

Morphological variation of hairs in *Malva alcea* L. (Malvaceae)

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Abstract: Hairs are one of the key taxonomic features in the *Malva alcea* complex. The paper presents preliminary results of research on the morphology and variation of hairs in *Malva alcea* from different geographic regions of Poland. In the studied populations several types of trichomes were distinguished, including simple ones (unibranched), bifurcate (2-branched) and stellate (multibranched, multicellular). Stellate hairs vary in number of branches from 3 to 10. However, in all types of trichomes (simple, bifurcate and stellate) each branch is composed exclusively of a single unbranched cell.

Key words: *Malva alcea*, Malvaceae, trichomes, morphology, epidermis

1. Introduction

Malva alcea the hollyhock is one of 11 species of mallows occurring in Poland (Mirek *et al.* 2002). It occurs in the entire Poland, particularly frequently in the western part of the country (Zajac & Zajac 2001). The main places of the hollyhock occurrence are old earthworks and other archaeological structures, roadsides, dry and sunny hillsides, areas of ruderal vegetation as well as thickets and forest edges. The species is recognized as a relict of former cultivation (Celka 1998, 1999).

A species which is closely related to *Malva alcea* is *Malva excisa*. The contemporary knowledge regarding the taxonomy of the *Malva alcea* complex is based primarily on the morphological structure of the hairs and corolla petals. According to Walas (1959) the main feature distinguishing *M. alcea* from *M. excisa* are hairs on the stem – their size and type, and the depth and shape of petals notches. Dalby (1968) regards the *M. alcea* as the ‘main’ species, and *M. excisa* as its extreme variety. Il’in (1974) in the *Flora of the U.S.S.R.* distinguishes also *M. excisa*. The range border of the two aforementioned species seems to be located in Poland (Walas 1959).

The aim of the research was to investigate the abundance of shapes, sizes and structure complexity and to verify previous information about the hairs of *M. alcea*

on the basis of the material collected from several localities in Poland and Germany.

2. Material and methods

The herbarium material for the morphological studies of the *Malva alcea* trichomes was collected from 8 localities in Poland and 1 site in eastern Germany (Fig. 1, Table 1). Exicata were deposited in the Department of Plant Taxonomy of the A. Mickiewicz University in Poznań.

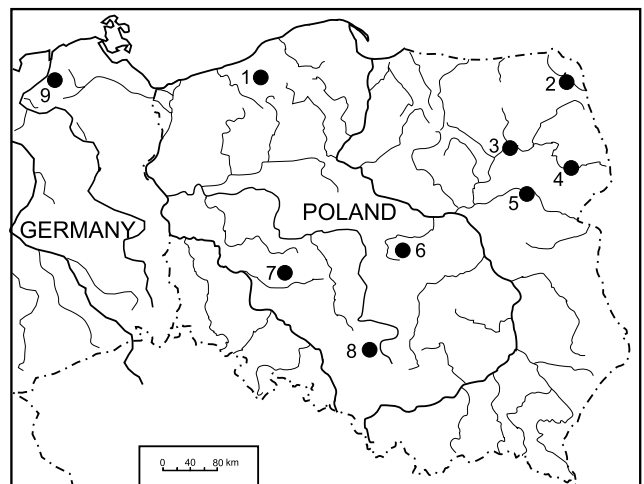


Fig. 1. Distribution of the studied locations of *Malva alcea* (see Table 1)

Table 1. Localities and habitats of the studied populations of *Malva alcea*

Number	Locality	Habitat	Collection date	Geographical location
1	Radomyśl near Storkowo (Szczecinek district, Zachodniopomorski region)	roadside	19.09.2002	N 53°45'39.1'' E 16°31'55.7''
2	Sejny (Sejny district, Podlaski region)	roadside	25.08.2001	N 54°10'54.4'' E 23°19'11.9''
3	Stara Łomża (Łomża district, Podlaski region)	embankments of the early medieval earthwork on the Narew river	25.07.2001	N 53°15'23.6'' E 22°12'05.7''
4	Płoski on the Narew (Białystok district, Podlaski region)	roadside near a bridge on the Narew river	31.07.2002	N52°54'13.1'' E23°13'58.5''
5	Wirów near Drohiczyn on the Bug (Siemiatycze district, Podlaski region)	cemetery (roadside, roadside ditch)	31.07.2002	N 52°26'35.7'' E 22°32'12.3''
6	Tum near Łęczycza (Łęczycza district, Łódzki region)	valley of the early medieval earthwork	03.07.2003	N 52°03'22.5'' E 19°13'57.9''
7	Karzec near Krobia (Gostyń district, Wielkopolski region)	roadside ditch next to a medieval earthwork	24.08.2002	N 51°45'06.0'' E 16°53'33.2''
8	Pątnów (Wieluń district, Łódzki region)	roadside ditch	24.08.2002	N 51°08'06.3'' E 18°36'30.7''
9	Groß Raden (Mecklenburg-Vorpommern, Germany)	embankments of the early medieval earthwork	23.07.2003	N 53°44'07.7'' E 11°52'36.7''

Four specimens were randomly chosen from the areas under study and from each specimen six samples of epidermis were taken for microscopic observations. These included sections from the upper and lower part of the stem and the adaxial and abaxial sides of leaves from the lower and upper part of the plant. Observations were carried out using the Jenamed 2 light microscope (LM) and scanning electron microscope (SEM). The Lucia Screen Measurement software was employed

for documentation purposes and the measurement of the studied features.

3. Results

Among the analyzed specimens from all populations, ten types of hairs were observed (Figs. 2a-d, 3a-f). They are covering hairs, non-glandular. All the hairs were diagnosed as dead structures, filled with air, non-headed

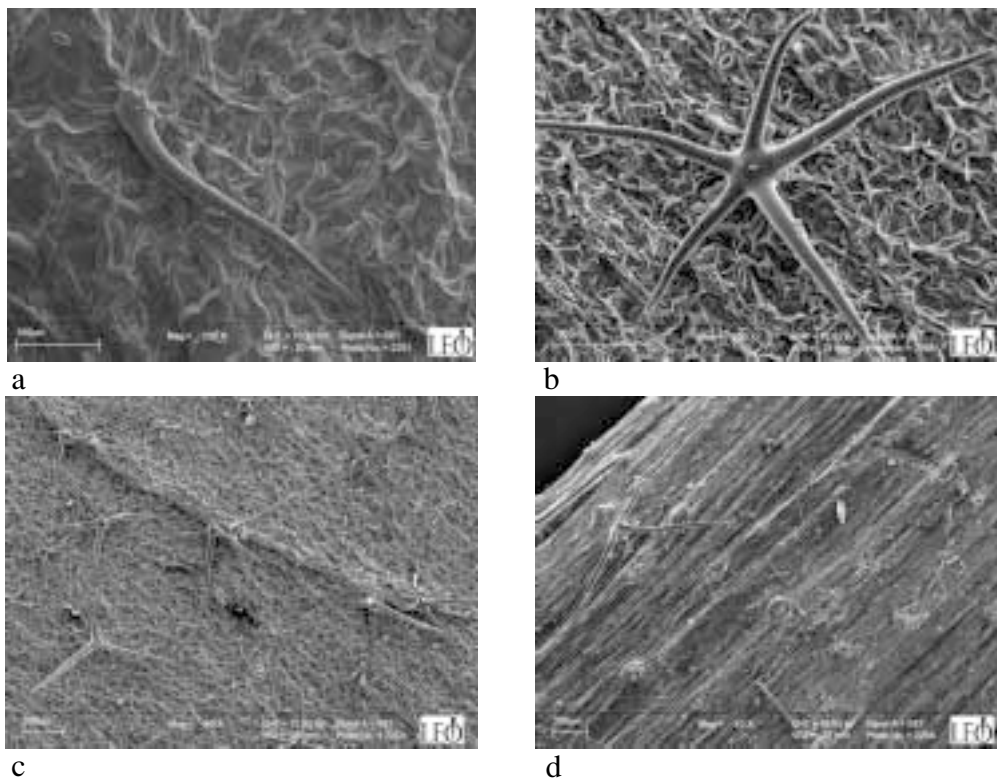


Fig. 2. Morphology of hairs in *Malva alcea* (SEM)

Explanations: a – single hair from the upper part of the leaf; b – multibranched hair from the upper part of the leaf; c – hairs on the upper part of the leaf; d – hairs on the upper part of the stem

with markedly lignified walls. They are significantly varied in terms of the length of branches. All of them are sharply edged at the top, sometimes curved; on the stem usually upright and on the leaves parallel to the surface of the epidermis.

A simple hair is composed of only one cell and is surrounded by a ring of accompanying cells (Fig. 3g). As regards the structure of the hair, we can distinguish the top part and the basal part. The basal part is widened and located in the epidermis at the same level as the other cells of the epidermis (Fig. 3h). The remaining part of the cell is elongated, cylindrical, narrowing to the top and sharply edged. The basal part of the hair is directly connected to its accompanying cells. Directly underneath them there are parenchymal cells. The presence of this kind of hairs was observed on the stem, both on the upper and lower part, and on the leaf blade of all individuals. The hairs of this type, depending on the place of occurrence, clearly differ in length and the

angle of arrangement in relation to the leaf surface or to the stem. In the lower parts of the stem, they are long, oriented perpendicularly to its surface. Frequently their length exceeds 600 μm . They occur singly, randomly and irregularly, and do not group together. Simple leaf trichomes are arranged in a similar way, occurring regularly on the blade, as in contrast to the stem trichomes, and are distinctly shorter.

Multicellular trichomes are made up of at least two branches. The basal parts of the branches are closely adjoin to each other, forming the base of the multicellular hair (Figs. 3g-i). This base, as in simple hairs, is surrounded with a ring of 6-8 modified epidermal cells, which nourish and support the trichome. Together, they form a distinct swelling of the epidermis. The remaining part of the cell of each branch is elongated, with a sharp apex, just like in a simple trichome. The branches vary greatly in length, from about 60 μm to 1800 μm . Such disproportions can be observed both within one

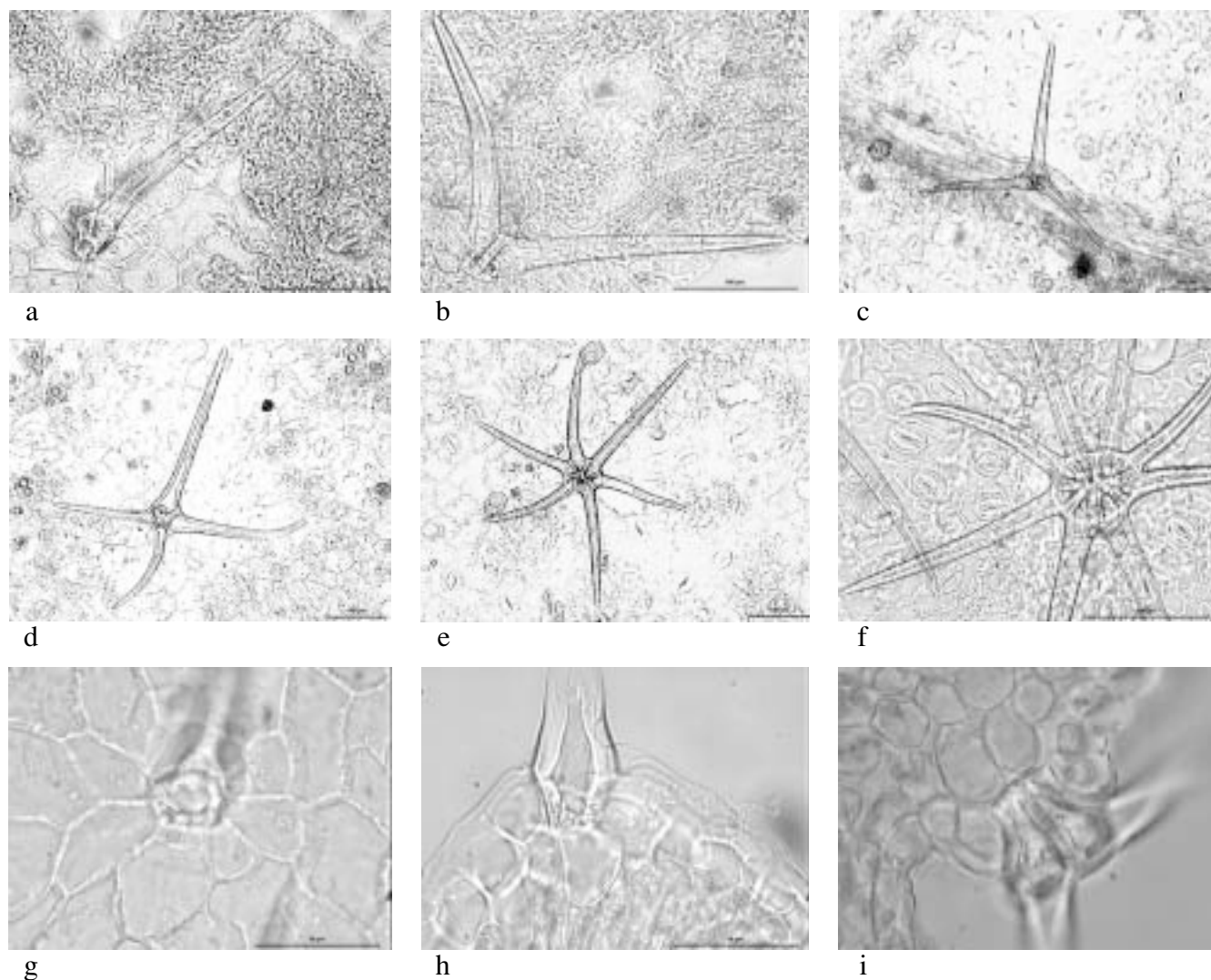


Fig. 3. Morphology of hairs in *Malva alcea* (LM)

Explanations: a – single (unibranch) hair; b – bifurcate (2-branched) hair; c – stellate (3-branched) hair; d – stellate (4-branched) hair; e – stellate (6-branched) hair; f – stellate (8-branched) hair; g – accompanying cells; h – basal part of a single hair; i – basal part of a multi-branched hair; a-g surface view; h-i cross section

trichome, and between neighboring trichomes (Figs. 2b-c). Bifurcate hairs are commonly found, both on the stem and on the leaf blade, in all studied populations. Similarly, stellate hairs are present in all studied plants from all localities, but are most numerous in the upper parts of the stem and on the leaf underside. The most frequent are 4- and 5-branched hairs, which cover about 90% of the plant.

4. Discussion

Features of hairs are widely regarded as useful for establishing the systematic relations within the Malvaceae family (Walas 1959; Il'in 1974; Ramayya & Shanmukha Rao 1976; Inamdar *et al.* 1983; Dorr 1990). Such view was put forward also by Kubitzki and Bayer (2003). In fact, they started the morphological description of the family from the analysis of non-glandular trichomes, at the same time postulating that the studies in this field are still insufficient to draw meaningful conclusions.

In keys and descriptions of *M. alcea*, various terms are used to describe its hairs, such as stellate, tufted

stellate, tufted, 2- or 3-furcate or simple (e.g. Walas 1959; Il'in 1974; Rutkowski 2004). Our research showed that in all populations of *M. alcea*, both unbranched unicellular and branched multicellular trichomes are present. The obtained results do not confirm the previous division into separate categories: stellate, tufted and the intermediate tufted stellate (see Walas 1959; Rutkowski 2004). In practice it is often difficult to choose the proper term (tufted, stellate, tufted stellate, 2- or 3-furcate) to describe an examined hair, due to the differences in hair classification in the published literature (McClerry 1907; Esau 1978; Malinowski 1980; Broda 1982; Payne 1978; Judd *et al.* 1999).

On the basis of Payne's (1978) classification, we divided the trichomes found in the studied samples into only 3 categories: simple (unbranched), bifurcate (2-branched) and stellate (multibranched, multicellular). Stellate hairs vary in number of branches from 3 to 10. However, in all types of hairs (simple, bifurcate, stellate) each branch is composed of a single cell.

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References

- BAYER C. & KUBITZKI K. 2003. Malvaceae. In: K. KUBITZKI & C. BAYER (eds.). The Families and Genera of Vascular Plants, vol. V, Flowering Plants, Dicotyledons: Malvales, Capparales and Not-betain Caryophyllales, pp. 225-311. Springer-Verlag Berlin-Heidelberg-New York.
- BRODA B. 1982. Zarys botaniki farmaceutycznej. 415 pp. PZWL, Warszawa.
- CELKA Z. 1998. *Malva alcea* L. as a relict of prehistoric and mediaeval cultivation. Phytocoenosis vol. 10 (N.S.). Suppl. Cartogr. Geobot. 9: 155-162.
- CELKA Z. 1999. Rośliny naczyniowe grodzisk Wielkopolski. Prace Zakładu Taksonomii Roślin UAM w Poznaniu 9: 1-159. Bogucki Wyd. Nauk., Poznań.
- DALBY D. H. 1968. *Malva* L. In: T. G. TUTIN, V. H. HEYWOOD, N. A. BURGESS, D. M. MOORE, D. H. VALENTINE, S. M. WALTERS & D. A. WEBB (eds.). Flora Europaea, 2, pp. 249-251. Cambridge at the University Press.
- DORR L. J. 1990. A Revision of the North American Genus *Callirhoe* (Malvaceae). Memoirs of the New York Botanical Garden 56: 1-76.
- ESAU K. 1973. Anatomia roślin. 809 pp. PWRiL, Warszawa.
- INAMDAR J. A., BALAKRISHNA BHAT R. & RAMANA RAO T. V. 1983. Structure, ontogeny, classification, and taxonomic significance of trichomes in Malvales. Korean J. Bot. 26: 151-160.
- IL'IN M. M. 1974. Family C. Malvaceae Juss. In: B. K. SHISHKIN & E. G. BOBROV (eds.). Flora of the U.S.S.R., 15, pp. 21-127. Izdatel'stvo Akademii Nauk SSSR, Moskwa-Leningrad. Israel Program for Scientific Translations, Jerusalem.
- JUDD W. S., CAMPBELL CH. S., KELLOGG E. A. & STEVENS P. F. 1999. Plant systematics a phylogenetic approach. 464 pp. Sinauer Associates, Ins. Publishers. Sunderland, Massachusetts U.S.A.
- MCCLERRY E. M. 1907. Stellate hairs and peltate scales of Ohio plants. The Ohio Naturalist. 7(3): 51-56.
- MALINOWSKI E. 1980. Anatomia roślin. 634 pp. PWN, Warszawa.
- MIREK Z., PIĘKOŚ-MIRKOWA H., ZAJĄC A. & ZAJĄC M. 2002. Flowering plants and pteridophytes of Poland. A checklist. In: Z. MIREK (ed.). Biodiversity of Poland 1, 442 pp. W. Szafer Institute of Botany, Polish Academy of Sciences, Kraków.
- PAYNE W. W. 1978. A glossary of plant hair terminology. Brittonia 30(2): 239-255.
- RAMAYYA N. & SHANMUKHA RAO S. R. 1976. Morphology, phyletic and biology of the peltate scale, stellate and tufted hairs in some Malvaceae. J. Indian Bot. Soc. 55: 75-79.
- RUTKOWSKI L. 2004. Klucz do oznaczania roślin naczyniowych Polski niżowej. Wyd. II, popr. i unowocześnione, 814 pp. Wyd. Nauk. PWN, Warszawa.
- WALAS J. 1959. Malvaceae, Ślazowate. In: W. SZAFER & B. PAWŁOWSKI (eds.). Flora polska. Rośliny naczyniowe Polski i ziem ościennych, 8, pp. 278-301. PWN, Warszawa.
- ZAJĄC A. & ZAJĄC M. (eds.). 2001. Distribution atlas of vascular plants in Poland. xii+714 pp. Edited by Laboratory of Computer Chorology, Institute of Botany, Jagiellonian University, Cracow.