Equisetum ×*robertsii* T. D. Dines (*E. arvense* × *E. telmateia*; Equisetaceae) in Poland

Equisetum ×*robertsii* T. D. Dines (*E. arvense* × *E. telmateia*; Equisetaceae) w Polsce

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ABSTRACT: *Equisetum* ×*robertsii* is one of two *E. telmateia* hybrids known from Poland. The diagrams of features dispersion show a good diversification of parental species and their hybrids. Five Polish localities of *Equisetum* ×*robertsii* are presented in this paper.

ABSTRAKT: *Equisetum* ×*robertsii* jest jednym z dwóch znanych z Polski mieszańców *E. telmateia*. Rozróżnienie gatunków rodzicielskich i ich mieszańców umożliwiają diagramy rozrzutu cech. W pracy przedstawiono pięć krajowych stanowisk *Equisetum* ×*robertsii.*

KEY WORDS: *Equisetum* ×*robertsii*, *Equisetum* ×*dubium*, *E. telmateia*, *E. arvense*, horsetail, hybrid

Introduction

The genus *Equisetum* belongs to the ancient and conservative clad of plants. Similarities to extinct species of the *Sphenophyllum* and *Calamites* genera prove this fact (Szweykowska, Szweykowski 2012). Moreover, horsetails have the high number of chromosomes 2n=216 (Bir 1960; Löve, Löve 1961), which is the evidence of the old polyploidization (Manton 1950). The knowledge about contemporary hybridization is also very interesting in this context. The first step of recognition of the process is to examine the hybrid population resources.

Formation of hybrids in the *Equisetum* genus is a rare phenomenon due to a very narrow ecological scale of gametophytes of all *Equisetum* species, especially giant horsetail *E. telmateia*. In addition, parental species must occur close to one another. The most data about the occurrence of interspecific

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hybrid populations in the *Equisetum* subgenus comes from the British Isles (Page 1973, 1988; Stace 1975, 2010; Jermy 1978; Roberts, Page 1979), whereas less information comes from other parts of Europe. Within the *Equisetum* subgenus, 8 hybrids have been described so far, including 3 hybrids, which parental species is *E. telmateia*, i.e. *E.* ×*bowmanii* Page (*E. sylvaticum* × *E. telmateia*), *E.* ×*robertsii* T. D. Dines (*E. arvense* × *E. telmateia*) and *E.* ×*font-queri* Rothm. (*E. palustre* × *E. telmateia*).

Equisetum ×*robertsii* 2n = 216 is a hybrid of *E. telmateia* 2n = 216 and *E. arvense* 2n = 216. The hybrid was described earlier by Dostál from Czechoslovakia as *Equisetum* ×*dubium* (Stace 1975) and this name was given in pteridological publications (Hauke 1978). The later revision of the Dostál herbarium collections proved that all determined specimens of *E.* ×*dubium* were actually the morphotypes of *E. arvense* (Hrouda 1997). Dines and Bonner (2002) proposed the present combination of *Equisetum* ×*robertsii* for the specimen collected on Anglesey (an island northwest of Wales). Nowadays, British localities are the only certain sites of this hybrid occurrence (Stace 2010).

Atypical specimens of horsetails were observed during research on *E. telmateia* populations in Poland. Due to the occurrence of both parental species and high probability of hybridization I decided to start a detailed research focused on *E.* ×*robertsii*.

1. Material and methods

Investigation were performed during the field research on existing populations of *E. telmateia*; in addition, herbarium specimens collected in Polish herbaria were analyzed.

In order to examine the basic macromorphological features, the specimens of *E. arvense* (10 shoots), *E.* ×*robertsii* (7 shoots), *E. telmateia* from fallow (4 shoots) and from carr (8 shoots) were collected in population found in Zajączkowice (the first confirmed stand of *E.* ×*robertsii* in Poland).

The morphological features, typically used to differentiate horsetail species, were measured in mature shoots. The features included: the height of the main shoot from the base to the top accurate to 0.5 cm, the length of internodes, the main shoot diameter accurate to 0.5 mm, the ratio of the width of a central canal to shoot diameter, the number of sheath teeth in whorls and the length of teeth accurate to 0.5 mm. The features of whorls and internodes were examined in medium internodes (6-10 whorls from the base of the shoot). The height of shoots and their diameter were measured before the collection of shoots. The color of the internodes was also described for living shoots.

Fig. 1. The specimen of *Equisetum* ×*robertsii* T. D. Dines (Zajączkowice near Jasło, 28.07.2005; photo D. Wróbel).
Ryc. 1. Okaz *Equisetum* ×*robertsii* T. D. Dines (Zajączkowice koło Jasła, 28.07.2005; fot. D. Wróbel).

The features of specimens of both parental species and a hybrid were presented in the typical diagrams of features dispersion (Stace 1993). The mean values, medians as well as maximum and minimum values of particular characteristics were analyzed. Because of the wide metrical dispersion of values in parental species (particularly *E. telmateia*), the hybrid index was not taken under consideration.

Distribution map of *E. ×robertsii* was prepared in 10 × 10 km squares of ATPOL grid (Zając 1978).

2. Results

Existing specimens of *E. ×robertsii* were found in three locations.

The individuals of *E. ×robertsii* (Fig. 1) were observed for the first time in Poland in Zajączkowice near Jasło, in the Jasło-Krosno Basin. In this area, three populations of *E. telmateia*, occurring in carr, in fallow and in the ecotone between them, have been examined since 2000. In the ecotone population, covering about 100 m^2, some vegetative shoots seemed to be of hybrid origin.

Another locality with the abundant occurrence of hybrid plants was found in Trzcinica (Jasło-Krosno Basin), where *E. ×robertsii* occurred in a plot of wet meadow.

The third stabile population of the hybrid was found in Kąclowa near Grybów (Lower Beskid Mts). It occurred in the ecotone between the plots of bog-spring and the nitrophilous herb communities. During 2004-2007, the occurrence of dozen shoots identified as *E. ×robertsii* was observed.

Further specimens were found during the revision of herbarium collection of Jagiellonian University (KRAM) from Skoczów (the Silesian Foothills) and the unspecified localities in the Lubcza forestry district (the Ciężkowickie Foothills). One specimen, collected there by Tacik in 1955, was identified as *E. maximum* (= *E. telemateia*), subsequently the identification was changed to *E. arvense*, and finally to *E. arvense ×telmateia*.

All known current localities of *E. ×robertsii* occur in Carpathians (Foothill and Lower Beskid), and the biggest distance between them is about 190 km (Fig. 2).

List of *E. ×robertsii* stands in Poland in ATPOL grid

DF 91: Skoczów (*K. Jędrzejko*; KRAM); **EF 89** Lubcza Forestry district (*T. Tacik, 1955*; KRAM); **EG 17** Kąclowa near Grybów, D. Wróbel 2004-2007; **FF 90**: Zajączkowice near Jasło in the Jaslo-Krosno basin, D. Wróbel 2000-2012; Trzcinica, D. Wróbel 2006;

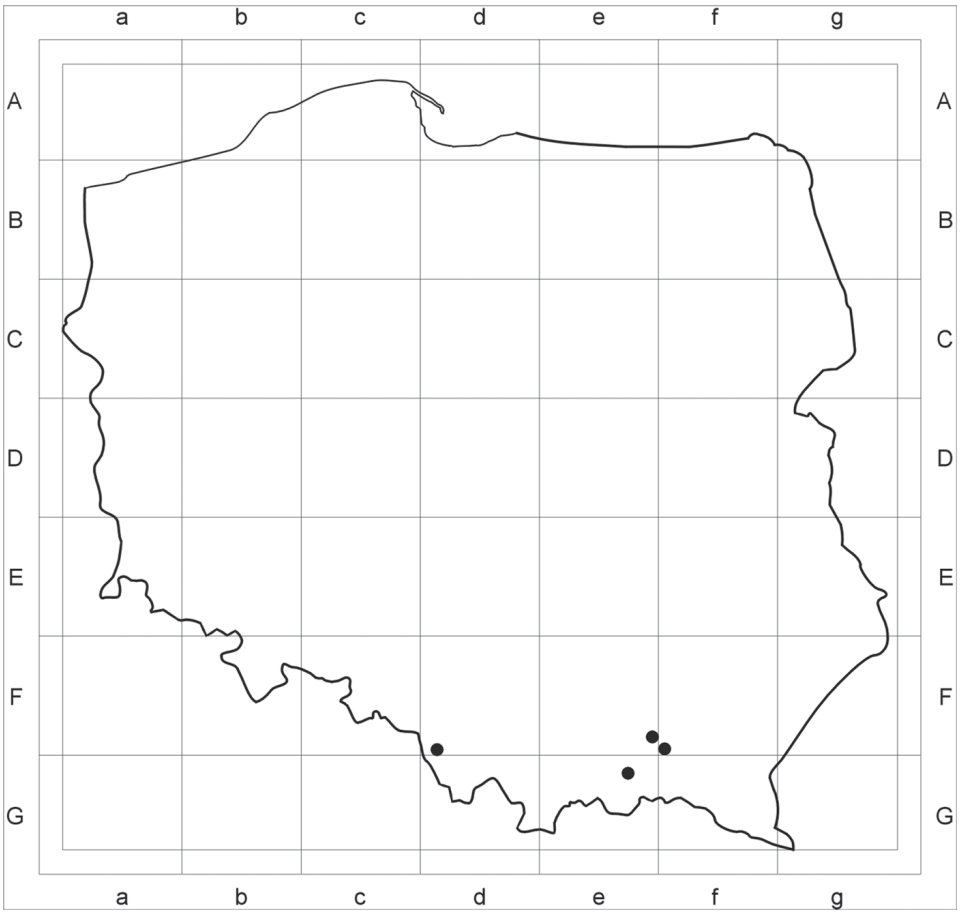

Fig. 2. Localities of *E.* ×*robertsii* T. D. Dines in Poland.
Ryc. 2. Stanowiska *E.* ×*robertsii* T. D. Dines w Polsce.

Analyzed morphological features are presented in Table 1. The most important features, differing *E.* ×*robertsii* from *E. arvense*, are the number of teeth in a single whorl and the shape of teeth. There is no problem to distinguish the hybrid from the typical specimens of *E. telmateia* grown in the optimal habitat of carr. They have significantly larger shoot diameter, longer sheath, more teeth in a whorl, as well as longer internodes, mostly ivory in color.

Table 1. Comparison of chosen features of *Equisetum arvense* L., *E.* ×*robertsii* T. D. Dines and *E. telmateia* Ehrh. in populations from Zajączkowice; F – fallow, C – carr.

Tabela 1. Porównanie wybranych cech populacji *Equisetum arvense* L., *E.* ×*robertsii* T. D. Dines i *E. telmateia* Ehrh. z Zajączkowic; F – ugór, C – łęg.

Features /Cechy	*E. arvense*	*E.* ×*robertsii*	*E. telmateia* - F	*E. telmateia* - C
Height / Wysokość (cm)	37 – 64 (51.51)	33 – 72 (50.78)	55 – 69 (60.00)	55 – 188 (87.34)
Internode length / Długość międzywęźla (mm)	33.0 – 51.5 (50.31)	29.5 – 59.5 (42.00)	38.0 – 45.0 (42.25)	53.5 – 91.0 (70.50)
Shoot diameter / Średnica łodygi (mm)	2.5 – 4.5 (3.6)	3.0 – 6.0 (4.29)	4.5 – 6.5 (5.62)	6.5 – 11.0 (9.13)
Ratio of the central hollow width to shoot diameter / Szerokość kanału centralnego w stosunku do średnicy łodygi	<1/3 – 1/2	1/4 – 3/4	>1/2 – 3/4	1/2 – 4/5
Sheath length without teeth / Długość pochwy łodygowej bez ząbków (mm)	4.0 – 6.0 (4.95)	5.0 – 7.5 (6.36)	5.0 – 10.0 (8.86)	10.0 – 15.5 (12.94)
Teeth length / Długość ząbków (mm)	2.0 – 3.5 (2.55)	3.0 – 7.0 (4.86)	4.0 – 7.0 (5.63)	6.5 – 10.5 (8.25)
Teeth number in a whorl / Liczba ząbków w okółku	10 – 16 (12.20)	16 – 22 (18.43)	18 – 21 (19.75)	22 – 35 (28.75)
Internodes color / Barwa międzywęźli	green / zielone	light green / jasnozielone	ivory / kości słoniowej	ivory – pale green / kości słoniowej - bladozielone
Sheath teeth shape / Kształt ząbków pochwy	triangle / trójkątne	needle / szydlaste	needle / szydlaste	needle / szydlaste

On the contrary, individuals of *Equisetum* ×*robertsii* can be confused during inaccurate evaluation both with the specimens of *E. arvense* and *E. telmateia* from the fallow population. The latter can be similar to the hybrid in the general habit and the range of some metrical features (Fig. 3). The distinguishing of the taxon is possible based on the color of the internodes: *E. telmateia* individuals always have the ivory or very pale green internodes. The shape of the sheath teeth in *E. telmateia* as well as in *E.* ×*robertsii* individuals is lengthened and subulate (Tab. 1).

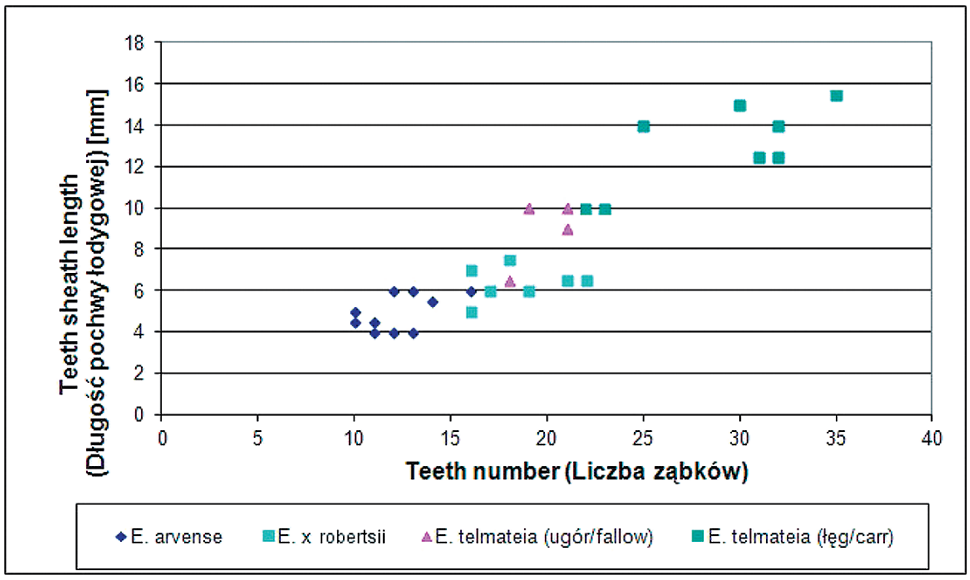

Fig. 3. Metrical features of *E.* ×*robertsii* T. D. Dines.
Ryc. 3. Diagram cech *E.* ×*robertsii* T. D. Dines.

3. Discussion

The hybrids of *Equisetum* species are able to breed vegetatively (Lubienski 2000), causing that the hybrid populations can exist in one place for many years. The features of hybrids of the *Equisetum* genus are of medium values compared to parental species (Jermy 1978). It also applies to *E.* ×*robertsii* (Dines, Bonner 2002). The problem is that parental species of this hybrid are characterized as morphologically changeable, which may hinder the identification of the

hybrid. The examples of such variability are present between the giant horsetail individuals (Wróbel 2006). The diversity of populations of this species is a result of the habitat modification. Only the set of features allows us to distinguish the individuals which belong to parental and hybrid populations.

It seems that the localities of hybrids of the *Equisetum* genus and subgenus are considerably more numerous than it is reported in publications and in data from herbarium collections. It can result from the problems in identification of hybrids, as well as in their occurrence in ecotone zones (Page 1988) and in habitats significantly changed by anthropopressure (Page 1973; Pigott 1984). Parental species usually grow in small distance from hybrid localities (Page 1988; Giovannini et al. 2003), thus their simultaneous occurrence can account for the possibility of hybrids formations. A more common presence of *Equisetum* ×*robertsii* is very probable in Polish Carpathians, where parental species often grow close to one another.

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Streszczenie

Equisetum ×*robertsii* T. D. Dines (ryc. 1) jest jednym z dwóch mieszańców *E. telmateia* występujących w Polsce. Jego populacje stwierdzono w Zajączkowicach i w Trzcinicy koło Jasła, w Kotlinie Jasielsko-Krośnieńskiej na Pogórzu Karpackim oraz Kąclowej w Beskidzie Niskim. Ponadto znaleziono osobniki *E.* ×*robertsii* podczas weryfikacji zbiorów zielnikowych ze Skoczowa w Dolinie Górnej Wisły oraz z Lubczy na Pogórzu Ciężkowickim. Są to jedyne znane stanowiska tego taksonu w Polsce (ryc. 2).

Na stanowisku w Zajączkowicach, w strefie ekotonowej między łęgiem i ugorem, stwierdzono kilka pędów podobnych do *E. telmateia*, ale mniejszych. Cechy makromorfologiczne miały wartości pośrednie między *E. telmateia* i *E. arvense*. Identyfikacja mieszańców była utrudniona ze względu na fakt, że ich pędy rosły na ugorze wraz z mniejszymi niż typowe osobnikami *E. telmateia*. W celach porównawczych zebrano rosnące w pobliżu pędy *E. telmateia* z populacji łęgowej i ugorowej, jak również pędy *E. arvense*. Ze względu na dużą rozpiętość cech metrycznych, klasyczny indeks mieszańców był mało przydatny. Natomiast w oparciu o diagram rozrzutu cech uzyskano dobre rozdzielenie osobników rodzicielskich i ich mieszańca (ryc. 3). Ugorowe osobniki *E. telmateia* wykazywały duże podobieństwo do mieszańców, jednakże po uwzględnieniu dodatkowej cechy (kolor międzywęźli - wyraźnie barwy kości słoniowej u osobników typowych *E. telmateia*), ich rozróżnienie nie było kłopotliwe.

Identyfikację osobników *E.* ×*robertsii* ze Skoczowa ułatwił fakt, że znajdujące się w zbiorach zielnikowych pędy zarówno obydwu gatunków rodzicielskich, jak i mieszańca o wyraźnie pośrednich cechach, pochodziły z tego samego stanowiska.

Wydaje się, że jakkolwiek mieszańce gatunków z podrodzaju *Equisetum* są rzadko obserwowane, to jednak ich występowanie jest częstsze niż wskazują na to publikacje naukowe. Powodem tego może być występowanie mieszańców w strefach ekotonowych i miejscach znacząco przekształconych antropogenicznie. Gatunki rodzicielskie zwykle rosną w niewielkiej odległości od stanowisk mieszańców i mogą być reprezentowane przez bardzo nieliczne populacje. Mieszańce gatunków rodzaju *Equisetum* charakteryzują się typową dla skrzypów zdolnością do rozmnażania wegetatywnego, co powoduje, że populacje mieszańcowe mogą trwać na jednym miejscu wiele lat.