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The role of railway grounds in the areas of the Lublin-Lvov Upland and Volhynian-Podolian Upland in the expansion of anthropophytes of *Poaceae* family

Rola terenów kolejowych na obszarach Wyżyn Lubelsko-Lwowskiej i Wołyńsko-Podolskiej w rozprzestrzenianiu się antropofitów z rodziny *Poaceae*

SUMMARY

In the areas of railway routes, because of their specific and highly diversified habitat conditions (from seminatural to extremely ruderal), characteristic processes of synanthropization occur. Plants spread here both from nearby ecosystems and by being accidentally brought in with railway transport. In turn, species brought into railway grounds habitats can proliferate into the surrounding areas. The present paper describes the role of railway areas in the process of plant expansion. The carried out analysis of this synanthropization process was based on the example of stations of 31 anthropophytes of *Poaceae* family located in railway grounds and the surrounding areas of the Lublin-Lvov Upland and Volhynian-Podolian Upland.

STRESZCZENIE

W niniejszym opracowaniu, biorąc pod uwagę antropofity z rodziny *Poaceae*, dokonano oceny roli terenów kolejowych w rozprzestrzenianiu się tych gatunków w rejonie Wyżyny Lubelsko-Lwowskiej i Wyżyny Wołyńsko-Podolskiej. Analizowane stanowiska roślin przedstawiono na podstawie danych publikowanych w cytowanej literaturze i materiałów niepublikowanych zgromadzonych w komputerowej bazie zielnikowej. Wśród rozpatrywanej grupy antropofitów zdecydowanie ilościowo przeważają rośliny uznawane za charakterystyczne dla 10 różnej rangi jednostek fitosocjologicznych z klas *Stelarietea mediae* (14 gat.), *Molinio-Arrhenatheretea* (1 gat.), *Galio-Urticenea* (1 gat.) nad synantropami o nieokreślonej wierności fitosocjologicznej (7 gat.). Uwzględniając status geograficzno-historyczny, 16 gat. należy do archeofitów, 15 gat. do kenofitów. Ilościowo przeważają rośliny o pochodzeniu śródziemnomorsko-irano-turańskim i śródziemnomorskim (po 10 gat.) nad roślinami azjatyckimi (5 gat.), amerykańskimi (3 gat.) i o nieznanym

pochodzeniu (3 gat.). Analiza geograficznego rozmieszczenia stanowisk poszczególnych antropofitów pozwoliła na stwierdzenie faktu, że na terenach kolejowych rozprzestrzenia się prawie taka sama liczba trawiastych antropofitów (25 gat.) co na otaczających je obszarach wyżyn (26 gat.). Na uwagę zasługują jednak gatunki notowane wyłącznie lub częściej na siedliskach terenów kolejowych, których brak, bądź pojawiają się rzadko na obszarach sąsiadujących. Odnosi się to, w pierwszym przypadku, do *Aegilops cylindrica, Bromus willdenowii, Setaria verticillata,* a w drugim, do *Bromus japonicus* i *Eragrostis pilosa.* Stanowiska wymienionych roślin pochodzą prawdopodobnie z przypadkowego zawleczenia z transportem kolejowym. Nieliczna jest natomiast grupa antropofitów notowanych wyłącznie bądź częściej poza terenami kolejowymi. Odnosi się to w pierwszym przypadku do *Lolium multiflorum, L. remotum, L. temulentum,* a w drugim do *Anthoxanthum aristatum, Avena fatua, Bromus secalinus, Hordeum murinum.* Na terenach kolejowych, pod względem ilościowego występowania stanowisk, zdecydowanie przeważają gatunki rosnące pojedynczo, w rozproszeniu, nad gatunkami tworzącymi zwarte płaty.

Key words: anthropophytes of *Poaceae* family, stations, railway areas, Lublin-Lvov Upland, Volhynian-Podolian Upland.

INTRODUCTION

The geobotanical role of grasses and their expansion arouses increasingly greater interest in Poland (10, 12, 14, 16, 19, 21, 25). The purpose of the present study is to present the role of railway grounds in the expansion of anthropophytes of *Poaceae* family into the surrounding areas of the Lublin-Lvov Upland and Volhynian-Podolian Upland (Fig. 1). The information concerning the current distribution of the stations of investigated species in the railway grounds and the surrounding areas of the two Uplands was compiled on the basis of published data (3, 4, 11, 22, 23, 24, 27, 30) and those unpublished (herbarium collections, field reports). The data published by Fijałkowski (3, 4) relating to the stations of the investigated area were used only to a limited extent for information purposes.

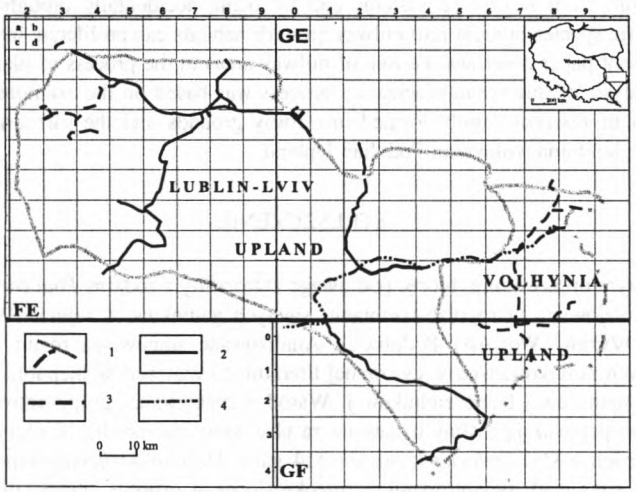

Fig. 1. Situation map of the area of investigations against the ATPOL grid. 1 — boundary of the country and macroregions, 2 — standard-gauge railway line, 3 — narrow-gauge line, 4 — wide-gauge (LHS)

The nomenclature of the investigated anthropophyte group was given according to Mirek et al. (15). The index of stations of the analyzed group of plants and basic information about them was included in the text. With each species investigated, there were additionally taken into account: its life-form, geographical and historical status (9, 13), geographical origin (18, 31), and phytosociological fidelity (13, 32).

The distribution of stations of individual anthropophytes was presented on maps (Fig. 2–32) against the ATPOL square grid fields proposed by Zając (28) for the territory of whole Poland. To localize stations connected with railway areas, squares with a side of 5 km×5 km (a, b, c, d) were used, while stations known from the surrounding areas of the two Uplands were presented in a square grid with a side of 10 km×10 km.

Explanations of Abbreviations

Plant life-forms: H — hemicryptophyte, T — terophyte. Geographical-historical elements: Arch — archaeophyte, Ag — agriophyte, Ep — epecophyte, Ef — ephemerophyte. Genetic elements: Asia — Asiatic, Am. — American, Ir.-Tur. — Irano-Turanean, Mdter. — Mediterranean, ukn. — unknown. Phytosociological elements: Ch/ Cl, O, All — characteristic species of class, order, and alliance respectively. Groups of plant stations: A — in railway areas, B — in the surrounding areas of the two Uplands, Stat. — station/stations, gat. — species. The following marks on the appended maps denote: • — stations in railway grounds, □ — stations located in the surrounding upland areas.

MATERIAL

The analyzed geobotanical material relates to the railway grounds and their surrounding areas of the Lublin-Lvov Upland and Volhynian-Podolian Upland (Fig. 1). The natural environment of these mesoregions is highly diversified in physico-geographical and geobotanical terms (1, 2, 8). They are upland areas dissected by river valleys, situated at 170–390 m above sea level and with a complex geological structure. In the outer substratum layer there predominate most often Quaternary loesses, loess-like and sandy formations, and boulder clay and alluvia (1, 6, 8). The Tertiary cretaceous bedrock often appears from under Quaternary covers. Spatially, the area in question is dominated by loess soils — brown, grey-brown and podzolic soils, less often rendzinas and para-rendzinas (26).

The climatic conditions in these areas are highly diversified (7, 33). The average annual air temperature ranges from 8.4°C–8.6°C. The average annual precipitation total ranges from 650–700 mm.

The total length of the investigated railway track section is ca. 650 km (Fig.1). It comprises three kinds of railway: standard-gauge, narrow-gauge and broad-gauge (20). The standard-gauge railway line is the main railway route that links Central-Polish uplands with the remaining part of Poland and Europe. The narrow-gauge railway located in the opposite ends of the investigated area has been successively dismantled since the 1960s. It functions only seasonally, on the route from Nałęczów to Karczmiska. The broad-gauge line, built in the 1980s on the Szczebieszyn–Hrubieszów route, has been used less and less often for well over a decade.

The investigated sections of railway lines run through areas with different habitat conditions, across farmland, meadows, forests, urban and industrial sites (22–24). There is a mosaic of different types of habitats here, from natural and seminatural to extremely specialized with a ruderal character. In the railway line grounds, habitat conditions are usually more or less onerous for plants for various reasons.

Conditions relatively favourable for plants are found on railway embankment slopes and track pits. However, in the habitats along railway tracks, in the vicinity of railway station buildings and on tops of railway embankments, where breakstone, gravel, sand and clay predominate in the substratum, there are conditions not conducive to the development of plant cover. Also worth noting is the fact that in the railway grounds the plant cover is periodically destroyed mechanically and chemically in order to protect railway traffic.

THE SURVEY OF STATIONS

Alopecurus myosuroides Huds. T, Arch., Mdetr. Ch/Cl:. *Stellarietea mediae.* Fig.2. **A.** Stat. published by Święs, Wrzesień (22): **GE/**83a, 85b, 86b. **B.** Stat. published by Kucharczyk (11). The species regarded as extinct in the Lublin region (5).

Apera spica-venti (L.) Beauv. T, Arch., unk. Ch/Cl:. *Stellarietea mediae.* Fig. 3. **A.** Stat. unpublished: **FE/**03c, d, 14a, 18c, 22d, 24b, d, 25a, b, 26c, 27d, 28a, d, 32b, 33a, b,d, 34a, c,d, 36b, d, 37a, b,c, 39a, b, 46a, b,d, 56b, c, 65a, b, 66a, d, 75bc, 76bc, 84b, 85a. **GE**30a, d, 52c, 57d, 62a, c, 67c, d, 68a, 72a, c,d, 73c, 76d, 77a, b, 81c, d, 82a, b, 83a, b, 84a, 86a, d, 91c, 96b, d. **GF/**00b, 01b, 02c, 05b, 06a, b, 07a, b,c, 12b, 14c, 24b, 25d, 34c, d, 44a. **B.** Stat. published by Zając (24).

Avena fatua L. T, Arch., Ir.-Tur. Ch/O: *Centauretalia cyani.* Fig. 4. **A.** Stat. unpublished: **FE/**28c, d, 37d, 39a, b, 46a, 65b, 76b. **GE/**52d, 72a, 76d, 81c, 82a, 83a. **GF/**24b, 35b, 44a. **B.** Stat. published by Zając (24).

A. strigosa Schreb. T, Arch., Mdetr. Ch/Cl: *Stellarietea mediae.* Fig. 5. **A.** Stat. unpublished: **FE/**28d. **B.** Stat. published by Zając (24).

Bromus arvensis L. T, Arch., N-Mdetr. Ch/O: *Centauretalia cyani.* Fig. 6. **A.** Stat. published by Święs, Wrzesień (22): **GE/**81c, 82a, 85a. **B.** Stat. published by Kucharczyk (11). The species regarded as extinct in the Lublin region (5).

B. secalinus L. T, Arch., Mdetr. Ch/O: *Centauretalia cyani.* Fig. 7. **A.** Stat. unpublished: **FE/**27d, 28d, 36b, 39a, 46a, 65b, 66a, 76b. **GE/**20d, 72a, 76d, 77b, 81c, 82a, 83a, 84b, 96b. **GF** /01a, 44a. **B.** Stat. published by Zając (24).

B. sterilis L. T, Arch., Mdetr.-Ir.-Tur. Ch/O: *Sisymbrietalia.* Fig. 8. **A.** Stat. published by Święs, Wrzesień (24): **FE/**28d, 46a, 65b, 76b. **GE/**52b, 72a, 82a, 83a. **GF/**00b. **B.** Stat. published by Zając (24).

B. tectorum L. T, Arch., Mdetr.-Ir.-Tur. Ch/O: *Sisymbrietalia.* Fig. 9. **A.** Stat. unpublished: **FE/**03c, d, 14a, 18c, 22d, 24b, d, 25a, b, 26c, 27d, 28a, c,d, 32b, 33a, b,d, 34a, c,d, 36b, d, 37a, b,c, 39a, b, 46a, b,d, 56b, c, 65a, b, 66a, d, 75b, c, 76b, c, 84b, 85a, **GE/**20d, 30a, d, 52c, 57d, 62ac, 67c, d, 68a, 72a, c,d, 73c, 76d, 77a, b, 81c, d, 82a, b, 83a, b, 84a, 86a, d, 91a, c, 96b, d. **GF/**00a, b, 01b, 02c, 05b, 06a, b, 07a, b,c, 12b, 14c, 24b, 25d, 34c, d, 44a. **B.** Stat. published by Zając (24).

Digitaria ischaemum (Schreb.) H. L. Mhl. T, Arch., unk. Ch/All: *Panico-Setarion.* Fig. 10. **A.** Stat. unpublished: **FE/**03d, 14d, 18c, 22d, 24b, d, 25b, 26c, 27d, 28d, 32b, 33a, b,d, 34a, c,d, 37b, c, 39a, 56c, 65a, b, 66a, 75b, c, 76b, 84b. **GE/**30d, 62a, c, 67bc, 68a, 72a, c, 73c, 76d, 81c, d, 82a, b, 83b, 84a, 86b, d, 91c, 98c. **GF/**00b, 01b, 02c, 05b, 06b, 07a, c, 17a, 24b, 25d, 35b, 44a. **B.** Stat. published by Zając (24).

D. sanguinalis (L.) Scop. T, Arch., Asia. Ch/All: *Panico-Setarion.* Fig. 11. **A.** Stat. unpublished: **FE/**03d, 13b, 24b, 25a, b, 28c, d, 33b, c,d, 34c, 36d, 37a, 39a, 46b, 56b, 65b, 66a, 84b. **GE/**52d, 72a, 76d, 81d, 82a, 83a. **GF/**12a, 35b. **B.** Stat. published by Zając (24).

Hordeum murinum L. T, Arch., Mdetr.-Ir.-Tur. ChO: *Sisymbrietalia.* Fig. 12. **A.** Stat. published by Święs, Wrzesień (24): **FE/**28c, **GE/**82b. **B.** Stat. published by Zając (24).

Echinochloa crus-gali (L.) P. Beauv. T, Arch., Asia. Ch/O: *Polygono-Chenopodietalia.* Fig. 13. **A.** Stat. unpublished: **FE/**03d, 18c, 22d, 24b, d, 25b, 26c, 27d, 28d, 32b, 33a, b,d, 34a, c, 37a, b, 39a, 46a, d, 56c, 65a, b, 66a, 75b, c, 76b, 84b. **GE/**30d, 62a, c, 67b, c, 68a, 72a, c, 73c, 76d, 77a, b, 81c, d, 82a, b, 83b, 84a, 85b, 86b, d, 91c, 98c. **GF/**00b, 01b, 02c, 05b, 06b, 07a, c, 17a, 24b, 25d, 35d, 44a. **B.** Stat. published by Zając (24).

Lolium remotum Schrank. T, Arch., Mdetr. Ch/All: *Lolio-Linion.* Fig. 14. **A.** Absence of data. **B.** Stat. published by Zając (24).

Lolium temulentum L. T, Arch., Mdetr. Ch/O: *Centauretalia cyani.* Fig. 15. **A.** Absence of data. **B.** Stat. published by Zając (24).

Setaria italica (L.) P. Beauv. T, Arch., unk. The synanthrope with indeterminate phytosociological fidelity. Fig. 16. **A.** Stat. unpublished: **FE/**28d. **B.** Absence of data.

S. pumila (Poir.) Roem. & Schult. T, Arch., Asia. Ch/All: *Panico-Setarion.* Fig. 17. **A.** Stat. unpublished: **FE/**03d, 18c, 22d, 24bd, 25b, 26c, 27d, 28d, 32b, 33a, b,d, 34a, c, 37a, b, 39a, 46a, d, 56c, 65a, b, 66a, 75bc, 76b, 84b. **GE/**30d, 62a, c, 67b, c, 68a, 72a, c, 73c, 76d, 81c, d, 82a, b, 83b, 84a, 85b, 86b, d, 91c, 97c. **GF/**00b, 01b, 02c, 05b, 06b, 07ac, 17a, 24b, 25d, 35d, 44a. **B.** Stat. published by Zając (24).

S. verticillata (L.) P. Beauv. T, Arch., Asia. Ch/O: *Sisymbrietalia.* Fig. 18. **A.** Stat. published by Święs, Wrzesień (24): **FE/**27d, 28c. **B.** Absence of data.

S. viridis (L.) P. Beauv. T, Arch., Ch/All: *Panico-Setarion.* Fig. 19. **A.** Stat. unpublished: **FE/**03c, d, 14a, d, 18c, 22d, 24b, d, 25a, b, 26c, 27d, 28a, c,d, 32b, 33a, b,d, 34a, c,d, 36b, d, 37a, b,c, 39a, b, 46a, b,d, 56b, c, 65a, b, 66a, d, 75b, c, 76b, c, 84b, 85a. **GE/**30a, d, 52c, 57d, 62a, c, 67c, d, 68a, 72a, c,d, 73c, 76d, 77a, b, 81c, d, 82a, b, 83a, b, 84a, 86a, d, 91c, 96b, d. **GF/**00b, 01b, 02c, 05b, 06a, b, 07a, b,c, 12b, 14c, 24b, 25d, 34c, d, 44a. **B.** Stat. published by Zając (24).

Anthoxanthum aristatum Boiss. T, Ep. Mdetr.-Ir.-Tur. Ch/All: *Arnoseridion minimae.* Fig. 20. **A.** Stat. published by Święs, Wrzesień (24): **FE/**18d, **GE/**30d. **B.** Stat. published by Zając (24).

Bromus carinatus Hook. & Arn. Ag. am. Ch/Cl: *Molinio-Arrhenatheretea.* Fig. 21. **A.** Stat. published by Święs, Wrzesień (22, 23): **GE/**30d, 72c, 76d, 81bc, 82b, 84b. **FE/**27d, 37a, 46b, 66b. **B.** Stat. published by Zając (24).

B. japonicus Thunb. & Murr. T, Ep. Mdetr.-Ir.-Tur. Ch/O: *Sisymbrietalia.* Fig. 22. **A.** Stat. published by Święs, Wrzesień (22, 23, 24): **GE/**52d, 62a, c, 72a, 76d, 77b, c, 81d, 82a, b, 83a, b, 84b, 85a, 91a, d. **GF/**01b, 24a, 25a, d, 35d. **FE/**03d, 14d, 18d, 25b, 26c, 27d, 28a, c,d, 36d, 37a, b,d, 46a, d, 56d, 66a, d, 75c, 76bc, 84b. **B.** Stat. published by Kucharczyk (11).

B. squarrosus L. T, Ep. Mdetr.-Ir.-Tur. Ch/O: *Sisymbrietalia.* Fig. 23. **A.** Stat. published by Święs, Wrzesień (22, 23): **GE/**62a, 77a, 82a, b, 84a, **FE/**56b, 66a. **B.** Stat. published by Fijałkowski (3, 4).

Eragrostis minor Host T, Ep. Ir.-Tur. ChAll: *Eragrostion.* Fig. 24. **A.** Stat. unpublished: **FE/**03d, 13b, 14a, d, 18d, 24b, c,d, 25a, b, 26c, 27d, 28a, c,d, 29a, 33a, b,d, 34d, 36b, 37a, 39a, 46b, 56b, 65b, 66a, 75d, 76b, 84b. **GE/**20d, 30a, d, 52d, 72a, 73b, 76d, 77b, 81c, 82b, 85a, 86d, 98c. **GF/**01a, 02c, 05b, 06b, 13c, 24b, 25d, 34b, 44a. **B.** Stat. published by Zając (24).

E. pilosa (L.) P. Beauv. T, Ep. Mdetr. ChAll: *Chenopodion fluviatile.* Fig. 25. **A.** Stat. published by Święs, Wrzesień (22, 23): **GE/**76, **GF/**05b, 44a. **FE/**03d, 14a, 25ab, 27d, 36a, 37c, 65b, 76b. **B.** Stat. published by Zając (24).

Lolium multiflorum Lam. H. Ag. Mdetr. The synanthrope with indeterminate phytosociological fidelity. Fig. 26. **A.** Absence of data. **B.** Stat. published by Zając (24).

Aegilops cylindrica Host. T. Ef. Asia. Ch/O: *Sisymbrietalia.* Fig. 27. **A.** Stat. published by Święs, Wrzesień (22, 23, 24): **GE/**62a, 76cd, 77b, 82b, 83b. **GF/**35bc. **FE/**27d, 28c, 46b, 65b, 66a, 75b, 76bc, 84b. **B.** Absence of data.

Avena sterilis L. T. Ef.. Mdetr.-Ir.-Tur. The synanthrope with indeterminate phytosociological fidelity. Fig. 28. **A.** Stat. unpublished: **FE/**27d, 28c. **GE/**82b, 83b. **B.** Absence of data.

Bromus willdenowii (Huds.) P. Beauv. T. Ef. Am. The synanthrope with indeterminate phytosociological fidelity. Fig. 29. **A.** Stat. unpublished: **FE**18c. **B.** Absence of data.

Panicum capillare L. T. Ef. Am. The synanthrope with indeterminate phytosociological fidelity. Fig. 30. **A.** Stat. published by Fijałkowski (3, 4): **FE**/27d, 28c. **B.** Absence of data.

Phalaris canariensis L. T. Ef. Mdetr. The synanthrope with indeterminate phytosociological fidelity. Fig. 31. **A.** Stat. Published by Fijałkowski (3, 4): **FE**/13b, 18d, 24b. **B.** Absence of data.

Vulpia bromoides (L.) S. F. Gray T. Ef. Mdetr. The synanthrope with indeterminate phytosociological fidelity. Fig. 32. **A.** Stat. published by Fijałkowski (3, 4): **FE**/28c. **B.** Absence of data.

RESULTS

Worth noting are numerous reported similarities and differences between the flora of anthropophytes of *Poaceae* family found in the railway grounds and their surrounding areas of the Lublin-Lvov Upland and Volhynian-Podolian Upland (Figs 2–32). A total of 31 grass species classified as anthropophytes were recorded. In this group the number of archeophytes is almost the same as that of kenophytes (16 and 15 species).

There is a definite numerical predominance of plants regarded as characteristic of 10 higher phytosociological units of different rank, of classes *Stelarieta mediae* (15 species), *Molinio-Arrhenatheretea* (one species), *Galio-Urticenea* (one species) over synanthropes with indeterminate phytosociological fidelity (7 species).

Among the investigated group of anthropophytes there is a predominance of Mediterranean-Irano-Turanean and Mediterranean elements (10 species each) over Asiatic (5 species) and American (3 species) elements and plants of unknown origin (3 species). However, with respect to affiliation to life-forms there is an absolute numerical predominance of terophytes (29 species) over hemicryptophytes (2 species).

Out of the plant group investigated, the following occur in railway grounds exclusively: *Aegilops cylindrica, Avena strigosa, Bromus willdenowii, Phalaris canariensis, Setaria italica, S. verticillata, and Vulpia bromoides* (Fig. 27, 5, 29, 31, 16, 18, 32). The stations of these plants come probably from being accidentally brought in with railway transport.

Exclusively outside the railway grounds, in their surrounding upland areas, the stations of *Lolium remotum, L. temulentum* and *L. multiflorum* were reported (Fig. 14, 15, 26). The remaining anthropophytes occur with varying frequency in both investigated areas under comparison.

However, the species such as *Eragostis pilosa, Bromus carinatus, B. japonicus, B. squarrosus* are more often reported in railway ground habitats than outside them. Stations of *Avena fatua, Anthoxanthum aristatum, Bromus secalinus* and

Hordeum murinum are mostly known, however, from the areas outside railway lines.

A considerable part of graminaceous anthropophytes belong to generally common species that occur in different types of habitats, both of railway grounds and their surrounding upland areas. Examples of these plants are: *Apera spica-venti, Bromus tectorum, Digitaria sanguinalis, Echinochloa crus-galli, Setaria pumila, S. viridis* (Fig. 3, 9, 11, 13, 17, 19). They are all characterized by exceptionally high fertility and the ease with which they spread in new habitat types.

Among the investigated group of anthropophytes, special attention should be given to the stations of *Alopecurus myosuroides* and *Bromus arvensis*, the species regarded as extinct in the Lublin region (4) and reported at present in the habitats of railway areas of the Volhynian-Podolian Upland (Fig. 2, 6). On the other hand, the presence of stations of *Eragostis pilosa* and *Aegilops cylindrica* (Fig. 25, 27) on the eastern bank of the Vistula river suggests the probability of having been brought with railway transport from the Ukrainian territories, where they occur comparatively frequently (17). This confirms thereby the role of these areas in the process of expansion of alien grass species and their excellent capacity to colonize open areas with a possibility of further migration into the neighbouring territories.

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