypteroid* ferns (Holttun, 1954).

#### 4. *Cyclosorus* (*Thelypteris*) aff. *C. truncatus* (Poir.) Tardieu — Fig. 1f.

Glandular hairs particularly abundant on the margin of the scales that cover the young fronds. Scales mainly attached to the lateral and adaxial sides of the circinnate leaf. Stalk of the glandular hairs up to 1.5 mm long. Hairs uniseriate, unbranched (sometimes with a cell similar to the acicular hairs on one of the stalk cells) more or less curled, built up of a 1–5-celled stalk and an apical glandular cell. Stalk cells up to 600  $\mu$  long, 20–35  $\mu$  wide, thin-walled, hyaline. Glandular cells about roundish, measuring up to 125  $\mu$ , sometimes more or less constricted near the base. Apart from glandular hairs, also acicular hairs were found all over the surface and on the margin of the scales. These acicular hairs are one-celled, up to 700  $\mu$  long, near the base 15–30  $\mu$  wide, stiff, whitish, tapering towards the acute or round apex. Aerophores occur as two lateral longitudinal lines on stipe and rachis, they are crowded with stomata.

The abaxial side of the young frond has but few scales, but is densely covered with unbranched glandular hairs similar to those found on the margin of the scales.

#### DISCUSSION

The *Plagiogyriaceae* stand apart among the leptosporangiate ferns, amongst others by having a naked rhizome. There is no trace of either scales or bristles. But the fast growing and unrolling leaf tissue, particularly above the widened base of the petiole, is densely covered with glandular hairs; the widened base itself bears but relatively few and few-celled glandular hairs.

From the descriptions of the two *Plagiogyria* species studied it is apparent that the hairs, although of the same type in both species, show significant differences both in orientation and in shape and size of stalk and glandular cell. As the specific delimitation within the genus *Plagiogyria* has become difficult, the structure of the hairs may offer useful additional criteria.

Nayar & Kaur (1962) reported 'sparse hairs' on the leaf base of *Plagiogyria euphlebia* (Kunze) Mett. These hairs may be morphologically comparable with those found by me in

*Plagiogyria communis*. However, the hairs studied by him were described as sometimes branched near the base, a fact never observed by me.

The Thelypteroid ferns have glandular cells that are much smaller than those found in *Plagiogyria*. None the less a large amount of mucilage is produced. Goebel (1926) reported a mucilage layer of 10 mm thick in *Cyclosorus (Dryopteris) callosus* (Bl.) Ching, a species related to *C. truncatus* (Poir.) Tardieu.

In *Thelypteris (Pseudocyclosorus) xyloides* (Kunze) Ching the glandular hairs are much-branched and arranged in a dense layer covering petiole and rhachis. The scales bear comparably few (un)branched hairs mainly on their margin. These trichomes resemble those occurring in *Cyclosorus (Dryopteris) callosus* and were figured by Kühn (1889), Goebel (l.c.), and van der Meer Mohr (1937). Hairs and scales, although homologous, are in the present paper treated as different structures.

In *Thelypteris xyloides* also small excrescences were found, functioning as aerophores and as hydathodes. Comparable organs were also reported by Goebel for *Cyclosorus (Dryopteris) callosus*.

In *Cyclosorus aff. C. truncatus* (Poir.) Tardieu hairs are especially abundant on the scales. Few-celled, unbranched glandular hairs also occur on the abaxial side of the petiole. The acicular hairs of this species differ from the small, needle-like hairs of the scales of several other Thelypteroid ferns.

Scales and hairs similar to those found by me in *Cyclosorus aff. C. truncatus* were described and figured already by Troll (1933) for a species which he called *Dryopteris sumatrana* v. A. v. R. but which represents, according to Prof. Holttum, a species related to *Cyclosorus truncatus* (Poir.) Tardieu. Troll reported both linear aerophores between the pinnae and excrescent aerophores at the bases of pinnae; in *C. truncatus* the latter are only apparent as slight swellings.

The mucilage of the species studied seems to be free of uronic acids as it scarcely stained by ruthenium red. The glandular hair cells and the excreted mucilage were not stained by the reagents of Lindt and of Joachimowitz, indicating that leucoanthocyanins or catechins are not present in the secretions.

It is of interest to know that the species studied were all growing in or near water or at least under everwet tropical conditions. Goebel (l.c.) reported that less mucilage was produced when *Cyclosorus (Dryopteris) callosus* was grown in a greenhouse. Troll (l.c.) and Holttum (l.c.) are of opinion that the production of mucilage is a possible way of excreting the superfluous amount of water that is needed by the fast growing tissue as a mineral supply. However, it needs to be confirmed by experiments that no water from the environment is attracted by the mucilage.

The aerophores make gas-exchange possible for the young fronds covered with mucilage. The production of mucilage is a continuous process during a certain period of the young frond. In the material examined all stages of the development of glandular-cells were found.

It is generally believed that the mucilage ultimately comes free by rupture of the wall of the full-grown glandular cell. In *Cyclosorus aff. C. truncatus* round hyaline swellings on the outer side of the glandular cells were sometimes observed.

#### CONCLUSIONS

This study shows that the circinnate fronds of several leptosporangiate ferns are densely covered with glandular hairs and additional structures.

These structures, which can only be well studied with young material, proved to be morphologically different within the genera and species studied. It is supposed that other genera with a less striking youth indument, do have characteristic (glandular) hairs on their young fronds as well.

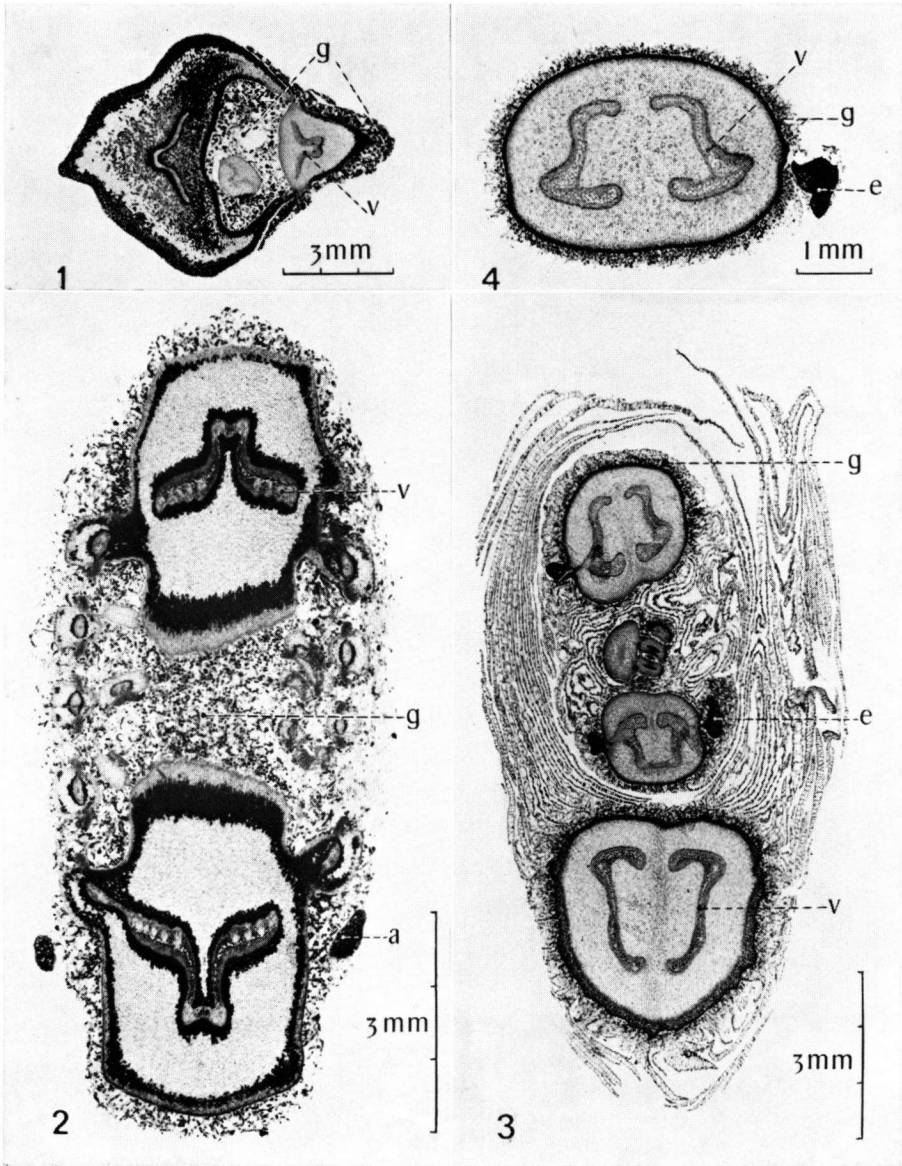
As the trichomes found on mature fronds are considered to be of essential importance in fern taxonomy, it seems worthwhile to investigate these ephemeral trichomes too, particularly in taxonomically difficult groups.

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Photographs. 1. *Plagiogyria communis* Ching, cross-section through circinnate leaf. 2. Id., of an older stage (Hennipman 3400). — 3. *Thelypteris xyloides* (Kunze) Ching, cross-section through circinnate leaf. 4. Id., cross-section through young petiole (Hennipman 3358). — (a = aerophore, e = excrecence, g = glandular hairs, v = vascular strand).