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THE *NASTURTIUM* ×*STERILE* (AIRY SHAW) OEFELEIN 1958 IN POLAND – FUTURE USEFUL HORTICULTURAL PLANT?

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Abstract. This study presents the taxonomic, cytometric and phytosociological characteristics of *Nasturtium* ×*sterile* as well as four areas of its occurrence in Poland. One of these areas was probably mistakenly identified near Cracow in 1916, but the other three still exist and are located in the geographical region of Wielkopolska (18 localities). Fruit-bearing specimens were found in two localities (Kłębowo and Biała). In the other localities only barren specimens were found, which were identified using flow cytometry. Further research on *N.* ×*sterile* is necessary to verify whether it has similar functional and therapeutic properties as one of its parent species.

Key words: *Nasturtium* ×*sterile,* nuclear DNA content, taxonomy, distribution, cultivation, Poland

INTRODUCTION

In Europe the *Nasturtium* R. Br. genus is represented by three taxa: *Nasturtium officinale* R. Br. 1812, *N. microphyllum* (Boenn.) Rchb. 1832, and by their hybrid *N.* ×*sterile* (Airy Shaw) Oefelein 1958 (Valentine 1964). In Poland the parent species are strictly protected by law (Rozporządzenie... 2014) and they are on the Polish red list of pteridophytes and flowering plants (Kaźmierczakowa et al. 2016): *N. microphyllum* (VU – vulnerable) and *N. officinale* (NT – near threatened). *N. microphyllum* is also listed in the Polish red book of threatened plant species with the VU status (Smoczyk 2001, Smoczyk & Czarna 2014).

Nasturtium officinale is the most common of the aforementioned taxa in Poland. It can be found in the lowlands as well as low mountains, except for northeastern and southeastern Poland (Zając & Zając 2001). So far *N. microphyllum* has been found in 11 localities in Poland, i.e. in the provinces of Wielkopolska, Western Pomerania and in the vicinity of Cracow (Smoczyk 2001, Czarna & Morozowska 2009, 2013, Kruk & Szymańska 2009, Czarna et al. 2013, Smoczyk & Czarna 2014).

The oldest report on the occurrence of *Nasturtium* ×*sterile* in Poland in a locality in the village of Dubie in the Cracow County dates back to 1916 (Tacik 1985). However, as results from our analysis, this locality was probably mistakenly listed (Czarna et al. 2012). Despite the report on the occurrence of *N.* ×*sterile* in this locality, this species is absent from the atlas of the distribution of vascular plants in Poland (Zając & Zając 2001, 2019) and from the Checklist published in 2001 (Mirek et al. 2002). *N.* ×*sterile* appeared in the Checklist published in 2020 (Mirek et al. 2020), which included this locality. In the meantime, new localities were found in the village of Biała near the town of Trzcianka (Czarna et al. 2012), in the North and South Canals of the Obra River and in the Obrzyca River (Morozowska et al. 2015).

The aim of the study was to prepare and describe a complete list of all localities of *N.* ×*sterile* in Poland, which includes the results published so far as well as nine new localities identified in our study in 2021. In order to reliably confirm the taxonomic identity of plants in all documented localities, the nuclear DNA content of the tested plants was estimated. Another aim of the study was to prepare the taxonomic and

phytosociological characteristics of *N.* ×*sterile* on the basis of a complete list of its current localities in Poland.

This work summarises results of research conducted so far, as in addition to the nine new localities we used published data from western Poland (Morozowska et al. 2010, 2015, Czarna et al. 2012). The methods used were the same as those applied in the previous studies.

MATERIAL AND METHODS

During the growing season of 2021 field investigations were conducted in the Wielkopolska region, namely in ditches leading to the Noteć River near the village of Biała, in the Mosina and Kościan Canals, in an unnamed ditch in the town of Krzyż Wielkopolski, as well as in the Molita River in the village of Drawski Młyn (Fig. 1).

The taxonomic characteristics of the specimens collected from all localities included in the research was based on their observation. The quantitative data were determined on the basis of 10 measurements of the following parameters: the length of the shoots, the number of leaf lobes, the length of the petals in the crown, the length and width of the siliquae, the number of set and dead seeds. The qualitative data were determined on the basis of five measurements of the following parameters: the shape of the leaf lobes, the edge of the leaves, the shape of the petals in the crown, the arrangement of the seeds in the siliqua. Phytosociological relevés were taken with the Braun-Blanquet method (Fukarek 1967).

Three samples of upper, fully developed leaves were collected from 10 plants in each population for cytological tests. The plants were at a distance of at least 5 m from each other.

Fig. 1. The distribution of *Nasturtium* ×*sterile* in Poland (1–18 see Table 1)

Fresh leaves collected from nine *N.* ×*sterile* populations were used for measurement of the 2C DNA content. The leaves of *Petunia hybrida* PxPc6 (2C = 2.85 pg; Marie & Brown 1993) were used as an internal standard. Nuclei suspensions were prepared according to the method described by Morozowska et al. (2010). For each sample 5,000–7,000 nuclei were measured using a Partec CyFlow SL Green flow cytometer (Partec GmbH, Münster, Germany), equipped with a laser with green light emission at 532 nm. Three *N.* ×*sterile* plants were analysed in each populations. A linear scale was used and histograms were analysed using the FloMax software (Partec GmbH, Münster, Germany). The coefficient of variation (CV) of the G0 /G1 peak of *N.* ×*sterile* accessions ranged from 2.47% to 3.78%. The linear relationship between the ratio of *N.* ×*sterile* and *P. hybrida* PxPc6 2C peak positions on the histograms was used to measure the nuclear DNA content.

The research material was deposited at the Herbarium of the Department of Botany, Poznań University of Life Sciences, Poland (POZNB).

RESULTS

It is difficult to identify species of the *Nasturtium* genus, because they usually do not bloom and produce no fruit. This was the case with *N.* ×*sterile* – among 18 localities only two of them (Biała and Kłębowo) had flowering specimens. When plants are only in a vegetative state, it is difficult to identify their species by the leaf habit (Fig. 2). All the three species of the *Nasturtium* genus were best differentiated by the arrangement of seeds in the siliqua (Fig. 3), as well as the SEM image of the primary and secondary seed coat sculpture, the number of cells on the seed surface, the shape and microfeatures of the cells of the fruit septum and the inner surface of the siliqua valve (for details see Morozowska et al. 2015). As the plants collected from most of the described localities were found only in the vegetative stage, the genome size was analysed to identify the *N.* ×*sterile* species. In earlier studies the 2C DNA content in *N.* ×*sterile* ranged from 1.121 to 1.140 pg (Czarna et al. 2012, Morozowska et al. 2015). In the present study the genome size was nearly identical and ranged from 1.096 pg/2C to 1.132 pg/2C, depending on the population (Table 1). The mean 2C DNA content in the 18 *Nasturtium* populations was 1.122 pg. According to the categorisation proposed by Soltis et al. (2003) the *N.* ×*sterile* species possess a very small genome (< 2.8 pg/2C; Fig. 4).

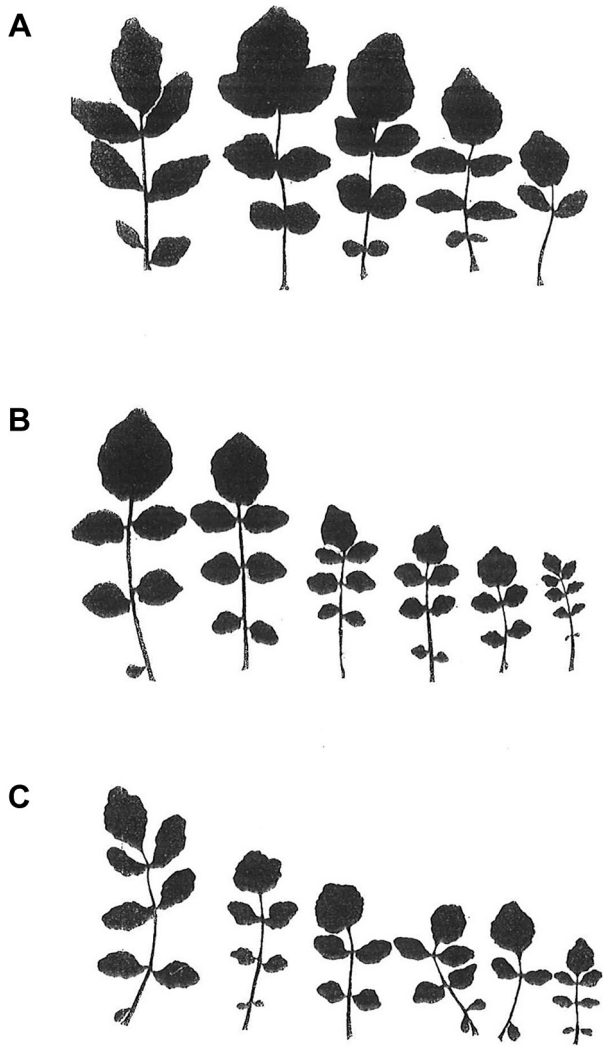

Fig. 2. Leaf variability: A – *Nasturtium officinale*, B – *Nasturtium* ×*sterile*, C – *Nasturtium microphyllum*

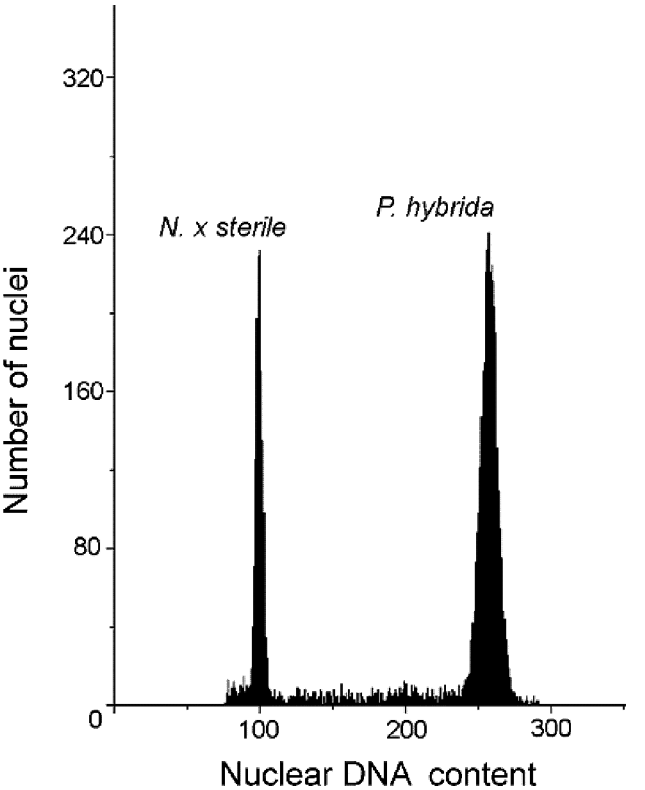

Fig. 4. Selected histogram of 2C DNA content of *Nasturtium* ×*sterile*

LOCALITIES

The first report on the hybrid species *N.* ×*sterile* found in Poland came from Tacik (1985), who based it on the herbarium sheet collected by K. Piech in the village of Dubie near the town of Krzeszowice (Cracow County) in 1916. According to the information

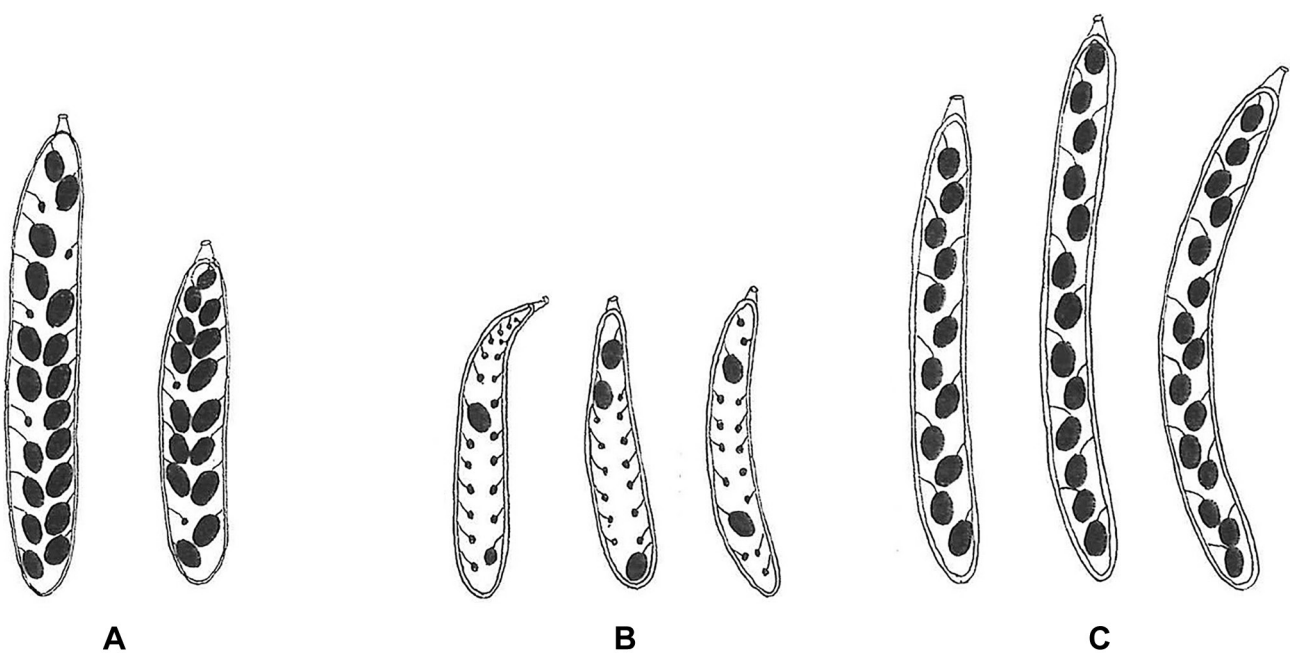

Fig. 3. The habit of the siliquae: A – *Nasturtium officinale*, B – *Nasturtium* ×*sterile*, C – *Nasturtium microphyllum*

Table 1. The localities of *Nasturtium* ×*sterile* communities in Poland and the size of the genome. All localities except for No. 10 (Lubuskie Voivodeship) were found in the Wielkopolskie Voivodeship

No.	Locality	County	ATPOL	Geographic coordinates	Watercourse	Flowering, fruit-bearing, non-flowering specimens	Nuclear DNA content (pg ± SD)	First found
1	Biała	Czarnków-Trzcianka	BC36	53.0467°N 16.5666°E	Łaga River	F, FB	1.125±0.004	Czarna et al. 2012
2	Krzyż	Czarnków-Trzcianka	BC53	52.5158°N 16.0129°E	Unnamed ditch	NF	1.096±0.007	2021
3	Drawski Młyn	Czarnków-Trzcianka	BC52	52.5189°N 16.0373°E	Molita River	NF	1.109±0.023	2021
4	Kłębowo	Wolsztyn	BD43	52.0253°N 16.0606°E	North Canal of Obra River	F, FB	1.128±0.013	Morozowska et al. 2015
5	Obra	Wolsztyn	BD32	52.0427°N 16.0240°E	North Canal of Obra River	NF	1.127±0.009	Morozowska et al. 2015
6	Jaromierz	Wolsztyn	BD32	52.0557°N 15.5704°E	North Canal of Obra River	NF	1.121±0.010	Morozowska et al. 2015
7	Kopanica	Wolsztyn	BD31	52.0557°N 15.5509°E	North Canal of Obra River	NF	1.122±0.012	Morozowska et al. 2015
8	Nowa Wieś	Wolsztyn	BD43	52.0048°N 16.1247°E	South Canal of Obra River	NF	1.123±0,005	Morozowska et al. 2015
9	Świętno	Wolsztyn	BD42	52.0031°N 16.0303°E	South Canal of Obra River	NF	1.130±0.009	Morozowska et al. 2015
10	Chwalim	Zielona Góra	BD31	52.0359°N 15.4917°E	Obrzyca River	NF	1.129±0,007	Morozowska et al. 2015
11	Mosina	Poznań	BD18	52.1466°N 16.5103°E	Mosina Canal	NF	1.132±0.010	2021
12	Krosinko	Poznań	BC28	52.1386°N 16.4901°E	Mosina Canal	NF	1.130±0.014	2021
13	Dymaczewo Stare	Poznań	BC27	52.1313°N 16.4706°E	Mosina Canal	NF	1.124±0.006	2021
14	Będlewo Forest District	Poznań	BC27	52.1295°N 16.4502°E	Mosina Canal	NF	1.113±0.004	2021
15	Zadory	Kościan	BC27	52.1016°N 16.4034°E	Mosina Canal	NF	1.121±0.020	2021
16	Sepienko	Kościan	BD36	52.0780°E 16.3624°E	Mosina Canal	NF	1.112±0.009	2021
17	Kościan	Kościan	BD36	52.0456°N 16.3818°E	Kościan Canal	NF	1.140±0.019	Morozowska et al. 2015
18	Kiełczewo	Kościan	BD36	52.0625°N 16.3758°E	Kościan Canal	NF	1.118±0.003	2021

Abbreviations: F – flowering specimens; FB – fruit-bearing specimens; NF – non-flowering specimens.

included on the herbarium label – the specimens were abundant in fruit. This historic site was found in our later research conducted in Dubie in 2011. The plants, which were found along the ditch running through the village and on the nearby breeding ponds, were abundant in fruit. Since *N.* ×*sterile* sets seeds very poorly or does not bear fruit at all, it is most likely that the researchers misidentified the species at this site and classified it as *N. officinale* (Czarna et al. 2012).

In 2008 a locality of *N.* ×*sterile* was found in the village of Biała (Czarnków-Trzcianka County), in the Łaga River, which flows into the Noteć River (Czarna et al. 2012). Between 2007 and 2011 further random research revealed localities of *N.* ×*sterile* in the North Canal of the Obra River in the villages of Kłębowo, Obra, Jaromierz, and Kopanica, in the South Canal of the Obra River in the villages of Nowa Wieś and Świętno, in the Kościan Canal in the town of Kościan and in the Obrzyca River in the town of Chwalim (Morozowska et al. 2015).

During the research conducted in 2021 no new localities of *N.* ×*sterile* were found in the ditches reaching the Noteć River near the village Biała. However, nine new localities were documented in the other watercourses which were included in the study. The following six localities were found in the Mosina Canal: Mosina, Krosinko, Dymaczewo Stare, Będlewo forester's lodge, Zadory, and Sepienko. One locality was found in the Kościan Canal near the village of Kiełczewo. The last two localities of the plant were identified in the town of Krzyż nd in the village of Drawski Młyn in Czarnków-Trzcianka County (Table 1, Fig. 1).

At present there are three areas of occurrence of *N.* ×*sterile* (18 localities) in Poland. The first area is near the town of Krzyż Wlkp. (two localities) and in the Łaga ditch in the village of Biała near the town

of Trzcianka (one locality). The second area is in the North (four localities) and South (two localities) Canals of the Obra River and in the Obrzyca River (one locality). The third area is in the Kościan Canal (two localities) and the Mosina Canal (six localities) (Fig. 1).

TAXONOMIC CHARACTERISTICS

Nasturtium ×*sterile* (Airy Shaw) Oefelein 1958 (= *N. officinale* R. Br. 1812 × *N. microphyllum* (Boenn.) Rchb. 1832) is a hexaploid hybrid ($2n = 48$). It is an aquatic species (hydrophyte), which blooms from June to November. It is a perennial, usually 10–50 cm long, but it may also grow to a length of about 2 m. It has a creeping stalk with adventitious roots at the bottom. The stalk often branches and is leafy, hollow or solid at nodes. It often forms a wide floating mat on riverbanks (Fig. 5). The leaves are slightly fleshy, vividly green or purple in autumn. The odd-pinnatisect lamina consists of 1–11 lobes, which increase towards the leaf tip or are equally sized. The lobes are usually elliptical or round. Most often they have a wedge-shaped or slightly heart-shaped base pulled into a very short petiole or they are sessile, where only the apex lobe has a longer petiole. The edge of the lobes is sinuate. The *N.* ×*sterile* forms apical inflorescences, which are initially flat and dense, but later they elongate into a loose raceme. There are four white crown petals, up to 4 mm in length, with an ovoid lamina, not too sharply demarcated from the claw. The plant has thin pedicels, which elongate as the fruit ripens. There are six stamens with yellow anthers. The siliquae are 7–12 mm long and 1–1.4 mm wide or unequal in width, usually bent (Figs 3, 6).

The micro-ornamentation pattern on the siliqua valve internal surface is reticulate with short and narrow cells with numerous (> 11) secondary transverse striations. Due to the presence of numerous secondary striations the outer cell boundaries are not well defined. The secondary sculpturing of the siliqua valve internal surface was found to be of taxonomic importance. The reticulate sculpturing of the fruit septum surface was also accepted as the useful diagnostic feature. The diamond-shaped cells with straight or slightly sinuate anticlinal walls were found to be taxonomically significant. The seeds are arranged in two rows, which are often incomplete or irregular, with one or two seeds set in the siliqua and 8–19 undeveloped ovules. The seed coat sculpturing is reticulate, subtype ocellate, with raised undulate anticlinal and flat periclinal walls. The anticlinal and periclinal walls are covered by delicate secondary transverse and longitudinal cuticle striations. The

Fig. 5. A view to a *Nasturtium* ×*sterile* community in the form of a floating mat in the North Canal of the Obra River (photo by A. Czarna)

Fig. 6. A fruit-bearing specimen of *Nasturtium* ×*sterile* in the Łaga River in the village of Biała (photo by A. Czarna)

seed coat sculpturing characteristics and the size of the cells on the seed coat surface were found to be of taxonomic importance.

PHYTOSOCIOLOGICAL CHARACTERISTICS

At the documented localities *N.* ×*sterile* grew in clear, deep, slow-flowing or stagnant waters, and almost always formed a wide floating mat at the reedbed layer (Fig. 5). It was found mainly in reedbed communities of the *Phragmitetea* class. Patches of *N.* ×*sterile* should be identified as a separate group, belonging to the *Sparganio-Glycierietum fluitantis* assotiation. *N.* ×*sterile* achieved a high degree of coverage in all phytosociological relevés (Table 2).

THREATS AND PROTECTION

Flood, water pollution, maintenance of the banks and bed of the ditch, as well as succession may be the greatest threats to the plant communities described above. In order to preserve these communities during ditch or canal maintenance small patches of *N.* ×*sterile* should be transferred to another basin and retransferred to the original place after the maintenance. The *N.* ×*sterile* plants in all localities were

Table 2. Plant communities with *Nasturtium* ×*sterile*. See Table 1 or Figure 1 to check the position of a locality (2, 3, 12, etc.)

Number	1	2	3	4	5	6	7	8
Position of locality	2	3	12	13	14	15	16	18
Date	7 Sep 2021	7 Sep 2021	1 Sep 2021	1 Sep 2021	2 Sep 2021	2 Sep 2021	2 Sep 2021	2 Sep 2021
Sample collection area [m²]	30	30	30	30	30	30	30	30
Cover of shrub layer b [%]	0	0	5	0	0	5	0	0
Cover of herbaceous layer c [%]	90	90	100	100	100	100	100	100
Number of species	11	11	13	10	13	12	7	10
Nasturtium* ×*sterile	**3.3**	**3.3**	**3.3**	**3.4**	**4.3**	**4.3**	**4.3**	**3.2**
I. Phragmitetea								
Alisma ×*rhicnocarpum*	.	.	.	.	r	.	.	.
Butomus umbellatus	r	.	.	.	.	.	.	.
Glyceria maxima	+	.	+	+	1.1	.	.	.
Phragmites australis	2.2	1.1	.	.	1.1	1.1	1.1	.
Sagittaria sagittifolia	+	+	1.1	+	+	.	.	.
Sparganium erectum	+	.	3.3	3.3	1.2	2.3	2.2	2.2
II. Lemnetea								
Lemna minor	+	.	2.3	3.3	3.3	3.3	+	4.4
III. Convolvuletaria								
Calystegia sepium	+	.	+	.	+	+	+	+
IV. Nymphaeion								
Hydrocharis morsus-ranae	.	.	.	r	+	+	.	.
Nuphar luteum	+	.	1.1	+	1.1	.	1.1	1.1
Potamogeton natans	.	+	.	.	.	.	.	.
V. Alnetea glutinosae								
Alnus glutinosa	.	.	+	.	.	.	.	.
Solanum dulcamara	.	.	.	r	.	r	.	.
VI. Potametea								
Ceratophyllum demersum	.	1.1	.	.	.	+	.	1.1
VII. Others								
Asparagus officinalis	.	.	r	.	.	.	.	.
Berula erecta	+	+	r	.	+	+	.	.
Carex acutiformis	.	.	.	.	.	.	.	1.1
Callitriche sp.	2.2	3.3	.	.	.	.	.	.
Elodea canadensis	.	+	.	.	.	.	.	.
Epilobium hirsutum	.	.	+	.	.	r	.	.
Lythrum salicaria	.	r	.	+		.	.	.
Phalaris arundinacea	.	+	.	.	+	+	.	+
Populus alba	.	.	.	.	.	1	.	.
Potamogeton pectinatus	.	1.1	.	.		.	.	.
Rorippa amphibia	.	.	.	.	.	.	+	.
Salix caprea	.	.	+	.	.	.	.	.
Scirpus sylvaticus	.	.	.	.	.	.	.	+
Urtica dioica	.	.	1	+	1.1	.	.	r

in good shape and in large numbers. Therefore, the species does not require protection, but the localities should be monitored.

DISCUSSION

Nasturtium officinale as well as *N.* ×*sterile* and *N. microphyllum* are the macrophytes which help to assess the ecological status of surface waters (Szoszkiewicz et al. 2010).

During the research the summer form of *Cardamine amara* was found, which was very similar to *N.* ×*sterile*, *N. microphyllum* or *N. officinale*. They were best distinguished by the seeds collected from mature siliquae. If there are no seeds, the species can be distinguished by the colour of anthers (*Nasturtium* – yellowish, *C. amara* – purple), and leaf trichomes (*Nasturtium* – trichomes on the leaf axis, *C. amara* – trichomes on leaf valves). The similarity of these species was noticed by Tacik (1985). The *Nasturtum* species can be also distinguished from *C. amara* according to the 2C DNA content. The published genome size of *C. amara* ranged from 0.45 pg/2C (Jonhston et al. 2005) to 0.59 pg/2C (Houben et al. 2003), while the 2C DNA content of *N. officinale*, *N.* ×*sterile* and *N. microphyllum* is 0.77 pg, 1.13 pg and 1.46 pg, respectively (Morozowska et al. 2015).

There is not much information about the functional properties of *N.* ×*sterile* in available scientific publications, but they provide a lot of data on one of the parent species of the this hybrid, i.e. *N. officinale*.

Since ancient times *N. officinale* has been prised for its health-promoting values and taste. As early as the 11th century the German pharmacist *Tabernemontanus* recommended its young leaves as delicious, nutritious lettuce. In the 12th century it was commercially grown in Europe (Podgórska & Podgórski 2004). It was considered the most important antiscorbutic drug. Salted *N. officinale* plants were taken on long journeys. As early as the 19th century it was sold in London and Sydney by vendors from baskets carried on their heads. At the time it was called St Patrick's cabbage. Later it fell into oblivion, but recently it has become fashionable again. Its therapeutic properties have been appreciated and now it is cultivated in Canada, the United States, and Australia (Szymanderska 2014).

The *N. officinale* herb contains mustard oil glucosides, e.g. gluconasturtium (usually in fresh plants). It has a slight antibacterial effect due to mustard oils, and possibly also a slight choleretic effect. Recently there have been no studies on *N. officinale*. The plant is usually used as an ingredient in blood-cleansing or slimming herbal mixtures (Frohne 2006).

N. officinale has interesting functional and health-promoting properties. In Poland this species grows wild in ditches, near springs and streams in the northern and western lowlands. Currently *N. officinale* seeds can be bought from the W. Legutko seed company, and seedlings can be purchased in garden nurseries. In the 17th century *N. officinale* was commercially grown in Europe. Nowadays its leaves are used for salads or as an additive, whereas its seeds are used for meat seasoning as a substitute for mustard seeds (Biggs et al. 2007, Podgórska & Podgórski 2004). The whole plant has slightly poisonous properties. It should not be eaten in excessive amounts, because it irritates the kidneys (Szymanderska 2014). *N. officinale* also has side effects. Gastrointestinal ailments rarely occur, especially when freshly pressed juice is consumed. Preparations containing *N. officinale* should not be used when one has gastric and intestinal ulcers or nephritis (Frohne 2006). Due care needs to be taken when consuming its leaves.

It cannot be ruled out that both the aforementioned therapeutic properties and side effects could also be attributed to *N.* ×*sterile*. However, the properties related to the use of seeds could not be attributed, because this species does not set them.

Although *N.* ×*sterile* was described only in 1958, it can be assumed that this hybrid has existed for a long time and it may also have been cultivated without scientists' awareness of this fact. At present there is neither direct information about the earlier cultivation of *N.* ×*sterile* in Poland nor about its running wild (Tacik 1985). However, this option cannot be ruled out.

As results from scientific publications, *N.* ×*sterile* is sometimes cultivated. Its young and fresh leaves as well as apical shoots are harvested in spring during flowering. They have a pleasant, hot, slightly bitter taste, reminiscent of mustard, radish or horseradish. *N.* ×*sterile* leaf salad served in early spring is an excellent medicine for pulmonary diseases, hypothyroidism, and vitamin C deficiency. Whole or finely chopped fresh shoots and leaves can be added to salads as well as bread and butter. They can be used as an ingredient for bread spreads, herbal cottage cheese and butter. They enrich the flavour of potato salads, omelettes, scrambled eggs, soups, and meats. They can be added to fresh vegetables, e.g. tomatoes, lettuce, or cucumbers. Short shoots (not exceeding 20 cm) with brittle, well-coloured leaves should be selected for consumption. After harvesting the whole plants should be immersed in cold water, closed and stored in a refrigerator for a few days in order to preserve their freshness. Larger amounts of *N.* ×*sterile* can be consumed as spinach. *N.* ×*sterile* juice combined with carrot, spinach or beetroot juice, is considered a valuable blood-cleansing agent. The plant is very popular in oriental cuisines. In Japanese and Chinese cuisines the tops of young shoots are used to decorate dishes (Podgórska & Podgórski 2004).

It is likely that *Nasturtium* ×*sterile* was cultivated in Poland in the Mosina and Kościan Canals and in the North and South Obra Canals. *N.* ×*sterile* plants still grow there, so cultivation can be continued and

its leaves can be harvested as an ingredient for vegetable salads.

Our study presents an updated list of documented localities of *N.* ×*sterile* plants. New results can be expected in further research. The micromorphological traits of seeds and fruits (if they are set) should be used for the correct and reliable taxonomic verification of potential new localities. If they do not occur, flow cytometry should be applied, because it is a reliable criterion of the taxonomic identification of specimens in a vegetative state

Hedge (1968) had predicted the occurrence of this hybrid taxon in the Flora Iranica area and mentioned one specimen from Pakistan with hybrid features. Two its localities were found in Iran: Gilan on 14 May 1971 and Mazandaran: Tonekabon, Nashtarud, Khoshkedaran on 13 June 2003 (Naquinezhad 2006).

SUMMARY AND CONCLUSIONS

The *Nasturtium* ×*sterile* plants in all 18 localities were identified by using flow cytometry to analyse the genome size (Table 1). The genome size ranged from 1.096 pg/2C to 1.140 pg/2C, with the mean value of 1.122 pg/2C for the genus. The plants from all localities were also characterised morphologically, including the vegetative traits of the leaves and generative traits of the fruit and seeds in the communities in which they appeared. The hybrid was best differentiated from its parent species by the arrangement of seeds in the siliqua (Figs 2, 6), as well as the number of cells on the seed surface, the shape of the cells on the surface of the septum and the inner surface of the siliqua valve, and the secondary seed coat sculpture.

Nasturtium ×*sterile* is nowadays valued in many European countries due to its significant health-promoting properties and taste. It could also be recultivated in Poland, making use of the canals in which it was found in the Wielkopolska region.

Like many aquatic and marsh species, *N.* ×*sterile* is characterised by a wide range of phenotypic variability depending on the diversity of the habitat conditions. The leaves are not a good distinguishing feature of individual species of the *Nasturtium* genus. If the plants bloom and bear fruit, their species can be best identified by their fruit and seeds. If there are barren specimens, flow cytometry helps to determine the genome size of these plants. If the plant sets seeds and fruit, the analysis of their micromorphological characteristics as well as flow cytometry are reliable criteria enabling the taxonomic identification of specimens in a vegetative state.

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AUTHORS' CONTRIBUTIONS

Aneta Czarna – research designing, conducting field experiments, writing the manuscript; Iwona Jędrzejczyk – conducting cytometirc experiments, statistics, writing the manuscript; Maria Morozowska – writing the manuscript.

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