

When the specialization is a curse: distribution of *Lolium remotum* Schrank in Slovakia

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Abstract: Distribution of *Lolium remotum* in Slovakia, a typical linicolous weed, is presented in this paper. The species was recorded in 30 quadrants of the Central European mapping grid; the most of localities were found in the Carpathians which is related to the areas of flax cultivation for the linen industry. While in the 19th century it was relatively common in flax fields, after the First World War it began to decline (flax sown areas decreased by three quarters in former Czechoslovakia during the world economic crisis of 1929-1933). In the second half of 20th century, the synergistic effect of several agrotechnical measures (precise cleaning of the seed, simplification of crop rotation, deep autumn plowing and application of herbicides) manifested; only single locality was documented. At present, it belongs to the extinct species of Slovak flora (RE), it has not been detected for over 60 years.

Keywords: central Europe, flax specialists, flax weeds, occurrence, rare species.

Introduction

Genus *Lolium* includes only six species in Europe: perennial *Lolium multiflorum* Lam. and *L. perenne* L. and four annual weeds *L. persicum* Boiss. & Hohen., *L. remotum* Schrank, *L. rigidum* Gaudin, and *L. temulenum* L. (Conert 1996; Eliáš et al. 2010). Several species are more or less similar and identification errors are

Tab. 1 Significant determining characteristics of Central European representatives of the genus *Lolium* (according to Conert 1996; Terrel 2007; Király 2009).

	<i>L. remotum</i>	<i>L. temulentum</i>	<i>L. perenne</i>	<i>L. multiflorum</i>
Life cycle	annual	annual	perennial	annual to shortly perennial
Culms	only fertile	only fertile	fertile and sterile	fertile and sterile
Leaf blade width	2 – 4 mm	3 – 12 mm	2 – 6 mm	3 – 13 mm
Glume	7 – 10 mm long, (1/2) 2/3 as long as to the spikelet	15 – 30 mm long, from 3/4 as long as to longer than the spikelet	3.5 – 15 mm long, 1/2 – 3/4 as long as the spikelet	5 – 18 mm long, 1/4-1/2 as long as the spikelet
Lemma	3.5 – 4.5 mm long, 1.2 – 1.8 mm wide, usually unawned, rarely shortly awned	5 – 8.5 mm long, 1.5 – 3 mm wide, usually long-awned	6 – 7 mm long, 0.8 – 2 mm wide, unawned	7 – 8 mm long, 1 – 2 mm wide, at least the upper one awned

frequent, the basic identification characteristics are listed in Tab. 1 (except *L. persicum* and *L. rigidum*, which do not occur in Central Europe).

The origin of *Lolium remotum* (syn. *Lolium linicola*, *L. temulentum* subsp. *linicola*, *L. temulentum* subsp. *remotum*) (Fig. 1) is not clear and is related to the anthropogenic character of its habitats. Some authors regarded it as mostly European (Nikitin 1983) or Eurasian and North African species (Conert 1996; Terrel 2007) others mentioned it native in Asia from northern Pakistan to Western Himalaya (POWO 2024). *L. remotum* is a weed belonging to group of so-called linicolous weeds or flax specialists (*Camelina alyssum*, *Cuscuta epilinum*, *Silene linicola*, and *Spergula maxima*), weedy plant species whose evolution is inextricably linked with flax cultivation (Smejkal 1981; Mirek 1997; Pinke & Pál 2005). Although data about humans using wild flax as a textile comes from Upper Paleolithic from the Caucasus (Georgia) 30,000 years ago, humans first domesticated flax in the Fertile Crescent region by circa 9,000 years ago (Balter 2009; Fu 2011). In Central Europe, flax cultivation is dated back to the middle of the eighth millennium BP (Zohary et al. 2012), the seeds of these above weeds have spread with the flax seed. Probably the oldest archaeobotanical data of *Lolium remotum* from the eastern part of Central Europe come from the Late Bronze Age circa 4200 years BP (Kühn 1981), therefore it belongs in archaeophytes in flora of this region (Kästner et al. 2001; Danihelka et al. 2012; Medvecká et al. 2012; Tokarska Guzik et al. 2012; Csiky et al. 2023). Currently, the species is either extinct (Austria – Schratt-Ehrendorfer et al. 2022; Hungary – Király 2007; Czech Republic – Grulich 2012; Slovakia – Eliáš et al. 2015; Germany – Metzinger et al. 2018) or critically endangered (Poland – Kaźmierczakowa et al. 2016) in countries of Central Europe.

Distribution of the majority of flax specialists has already been processed in detail in Slovakia (Chrtek 1988; Eliáš 2002; Eliáš et al. 2010; Mereda et al. 2012; Šípošová 2012) with an exception of *Lolium remotum*. Therefore, this contribution aims to reconstruct its (historical) distribution and discuss the reasons for its vanishing in Slovakia.

Material and Methods

The study was conducted in the years 2022–2024. We processed the distribution of *Lolium remotum* in Slovakia using revised herbarium specimens from 15 herbarium collections (BP, BRA, BRNM, BRNU, LTM, NI, OLM, PMK, PRC, PR, SAV, SLO, SMBB, ZAM, ZV), published and manuscript works (using the database of floristic data of the Department of Taxonomy of Higher Plants of the Botanical Institute of the Slovak Academy of Sciences in Bratislava) and web page Virtual Herbaria (<https://herbarium.univie.ac.at/database/collections.htm>). Acronyms of herbaria are given according to the work of Thiers (2024+), regional herbaria are listed according to the work of Vozárová & Sutorý (2001). A list of sites is given as an Appendix at the end of the article. Data in Appendix are divided on two groups – herbarium vouchers and published data. Distribution data related to one site are arranged chronologically, data on habitat type were obtained from herbarium labels, publications and manuscript notes, respectively. In the Appendix, citations are presented in an abbreviated form. The current names of municipalities are given according to work of Majtán (1998); the original names from herbarium labels different from the above work are given in square brackets.

Results of this study are presented in a dot map. The map was designed using Corel Draw according to the grid mapping method described by Niklfeld (1971). Nomenclature of flowering plants follows Marhold & Hindák (1998). Herbarium and literature data are arranged according to phytogeographical districts published by Futák (1984). Categories of threat were applied according to the IUCN Red List Criteria (IUCN 2012).

Results and Discussion

The species was recorded in 30 quadrants of the Central European mapping grid (Fig. 2) in Slovakia. First data were found in the first third of the 19th century (Wahlenberg 1814; Endlicher 1830). The vast majority of the localities were situated in the Carpathian region, especially in the sub-district of Spišská kotlina valley (8 quadrants) and districts Nízke Tatry Mts (4 quadrants) and Pieniny Mts (3 quadrants). In the all Pannonian region, the species occurred very rarely (5 quadrants). Occurrence of *Lolium remotum* is significantly correlated with flax cultivation for linen production. According to several authors (Štefánik & Lukačka 2010; Beňušová & Kulášová 2018; Špiesz 2021), the centre of linen production from the Middle Ages to 20th century was Spiš region (NE Slovakia), followed by Orava (NW Slovakia) and Šariš regions (NE Slovakia). This required sufficient amount of flax, which was usually grown in the vicinity of the places of linen production. However, *L. remotum* data from Orava region in Slovakia are relatively rare (1 quadrant, 2 localities), although there is enough data from the adjacent territory of Poland (Zajac & Zajac 2001). We believe this was due to the absence of botanical research of (flax) fields in the area. If we considered the occurrence of *L. remotum* over time (Fig. 3), we found that the

number of data before 1900 (18 localities) is only slightly lower than between 1900 – 1950 (22 localities) although the intensity of botanical research was, especially in the period between the world wars, much more intense (Hendrych 1996). We believe that this points to two facts, i) the species was a relatively common weed of flax fields in the 19th century and ii) its slow retreat began most probably already after the First World War in Slovakia. This process increased after 1950, when we documented only one herbarium specimen from north-eastern Slovakia (V. Pospíšil 1962 BRNM), where *L. remotum* apparently survived from the seed bank. In the next

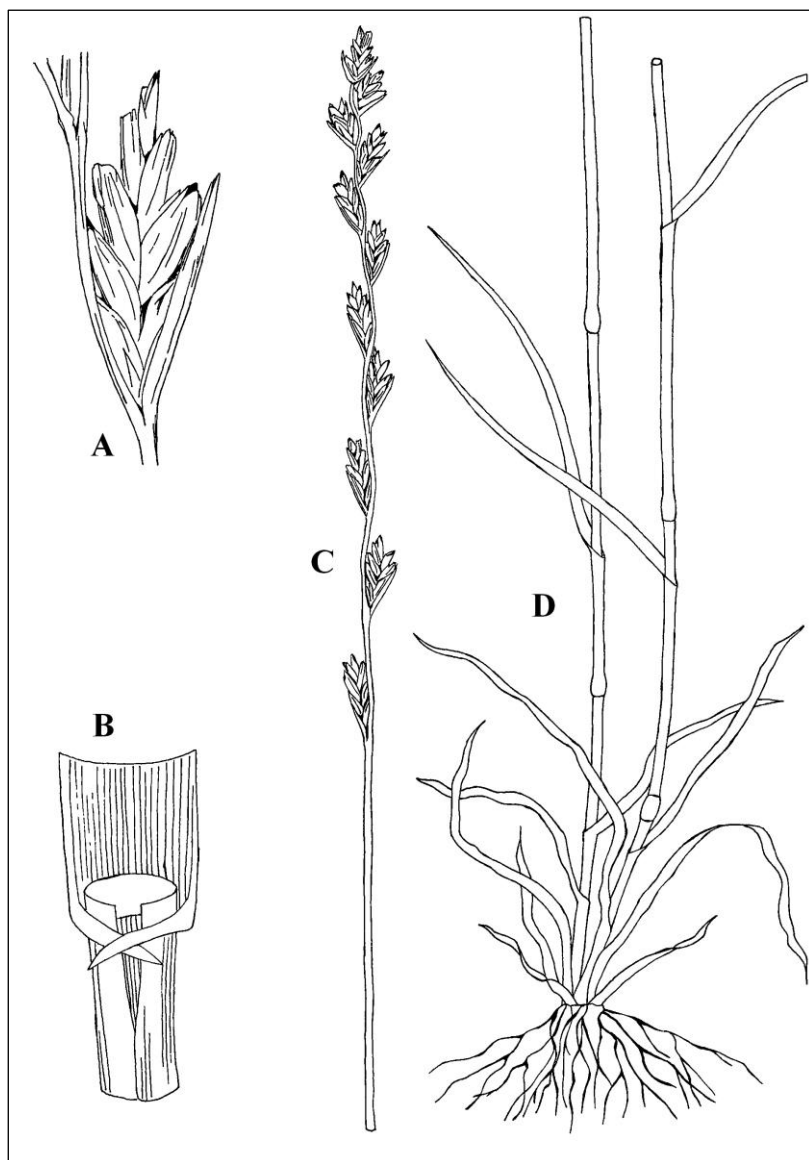


Fig. 1 *Lolium remotum*: A – spikelet, B – ligula and auricles, C – inflorescence, D – basal and central part of the plant (orig. S. Kšíňan).

period up to today, *L. remotum* was no longer recorded (see Appendix), all data turned out to be confusions with *L. perenne* (e.g. Č. Deyl 1984 OLM) and *L. multiflorum* (e.g. Horváthová 1979 BRA). We can therefore conclude that the assessment of this species as regionally extinct (RE) is justified (Eliáš et al. 2015). Other flax specialists also disappeared in the same period or even earlier, the last data on the occurrence of *Cuscuta epilinum* is from 1939 (Chrték 1988), *Camelina alyssum* was last collected in 1952 (Eliáš jun. 2002). A similar disappearance of linicolous weeds in the course of 1950s and 1960s was observed in a number of European countries (Eliáš sen. 1987, 2007; Mirek 1997; Zajac et al. 2009; Pinke et al. 2011; Fanfarillo et al. 2020; Fried 2020; Hyvönen et al. 2020).

For all obligate weeds of flax crops (as for most annual weeds) was characteristic of the seed being harvested with the crop and resown in contaminated seed. As the reasons for the retreat of *L. remotum*, it is generally accepted that it was caused by the development of effective cleaning mechanisms of flaxseed replacing the previous seed cleaning by simple winnowing (Smejkal 1981; Mirek 1997). However, we think first phase of retreat started already in the period after the First World War due to a gradual reduction in the acreage of flax in the former Czechoslovakia. During the world economic crisis (1929 – 1933), the cultivated areas of flax decreased by more than three quarters compared to the year 1900 (Binder 1965). The range became fragmented, gene flow within local populations was severely restricted, and the seed bank ceased to regenerate. The second, decisive phase began after the Second World War, while the synergistic effect of several agrotechnical measures – precise cleaning of the seed, simplification of crop rotation, deep autumn plowing and application of herbicides – manifested.

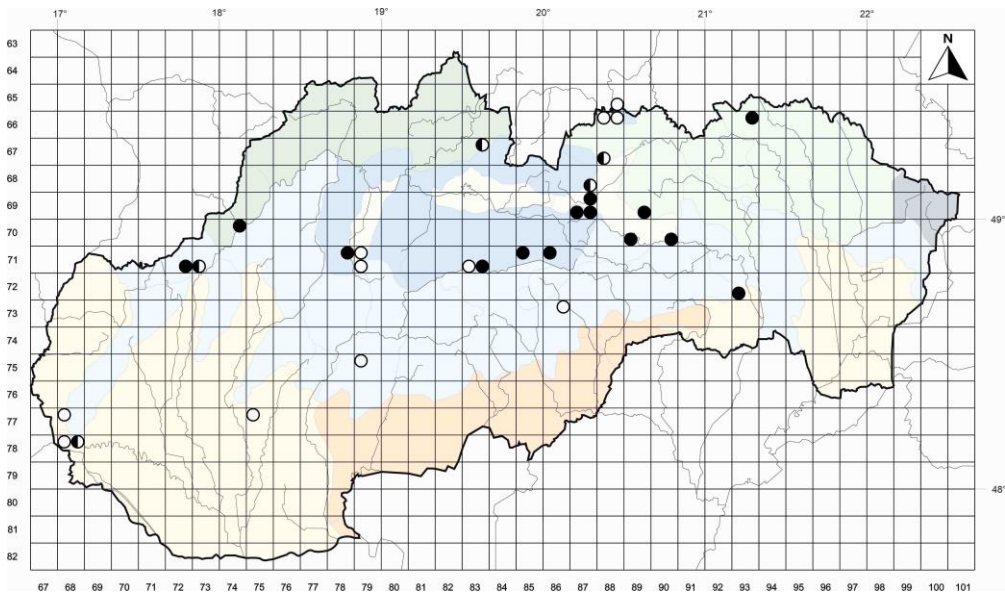


Fig. 2 Distribution of *Lolium remotum* Schrank in Slovakia: ● – herbarium vouchers, ○ – literature data, ◐ – both herbarium vouchers and literature data.

Common weeds as *Agrostemma githago*, *Bromus secalinus* and *Cyanus segetum* became rare; previously rare and especially specialised species became extinct (Eliáš et al. 2007; Pinke 2020). In the case of flax specialists, this process was well documented in Poland. Kornas (1961) mentioned the disappearance of specialized flax weeds (*L. remotum*, *Silene linicola*, *Camelina alyssum*, *Spergula maxima* and *Cuscuta epilinum*) in southern Poland ten years after traditional flax cultivation had ceased. Five decades after this study, none of these species were found within intensively cultivated flax crops throughout Poland and are now considered extinct. Flax plantations were affected by weed species associated with root crops and cereals (Heller 2010). Such a process undoubtedly took place in the former Czechoslovakia as well, but it is not documented (Eliáš sen. 2007). However, we can reconstruct it precisely based on herbarium collections and literary data on the occurrence of linicolous species. While the cultivation areas of flax reached more than 50 thousand hectares in the 1950s and 1960s of the 20th century in the former Czechoslovakia (Binder 1965), the number of localities of flax specialists was very low (Smejkal 1981; Eliáš 2002). They were not able to establish themselves and maintain themselves not even on replacement ruderal types of habitats, as was found in the case of *Lolium temulentum* (Eliáš et al. 2010) or *Bromus secalinus* (Devánová et al. 2006), and their narrow ecological niche became their curse. *L. remotum* was last recorded in 1962; it became extinct as the last of these specialized linicolous species in Slovakia.

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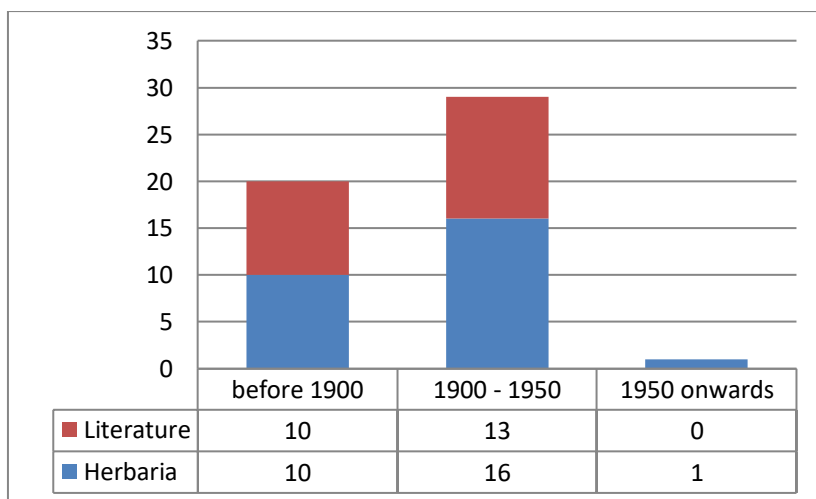


Fig. 3 Time scale comparison of *Lolium remotum* data obtained from herbaria and literature.

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Appendix

List of *Lolium remotum* localities in Slovakia.

The records are arranged according to the phytogeographical division of Slovakia (Futák 1984).

Herbarium specimens

Pannonicum

7. Košická kotlina basin: Košice [Kassa] (Schilb. 1889 BP; Thaisz 1909 BP).

Carpaticum

9. Biele Karpaty Mts (southern part): Zemianske Podhradie [Ns. Podhragy], rare in flax field (Holuby 1865 BRA, SLO, 1882 BP, 1895 BRA). – Bošáca, flax fields (Holuby 1895 BP, 1897 BRA, PRC). **10. Malé Karpaty Mts:** Bratislava, Kalvária (V. Nábělek 1936 SAV). **22. Nízke Tatry Mts:** Brezno, flax field (Ptačovský 1938 SAV). – Polomka, flax fields (Lengyel 1938 BP). – near Pohorelá [ad Pohorellam], flax field (Lengyel 1926 BP). **23b. Vysoké Tatry Mts:** Dolný Smokovec [Alsó-Tátrafüred] (Széplingtoni 1884 BP). **25. Turčianska kotlina Basin:** Dubové [Dubovó, Turocztolgyes], flax fields, 500 m (Thaisz 1912 BP, BRA). **26b. Spišská kotlina Basin:** Spišská Teplica [Szepes Teplicz], fields (Lendvay 1907 BP). – Poprad, part Veľká [Poprád-Felka], in crop (Simonkai 1890 BP). – Lendak, flax field (Domin 1925 PRC). – Gánovce [Gánóc], flax fields (Borbás 1899 BP). – Levoča [Leutschau], flax field (Greschik 1935 SLO). – Spišská Nová Ves [Igló] (Hazslinsky 1844 BP, sine data BP). – Spišská Nová Ves [Igló], flax field, 460 m (Dietz 1875 BP, 1878 BP, BRNU, PRC, 1887 BRNM; Ptačovský 1939 SAV). – Spišské Vlachy, flax field [Wallendorf] (Greschik 1929 SLO). **27a. Biele Karpaty Mts (northern part):** Horné Srieň near Trenčín, flax fields (Holuby 1870 BP). **28. Západné Beskydy Mts:** Habovka, Blatná valley, flax fields, 760 m (Scheffer 1926 BP). **30c. Nízke Beskydy Mts:** Rokytov, field E from the village, 330 m (V. Pospíšil 1962 BRNM). **Common data: 26b. Spišská kotlina Basin:** Spiš [Scepusii] (Kalchbrenner sine data SLO). **29. Pieniny Region:** in valey of the Dunajec River [in valle fluminis Dunajec] (Domin 1932 PRC). **Unidentified locality:** Eastern Slovakia, in fields Jastreba (Májovský 1949 SLO).

Data from literature

Pannonicum

4. Záhorská nížina Lowland: Stupava [Stamphen], fields (Endlicher 1830: 100). **5. Devínska Kobyla Hills:** Bratislava [Pressburg], Karlova Ves [Carlsdorf], rare in fields (Endlicher 1830: 100; Kornhuber, Die Gefässpflanzen der Pressburger Flora, 1860: 26). **6. Podunajská nížina Lowland:** Bratislava (Reuss, Května Slovenska, 1853: 483). – Golianovo[Lapásgyarmat], in flax fields (Knapp, Ver. Zool-bot. Ges. Wien 15: 106, 1865).

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9. Biele Karpaty Mts. (southern part): Bošáca [Bosác] (Holuby, Schedae ad Floram exsiccata Austro-Hungaricam, Centuria XL, nr. 3941, Bot. Közl. 13: 43, 1914). **14e. Štiavnické vrchy Mts:** Banská Štiavnica, fields [Schemnitz] (Knapp, Oesterr. Bot. Z. 14/4: 114, 1864). **15. Slovenské rudohorie region:** Revúca [V. Revúca] (Reuss, Května Slovenska, 1853: 467). **22. Nízke Tatry Mts:** Horná Lehota [Felsőszabadi], flax fields (S. Kupčok, Bot. Közl. 13: 97, 1914). **23b. Vysoké Tatry Mts:** Dolný Smokovec, flax fields (Czakó, Jahrbuch des Ungarischen Karpathen-Vereins XV: 223, 1888). **24. Pieniny Mts:** flax fields near Červený Kláštor [Nižné Šváby], sometimes very abundant – Havka [Hurka] – Haligovce – Huta farmstead (all data Domin 1920 ined.). **25. Turčianska kotlina Basin:** Čremošné [Turóc, Cseresnyés], flax field, 700 m (Margittai, Magy. Bot. Lap. 10: 237, 1913). – Horná Štubňa [Stubnya], flax fields – Diviaky [Divék], flax fields (both data Wagner, Jahrbuch des Ungarischen Karpathen-Vereins XXVIII: 57, 1901). **26b. Spišská kotlina Basin:** Lendak, flax field (Domin 1925, 1937 ined.). **28. Západné Beskydy Mts:** Habovka, flax fields – Zuberec, flax fields (both data Rechinger & Scheffer, Feddes Repert. Spec. Nov. Regni Veg. Beih. 31: 312, 1933). **29. Spišské vrchy Mts:** Lechnica, flax fields (Domin 1920 ined.).
Common data: 9. Biele Karpaty Mts. (southern part): Biele Karpaty Mts., region on foothill of the Javorina Hill, rare in flax fields (Holuby, Let. Matice Slov. 8: 5–43, 1871). **26b. Spišská kotlina Basin:** Spiš [Scepusii] (Wahlenberg 1814: 36). – surrounding of Poprad town (Scherffel, Jahrbuch des Ungarischen Karpathen-Vereins VI: 259, 281, 1879).