

Distribution and habitats of *Polypodium vulgare* L. in Lithuania

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Polypodium vulgare L. is a perennial evergreen rhizomatous fern of family *Polypodiaceae* (Bercht. et J. Presl.). The state of *P. vulgare* is considered to be rare or fairly rare in Lithuania. The ecological and botanico-geographical status of *P. vulgare* in Lithuania might be critical as this fern appears to be an oceanic–suboceanic species whose habitats correspond to hillsides.

The first distribution maps of *P. vulgare* in Lithuania were made by P. Snarskis and A. Minkevičius in the sixth decade of the 20th century. Their works have not been continued in Lithuania until this research. The current paper presents an objective distribution of *P. vulgare* in Lithuania, based on herbarium material and information provided by experts of protected areas of Lithuania. The authors of the paper are stating that localities of *P. vulgare*, a rare or fairly rare evergreen fern in Lithuania, have increased significantly during the last 50 years.

Key words: *Polypodium vulgare*, fern, distribution, habitats, Lithuania

INTRODUCTION

Polypodium vulgare L. is an evergreen perennial rhizomatous fern of family *Polypodiaceae* (Bercht. et J. Presl.) growing to 20–30 cm. In Lithuania *P. vulgare* are usually found in small groups in forests, especially on slopes in dry pine forests. Sometimes *P. vulgare* are cultivated for decorative purposes in flower gardens, particularly rock gardens.

According to various botanists (Table 1) *P. vulgare* is stated as rare or fairly rare in Lithuania although it has no protection status. On the other hand, the ecological and botanico-geographical status of *P. vulgare* might be critical because of the following reasons: (1) in terms of continentality *P. vulgare* is an oceanic-suboceanic species (Elenberg, 1974), and (2) its habitats correspond to hillsides where *P. vulgare* usually grows as an epiphyte on tree trunks or branches or as an epilith on rocks (Johnson, 1921; Derzhavina, Shorina,

1992; Jonsell et al., 2000). In addition, Lithuania is in the eastern part of *P. vulgare* areal. Our findings show that localities and populations of *P. vulgare* have been increasing in the previous years.

The aim of this paper is to determine *P. vulgare* distribution characteristics and dynamics as well as to analyse the diversity of *P. vulgare* habitats and substrates in Lithuania. The present research includes: (1) making a new distribution map of *P. vulgare* according to the data provided by herbarium material and results of special survey, (2) critical evaluation of the first two *P. vulgare* distribution maps in Lithuania made by Snarskis (1954) and Minkevičius (1959), and (3) evaluation of diverse *P. vulgare* habitats and substrates according to the information provided by the labels of herbarium specimens.

MATERIALS AND METHODS

The data of *P. vulgare* distribution and habitats in Lithuania were collected from three sources: (1) analysis of herbarium material, (2) results of

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Table 1. Habitats and distribution of *P. vulgare* in Lithuania according to different authors

No	Literature	Habitat	Distribution
1.	Dagys, Kuprevičius, Minkevičius, 1934	Around tree-stumps in forest, on shady cliffs	Fairly rare
2.	Snarskis, 1954	Shady forests, sometimes on tree-stumps, stone walls, cliffs in open places	Rare, reports from northern have, so far, not been verified
3.	Minkevičius, 1959	Shady forests, sometimes on tree-stumps, stone-fences (often in cervices), slopes in open places	Fairly common, usually grow in small groups
4.	Snarskis, 1968	Forests, on cliffs, stone walls	Fairly rare
5.	Murkaitė, Karazija, 1977	Shady forest (usually pine), among moss, sometimes in the banks of forest streams, on old tree roots	Rare
6.	Parfionov, Lekavičius et al., 1987	Pine forest, mixed forest with addition of pine, notably in hillsides	Fairly common in western and southern area
7.	Lekavičius, 1989	Forests, slopes, around tree-stumps, as an epiphyte on tree trunks	Fairly common, should be protected
8.	Naujalis, 1995	Forests (notably pine), usually on cliffs, around tree stumps, as an epiphyte on tree trunks	Fairly common
9.	Vilkonis, 2008	Forests (notably pine), usually on cliffs, around tree stumps, as an epiphyte on tree trunks; dolomite outcrops	Fairly common, should be protected

a questionnaire survey, (3) analysis of literature sources. The herbarium material of *P. vulgare* was evaluated in 6 different herbaria in 2010–2011: Vilnius University Herbarium (WI), Institute of Botany of Nature Research Centre Herbarium (BILAS), Station of Nature Research and Environmental Education Herbarium (HSUD), Šiauliai University Herbarium (HUS), Lithuanian University of Educational Sciences Herbarium, and Vytautas Magnus University Botanical Garden Herbarium (KA). The latter did not provide any *P. vulgare* specimens. The Lithuanian University of Educational Sciences Herbarium is not registered officially. In the present study 121 specimens of *P. vulgare* were evaluated: 16 provided by WI, 77 by BILAS, 16 by HSUD, 1 by HUS, and 11 by University of Educational Sciences.

A special survey of experts working in protected areas of Lithuania (reserves, national and regional parks) was carried out during 2011. The main aim of the survey was to get information about *P. vulgare* localities verified during ten past years. The provided questionnaires consisted of two main questions: (1) Are there any known *P. vulgare* localities in a specific protected area, and (2)

Are geographical coordinates provided for these localities? It has also been asked to withhold information about *P. vulgare* localities which cannot be accurately assigned to a specific botanical square or if there are doubts concerning the presence of this fern. 36 questionnaires were sent and 25 responses to the information requested have been received.

The data of the questionnaire survey was not re-checked in field, thus their purpose was mostly to renew and support data obtained from herbariums. If there were information overlaps in the map making process, preference was given to herbarium data in opposition to information provided by experts in protected areas. However, the survey data was useful in cases when there were no herbarium specimens representing a botanical square.

Information gathered from herbarium analysis, questionnaire survey and field notes of the paper authors were used to make *P. vulgare* distribution map (Fig. 3). The grid-square system of Lithuania used in this work was created in the Institute of Botany (currently, Institute of Botany of Nature Research Centre) (Gudžinskas, 1993). Botanical

squares were arranged according to geographical coordinates with sides 6' latitude and 10' longitude. Lithuanian territory was divided into 629 squares each covering from 116.5 to 123.2 km² area. Possible abundance of *P. vulgare* is not seen in these squares as all localities found in the same square are marked by one point.

The grid-square maps representing distribution of *P. vulgare* in Lithuania in the sixth decade of the 20th century were done using cartographic data provided by Snarskis (1954) (Fig. 1) and Minkevičius (1959) (Fig. 2). The pattern of *P. vulgare* distribution was analysed according to the geobotanical division of Lithuania made by Natkevičaitė-Ivanauskienė et al. (2005).

P. vulgare habitat and substrate analysis was made referring to information provided by various literature sources and labels of herbarium specimens preserved in all herbariums of Lithuania.

P. vulgare distribution records could either be interpreted as presence-only or presence-absence data, depending on what assumptions are made about the search patterns of contributors. To avoid this problem, a subsample of botanical squares

with the presence-absence data was made for further analysis. Botanical squares were sampled according to the following criteria: (1) a reserve, a national or regional park takes not less than 50% of the whole area of the square, and (2) the presence or absence data of *P. vulgare* localities in a particular square are provided by authorities of these protected areas. Association between patterns of *P. vulgare* distribution in different geobotanical divisions obtained from the two types of data (presence-absence and presence-only) was tested using Spearman's rank correlation coefficient. Cramer's V was chosen as a measure of associations between patterns of *P. vulgare* distribution in different geobotanical divisions. Statistical data analysis has been performed using a computer program PAST version 2.08 (Hammer et al., 2001).

RESULTS AND DISCUSSION

P. vulgare distribution according to P. Snarskis

The first *P. vulgare* distribution map was made by P. Snarskis in 1954 (original cartographic data represented on the grid-square map in Fig. 1).

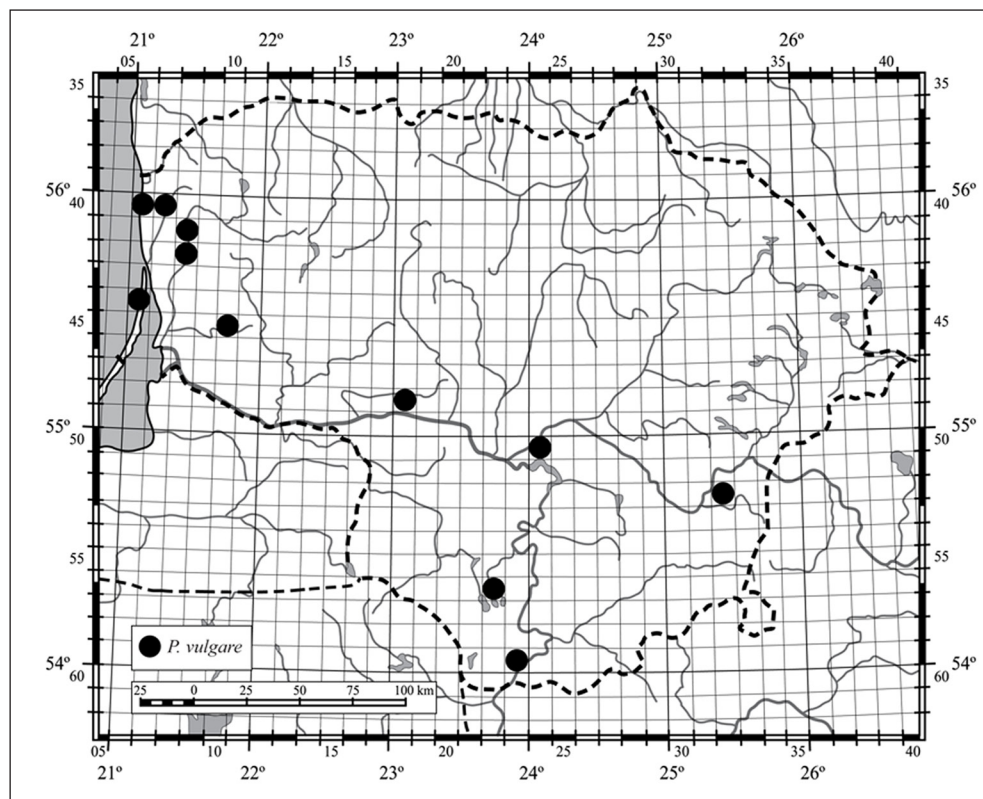


Fig. 1. Distribution of *P. vulgare* L. in Lithuania (according to Snarskis, 1954)

Unfortunately, Snarskis did not provide references of his information source. However, it is thought that probably the most important part of information had been derived from personal field notes (Snarskis was a very active investigator of Lithuanian flora) and herbarium material collected by other botanists. Snarskis reported 11 localities of *P. vulgare*: 6 of them were situated in western, 2 in central, 2 in southern, and 1 in eastern Lithuania. These results indicate that distribution of *P. vulgare* in Lithuania is irregular. This might be explained by the incomplete data on Lithuanian flora at that time, or irregular distribution of *P. vulgare* might be caused by its ecological preference to uplands in the main part of its range and epiphytic life-form. Snarskis (1954) named *P. vulgare* as a rare fern in Lithuania but did not recommend a protection status. In later works (Snarskis, 1968) he named *P. vulgare* as a fairly rare fern in Lithuania.

P. vulgare distribution according to A. Minkevičius

The second *P. vulgare* distribution map was made by A. Minkevičius in 1959 (original cartographic data represented on the grid-square map in Fig. 2). Minkevičius as well as Snarskis did not specify his information sources of the map. The floristic map of *P. vulgare* made by Minkevičius was published in *Lithuanian SSR Flora*, Volume I. Therefore, it might be assumed that Minkevičius mapped *P. vulgare* referring strictly to herbarium material. Minkevičius reported 15 localities of *P. vulgare*: 6 of them were situated in western, 4 in central, 2 in southern, 2 in eastern, and 1 in northern Lithuania. This second map was supplemented with two localities of *P. vulgare* that had not been mentioned by Snarskis: 1 in northern and 1 in eastern Lithuania. In addition, Minkevičius indicated more localities of *P. vulgare* in central Lithuania. Minkevičius did not investiga-

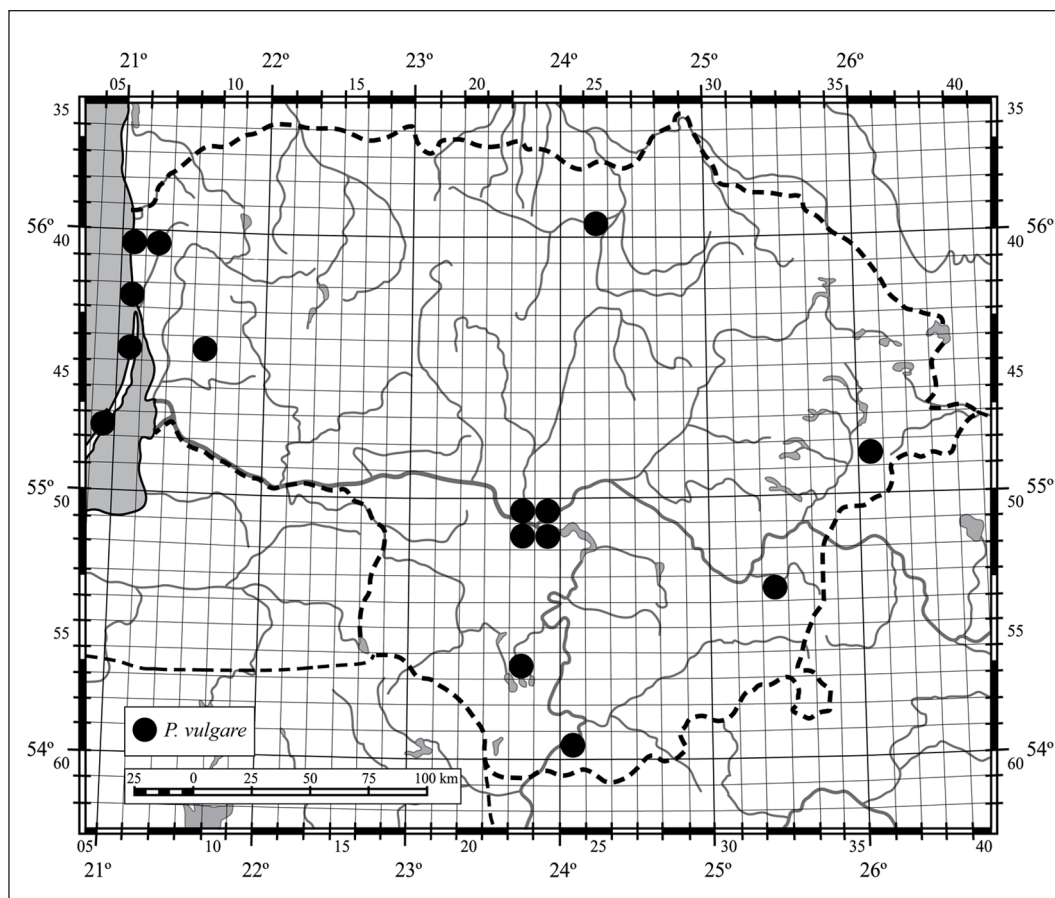


Fig. 2. Distribution of *P. vulgare* L. in Lithuania (according to Minkevičius, 1959)

te localities of *P. vulgare* on purpose. New reports about the distribution of this fern were evoked by intensified floristic studies in Lithuania in general as at that moment information on various plant species were being collected for the voluminous publication *Lithuanian SSR Flora*. It must be highlighted that some *P. vulgare* localities indicated by Snarskis in 1954 were not noted in the map made by Minkevičius in 1959.

***P. vulgare* distribution according to information based on herbarium material of herbaria and survey in protected areas of Lithuania**

In the present study the newest distribution map of *P. vulgare* (Fig. 3) based on herbarium material and results of a questionnaire survey is made.

Only 85 of 629 botanical squares are representing *P. vulgare* localities (that is 13.5% of the grid) in Lithuania. In this way, the number of botanical squares where *P. vulgare* is reported has increased 5.7 times since 1954. A significant increase in

P. vulgare localities compared to previous reports (Snarskis, 1954; Minkevičius, 1959) might be due to the following reasons: (1) a more comprehensive territorial investigation of Lithuanian flora on the whole; (2) the origin of new populations of this fern.

A more comprehensive investigation of Lithuanian flora (in comparison to the sixth decade of the 20th century) might be seen in the distribution of herbarium specimens of different dates in herbaria (Fig. 4). In all, 121 herbarium specimens of *P. vulgare* are stored in Lithuanian herbaria. They were collected most intensively in the 7th, 8th, and 10th decades of the 20th century. Throughout this period no *P. vulgare* distribution studies were carried on, all specimens were compiled during general floristic investigations. Therefore, an important information source for distribution of *P. vulgare* in Lithuania is believed to be reports of new populations of *P. vulgare* made by experts of protected areas in various places

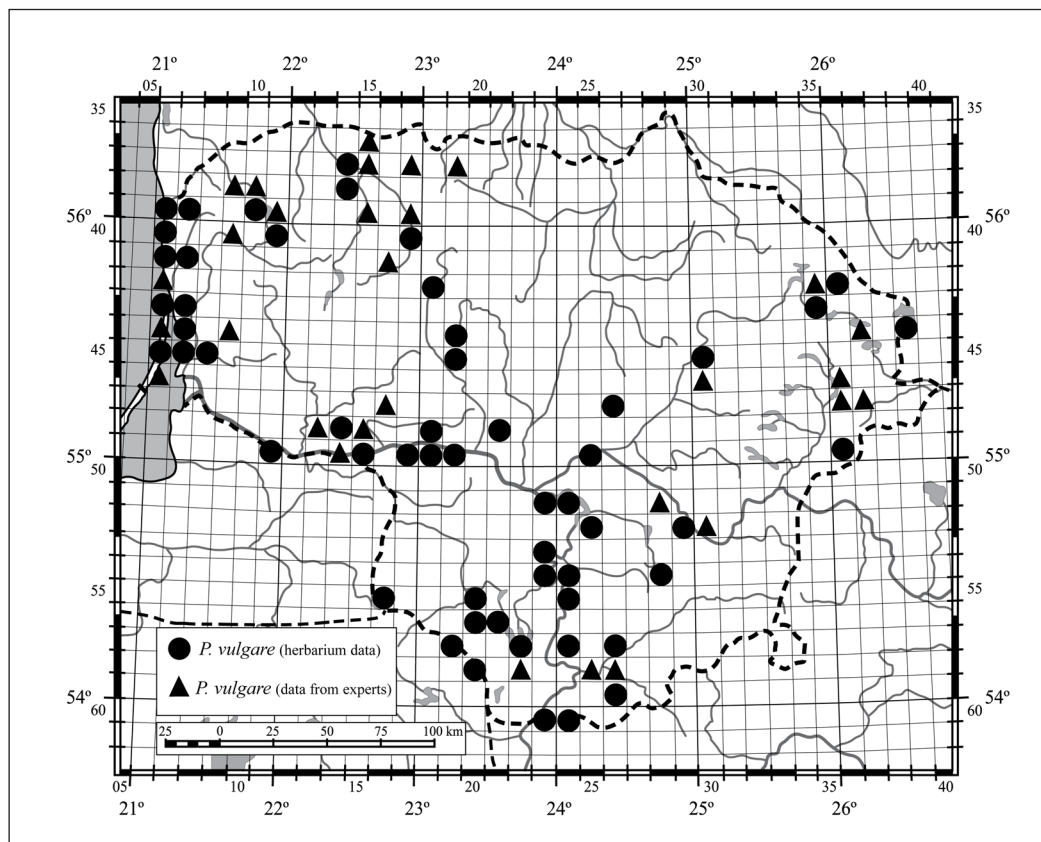


Fig. 3. Distribution of *P. vulgare* L. in Lithuania (according to WI, BILAS, HSUD, HUS, Lithuanian University of Educational Sciences Herbaria and information from specialists of protected areas)

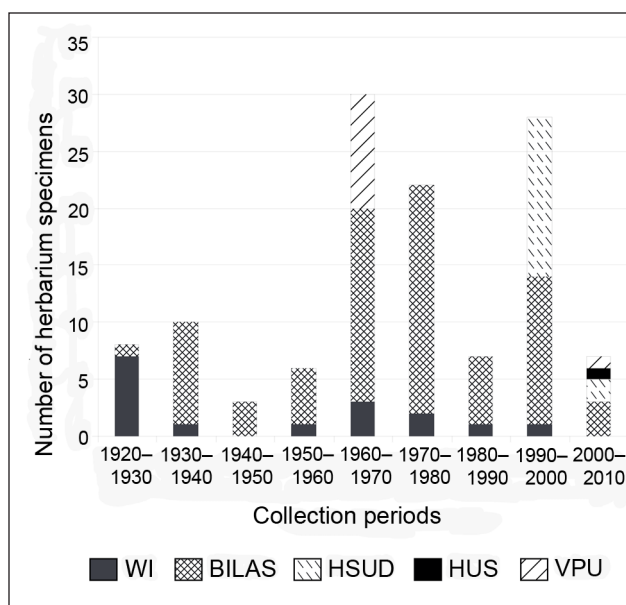


Fig. 4. Distribution of *P. vulgare* herbarium specimens of WI, BILAS, HSUD, HUS and Lithuanian University of Educational Sciences Herbaria according to the date of collection

in Lithuania, especially in northern and eastern parts of the country where herbarium material collected is the poorest.

Even though localities of *P. vulgare* have increased considerably in Lithuania, their distribution pattern – as first discovered by Snarskis

(Fig. 1) – proved to be irregular. Irregular distribution of *P. vulgare* is common to some territories of Eastern Europe (Darafjev, 1993; Tzveliov, 2000). In Lithuania the irregular distribution pattern of *P. vulgare* depends undoubtedly on climatic and edaphic conditions. A comparative analysis of *P. vulgare* distribution in geobotanical divisions of Lithuania (Table 2) showed that there are no registered populations of *P. vulgare* in Eastern Europe Province at all. Similarly, few localities (8.4% of all botanical squares) are found in the Northeastern Zone Belts of Baltic Subprovince of Central Europe Province. Taking all geobotanical divisions into account, the Western Subzone of Southern Belt of Northeastern Zone of Baltic Subprovince of the latter sector stands out: *P. vulgare* is the most common (28.6%) there in Lithuania. In Lithuania *P. vulgare* localities are statistically significantly associated to the Southern Belt of Northeastern Zone of Baltic Subprovince plus Dainava-Polesye Subprovince of Central Europe Province (Cramer's $V = 0.205$, $p = 0.0001$). However, since Cramer's V value can range from 0 (no association) to 1 (complete association), the value shows a small degree of association. This might be caused by two reasons: differences of botanical squares which are not reflected in the geobotanical division of Lithuania,

Table 2. General distribution of *P. vulgare* in the geobotanical divisions of Lithuania

The geobotanical division of Lithuania according to Natkevičaitė-Ivanauskienė et al. (2005)	Number of botanical squares	Number of botanical squares with presence of <i>P. vulgare</i>	Percentage of botanical squares with presence of <i>P. vulgare</i> , %
Provinces:			
Eastern Europe	30	0	0.0
Central Europe	599	85	14.2
Subprovinces of Central Europe Provinces :			
Baltic	543	73	13.4
Dainava-Polesye	56	12	21.4
Subsectors of Northeastern Sector of Baltic Subprovinces:			
Eastern	445	52	11.7
Western	98	21	21.4
Northeastern Zone Belts of Baltic Subprovince:			
Northern	345	29	8.4
Southern	198	44	22.2
Western Subzone of Southern Belt of Northeastern Zone of Baltic Subprovince	56	16	28.6
Lithuania	629	85	13.5

and incomplete records of *P. vulgare* localities in all 629 botanical squares of Lithuania. For further analysis a total of 32 botanical squares with presence-absence data were selected (that is 5.1% of all botanical squares in Lithuania). Botanical squares concerning *P. vulgare* localities were sampled and correspondence to the general distribution of this fern in Lithuania was estimated according to the data in Fig. 3. A strong positive association (Spearman's $r_s = 0.73$, $p = 0.047$) was found between patterns of *P. vulgare* distribution in different geobotanical divisions obtained from the data of two different sources: from all botanical squares and from botanical squares representing protected areas only (Table 3). Taking these results into consideration it might be assumed that the pattern of *P. vulgare* distribution in Lithuania slightly corresponds to certain geobotanical divisions. On the other hand, no statistically significant associations (Cramer's V test) were found in all levels of geobotanical divisions (provinces, subprovinces, sectors and zones) using only the data from botanical squares representing protected areas of Lithuania. Presumably, the number of the investigated botanical squares concerning the presence-absence data of *P. vulgare* localities was insufficient to determine the correspondence.

In future investigations and having more information about *P. vulgare* localities there should be made a more comprehensive analysis of *P. vulgare* preferences to geobotanical divisions in Lithuania.

Habitats of *P. vulgare* in Lithuania

The distribution of *P. vulgare* at a major extent depends on the diversity of suitable habitats and specific substrates. According to Lithuanian florists (Table 1) the most common habitats of *P. vulgare* are pine forests and mixed forests. This fern is frequently found in hill slopes of these habitats. It also shows preference to forested riversides or lakeshore slopes.

In all forests *P. vulgare* growth depends greatly on microclimatic conditions as the majority of populations are found not only on hill slopes but at the bases of trees or bushes, next to windfalls or boulders. Analysis of herbarium material rather than literature information showed a bigger diversity of *P. vulgare* habitats (Fig. 5). Analysis of *P. vulgare* habitats was based on 89 data labels of herbarium specimens (that is 73.6% of all herbarium specimens). The rest of 32 herbarium labels did not provide enough information for habitat identification. Analysis of herbarium material indicated that the majority of *P. vulgare* localities are found in pine forests, specifically on hill slopes.

Table 3. Distribution of *P. vulgare* in the geobotanical divisions of Lithuania, based on data from botanical squares representing only protected areas of Lithuania

The geobotanical division of Lithuania according to Natkevičaitė-Ivanauskienė et al. (2005)	Number of botanical squares from protected areas	Number of botanical squares with presence of <i>P. vulgare</i> from protected areas	Percentage of botanical squares with <i>P. vulgare</i> from protected areas, %
Provinces:			
Eastern Europe	0	0	0
Central Europe	32	13	40.6
Subprovinces of Central Europe			
Provinces:			
Baltic	28	11	39.3
Dainava-Polesye	4	2	50.0
Subsectors of Northeastern Sector of Baltic Subprovinces:			
Eastern	21	8	38.1
Western	7	3	42.9
Northeastern Zone Belts of Baltic Subprovince:			
Northern	20	9	45.0
Southern	8	4	50.0

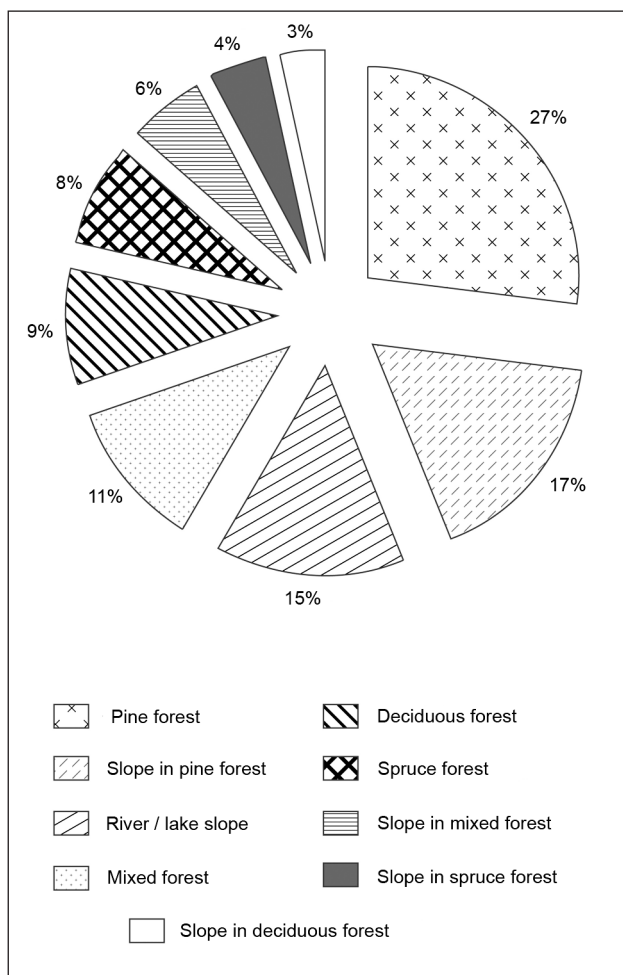


Fig. 5. The prevalence of *P. vulgare* in different habitats of Lithuania (based on 73.6% from herbaria data)

However, it is common for *P. vulgare* to grow in deciduous forests, such as oak, lime, hornbeam and black alder forests. Occasionally, *P. vulgare* is recorded on hilly slopes of spruce forests. Analysis of *P. vulgare* habitats also showed that this fern was rarely found on the slopes of mixed or deciduous forests. Yet this assumption requires verification as herbarium labels provide very superficial information for *P. vulgare* habitat characterization.

In Lithuania *P. vulgare* is usually an epigeic fern. This life-form is exclusive to Lithuania as in the uplands, where the main part of the fern range is, *P. vulgare* almost always grows as an epiphyte on tree trunks and branches or as an epilith on rocks (Johnson, 1921; Derzhavina, Shorina, 1992). From all 121 *P. vulgare* herbarium specimens only 13 (that is 10.7% of all herbarium specimens) were used for substrate analysis (Fig. 6). Substrate ana-

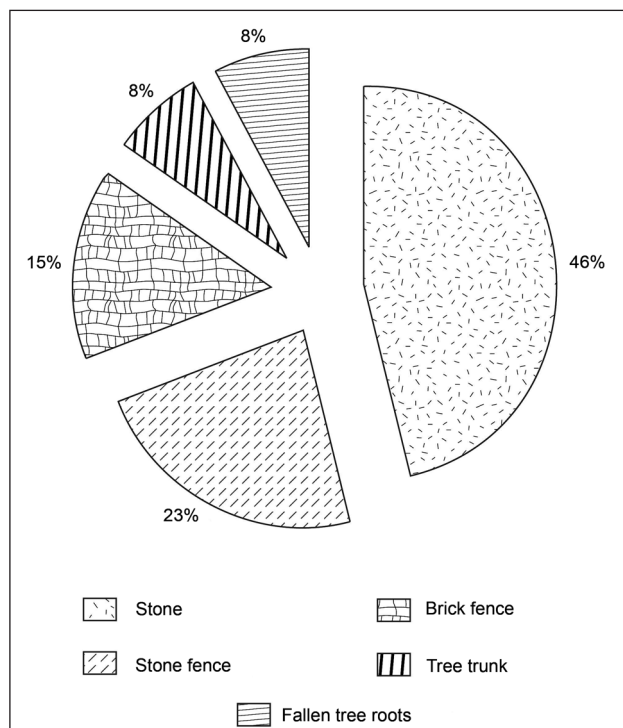


Fig. 6. The prevalence of *P. vulgare* in different not epigeic substrates of Lithuania (based on 10.7% from herbaria data)

lysis showed that in Lithuanian climatic conditions *P. vulgare* very rarely (1 herbarium specimen) grows as a facultative epiphyte on *Quercus robur* trunks. The fern also grows as an epiphyte on tree fall roots (1 herbarium specimen). More frequently (12 herbarium specimens) in Lithuanian conditions *P. vulgare* grows as a facultative epilith on mossy and soil covered stones. In Lithuania *P. vulgare* is also present on man-made substrates such as old stone walls in cemeteries (Fig. 6).

CONCLUSIONS

1. An analysis of herbarium material and survey information of protected areas showed that during the last 50 years the localities of *P. vulgare*, a rare or fairly rare evergreen fern in Lithuania, have increased significantly (approximately as much as 5.7 times). At the current time *P. vulgare* generally covers 13.5% of botanical squares in Lithuania.

2. *P. vulgare* growth in botanical squares concerning different geobotanical divisions of Lithuania varies from 0.0 to 28.6%. In Lithuania *P. vulgare* localities faintly correspond to the following

geobotanical divisions: Southern Belt of Northeastern Zone of Baltic Subprovince plus Dainava-Polesye Subprovince of Central Europe Province (Cramer's $V = 0.205$, $p = 0.0001$).

3. The majority of localities of this oceanic-suboceanic species, *P. vulgare*, are recorded in western, south-western and southern Lithuania.

4. In Lithuania *P. vulgare* is found in various habitats, usually on hilly slopes of dry light pine forests (44%). In all the habitats *P. vulgare* grows exclusively as an epigeic fern (89.3%). This life-form is not common in the main part of *P. vulgare* range as in uplands the fern is usually present as an epiphyte on tree trunks and branches or as an epilith on rocks.

ACKNOWLEDGEMENTS

The authors of this article are deeply grateful for information of *P. vulgare* localities in Lithuania to these experts of protected areas: A. Aliukonis (Labanoras Regional Park), J. Auglys (Krekenava Regional Park), A. Bagočienė (Salantai Regional Park), A. Čerkauskas (Gračutė Regional Park), R. Giedraitis (Panemunė Regional Park), R. Ginkus (Žagarė Regional Park), V. Greičius (Dubysa Regional Park), O. Grigaitė (Čepkeliai State Nature Reserve), V. Grigaliūnas (Kamanos State Nature Reserve), M. Jankauskienė (Žemaitija National Park), I. Jusienė (Sirvėta Regional Park), R. Kubilius (Nemunas Delta Regional Park), V. Leonavičius (Vištytis Regional Park), V. Lopeta (Kurtuvėnai Regional Park), D. Norkūnienė (Sartai Regional Park), L. Novikas (Varniai Regional Park), E. Paplauskis (Pajūris Regional Park), A. Pranaitis (Žuvintas Biosphere Reserve), Ž. Preikša (Nemuno Kilpos Regional Park), S. Pupininkas (Neris Regional Park), J. Radžiūnienė (Pavilniai and Verkiai Regional Parks), R. Rutkauskienė (Anykščiai Regional Park), G. Sidabrienė (Žemaitija National Park), Ž. Sinkevičius (Žuvintas Biosphere Reserve), B. Šablevičius (Aukštaitija National Park), A. Uselienė (Viešvilė Reserve), R. Vabuolas (Žuvintas Biosphere Reserve), J. Zarankaitė (Kuršių Nerija National Park).

Special thanks are to colleague Vilma Kuodytė for helping to translate this article into English, her support and encouragement.

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Received 3 October 2011

Accepted 16 December 2011

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herbariuminio pavyzdžio tik viename užfiksuotas ant *Quercus robur* kamieno augęs *P. vulgare*. Epifitinis šio paparčio augimas pasireiškia ir jo tarpsmu ant išvirtusių medžių šaknų. Pastaraisiais metais vis daugiau naujų šio paparčio populiacijų atsiranda ant dirbtinių substratų, ypač senų akmeninių tvorų ar mūrinių sienų.

Raktažodžiai: *Polypodium vulgare*, papartis, paplitimas, augavietės, Lietuva

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POLYPODIUM VULGARE L. PAPLITIMAS IR AUGAVIETĖS LIETUVOJE

Santrauka

Lietuvos herbariumuose (WI, BILAS, HSUD, HUS, KA ir Lietuvos edukologijos universiteto) esančių *P. vulgare* pavyzdžių analizė ir ekspertų specialių apklausų metu gauti saugomų teritorijų duomenys rodo, kad per pastaruosius 50 metų Lietuvoje reto arba apyreičio visžalio paparčio *Polypodium vulgare* radaviečių skaičius ženkliai padidėjo. Remiantis iš visų Lietuvos herbariumų ir saugomų teritorijų ekspertų surinkta informacija, buvo sudarytas naujausias *P. vulgare* paplitimo mūsų šalyje žemėlapis. Bendrasis šio paparčio radaviečių užimtumas Lietuvos botaniniuose kvadratuose dabar siekia 13,5 %. Įvairiuose Lietuvos geobotaniniuose padaliniuose *P. vulgare* botaninių kvadratų užimtumas varijuoja nuo 0,0 iki 26,8%. Toks *P. vulgare* radaviečių pasiskirstymas gali atspindėti būtinas šiam paparčiui ekologines sąlygas, tačiau gali būti nulemtas ir nevienodo mūsų šalies floristinio ištirimo atskiruose geobotaniniuose rajonuose. Daugiausia šios galimai ekologijos, botaniniu-geografiniu atžvilgiu kritinės rūšies radaviečių telkiasi Vidurio Europos Baltijos provincijos Šiaurės sektoriaus pietinėje juostoje ir Dainavos-Polesės provincijoje (Cramer $V = 0,205$, $p = 0,0001$). Išaiškinta stipri teigiama koreliacija (Spearman $r_s = 0,73$, $p = 0,047$) tarp *P. vulgare* paplitimo visuose botaniniuose kvadratuose ir kvadratuose su išskirtiniu šio paparčio radaviečių ištirimu (rezervatuose, nacionaliniuose ir regioniniuose parkuose). Galime teigti, jog *P. vulgare* paplitimas Lietuvoje nors ir silpnai, tačiau visgi siejasi su šio paparčio prieraišumu tam tikriems geobotaniniams padaliniams.

P. vulgare Lietuvoje tarpsta įvairiose augavietėse, tačiau dažniausiai pasitaiko sausų, šviesių pušynų šlaituose. Mūsų šalyje *P. vulgare* visose augavietėse su retomis išimtimis auga kaip epigėjinis papartis. Tokiu savo gyvenimo būdu mūsų šalyje *P. vulgare* labai skiriasi nuo šio paparčio elgsenos pagrindinėje savo arealo dalyje, kur kalnuotose vietovėse šis augalas beveik visada tarpstakaip epifitas ant medžių kamienų ir šakų arba kaip epilitas ant įvairaus statumo uolų (Johnson, 1921; Derzhavina, Shorina, 1986). Iš 121 ištirto