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ROOT IN VASCULAR CRYPTOGAMS AND
ANGIOSPERMS**

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Trichomes of the Root in Vascular Cryptogams and Angiosperms by Robert Greenleaf Leavitt

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ROBERT GREENLEAF LEAVITT

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BY ROBERT GREENLEAF LEAVITT, A. M.

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No. 7.—TRICHOMES OF THE ROOT IN VASCULAR
CRYPTOGAMS AND ANGIOSPERMS.¹

BY ROBERT GREENLEAF LEAVITT, A. M.

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TWO CLASSES OF RADICAL TRICHOMES.

THE trichomes which arise in the superficial layer of the root of vascular plants as organs of absorption are of two types. Trichomes of one kind result from a differentiation of the meristematic cells of the young epidermis near the apex of the root; those of the other class have a simpler origin. The more commonly recognized and less highly specialized type will be first described.

¹Contributions from the Ames botanical laboratory, no. 2.

THE FIRST TYPE.

Trichomes of the first type are characteristic of the Dicotyledons, of some divisions of the Monocotyledons, and of the Filices. In these groups, as a rule, any cell of the piliferous layer may, at a certain stage in the development of the tissue, acquire the character of a trichome¹ by putting out a hair. All the cells over considerable areas may be piliferous, or only a part of them, determined apparently by chance. From the appearance of the cells of the young epidermis it is not possible to predict which ones are to become trichomes. Below the region of the youngest hairs there is no visible specialization or predetermination of the future trichomic cells. Every cell, we may suppose, is a potential trichome. The actual fate of any cell, whether it shall be that of a trichome or of an atrichomic element, is first to be ascertained in the young fixed tissue, after the cells have undergone a considerable extension, and after cell division has altogether ceased. The first indication of trichomic development is the appearance of a papilla, usually near the lower or distal end of the epidermal cell, that is, near the end lying toward the apex of the root.

Distribution of the first type in vascular Cryptogams and Angiosperms.—The following groups have been investigated with respect to the species named. The trichomes in these species are not predetermined in the nascent epidermis of the root, so far as can be seen.

FILICES.

Hymenophyllaceae: *Trichomanes* sp.

Cyatheaceae: *Alsophila australis*, *A. Cooperi*, *Cibotium Schiedei*, *Cyathea insignis*, *C. medullaris*, *C. regalis*, *Dicksonia antarctica*, *D. davallioides*.

Polypodiaceae: *Adiantum aneitense*, *A. Capillus-Veneris*, *A. cuneatum*, *A. decorum*, *A. gracillimum*, *A. macrophyllum*, *A. Wie-*

¹ It seems necessary, in describing the structures under consideration, to use the word *trichome* for the whole cell, including the tube, or *hair*, or *root-hair*, and the basal portion imbedded in the epidermis, or *base*. The adjective *trichomic* and its opposite *atrichomic* have been coined for convenience in the present discussion.

gandi, *A. Williamsii*, *Aspidium filix-mas*, *A. marginale*, *A. molle*, *A. trifoliatum*, *Asplenium angulare*, *A. bulbiferum*, *A. decussatum*, *A. Trichomanes*, *Blechnum brasiliense*, *B. occidentale*, *B. spicans*, *Cyrtomium* sp., *Gymnogramme sulphurea*, *Lomaria gibba*, *Microlepia hirta*, *Davallia fijiensis*, *Doodia rupestris*, *Nephrodium Shepardii*, *Nephrolepis bulbifera*, *N. davallioides*, *N. exaltata*, *Onoclea sensibilis*, *Pellaea hastata*, *Phegopteris polypodioides*, *Platycerium Alaicorne*, *Polypodium aureum*, *P. plectolepis*, *P. vulgure*, *Pteris aurata*, *P. cretica*, *P. pedata*, *P. serrulata*, *P. tremula*, *Scolopendrium vulgare*, *Woodsia obtusa*, *Woodwardia angustifolia*.

Osmundaceae: *Osmunda regalis*.

Marattiaceae: *Angiopteris evecta*, *Marattia alata*.

In *Ophioglossum vulgatum* and *Botrychium ternatum* (the only members of the Ophioglossaceae the roots of which were seen) no trichomes could be found.

The available species of the family Schizaeaceae were exceptional amongst the Filices examined in bearing trichomes of the second type. This case will be described below.

HYDROPTERIDAE.

Marsiliaceae: *Marsilia quadrifolia*, *M. (uncinata?)*.

In *Azolla*, the epidermis of the root has a somewhat complicated development, which is fully described below. *Salvinia* is without roots, if we except the transitory root of the sporeling, which I have not seen.

MONOCOTYLEDONS.

In a large number of Monocotyledons the hairs are borne by special cells predetermined at an early stage, in the manner to be described below. The Liliiflorae, however, with but slight exception, the Spadiciflorae in the main, and numerous examples from other subdivisions of the Monocotyledons, present trichomes of the first type only. The species in which I have determined this to be the case are the following:—

Glumiflorae.

Gramineae: *Brachypodium distachyon*, *Coix agrestis*, *C. lachryma*,
Eleusine corneana, *Oryza sativa*, *Sporobolus airoides*, *S.*
cryptandrus.

About 50 species of grasses were examined. Only the seven named were assigned to the class in which they are here put; and in several of these there was much doubt, and the determination was made provisionally. This matter will be further discussed below under Gramineae (p. 296).

Spadiciflorae.

Palmae. Of the palms examined only one had root-hairs. This was *Oreodoxa regia*. On the roots of seedlings a few hairs were found. They come from ordinary elongated epidermal cells. Gillain has examined the roots of many Palmae. The epidermis was one of the parts to which special attention was paid. In summarizing the results of this study of thirty-five species of palms he says of the epidermis: "It is retained only on the smaller parts of the roots, and then shows elongated cells, whose outer membrane is more or less strongly cuticularized. Only in *Trachycarpus excelsus* are hair formations and papillae present, such as Mohl has reported for *Diplothemium maritimum*."¹

Cyclanthaceae: *Carludovica atrovirens*.

Typhaceae: *Sparganium* sp., *Typha latifolia*.

Araceae: *Aglaonema picta*, *Anthurium Dechardi*, *A. magnificum*,
Arisaema triphyllum, *Caladium esculentum*, *Dieffenbachia*
picta, *Zantedeschia aethiopica*.

Liliiflorae.

Liliaceae: *Allium narcissiflorum*, *A. cepa*, *Anthericum Bernarnii*,
Asparagus plumosus, *A. truophinus*, *Brodiaea congesta*,

¹Gillain, G.: Beiträge zur anatomie der palmen- u. pandanaceen-wurzeln. Bot. centralb., 83: 337 (1900).

Dianella coerulea, *D. revoluta*, *Funkia cvata*, *Hyacinthus amethystinus*, *Lilium longiflorum*, *L. speciosum*, *Muscari Argaei*, *Xanthorrhoea arborea*, *Xerotes longifolia*.

Convallariaceae: *Aspidistra lurida*, *Cordyline stricta*, *Dracaena nutans*, *D. hybrid*, *Polygonatum biflorum*, *Yucca angustifolia*.

Amaryllidaceae: *Amaryllis amethystinus*, *Eucharis amazonica*, *Hypoxis erecta*, *Leucorum autumnale*, *Pancratium ovatum*.

Bromeliaceae: *Billbergia Leopoldii*, *B. Quesneliana*, *Nidularium argenteum*, *Tillandsia Lindenii*.

Iridaceae: *Freesia refracta*, *Iris Histrio*, *I. pseudacorus*, *Ixia* sp., *Moraea Robinsoniana*, *Sisyrinchium atlanticum*, *Watsonia Ardernei*.

The tegumentary tissues of the root were carefully examined and described by Juel for a large number of the Liliiflorae representing 42 genera. He makes no mention of specialized hair-cells in this group, although he noted several instances in other groups. This negative evidence is in agreement with my own observations. In the Liliiflorae in general the trichomes are of the unspecialized type.

Gynandreae.

The trichomes are sometimes predetermined, as in *Pogonia ophioglossoides* and other species mentioned below; but in many and probably in most of the Orchidaceae, any cell of the external layer may put out a root-hair as in *Goodyera tessellata*, *Liparis Loeselii*, *Odontoglossum luteo-purpureum*, *Selenipedium Sedenii*, *Vanda tricolor*, and *Vanilla planifolia*. In the Orchidaceae generally the tegumentary apparatus is highly modified. Of especial interest in connection with the occurrence of trichoblasts in several terrestrial species, is the character of the exodermal layer in the species the roots of which are provided with a velamen. The exoderm as constituted in these members of the group will be considered in another place.

DICOTYLEDONS.

The Dicotyledons, with the exception of a single aberrant group, the Nymphaeaceae, to be discussed later, agree among themselves in