

Taxonomy and distribution of *Allium ursinum* (Liliaceae) in Poland and adjacent countries

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Abstract: The paper presents distribution data on *Allium ursinum* L. in Poland, with additional records from the other European countries. The study comprised 367 herbarium specimens, drawn from most of Polish herbaria and individuals obtained during field investigations. Two subspecies have been recorded: *A. ursinum* L. subsp. *ursinum* and *A. ursinum* subsp. *ucrainicum* Kleop. et Oxner. The study also documents the presence of intermediate populations at the border of the distribution ranges for both subspecies. In addition, the paper presents the pedicel structure and pollen grains ultrasculpture of each subspecies under a scanning electron microscope (SEM). Finally, questions in respect of the distribution data and habitat preferences are discussed.

Key words: *Allium ursinum*; distribution; pollen morphology; SEM; taxonomy

Introduction

Allium ursinum L. belongs to monotypic *A.* sect. *Arc-toprasum* Kirschl. within subgenus *Amerallium* Traub. (Friesen et al. 2006). *Allium ursinum* comprises two subspecies, which are distinguished on the basis of pedicel morphology (Bordzilovskij 1950). *Allium ursinum* L. subsp. *ursinum* has scabrous pedicels with numerous papillae and occurs in the western part of the species distribution area (Stearn 1978, 1980). *Allium ursinum* subsp. *ucrainicum* Kleop. et Oxner, however, is characterized by smooth pedicels and occurs in the eastern part (Bordzilovskij 1950; Stearn 1978). Moreover, various intermediate populations frequently occur at the border between the distribution ranges for both taxa (Zahariadi 1966; Soják 1968). Nevertheless, the general division of geographical range for both subspecies is evident.

The distribution centre of *A. ursinum* subsp. *ursinum* is located in Western Europe. The subspecies occurs from Portugal, Spain, France, Switzerland, Belgium, Netherlands, Great Britain and Germany, running through Italy, Austria and the Czech Republic and up to Lithuania and the Scandinavian countries (Bordzilovskij 1950; Tutin 1957; Soják 1968; Karpavičienė 2005, 2006; Aguiar & Aedo 2006; Krahulec & Duchoslav 2010; Aedo 2011). *Allium ursinum* subsp. *ucrainicum* has been described from Dnieper Upland in the central part of Ukraine (Bordzilovskij 1950); however, it is widely distributed in Eastern and South Eastern Europe. Its distribution range includes Austria, the Czech Republic, Poland, Slovakia, Hungary, the countries of the former Yugoslavia, namely Slovenia,

Croatia, Bosnia and Herzegovina, Serbia, Montenegro, Macedonia and Kosovo, as well as Bulgaria, Romania, Ukraine, Belarus and the European part of Russia (Bordzilovskij 1950; Soják 1968; Zahariadi 1966; Krahulec & Duchoslav 2010). It has also been reported from the Caucasus and Anatolia (Bordzilovskij 1950; Soják 1968), Moldavia (Chifu et al. 2006) and Italy (Soják 1968; Stearn 1978; Conti et al. 2005). It is important to note that *A. ursinum* subsp. *ucrainicum* is also cultivated as a garden or medicinal plant, being treated as a spice or food additive, as well as being planted in parks and cemeteries. This fact perhaps explains its rather surprising occurrence in some localities in Western Europe (see Hanelt 2001; Seidemann 2005).

No distributional and morphological studies on *A. ursinum* have been carried out in Poland to date. Owing to the fact that the distribution of the subspecies was previously recognized in the former Czechoslovakia by Soják (1968), and given his results, it might well be assumed that the border of the distribution ranges for both taxa also passes through Poland. Thus, I decided to investigate the situation in that country. Moreover, further investigation into the distribution in adjacent European countries for the two subspecies is undertaken on the basis of available material.

The main purpose of this study is therefore to delimit the distribution range of the species in Poland on the basis of herbarium specimens with additional records from other countries. It also addresses the attempt to examine micromorphological structure of pedicels and ultrasculpture of pollen grains for both subspecies, something which has not been documented to date. Finally, questions in respect of the distribution

data and habitat preferences are discussed.

Material and methods

The analysis comprised 367 herbarium specimens from the following Polish herbaria: BIL, KRA, KRAM, LBL, LOD, OLS, POZ, SZUB, UGDA, WA. In addition, field investigations were carried out in 2009 and 2010. The list of specimens examined is presented in the appendix. The study was carried out in order to determine the distribution range of *A. ursinum* subsp. *ursinum* and *A. ursinum* subsp. *ucrainicum* in Poland and adjacent countries as well as to analyse the course of the boundary line and the situation on the border of the distribution ranges for both taxa. After the herbarium examination, one locality, namely the Parkowe nature reserve (50°41'36.82" N; 19°24'58.35" E), on the border of distribution ranges for both taxa was selected for further morphological investigation of the pedicels of intermediate forms in this population. The herbarium material was deposited in the herbarium of the Institute of Botany, Jagiellonian University (KRA) in Kraków.

As regards the further analyses, the morphological features of *A. ursinum* were first observed in a stereoscopic microscope (the Olympus SZX9). The micromorphology of pedicels and pollen grains were studied using scanning electron microscopy (SEM) (the HITACHI S-4700 and NORAN Vantage) at an acceleration voltage of 10–20 kV. The use of SEM facilitated investigation of the details of the exine sculpture of the pollen grains, as well as pedicel ultrastructure after sputter-coating with a thin layer of gold-palladium. The observations were made on the basis of 22 herbarium specimens selected from different parts of the species distribution range. The analysis was carried out in order to explore the structure of the pedicel morphology, the most essential characteristic for diagnosis, and to verify whether characteristics of pollen morphology have taxonomic value. The observations were performed in the Scanning Microscopy and Microanalysis Laboratory at the Institute of Geological Sciences, Jagiellonian University in Kraków. The terminology describing the pollen morphology follows Moore et al. (1991), Kosenko (1999) and Hesse et al. (2009).

Results and discussion

Distribution in Poland and adjacent countries

The distribution of *A. ursinum* has been already recognized in Poland (Zajac & Zajac 2001); however, the distribution ranges of each subspecies have not been studied to date. Two subspecies were recorded during the course of this study, namely *A. ursinum* subsp. *ursinum* and *A. ursinum* subsp. *ucrainicum*. The list of specimens examined is presented in the appendix. The occurrence of *A. ursinum* subsp. *ucrainicum* in Poland was previously supposed (Soják 1968; Stearn 1978), but without providing any respective localities. This study has confirmed its occurrence in the country along with the determination of this subspecies range. In addition, a contact boundary line for the two subspecies' ranges in Poland has been outlined (Fig. 1). According to the results of the study, *A. ursinum* subsp. *ucrainicum* occurs mainly in the Carpathians and Carpathian Foothills, although single localities of this subspecies are also recorded in South Eastern Poland.

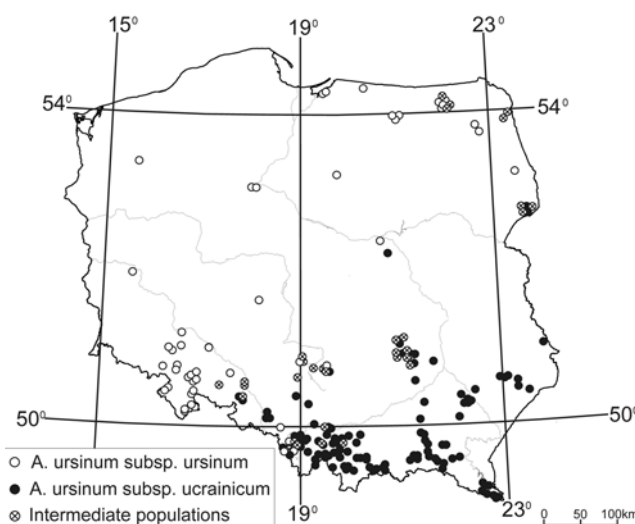


Fig. 1. Distribution of *Allium ursinum* in Poland.

The NE limit of this subspecies connects the Wyżyna Śląska upland with the Polesie Wołyńskie region and the Nizina Północnopodlaska lowland (Białowieża Forest) via the Wyżyna Krakowsko-Częstochowska upland, the Wyżyna Kielecka upland, the Wyżyna Lubelska upland and Roztocze (Fig. 1). It should be emphasized that most of the localities are concentrated in deciduous woodlands in the Carpathians and Carpathian Foothills, where *A. ursinum* subsp. *ucrainicum* frequently creates compact clusters, usually covering several hectares. It is most abundant at altitudes from 300 to 700 m above sea level, but reaches an altitude of 1100–1150 m in the Babia Góra Mountains, the Gorce Mountains, the Pasma Radziejowej Mountains and the Bieszczady Zachodnie Mountains. In the north-western part of *A. ursinum* subsp. *ucrainicum* distribution range, the subspecies is rather rare and its localities are mainly connected with large and mostly ancient forest complexes, such as, for instance, Białowieża Forest and Puszcza Świętokrzyska Forest. The localities of *A. ursinum* subsp. *ursinum* are concentrated in the southwestern and northern parts of the country; however, it occurs most frequently in the Sudety Mountains and the Lower Silesian region (Fig. 1). Taking into account the distribution of both subspecies in the southern part of the country, this situation is consistent with the data from the Czech Republic and Slovakia presented by Soják (1968).

It should be added that intermediate forms occur at the border of the distribution ranges for both subspecies in Poland. This study has documented the presence of several populations represented by numerous specimens with intermediate morphotypes, for example those in the Parkowe nature reserve, the Góry Świętokrzyskie Mountains or the Białowieża Forest (Fig. 1). On the basis of the morphological observation of numerous individuals in the population in the Parkowe nature reserve, it can be concluded that, within a single locality, both intermediate individuals and sometimes representing one of the subspecies

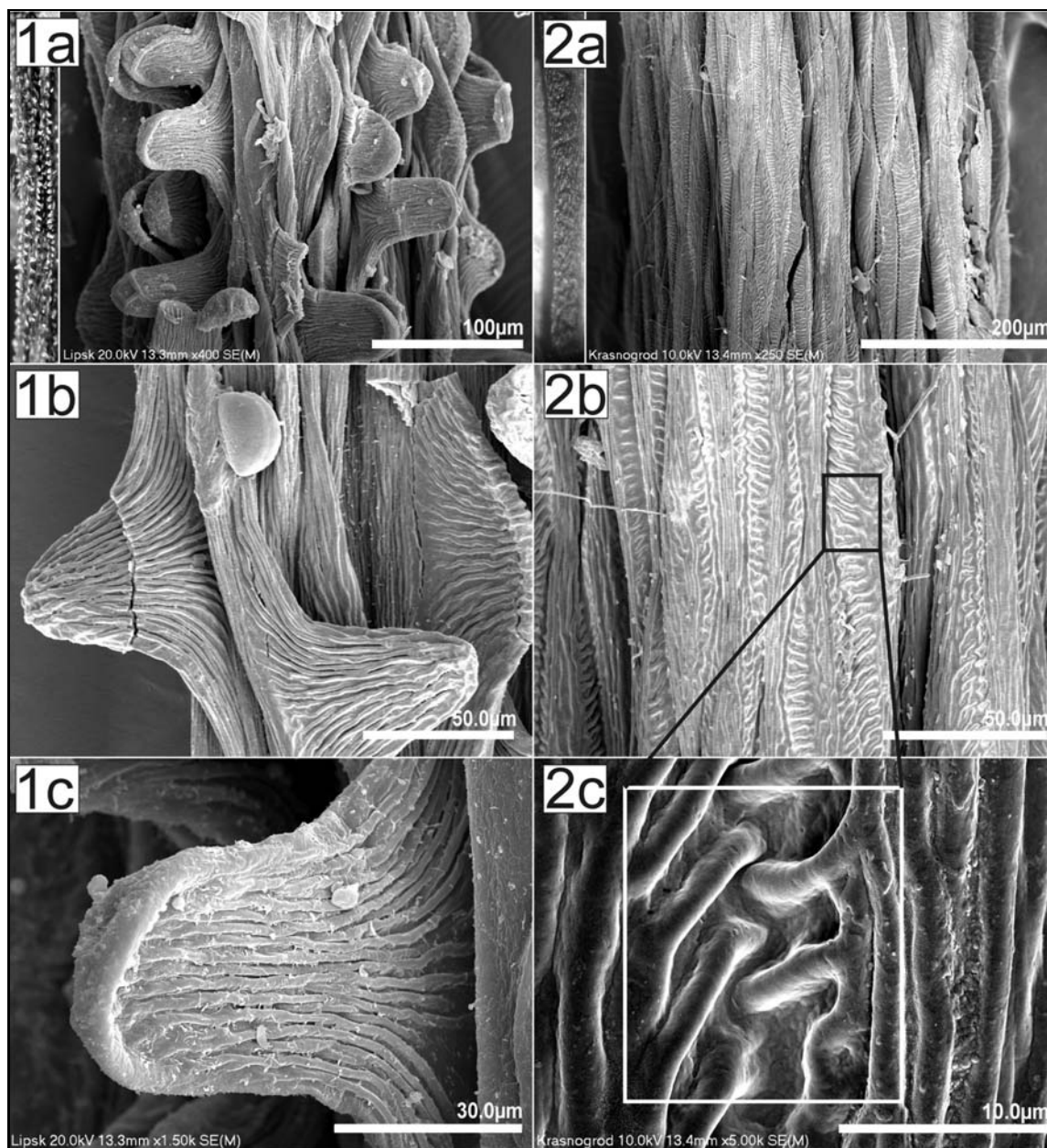


Fig. 2. SEM and stereoscopic microphotographs of pedicel micromorphology: 1 – *Allium ursinum* subsp. *ursinum*. 1a,c – Saxony, Rosenthal in Leipzig, 18.05.1872, R. Albrecht (POZ). 1b – Wysoczyzna Elbląska plateau, Kadyny village, riparian forest, 25.05.1972, Piotrowska (UGDA). 2 – *A. ursinum* subsp. *ucrainicum*. 2a – Bieszczady Zachodnie Mts, Wołosate village, 18.06.1956, H. Piotrowska (POZ). 2b,c – Roztocze, Szumy village near Krasnobród, beech-fir forest, 24.05.1974, D. Fijałkowski (LBL).

were recorded. The intermediate populations, of presumably hybrid origin, can be characterized by the variable occurrence of papillae within the same pedicel, the whole single inflorescence or even between inflorescences within one individual. However, resolving the taxonomic status of these forms is not the intention of this work and should be subjected to further molecular studies.

During the study, available specimens from 13 other European countries were also examined. The results obtained from herbarium examination are consistent with the data reported by Soják (1968) and Stearn (1978), with the exception of the occurrence of *A. ursinum* subsp. *ursinum*, rather than *A. ursinum* subsp. *ucrainicum*, in Lithuania, something which has

also been ascertained previously by Karpavičienė (2005, 2006). In addition, the existence of intermediate forms in Latvia can be confirmed. The list of specimens examined is presented in the appendix.

Pedicel morphology and pollen ultrasculpture of both subspecies

The review of the herbarium collections and the field investigations in Poland clearly distinguished two morphologically distinct taxa: *A. ursinum* subsp. *ursinum* and *A. ursinum* subsp. *ucrainicum*. The main feature differentiating the subspecies is the occurrence of characteristic epidermal structures, known as papillae, on the pedicels in *A. ursinum* subsp. *ursinum*, while *A. ursinum* subsp. *ucrainicum* has smooth pedicels with-

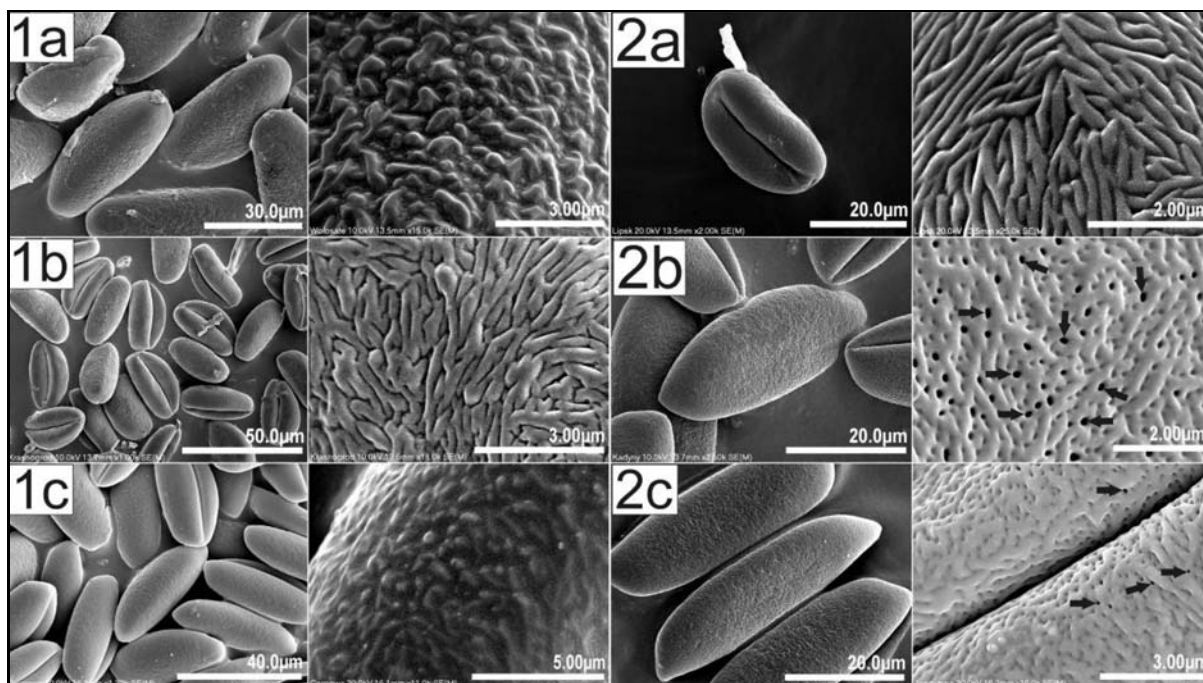


Fig. 3. SEM microphotographs of pollen grains showing the variability of exine ornamentation: 1 – *Allium ursinum* subsp. *ucrainicum*. 1a – granulate-rugulate ornamentation: Bieszczady Zachodnie Mts, Wołosate vill., 18.06.1956, H. Piotrowska (POZ). 1b – rugulate-striate ornamentation: Roztocze, Szumy vill. near Krasnobród, beech-fir forest, 24.05.1974, D. Fijałkowski (LBL). 1c – granulate-rugulate ornamentation: Beskid Niski Mts, Cergowa Góra Mt., 16.06.1955, K. Zarzycki (KRAM 042551). 2 – *A. ursinum* subsp. *ursinum*. 2a – rugulate-striate ornamentation: Saxony, Rosenthal in Leipzig, 18.05.1872, R. Albrecht (POZ). 2b – perforate-rugulate ornamentation: Wysoczyzna Elbląska plateau, Kadyny vill., riparian forest, 25.05.1972, Piotrowska (UGDA). 2c – perforate-rugulate ornamentation: Przedgórze Sudeckie Foothills, Jaworzyna Śląska, riparian forest, 07.05.2008, W. Bartoszek, K. Piątek, M. Wayda (KRA 0348223). Prominent perforations are pointed out with arrows.

out papillae (Fig. 2). Furthermore, because of the occurrence of numerous papillae in the first subspecies, the pedicel surface has a different sculpture (Fig. 2).

The use of scanning electron microscope also facilitated investigation of the details of the pollen exine sculpture. The ultrasculpture of *A. ursinum* pollen grains were previously investigated (Pastor 1981), but never in relation to both taxa. The SEM observations showed the pollen grains of *A. ursinum* to be monad, medium-size, and monosulcate with bilateral symmetry. The ultrasculpture of the exine revealed great variability within each subspecies. This was rather surprising, particularly in view of the fact that the palynological characters of *Allium* genus members were previously evaluated for delimitation of the species (Namin et al. 2009), with the emphasis on taxonomic implications. During the study, three types of exine sculpture were observed. In case of *A. ursinum* subsp. *ucrainicum* two types were recorded, namely granulate-rugulate and rugulate-striate; whereas *A. ursinum* subsp. *ursinum* in addition to abovementioned sculptures has also perforate-rugulate ornamentation (Fig. 3). The first type is granulate-rugulate ornamentation, where irregularly arranged, elongated exine elements (rugulae) are accompanied by minor structures smaller than 1 µm (granulum) (Fig. 3: 1a,c). In some cases, perforate-rugulate ornamentation was recorded (Fig. 3: 2b, c). This differs from the first in having prominent perforations. Clearly visible perforations occurred frequently only in the case of *A. ursinum* subsp. *ursinum*; how-

ever, their occurrence cannot be considered as a diagnostic feature, because the presence of perforations has not proved to be a constant feature in this subspecies. The diameter of these microperforations ranges from 0.12 to 0.17 µm. Moreover, the density of the perforations varied between samples. The third and final type of ornamentation observed is rugulate-striate and can be characterized by the presence of elongated exine elements separated by grooves and rugulae arranged predominantly in parallel (Fig 3: 1b, 2a). In addition, the pattern of exine ornamentation, as well as the occurrence and density of perforations, were constant in relation to all the pollen grains taken from one specimen in one sample. The question of the differentiation of these features among individuals from one population promises to be an interesting one and will be subjected to further studies.

Habitats

In Poland, *Allium ursinum* primarily inhabits damp but well-drained and shady deciduous forest, usually with a high humus content. On the basis of the research, it seems that there are no differences in habitat preferences between the two subspecies. Different kinds of beechwoods belonging to *Fagion sylvaticae* and mainly located in the mountains, though also in the lowlands, appear to be the optimal habitat (38% of specimens examined); however, *A. ursinum* was also recorded in forests belonging to the *Carpinion betuli* alliance (28%). The other habitats for *A. ursinum* are various kinds

of riparian forests belonging to the *Alno-Ulminon* alliance, *Salicetea purpureae* or *Alnetea glutinosae* associations (20%). Recordings in parks, abandoned gardens and cemeteries were also relatively frequent (9%). In the northern part of the country, the species is rather rare and its localities are mainly connected with large and mostly ancient forest complexes, such as, for instance, Białowieża Forest, Puszcza Świętokrzyska Forest or Puszcza Borecka Forest. This distribution is consistent with the argumentation of Hermý (1992) and Dzwonko & Loster (2001) which assumes that the species belongs to the category of ancient forest species that are unable, or almost unable, to establish in secondary forests. The similar situation was found in Lithuania (Karpavičienė 2006). Most of the *A. ursinum* habitats in Poland are located in protected areas such as nature reserves and national parks, which should be considered as a positive aspect. However, human influence is also noticeable even in areas such as these.

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Appendix

List of herbarium specimens studied

Allium ursinum subsp. *ucrainicum*

Poland: **Beskid Makowski Mts:** Budzów vill., 26.05.2006, D. Kempa (KRA 0348204); Uklejna hill near Myślenice, 05.05.1968, J. Warzycki (KRA 091873); Zębłowa Mt., 05.06.1966, H. Błaszczuk (KRA 83476); Mędralowa Mt., 07.07.1937, M. Łańcucha (KRAM 021340); **Beskid**

Mały Mts: Kozy Małe vill., 21.06.1980, B. Kotońska (KRA 0326518, 0326594); Leskowiec Mt., 29.06.1985, B. Kotońska (KRA 0326593); Wielka Góra Mt., 28.06.1985, B. Kotońska (KRA 0326519, 0326520); Jaworze, 31.05.2002, K. Jędrzejko, E. Walusiak (KRAM 511044); Sułkowice vill. near Andrychów, 10.05.2001, K. Jędrzejko (KRAM 509251); Wadowice, 22.06.2003, K. Jędrzejko, E. Walusiak (KRAM 516393); **Beskid Niski Mts:** Dukla, along Jasiołka river, 21.05.1923, K. Piech (KRAM 254096, 253375); Cergowa

Góra Mt., 14.06.1955, T. Tacik (KRAM 391271); Cergowa Góra Mt., 16.06.1955, K. Zarzycki (KRAM 042551); Cergowa Góra Mt., 16.06.1955, E. Paucel (KRAM 243331); Cergowa vill., 21.05.1923, K. Piech (KRAM 254097); Dukla vill., 05.1967, B. Tarnowska (KRAM 267325); Krempna vill., 07.05.2007, M. Kozak (KRA 0364311, 0364188); Krosno along Wisłok river, 24.05.1974, E. Lorenc (LOD 154882); Osiek Jasielski vill., 12.05.1990, K. Oklejewicz (KRA 0135175); Ostra vill., 27.05.1967, E. Barodziej, A. Frey, K. Luchter (KRA 062168); Posada Jaćmierska vill., 18.05.1989, K. Oklejewicz (KRA 0135177); Ropica Dolna vill. (UGDA); Roztoki vill. near Jasło, 23.04.1990, K. Oklejewicz (KRA 0135178); Siary vill. near Gorlice, 19.05.1990, K. Oklejewicz (KRA 0135173); Świerchowa vill., 17.04.1990, K. Oklejewicz (KRA 0135176); **Beskid Sądecki Mts:** Przysietnica stream, 18.05.1918, B. Pawłowski (KRA 0120551, KRAM 079912); Pasma Radziejowej range (KRAM 079942); Rytro vill., 06.1913, K. Miczyński (KRAM 042552); **Beskid Śląski Mts:** Bielsko Biała – Lipnik, 01.05.2004, K. Jędrzejko, E. Walusiak (KRAM 504837); Szyndzielnia Mt., 23.07.1965, K. Szczerbińska (KRAM 021336, 021338); **Beskid Wyspowy Mts:** Chyszówki vill., 18.07.1966, K. Towpasz (KRA 0124010, 0124014); Mogielica Mt., 04.06.1967, K. Towpasz (KRA 0124013, 0124012, 0124011, 82186); Mogielica Mt., 19.04.1956, Pogan (KRA 0240091); **Beskid Żywiecki Mts:** Babia Góra Mt. near Czarna Hala, 30.05.1925, B. Pawłowski (KRA 0120550); Babia Góra Mt., 05.06.1929, J. Walas (KRA 0126511); Babia Góra Mt. (WA 0000017732); Babia Góra Mt., 07.1927, E. Śliwińska (WA 0000017753); Babia Góra Mt., 14.06.1913, K. Piech (KRAM 079963, 079964); Babia Góra Mt., 30.05.1925, J. Trela (KRAM 079945); Babia Góra Mt., A. Rehmann (KRAM 079919); Babia Góra Mt., Czarna Hala, 15.07.1876, H. Zapałowicz (KRAM 079967); Babia Góra Mt., Majus (WA 0000017735); Babia Góra Mt., Markowe Szczawiny, 01.07.1935, F. Krawiec (POZ); Lipowska Mt., 20.06.1971, K. Bialecka (KRA 0109397); Naróże Mt., 15.05.1954, H. Baran (KRA 0205750); Sopotnia Wielka vill., K. Bialecka (KRA 0109398); Pasma Policy range, Psia Dolina valley, 22.07.1957, B. L. Stuchlikowa (KRAM 059218); Bielanka vill., 04.07.1962, M. Guzikowa (KRAM 082692, 082693, 082694); **Bieszczady Zachodnie Mts:** Besko vill., 21.04.1989, W. Deptuch (KRAM 395587); E from Wołosate vill., 18.06.1956, H. Piotrowska (POZ); Rozsypaniec Mt., 08.06.1990, L. Nowak, A. Jasiewicz (KRAM 407223); Rozsypaniec Mt., 27.06.1974, M. Kotańska (KRA 76291); S from Ustrzyki Górne vill., 18.05.1955 (POZ); Tarnica Mt., 06.06.1959, A. Korczyk (OLS 7638, 7637); Zatwarnica vill., 06.06.2005, M. Radoszek, J. Żelazny (KRA 0274752, 0274751, 0274750, 0274749); Zwir stream near Bereżki vill., 07.1891, Wołoszczak (KRAM 079927); 07.06.1960, H. Piękoś (KRAM 205600); **Gorce Mts:** Mostownica Mt., 15.06.1965, S. Lisowski, K. Tobolski (POZ); Obidowiec Mt., 01.06.1952, T. Tacik (KRAM 391268); Rezerwat Orkana nature reserve, 19.06.1951, Szczepanek (KRA 0111391); Rezerwat Orkana nature reserve, 20.06.1951, A. Jasiewicz (KRAM 411252); 15.06.1951, B. Gumińska (KRA 0258639); **Kotlina Orawsko-Nowotarska valley:** Nowy Targ, 18.05.1913 (KRA 0205773); **Kotlina Oświęcimska valley:** Ryczów vill., 12.04.1999, B. Banaś (KRA 0243378); Zator, 1954 W. Miś (KRAM 065304); Rezerwat Żaki nature reserve, 28.05.1985, K. Jędrzejko, H. Klama, J. Żarnowiec (KRA 0130303); **Kotlina Rabczańska valley:** Żeleznica vill., 24.05.1963, R. Rajchel (KRA 0115737); **Kotlina Sandomierska valley:** Dolina Dolnego Sanu valley, Ryczki

vill., 01.05.2004, A. Michalewska (KRA 0329286, 0329287, 0329288); Brzózka Królewska vill., 11.05.1960, J. Bystrek (LBL); Wólka Niedźwiedzka vill. near Leżajsk, 22.05.1922 K. Miczyński (KRAM 042553); Wólka Niedźwiedzka vill. near Leżajsk, 22.05.1922, M. Nowiński (KRAM 079362); Płaskowyż Kolbuszowski plateau, Brzózka Królewska vill., 12.06.1975, S. Loster, E.U. Zając (KRA 0111740); Płaskowyż Kolbuszowski plateau, Buczyna nature reserve, 17.06.1975, R. Ochrya (KRAM 226077); Płaskowyż Kolbuszowski plateau, Rezerwat Buczyna w Cyrance nature reserve, 17.06.1975, J. Kornaś (KRA 0110387); Równina Tarnobrzewska plain, Kamień vill., 02.05.2006, A. & M. Nobis (KRA 0351611); **Kotlina Żywiecka valley:** Grojec Mt. near Żywiec, 04.05.1985, Kazimierz Nowak (KRAM 529781); **Nizina Północnomazowiecka lowland:** Pisza-Gągolina vill. near Żyrardów, 23.05.1992, B. Sudnik-Wójcikowska (WA 0000017766); **Nizina Północnopodlaska lowland:** Białowieża National Park, 05.1954, L. Fagasiewicz (LOD 57804); Białowieża National Park, 17.05.1970, J. Stasiak (UGDA); Białowieża National Park, 30.05.1930, J. Sieleżyński (WA 0000017752); Białowieża vill., 01.06.1959, H. Piotrowska (UGDA); **Nizina Śląska lowland:** Kuźnia Raciborska vill., 14.05.1973, A. Sendek (KRA 0137231); Łęczczok nature reserve near Racibórz, 09.05.1959, A. Sendek (KRA 0137230); Łęczczok nature reserve near Racibórz, 30.05.1962 A. Sendek (KRAM 375164); **Obniżenie Gorlickie Depression:** Biecz vill., 07.05.1990, K. Oklejewicz (KRA 0135174); **Pieniny Mts:** Księżna Młaka, 1880 (KRAM 079070); Ociemny stream, 20.05.1967, K. Zarzycki (KRAM 379529, 379565); **Pogórze Ciężkowickie Foothills:** Góra Zamczysko Mt., 2004, K. Piątek (KRA 0339266); **Pogórze Dynowskie Foothills:** 22.04.1972, J. Bober (KRA 71360); Czarnorzeki vill., 31.07.1971, J. Bober (KRA 71359); Podlesice vill., 29.05.1969, J. Przybyło (KRA 0252014); **Pogórze Jasielskie Foothills:** Liwocz vill., K. Wiśniewicz (KRA); **Pogórze Strzyżowskie Foothills:** Kluczowa vill. along Wiślaka river, 04.05.1978, K. Towpasz (KRA 0325144); Przeczyca vill., 15.05.1972, K. Towpasz (KRA 0325993, 0326069, 0325994); **Pogórze Śląskie Foothills:** Cisownica vill., 22.05.1961, S. Pele (KRA 0246666); Kozy vill., 10.05.2002, K. Jędrzejko, E. Walusiak (KRAM 504584); Kozy vill., 10.05.2002, K. Jędrzejko, E. Walusiak (KRAM 522749); Landek vill., 04.05.1985, M. Zając (KRA 0293826); Rudzica vill., 10.05.1985, M. Zając (KRA 0294375); **Pogórze Wielkie Foothills:** Dobczyce, 22.05.1979, B. Romańczyk (KRA 0122960); Kalwaria Zebrzydowska – Bugaj, 05.06.2000, K. Jędrzejko (KRAM 517789); Kalwaria Zebrzydowska, 13.05.2004, K. Jędrzejko, E. Walusiak (KRAM 522251); Lanckorona, 02.05.2001, K. Jędrzejko (KRAM 519500); Lanckorona, 29.04.2002, K. Jędrzejko, E. Walusiak (KRAM 505720); Lipnik vill., 14.05.2004, K. Stawowczyk (KRA 0338170); near Lanckorona, 21.05.2001, K. Jędrzejko (KRAM 507793); Brody vill. near Kalwaria Zebrzydowska, 02.05.2001, K. Jędrzejko (KRAM 519026); Brody vill. near Kalwaria Zebrzydowska, 27.05.1925, J. Trela (KRAM 079946); Lanckorona, 15.06.2001, K. Jędrzejko (KRAM 519935); Skawina stream in Kalwaria Zebrzydowska, 16.05.1931, I. Trela (KRAM 035622, WA 0000017740; POZ); **Przedgórze Sudeckie Foothills:** Głogówek vill. near Prudnik, 20.05.1965 P. Szotkowski (KRAM 375159, 375167); **Roztocze:** Huta-Złomy vill., 31.05.1955, Bryski (KRAM 273576, 273577); Narol vill., 31.05.1955, W. Wojewoda (KRA 065182); Obroc vill. near Zwierzyniec, 14.06.1962, D. Fijałkowski (LBL); Rezerwat Obroc nature reserve, 14.05.1958, K. Izdebski (LBL); Szumy vill. near Krasno-

bród, 24.05.1974, D. Fijałkowski (LBL); Zawadki vill. near Krasnobród, 24.05.1974, D. Fijałkowski (LBL); Zwierzyniec vill. near Zamość, 29.06.1967, A. Jasiewicz (KRAM 411251); **Wyżyna Kielecka upland:** Garb Gielniowski, Skarbowa Góra hill, 05.05.2005, M. Podgórska (KRA 0352727, 0352728, 0352729, 0352730 0352726); Góry Świętokrzyskie Mts, Chełmowa Góra Mt., 10.05.1956, Michalik (KRAM 454311); Bodzentyn vill., 05.06.1897, N. Purin (KRAM 079937); Bodzentyn, 24.05.1897, H. Óypčič (WA 0000017736); Staszów, 15.05.1906, J. Muszynek (WA 0000017734); **Wyżyna Krakowsko-Częstochowska upland:** Wały hills near Złoty Potok, 16.07.1976, L. Pękala (LOD 93474); Złoty Potok vill., 21.05.1934, H. Błaszczyk (KRA 93670); **Wyżyna Śląska upland:** Będzin, Grodziec, 05.1969, K. Zagórna (LOD 57805); Rezerwat Segiet nature reserve near Bytom, 16.05.2009, B. Bełczowska (KRAM 579275, 579276);

Bosnia and Herzegovina: Zvijezda planina near Vareš, 21.06.1929, J. Paczosi (POZ) **Czech Republic:** Moravia, Opava, 31.05.1956, J. Duda (POZ); Moravian-Silesian region, Kónská near Trinec, (POZ); Moravian-Silesian region, Kónská along Olza river, 29.06.1914, K. Piech (KRAM 253314); **Romania:** Oltenia, Vâlcea district, 02.05.1968, G. Popescu (KRAM 085496; 096295); Bihghir near Buhoci, 05.05.1972, D. Mititelu, N. Barabas, L. Mititelu (KRAM 229127); **Russia:** Sumskaja, Leningrad oblast, 08.06.1954, A. Grin' (KRA 0205790); **Ukraine:** Majdan, Lviv Oblast, H. Zapałowicz (KRAM 079969); Ivanivtsi, Lviv Oblast, 27.06.1980, Hemkiński (KRAM 079969); Ternopil Oblast, Skalat, Rasztowce, A. Retomau (KRAM 079918); Lviv Oblast, Drohobych, E. Turczyński (KRAM 079964); Lviv Oblast, Borsheychi, 1877, Lentz (KRAM 079965); Tustanowice, Boryslav, 03.05.1911, S. Fedorowicz (KRAM 079936); Kiev Oblast, Ivankiv, 19.05.1947, K. Hankiewicz (KRAM 079938); Vinnytsia Oblast, Smila, Sunky, 17.05.1924, G. Kleopow (KRA 0315573); Kiev Oblast, Bila Tserkva, 06.06.1929, E. Polonska (KRA 0205776); Ternopil Oblast, Bilokrynytsya, 05.1934 (WA 0000017745); Khmelnytsky Oblast, Zelentsi, 1890, K. Łapczyński (WA 0000017743); Volhynia, Smordowskie Forest, 07.1932 (WA 0000017765); Kożanka, Lypovets' district, 13.05.1902, F. Błoński (WA 0000017756); Podolian upland, Miodobory, 15.05.1909, W. Szafer (KRA 0205768); Ternopil Oblast, Buchach, 1883, S. Trusz (KRAM 079917, 079916); Khmelnytskyi Oblast, Krasyliv, 1873, Rehmann (KRAM 079963); Ternopil Oblast, Borschiv district, Sapohiv, 1877, H. Lenz (KRAM 079965); Eastern Carpathians, Magura Łomnińska Mt. near Lopushanka, 1880, Kotula (KRAM 079923); Eastern Carpathians, Ivano-Frankivsk Oblast, Chornohora Mt., 31.05.1912, S. Fedorowicz (KRA 0205754); Ternopil Oblast, Cygany vill., 13.05.1907, K. Hankiewicz (KRA 0205718).

Allium ursinum subsp. *ursinum*

Poland: **Nizina Południowielkopolska lowland:** Kalisz-Piwnice, 10.05.1999, J. Janowska (LOD 147404); **Nizina Północnomazowiecka lowland:** Warszawa vicinity (WA 0000017751); **Nizina Północnopodlaska lowland:** Czeremchowa Tryba near Białystok, 21.06.1973, I. Dawidziuk (BIL 53385); Kuligi vill., 07.05.1973, J. Wołkowycki (BIL 51492, 51082); **Nizina Staropruska lowland:** Wzniesienia Górowskie hills, Góra Zamkowa hill, 09.06.1965, T. Krotoska (POZ); **Nizina Śląska lowland:** Niemodlin vill., 16.05.1959, P. Lelonek (LOD 154881); Kotołowice vill. near Wrocław, 03.05.1959, S. Michalak (KRAM 375178, 375179, 375180); Osiek vill. near Środa Śląska,

27.04.1962, M. Ciaciura (KRAM 375181); Piotrowice vill. near Środa Śląska, 27.04.1962 J. Serwatka (KRAM 375177); **Pobrzeże Gdańskie:** Wysoczyzna Elbląska plateau, Kadyny vill., 1969, H. Piotrowska, R. Markowski (UGDA); Wysoczyzna Elbląska plateau, Kadyny vill., 25.05.1972, H. Piotrowska (UGDA); **Pobrzeże Szczecińskie:** Wielogoszcz vill. near Recz (SZUB); **Pogórze Śląskie Foothills:** Góra Tuł Mt., 25.05.1930 (POZ); **Pojezierze Chełmińsko-Dobrzyńskie lakeland:** Rezerwat Szumny Zdrój nature reserve, 29.05.1973, R. Markowski (UGDA); **Pojezierze Mazurskie lakeland:** Puszcza Borecka forest, 17.05.1988, J. Dziedzic (OLS 12707, 12708); Puszcza Borecka forest, Walisko forestry, 11.06.1974, A. Jutrzenka-Trzebiatkowski (OLS 7809, 7808, 7807, 7810, 7811, 7812, 7813, 7814); Szymanowo vill., 01.07.1983, A. Jutrzenka-Trzebiatkowski (OLS 10180, 10179, 10178); Walisko forestry, Gizycko distr., 12.05.1955, B. Polakowski (OLS 3842, 4893, 6351); **Pradolina Toruńsko-Eberswaldzka valley:** Pszczółczyn near Bydgoszcz, 25.05.1974, W. Gugnacka (KRAM 229806, WA 0000017739, LOD 10496); **Przedgórze Sudeckie Foothills:** Grodziszczce near Ząbkowice Śląskie, 29.05.1964, E. E. Kuźniewscy, Ciaciura (KRAM 375174); Jaworzyna Śląska, 07.05.2008, W. Bartoszek, K. Piątek, M. Wayda (KRA 0348228, 0348227, 0348223, 0348229); Kamieniec Ząbkowicki, 27.05.1951, E. Ostrowska (KRAM 021221, KRA 029302, WA 0000017741, OLS 3843, LOD 154885, BIL 49000, POZ); Niemcza vill., 06.05.2008, W. Bartoszek, K. Piątek, M. Wayda (KRA 0348014 0348022, 0348021, 0348238, 0348237, 0348236); Pastuchów vill., 12.05.1974, Szadkowska (LOD 154879); Pisarzów vill. near Ząbkowice Śląskie, 29.05.1964, E. E. Kuźniewscy, Ciaciura (KRAM 375169); Radnica vill. near Ząbkowice Śląskie, 29.05.1964, E. E. Kuźniewscy, Ciaciura (KRAM 375175); Wawrzeńczyce vill., 27.04.1962, J. Serwatka (KRAM 375186); **Sudety Środkowe Mts:** Góry Stołowe Mts, Darnków vill. (POZ); Góry Sowie Mts, Bielawa vill., 08.06.1952, J. Nowak (KRA 0205767); Góry Sowie Mts, Sędzimirz vill. near Wałbrzych, 17.05.1964, E. E. Kuźniewscy, Ciaciura (KRAM 375163); **Sudety Wschodnie Mts:** Góry Złote Mts, Orłowiec vill., 28.05.1999, E. Cieślak (KRAM 417681, 417682); Masyw Śnieżnika Mts, along Kleśnica stream, 26.06.1987, Z. Szelać (KRAM 445604); Masyw Śnieżnika Mts, along Wilczka stream, 18.07.1988, Z. Szelać (KRAM 445656); Masyw Śnieżnika Mts, Czarna Góra Mt., 21.06.1987, Z. Szelać (KRAM 445582); Masyw Śnieżnika Mts, Czatków vill., 21.06.1987, Z. Szelać (KRAM 445584); Masyw Śnieżnika Mts, Młyńsko Mt., 20.06.1987, Z. Szelać (KRAM445603); Masyw Śnieżnika Mts, Międzygórze vill., 14.07.1950 (POZ); **Wyżyna Krakowsko-Częstochowska upland:** Złoty Potok vill., 08.05.1948, R. Owsiański (LOD 154880); Kłobuck vill., 18.05.1973, J. Hereźniak (LOD 78717); **Wyżyna Śląska upland:** Markłowice vill., 05.06.1933, A. Kozłowska (KRAM 079972); **Wzniesienia Zielonogórskie Hills:** Zatonie vill., 26.05.1966, J. Serwatka (KRAM 375185); **Austria:** Vienna, 1867, Karpiński (KRAM 079930); Neuwaldegg, 13.05.1915, I. Król (KRAM 042555) **Germany:** Hesse, kr. Alsfeld, Strumpertenrod, 26.05.1969, H. Hupke (KRAM 208964); Bavaria, Brannenburg, 07.06.1898, B. Kotula (KRAM 085496); Bavaria, Inn valley, E from Munich (KRAM 085497); Saxony, Bathsholze near Leipzig, 07.06.1905, C.F. Seidel (KRA 0205785); Hesse, Oberwestwald, Odersberg, 17.05.1980, H. Kalheber (KRAM 261319); Hesse, Darmstadt Bessungen, 13.05.1911, H. Schenck (POZ); Heidelberg, 1865, H. Diesterweg (POZ); Harz Mts, Thale, Eingang im Bodethale, 1897, A. Matz (POZ); Sax-

ony, Rosenthal in Leipzig, 18.05.1872, R. Albrecht (POZ); Brandenburg, Paulinenaue, 05.1981, E. Neumann (POZ); Bavaria, Kupferberg, A. Matz (POZ); Saxony-Anhalt, Merseburg, 16.05.1869 (POZ); Rhineland-Palatinate, Frankenthal, 17.04.1888, A. Matz (POZ); **Great Britain:** Chudleigh Devon, 28.05.1978, Edwards (KRAM 249390); Pentyrch Lane, Radyr, Glamorgan, 05.1976, B.L. Price (KRAM 228283); **Lithuania:** Vilnius-Trakai district, 11.07.1932, J. Limanowska (KRAM 079971); **Norway:** Akershus county: Baerum, Isidalen, 31.05.2004, P. Sunding (KRA 0276705); **Switzerland:** Sergey, Canton de Vaud, 12.06.1910 (KRA 0205781).

Intermediate populations

Poland: **Beskid Mały Mts:** Leskowiec near Targoszów, 15.07.1954, S. Pelc (KRAM 223251); **Beskid Śląski Mts:** Dębowiec Mt., 28.05.1980, M. Szewczyk (KRAM 289882); **Kotlina Ostrawska valley:** Skoczów near Cieszyn, 07.08.1966, M. Ciaciura (KRAM 375184); **Kotlina Oświęcimska valley:** Zator, 29.05.1954, T. Tacik (KRAM 391269); Przeciszów vill., 29.05.1954, J. Sosnowska (KRA 0205770); **Nizina Północnopodlaska lowland:** Białowieża National Park, 31.05.1952, Matuszkiewicz (WA 0000017738, 0000017737); Białowieża vill., 05.1972, J. Zakrzewski (LOD 154883); Hajnówka vill., 1970, A. Sokołowski (BIL 38992, 33716); Białowieża National Park, 18.05.1966, A. Sokołowski (BIL 7244, 7243, 6956, 6957); Białowieża National Park, 1951 (BIL 6237, 6238, 6239, 6240, 6241, 6242, 6243, 6244); **Nizina Śląska lowland:** Ligota vill. near Krapkowiec, 19.05.1967 P. Szotkowski (KRAM 375160, 375161); Rusocin vill. near Nysa, 08.05.1964, J. Serwatka (KRAM 375187); **Pogórze Śląskie Foothills:** Leszna Górna vill., 02.06.1987, M. Matyjaszkiewicz (KRA 0238138, 0238139); Bielsko vill., 05.1934, H. Żurkówna (POZ); **Pogórze Wielickie Foothills:** Brody vill. near Kalwaria Zebrzydowska (KRAM 035623); Kalwaria Zebrzydowska, 26.05.1952, K.

Kostrakiewicz (KRAM 229870); **Pojezierze Litewskie:** Równina Augustowska plateau, along Kanał Augustowski canal, 1938 (WA 0000017755); Równina Augustowska plateau, Puszcza Augustowska forest near Augustów, 06.1937, H. Wiśniewska (WA 0000017750); **Pojezierze Mazurskie lakeland:** Puszcza Borecka forest, 05.1984, Z. Endler (OLS 11159); Puszcza Borecka forest, 17.05.1988, Z. Endler (OLS 12710, 12709); **Wyżyna Kielecka upland:** Góry Świętokrzyskie Mts, Orłowiny vill. near Opatów (POZ); Bliżyn vill., Rezerwat Świnia Góra nature reserve, 16.06.1964, H. Piękoś (KRAM 058511); Świnia Góra nature reserve, 05.07.1966, H. Piękoś (KRAM 058509, 058510); Bukowa Góra nature reserve, 29.05.1924, Kocznowski (KRAM 079443); Kielce, Biesak street, 26.05.1921, Kocznowski (KRAM 079944); Góry Świętokrzyskie Mts, Bukowa Góra nature reserve, 18.06.1954, T. Tacik (KRAM 391270); Góry Świętokrzyskie Mts, Cisów vill., 05.05.1990, W. Paul (KRAM 399734); Góry Świętokrzyskie Mts, Łysica Mt., 15.05.1910 (WA 0000017733, 0000017731, 0000017760, 0000017749, 0000017746); Góry Świętokrzyskie Mts, Łysica Mt., 06.07.1976, B. Jakubowska (LOD 69025); **Wyżyna Krakowsko-Częstochowska upland:** Złoty Potok vill., 05.1959, B. Kędziszko (KRA 0205772); Rezerwat Dębowa Góra nature reserve, 21.08.1987, K. Jędrzejko, H. Klama, J. Żarnowiec (KRA 0133485); Złoty Potok vill., 15.06.1953, Mamak (KRA 0205775); Rezerwat Parkowe nature reserve, 29.05.1974, J. Hereźniak (LOD 78715, 78716, 78721); Kłobuck vill., 18.05.1973, J. Hereźniak (LOD 78717); Boronów vill., 21.06.1976, J. Hereźniak (LOD 78718); **Austria:** Dornbach near Vienna, 06.06.1869, D. Wołoszczak (KRAM 079940); **Czech Republic:** Moravia, Brno, 13.05.1926, R. Dolezal (KRA 0205788); Moravia, Černovice-Brno, 09.05.1937, G. Brižický (KRA 0205779); Bile Karpaty Mts, Haj Mt., supra vicum Velka, 22.05.1929, P. Sillinger (KRA 0205789); **Latvia:** Livonia, Riga, 1901, K.R. Kupffer (KRAM 079931);