

## *EQUISETUM TELMATEIA* EHRH. MORPHOTYPES RELATED TO ANTHROPOGENIC HABITATS

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### ABSTRACT

The Giant Horsetail (*Equisetum telmateia*) is the only representative of *Equisetum* genus included in the list of strictly protected species. In Central and Western Europe the species is found in communities belonging to alliances: *Alno-Padion* and *Calthion*. With progressing destruction of these biotopes, one can observe the phenomenon of this species moving to the habitats extremely anthropogenic in character.

Frequent and intensive observations of this phenomenon were conducted in the Jasło – Krosno Dale area in southern Poland in three anthropogenic localities. In these localities three interesting, irregular *Equisetum telmateia* morphotypes were found: fo. *serotinum* subfo. *proliferum*, fo. *spiralis* and a morphotype with branched shoot.

The phenomenon of morphological plasticity of sporophytes is thought to be connected with the action of genes, which regulate the identity of developing plant organs and their distribution. These genes perform a superior part in relation to the system of growth regulators.

KEY WORDS: anthropogenic habitat, Giant Horsetail, morphotype, sporophyte, phenotypic variation.

### INTRODUCTION

The Giant Horsetail (*Equisetum telmateia*) is the only representative of *Equisetum* genus, which is on the list of strictly protected species in Poland. It represents a rare type of distribution: most stations are situated in the Carpathian Foothills and few in the lowlands. In Central and Western Europe the species is found in communities belonging to alliances: *Alno-Padion* and *Calthion* (Matuszkiewicz 1984; Raciborski 1919; Rothmaler 1981). With progressing destruction of these biotopes, one can observe the phenomenon of this species moving to habitats extremely anthropogenic in character. These are mostly places, which share characteristics and habitat conditions of riverside phytocenoses, for example wet ditches, but also places entirely new for this species, often offering extreme conditions, such as: fallows, sandy slopes, road embankments, railway embankments and trackages, as well as hardened roadsides. The first brief reports on this subject, in Poland date back to 1959 (Kornaś et al. 1959) and abroad – to 1985 (Londo 1985). The description of the process of occupying such habitats and the analysis of the fact that species, regarded so far as riverside species can survive in these habitats, may play an important role in planning its protection. Forms in the capacity of developmental anomalies appear only in such localities.

Frequent and intensive observations of this phenomenon were conducted in the three anthropogenic localities in southern Poland.

### LOCALITIES

1) The locality topoliny is situated on the railway embankment of „Gamrat” factory track near Jasło, about a kilometre from the road Jasło – Nowy Sącz, at the crossing with hardened dirt road. From the North and North-West the locality is sheltered by the heights of Ciężkowice Foothills and is situated in the immediate vicinity of „Wały” old rampart. In the vicinity, in the south-eastern direction, there is an old riverbed of the Ropa an River. The present riverbed is 600 m away from the locality. The „Gamrat” railway side-track was built not later than in 1938. Its body and foot are made of native material fill, taken from the immediate vicinity. The crown is made of two layers. Under the sleeper of impregnated wood there is a layer of grit, whose thickness is about 50 cm, and below it there is a layer of sub-crust, of which the grain diameter is 20-35 mm. Both layers are of similar thickness. During utilization of the railway embankment both top layers were deformed and now they occupy the whole crown of the railway embankment. At present the track is very rarely used. Chemical weed control is not carried out. Several times a year the plants are mown; also local people often take a short way across the trackage in order to get to a few suburban hamlets, and thus treading the plants plays an important role here.

*Equisetum telmateia* individual plants go down from the trackage and the railway embankment to their base, covering ditches and temporarily wet lowerings on the north-

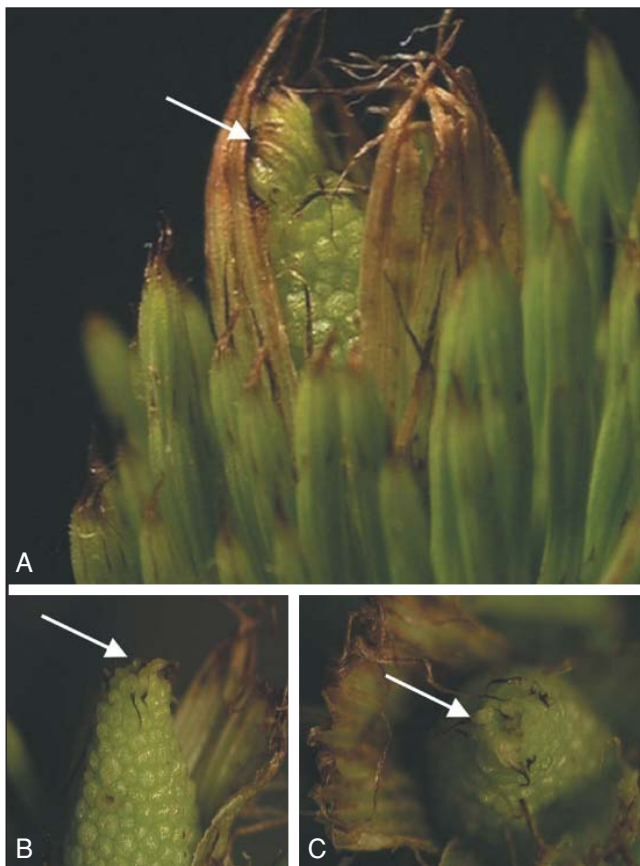


Fig. 1. *Equisetum telmateia* fo. *serotinum* subfo. *proliferum* – proliferated spore-bearing cone; A – the arrow points at vegetative whorls which developed above cone; B, C – arrows point at teeth with dark ends which are characteristic for vegetative sheath.

western side and the banks of draining watercourse, they bush at the foot of the railway embankment, and also enter corn fields on the embankment's south-eastern side. In the vicinity the giant horsetail can also be found on riverside habitats. Representatives of the population of Topoliny, whether growing in xerothermic places (the crown of the railway embankment) or in wet places (the base of the railway embankment), never reach big sizes. They grow up to 120 cm, and only occasionally exceed this height. Typical *Equisetum telmateia* individual plants reach even more than 200 cm (Raciborski 1919; Dostál 1984).

This locality is rich in *E. telmateia* morphotypes. They all group at the top part of the railway embankment and descend to its base on the south-eastern side. The conditions are there particularly unfavourable, due to the heating of the base caused by strong sun operation and quick flow of rain waters. In shaping up the physiognomy of these thermophilous communities *E. telmateia* form (fo.) *serotinum* mainly takes part. It is the morphotype developing a cone on vegetative shoot. There are many modifications of this morphotype. One of them is fo. *serotinum* subfo. *proliferum* (see a detailed description below). I found there also some specimens with branched main shoot and a few with spiral leaf sheath (fo. *spiralis*). The latter two phenotypes appear independently and are not necessarily associated with the appearance of *serotinum* phenotype. The opposite side of the railway embankment is covered with meadow vegetation, nitrophilous skirts and veil assemblages.

2) Another locality is situated on the edge of the road Jasło – Nowy Sącz, on the active landslide in Lisówiek. *Equisetum telmateia* plants cover the whole slopes southwards from the tarred roads as far as the dirt road below and they do not spread beyond it. The morphotypes of very limited growth, not exceeding the height of 40 cm, abound there. The specimens with typical, spore-bearing cone on the vegetative shoot are found relatively rarely. Some specimens have however been found (in the whole population, regardless typical form or fo. *serotinum*), which have a continuous spiral leaf sheath on the main shoot, or a branched main shoot. All-season moving of the base is specific for this locality. Each year, especially after heavy rainfall, slidings, slumps and cracks appear in the base; the road going that way is undermined or covered up. The exposures occurring here seem to stimulate primordia of vegetative shoots to grow from the rhizomes, which grow up during the whole season, producing normally developed green shoots. The most specific is the occurrence of concentration of *E. telmateia* in the immediate vicinity of the road, where, due to road works on the extended roadside, one can find slightly cracked layers of hardened asphalt, which create an extremely xerothermic habitat with an extremely thin layer of soil (or its lack in some places). Very numerous fertile and vegetative shoots of *E. telmateia* grow up through the narrow cracks (from a few to several centimetres in diameter), giving the impression of a smooth cornfield. Within the layers of the landslide poorly efficient water-bearing horizon functions, the existence of which is proved by local outflows and water seepage, which are better seen after rain-

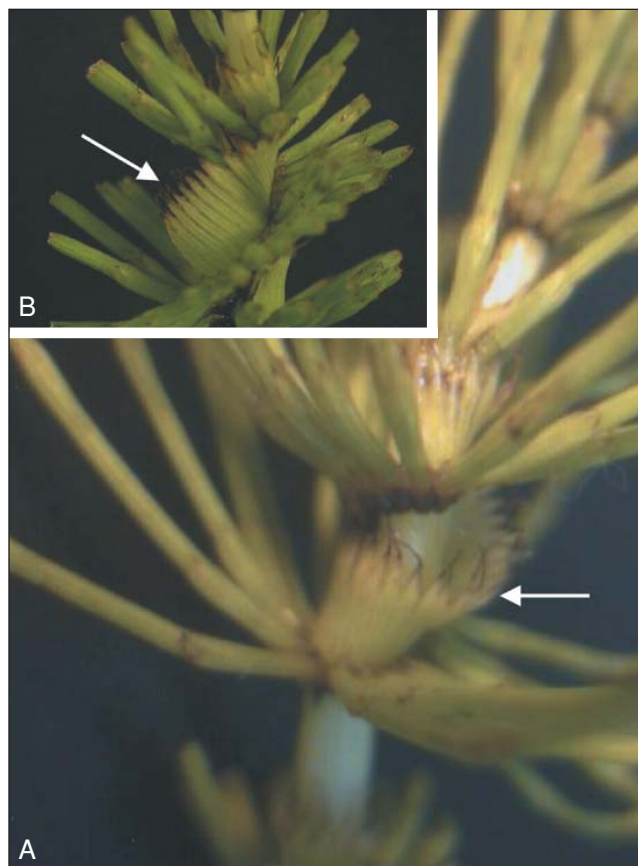


Fig. 2. *Equisetum telmateia* fo. *spiralis*; A, B – arrows point at continuous spiral sheath encircling the stem (distant part of branch was cut off for better view).



Fig. 3. The herbarium specimen *Equisetum telmateia* fo. *serotinum* subfo. *proliferum*, with a spiral sheath on a part of a new vegetative shoot positioned above cone. In ontogeny of this individual plant the activity of its shoot apical meristem altered three times.



Fig. 4. The herbarium specimen of morphotype with branched shoot.

fall and sliding of the ground. It is very likely that the rhizomes of giant horsetail use this water source.

3) The third locality is situated on the freshly made soil bank on the roadside in Krosno, which was made while the sewerage was being built there. The soil at the base contains a high proportion of skeletal fraction. In the immediate vicinity *E. telmateia* covers also the roadside, the gravely scree and building lime. The occurrence of giant horsetail on the ruderal habitat can be explained by the fact that most probably the soil containing the rhizomes of this species has been brought there. This can also be the confirmation of the argument about stimulating effect that the moving of the base might have on the rhizome, because *E. telmateia* shoots grow up extremely densely, despite the fact that they came into existence quite recently. I found there some specimens of fo. *serotinum*, subfo. *proliferum* and also a few of fo. *spiralis*.

## MORPHOTYPES

### 1. *Equisetum telmateia* fo. *serotinum* subfo. *proliferum*

From the extensive studies of the author of this report it appears that *serotinum* form is most frequent among *Equisetum telmateia* morphotypes described here. It can also be found quite often in the herbarium collections. This form has a few or even a dozen or so variants and modifications, which might prove the lack of stability of morphological mechanisms controlling the order of creating the organs of different identity. The shoots of giant horsetail (which is a dimorphic species) are fertile or vegetative. The first are topped with a cone producing spores. It matures in spring, appearing above the ground already in the autumn of the preceding year. The second, green and barren, grows in spring and summer. They sometimes form a cone on the top of the shoot and these cases represent fo. *serotinum*. The percentage of *serotinum* vegetative shoots in the wild populations fluctuates between a few to over 30 percent. From among the whole variety of modifications found in the representatives of this form, most interesting is a reversion of the shoot apex, which leads to producing at the top of the cone a new vegetative axis with a few internodes. Individuals producing such shoots are regarded as fo. *serotinum* subfo. *proliferum* (Fig. 1, 3). The shoots with such features were found only in highly isolated and not shadowed parts of the railway embankment.

This form is not widely known. Nevertheless, it was the most frequent morphotype among those encountered in this research. In Polish herbarium collections are only few specimens of this morphotype (e.g. The Herbarium of Museum of Natural History, University of Wrocław, WRSL, 08.08.1922. Ziębice – locality probably non-existing, coll. T. Schube).

### 2. *Equisetum telmateia* fo. *spiralis*

The basic feature of this form is the temporary change of the main shoot phyllotaxy from whorled to an alternate one. Continuous spiral sheath encircling the stem begins and ends in the whorl possessing normally developed sheath (Fig. 2). The specimens with a left spiral were found four times and with a right spiral also four times. The spiral consist of 1.5 to a several turns, and the stem above it most often returned to a typical (i.e. whorled) phyllotactic arran-

gement. The width of the sheath fluctuated between 1.5 mm and 18 mm (not counting the teeth of the sheath). Quite often plants were observed with well-developed spiral sheath and with dead upper part. However the true reason of the death of the shoot apical meristem following the earlier appearance of aberrations, remains unknown. It should be pointed out that fo. *spiralis* may (but does not have to) be associated with the presence of *serotinum* phenotype on the same shoot.

The individuals representing this morphotype were found four times in Topoliny and in Krosno and once in the locality in Lisówek. This phenomenon in horsetails has not been described in Poland so far. Schaffner (1933) and later Gifford and Foster (1988) provide us with some information on this morphotype as present not only in *E. telmateia* but also in other *Equisetum* species. The only herbarium specimens of this form were found by the author of present work in the herbarium of W. Szafer Institute of Botany, Polish Academy of Sciences in Kraków (KRAM 100638, collected in Schleswig – Holstein by Christiansen, probably in the year 1909) and in the Institute of Botany, Jagiellonian University (KRA 87121, collected near Nürnberg by I. Kaulefuß 12.07.1902).

### 3. Morphotype with branched shoot

I have been coming across specimens with branched main shoot very often in the locality in Topoliny and twice in Lisówek. In literature the phenomenon has not been reported for this species until now. This type of branching seems to be connected with development of normal side branching of the whorl, with every branch developing in a way that is typical for the main shoot. Every „main-branch” shoot has got a smaller than typical (for the proper main axis) for this species number of ribs and teeth of the sheath, usually below ten. This unusual differentiation rarely happens in the upper part of the main shoot. It usually takes place in the part of the stem situated close to the surface of substratum. Dying apex or arrested growth of the top of the main shoot are most probably the factors making such transformation possible. Such suggestion is validated by the fact that the broom-like bunches of twigs appear quite frequently in the lower part of the mowed shoot. These atypical laterals may resemble the shoots of other species of horsetail (Fig. 4), mainly because of the decreased number of ribs.

The observed specimens belonged both to the typical form and to the fo. *serotinum*. Gifford and Foster (1988) provide some information on a specimen with dichotomously branched stem, but in this case it rather suggests the setback of the process of the apical domination.

With reference to the specimen of the latter morphotype and also *proliferum* form, it is striking that it occurs only in hot places which need not be necessarily dry, but at least temporarily showing shortages of humidity. All the morphotypes mentioned here grew from the rhizome, on which the typical shoots were also present.

## DISCUSSION

*Equisetum* species are known for their morphological plasticity, which may be connected with lack of stability of the system of growth regulators (Gifford and Foster 1988).

This plasticity is demonstrated by creation of many unusual, sporophytic morphotypes (cone bearing sporangiophore on the vegetative shoot, numerous small cones on the ends of branching in the top whorls, overgrown cone, continuous spiral leaf sheath of the shoot, the setback of the growth). Development of diverse gametophytes is another example of analogical plasticity. In normal conditions about 20% constitute male gametophytes, are finer and more delicate and of poorer growth. Others are initially female, but later produce male organs (Duckett 1970). Nowadays, in the era of molecular genetics, the phenomenon of morphological plasticity of sporophytes, is thought to be connected with the action of genes, regulating the identity of developing plant organs and their distribution. These genes may override the action of the system of growth regulators (Howell 1998). However, there are no publications describing the genetic basis of the above phenomena in pteridophytes. So far the attention of researchers has been focused on flowering plants. For the time being one cannot either confirm or reject the possibility of consolidation of developmental changes (mentioned above). It requires thorough studies in many disciplines.

Information on *Equisetum* intraspecific taxons is very poor, whether in reference to the morphology of such individuals, or their ecological requirements. In the case of *E. telmateia* it is extremely important to extend this knowledge, as this is a strictly protected species and its distribution at present shows strong dynamic tendencies.

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#### MORFOTYPY *EQUISETUM TELMATEIA* EHRH. ZWIĄZANE Z SIEDLISKAMI ANTROPOGENICZNYMI

#### STRESZCZENIE

Skrzyp olbrzymi (*Equisetum telmateia*) jest jedynym przedstawicielem rodzaju *Equisetum*, który znajduje się na liście gatunków chronionych w Polsce. W środkowej i zachodniej Europie jest tradycyjnie uznawany za gatunek występujący w zbiorowiskach związków *Alno-Padion* i *Calthion*. Wraz z postępującym niszczeniem tych biotopów obserwuje się przechodzenie tego gatunku na skrajnie antropogeniczne siedliska.

Częste i intensywne obserwacje prowadzono na trzech antropogenicznych stanowiskach w Kotlinie Jasielsko-Krośnieńskiej. Znalezione tam trzy interesujące, nietypowe morfotypy *Equisetum telmateia*: fo. *serotinum* subfo. *proliferum*, fo. *spiralis* i morfotyp z rozgałęzionym pędem.

Zjawisko morfologicznej plastyczności sporofitów tego gatunku jest prawdopodobnie związane z zakłóceniem działania genów kontrolujących tożsamość i rozmieszczenie organów. Geny te pełnią nadrzędną rolę w stosunku do funkcjonowania regulatorów wzrostu.

KEY WORDS: *Equisetum telmateia*, morfotyp, skrzyp olbrzymi, sporofit, zbiorowiska antropogeniczne.