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Chromosome numbers of *Allium* from Lithuania

Birutė Karpavičienė

Institute of Botany, Žaliųjų Ežerų g. 49, LT-08406 Vilnius, Lithuania (e-mail: biruta.k@botanika.lt)

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The somatic chromosome numbers of a total of 57 populations of five *Allium* species were studied in Lithuania. The chromosome numbers were: *A. angulosum* 2n = 16, *A. lusitanicum* 2n = 32, *A. oleraceum* 2n = 32 and 40, *A. scorodoprasum* 2n = 16 and 24, and *A. vineale* 2n = 32 and 24. *Allium oleraceum*, *A. scorodoprasum* and *A. vineale* showed ploidy differences both within and among populations.

Key words: *Allium*, chromosome numbers, cytotaxonomy

Introduction

There are seven native *Allium* species in Lithuania: *A. angulosum*, *A. lusitanicum*, *A. oleraceum*, *A. scorodoprasum*, *A. schoenoprasum*, *A. ursinum* and *A. vineale*. The most common of them is *A. oleraceum*, while the other species are rare or very rare (Karpavičienė 2004).

Diverse chromosome numbers are recorded for *A. angulosum* (Bertagna *et al*. 1983, Probatova & Sokolovskaya 1986), *A. lusitanicum* (Bertagna *et al*. 1983, Friesen & Herrmann 1998), *A. oleraceum* (Duchoslav *et al*. 2005), *A. scorodoprasum* and *A. vineale* (Åström & Hæggström 2003). An exception is *A. ursinum*, a karyologically invariable species. The only diploid level 2n = 14 is recorded in this species, *see* Cheshmedzhiev (1970), Labani and Elkington (1987), Loidl (1988), Baranyi and Greilhuber (1999), Murin *et al*. (1999), and Ohri and Pistrick (2001). Despite the large number of published karyological records of *Allium* species from Europe, no data has been reported from Lithuania. This paper reports an initial study of five *Allium* species native in Lithuania.

Material and methods

Propagules (bulbs, bulbils and seeds) of the *Allium* species were collected from natural populations from 1999 to 2005. Bulbs and bulbils collected before 2004 were planted in the field collection of the Institute of Botany in Vilnius. Bulbs, bulbils and seeds of the established plants as well as those collected from the natural populations in 2004–2005 were used for the chromosome counts. A total number of 280 plants were sampled from 57 populations of *A. angulosum* (three populations), *A. scorodoprasum* (four populations), *A. lusitanicum* (one population), *A. vineale* (six populations) (Fig. 1) and *A. oleraceum* (43 populations) (Fig. 2).

All studied *Allium* species propagate via daughter bulbs and seeds, with the exception of *A. scorodoprasum*, which produces sterile flowers. Additionally, *A. oleraceum*, *A. scorodoprasum* and *A. vineale* produce numerous bulbils in the inflorescences.

Bulbs, aerial bulbils and seeds were germinated in Petri dishes on moist paper at ambient room temperature (18 °C) and light conditions.

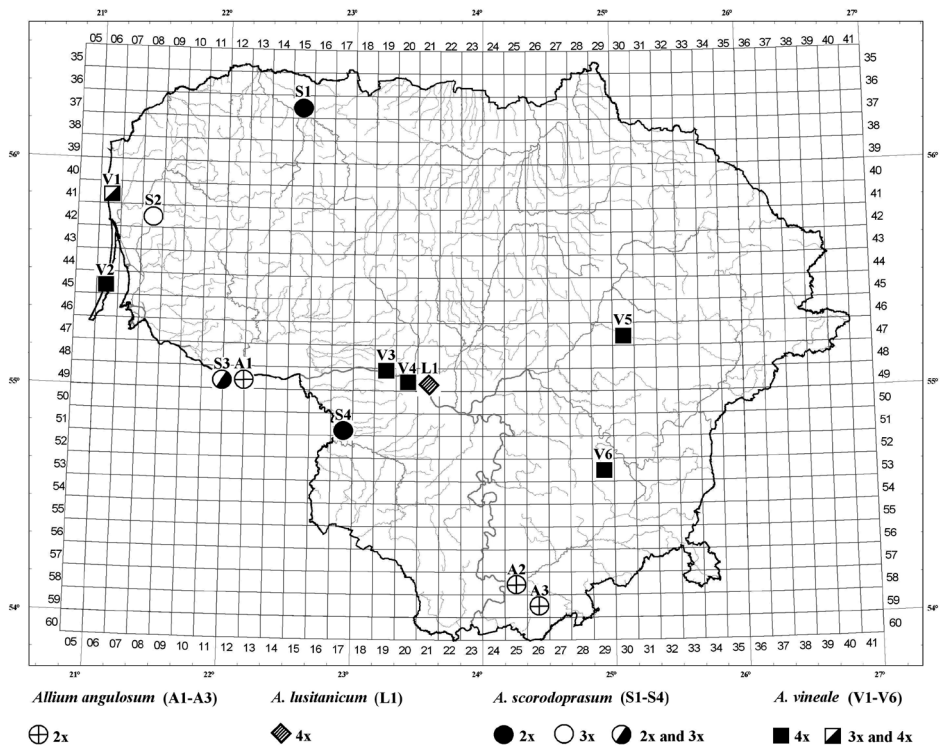

Fig. 1. Distribution of sampled populations of *Allium angulosum* (A1–A3), *A. lusitanicum* (L1), *A. scorodoprasum* (S1–S4) and *A. vineale* (V1–V6). Codes for populations correspond to those in Tables 1, 3 and 4.

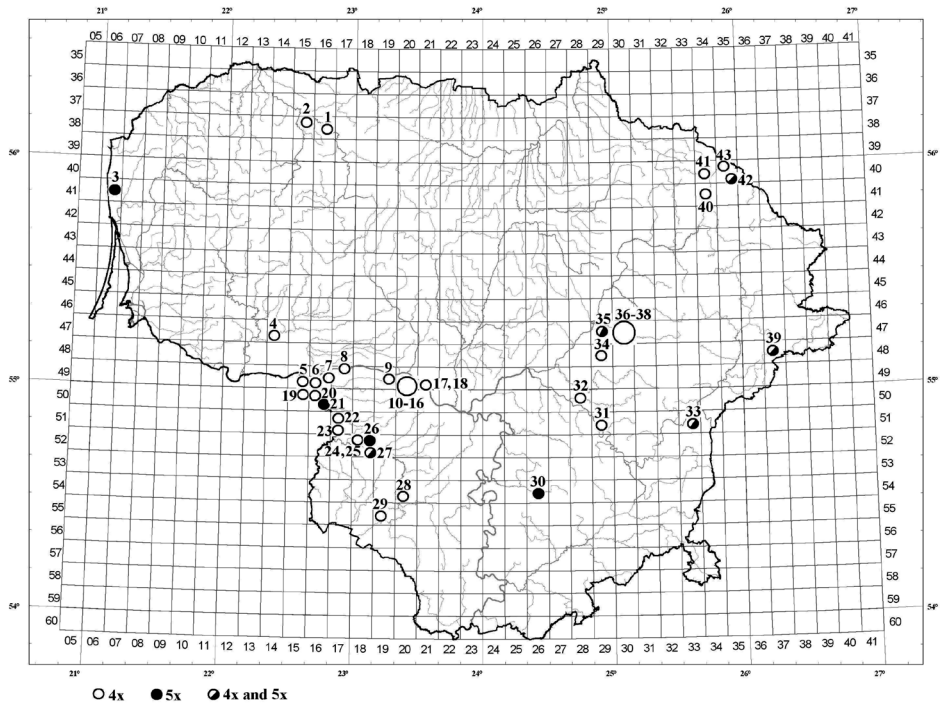

Fig. 2. Distribution of sampled populations of *Allium oleraceum* (O1–O43). Codes for populations correspond to those in Table 2.

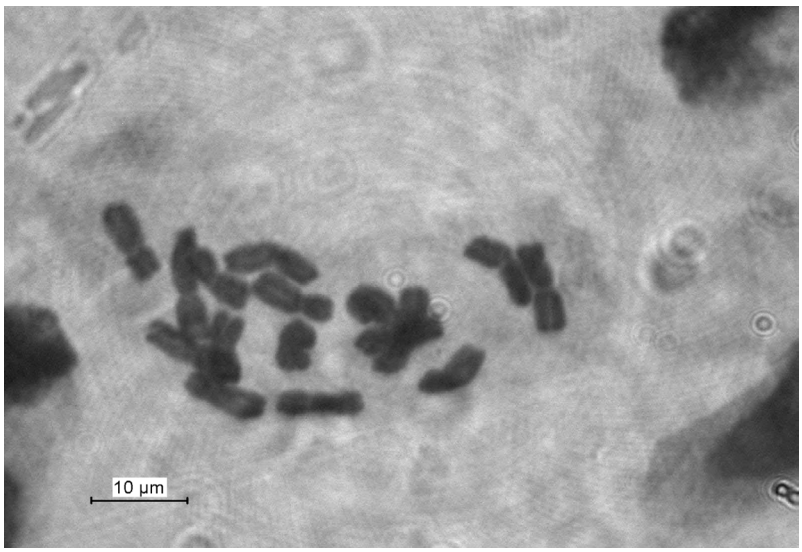

Fig. 3. Metaphase chromosomes of *Allium angulosum*, 2n = 16.

For chromosome counts the roots were treated with 0.05% water solution of colchicine for 3–6 h at room temperature. Then the roots were washed several times in distilled water and fixed in a cold mixture of 96% ethanol and glacial acetic acid (3:1) for 24 h. The roots were then macerated in 1 N HCl at 60 °C for 6 min. and washed in water. The tips were cut off, squashed and stained in 10% Giemsa solution in phosphate buffer.

The taxonomic concepts of Mathew (1996) and Friesen and Herrmann (1998) were adopted.

Results and discussion

Allium angulosum

All of the examined plants collected from the natural populations were diploid (2n = 16) (Table 1 and Fig. 3). The clonal offspring of these plants, planted in the field collection in 2003, produced diploid, triploid (2n = 24) and tetraploid (2n = 32) specimens in 2005. This variability could be a consequence of an interspecific hybridisation between *A. angulosum* and, e.g., *A. lusitanicum*.

In general, the diploid chromosome number prevails in *A. angulosum*. This has been reported from almost the entire area of distribution of the species: Italy (Bertagna *et al*. 1983), Bulgaria (Cheshmedzhiev 1973), Austria (Wittmann 1984, Baranyi & Greilhuber 1999), Slovakia (Murin *et al*. 1999), Germany (Friesen & Herrmann 1998, Ohri & Pistrick 2001), Poland (Czapik *et al*. 1996), Belarus (Semerenko, cited in Takhtajan 1990) and Russia (Friesen 1986). The tetraploid chromosome number has been reported from the central and eastern parts of the distribution area: Slovakia (Majovsky *et al*. 1987), Russia (Probatova & Sokolovskaya 1986) and Kazakhstan (Nanuscyan & Polyakov 1989). B-chromosomes have been recorded in the diploids (2n = 16 + 0 – 3B) as reported from the Czech Republic (Měsíček & Javůková-Jarolímová 1992).

Table 1. Sampling locations and chromosome numbers of *Allium angulosum* (A1–A3) and *A. lusitanicum* (L1).

Code	Location	Long. E	Lat. N	2n
A1	Šilutė district, Bitėnai, meadow in the valley of the river Nemunas	22°02´20´´	55°03´24´´	16
A2	Varėna district, Merkinė, meadow in the valley of the river Merkys	24°11´30´´	54°08´31´´	16
A3	Varėna district, Marcinkonys, dry meadow at the SW border of the village	24°23´11´´	54°03´26´´	16
L1	Kaunas district, Brūžė, small hill in the valley of the river Nemunas	23°15´19´´	55°00´35´´	32

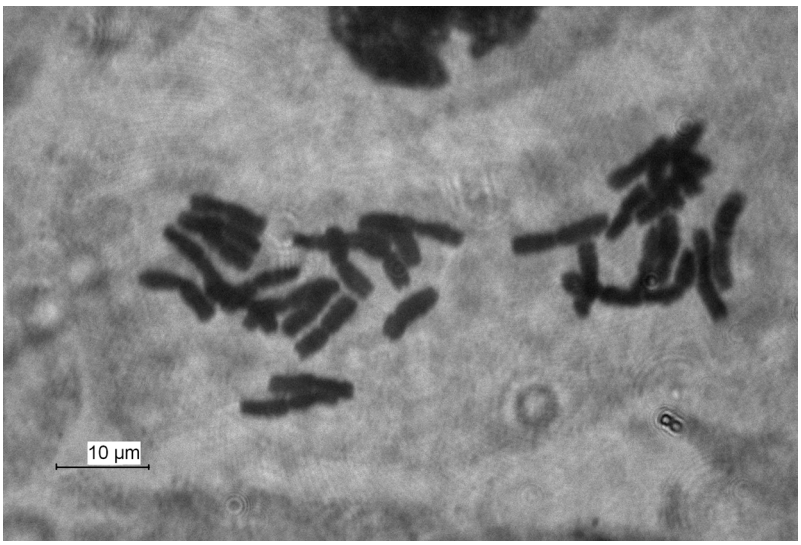

Fig. 4. Metaphase chromosomes of *Allium oleraceum*, 2n = 32.

Allium lusitanicum

There is only one habitat where *A. lusitanicum* is found in Lithuania. This population is recorded (Table 1) to have a tetraploid chromosome number (2n = 32).

Tetraploids have been frequently reported, e.g., from Italy (Bertagna *et al*. 1983, D'Ovidio 1986), Bulgaria (Cheshmedzhiev 1973), Austria (Wetschnig 1992, Baranyi & Greilhuber 1999), the Czech Republic (Bertagna *et al*. 1983, Friesen & Herrmann 1998) and Slovakia (Májovský 1970, 1978). Tetraploids and diploids are known from Iberian Peninsula (Pastor 1982). Diploid plants (2n = 16) of *A. lusitanicum* are reported from Spain (Fernandes-Casas *et al*. 1978), triploids (2n = 24), from Austria and Hungary (Bakšay 1956, Speta 1984), and hexaploids (2n = 48) from Italy (Bertagna *et al*. 1983). B-chromosomes have been recorded in the tetraploids as reported from Ukraine (2n = 32 + 2B: Chopik *et al*., cited in Takhtajan 1990), Italy and the Czech Republic (2n = 32 + 0 – 5B: Bertagna *et al*. 1983, Wetschnig 1992).

Allium oleraceum

More than 80% of the examined populations consisted of tetraploid (2n = 32) plants (Table 2 and Fig. 4). Three populations consisted of pentaploid (2n = 40) specimens and five populations were heterogeneous, with tetraploid and pentaploid individuals. 88% of the studied populations contained only one cytotype. This is in agreement with the data from the Czech Republic, where 77% of the populations of *A. oleraceum* are karyologically homogeneous (Duchoslav *et al*. 2005). According to Lavania (2002) ploidy variation is common in vegetative populations.

The above-mentioned tetraploid and pentaploid chromosome numbers evidently prevail in this karyologically polymorphic species. Both cytotypes are reported from Austria (Tschermak-Woess 1947, Speta 1984, Wittmann 1984, Baranyi & Greilhuber 1999), Sweden (Lövkvist & Hultgård 1999), Finland (Åström & Hæggström 2004) and Russia (Vakhtina 1985, Vakhtina & Kudryashova 1985). Three cytotypes, tetraploid, pentaploid and hexaploid (2n = 48), have been recorded in Switzerland (Wetschnig 1992) and the Czech Republic (Šafářová 2004, Duchoslav *et al*. 2005). According to Duchoslav *et al*. (2005) pentaploids are most abundant and distributed evenly over the area of the Czech Republic, while hexaploids and tetraploids are less abundant and show partially vicarious patterns of distribution. The hexaploid cytotype is found in the Iberian Peninsula as well (Pastor 1982). Tetraploids are reported from Slovakia (Murin *et al*. 1999), Poland (Pogan *et*

al. 1986, Joachimiak 1990), Belarus (Parfenov & Semerenko as cited in Takhtajan 1990) and Latvia (Vakhtina & Kudryashova 1985). Pentaploids are recorded in Italy (Baranyi & Greilhuber 1999). The triploid forms (2n = 24) of *A. oleraceum* seem to be the rarest and are reported from Russia (Vakhtina 1985) and Hungary (Krahulcová 2003).

Allium scorodoprasum

Two ploidy levels of this species were registered in the studied populations: diploid (2n = 16) and triploid (2n = 24) (Table 3 and Fig. 5). Two populations were diploid and one triploid. One of the studied populations consisted of individuals of both ploidy levels.

Table 2. Sampling locations and chromosome numbers of *Allium oleraceum*.

Code	Location	Long. E	Lat. N	2n
O1	Akmenė district, Gumbakiai, open slope of the river Venta	22°51´06´´	56°06´14´´	32
O2	Akmenė district, Palnosai, shrub area in the valley of the river Venta	22°34´27´´	56°13´34´´	32
O3	Klaipėda district, Nemirseta, dry meadow next to the road	21°03´49´´	55°52´45´´	32
O4	Tauragė district, Kalniškiai, meadow in the valley of the river Šešuvis	22°22´07´´	55°12´28´´	32
O5	Šakiai district, Sudargas, slope	22°38´31´´	55°02´46´´	32
O6	Šakiai district, Rociškiai, meadow in the valley of the river Jotija	22°41´41´´	55°00´39´´	32
O7	Šakiai district, Pervazninkai, meadow in the valley of the river Nemunas	22°42´09´´	54°03´15´´	32
O8	Jurbarkas district, Šilinė, oak-wood glade	22°57´02´´	55°05´13´´	32
O9	Šakiai district, Dulinčiškiai, meadow in the valley of the river Nyka	23°18´52´´	55°03´11´´	32
O10	Šakiai district, Žūklijai, slope of the runlet	23°21´21´´	55°03´19´´	32
O11	Šakiai district, Baraviškiai, meadow in the valley of the river Nemunas	23°22´28´´	55°04´06´´	32
O12	Šakiai district, Prasčiūnai, dry slope	23°24´54´´	55°03´40´´	32
O13	Šakiai district, Klangiai, meadow in the valley of the river Nemunas	23°25´07´´	55°03´10´´	32
O14	Šakiai district, Sirvydai, slope of the runlet Žiegždris	23°28´52´´	55°01´02´´	32
O15	Šakiai district, Tirmėnai, slope of the runlet	23°31´14´´	55°00´42´´	32
O16	Šakiai district, Šėtijai, slope of the runlet	23°32´28´´	55°00´08´´	32
O17	Šakiai district, Klangiai, meadow in the valley of the river Nemunas	23°25´32´´	55°03´53´´	32
O18	Šakiai district, Žemoji Panemunė, slope	23°27´57´´	55°02´38´´	32
O19	Šakiai district, Barkiai, meadow in the valley of the river Šešupė	22°38´19´´	54°59´06´´	32
O20	Šakiai district, Slavikai, meadow in the valley of the river Šešupė	22°43´49´´	54°57´01´´	32
O21	Šakiai district, Juškakaimiai, meadow in the valley of the river Siesartis	22°44´09´´	54°56´16´´	40
O22	Šakiai district, Turčinai, meadow in the valley of the river Šešupė	22°50´53´´	54°52´49´´	32
O23	Šakiai district, Bajoraičiai, meadow in the slope of the river Šešupė	22°52´08´´	54°50´11´´	32
O24	Šakiai district, Stočkai, meadow in the valley of the river Šešupė	23°03´22´´	54°45´39´´	32
O25	Šakiai district, Vilktrakiai, meadow in the valley of the river Šešupė	23°05´10´´	54°44´45´´	32
O26	Šakiai district, Vilktrakiai, meadow in the valley of the river Šešupė	23°06´51´´	54°44´53´´	40
O27	Šakiai district, Simokai, meadow in the valley of the river Šešupė	23°09´13´´	54°44´02´´	32, 40
O28	Marijampolė district, Padovinys hill	23°26´25´´	54°30´30´´	32
O29	Marijampolė district, Stebuliškės, meadow in slope of the river Sūduonia	23°18´55´´	54°28´36´´	32
O30	Prienai district, Krištapiškės, slope of the hill near lake Lielius	24°22´17´´	54°34´24´´	40
O31	Širvintos district, Kernavė hill near the river Neris	24°51´12´´	54°52´55´´	32
O32	Kaišiadorys district, Paparčiai, meadow in the slope of the river Žiežmara	24°44´12´´	54°54´14´´	32
O33	Vilnius district, Pailgė, slope	25°33´08´´	54°53´21´´	32, 40
O34	Ukmergė district, Šešuoliai, slope of lake Šešuolis	24°57´47´´	55°10´25´´	32
O35	Ukmergė district, Minikiai, slope of the river Siesartis	25°02´13´´	55°15´25´´	32, 40
O36	Ukmergė district, Laukeliai, slope	25°03´33´´	55°15´17´´	32
O37	Ukmergė district, Rutiškiai, slope of the river Siesartis	25°07´00´´	55°14´35´´	32
O38	Ukmergė district, Meilūnai, slope of the river Siesartis	25°07´29´´	55°14´39´´	32
O39	Švenčionys district, slope of lake Beržuvis	26°11´13´´	55°10´08´´	32, 40
O40	Rokiškis district, Rukeliai, meadow in the slope of the river Biržupys	25°41´45´´	55°53´02´´	32
O41	Rokiškis district, Papiliai, meadow in the slope of the hill	25°45´44´´	55°55´15´´	32
O42	Rokiškis district, Šapeliai, the slope of the runlet	25°56´29´´	55°58´05´´	32
O43	Rokiškis district, Tilvikai, the slope next to the road	25°55´28´´	55°58´36´´	32, 40

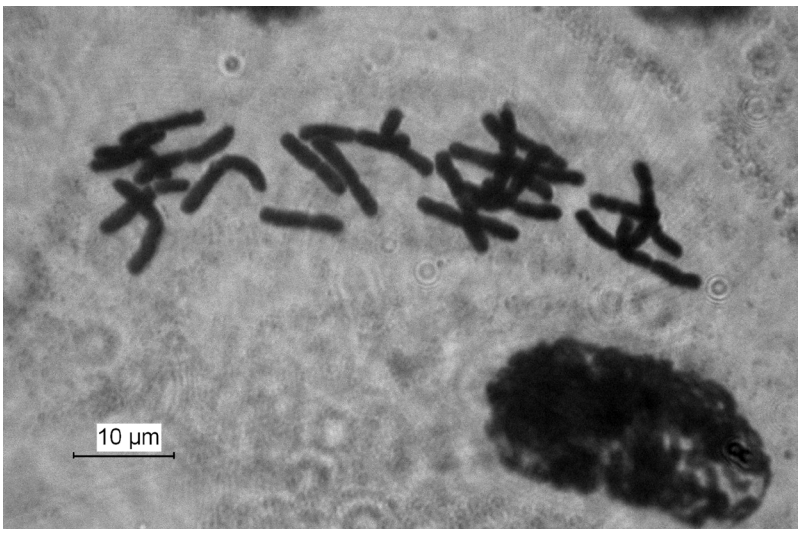

Fig. 5. Metaphase chromosomes of *Allium scorodoprasum*, 2n = 24.

These chromosome numbers correspond to the diploid and triploid levels that prevail in Europe, and are reported from Austria (Tschermak-Woess 1947, Speta 1984, Wetschnig 1992), Slovakia (Murin 1976, Murin & Ferakova 1988), Finland and Ukraine (Halkka 1985, Åström & Hæggström 2003). Diploid plants are reported from European Turkey (Özhatay *et al*. 1993), British and Irish isles (Al-Bermani *et al*. 1993), Belarus (Semerenko, cited in Takhtajan 1990). The triploid ploidy level is registered in Germany (Ohri & Pistrick 2001) and the Czech Republic (Měsíček & Javůková-Jarolímová 1992). There is only one record of tetraploid (2n = 32) plants, from Turkey (Özhatay 1990, 2002). B-chromosomes have been recorded in diploids (2n = 16 + 0 – 2B) and reported from south Sweden (Lövkvist & Hultgård 1999).

Allium vineale

Five examined populations were tetraploid (2n = 32) and one showed heterogeneity, because tetraploid and triploid (2n = 24) individuals were observed (Table 4).

Table 3. Sampling locations and chromosome numbers of *Allium scorodoprasum*.

Code	Location	Long. E	Lat. N	2n
S1	Akmenė district, Palnosai, shrub area in the valley of the river Venta	22°34´27´´	56°13´34´´	16
S2	Klaipėda district, Gargždai, meadow in the valley of the river Minija	21°24´30´´	55°42´41´´	24
S3	Šilutė district, Bitėnai, meadow in the valley of the river Nemunas	22°02´23´´	55°03´24´´	16, 24
S4	Šakiai district, Bajoraičiai, meadow in the valley of the river Šešupė	22°52´43´´	54°50´15´´	16

Table 4. Sampling locations and chromosome numbers of *Allium vineale*.

Code	Location	Long. E	Lat. N	2n
V1	Klaipėda district, Nemirseta, dry meadow next to the road	21°03´49´´	55°52´45´´	24, 32
V2	Klaipėda district, Neringa, dry meadow next to the road	21°03´57´´	55°25´38´´	32
V3	Jurbarkas district, Veliuona, slope of the river Nemunas	23°35´10´´	55°04´30´´	32
V4	Šakiai district, Žemoji Panemunė, meadow on slope	23°27´57´´	55°02´38´´	32
V5	Ukmergė district, Želva, slope of the river Želva	25°06´15´´	55°13´27´´	32
V6	Trakai, meadow near lake Akmena	24°54´38´´	54°39´47´´	32

The chromosome number 2n = 32 is the most frequently reported for *A. vineale*. It is reported from Turkey (Özhatay 2002), Greece (Tzanoudakis 1985), Bulgaria (Cheshmedzhiev 1970), Serbia (Lovka 1995), Austria (Speta 1984; Wittmann, 1984), the Czech Republic (Fialova 1995), Slovakia (Májovský 1976, Murin *et al*. 1999), Poland (Joachimiak *et al*. 1994), Sweden (Lövkvist & Hultgård 1999), Finland and Ukraine (Åström & Hæggström 2003) and Armenia (Pogosjan, cited in Takhtajan 1990). Tetraploids and pentaploids (2n = 40) are reported from Norway (Laane & Lie 1985). The higher ploidy levels, pentaploids and hexaploids (2n = 48), as well as diploids (2n = 16) are reported from the Iberian Peninsula by Pastor (1982) and Fernandes *et al*. (cited in Åström & Hæggström 2003). A hexaploid cytotype was recorded in Morocco (Arends & van der Laan 1979). B-chromosomes have been recorded in tetraploids (2n = 32 + 1 – 4B) and reported from the Czech Republic (Měsíček & Javůková-Jarolímová 1992).

The triploid cytotype found in Lithuania is the first report of a triploid *A. vineale*.

The highest ploidy levels of *Allium* species with the exception of *A. angulosum* were registered in the southern parts of their distribution areas: *A. oleraceum*, Iberian Peninsula (Pastor 1982) and the Czech Republic (Duchoslav *et al*. 2005); *A. lusitanicum*, Italy (Bertagna *et al*. 1983); *A. scorodoprasum*, Turkey (Özhatay 1990, 2002); *A. vineale,* Iberian Peninsula (Pastor 1982). According to Ramsey and Schemske (1998) environmental factors such as herbivory, wounding, water and nutrient stress and, especially, temperature stimulate 2n gamete production and polyploidy formation. However, in order to confirm the relation between distribution of ploidy levels of *Allium* species and environmental factors it is necessary to carry out a more extensive research.

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