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Arabis recta Vill. (Brassicaceae) in Poland: distribution, habitats and threat assessment

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Abstract: *Arabis recta* is one of the rarest species in Poland. It has been reported from 15 sites, mostly in the Nida Basin (Małopolska Upland). The plant is a component of xerothermic grasslands but it can also grow in arable fields and fallows. In Poland, *Arabis recta* is considered to be threatened by natural succession and herbicide use. However, according to recent studies, it should be treated as an endangered species (EN category) in the country.

Key words: *Arabis recta*, distribution, habitat, Poland

1. Introduction

Arabis recta Vill. [*A. auriculata* sensu DC., non Lam.] (Brassicaceae) belongs to the sub-Mediterranean Irano-Turanian element (Zając & Zając 2009). In Europe, its continuous range comprises mostly south-eastern part of the continent, whereas in Central Europe it has only a few localities (Meusel *et al.* 1965).

Arabis recta is one of the rarest vascular plant species in Poland, known almost exclusively from the Nida Basin (SE part of the Małopolska Upland). Because of the low number of known localities and successional changes observed within its habitats, Mirek & Kaźmierczakowa (2001) considered it as critically endangered component of the Polish flora. The species is threatened also in the neighboring countries. In Germany it is considered to be endangered (Korneck *et al.* 1996), whereas in the Czech Republic as a vulnerable (Grulich 2012).

Nobis *et al.* (2007a) have given a supplemented list of all *Arabis recta* localities recorded in Poland. Afterwards, during recent field studies, we discovered some subsequent new localities of the species. The aims of the study were: (1) to present current distribution of *Arabis recta* in Poland, (2) to complete the knowledge on the species habitats, and (3) to assess actual degree of threat to *Arabis recta* in our country.

2. Methods

The list of *Arabis recta* localities is based on field studies conducted by us in 2006-2010. The location of the sites was determined using a GPS receiver (the WGS84 coordinate system) and the ATPOL grid square system where capital letters indicate the 100-km square and the digits denote: the first two – the 10-km square, and the next two – the 2.5-km square (Zając 1978). The distribution of the species was mapped in the ATPOL cartogram grid (Fig. 1). The population size was estimated for each finding. Phytosociological relevés were performed at the localities where *A. recta* was a component of homogeneous vegetation patches. A total of eighteen relevés were made using the standard Braun-Blanquet method (Pawłowski 1977). Relevés are presented in Table 1. Floristic lists were compiled for sites at which phytosociological relevés could not be performed. The nomenclature of the species follows Mirek *et al.* (2002), Ochyra *et al.* (2003) and Fałtynowicz (2003), and the nomenclature of the syntaxa is based on studies by Medwecka-Kornaś *et al.* (1972) and Matuszkiewicz (2001).

The herbarium material of *Arabis recta* is deposited in the Herbarium of the Jagiellonian University in Kraków (KRA).

Table 1. Plant communities with *Arabis recta* Vill. in Poland

No. of relevé	1	2	3	4	5	6	7	8	9	10
Date	06.06. 2006	06.06. 2006	06.06. 2006	14.06. 2006	23.05. 2009	15.05. 2010	26.05. 2009	26.05. 2009	26.05. 2009	25.05. 2009
Area of relevé [m^2]	20	15	10	15	4	4	1	2	20	4
Exposure	SSE	SSE	SE	SW	SSE	S	SSE	S	S	S
Inclination [°]	40	10	3	40	10	20	10	5	2	10
Altitude a.s.l. [m]	200	210	210	215	240	185	255	265	240	250
Cover of C layer [%]	75	60	60	60	60	65	50	40	60	40
Cover of cultivated plants [%]	-	-	-	-	-	-	-	-	-	-
Cover of weeds [%]	-	-	-	-	-	-	-	-	-	-
Cover of D layer [%]	3	15	20	5	0	10	5	5	5	20
Ch. Ass. *Sisymbrio-Stipetum capillatae*										
Arabis recta	**+**	**+**	**+**	**+**	**1**	**+**	**2**	**1**	**+**	**+**
Carex supina	3	+	.	.	.	.	.	.	.	.
Festuca valesiaca	3(4)	+	+	.	.	.	.	.	.	.
Sisymbrium polymorphum	+	.	.	.	.	.	.	.	.	.
Veronica praecox	+	+	+	+	+	+	+	+	+	.
Ch. All. *Festuco-Stipion*										
Koeleria macrantha	.	+	+	+	1	.	.	.	.	.
Stipa capillata	+	2	.	3	1	2	.	.	.	1
Ch. O. *Festucetalia valesiacae*										
Achillea pannonica	.	.	.	.	.	.	+	.	.	.
Anthemis tinctoria	.	.	.	.	.	.	.	.	.	.
Campanula sibirica	.	.	.	.	.	.	.	.	+	+
Potentilla arenaria	2	1	3	1	1	+	1	+	+	2
Stipa pennata	.	.	.	.	.	.	.	+	+	+
Thesium linophyllon	.	1	.	.	.	.	.	.	.	1
Thymus austriacus	.	.	.	.	.	2	.	.	.	2
Thymus glabrescens	.	.	1	.	.	2	.	2	.	.
Thymus marschallianus	1	+	.	2	2	.	2	.	.	1
Thymus kosteleckyanus	.	+	2	.	.	.	1	+	+	.
Ch. et D. Cl. *Festuco-Brometea*										
Anthyllis vulneraria	.	+	.	+	.	+	.	.	.	+
Arabis hirsuta	.	.	+	.	.	.	.	.	1	.
Artemisia campestris	+	2	.	2	1	1	.	+	2	.
Carex humilis	.	2	.	.	.	.	.	1	.	+
Centaurea scabiosa	.	.	.	.	1	1	.	.	.	+
Centaurea stoebe	.	1	+	1	.	.	.	.	.	.
Euphorbia cyparissias	1	1	+	1	1	+	.	.	+	2
Festuca rupicola	.	1	1	.	3	3	.	1	.	.
Helianthemum nummularium subsp. *obscurum*	.	.	.	1	.	.	.	1	.	1
Holosteum umbellatum	.	+	.	.	.	.	+	+	.	.
Phleum phleoides	.	.	.	.	1	+	.	1	3	.
Poa compressa	.	.	1	.	.	.	.	+	.	.
Sanguisorba muricata	.	.	.	.	.	.	.	.	+	.
Ch. Cl. *Trifolio-Geranietea sanguinei*										
Coronilla varia	.	.	.	.	.	.	+	.	1	.
Fragaria viridis	.	.	+	.	.	.	.	.	.	.
Galium verum	1	+	+	+	1	1	1	.	.	.
Medicago falcata	+	1	1	.	.	+	.	+	.	.
Melampyrum arvense	.	.	.	.	+	.	.	.	.	.
Peucedanum oreoselinum	.	1	.	.	.	1	.	.	.	+
Ch. Cl. *Koelerio glaucae-Corynephoretea canescentis*										
Cerastium semidecandrum	+	.	.	.	1	.	.	.	+	.
Erophila verna	+	+	.	+	.	.	.	.	.	.
Sedum acre	.	+	1	.	.	.	.	.	+	.
Silene otites	.	1	.	.	.	1	.	.	.	.
Ch.O. *Centauretalia cyani*										
Consolida regalis	.	.	.	.	.	.	.	.	.	.
Lithospermum arvense	.	.	.	.	.	.	.	.	.	.
Papaver rhoeas	.	.	.	.	.	.	.	.	.	.
Ch.Cl. *Stellarietea mediae*										
Descurainia sophia	.	.	.	.	.	.	.	.	.	.
Neslia paniculata	.	.	.	.	.	.	.	.	.	.
Viola arvensis	.	.	+	.	.	.	.	.	.	.
Ch.Cl. *Agropyretea intermedio-repentis*										
Convolvulus arvensis	.	.	.	.	.	+	+	.	.	.
Elymus hispidus subsp. *barbulatus*	2	+	.	.	.	.	.	+	.	.
Falcaria vulgaris	+	.	.	.	.	.	1	.	.	.

11	12	13	14	15	16	17	18
25.05.	23.05.	25.05.	15.05.	25.05.	26.05.	23.05.	25.05.
2009	2009	2008	2010	2008	2009	2009	2009
20	4	10	16	10	25	4	2
-	-	-	SE	-	SE	-	E
10	-	-	2	-	2	-	45
245	230	-	265	-	268	235	240
70	85	80	60	75	60	75	40
-	-	-	-	50	-	50	-
-	-	-	-	25	-	25	-
20	30	5	0	0	5	5	0
+	**+**	**1**	**1**	**1**	**2**	**1**	**2**
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.
.	.	1	.	.	+	.	.
.	+	.	.	.	.	.	.
.	.	.	.	.	.	.	.
+	+	1	+	.	.	+	.
.	.	1	1	.	2	.	.
+	+	.	.	.	.	.	.
.	2	.	.	.	.	.	.
3	.	.	.	.	.	.	.
.	1	.	.	.	.	.	.
2	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.
1	2	.	.	.	.	.	1
.	1	.	.	.	.	.	.
.	+	.	.	.	.	.	.
1	1	.	.	.	.	.	.
+	.	+	.	.	.	.	.
.	.	.	.	.	.	.	.
1	1	+	.	.	.	+	.
.	.	.	.	.	.	.	.
.	1	1	.	.	.	.	.
.	2	.	.	.	.	.	.
.	.	.	.	.	.	.	.
.	.	.	.	.	+	.	.
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	1
.	+	.	.	.	.	.	1
.	.	.	.	.	+	.	.
+	.	.	.	.	+	.	.
+	+	.	.	.	.	.	2
.	.	.	.	.	.	.	.
.	.	+	+	.	.	.	.
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.
.	+	.	.	.	.	.	.
.	.	.	.	.	.	.	2
.	+	.	.	.	.	.	.
.	.	.	+	.	+	+	.
.	.	1	+	2	.	.	.
.	.	+	.	2	1	+	.
.	.	+	.	1	+	.	.
.	.	+	+	1	.	.	.
.	.	+	+	+	1	+	.
.	.	.	2(3)	.	.	.	.
.	.	2	.	.	.	.	.
.	.	+	+	.	.	.	1

3. Results

Currently, 15 localities of *Arabis recta* are known from Poland. Two of them, were not confirmed during the studies and seven were newly encountered by the authors (Appendix). All of the new stations were located in the southern part of the Małopolska Upland (Fig. 1).

Arabis recta is usually a component of xerothermic grasslands developed on shallow limestone soils (with gypsum or chalk as the parental rock) mainly on south-facing slopes (Fig. 2). The species occurrs mainly within the patches of the *Sisymbrio-Stipetum capillatae* association representing the *Festuco-Stipion* alliance. Our relevés showed that species typical of the *Cirsio-Brachypodion pinnati* alliance made up a considerable proportion in the patches with *A. recta* (Table 1). It was because phytocoenoses of this alliance occurr fairly often in the immediate proximity of *Sisymbrio-Stipetum capillatae* association patches. While *A. recta* grows in patches with species characteristic of the *Festucetalia valesiacae* order and the *Festuco-Brometea* class, plants typical of forest-edge communities (*Trifolio-Geranietea sanguinei* class) and sandy grasslands (*Koelerio glaucae-Corynephoretea canescentis* class) were also recorded in these patches.

Arabis recta is also recorded in anthropogenic habitats. These include arable fields occurring on calcium carbonate-rich soils and former arable fallows. The species is a component of communities representing *Caucalidion lappulae* alliance in arable fields. The vegetation of fallows was usually difficult to classify and could comprise species belonging to a variety of vegetation classes penetrating the sites from adjacent areas. The following groups of species were observed in fallows together with *A. recta* (Table 1): species of xerothermic grasslands of the *Festuco-Brometea* class, field weed species mostly of the *Centauretalia cyani* order (*Stellarietea mediae* class), rhizome species of the ruderal-xerothermic *Agropyretalia intermedio-repentis* order, expansive ruderal species of the *Artemisietea vulgaris* class and common meadow species, mostly of the *Arrhenatheretalia* order. We recorded *A. recta* in fields and former arable fallows surrounded by xerothermic grasslands which provided the source of its propagules. The small density of the vegetation and high light availability are favourable for the development of *A. recta* specimens. In anthropogenic habitats, its specimens grow to reach a considerable size (up to 40-50 cm in height) and can sometimes be abundantly branched. The size of its populations in arable fields and fallows is considerably higher than in patches of xerothermic grasslands. The total of *A. recta* population recorded in fields and fallows should be estimated at about 1 million individuals.

Table 1. Cont.

No. of relevé	1	2	3	4	5	6	7	8	9	10
Date	06.06. 2006	06.06. 2006	06.06. 2006	14.06. 2006	23.05. 2009	15.05. 2010	26.05. 2009	26.05. 2009	26.05. 2009	25.05. 2009
Area of relevé [m^2]	20	15	10	15	4	4	1	2	20	4
Exposure	SSE	SSE	SE	SW	SSE	S	SSE	S	S	S
Inclination [°]	40	10	3	40	10	20	10	5	2	10
Altitude a.s.l. [m]	200	210	210	215	240	185	255	265	240	250
Cover of C layer [%]	75	60	60	60	60	65	50	40	60	40
Cover of cultivated plants [%]	-	-	-	-	-	-	-	-	-	-
Cover of weeds [%]	-	-	-	-	-	-	-	-	-	-
Cover of D layer [%]	3	15	20	5	0	10	5	5	5	20
Ch.Cl. *Artemisietea vulgaris*										
Artemisia vulgaris	.	.	.	.	.	.	.	.	.	.
Others										
Alyssum alyssoides	+	+	.	.	.	.	.	.	.	.
Abietinella abietina (D)	.	.	2	.	.	.	.	+	.	1
Arenaria serpyllifolia	+	.	.	.	+	.	.	.	+	+
Bryum sp. (D)	.	2	.	+	.	.	.	.	.	2
Camelina microcarpa subsp. *sylvestris*	+	+	.	.	+	.	+	+	.	.
Cladonia foliacea (D)	.	+	.	1	.	.	.	.	.	.
Draba nemorosa	+	.	+	.	.	.	.	.	+	.
Euphorbia esula	.	.	.	.	.	.	+	.	+	.
Sedum maximum	.	.	+	.	.	.	.	.	+	.
Syntrichia ruralis (D)	+	1	1	.	.	.	.	.	.	1
Taraxacum officinale agg.	.	.	.	.	.	+	.	.	+	.

Sporadic: Ch. O. *Festucetalia valesiacae*: *Allium montanum* 6(+), *Asperula tinctoria* 2(+), *Astragalus danicus* 3(+), 12(+), *Campanula sibirica* 4(+), *Carex praecox* 1(1), *Eryngium campestre* 1(r), *Eryssimum pannonicum* 8, *Inula ensifolia* 12(+), 13(2), *Ornithogallum collinum* 2(+), *Scabiosa ochroleuca* 10(+), *Senecio integrifolius* 9(+), *Stipa pulcherrima* 12(4); **Ch. Cl. *Festuco-Brometea*:** *Acinos arvensis* 3(+), *Avenula pratensis* 7(+), *Brachypodium pinnatum* 5(2), 9(1), *Carex caryophyllea* 12(+), *Cerastium glutinosum* 6(1), 9(+), *Dianthus carthusianorum* 2(+), 6(+), *Filipendula vulgaris* 2(+), *Linosyris vulgaris* 4(+), *Orthanta lutea* 2(+), 4(1), *Plantago media* 12(+), *Seseli annuum* 12(1), *Stachys recta* 1(+), 10(+), *Sanguisorba minor* 11(1), 18(+), *Thlaspi perfoliatum* 15(+), 16(+), *Veronica spicata* 9(+); **Ch. Cl. *Trifolio-Geranietea sanguinei*:** *Achillea millefolium* 14(+), *Anthericum ramosum* 8(+), 10(+), *Campanula rapunculoides* 13(+), *Geranium sanguineum* 8(1), *Peucedanum cervaria* 11(2), *Silene nutans* 9(1), *Thalictrum minus* 6(+), 12(+), *Verbascum lychnitis* 14(+); **Ch. Cl. *Koelerio glauce-Corynephoretea canescentis*:** *Androsace septentrionalis* 9(+), *Festuca psammophila* 4(1), *Gypsophila fastigiata* 2(+), 4(1), *Potentilla argentea* 13(+), 16(+), *Sedum sexangulare* 4(+), 10(2), *Senecio vernalis* 14(+), 16(2), *Thymus serpyllum* 3(1); **Ch. O. *Centauretalia cyani*:** *Adonis aestivalis* 13(+), *Agrostemma githago* 15(+), *Lathyrus tuberosus* 9(+), 14(1), *Papaver argemone* 13(+), 15(+), *Sherardia arvensis* 14(+), *Valerianella dentata* 17(+), *Veronica hederifolia* 14(1), *Vicia angustifolia* 14(+), *V. villosa* 13(1), 18(+); **Ch. Cl. *Stellarietea mediae*:** *Fallopia convolvulus* 13(+), *Geranium pusillum* 14(1), 15, *Lactuca serriola* 14(+), 16(1), *Lamium amplexicaule* 14(+), *Myosotis arvensis* 15(1), 16(1), *M. stricta* 13(+), 14(+), *Veronica arvensis* 15(+), *V. polita* 13(+), 14(1); **Ch. Cl. *Agropyretea intermedio-repentis*:** *Cirsium arvense* 14(+), *Elymus hispidus* subsp. *hispidus* 3(+), *E. repens* 16(+), *Poa angustifolia* 13(1); **Ch. Cl. *Artemisietea vulgaris*:** *Carduus acanthoides* 7(+), *Daucus carota* 13(1), 14(+), *Galium aparine* 14(+), 15(+), *Medicago lupulina* 6(2), 10(1), *Melandrium album* 13(+), 14(+), *Pastinaca sativa* 13(+), 14(+), *Picris hieracioides* 14(+), *Tragopogon dubius* 13(+), *Verbascum phlomoides* 16(+); **Ch. Cl. *Molinio-Arrhenatheretea*:** *Arrhenatherum elatius* 7(+), 18(+), *Cerastium holosteoides* 14(+), *Crepis biennis* 17(+), *Dactylis glomerata* 17(+), *Festuca pratensis* 17(+), 18(1), *Galium mollugo* 13(+), *G. boreale* 6(2), *Leontodon hispidus* 9(1), *Plantago lanceolata* 14(+), *Poa pratensis* 16(+), *Trifolium montanum* 3(+), 6(1), *T. repens* 17(1); **Others:** *Acer pseudoplatanus* 14(+), *Achillea* sp. 3(+), *Artemisia* sp. 4(+), *Briza media* 12(+), *Ceratodon purpureus* (D) 1(2), *Cladonia pyxidata* (D) 2(+), *Cornus sanguinea* (C) 14(+), *Crataegus* sp. (C) 11(+), *Cuscuta epithymum* 6(+), *Diplotaxis muralis* 15(+), *Echium vulgare* 2(+), 13(+), *Erigeron acris* 9(+), 13(+), *E. annuus* 1(2), 4(+), *Erodium cicutarium* 17(+), *Festuca rubra* 16(1), *F. trachyphylla* 2(+), *Frangula alnus* (C) 14(+), *Fulgensia bracteata* (D) 4(+), *Hieracium pilosella* 11(1), *H. piloselloides* 6(1), *Hypericum perforatum* 13(+), 16(2), *Nonea pulla* 13(+), *Ornithogallum umbellatum* 6(1), *Orobanche* sp. 6(+), *Peltigera rufescens* (D) 2(+), *Pimpinella saxifraga* 11(+), 13(1), Planta sp. 10(2), 11(+), 16(1), *Poa pratensis* 3(1); Poaceae indet. 14(2), 17(+), *Polygala comosa* 12(+), *P. vulgaris* 3(+), *Rosa* sp. (C) 12(+), *Salvia pratensis* 3(1), *Scabiosa* sp. 4(+), *Senecio jacobea* 9(+), *Silene vulgaris* 13(1), *Solidago virgaurea* 13(+), *Toninia sedifolia* (D) 4(+), *Tragopogon* sp. 14(+), *Verbascum phlomoides* 16(+); **Cultivated plants:** *Secale cereale* 13(2), 15(4), *Medicago sativa* 17(3)

Localities of records:

1. 'Skorocice' reserve near Busko-Zdrój, on the left of the Skorocicki stream, xerothermic grassland, 50°25'20.6''N / 20°40'26.3''E
2. 'Skorocice' reserve near Busko-Zdrój, on a small hill with gypsum rock outcrops, on the right of the Skorocicki stream, xerothermic grassland, 50°25'27.8''N / 20°40'30.0''E
3. Ca. 100 m NW of the border of the 'Skorocice' reserve, xerothermic grassland, 50°25'41.2''N / 20°40'29.6''E
4. Between the villages of Winiary and Nowa Zgość near Busko-Zdrój, near the top of the hill, xerothermic grassland, 50°25'54.6''N / 20°37'31.6''E
5. Bronina near Busko-Zdrój, on a small hill with gypsum rock outcrops, xerothermic grassland, 50°27'37.2''N / 20°44'57.3''E
6. Górki near Wiślica, xerothermic grassland, 50°20'50.9''N/20°43'45.2''E
7. Stawiany near Pińczów, xerothermic grassland, 50°35'31.3''N / 20°37'20.3''E
8. Between Sędziejowice and Chomentówek near Pińczów, xerothermic grassland, 50°34'23.0''N/20°39'42.7''E
9. Stawiany near Pińczów, xerothermic grassland, 50°35'21.3''N / 20°37'20.6''E
10. Gartatowice near Pińczów, xerothermic grassland, 50°34'49.3''N/20°37'41.6''E
11. Gartatowice near Pińczów, xerothermic grassland, 50°34'47.0''N/20°37'40.6''E
12. Bronina near Busko-Zdrój, xerothermic grassland, 50° 27'41.1''N / 20°44'36.2''E
13. Sułkowice near Busko-Zdrój, fallow, 50°25'20,5''N/20°51'15,2''E
14. Kików near Busko-Zdrój, fallow, 50°24'57,5''N/20°51'39,0''E
15. Sułkowice near Busko-Zdrój, arable field, 50°25'15,8''N/20°51'12,2''E
16. Beetween Sędziejowice and Chomentówek near Pińczów, fallow, 50°34'11.8''N/20°39'48.5''E
17. Bronina near Busko-Zdrój, arable field, 50°27'40.5''N / 20°44'55.1''E
18. Gartatowice near Pińczów, grassland, 50°34'37.3''N/20°37'30.0''E

11	12	13	14	15	16	17	18
25.05. 2009	23.05. 2009	25.05. 2008	15.05. 2010	25.05. 2008	26.05. 2009	23.05. 2009	25.05. 2009
20	4	10	16	10	25	4	2
-	-	-	SE	-	SE	-	E
10	-	-	2	-	2	-	45
245	230	-	265	-	268	235	240
70	85	80	60	75	60	75	40
-	-	-	-	50	-	50	-
-	-	-	-	25	-	25	-
20	30	5	0	0	5	5	0
.	.	1	2	.	.	+	+
.	.	.	.	.	.	.	1
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4. Discussion

Arabis recta was included in the Polish red data book as a critically endangered species (CR category) based on a very low number of its localities (Mirek & Kaźmierczakowa 2001). Only four localities were known before 2001 of which only one was confirmed. At present, 15 localities are known, and only two of them have not been confirmed. As the number of known localities of the species has increased in the last few years and the populations occurring at the sites are relatively abundant, we propose to change the threat category of *A. recta* and list it as an endangered species in Poland (EN category).

Arable fields and formerly arable fallows, where *Arabis recta* is recorded, are quite often a good alternative habitat for the species. The vegetation density in arable and fallowed fields is relatively low during *A. recta* germination period occurring in Poland in April and early May. An increase in plant density in fallowed fields in successive years can lead to a withdrawal of *A. recta*. However, it does not seem that the species has

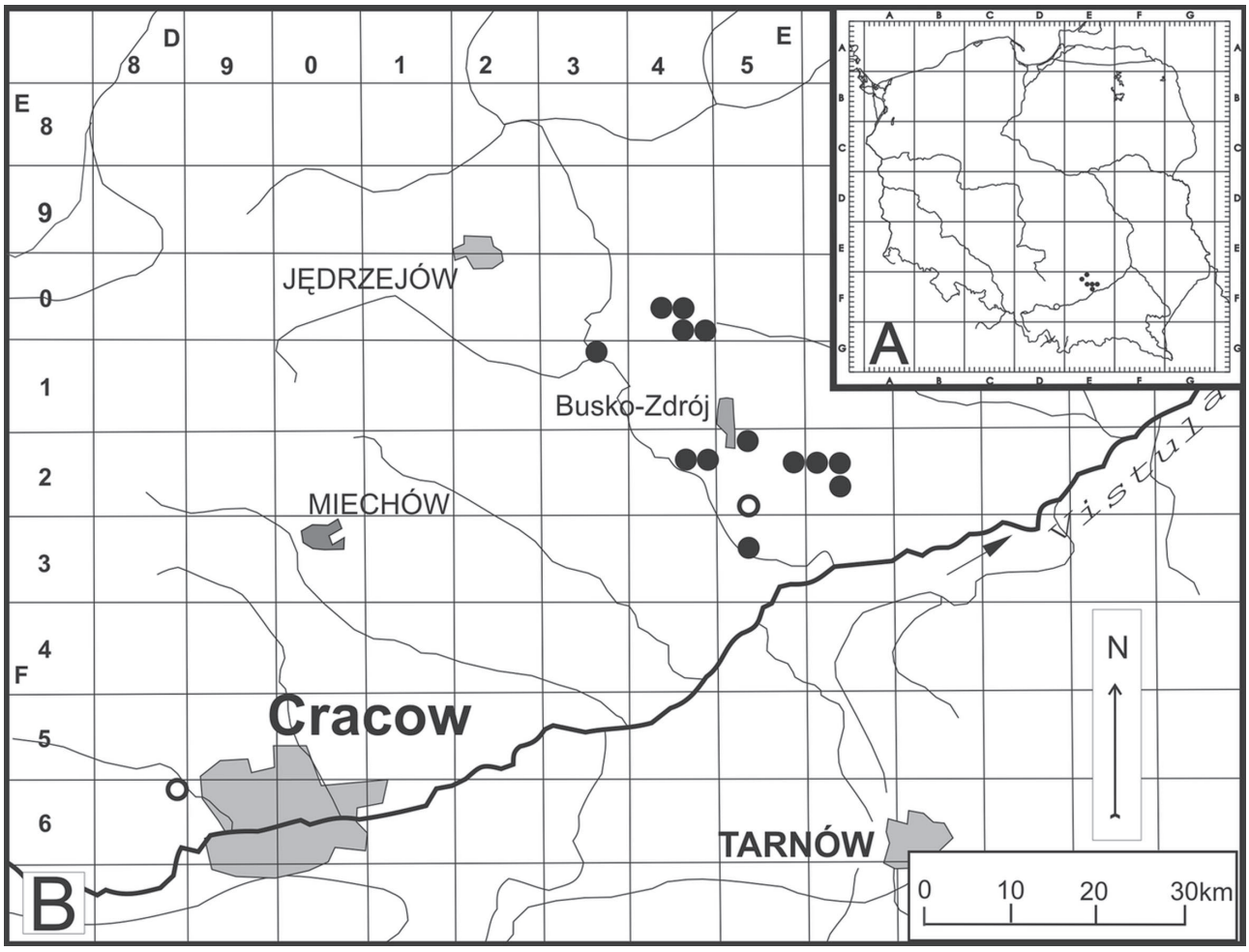

Fig. 1. Distribution maps of *Arabis recta* Vill.
Explanations A – in Poland (in the ATPOL grid of squares 10 km x 10 km), B – in the Małopolska Upland (in the ATPOL grid of squares 2.5 km x 2.5 km), ● – locality existing at present, ○ – locality not confirmed

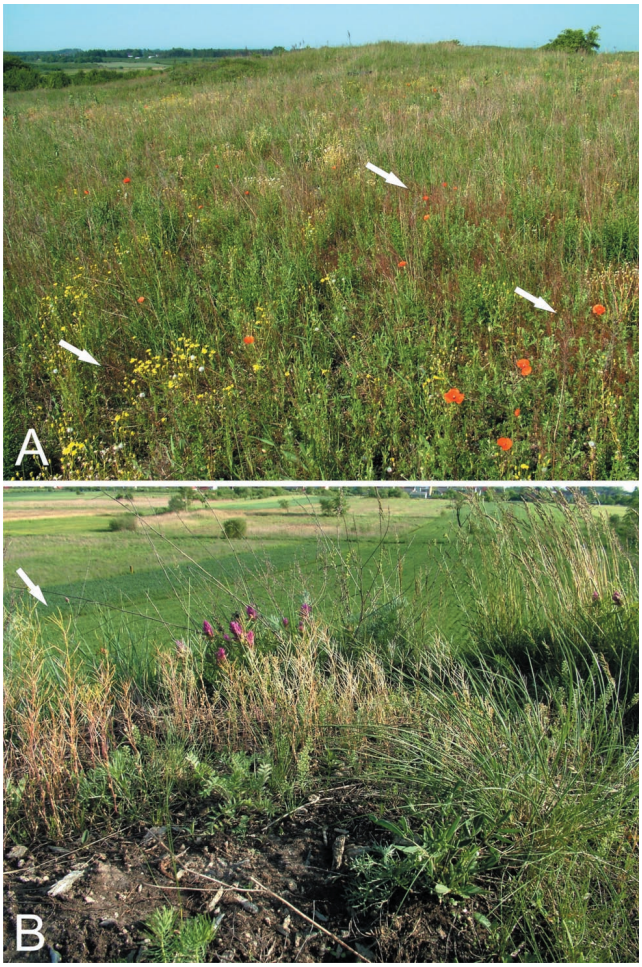

Fig. 2. Habitats of *Arabis recta* Vill.
Explanations: A – post-field fallows between Sędziejowice and Chomentówek villages (photography by M. Nobis, 26.05.2009), B – xerothermic grassland between Bronina and Owczary villages (photography by M. Nobis, 24.05.2009)

become fully extinct in the anthropogenic habitat (a former arable fallow) near Stawiany, as observed by R. Kaźmierczakowa at this site (Trzcińska-Tacik *et al*. 1998; Mirek & Kaźmierczakowa 2001). During our field studies we discovered over ten scattered populations near Stawiany both in semi-natural habitats (in gaps between xerothermic grasslands) and in anthropogenic habitats (excavation margins, former arable fallows). Herbicide use and dense crops are serious threats to *A. recta* in arable fields and the species has been recorded only in those parts of fields that are not sprayed during treatment (e.g. near poles, field margins).

It is worth mentioning that occurrence of *Arabis recta* in fallows and arable fields in Poland was noted very recently. It seems to be very important and useful for the preparation of proper conservation strategies for the species. In our opinion, it is necessary to think of effective protection methods. One of possible solutions could be introducing a special, additional payment system for farmers maintaining traditional forms of cultivation in this region. Additionally, growing *A. recta* together with other rare and threatened species of weeds, eg. *Scandix pecten-veneris*, *Conringia orientalis*, *Lygia passerina*, *Veronica praecox*, *Bupleurum rotundifolium*, *Caucalis platycarpos*, etc. in heritage parks or botanical gardens should be considered (Nobis *et al*. 2007b).

The finding of numerous populations of *Arabis recta* in the Nida Basin is caused not only by the presence of adequate habitat conditions but also by exceptionally favourable weather conditions, mostly high spring precipitation in 2007-2010. Approximately, 100 specimens of *A. recta* were observed in Skorocice in 2006 (Nobis *et al*. 2007a) and the population abundance at this site was estimated at a few thousand specimens in 2008.

Long-term observations are necessary to determine accurately the number of specimens of *Arabis recta* occurring at a particular site as the population size of this therophyte varies in individual years. However, the total resources of *A. recta* in Poland may reach even over one million specimens in years with the most favourable weather conditions.

It is likely that further sites of *Arabis recta* will be discovered because potential habitats of the species are numerous in the Nida Basin. The small number of records of *A. recta* to date is most probably caused by its very short life cycle lasting approximately six weeks from germination to seed spillage. Because of the plant small size, *A. recta* can be also easily overlooked by the botanists.

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Appendix. List of new localities of *Arabis recta* in Poland

1. Between Sułkowice, Konary, Zagaje Kikowskie and Kików villages (near Busko Zdrój) (ATPOL grid squares – EF2513, EF2610, EF2611, EF2612, EF2622). The population consisted of about l million individuals, divided into about ten subpopulations, e.g.: ca. 400-900 m E of Sułkowice village – loose xerothermic grassland on a hill (S-facing) (50°25'12.4''N/20°51'19.8''E, alt. 295 m); xerothermic grassland margins, arable field margins, margins of a disused quarry (50°25'19.2''N/20°51'14.1''E, alt. 293 m); arable fields (in crops), (50°25'15.8''N/20°51'12.2''E, alt. 288 m); fallows and arable field margins (50°25'20.5''N/20°51'15.2''E, alt. 288 m; 50°24'57.5''N/20°51'39.0''E, alt. 265 m); fallows, along a field road near a disused quarry (50°25'11.9''N/20°51'44.3''E, alt. 287 m).

2. Górki settlement near Wiślica village (ATPOL grid square – EF3511) – xerothermic grasslands on gypsum hills near fish ponds (50°20'52.4''N/20°43'50.6''E and 50°20'50.9''N/20°43'45.2''E, alt. 180 m). The population consisted of over 500 specimens. *Arabis recta* grows together with *Stipa pennata*, *Veronica praecox*, *Senecio integrifolius*, *Scorzonera purpurea*, *Stipa capillata*, *Draba nemorosa*, *Erophila verna*, *Festuca rupicola*, *Potentilla alba*, *Sesleria uliginosa*, *Polygala comosa* and *Astragalus danicus*.

3. Between Bronina and Owczary villages (near Busko Zdrój) (ATPOL grid square – EF1501). The population consisted of over 500 specimens divided into several subpopulations, e.g.: xerothermic grassland on the eastern edge of a gypsum hill (SE-facing) (50°27'37.2''N/20°44' 57.3''E, alt. 240 m); arable field (*Medicago sativa* culture) by a hill covered by a xerothermic grassland (50°27'40.5''N/20°44'55.1''E, alt. 235 m); xerothermic grassland on the western side of a gypsum hill (50°27' 41.1''N/20° 44' 36.2''E, alt. 245 m).

4. Between Sędziejowice and Chomentówek villages (near Pińczów) (ATPOL grid square – EF0433). The population consisted of several thousand specimens, divided into several subpopulations, e.g.: fallow close to xerothermic grasslands developed on calcareous rocks (50°34'11.8''N/20°39'48.5''E, alt. 270 m); loose xerothermic grassland on a hill (50°34'23.0''N/20°39'42.7''E, alt. 270 m); loose xerothermic grassland on a hill near an orchard (50°34'11.1''N/20°39'44.6''E, alt. 260 m).

5. Gartatowice village (near Pińczów) (ATPOL grid squares – EF0422, EF0423). The population consisted of several thousand specimens, divided into several subpopulations, e.g.: xerothermic grassland developed by the southern part of a disused quarry (near arable fields), (50°34'49.3''N/20°37'41.6''E, alt. 250 m); xerothermic grassland developed on a gypsum hill top (between arable fields) (50°34'47.0''N/20°37'40.6''E, alt. 245 m); xerothermic grassland developed on the slope of the southern part of a disused quarry (50°34'38.3''N/20°37'30.6''E, alt. 245 m); xerothermic grassland developed on the slope of the eastern part of a disused quarry (50°34'37.3''N/20°37'30.0''E, alt. 270 m).
6. ‚Skowronno' nature reserve (Skowronno Dolne village near Pińczów) (ATPOL grid square – EF1302). The population consisted of over 500 specimens, divided into two subpopulations: xerothermic grassland by the eastern border of the reserve (50°32'51.7''N/20°29'16.4''E, alt. 230 m); xerothermic grassland developed on a calcareous rock by an excavation in the reserve (50°32'57.7''N/20°29'10.7''E, alt. 236 m).
7. Between Stawiany and Samostrzałów villages (ATPOL grid squares – EF0421, EF0422). The population consisted of over 10 000 specimens, divided into over ten subpopulations, e.g.: xerothermic grasslands on hills (50°35'25.2''N/20°37'20.3''E, 50°35'31.3''N/20°37'20.3''E, alt. 253 m); xerothermic grassland (SSE-facing) (50°35'25.2''N/20°37'20.3''E, alt. 250 m); loose xerothermic grassland developed on a former arable field (50°35'21.3''N/20°37'20.6''E, alt. 235 m); xerothermic grassland near an excavation (50°35'46.0''N/20°37'32.1''E, alt. 257 m). *Arabis recta* grows there together with other plant species rare in Poland, e.g.: *Androsace septentrionalis*, *Reseda phyteuma*, *Senecio integrifolius*, *Stipa pennata*.