ONTOGENY OF TRICHOMES IN TAXA OF THE GENUS *PLANTAGO* SUBG. *PSYLLIUM* (*PLANTAGINACEAE*)

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ABSTRACT

This paper is a continuation of the investigation of hair ontogeny in taxa of the *Plantaginaceae* family. The previous publication dealt with the development of hairs in representatives of the subgenus *Plantago*. The present paper concerns the investigation of 5 species of the subgenus *Psyllium*: *Plantago squarrosa*, *P. arenaria*, *P. afra*, *P. webbii* and *P. arborescens*. The development of three types of headed hairs and one type of headless hair has been studied. The hypotetic phylogeny of the hairs of the genus *Plantago* is presented.

KEY WORDS: *Plantaginaceae*, *Plantago* subg. *Psyllium*, hair ontogeny.

INTRODUCTION

The ontogeny of trichomes in the taxa of the genus *Plantago* L. subg. *Plantago* was discussed in an earlier paper (Andrzejewska-Golec 1991). The present paper deals with the ontogeny of trichomes in taxa of the genus *Plantago* L. subg. *Psyllium*.

The results of both anatomical and chemotaxonomic investigations indicate the distinctiveness of the taxon *Psyllium* (Kuzmanov et al. 1984; Andrzejewska-Golec 1992, 1993; Andrzejewska-Golec & Świętosławski 1993). Some authors even regard it as a separate genus (Soják 1972; Holub 1973; Dietrich 1980). However, the concept of Rahn (1978) of enlarging subg. *Psyllium* by six sections from subg. *Plantago* sensu Pilger (1937) seems unjustified (Andrzejewska-Golec & Świętosławski 1989a; 1989b, 1993). The subgenus *Psyllium* contains different iridoids and different types of hairs (Andrzejewska-Golec & Witek 1984; Andrzejewska-Golec & Świętosławski 1993; Andrzejewska-Golec et al. 1993). The purpose of this work was to find out whether the ontogeny of hairs reflects these differences.

MATERIALS AND METHODS

The development of hairs was examined in the following species of *Plantago* subg. *Psyllium*: *Plantago squarrosa* Murray (Copenhagen), *P. arenaria* Waldst. et Kit. (Liege), *P. afra* L. (Frankfurt), *P. webbii* Barn. (Halle), and *P. arborescens* Poirlet (Dublin).

The seeds (received from various European botanical gardens, the names of which are given in brackets) were sown on Petri dishes covered with a filter paper dampened with tap water. The young seedlings were grown on Petri dishes. The material was examined from the moment of sowing till the appearance of the first leaves. The cotyledons, hypocotyl, epicotyl and first leaves were used. Cross-sections of the above

mentioned plant parts, crushed preparations, or peeled epidermis were examined. The samples were fixed in an aqueous solution of chloral hydrate. Light microscopic figures were drawn with the use of Abbe's apparatus.

RESULTS AND DISCUSSION

The development of four types of hairs was observed. Among them 3 are headed hairs of the following types: 1) with unicellular stalk and head divided vertically into two cells (Fig. 5, hair type b), 2) clavate (club-shaped, club-like) hairs – with unicellular stalk and head divided horizontally into two, rarely three cells (Fig. 5., hair type h), 3) with unicellular round head and (2) 3-4 (-8) celled stalk (Fig. 5, hair type i). The development of one type of headless hairs was also observed, namely of multi-cellular hairs to fourteen (fifteen) celled hairs. The detailed description of anatomy of these hairs was presented in a previous work (Andrzejewska-Golec & Świętosławski 1993). The development of the hairs is shown in Figs 1-4.

The ontogeny of hairs in the investigated representatives of the subgenus *Psyllium* begins as early as the germination, just as in the taxa of the subg. *Plantago* (Andrzejewska-Golec 1991) and plants belonging to other families (Hummel & Staeche 1962; Danilova & Kašhina 1987; hanlidou et al. 1991, Duke & Paul 1993).

All the hair types observed in the taxa of the subgenus *Psyllium* originate from a single initial cell, which differs from other epidermal cells in its size. The initial cells are characterized by dense cytoplasm and a clearly visible, large cell nucleus (Fig. 1a; Fig. 2a; Fig. 3a). At the earliest stage of development it is impossible to differentiate the initial cells of headed hairs from those of headless hairs. However, at the stage of well developed parent cell, immediately before its division it is evident that the parts of initial cells protruding above the surface of the epidermis are round for the headed

Fig. 1. Developmental stages of the hairs with unicellular head, situated on cotyledons of *Plantago squarrosa*. a-d – Epidermal cells with the initial cell (1), unicellular stage (2) and two-celled stage of the hairs (3). e, f – Three-celled stage. g, h – Four-celled stage. i – Young hair with three-celled stalk. j – Mature hair: basal cell (4), stalk cells (5), head (6).

Fig. 2. Developmental stages of clavate hairs, positioned on cotyledons of *Plantago arenaria*. a – An initial cell. b – Unicellular stage in division. c, d – Two-celled stage. e, f – Three-celled stage. g, h – Mature hair: basal cell (1), stalk (2), head (3).

Fig. 3. Developmental stages of hairs with a unicellular stalk and head divided vertically into two cells, positioned on cotyledons of *Plantago webbii*. a – An initial cell. b – Two-celled stage. c, d – Three-celled stage. e – Mature hair: basal cell (1), stalk (2), head (3).

Fig. 4. Developmental stages of headless hairs on cotyledons of *Plantago webbii*. a – Unicellular stage. b-d – Two-celled stage. e – Three-celled hairs. f, g – Young hairs. h-j – Mature hairs: basal cell (1).

Fig. 5. A proposed phylogeny of the hairs of the taxa of the genus *Plantago* L. The hair type on the leaf in the genus *Plantago*: a-g – hair types present in the taxa of subgenus *Plantago*, b, h, i, hair types present in the taxa of subgenus *Psyllium* (the detailed description of anatomy of these hairs is presented in: Andrzejewska-Golec. Trichomes in *Plantago* L. Ann. Acad. Med. Lodzensis – in press), k-a – hypothetical parent hair. The arrows indicate the proposed direction of the evolution of hairs.

hairs (Fig. 1a-c) and pointed to the headless ones (Fig. 4a). Hummel & Staechle (1962) noticed similar differences between glandular and non-glandular hairs.

Initial cells of clavate hairs and hairs with a unicellular stalk and head divided vertically into two cells are smaller than the surrounding epidermal cells. A similar regularity occurs in the cases of headed hairs present in the representatives of the subg. *Plantago* (Andrzejewska-Golec 1991) and of the *Verbenaceae* family (Mathew & Shah 1983). The initial cells of headless hairs and of hairs with a unicellular head are larger than the surrounding cells.

The course of development of hairs of the same type was analogous in all the parts of the plant. Gupta & Murty (1977) who investigated the hairs of the species belonging to the genera *Ononis* and *Trifolium* maintain that there are no significant differences between the courses of ontogeny of hairs of the same type in the vegetative and the generative parts.

The development of hairs with a unicellular stalk and two-celled head (Fig. 3) in the taxa of the subgenus *Psyllium* take the same course as that observed in the representatives of the subgenus *Plantago* (Andrzejewska-Golec 1991) and in plants belonging to the *Labiatae* and *Moraceae* families (Singh et al. 1974; Gangadhara & Inamdar 1977; Danilova & Kašhina 1987).

The development of clavate hairs (Fig. 2) is similar to the ontogeny of headed hairs of *Sambucus racemosa* L. (Weberling 1977). However, the analogy can be traced only to a certain stage, at which the development of clavate hairs ceases in the taxa of the subg. *Psyllium*.

The development of hairs with a unicellular head (Fig. 1) in the investigated species is similar to the development of hairs of this type in other plants, e. g. in *Vahlia digyna* (Retz.) O.K. – *Saxifragaceae* (Inamdar & Patel 1971), in *Agrimonia eupatoria* L. – *Rosaceae* (Jain & Singh 1973) and in *Solanum* L.

– *Solanaceae* (Seite & Anderson, 1982). Phenotypically similar developmental pathways of hairs in unrelated families tell about the frequency of parallel evolution. The development of headless hairs (Fig. 4) in the representatives of the subgenus *Psyllium* is analogous to that observed in the taxa of the subg. *Plantago* (Andrzejewska-Golec 1991).

The subgenera *Psyllium* and *Plantago* differ essentially with respect to the types of headed hairs. The hairs of h and i types (see Fig. 5) are characteristic of the former subgenus, and hairs of a and c-g types – of the taxa of the latter one. The hairs of type b occur in both subgenera, thus, they are the characteristic feature of the whole genus *Plantago*.

The analysis of the types of headed hairs and investigation of their ontogenesis in both subgenera indicates the distinct character of the taxon *Psyllium*. Comparative investigation of the ontogenesis of the hairs occurring in both subgenera allows for taking into consideration the possibility of evolutionary development of the headed hairs. The analysis of development of the clavate hairs (Fig. 2) and hairs with a unicellular stalk and head divided vertically into two cells (Fig. 3) allow to suppose that the early stages of development of both the above mentioned types of hairs are undistinguishable up to the three-celled stage (Fig. 2a-f; Fig. 3a-d). Most probably these hairs have a common phylogenetic origin, while the origin of the hairs with a unicellular head is different. The postulated course of phylogeny of the hairs of the genus *Plantago* L. is presented in Fig. 5.

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ONTOGENEZA WŁOSKÓW U TAKSONÓW RODZAJU *PLANTAGO* L. PODRODZAJU *PSYLLIUM* (MILLER) HARMS

STRESZCZENIE

Praca jest kontynuacją badania ontogenezy włosków u taksonów rodziny *Plantaginaceae*. Wcześniejsza publikacja (Andrzejewska-Golec 1991) dotyczyła rozwoju włosków przedstawicieli podrodzaju *Plantago*, obecna ogranicza się do podrodzaju *Psyllium*. Obserwowano rozwój 3 typów włosków główkowych i jednego typu włosków bezgłówkowych. Przedstawiono hipotetyczny schemat filogenezy włosków występujących u taksonów rodzaju *Plantago*.

SŁOWA KLUCZOWE: *Plantaginaceae*, *Plantago* subg. *Psyllium*, ontogeneza włosków.