

NOTES ON THE ENIGMATIC *THESIUM LINOPHYLLON* AND REPORT ON *THESIUM RAMOSUM* IN LITHUANIA

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## Abstract

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Two species of the genus *Thesium* (*T. ebracteatum* and *T. linophyllum*) are constantly recognized as members of the flora of Lithuania. However, the study on plants currently occurring in Lithuania and usually identified as *T. linophyllum* revealed that in fact they belong to *T. ramosum*. The analysis of all available data on the occurrence of *T. linophyllum* in Lithuania indicated that this species has never been recorded. The report on the occurrence of *T. linophyllum*, published at the end of the 18th century, was based on misidentified *T. ebracteatum*. Thus, *T. linophyllum* should be excluded from the list of vascular plants of Lithuania. Occurrence of *T. ramosum* was reported for the first time in the country. Currently, one population of this species with two subpopulations are known in the environs of Varnikai village (Trakai distr., Trakai Historical National Park). Morphological description of *T. ramosum* and diagnostic features of this species were provided. The structure and habitat conditions of two subpopulations were investigated in 2017. The present population of this species was revealed to consist of 52 individuals. Occurrence of young individuals in one subpopulation indicates generative reproduction of *T. ramosum*. Negative relationship between the number of *T. ramosum* individuals and the coverage of Poaceae species, and positive relationship between the coverage of Fabaceae species were revealed. Localities of *T. ramosum* in Lithuania are far from the area of its native distribution, and this species is ascribed to the group of established alien species. Further spread and invasion of the species is not expected.

**Keywords:** alien species, conservation, distribution, establishment, native species, population structure, reproduction, Santalaceae.

## INTRODUCTION

The genus *Thesium* L. (Santalaceae) includes about 330 hemiparasitic species and is the largest genus in the order Santalales (NICKRENT et al., 2010). Though molecular phylogenetic studies have revealed six clades classified as separate families with Thesiaceae among them (NICKRENT et al., 2010; NICKRENT & GARCÍA, 2015), in the latest Angiosperm Phylogeny Group classification for the orders and families of flowering plants (APG, 2016) the family Thesiaceae has not been accepted and has been included into Santalaceae.

Species of *Thesium* are distributed in Europe, Africa, Asia, Australia, South America and introduced

in North America (NICKRENT et al., 2010; NICKRENT & GARCÍA, 2015). The highest diversity of the genus *Thesium* is in Southern Africa, where at least 160 species are found. At least 82 species of this genus are distributed in Tropical Africa, 79 species in Eurasia, whereas in South America this genus is represented by three species (MOORE et al., 2010).

Most of 25 *Thesium* species registered in Europe (HENDRYCH, 1993) are distributed in the Mediterranean region and in European mountains, whereas further to the North, only a few species occur (HENDRYCH, 1993; UOTILA, 2011). *Thesium alpinum* L., which is recorded in Leningrad region of Russia (about 60 N), and *T. ebracteatum* Hayne, occurring in Estonia (60 N), are distributed at the northernmost

limit of the native range of the genus (JALAS & SUOMINEN, 1976; TZVELEV, 1996; UOTILA, 2011).

The genus *Thesium* is poorly represented in Lithuania, because the country is close to the northern limit of its distribution area. Since the 1830s, two *Thesium* species, i.e. *T. ebracteatum* and *T. linophyllum* L., have been recognized as members of the flora of Lithuania (JUNDZILL, 1830; SNARSKIS, 1954, 1968; JALAS & SUOMINEN, 1976; LEKAVIČIUS, 1961, 1989; LEKAVIČIUS et al., 1993; UOTILA, 2011).

The diversity of *Thesium* species in the countries adjacent to Lithuania is also quite low. Three species of the genus *Thesium* have been recorded in Estonia: the native *T. ebracteatum* and alien *T. ramosum* and *T. refractum* C.A. Mey. (EICHWALD, 1971; LEKAVIČIUS et al., 1993; KUKK, 2013). In Belarus, two species of *Thesium* have been reported: *T. ebracteatum* and *T. ramosum* (PARFENOV, 1999). In Latvia, this genus is represented by two native (*T. ebracteatum* and *T. alpinum*) and one alien (*T. ramosum* Hayne, reported as *T. arvense* Horv.) species (GAVRILOVA & ŠULCS, 1999; PRIEDĪTIS, 2014). *T. alpinum* is a very rare endangered species recorded in two localities in the eastern part of Latvia (BARONIŅA, 2003; PRIEDĪTIS, 2014). Four *Thesium* species occur in Poland: *T. alpinum*, *T. ebracteatum*, *T. linophyllum* and *T. pyrenaicum* Pourr. Occurrence of *T. bavarum* Schrank in Poland is doubtful (MIREK et al., 1995). Furthermore, *T. pyrenaicum* is treated as regionally extinct in Poland (KAŹMIERCZAKOWA et al., 2016).

*Thesium ebracteatum* and *T. linophyllum* have been included into the *List of protected animal, plant and fungi species of Lithuania* (APLINKOS MINISTERIJA, 2007; GUDŽINSKAS, 2007). In 2016, the project on evaluation of protected species of Lithuania, applying the IUCN criteria, was initiated and we started the studies on state of populations, habitats and conservation measures of the selected plant species, including *T. linophyllum*. There were some doubts concerning the identity of *T. linophyllum* during the field investigations in summer 2017, because certain plant features were different compared to plants of this species observed in Central Europe. Later, the study on the collected specimens revealed that plants, currently occurring in Lithuanian and earlier identified as *T. linophyllum*, in fact belong to other species, i.e. *T. ramosum*.

The aim of this research was to evaluate all

available data on the occurrence of *T. linophyllum* in Lithuania, and to study the distribution, habitats, structure of populations and evaluate the status of newly discovered *T. ramosum*.

## MATERIALS AND METHODS

Field studies on *T. ramosum* were performed in June and July 2017. Population of this species was investigated in Trakai district (the south-eastern part of Lithuania), the Varnikai Botanical and Zoological Reserve of Trakai Historical National Park. The population consisted of two subpopulations separated by about 350 m wide swamp forest and Lake Baluosys. Both studied subpopulations occurred in dry grassland habitats abandoned for at least seven years. The first subpopulation (54.639326° N; 24.957938° E) located near the road Trakai–Varnikai was on a gentle (about 2°) south-western slope. The second subpopulation (54.639666° N; 24.962845° E) was found at the foot of a steep slope, in a flat area along seldom used field track, which was situated between the edge of forest and the north-eastern shore of Lake Baluosys.

Two subpopulations were examined in transects of 20 sampling plots of 1 m<sup>2</sup> (1 × 1 m sides). In each sampling plot, the coverage of the studied species, all herbs, bryophytes, lichens, woody species, bare soil and debris were estimated in the percentage scale (from 0.1% to 100%). The height of the herb layer was measured at two points on opposite sides of each sampling plot.

All individuals of *T. ramosum* were evaluated according to their development stage, and grouped according to the presence or absence of flowers (vegetative or generative individuals). The height of the highest shoot was measured using ruler as well as the number of vegetative and generative shoots of each plant were counted. Herbarium specimens collected during this study were deposited at the Herbarium of the Institute of Botany of the Nature Research Centre (BILAS). The list of the studied specimens of *T. ramosum* from Lithuania and additional specimens of this and other species used for comparison and illustrations is presented in Appendix I. The list of specimens is arranged chronologically.

Analysis of the collected data was performed employing *Statistica 8* software. Normality of the data

distribution was evaluated using the Shapiro-Wilk test. Because a part of the data sets were not normally distributed, correlations between the data sets were tested applying Spearman's rank correlation test. Descriptive statistical analysis includes mean value and standard deviation (mean  $\pm$  SD).

## RESULTS

### What is *Thesium linophyllum* in Lithuania?

*Thesium linophyllum* as a member of the flora of Lithuania was mentioned at the end of the 18th century, when S.B. JUNDZILL (1791) indicated it occurring in the environs of Vilnius. Other botanists following the reports by JUNDZILL (1791, 1811) included *T. linophyllum* into the lists of plants of Vilnius region (ZELENCOV, 1890; MOWSZOWICZ, 1938) or treated as a member of the flora of Lithuania (SNARSKIS, 1954, 1968; LEKAVIČIUS, 1961, 1989; LEKAVIČIUS et al., 1993; UOTILA, 2011, etc.). However, in the checklist of vascular plants of Lithuania (GUDŽINSKAS, 1999), *T. linophyllum* was marked as doubtfully recorded species in Lithuania.

In 2003, *Thesium* plants with two bracteoles were found in Trakai district. By using local manuals for plant identification, they were determined as *T. linophyllum* (KRIAUCIŪNIENĖ, 2007). Therefore, this species was included into the list of protected species of Lithuania (APLINKOS MINISTERIJA, 2007; GUDŽINSKAS, 2007).

As it was already mentioned, JUNDZILL (1791) was the first, who reported *T. linophyllum* occurring in the environs of Vilnius. It should be noted that the name was frequently spelled as '*T. linophyllum*', and this spelling, hereafter, is retained when used in cited references. In the second edition of his work on the flora of Lithuania, JUNDZILL (1811) reported this species applying the name *T. intermedium* Schrad., and indicated its occurrence in the environs of Ribiškės (currently the south-eastern part of Vilnius). It is not clear, whether the reports by JUNDZILL (1791, 1811) were based on the same or on two separate records. However, localities of many other species in the environs of Vilnius, mentioned in the first edition (JUNDZILL, 1791), were provided more precisely in the second edition of his work (JUNDZILL, 1811). Thus, we suppose that the report of *T. linophyllum* was based on the same record, but in the later pub-

lication he provided more precise information about the locality of the species.

There are many more questions to consider the identity of *Thesium* species described by JUNDZILL (1791, 1811). Brief description of *T. linophyllum* provided by JUNDZILL (1791) in the first edition of his publication is very close to *T. ebracteatum*, especially some its features, e.g. stem simple, about 15 cm tall, flowers in May. In the second edition, Latin name of the plant was changed to *T. intermedium*, and the author provided short Latin description: *caule stricto, elongato; foliis lineari lanceolatis, trinerviis; panícula foliacea* (JUNDZILL, 1811), which was taken from the publication of SCHRADER (1794) without changes. However, in this edition, in Latin and Polish descriptions, the most important diagnostic features were not indicated, but the height of plants (about 15 cm [1/4 łokciowe]) better fits to *T. ebracteatum* than to *T. linophyllum*.

J. JUNDZILL (1830) described two species of the genus *Thesium*: *T. linophyllum* and *T. ebracteatum*. At the end of the description of *T. linophyllum*, he provided synonym *T. intermedium* Schrad. In this work, Latin and Polish descriptions contain the main diagnostic features of *T. linophyllum* (*pedunculis bracteatis*) and of *T. ebracteatum* (*pedicellis ebracteatis*). However, J. JUNDZILL (1830) did not indicate any localities for both species and just mentioned that they grew together. In the herbarium of Józef Jundziłł, which is deposited at the Herbarium of Jagiellonian University (Krakow, Poland), there is one specimen of *Thesium* with the label "*Thesium ebracteatum* Hayne c.v. *Zinophyllum*, z okolic Wilna" (KÖHLER, 1995). According to KÖHLER (1995), a part of hand-written text is difficult to read, but in our opinion, after the abbreviation (c.v.) probably follows word '*Linophyllum*' with intricately written capital 'L'. This herbarium specimen was identified as *T. ebracteatum* (KÖHLER, 1995). Thus, the analysis of all available information enabled us to conclude that JUNDZILL (1791) named *T. ebracteatum*, which was described almost a decade later by HAYNE (1800), as *T. linophyllum*. He selected this name as the most convenient from among four *Thesium* species described by LINNAEUS (1753): *T. linophyllum*, *T. alpinum*, *T. capitatum* and *T. umbellatum*. When SCHRADER (1794) described *T. intermedium*, JUNDZILL (1811) accepted this name instead of previously used

*T. linophyllum*. Probably, he noticed contradictions between the meaning of that name and plants, which were recorded by him in the environs of Vilnius.

The Herbarium of Jean Emmanuel Gilibert at the M.H. Kholodny Institute of Botany (Kiev, Ukraine) contains four sheets of *Thesium* plants from the environs of Grodno (*Circa Grodnam*) with initial identification as *T. linophyllum*. Examination of these specimens proved that in fact they belong to *T. ebracteatum* (SHIYAN et al., 2013). This fact also supports an assumption that at the end of the 18th and at the beginning of the 19th centuries the name *T. linophyllum* was frequently misapplied for *T. ebracteatum*.

Thus, summarizing the analysis of all available data we can conclude that *T. linophyllum* (frequently spelled '*T. linophyllum*') has been reported erroneously in Lithuania, and the name as well as its synonyms *T. intermedium* Schrad. and *T. linifolium* Schrank. have been misapplied for *T. ebracteatum*. Therefore, *T. linophyllum* in fact was not recorded in Lithuania in the 18th and the 19th centuries, and all later reports (ZELENCOV, 1890; MOWSZOWICZ, 1938; SNARSKIS, 1954, 1968; LEKAVIČIUS, 1961, 1989; JALAS & SUOMINEN, 1976; LEKAVIČIUS et al., 1993; UOTILA, 2011, etc.) based on information provided by JUNDZILL (1791, 1811) are unjustified.

### ***Thesium ramosum***

*Thesium ramosum* Hayne, J. Bot. (Schrader), 1: 30. 1800. – Perennial plant with several to many (up to 20, occasionally more) ascending or erect, 15–40 cm tall stems, arising from capitate rootstock. Leaves linear to linear oblong, 5–40 mm long and 1–3 mm wide. Stem ridges and leaves covered with small, about 0.1–0.2 mm long translucent papillae. Inflorescence is a raceme usually branched in the lower part. Bract usually about 3–4 times (up to 8 times) longer than nut. Bracteoles two, slightly shorter than nut or up to two times longer. Flowers white, perianth infundibular, about 2.5 mm in diameter, with narrowly triangular lobes (Fig. 1). Fruit ellipsoid, longitudinally nerved, about 3 mm long and 1.5–2 mm wide nut. Perianth persistent, 3–5 times shorter than nut. Pedicel slightly swollen.

The native distribution area of this species in Europe stretches to the South and East from Austria and the Czech Republic, including the Balkan Peninsula, Ukraine, the south-eastern part of Russia, the

Caucasus, West, South-West and Central Asia to the Tian-Shan Mountains (JALAS & SUOMINEN, 1976; HENDRYCH, 1993; TZVELEV, 1996; UOTILA, 2011). According to HENDRYCH (1961), *T. ramosum* has the largest area of distribution among all species of the genus *Thesium*.

In Lithuania, *T. ramosum* was first recorded on 10 June 2003 by A. Kriauciūnienė in the environs of Varnikai village (Trakai district, Trakai Historical National Park). In dry meadow formed on sandy soil, one flowering individual with four generative shoots was found and identified as *T. linophyllum* (KRIAUCIŪNIENĖ, 2007). Next year, she discovered another group of plants in the environs of Varnikai village, in a meadow at the forest edge. In that locality, 26 flowering individuals were registered. Both localities were separated by bog woodland and lake.

Approximately in the same year, Ž. Lazdauskaitė recorded *Thesium* species in village Rykantai (Trakai district), on a slope near the railway embankment and identified it as *T. linophyllum* (GUDŽINSKAS, 2007).



Fig. 1. Upper part of flowering shoot of *Thesium ramosum* in the environs of Varnikai village

However, herbarium specimen from that locality is not available, and it is impossible to verify the accuracy of the determination. The search for this species in 2006–2007 in the same locality was unsuccessful. Further studies of the locality are required, though extinction of these plants is not excluded. Nevertheless, we suspect that plants from Rykantai also may belong to *T. ramosum*.

### Diagnostic characters of *Thesium* species

*T. ramosum*, newly reported in Lithuania, is easily distinguishable from *T. ebracteatum* by the presence of two bracteoles (Fig. 2, a), several to numerous stems growing from the rootstock and usually much branched inflorescence. *T. ebracteatum* is characterized by the absence of bracteoles (Fig. 2, d), solitary shoots growing from underground rhizomes and usually unbranched stem and inflorescence (if the stem is branched, then lateral branches usually are sterile and grow from the lower part of the stem). *T. ramosum* differs from *T. linophyllum* by the type of the inflorescence. Inflorescence of *T. linophyllum* is a panicle composed of dichasia, i.e., the lower and middle part of the inflorescence is composed of multifloral branchlets (Fig. 2, b). The inflorescence of *T. ramosum* is branched below; however, all branchlets in the inflorescence are with one flower. *T. ramosum* also differs from *T. linophyllum* and *T. bavarum* Schrank (= *T. linophyllum* subsp. *montanum* (Schrad.) Čelak.) by the length of bracts. Bracts of *T. ramosum* are distinctly longer than flowers (only occasionally sub-equal), whereas bracts of *T. linophyllum* are equal with flowers and later become shorter than fruit (Fig. 2, b). It should be noted that *T. linophyllum* is a rhizomatous plant, whereas *T. ramosum* and *T. bavarum* have no rhizomes, and stems usually grow from rootstock. Another species quite similar to *T. ramosum* is *T. alpinum*. *T. ramosum* from this species is easily distinguished by flowers with five perianth lobes, whereas flowers of *T. alpinum* are predominantly with four perianth lobes. Another important and reliable character is the length of persistent perianth, which is about twice shorter than nut in *T. ramosum* and 2–3 times as long as nut in *T. alpinum* (Fig. 2, c). It should be noted that stem ridges, especially in the upper part, leaves and pedicels of all studied plants of *T. ramosum* from Lithuania, Ukraine and the Caucasus are quite densely covered by almost translucent short (0.1–0.2 mm)



Fig. 2. Branchlets with fruit, bract and bracteoles of *Thesium ramosum* (a), *Thesium linophyllum* (b), *Thesium alpinum* (c) and *Thesium ebracteatum* (d)

papillae, whereas the studied specimens of *T. linophyllum* from the Czech Republic and *T. alpinum* from Slovakia are without papillae.

### Characteristics of habitats

Two studied subpopulations of *T. ramosum* in the environs of Varnikai village occurred in dry abandoned grasslands (Fig. 3) on sandy soil with admixture of gravel. Coverage of the herb layer in the community of the first subpopulation was 60%, and in the community of the second subpopulation it was 80% (mean coverage 70%). The most abundant and frequent species of the herb layer in both subpopulations were *Achillea millefolium*, *Dactylis glomerata*, *Festuca rubra*, *Medicago falcata*, *Pilosella officinarum*, *Plantago lanceolata*, *Poa pratensis*. Community of the first subpopulation was characterized by higher diversity and abundance of xerothermic species such as *Arabis hirsuta*, *Artemisia campestris*, *Campanula rotundifolia*, *Carex ericetorum*, *Echium vulgare*, *Helianthemum nummularium*, *Polygala comosa*, *Po-*



Fig. 3. Habitat of *Thesium ramosum* in the environs of Varnikai village

*tentilla arenaria*, *Ranunculus bulbosus*, *Sedum acre* and *Seseli annuum*. Habitat of the second subpopulation was characterized by slightly higher presence of mesic species such as *Anthoxanthum odoratum*, *Festuca pratensis*, *Galium mollugo*, *Helictotrichon pubescens*, *Pimpinella saxifraga*, *Trifolium pratense* and *Vicia cracca*.

Coverage of the bryophyte layer in both habitats ranged from 40% to 50%. The most abundant bryophyte species in both plant communities were *Abietinella abietina*, *Rhytidiadelphus squarrosus* and *Racomitrium canescens*. In the community of the first subpopulation, lichen species of the *Cladonia* and *Peltigera* genera were recorded, however, their coverage was about 1%.

The shrub layer covered about 10% of both studied habitats, in which *Pinus sylvestris* was the most abundant species. Other woody species (*Betula pendula*, *Frangula alnus*, *Quercus robur*, etc.) were presented by solitary individuals in both communities.

Because of the abandonment, a thick layer of plant debris in both plant communities was formed. Coverage of plant debris in individual sampling plots ranged from 5% to 82% of the surface, however, the mean coverage of plant debris was 40.5% and was similar in both communities (40.0% in the community of the first and 40.9% of the second subpopulation).

#### Size and structure of the population

Detailed studies on the density and size of both subpopulations of *T. ramosum* revealed significant differences between the number and density of individuals. In all sampling plots of the first subpopulation, 21 individuals of *T. ramosum* were recorded. The second subpopulation was significantly smaller and consisted of seven individuals only. The mean density of individuals in the densest part of the first subpopulation was  $1.05 \pm 1.36$  individuals/m<sup>2</sup>, whereas in the entire second subpopulation it was  $0.35 \pm 0.75$  individuals/m<sup>2</sup> (Fig. 4).

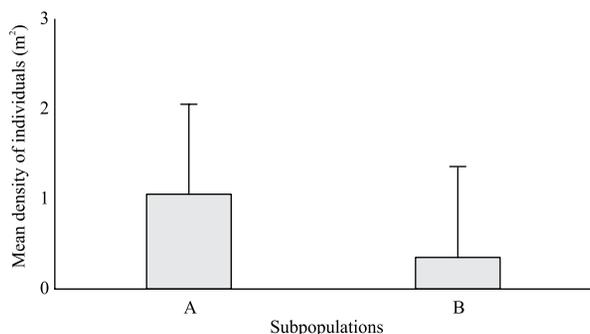


Fig. 4. Mean density of *Thesium ramosum* individuals in the first (A) and the second (B) subpopulations in the environs of Varnikai village

The highest number of individuals recorded in the sampling plot of the first subpopulation was five individuals, whereas that of the second subpopulation – three individuals. The habitat of the first subpopulation occupied about 400 m<sup>2</sup>, however, in the periphery of the densest concentration of *T. ramosum*, individuals grew sparsely, and 24 individuals were recorded outside the sampling plots. Thus, a total of 45 individuals were recorded in the first subpopulation. In the second subpopulation, which occupied about 20 m<sup>2</sup>, seven individuals of this species were registered. In 2017, entire population of *T. ramosum* in the environs of Varnikai village consisted of 52 individuals.

The study on the stage of development of the individuals revealed that in the first subpopulation, 16 of 21 recorded individuals were generative and other five individuals were vegetative. Thus, young individuals comprised 23.8% of all *T. ramosum* individuals. This fact confirms constant recruitment of this species in the first subpopulation. In the second subpopulation, all seven recorded individuals were at generative stage. Recruitment of this species may be hindered by more dense coverage of herbs in the community of the second subpopulation (mean herb

coverage 69.3% versus 47.0% in the first subpopulation).

### Morphological characteristics of individuals

The height and number of shoots of *T. ramosum* individuals in the sampling plots were recorded aiming to assess their performance in the community. The height of generative individuals in both subpopulations was similar. The mean height of generative individuals in the first subpopulation was 26.56 ± 4.15 cm (ranged from 19 cm to 34 cm), whereas plants of the second subpopulation tended to be slightly higher and their mean height was 30.57 ± 6.85 cm (ranged from 19 cm to 42 cm). The mean height of vegetative individuals, which were recorded in the first subpopulation only, was 17.00 ± 3.24 cm (ranged from 13 cm to 22 cm) (Table 1).

The mean number of generative shoots of mature individuals was 5.63 ± 4.38 shoots (ranged from one to 16 shoots per plant) and 6.29 ± 5.99 shoots (ranged from one to 19 shoots per plant) in the second subpopulation. The mean number of vegetative shoots of generative individuals was significantly lower than the number of generative shoots. The mean number of vegetative shoots of generative individuals in the first subpopulation was 3.38 ± 2.22 shoots (ranged from zero to eight shoots per plant), whereas in the second subpopulation, individual had on average 0.86 ± 0.69 shoots (ranged from zero to two shoots). Vegetative individuals, which were presented in the first subpopulation only, had from one to four shoots, and their mean number was 1.80 ± 1.30 shoots (Fig. 5).

The number of generative and vegetative shoots of an individual (Fig. 5), in our opinion, reflects its relative age. Probably the more generative shoots an individual has, the older it is. Thus, distribution of *T. ramosum* individuals according to the number of shoots indirectly indicates the presence of individu-

Table 1. Number and height of generative and vegetative shoots of the studied *Thesium ramosum* individuals in 2017

Character	n	Mean ± SD	Minimum	Maximum
<b>Generative individuals</b>				
Number of generative shoots	23	5.83 ± 4.79	1	19
Number of vegetative shoots	23	2.61 ± 2.21	0	8
Height of generative shoots	23	27.78 ± 5.30	19	42
<b>Vegetative individuals</b>				
Number of vegetative shoots	5	1.80 ± 1.30	1	4
Height of vegetative shoots	5	17.00 ± 3.24	13	22

als of various age in the population and confirms constant, though quite slow, natural renewal of the population.

**Relationship between other species and habitat conditions**

Our study revealed statistically significant negative correlation between the number of *T. ramosum* individuals in sampling plots and the coverage of Poaceae species ( $R_s = -0.53; p = 0.0005$ ) (Fig. 6). Positive relationship was found between the number of *T. ramosum* individuals in sampling plots and the coverage of Fabaceae ( $R_s = 0.47; p = 0.001$ ) (Fig. 5).

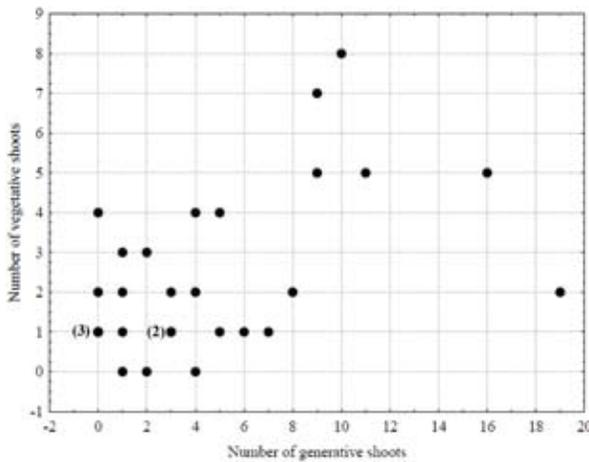


Fig. 5. Number of generative and vegetative shoots of the studied *Thesium ramosum* individuals in both subpopulations in the environs of Varnikai village. Numbers in brackets next to dots indicate the number of individuals with the same number of vegetative and generative shoots

No statistically significant relationships were found between the number of individuals and the coverage of bryophyte layer, the coverage of plant debris and bare soil. We did not study hosts of *T. ramosum*, however, some relationships between microhabitat characteristics were found. Our study revealed statistically significant negative correlation between the number of *T. ramosum* individuals and the total coverage of herb layer ( $R_s = -0.32; p = 0.04$ ) as well as between the mean height of herbs ( $R_s = -0.45; p = 0.003$ ). Thus, *T. ramosum* in the studied subpopulations selects microhabitats of meadows with more sparse and lower sward.

**DISCUSSION**

Though *T. ramosum* has the largest distribution area of all species of this genus (HENDRYCH, 1961), the locality in Lithuania is separated by about 600 km distance from the nearest localities in its native range in Ukraine and Slovakia (HENDRYCH, 1968; JALAS & SUOMINEN, 1976; BERTOŲA & ZAHRADNĪKOVÁ, 1984). Thus, *T. ramosum* should be considered as alien species in Lithuania as it is treated in Latvia (BUMBURE, 1955; LEKAVIČIUS et al., 1993; GAVRILOVA & ŠULCS, 1999) and Belarus (PARFENOV, 1999). This species has also been recorded in the environs of Vyborg (Leningrad region, Russia), and treated as an alien (TZVELEV, 2000). Means of introduction of this species to Lithuania are uncertain, however, we suppose that most probable mean of introduction are seeds of forage herbs or seeds of other cultivated plants.

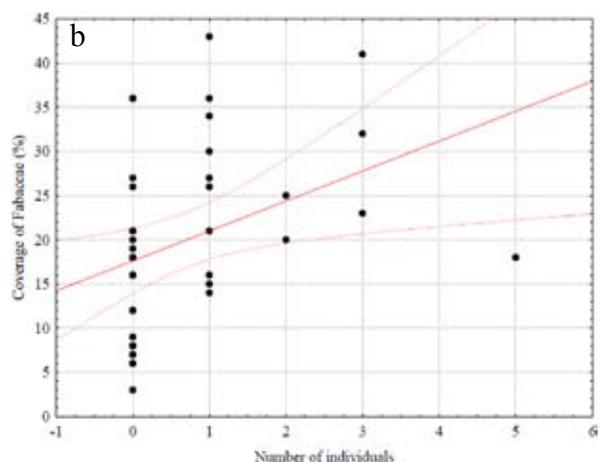
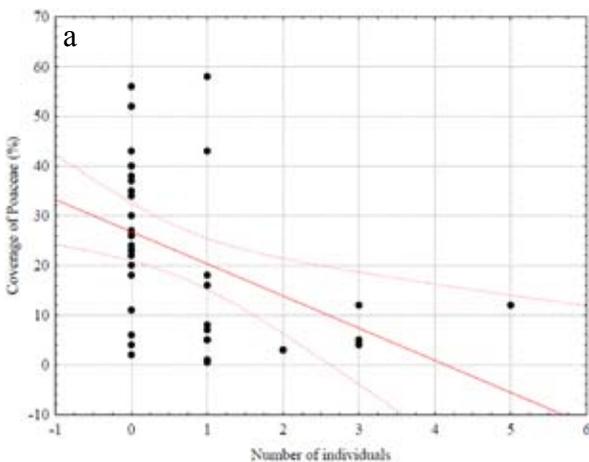


Fig. 6. Relationship between the number of *Thesium ramosum* individuals and the coverage of Poaceae (a) and Fabaceae (b) species in sampling plots of both subpopulations in the environs of Varnikai village

*Thesium ramosum* is a very rare alien species in Estonia (KUKK, 2013). In Saaremaa Island, it has been recorded as an alien species in cereal crops and considered as introduced plant with grain (EICHWALD, 1971; LEKAVIČIUS et al., 1993). In Latvia, *T. ramosum* has been recorded in two localities in the western and central parts of the country (BUMBURE, 1955; LEKAVIČIUS et al., 1993; GAVRILOVA & ŠULCS, 1999). In Belarus, this species is also very rare. It has been recorded in two localities on slopes of railway embankments in the environs of Borisov (Minsk region) and in the vicinities of Gomel (Gomel region) (PARFENOV, 1999). In Poland, this species has been first recorded quite recently in Siedlce at the railway ramp (KALINOWSKI, 2014). In Italy, *T. ramosum* is ascribed to the group of naturalized alien species (CONTI et al., 2005). *T. ramosum* is alien and locally well-established species in North America, which has potential for significant range expansion (NICKRENT, 2016).

After the recommendation of HENDRYCH (1961), the name *T. arvense* Horvátovszky is usually applied for *T. ramosum* in the publications of European botanists. However, GUTERMANN (2009) has revealed that this name was used by Horvátovszky as a replaced synonym for Linnaean species *T. alpinum* and, therefore, is illegitimate. The opinion of GUTERMANN (2009) is increasingly accepted and the name *T. ramosum* is more frequently applied (UOTILA, 2011; NICKRENT, 2016, KAPLAN et al., 2017, etc.).

When it was first recorded in 2003 and 2004 in two localities in the environs of Varnikai village (Trakai distr.), the estimated number was one and 26 mature individuals of *T. ramosum* (KRIAUCIŪNIENĖ, 2007). The first author of this paper also surveyed both subpopulations of *T. ramosum* on 21 June 2006. A total of more than 200 individuals of this species were counted (GUDŽINSKAS, 2007). The first subpopulation that occurred in a dry sandy meadow contained ca. 160–170 individuals, whereas in the second subpopulation, which was situated in a meadow at the edge of the forest, over 30 generative individuals were recorded. Currently, *T. ramosum* in Lithuania occurs in two subpopulations in the environs of Varnikai village, and detailed studies conducted in 2017 revealed that both subpopulations consist of 52 individuals. Though the total number of individuals decreased, the presence of young individuals, which did not reach generative stage, showed that *T. ramosum* reproduces by seeds.

Species of the genus *Thesium* can use a wide range of plant species as hosts, however, little is known about host range and host selectivity in wild populations (DOSTÁLEK & MÜNZBERGOVÁ, 2010). Our study revealed statistically significant negative correlation between the number of *T. ramosum* individuals in sampling plots and the coverage of Poaceae species, and positive relationship was found between the number of *T. ramosum* individuals and the coverage of Fabaceae. It should be noted that negative association has also been revealed between *T. linophyllum* and Poaceae during the studies in Central Europe. However, association of *T. linophyllum* with species of Fabaceae in general is negative, though with certain species of this family positive relationship has been found (DOSTÁLEK & MÜNZBERGOVÁ, 2010).

The study by SUETSUGU et al. (2008) has revealed that *T. chinense* Turcz. parasitize 57.9% of the plant species at the study site. DOSTÁLEK & MÜNZBERGOVÁ (2010) have found that haustoria of *T. linophyllum* are attached to 94% of all species occurring in the study plots, and concluded that *Thesium* species do not specifically select hosts, but rather occur in microhabitats with specific conditions. We did not study hosts of *T. ramosum*, however, some relationships between microhabitat characteristics were revealed. Our study revealed statistically significant negative correlation between the number of *T. ramosum* individuals and total coverage of the herb layer as well as between the mean height of herbs. Thus, *T. ramosum* in the studied subpopulations selects microhabitats of meadows with more sparse and lower sward.

The analysis of all available data on the occurrence of *T. linophyllum* in Lithuania, which had been constantly included into the lists of the flora of the country since the late 18th century, revealed that this species has never been recorded. Indications of this species are based on misidentified *T. ebracteatum*. Records of *T. linophyllum* at the beginning of the 21st century also were based on misidentified specimens of *T. ramosum*. The herbarium specimens from one locality in the environs of Rykantai (Trakai district) are absent and the identity of the recorded plants is unknown, however, it is supposed that this report of *T. linophyllum* is based on misidentified *T. ramosum*. Thus, *T. linophyllum* should be excluded from the list of vascular plants of Lithuania.

The results of a 15-year survey on two sub-

populations of *T. ramosum* in Lithuania enable us to conclude that it is an established alien, however, considering biological characteristics and peculiar ecological conditions necessary for this species, it can hardly become invasive, and its further spread without new introductions is unlikely.

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## PASTABOS APIE MĮSLINGĄJĮ *THESIUM LINOPHYLLON* IR PRANEŠIMAS APIE *THESIUM RAMOSUM* LIETUVOJE

Zigmantas Gudžinskas, Egidijus Žalneravičius

### Santrauka

Lietuvoje ilgą laiką buvo nurodomos dvi linlapio (*Thesium*) genties rūšys – plikažiedis linlapis (*T. ebracteatum*) ir melsvasis linlapis (*T. linophyllum*). Išsamiai išnagrinėjus herbariumo rinkinius ir gamtoje augančius augalus nustatyta, kad anksčiau *T. linophyllum* vadinti augalai iš tikrųjų priklauso kitai rūšiai – *T. ramosum*. Kadangi *T. linophyllum* Lietuvoje buvo minimas nuo XVIII a. pabaigos, buvo išnagrinėta visa esama informacija ir nustatyta, kad senosios nuorodos paremtos klaidingai apibūdintais *T. ebracteatum* augalais. Taigi Lietuvoje *T. linophyllum* nebuvo rastas ir jį reikia išbraukti iš šalies induočių augalų rūšių sąrašų.

Straipsnyje pateikta informacija apie anksčiau Lietuvoje nemintą rūšį – šakotąjį linlapį (*T. ramosum*). Pirmą kartą šios rūšies augalai buvo aptikti 2003 m. Varnikų k. apylinkėse, Trakų istorinio nacionalinio parko teritorijoje (Trakų r.). Dabar Varnikų k. apylinkėse žinomos dvi šios rūšies augalų grupuotės, kurias skiria maždaug 350 m pločio pelkinio miško ir ežero ruožas. Šakotieji linlapiai auga sausose, da-

bar jau nebešienaujamose pievose. Nustatyta, kad 2017 m. visą populiaciją sudarė 52 individai.

Atlikus populiacijos tyrimus nustatyta, kad joje vyrauja generatyviniai individai, tačiau yra ir jaunų, dar tik vegetatyvinės stadijos individų. Iš to daroma išvada, kad šakotieji linlapiai Lietuvoje dauginasi sėklomis. Nustatyta neigiama šios rūšies individų gausumo priklausomybė nuo miglinių šeimos augalų projekcinio padengimo ir teigiama priklausomybė nuo pupinių šeimos augalų projekcinio padengimo.

Lietuvoje aptikta *T. ramosum* populiacija yra ne mažiau kaip per 600 km nutolusi nuo savaiminio rūšies arealo. Dėl to manome, kad Lietuvoje, kaip ir kaimyninėse šalyse (Latvijoje, Lenkijoje ir Baltarusijoje) yra svetimžemis augalas. Kadangi rūšies populiacija šalyje egzistuoja jau ne mažiau kaip 15 metų ir augalai dauginasi sėklomis, *T. ramosum* priskirtas prie įsitvirtinusių rūšių grupės, tačiau mažai tikėtina, kad šie augalai toliau plisų ir beveik nėra tikimybės, kad rūšis Lietuvoje galėtų tapti invazine.

### APPENDIX I

#### Studied specimens of *Thesium*

***Thesium ramosum* from Lithuania.** 1. Trakai district, environs of Varnikai village, Trakai Historical National Park, the north-eastern shore of Lake Baluosys, in a dry meadow on slope, 21 June 2006; 54.63972° N; 24.96306° E; leg. Z. Gudžinskas [ut *T. linophyllum*]. 2. Trakai district, environs of Varnikai village, Trakai Historical National Park, the Varnikai Botanical and Zoological Reserve, in an abandoned dry meadow, 16 June 2017; 54.639326° N; 24.957938° E; leg. Z. Gudžinskas and E. Žalneravičius.

***Thesium ebracteatum* from Lithuania.** Elektrėnai district, 2 km east of Vievis, in a dry meadow at the forest edge close to railway, 13 June 2005; 54.768177° N; 24.847932° E; leg. Z. Gudžinskas.

***Thesium ramosum* from other countries:** 1. **Ukraine**, Crimea, vicinity of Bakhchysarai, Chufut-Kale village, on a dry slope, 16 September 1959; leg. R. Jankevičienė. 2. **Ukraine**, Donetsk region, Volodarsk district, in the environs of Kamennye Mogily Nature Reserve, in a fallow land, 14 May 1983; leg. R. Jankevičienė. 3. **Armenia**, Ashtarak district, environs of Saghmosavan village, on a stony slope, 18 May 1985; leg. D. Taurinskaitė.

***Thesium alpinum*:** **Slovakia**, Lower Tatry Mountains, between Čertovica and Vyšná Boca, in a dry meadow on a slope, 12 July 2001; leg. Z. Gudžinskas.

***Thesium linophyllum*:** **Czech Republic**, Bílé Karpaty Protected Landscape Area, about 4 km South of Kněždub, Čertoryje National Nature Reserve, in a dry meadow, 18 July 2015; leg. V. Rašomavičius.