

# *Equisetum variegatum* Schleich. ex Weber et Mohr in Lithuania: habitat diversity, distribution patterns and environmental status based on herbarium collection

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Mindaugas Rasimavičius\*,

Jonas Remigijus Naujalis

Department of Botany and Genetics,  
Faculty of Natural Sciences,  
Vilnius University, M. K. Čiurlionio 21/27,  
LT-03101 Vilnius, Lithuania

*Equisetum variegatum* Schleich. ex Weber et Mohr (*Equisetaceae* L. Rich. ex DC.) is a perennial evergreen plant with a long rhizome. It grows in Arctic tundra and mountain habitats. Usually *E. variegatum* is assigned to rare or fairly frequent plant species in Lithuania. During the last six decades the number of *E. variegatum* localities increased more than tenfold. Therefore it is important to perform an analysis of *E. variegatum* distribution patterns, diversity of localities, and environment protection status in Lithuania.

In order to analyse *E. variegatum* distribution and habitats, herbarium specimens of the horsetail in four Lithuanian herbaria as well as the data obtained during personal research were used. The analysis showed that *E. variegatum* is found in 27 of 60 administrative districts of Lithuania. Approximately 70% of *E. variegatum* habitats are anthropogenic, found mainly in the abandoned sand or gravel quarries.

Three naturally occurring *E. variegatum* habitat concentration zones were determined in south-eastern and western Lithuania as well as on the coast. Typical naturally occurring *E. variegatum* habitats in Lithuania are wet meadows, lake shores, fen, coastal dunes, and pine forests. *E. variegatum* is rare or very rare in natural habitats and fairly rare or fairly common in anthropogenic habitats in Lithuania. In the latter habitats *E. variegatum* frequently forms thicket.

**Key words:** *Equisetum variegatum*, herbarium material, horsetail, distribution, habitats, Lithuania

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## INTRODUCTION

Over the last few decades a significant increase in discovering evolutionary archaic sporulating vascular plant species localities has been noticed in Lithuania (Rudnickaitė et al., 2011). On the one hand, the plant habitat number increase might be just the result of a more intensive research into flora in certain territories. On the other hand, the increase in the number of habitats may display a species ability to adapt to the modern anthropogenic environmental conditions (Dobrovolskaitė, Gudžinskas, 2011). Therefore, the analysis of abundance of plant species habitats is a scientific prob-

lem. In particular, such analysis is important for plants that are classified as rare or fairly rare and found in evolutionarily archaic taxonomic groups.

One of vascular sporulating plants with increasing habitats in Lithuania is from a family *Equisetaceae* – a perennial evergreen horsetail *Equisetum variegatum* Schleich. ex Weber et Mohr. It is estimated that in Central Europe *E. variegatum* is thriving as a relic from the Würm glacial period (Dostal, 1984). In general, *E. variegatum* has a stenotopic prevalence and thrives in specific habitats – alkaline fern, lakeshores, river and stream banks, wet meadows. Lithuanian botanists (Snarskis, 1954, 1968; Minkevičius, 1959; Lekavičius, 1989) assign *E. variegatum* to rare or fairly rare plant species. In the eighth decade of the last

\*Corresponding author:

E-mail: mindaugas.rasimavicius@gf.stud.vu.lt

century *E. variegatum* was assigned to a very rare plant species (Jankevičienė, 1978).

Recent studies (Rasimavičius, Naujalis, 2011) show that *E. variegatum* is successful in settling anthropogenic habitats such as sand and gravel quarries.

The key purpose of this publication is to accomplish an analysis of *E. variegatum* habitat diversity, distribution patterns and protection status in Lithuania based on herbarium material and our field survey data.

## MATERIALS AND METHODS

The variety of *E. variegatum* habitats and distribution patterns in the Lithuanian territory were established during the analysis of the label data of horsetail specimens that were stored in Lithuanian herbaria (Table) or personally collected. The literature data on *E. variegatum* distribution and its habitat ecological conditions was also analysed. During the field study 36 sand-gravel quarries were investigated. Furthermore, data analysis was performed using information from 81 herbarium specimen label of *E. variegatum*. The main analysis indicators were as follows: 1) *E. variegatum* herbarium specimen collection year; 2) *E. variegatum* habitat frequency within Lithuanian administrative units; 3) *E. variegatum* habitat breakdown depending on the origin (natural, semi-natural or anthropogenic); 4) *E. variegatum* frequency in different types of habitats.

In the analysis of the data for *E. variegatum* distribution in natural, anthropogenic and semi-natural habitats only specimens from 62 different locations were used, i. e. data from the labels of herbarium specimens collected in the same locations was not used. Also, four labels from *E. variegatum* herbarium specimens were not

used in the analysis, since specific data on horsetail growth areas had not been recorded in them.

Currently, Lithuania is divided into 60 districts and urban municipalities. These are the main Lithuanian administrative territorial units. During data analysis *E. variegatum* habitats in the urban municipalities were assigned to respective district municipalities.

Natural habitat (meadow, forest, marsh) – an original habitat which is not entirely or is weakly impacted by human.

Semi-natural habitat (urban lake shores) – man-transformed primary habitat.

Anthropogenic habitat (quarry, railroads, roadsides) – man-made secondary habitat, which gets an intense direct human impact on the natural environment.

In maps, *E. variegatum* prevalence in Lithuania is marked using a dot method. Mapping of *E. variegatum* habitats was based on a square grid system developed by Institute of Botany of Nature Research Centre. The distribution of *E. variegatum* is depicted using geographical coordinates with margins of 00°06' north latitude and 00°10' east longitude, while the cartographical interval is 10 km (Rašomavičius et al., 2007). In this way, the territory of Lithuania is divided into squares with an area ranging from 116.5 to 123.2 km<sup>2</sup> (Gudžinskas, 1993). Different type *E. variegatum* habitats were mapped with a distinct dot. If one square had a number of the same type habitats on the map they were shown as the same dot. There were no problems in assigning habitats to a particular square during the data analysis, thus all mapping data is of first grade of accuracy.

Naturally occurring *E. variegatum* habitat concentration zones were separated on the basis of physical geographical classification of Lithuania (Basalykas, 1965).

Table. Number of *E. variegatum* herbarium specimens in Lithuanian herbaria

Herbarium	Acronym of herbarium	Number of <i>E. variegatum</i> herbarium specimens
Institute of Botany of Nature Research Centre	BILAS	39
Vilnius University	WI	30
Šiauliai University	HUS	6
Flora of Suvalkija	HSUD	6
<b>Total</b>	<b>4</b>	<b>81</b>

## RESULTS AND DISCUSSION

### Analysis of *E. variegatum* specimens found in Lithuanian herbaria

Herbarium specimen is the most important botanical document to give evidence on the existence of the species in a given area. In Lithuanian herbaria there is 81 *E. variegatum* herbarium specimen (Table) from 65 different localities belonging to 27 administrative districts in Lithuania (Fig. 1). Thus, *E. variegatum* is known in 45% of Lithuanian territorial administrative districts. In the early fifties of the 20th century *E. variegatum* was known only in six Lithuanian administrative districts (Snarskis, 1954). Thus, *E. variegatum* localities have increased almost tenfold over the past six decades.

The majority of *E. variegatum* herbarium specimens are in BILAS and WI herbaria (Table). Most

of the analysed horsetail herbarium specimens were collected in Varėna, Biržai and Vilnius districts, and Marijampolė and Palanga municipalities. *E. variegatum* herbarium specimen analysis by their collection year showed that during a decade only 2–6 herbarium specimens of this species are collected (Fig. 2). The data indirectly suggests that *E. variegatum* is not a common horsetail in Lithuania. The oldest herbarium samples (WI) were collected by K. Jablonskis in 1927 and 1929 in Kaunas region and Jurbarkas surroundings. Although their labels do not provide the exact habitat of *E. variegatum*, they are the oldest surviving documents demonstrating the existence of *E. variegatum* in the current territory of Lithuania.

The collection of *E. variegatum* herbarium specimens significantly increased during the period of 1990–1999 (Fig. 2). The main *E. variegatum* herbarium specimen collectors were botanists

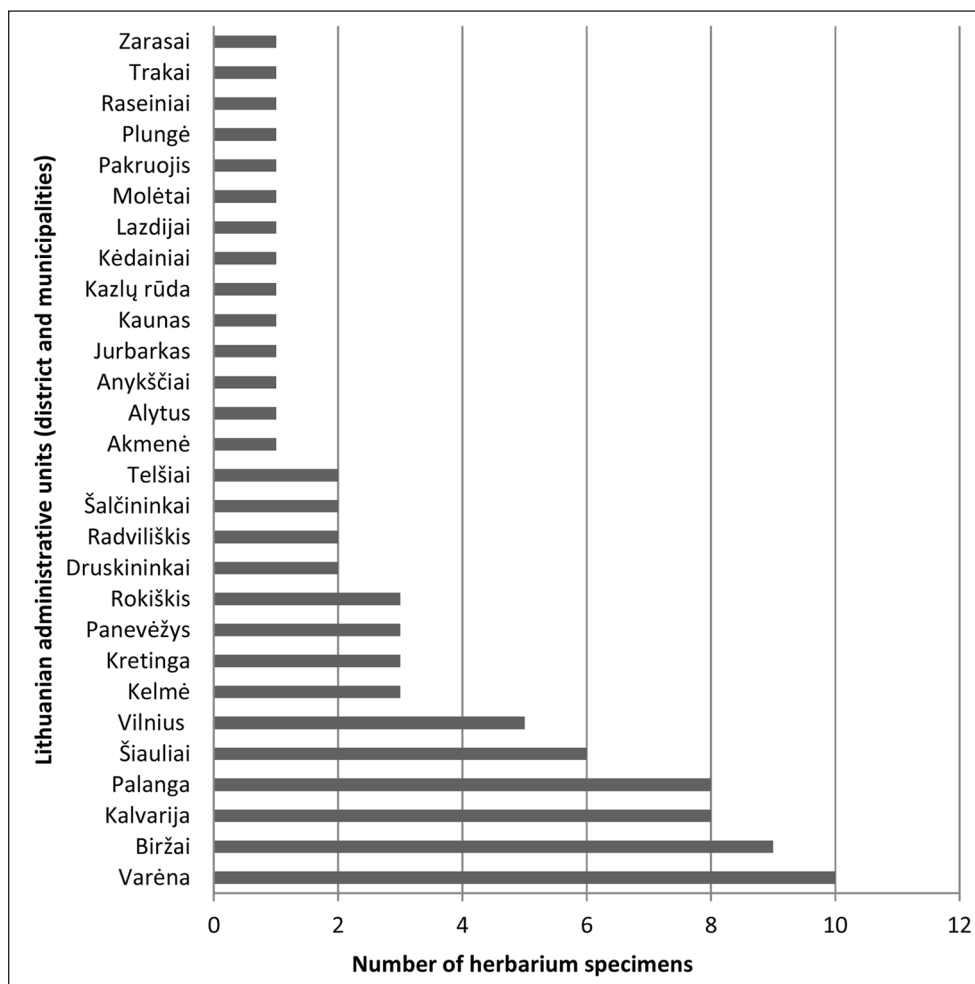


Fig. 1. Number of *E. variegatum* herbarium specimens in Lithuanian administrative units

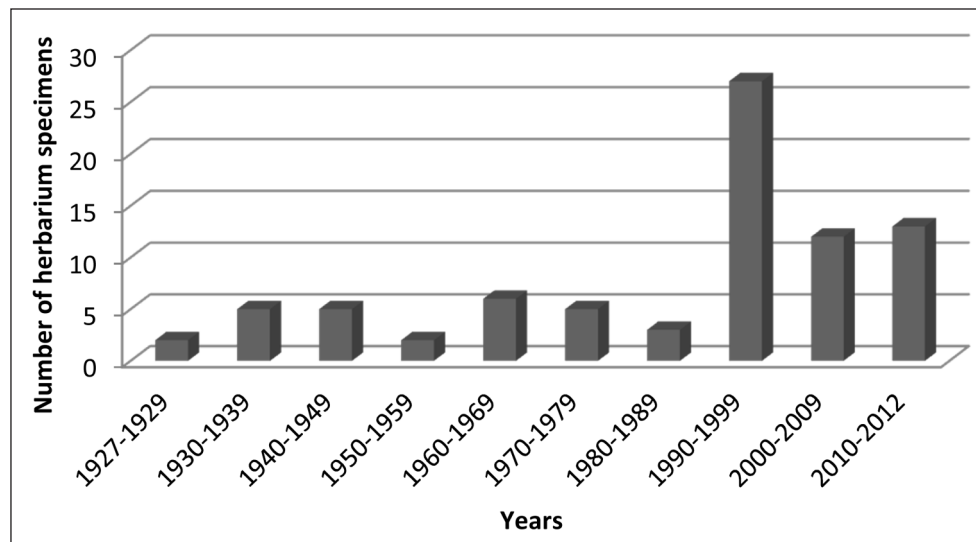


Fig. 2. Intensity of *E. variegatum* herbarium sample collection in the 20–21th centuries

Z. Gudžinskas and V. Rašomavičius from Institute of Botany of Nature Research Centre. Most of *E. variegatum* herbarium specimens of this period (82%) were collected from anthropogenic habitats that had been investigated for alien plant diversity. During the period of 2000–2009, 67% of *E. variegatum* herbarium specimens were collected from anthropogenic habitats. No herbarium specimens were collected from natural habitats. Over the past three years, 85% of *E. variegatum* herbarium specimens were once again collected from anthropogenic habitats. A rather significant increase of horsetail herbarium specimens in the 21st century compared to the previous periods is due to the research into ecology of *E. variegatum* performed by the authors of this article (Rasimavičius, Naujalis, 2011).

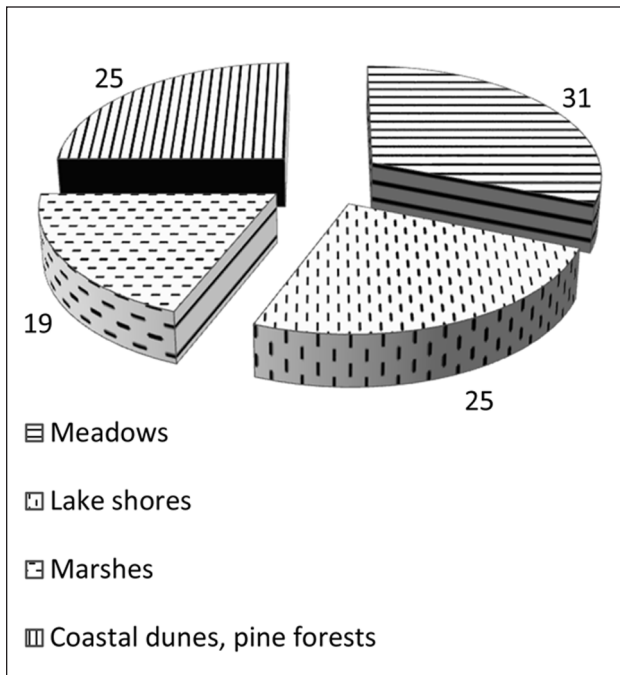
Thus, *E. variegatum* herbarium specimen label analysis showed that 63% of the horsetail habitats in Lithuania are anthropogenic, 25% are natural, and 6% are of semi-natural origin. The remaining localities of *E. variegatum* herbarium specimens are not specified. This *E. variegatum* attachment to certain habitats can be explained by the fact that Lithuania, in general, lacks suitable habitats for *E. variegatum*, such as lowland fen, which are most appropriate *E. variegatum* habitats, occupy only about 7.7% of the total area of the country (Povilaitis et al., 2011). On the other hand, a new *E. variegatum* population is much easier formed in anthropogenic than natural environmental conditions since the germination of spores requires free ecological niches and sufficiently moist soil. The-

refore, it is in the bottom of quarries where water bodies are formed naturally or artificially that one can find the most favourable conditions for new *E. variegatum* populations to occur.

The majority of different types of *E. variegatum* habitats are recorded in Biržai, Varėna, Šiauliai districts and Palanga municipality. Biržai, Kretinga, Panevėžys districts and Marijampolė municipality – all harbour anthropogenic *E. variegatum* habitats. Whereas in Druskininkai municipality all *E. variegatum* habitats are of natural origin. Palaeobotanical data shows that in this territory *E. variegatum* could have settled earlier than in other parts of the country since in southeastern Lithuania horsetail spores were found from the old Dryas chronozone period (Kabailienė, 2006).

#### ***E. variegatum* natural habitats in Lithuania**

All natural habitats of *E. variegatum* in Lithuania make up local groups. Major *E. variegatum* natural habitats in Lithuania are meadows, lake shores, fern and coastal dunes, and pine forests. Customarily *E. variegatum* thrives in moist wet meadows, this type of habitat accounts for 31% of the total number of naturally occurring habitats (Fig. 3). Also, *E. variegatum* is found on lakeshores and at the coast. Alkaline fern, which are typical representatives of this type of habitat for *E. variegatum* in the plains of Europe (Meusel et al., 1971), occur quite rarely in Lithuania. In general, *E. variegatum* is basophilic or, in the Arctic, almost indifferent to substrate horsetail,



**Fig. 3.** Main natural *E. variegatum* habitats in Lithuania and their percentage distribution

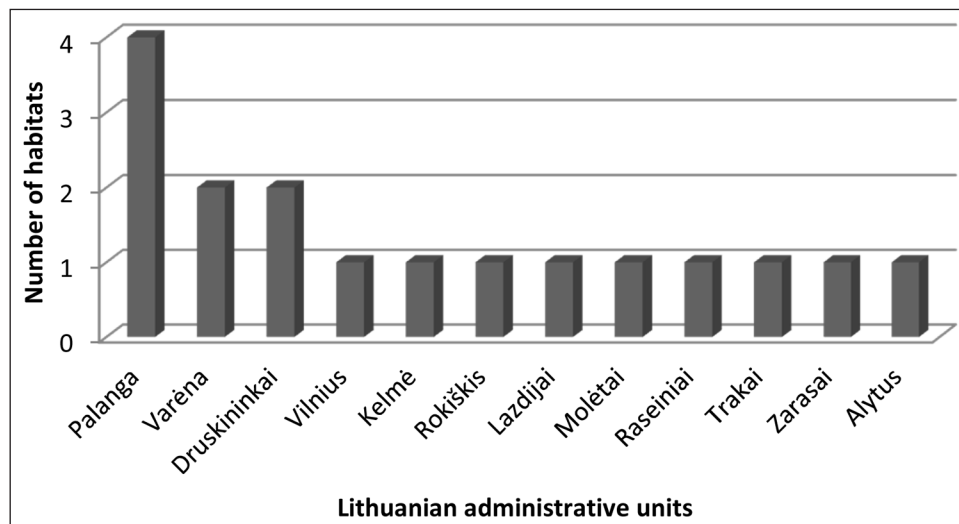
which shows calciphily only in individual parts of the range (Jonsel, 2000).

The majority of *E. variegatum* natural habitats was recorded in the west (Palanga) and southeast (Varėna, Druskininkai) parts of Lithuania (Fig. 4). Other Lithuanian administrative units are known to have only one naturally occurring *E. variegatum* habitat (Fig. 4). Western Lithuania *E. variegatum* habitats are mostly exposed to marine climate, while

the eastern and southeastern parts are affected by continental climate. This confirms the statement that *E. variegatum* generally does not have a distinct geographical attachment to marine or continental climate regions (Natkevičaitė-Ivanauskienė et al., 1977; Rothmaler, 2005). It is more important that in both regions *E. variegatum* habitats are dominated by glaciofluvial sands (Juodis, 2001).

All natural *E. variegatum* habitats in Palanga area are in white coastal dunes or pine forests. Due to drifting sand and open vegetation this type of habitat is particularly suitable for pioneer character plant – *E. variegatum*. Similar environmental conditions are found in sand quarries where this species of horsetail grows (Rasimavičius, Naujalis, 2010). According to the Lithuanian physical geographical classification of Palanga area, the habitat of *E. variegatum* belongs to the Baltic depression (Basalykas, 1965). This area is dominated by marine and old and new eolian origin parent rock. Sand plains in Palanga surroundings have more carbonates (Basalykas, 1965) than eolian sands, thus, their habitats are more productive. This type of habitat is more suitable for *E. variegatum* to settle due to reduced plant competition and soil carbonates. It is for these causative factors that about 25% of *E. variegatum* natural habitats in Lithuania are on the seaside.

In Druskininkai municipality and Varėna district *E. variegatum* natural habitats are on lakeshores, meadows and fen. According to the Lithuanian physical geographical classification, these administrative units are attributed to the last glacial period



**Fig. 4.** Main natural *E. variegatum* habitats in Lithuanian administrative units

zandric plains area of the southeast plain (Basalykas, 1965). In this area, at the beginning of the last glaciation, interglacial valleys were deposited with rich sediments that covered fen, lake ice age riverbeds. Typical *E. variegatum* habitats formed in old riverbed fens.

### Anthropogenic *E. variegatum* habitats in Lithuania

*E. variegatum* adaptation to grow in anthropogenic habitats is determined by highly specific pioneering features characteristic to this horsetail. *E. variegatum* pioneer qualities are also described by other researchers (Glisson, 2003). *E. variegatum* pioneering features are mainly due to the following phenomena: 1) a long period of spores dispersion (in Lithuania this period usually lasts from June to October) provides access for spores to germinate in suitable places throughout the vegetation season and 2) intensive vegetative development processes (in sandy soil conditions during a single growth season rhizomes grow up to 240 cm in length) ensure rapid occupation of new areas (Naujalis, 1995). Such strategies enable plants to easily change biotopes. It is because of their pioneer features that *E. variegatum*, in many cases, thrives in different anthropogenic sites where plant competition is weakened.

*E. variegatum* prevalence in anthropogenic habitats shows that this horsetail usually grows in quarries, railroads, waste land, cemeteries, drainage ditches and on the edges of ponds, and roadsides. In anthropogenic sites, in the absence of strong competition of other plants, *E. variegatum* may even become dominant and form lush vegetation with a turf-type derivative (Rasimavičius, Naujalis, 2011). However, during gradual changes in associations *E. variegatum* loses dominant properties.

Typical *E. variegatum* anthropogenic habitats in Lithuania are sand quarries (Fig. 5). This type of *E. variegatum* habitats is likely to increase in the future, since from 2001 there has been an increase in sand and gravel mining in Lithuania. Lithuanian Geological Survey data shows that prior to 1991 Lithuania had 242 operational sand-gravel quarries (Bukantis et al., 2008). During recent years in various places in Lithuania 36 sand-gravel quarries have been specifically examined and 20 of them housed *E. variegatum*. All quarries which had *E. variegatum* were characterized by water bodies which kept the soil moist. Quarries that had no

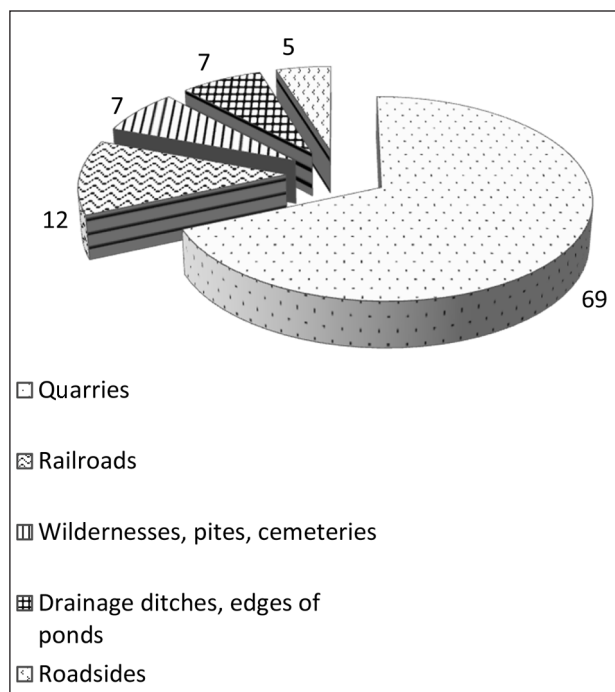


Fig. 5. Main anthropogenic *E. variegatum* habitats in Lithuania and their percentage distribution

water bodies were without *E. variegatum*. The turf-type associations are formed by *E. variegatum* only in wet quarry pits (Rasimavičius, Naujalis, 2011).

The majority of *E. variegatum* anthropogenic habitats was recorded in Biržai area (Fig. 6). In this area all *E. variegatum* habitats are in quarries. According to the Lithuanian physical geographical classification, Biržai is assigned to Baltic lowlands area, Mūša-Nemunėlis plain. It is dominated by calcareous gleysols or combined soils with calcareous gleysols and luvisols (Juodis, 2001).

However, currently there are almost no lakes in Biržai area, and most of the former marshes have turned into grassland or pastures (Basalykas, 1965). *E. variegatum* could have grown in these types of habitats in the past but due to intensive natural environment usage it has probably become extinct. Under these conditions, *E. variegatum* remains in anthropogenic habitats, especially in quarries. *E. variegatum* adaptation to grow in quarries is determined by four basic factors: 1) a good opportunity for spores to germinate in open substrate conditions; 2) microhabitat variety in isolated environments; 3) lack of intense competition among plants; 4) soil carbonates. In general, *E. variegatum* prevalence in different types of anthropogenic habitats is mostly influenced by 1) soil suitability and

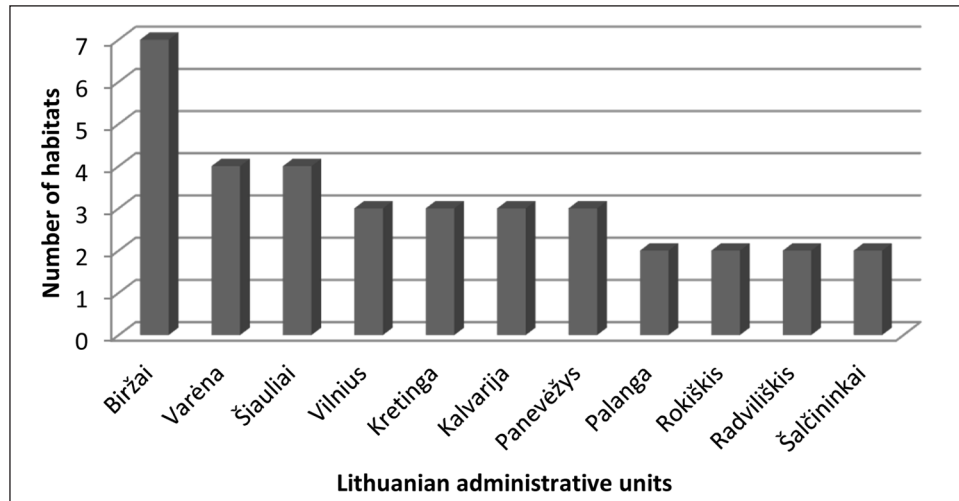


Fig. 6. Main anthropogenic *E. variegatum* habitats in Lithuanian administrative units

2) lack of other plants. Under these conditions, *E. variegatum* can grow in an isolated habitat type, although the ecology of species does not change.

Semi-natural origin *E. variegatum* habitats are found in Kelmė and Šiauliai districts. *E. variegatum* habitat in Kelmė district near Mančiai village is on the outskirts of permanent pasture meadow. *E. variegatum* habitat in Šiauliai district Talkša

lake is constantly subjected to anthropogenic recreational effects. Due to low number of *E. variegatum* habitats it has not been analysed in detail.

**Mapping of *E. variegatum* habitats in Lithuania**

The first *E. variegatum* distribution map in Lithuanian territory was made by P. Snarskis (Snarskis, 1954) (Fig. 7). After a few years A. Minkevičius

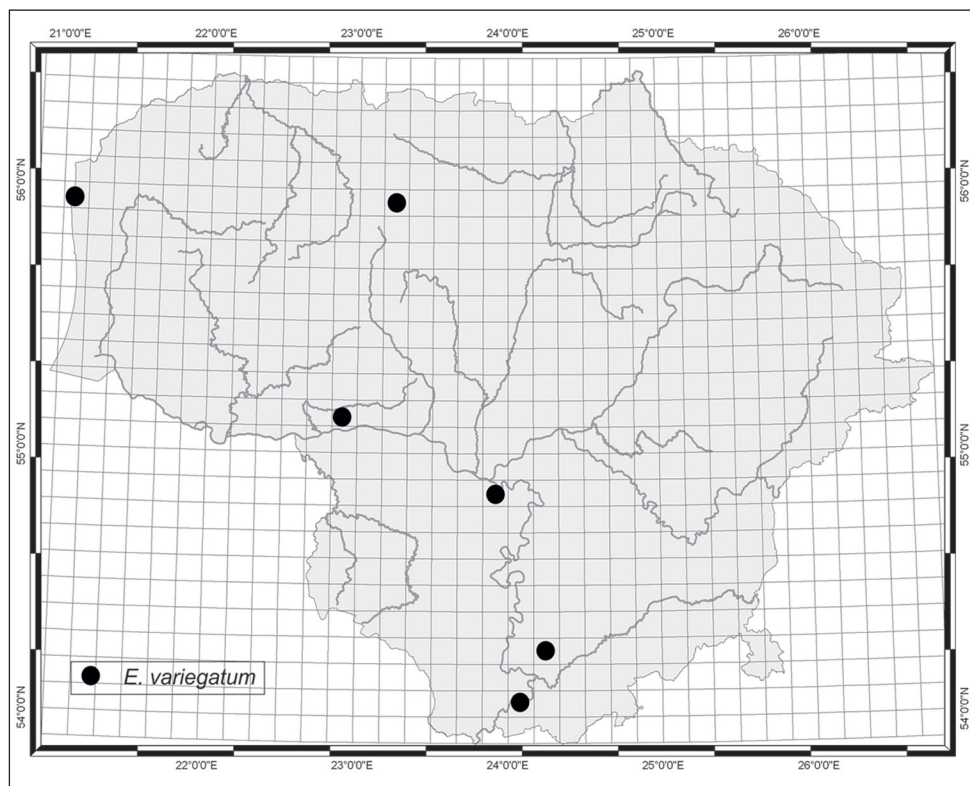


Fig. 7. Map of *E. variegatum* distribution in Lithuania by P. Snarskis (1954)

produced a new *E. variegatum* distribution map (Minkevičius, 1959) (Fig. 8). Both maps marked six localities of *E. variegatum*. A. Minkevičius pointed out *E. variegatum* locality in Molėtai which had not been shown in P. Snarskis' map. P. Snarskis found *E. variegatum* locality near Šiauliai. Both maps did not divide *E. variegatum* habitats into natural or anthropogenic.

Some botanists consider that southern range limit of *E. variegatum* passes through the territory of Lithuania (Parfenov et al., 1987). However, this view lacks compelling arguments and detailed explanations. Therefore, a reference to the southern *E. variegatum* range limit in the Lithuanian territory is questionable, since a number of *E. variegatum* habitats is observed farther to the south in the Republic of Poland (Zajac, Zajac, 2001).

Based on the data collected from herbarium specimens and personal studies, the authors created a new hypothetical map of *E. variegatum* distribution in Lithuania (Fig. 9). This map shows natural, semi-natural and anthropogenic habitats of *E. variegatum*. The map can be divided into three *E. variegatum* natural habitat concentration areas: A) southeast Lithuania, B) west Lithuania, C) coastal zone. All

isolated areas are dominated by eolian, fluvio-glacial origin sands.

A) Southeast Lithuania Zone. The last glacial peripheral moraine highlands and zandric plains area. According to environmental conditions, this zone is suitable for growth of *E. variegatum*. The zone relief is with ravines and pits with many small lakes and wetlands. Hence, in this area the most common naturally occurring *E. variegatum* habitats are lakesides, meadows and lowland fern. The last glacial zandric plain areas have sandy soils and sizable thermal contrasts (Basalykas, 1965). Prevailing climate is more continental compared with the Baltic or Course-Samogitian area. Winters are colder, longer, and with more snow (Galvonaitė, 2007). In Eurasian flora, *E. variegatum* is assigned to arctic-mountain flora element. In Northern Norwegian mountains *E. variegatum* thrives in fjord lakeshores, in areas with sudden temperature inversions (Kuvaev, 2006). Also, *E. variegatum* is attached to areas with long-lasting snow cover (Meusel et al., 1971). All these facts confirm that this area has the best environmental conditions complying with *E. variegatum* ecological qualities.

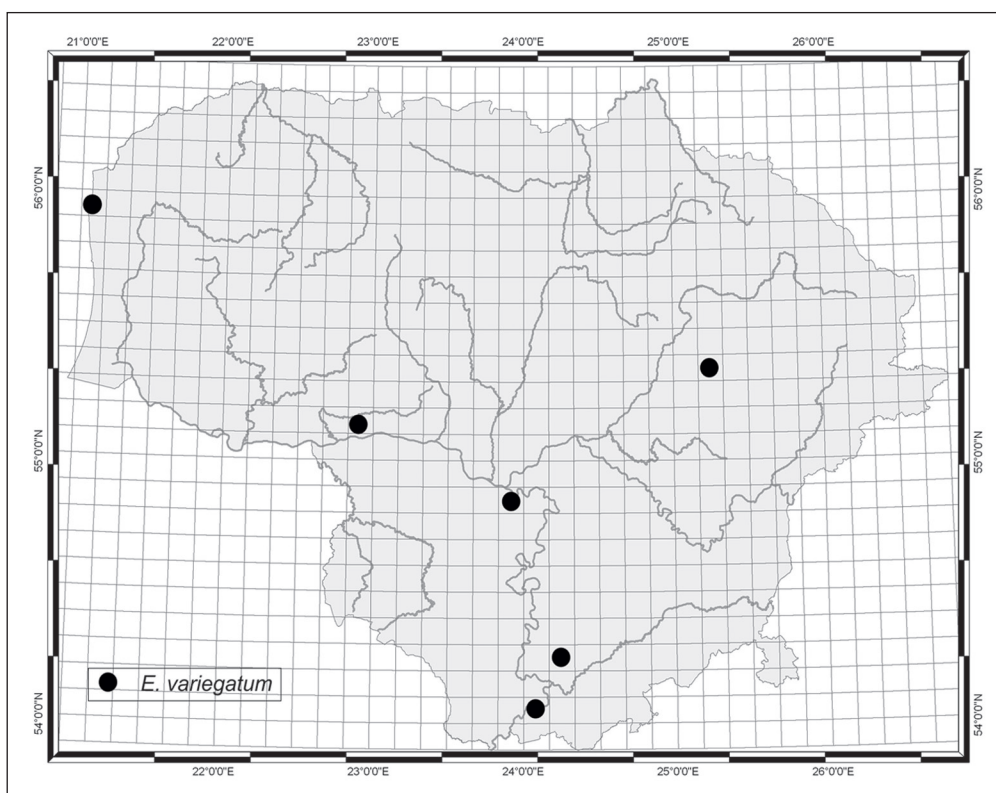
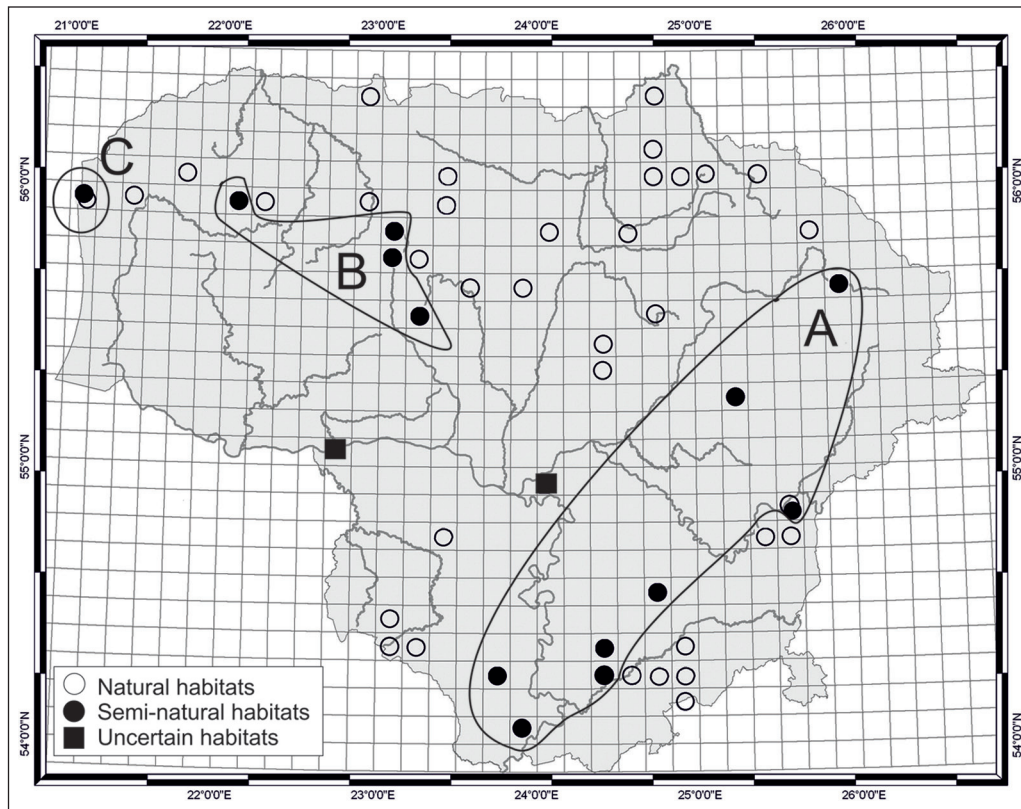


Fig. 8. Map of *E. variegatum* distribution in Lithuania by A. Minkevičius (1959)





**Fig. 9.** Map of *E. variegatum* distribution in Lithuania by the authors of this article. The map was created according to the herbarium samples and sorting the habitats into naturally occurring, semi-natural or anthropogenic

B) Western Lithuania Zone. This zone includes Course-Samogitian area characterized by the coolest and shortest vegetation season and reduced soil moisture evaporation (Basalykas, 1965). In this zone *E. variegatum* thrives in lakeshores, springy meadows and marshes. Here, *E. variegatum* spread and persistence in communities are determined by wet soil and the coolest vegetation period.

C) Coastal Zone. This area includes the Baltic Sea lowland area dominated by eolian sands. The prevailing marine climate most prominent features include the mildest winters and the coolest summers in Lithuania (Galvonaitė, 2007).

Natural *E. variegatum* habitats were not observed in the Middle Lithuania lowlands, although this part of Lithuania is dominated by alkaline soils suitable for *E. variegatum* (Juodis, 2001). In Central Europe, *E. variegatum* is attached to weakly alkaline soils (Ellenberg, 1974). It can be assumed that *E. variegatum* habitats are extinct due to intensive agricultural activity.

### ***E. variegatum* environmental status and emergence in Lithuania**

Canada, U. S. A., Latin America and the Caribbean granted *E. variegatum* G5 protection status. This means that in South and North America this species is not threatened with extinction (NatureServe, 2001). In Europe, though *E. variegatum* populations are fairly stable, in general, the continental *E. variegatum* populations tend to decrease (Khela, 2012). Therefore, different locations in Europe may designate a different protection status to *E. variegatum*. International Union for Conservation of Nature (IUCIN) assigns *E. variegatum* the lowest protection status in this category (LC), together with an indication that *E. variegatum* environmental protection status in different regions may vary. *E. variegatum* protection status in Czech Republic, Germany, Denmark and Hungary ranges from the category of critically endangered to endangered (Khela, 2012). North-West Russia recommends to grant a protection status to *E. variegatum* (Tzvelev, 2000). In the European part of

Russia *E. variegatum* is of rare occurrence (Maevskij, 2006). Throughout the territory of Latvia *E. variegatum* is a rare horsetail species (Pētersone, 1953). In Belarus, Vitebsk region, *E. variegatum* is common, however in other areas of the country it is rare (Parfenov, 2009).

In Lithuania *E. variegatum* is usually assigned to rare plants (Snarskis, 1954, 1968; Minkevičius, 1959; Lekavičius, 1989; Laasimer et al., 1993). Previously all natural associations with *E. variegatum* habitats were proposed to be assigned a protection status (Balevičienė et al., 2000). Lithuanian natural *E. variegatum* habitats are found in typical alkaline fen that are of European significance (Matulevičiūtė et al., 2012). During the seventies *E. variegatum* was included into the lists of very rare plant species (Jankevičienė, 1978).

*E. variegatum* protection status and the nature of distribution in Europe can be attributed to relict condition of this horsetail (Dostal, 1984). There had not been performed any specific research to establish or deny *E. variegatum* relict status in Lithuania. However, there is no general opinion in Lithuania concerning *E. variegatum* relict nature. Peer-reviewed papers intended for Lithuanian flora research (Snarskis, 1954, 1968; Minkevičius, 1959; Lekavičius, 1989) generally do not analyse *E. variegatum* possible relict origin. As a possible relict species in Lithuania *E. variegatum* for the first time was mentioned in the 9th decade of the last century (Parfenov et al., 1987). Plants that grow within continuous range boundaries are not relict, but growing in the areas scattered from their continuous natural range boundaries and forming residual habitats can be called relict (Natkevičaitė-Ivanauskienė, 1983). Therefore, in Lithuania, as in many other Central European countries, *E. variegatum* should be considered a relict species horsetail. During the last Würm glacial period, the Nemunas stage, glaciers from the Finnish and Swedish sides (Česnulevičius, 2010) moved the *E. variegatum* habitat from the mountains and tundra towards Central Europe. Therefore, it can be assumed that *E. variegatum* came to Lithuania from the Scandinavian mountains. In our country the oldest *E. variegatum* habitats may have formed during the last ice age in the ice-free part of Lithuania. In this part of Lithuania horsetail spores were found dating back to the old Dryas period (Kabailienė, 2006). Melting

glaciers extended the territory of *E. variegatum* in Lithuania in their suitable habitats. At the same time, *E. variegatum* returned to the tundra zone in the mountains. This may be one of the habitat expansion cases (Natkevičaitė-Ivanauskienė, 1983). That is why some scientists in Europe considered *E. variegatum* a relict species from the last Würm glacial period (Dostal, 1984).

Palynological analyses show that representatives of the genus *Equisetum* thrive in the territory of Lithuania from the Pleistocene period (Kabailienė, 2006). However, all attempts to identify *Equisetum* spores to species level based on the remaining features were unsuccessful. Comparing *E. variegatum* ecological characteristics and typical horsetail habitat properties with the prevailing natural environmental conditions of the late glacial period beginning (11 900–14 000 years ago) in which the plants of the genus *Equisetum* started to spread in the territory of Lithuania one can find a number of contact points. *E. variegatum* is one of three species of the genus *Equisetum* which are classified as Arctic plants (Meusel et al., 1965). *E. variegatum* selects areas with relatively long-lasting snow cover (Meusel et al., 1971). It is therefore possible that in the late-glacial period *E. variegatum* began to spread through the territory of Lithuania.

For the growth of *E. variegatum*, open vegetative cover and wet soil on river banks and coastal streams are most suitable. *E. variegatum* could have spread into the valleys and lake shores from the coastal streams of glaciers – the spread that was captured in Putorana Mountains in Central Siberia. In Northern Norwegian mountains *E. variegatum* grows near the fjords on shores of lakes with cold and wet soil subject to rapid changes of temperature inversion (Kuvaev, 2006).

During climate warming periods species such as *E. variegatum* thrive in local usually isolated, relevant to this kind of horsetail ecological needs, habitats. When climate in Europe started to warm up *E. variegatum* remained in springy wet meadows, calcareous moors, lake shores, stream banks with moving subsoil water or in the habitats with constantly moving sand and open plant coverage. Thus, *E. variegatum* became a restricted and isolated horsetail species. *E. variegatum* ecological constitution and paleobotanical studies suggest that some part of the horsetail populations in

the territory of Lithuania potentially are known to thrive ever since the Pleistocene period.

Possible *E. variegatum* relic state can be indirectly related to Lithuanian flora botanical-geographical status. Chorological analysis of flora shows that Lithuania is dominated by temperate flora and vegetation characteristics attribute Lithuania to the Central European broad-leaved deciduous forest zone (Natkevičaitė-Ivanauskienė, 2005). World-wide *E. variegatum* is a circumpolar Arctic-Alpine prevalence species (Meusel et al., 1965; Tzveliov, 2000; Kuvaev, 2006; Aiken, 2007). That is why in many European nemoral areas *E. variegatum* is a rare horsetail species (Jonsell, 2000).

## CONCLUSIONS

1. Analysis of the herbarium and personal research material shows that over the past fifty-eight years usually rare species horsetail *E. variegatum* habitats increased approx. 10 times in Lithuania. The main reasons being *E. variegatum* characteristics of adaptation in settling and surviving in anthropogenic habitats.

2. 70% of Lithuanian *E. variegatum* habitats are anthropogenic in nature. Basic *E. variegatum* anthropogenic habitats are sand and gravel quarries (68%) and railway slopes (12%).

3. In Lithuania merely 30% of *E. variegatum* habitats are natural or semi-natural. Common natural habitats are wet meadows (31%), lakeshores (25%) and seaside dunes as well as pine forests (25%).

4. Lithuanian florists generally assign *E. variegatum* to fairly rare or rare plant species. Naturally originating *E. variegatum* communities in alkaline fen require protection. However, the exact *E. variegatum* distribution in nature and its environmental status in Lithuania are quite complicated to define, since there is no single methodology for the evaluation of territorial occurrence for such species. When analysing *E. variegatum* territorial occurrence it would be advisable to separate the frequency of this type of horsetail in natural and anthropogenic habitats. Thus, in Lithuania *E. variegatum* is a rare or very rare species in natural habitats and of average frequency or fairly rare in anthropogenic habitats.

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Mindaugas Rasimavičius, Jonas Remigijus Naujalis

**EQUISETUM VARIEGATUM SCHLEICH. EX WEBER ET MOHR LIETUVOJE: AUGAVIEČIŲ ĮVAIROVĖ, PAPLITIMO DĖSNINGUMAI IR GAMTOSAUGINIS STATUSAS (HERBARIUMŲ PAVYZDŽIŲ ANALIZĖS PAGRINDU)**

*S a n t r a u k a*

*Equisetum variegatum* Schleich. ex Weber et Mohr yra daugiametis visžalis, ilgus šakniastiebius išauginantis *Equisetaceae* L. Rich. Ex DC. šeimos augalas, kurio pagrindinės augavietės yra arktinėse tundrose ir kalnuose. Lietuvoje *E. variegatum* paprastai priskiriamas prie retų ar apyretų augalų rūšių. XX a. aštuntajame dešimtmetyje *E. variegatum* buvo įtrauktas į Lietuvos saugomų induočių augalų rūšių sąrašus. Per pastaruosius šešis dešimtmečius *E. variegatum* radaviečių Lietuvoje pagausėjo daugiau nei dešimt kartų, todėl svarbu atlikti *E. variegatum* paplitimo dėsningumą, augaviečių įvairovės ir gamtosauginio statuso Lietuvoje analizę.

*E. variegatum* paplitimas ir augavietės analizuotos remiantis keturiuose Lietuvos herbariumuose saugomo 81 pavyzdžio duomenimis ir asmeninių tyrimų metu sukaupta medžiaga. Atlikta analizė rodo, kad *E. variegatum* auga 27 iš 60 Lietuvos administracinių rajonų. 63 % *E. variegatum* augaviečių Lietuvoje yra antropogeninės, 25 % natūralios, o 6 % pusiau natūralios kilmės. Dauguma antropogeninės kilmės *E. variegatum* augaviečių

yra buvusiuose smėlio ar žvyro karjeruose. Šio tipo augaviečių ateityje turėtų daugėti, kadangi nuo 2001 m. Lietuvoje smėlio ir žvyro gavyba labai išaugo (Bukantis et al., 2008). Per pastaruosius metus įvairiose Lietuvos vietose specialiai buvo ištirti 36 smėlio, žvyro karjerai, 20-yje iš jų užfiksuotas *E. variegatum*. Visuose karjeruose, kuriuose augo *E. variegatum*, buvo vandens telkinių ar bent pažemėjimų su nuolat drėgnu dirvožemiu. Daugiausia *E. variegatum* antropogeninės kilmės augaviečių užfiksuota Biržų rajone.

Visose natūralios kilmės augavietėse Lietuvoje *E. variegatum* sudaro lokalius sąžalynus. Pagrindinės *E. variegatum* natūralios kilmės augavietės Lietuvoje yra pievos, paežerės, žemapelkės ir pajūrio kopos bei pušynai. Daugiausia *E. variegatum* natūralios kilmės augaviečių užregistruota Vakarų ir Pietryčių Lietuvoje.

Pirmieji *E. variegatum* paplitimo Lietuvos teritorijoje žemėlapiai buvo sudaryti 1954 ir 1959 metais. Šiuose žemėlapiuose pažymėta po šešias *E. variegatum* radavietes. Straipsnio autorių sudarytame *E. variegatum* paplitimo žemėlapyje yra 62 radavietės. Nustatytos trys natūralios kilmės *E. variegatum* augaviečių koncentracijos zonos – Pietryčių Lietuvoje, Vakarų Lietuvoje ir Pajūryje. Natūralios kilmės augavietėse *E. variegatum* Lietuvoje yra retas arba labai retas, o antropogeninės kilmės augavietėse šis asiūklis yra vidutinio dažnumo ar apyretis.

**Raktažodžiai:** *E. variegatum*, herbariumo medžiaga, asiūklis, augavietė, Lietuva

